Local Flaps in Head and Neck Reconstruction

Second Edition

Ian T. Jackson
Local Flaps
in Head and Neck
Reconstruction
Important note: Medicine is an ever-changing science undergoing continual development. Research and clinical experience are continually expanding our knowledge, in particular our knowledge of proper treatment and drug therapy. Insofar as this book mentions any dosage or application, readers may rest assured that the authors, editors, and publishers have made every effort to ensure that such references are in accordance with the state of knowledge at the time of production of the book.

Nevertheless, this does not involve, imply, or express any guarantee or responsibility on the part of the publishers in respect to any dosage instructions and forms of applications stated in the book. Every user is requested to examine carefully the manufacturers’ leaflets accompanying each drug and to check, if necessary in consultation with a physician or specialist, whether the dosage schedules mentioned therein or the contraindications stated by the manufacturers differ from the statements made in the present book. Such examination is particularly important with drugs that are either rarely used or have been newly released on the market. Every dosage schedule or every form of application used is entirely at the user’s own risk and responsibility. The authors and publishers request every user to report to the publishers any discrepancies or inaccuracies noticed. If errors in this work are found after publication, errata will be posted at www.thieme.com on the product description page.

Some of the product names, patents, and registered designs referred to in this book are in fact registered trademarks or proprietary names even though specific reference to this fact is not always made in the text. Therefore, the appearance of a name without designation as proprietary is not to be construed as a representation by the publisher that it is in the public domain.
Why change a book that consistently sells well, even after 20 years? Despite the passage of time, this book is surprisingly current; the basic concepts and techniques originally described are as valid today as they were when this work was first published. Nevertheless, there are valid reasons for revising and updating, and these are twofold: time marches on, and knowledge expands. So this new edition represents the culmination of years of experience devoted to finding reconstructive solutions for problems both simple and complex. This has always been a fascinating endeavor for me, not only because of the challenge of putting the pieces of a puzzle back together, but because of the truly transforming nature of head and neck surgery on the patients we treat. It is my hope to convey some of this enthusiasm in this new edition and to reflect on the lessons I have learned over the years in confronting and solving these problems.

What is new in this edition? The most dramatic change is in the addition of color throughout, which increases the impact of the medical illustrations and photographs and provides a three-dimensional perspective that contributes to a better understanding of many of the repairs that are described. Another important addition is the summary tables that conclude each of the chapters focusing on reconstruction of a specific anatomic area. These provide insight into the rationale and decision-making process involved when choosing the best flap option for a specific reconstructive problem. Some of the more distant local head and neck flaps have also been added for completeness. There are also numerous new cases with detailed operative sequences describing the design and elevation of these flaps. Additionally, I have included annotated references to promote further reading on this topic.

The most significant additions to this book are two new chapters: one on tissue expansion and the other on problems and complications. Tissue expansion is a significant tool for the reconstructive surgeon and is particularly important in head and neck reconstruction, where skin quality, texture, and color have a major impact on the final aesthetic result. This technique represents a tremendous advance in facial resurfacing, because it provides local skin and subcutaneous tissue for reconstruction. No longer are we unable to perform our preferred reconstruction because of skin insufficiency; we simply expand the chosen skin area to the size required to perform the reconstruction. Because the skin is frequently thin and supple, this brings a degree of ease to our reconstructive efforts. Tissue expansion has made a significant
contribution to advancing the use of local flaps in head and neck reconstruction. This chapter fully explores the range of expansion applications in the head and neck, as well as my personal approach to using exterior ports, with patients or their parents performing the expansion for a quicker and less costly approach to the expansion process.

The chapter devoted to problems and complications covers the range of common situations encountered during head and neck reconstruction, discusses why these problems occur, and offers practical solutions for addressing complications should they occur. Also covered in this chapter are a number of tricks and innovations that have proved helpful in the head and neck area and elsewhere, such as the use of scarlet red (an amazing healing material) in epithelialization and wound healing, the treatment of cocaine fistulas, and the repair of split earlobes.

In planning this edition, I seriously contemplated adding a section on free flaps. These are extremely useful in large head and neck reconstructions, particularly when compared with the staged techniques of the past. As true reconstructions, they leave much to be desired, but this is improving as we become more sophisticated in their design. They can be used to close a defect, but the skin color and texture may not be satisfactory. In addition to this, their bulk requires later modification. After considerable thought and consultation with colleagues, I decided not to include microsurgical flaps in this new edition. There were a number of reasons. Most compelling was my desire to appeal to the broadest possible audience, recognizing that there are many surgeons who do not perform microsurgical procedures. Local flaps are of interest to residents and experienced surgeons alike, regardless of whether they perform free flaps. Local flaps are also the basic foundation of reconstructive surgery, and knowledge of them is essential when closing any defect, however small. Nevertheless, I am also aware of the substantial interest in this subject by young surgeons in training, those entering practice, and others who are more experienced. To address that interest, further information on microsurgery in head and neck reconstruction will be forthcoming in a second companion volume edited by Drs. Peter C. Neligan and Fu-Chan Wei, scheduled for publication next year.

Writing a book is enormously time consuming, representing time away from family and practice. There are never enough hours in the day. So why do it? For me, the answer is obvious: it is an educational opportunity and a chance to convey lessons learned from many years of experience. My hope is that this new edition will prove as helpful as the previous one to plastic surgeons and others who perform facial surgery.
Acknowledgments

It remains for me to thank my wife, Marjorie, who is my office manager and my lifetime partner; she has prodded, cajoled, encouraged, and supported me throughout the entire writing process. Susan, Marjorie’s assistant and our daughter, took on much of Marjorie’s work to allow more time for the book, and we are both very grateful for this. Gretchen Hoffman has also contributed enormously to this endeavor. She has transcribed manuscripts and typed and retyped chapters; it has been especially hard for her, since during the time she was absent last year looking after her new baby boy, a tremendous amount of work piled up. Even with all the catch-up of daily work, she powered on and kept my nose to the grindstone! I am truly appreciative of the speed with which she accomplished all this. Without her hard work we could never have met the deadlines Karen set for us, and I thank her most sincerely. Our sincere thanks also go to our photographers, Lynn and Ken Eads, who have devoted many hours to finding the cases for this book and to ensuring that they were of top quality. They have made many aspects of this project possible. Without them the book would not have come to pass. My operating room nurses have had to accept stoppages for photographs and have been very gracious about this. I have also to thank Ibrahim Canter, my Clinical Fellow from Turkey, who put together the summary tables.

I thank Karen Berger’s staff, particularly Amy Debrecht and Julie Dill, for all the help and encouragement they have given me throughout the process of putting this book together. Amanda Behr, QMP’s talented Director of Medical Illustration, is a most gracious young woman, and she has accomplished an amazing amount of artwork extremely quickly, efficiently, and with a minimum amount of disturbance to me. Her work is beautiful, and I thank her most sincerely. I am indebted to all the QMP professionals who have worked tirelessly to make this book happen.

I appreciate greatly that my office staff have been so very patient and supportive during all these months and in so doing have contributed greatly to this project; my thanks go to them. Without this very supportive collection of family and colleagues, I would not have faced up to the challenge of a second edition. They were my inspiration.
Last, I have found the best publishing company in the world. I want to thank my good friend, Karen Berger, and her husband, Phil. Phil has given Karen the freedom to be the amazing force she has been in accomplishing the formation of this second edition of the book, and my sincere thanks to him for this. Professionally Karen is brilliant: she is tenacious but gracious, she is demanding but supportive, she is relentless but encouraging, and sometimes even a little terrifying! Truly, she is a warm and wonderful friend, and that our friendship has survived through all of this is a significant comment on the depth of that friendship. I thank her most sincerely.

Ian T. Jackson
Contents

1  General Considerations  1
2  Patient Management  33
3  Forehead Reconstruction  47
4  Nose Reconstruction  101
5  Cheek Reconstruction  241
6  Ear Reconstruction  313
7  Eyelid and Canthal Region Reconstruction  347
8  Lip Reconstruction  429
9  Tissue Expansion  533
10 Problems and Complications  569

Index  599
Local Flaps
in Head and Neck
Reconstruction
The face has long been heralded by poets and artists alike as a symbol of beauty, wisdom, and character. It is the canvas on which our expressions are painted and where the first signs of aging appear. Because of its visibility, the face presents a special challenge to the reconstructive surgeon; scars or imperfections are difficult to camouflage, may be obvious to others, and are distressing to the affected individual. A surgeon reconstructing facial defects must employ considerable skill and finesse, because the cosmetic result will have physical and psychological implications for the patient. The surgeon’s goal is to avoid unsightly scars while using the simplest, most effective reconstructive approach.
Advantages of Local Flaps

Local flaps of tissue obtained from the area surrounding the defect provide an ideal solution for the problems encountered in facial reconstruction. With these flaps, the skin used for reconstruction is likely to be similar in color and texture to the skin at the site of the defect. In addition, most minor procedures can be performed on an outpatient basis under local anesthesia, and secondary defects can frequently be closed directly.

It can be argued that skin grafts are just as effective as local flaps and are easier to perform. In fact, full-thickness skin grafts from the retroauricular area and the upper eyelids are satisfactory for use on the eyelids and medial canthal areas. Nasolabial skin also has been used as a free full-thickness graft for the nose. Unfortunately, however, grafts do not have a 100% survival rate. They often become paler or more pigmented than the surrounding skin. Occasionally the graft becomes pinker, and the suture line surrounding the graft may be somewhat obvious and raised in some cases.

The theory that skin cancer is best treated by excision, skin grafting, and observation is fallacious, because it ignores the possibility that excision of the tumor may be incomplete. There may be a limited resection in depth to maintain a vascular layer that will accommodate a skin graft. This is a frequent occurrence in the medial canthal area and has dire consequences for the patient. To ensure total resection, it is better for the surgeon to perform radical excision down to and including bone, if necessary, and then reconstruct with a local flap. In full-thickness defects of the nose, lips, eyelids, and ear, flap reconstruction is imperative.

The specimen submitted should be tagged to provide orientation for the pathologist. This enables him or her to give an accurate report as to the position of any residual lesion. If there is any doubt about the completeness of excision, either before or during surgery, a frozen section is obtained. If the pathologist reports “incomplete excision” and indicates where this is, a further excision is performed; if necessary, this is carried out until the tumor is completely removed.

Functionally, flaps are much better than grafts, because little or no scar contracture occurs. Thus ectropion, epiphora, and loss of oral competence are prevented. A flap provides an additional blood supply, which is important in lower lip reconstruction where the tongue flap is used and in cases involving previous radiation therapy (see Chapter 8).

A surgeon who is experienced in the use of local flaps and plans the procedure carefully almost always succeeds with this type of surgery. Not only do local flaps provide better oncologic and functional results; they also offer the best aesthetic solution for the patient because the skin chosen is the correct color and texture.
**Disadvantages of Skin Flaps**

The greatest drawback to the use of skin flaps is that they require planning and experience. If the flap is not planned properly, functional problems can occur, such as ectropion and nasal obstruction. If functional complications occur, concurrent aesthetic complications frequently will result from scarring and distortion. In addition, skin of the wrong color and texture may be used, hair-bearing skin may be moved into an area where hair is not normally present, or the flap may be too thick and bulky. When designing a flap, the surgeon should ensure that it is the same size and thickness as the defect to be reconstructed. The patient’s age will factor into the availability of tissue and the aesthetic repercussions of scarring and rearranged local anatomy (for a detailed discussion of patient considerations in planning local flaps, see Chapter 2).

When a flap fails, an area of tissue availability has been exhausted and the surgeon must then use the less desirable skin graft. Because the graft is then a secondary reconstruction, more scarring and more functional and aesthetic deformity will result. This consequence further supports the need for close study of the design and use of skin flaps (for more information on complications, see Chapter 10). In this situation, tissue expansion is an effective solution to this particular problem.

**General Principles**

To use local flaps effectively, the plastic surgeon needs more than a simple understanding of the different techniques available for moving tissue. He or she must first understand some of the general principles governing the use of local flaps. Knowledge of geometry, skin biomechanics, and facial anatomy must be combined with a sense of aesthetics and an appreciation for shape, symmetry, and color. After identifying the areas of tissue availability and examining the defect, the surgeon needs information on the general and specific types of skin flaps, the principles by which these flaps are moved, and the advantages, disadvantages, and complications associated with these flaps. Finally, the surgeon must consider all this information and carefully plan the appropriate approach for each individual patient to achieve the best aesthetic result.
SKIN BIOMECHANICS

Fundamental knowledge about the basic characteristics of skin is necessary in almost every surgical maneuver involving closure of a skin defect or tightening of skin. Extension of skin is a mechanical property that is time dependent; continuing tension produces ongoing lengthening to a point. As skin stretches, because of increased load or force, a contraction occurs at right angles to the line of extension. Many materials, such as elastic, become narrower as they are stretched. In vivo this further increases the vascular compromise that results from the original stretching. It has been noted in vitro that the volume of the skin decreases with stretching (that is, it becomes thinner), probably because of fluid extruding from its undersurface.

A graph of the in vitro extension curve shows great initial stretch with a small load. The upward sweep indicates that a small increase is obtained with rapidly increasing load, and the vertical part illustrates that after a certain amount of extension the skin will not stretch any further, no matter how much the load increases. In the clinical situation, a balance between stretching and vascularity must be achieved. When the skin has been stretched beyond safe limits, circulation is likely to be compromised, with blanching and eventual distal necrosis of the flap tissue. Thus, to effectively plan surgery, the surgeon must understand two main characteristics of skin biomechanics: stress relaxation and creep.
Stress Relaxation and Creep

If a constant loading or stretching force is applied to any material, it will exhibit stress relaxation or creep. Stress relaxation occurs when a constant load applied to skin causes it to stretch. With time, the load required to maintain the skin in its stretched position decreases. Creep occurs when a sudden load applied to skin is kept constant. The amount of extension increases with the passage of time. Stress relaxation and creep are termed the viscoelastic properties of skin. The extent to which these phenomena occur depends on the size of the load applied and other factors, such as the extrusion of fluid from the skin framework, the stretching and subsequent compacting of the framework fibers, and the viscoelastic behavior of the collagen bundles.

What is the practical value of this phenomenon? In many situations it is necessary for surgeons to use their knowledge of stress relaxation and creep; otherwise they would be unable to close many defects. Because the skin stretches, skin flaps can be taken and placed into larger defects without a resulting skin shortage or tightness. For example, in the case of a scalp flap that is too tight, if one pulls on the flap as hard and as steadily as possible for 5 to 10 minutes, stress relaxation and creep come into play, and the skin stretches and produces a closure under normal tension. The intrinsic viscoelastic qualities of skin may be the redeeming feature for many flaps, allowing the flap to fill a defect that is larger than the actual flap area. The tight suture line actually causes the flap to lengthen, and so the flap changes from white to pink, which is a positive sign.

An obvious antagonistic relationship exists between tension and vascularity, and the surgeon must judge the appropriate amount of extension the skin will permit before its blood supply is compromised. No measurements or theories can substitute for sound clinical judgment. For some surgeons, such judgment is second nature; for others, it comes by experience. However, this helpful aphorism should be imprinted indelibly in the mind of every plastic surgeon: “On the face, white flaps are safe flaps; they become pink.”

Tissue expanders, which are used to supply local skin for large defects, rely primarily on the biomechanical phenomena outlined above.
Planning the Surgical Approach

Areas of Tissue Availability

For effective use of local facial flaps, excess facial skin must be available. The regions containing this extra skin, called areas of tissue availability, need to be inspected carefully during the planning stages.

As a person ages, the amount of skin present in these areas (except for the lips) becomes more plentiful, and aging lines or wrinkles appear. In biomechanics these are referred to as lines of minimal relaxed tension—that is, the skin tension is least at right angles to these lines, and thus in this direction there is loose skin available for reconstruction. Fortunately, skin cancer usually appears in older patients; because skin stretchability increases with age, more skin is available for reconstructing the defects left from tumor excision in these patients. Reconstruction of skin defects in the young is more challenging because of the reduced amount of donor tissue available.
SKIN RECRUITMENT

Skin stretching by suture skin recruitment requires judgment and multiple sutures.

EXAMINATION OF THE DEFECT AND DONOR AREA

Placement of Incisions

The area of the proposed defect should be inspected to determine the best position for flap placement. Incision lines for the flap and donor area should fall into the lines of minimal relaxed tension. In this way the scars will heal effectively because they will have a minimal transverse force on them. In addition, if incisions are placed in this position, they will lie on the aging lines of the face and will be as inconspicuous as possible.
In cases where a rotation flap has been used without a back cut, the wound has a short inner edge and a longer outer edge. The excess of outer skin becomes a “dog-ear” that is excised away from the flap. In this way there is no compromise of the flap base. The rotation flap works very well on convexities such as the malar area or the scalp.

**Methods of Skin Movement: General Principles**

**ROTATION**

In this classic rotation method the surgeon triangulates the defect, making the shortest side the base of the triangle. The base then forms a portion of the circumference of a circle, and a flap is constructed so that its leading tip will rotate around the circumference of the circle on which the triangular defect lies. In effect, the base of the flap is the radius of the large circle. When the flap is elevated, it can be rotated to close the defect. In situations where sufficient flap rotation is not possible, because of local circumstances such as skin tension or contour problems, a back cut is necessary. With a back cut, an incision is made toward the center of the circle; this allows a defect to open and makes further rotation possible. Usually the back cut is closed directly.

The skin surrounding the area to be reconstructed is also carefully examined. In the early planning stage, the requirements for skin type and quantity are determined. Donor skin, which should be approximately the color and texture of the recipient area, must be of sufficient quantity to reconstruct the total surface contour.
To plan a transposition or rotation flap, a sponge, tape, or piece of gauze is a convenient method for mimicking the flap and its pattern of rotation. The sponge is stabilized at the base or origin of the proposed flap and held under tension at the leading edge of the proposed flap to simulate its rotation or transposition. The excision margins of the tumor have already been marked out and the flap is designed to cover the defect. The sponge is either transposed or rotated and the flap is drawn accordingly. This planning method can work for either mode of transfer and will indicate whether the leading edge is long enough to close the defect.
If the trial of rotation reveals that the flap will not close the defect without undue tension, the maneuver illustrated here should be used. The circumference of the rotation flap is moved out from \( b \) to \( b' \), thus lengthening the leading edge of the flap. On rotation, the defect is now closed comfortably. A small portion of skin may need to be excised from the outer edge of the defect to allow the flap to be inset in a more satisfactory fashion.

In a rotation flap, the line of maximal tension (LMT) extends from the pivot point of the flap to where the edge of the defect nearest to the flap previously lay. If there is undue tension along this line, the area of the flap covering the defect will become ischemic and may not survive. Much of the movement of a rotation flap and of a transposition flap that follows is not consistent with mathematic analysis because of the biomechanical features of skin stretching described earlier.
The anatomy of the area must also be taken into consideration.

**TRANSPOSITION**

It is difficult to differentiate between rotation flaps and transposition flaps because they share certain characteristics of skin movement. The required flap movement may be small when the defect is immediately adjacent, or it may be taken farther around the circle of which the flap diagonal is the radius. The maximal possible transposition of the flap is 90 degrees from its original position.
When the flap is transposed over a larger distance (for example, 90 degrees), there is an interpositional area of intact skin; it is usually possible to close all areas primarily. It may be necessary to trim the flap a little to obtain an exact fit into the defect. At the upper end of the donor site defect, a triangle of skin will be excised to facilitate direct closure.

It is important to have assessed whether the donor site can be closed before the flap is moved.
ADVANCEMENT

Although there are various types of advancement, the basic procedure is the same. As the name implies, this method of tissue movement involves sliding tissue forward for defect closure or for augmentation (for example, to eliminate a notch in the lip margin after trauma or cleft repair). The simplest type of movement is the V-Y advancement.

The skin is lifted as a V, moved forward, with direct closure of the posterior defect; thus a Y-shaped suture line is formed. The skin to be advanced can be converted into a triangular island flap that can be used to close a rectangular defect lying in front of the triangle. (For more information, see Chapter 5.) The extra movement is obtained as a result of the vertical subcutaneous pedicle lying below the island of skin. This pedicle provides the blood supply to the flap.
Another type of advancement flap is the direct type used for coverage of square defects. One of the sides of the square is chosen for donor tissue because of tissue availability, and a rectangular flap is drawn. This flap is elevated to its base and advanced. In some situations, this is all that is necessary.

In others, excess skin appears laterally as Burow’s triangles. These triangles are excised lateral and anterior to the flap base.

Advancement flaps are very safe and probably underused.

**Island Technique**

Island flaps are of two types, depending on the flap blood supply. In one type the base is subcutaneous tissue without definite blood vessels. Of necessity, the flap pedicle is short and the arc of rotation is therefore limited. In the second type there is a definite vascular pedicle (for example, temporal vessels); thus the pedicle can be considerably longer and the arc of rotation more extensive.

The tumor is excised and a defect is created. The surgeon then designs and marks the island, making sure that its arc of rotation allows it to move in such a way as to close the defect. If the flap has a subcutaneous pedicle, the pedicle is dissected out from under the skin and elevated from the underlying fascia.

To be absolutely sure of survival, especially when small island flaps are being moved over long distances, it is advisable that the Doppler device be used to identify the presence of a pedicle for the flap. When the soft tissue pedicle is short, this is not as necessary; the supply in the subcutaneous pedicle seems sufficient. This is a very versatile technique for the transfer of small amounts of tissue.
A tunnel is then made from the defect to the pedicle base.

The island flap is transposed through the tunnel and into the defect.

In a flap with a true vascular pedicle the vessels may be dissected out, allowing great facility of movement. The arc of rotation may be 180 degrees.

A particular variety of island flap, alluded to under advancement flaps, has a subcutaneous pedicle lying directly under the flap. It is extremely safe, but movement is limited to advancement. There is no arc of rotation (see p. 14).
In planning island flaps, the surgeon should not make the flap pedicle too long without a definite vessel because ischemia may occur. It is also important to create an adequately large tunnel to avoid constriction of the pedicle as a result of postoperative swelling. Such constriction may result in ischemia and necrosis of the flap.

Because this is a circular flap, there is always the possibility of “trapdooring” or “pin-cushioning” with a subsequently poor result. This situation can be extremely difficult to correct (see Chapter 10).

**Specific Types of Local Flaps**

Having discussed the various methods of skin movement, it is important to examine how these principles are incorporated into and modified in the commonly used local flaps.

**Rhomboid (Limberg) Flap**

This flap was introduced by Limberg in 1946, and further developed by him and others (see References, p. 32). The rhomboid flap is an interesting procedure for skin movement in which a rhomboid defect is created and then closed with a rhomboid-shaped flap of similar size. To learn about this flap and how to use it is an excellent introduction to the concept of geometric flaps and how they aid in planning of flap excision and subsequent reconstruction.

The lesion is excised as a rhomboid. The orientation is such that the 120-degree angle of the rhomboid is placed where the excess of skin lies, the position of which is judged by pinching the skin between the thumb and forefinger. This excess will form the rhomboid flap. An additional consideration is the position of the donor defect; it should lie, if possible, in the long axis of a line of minimal tension. Its closure should not distort local anatomic features such as the hairline or the eyebrow.

In designing a rhomboid flap, the surgeon draws a line from the outer point of the 120-degree angle; this line bisects the angle, with its length being equal to that of the side of the rhomboid. From the outer point of this line, another line is drawn at 60 degrees parallel to the side of the rhomboid defect. Its length again equals that of the side of the rhomboid. Before any incisions are made, a further check of skin availability is made with the thumb and forefinger. This can be done in any area where tissue is required and available.
This can be assessed by pinching the skin and noting the resulting deformity. This checking procedure ensures that the donor defect will close. If it will not, the original rhomboid may be changed in position or another donor flap can be used.

As depicted in A, four potential flaps can be designed for each rhomboid. Using the principles outlined here, the surgeon chooses the most convenient one. The excision is completed and the donor flap is elevated (B). As with the Z-plasty, this elevation should extend slightly beyond the base of the flap (C). The flap is now transposed into the postexcisional defect which is usually closed without difficulty. The angles of the flap are fixed by three-point sutures. D. The donor site is closed directly. With good planning little or no trimming of the flap is necessary. If the facial contours are irregular, the flap may not fit exactly and more extensive modification will be required.
Double Rhomboid

The rhomboid principle can be extended for closing long defects, which are made into parallelograms by placing two rhomboids end to end. It is possible to plan four available rhomboids on the 120-degree angles. The rhomboid flaps are chosen according to the requirements of the local situation.

In the arrangement at the top of the page, the use of the flaps is somewhat uncommon. The arrangement illustrated below is the one more frequently used. The rhomboid flaps are virtually diametrically opposed to one another. This seems most convenient in the majority of situations.
Chapter 1  General Considerations

Triple Rhomboid

A large circular defect can be converted into a hexagon, and the hexagon in turn can be broken up into three rhomboids. Rhomboid flaps can be planned on the 120-degree angle, and thus six potential flaps are available. The three flaps are chosen as is convenient.

One interesting feature of the rhomboid flap is its lack of pincushioning or “trap-dooring,” a common occurrence with circular flaps. The contraction of the circular scar line causes bunching of the flap tissue and a resulting contour defect. In contrast to the circular flap, the rhomboid flap possesses straight lines and angles. It is probably this combination that prevents scar contracture from having the same effect as in a circular flap. This fact should be taken into consideration in making the choice between one method or the other. Many other factors influence such a decision, including the excessive incision lines and consequent scars resulting from raising the rhomboid, and the area and amount of tissue availability also need to be considered. It is interesting to note in the geometric, straight-lined flaps that hypertrophic scarring or pincushioning is rarely seen.
DUFOURMENTEL FLAP  
(LAMBEAU EN L POUR LOSANGE, THE “LLL” FLAP)

The Dufourmentel flap technique, described by Dufourmentel in 1962, is a modification of the rhomboid flap. Although the originator did not give specific angle values, it is best to consider the narrow angle to be approximately 30 degrees and the wide angle to be approximately 150 degrees. The diagonals are drawn into the figure. On the wide angle, the short diagonal and one side are extended outward. The angle formed by these is bisected by a line that equals a side length. From the outer end of this line, to form an acute angle, the surgeon should draw another line of equal length parallel with the long diagonal. In this way the donor flap is fashioned.

This somewhat complex rhomboid type of flap undoubtedly provides more tissue to close the defect than is absolutely necessary; thus the closure of the donor defect may be slightly easier, facilitated by an actual mobilization of flap dce. Closure has then been achieved by means of an unequal Z-plasty. Thus in certain specific instances, when a rhomboid flap may give difficulty in donor site closure, and with proper experience, this technique may be chosen. As with the standard rhomboid flap, four potential donor flaps are available.
These two photographs demonstrate that it is possible to use one of two flaps for coverage after excision of a basal cell carcinoma of the right nasolabial fold. One chooses the flap from the area for several reasons. First, the tissue must be available. Second, the scar should lie in as ideal a position as possible, and it is important that a true rhomboid be made.
Single Rhomboid

In these photographs, it can be seen how this flap is fashioned. The lesion is excised and the donor flap is transposed into the nasolabial defect. The flap donor site is then closed directly. The alignment of the flap position is not ideal, but the end result should be satisfactory.
Double Rhomboid

In this case the resection is planned in a double rhomboid form. Double rhomboids are designed for closure. The basal cell carcinoma is excised and the defect closed with the rhomboid flaps. The donor sites are closed directly. The long-term result is satisfactory.

For the vast majority of situations and surgeons, it is advised that the standard rhomboid flap be used. It is simpler to design and less likely to cause problems.
The bilobed flap was first described by Esser in 1918 for use in nasal tip defect reconstruction. Zimany showed how the principles for this procedure could be applied to many areas of reconstruction. McGregor and Soutar expanded the understanding of choosing the area in which to use the bilobed flap. They have explained the geometry in a clear fashion and have shown where this type of flap can be used to best advantage. In facial reconstruction the bilobed flap is most useful on the nose. This flap is basically a rotation flap that “spreads the load,” masquerading as two transposition flaps. The planned defect is outlined, and two flaps are drawn, each slightly smaller than the other in transverse dimensions. The width of flap 1 is slightly less than the diameter of the defect, and that of flap 2 is correspondingly less than flap 1.

The flaps are fashioned so that they are in effect the radius of a circle on whose edge the outer rim of the defect lies (A). Each flap may rotate 90 degrees or less (B). The flaps must be elevated to their bases and beyond to achieve good movement (C). The secondary defect of flap 2 should be capable of comfortable direct closure (D). It may be necessary to trim the ends of the flaps and the dog-ears resulting from the rotation.

What has been achieved is transfer of available tissue around the arc of the circle. To assess the feasibility of the flap, the surgeon must test tissue availability along the circumference of the circle of rotation to determine whether the tissue excess can be translated through 180 degrees or less. Because these are rounded flaps, there is a potential for pincushioning as the scars heal and contract. In addition, the area of scarring is extensive.

Despite this, the technique is very useful, especially for the nasal region, where the looseness of the bridge area is translated to a defect in the more fixed nasal tip.
Crescentic Advancement Flap

A crescentic advancement flap was first used for lip reconstruction by Webster. It had been described by others in the past but in a less sophisticated way. The principle involved in this type of flap is ideally suited to the perialar and upper lip regions of the face. The technique is ingenious and, like all good methods, intrinsically simple.

The tumor is resected, and a triangular defect is left (A). An ellipse of skin is excised vertically above one end of the base of the triangle. This ellipse is fashioned so that its outer edge, $ab'$, is of a greater length than $ab$. It may equal or be slightly less than the combined length of the inner edge of the ellipse and the base of the triangle $cd$ (B). The flap $ab'c$, is undermined widely and advanced until complete closure is obtained without tension (C and D).

The scars can be fitted into convenient areas, for example, the perialar region when this flap is used in upper lip reconstruction.
Z-plasty, although not discussed at great length in the remainder of this book, should be considered because it introduces the concept of a strict mathematical approach to a skin problem. It can be used in conjunction with some flaps to improve cosmesis or flap movement. The basic principle of the Z-plasty, initially described by Horner in 1837, is to transfer a lateral skin excess transversely to lengthen the area along the line of the wound or a tight scar. This increase in length will prevent contracture and resulting contour deformities. It will also allow the subsequent scar to conform to surface irregularities such as convexities and concavities. The method of achieving this result is what makes the procedure fascinating.

When planning flaps, the surgeon should consider where the transverse limb of the new Z-plasty will lie. According to the trigonometric studies of McGregor, as the angle of the Z opens up, the amount of lengthening increases. In theory, an increase in length occurs as the Z-plasty angle increases up to 130 degrees; however, angles much greater than 60 degrees are not a practical proposition; thus this value is chosen in relation to the clinical situation. In some situations multiple Z-plasties will be used for long contractures; in these a series of 60-degree angles is most convenient. Sometimes unequal Z-plasties may be employed.
A few technical tips can make the performance of the Z-plasty somewhat easier. Forecasting where the transverse limb will lie is done by drawing its projected position across the scar to be revised and the flaps are then outlined to establish their correct position.

By curving the Z flaps, the surgeon can include extra tissue in the flap base and may augment flap vascularity, which can be important in heavily scarred or irradiated areas. The extra tissue may lead to a standing cone midway along the transverse limb. On the face this excess of skin should be trimmed. The flaps should be fully elevated, probably to slightly beyond their bases, allowing for ease of rotation. The tip of the Z-plasty should be stabilized initially with the Gillies three-point suture. If planning has been accurate, little or no trimming will be required.
Four-Flap Z-Plasty

To obtain maximal lengthening, a four-flap Z-plasty, first described by Berger in 1904, may be used. In significantly scarred contracted areas this technique will bring unscarred skin into the central Z area. This is helpful in preventing further heavy scarring and contracture.

W-Plasty

For the sake of completeness, the W-plasty technique is included here. The concept, introduced by Borges in 1959, produces a zigzag scar in a simpler way than by using a multiple Z-plasty. The main function of the W-plasty is in scar revision, and it is particularly useful in the forehead and cheek. There is probably a slight lengthening potential with this technique. Undoubtedly, W flaps are also used to some degree in preventing scar contracture. A further advantage of the W-plasty is the simplicity of its planning.
By using the back cut, the surgeon extends flap movement in rotation and transposition flaps. The cut is made gradually until the length required to produce adequate movement at the end of the flap is obtained. Failure to use a back cut can lead to a diagonal tension line across the flap, with ischemia distal to this tension line; this is a bad situation because it can mean loss of the most essential part of the flap. In making this back cut, a frequent maneuver in a scalp flap, vascularity may be prejudiced by reduction in the width of the base of the flap. The back cut in the donor area can usually be closed directly, but occasionally a skin graft may be required. Both of these are rare situations.
**DOG-EARS**

As skin is moved around, dog-ears, or excess skin folds (the “standing and lying cones” of Limberg), are formed. With some preplanning, this excess skin can be incorporated into the reconstruction; otherwise excision should be performed. Care must always be taken in this maneuver to ensure that vascularity of the flap is not compromised. If this seems likely, the dog-ear resection is postponed to a later date.

An attempt to close a circular defect results in skin excess lateral to the closure. Any existing tension may be released by making the skin excess into triangular island flaps based on a subcutaneous pedicle. These can then be moved medially, as advancement flaps, to close the main defect, with the V-Y principle applied for closure of the secondary defect.

In a straight advancement flap, as the defect at the leading edge of the flap is closed, folds of skin appear bilaterally just lateral to the flap base. These can be excised as Burrows triangles with a twofold effect: the contour problem is dealt with, and, as the skin is pulled toward the flap base, the tension is shared between the skin of the defect and the skin of the flap—an admirable compromise.
Occasionally, when circumstances are right, the dog-ear can be used to form a flap to reconstruct another neighboring defect. After closing the primary defect and leaving a dog-ear, the surgeon may elevate the dog-ear as a long finger type of transposition flap, which can then be trimmed and used to deal with a skin lesion within a 90-degree radius of it.

Although considerable emphasis has been placed on the mathematics of flaps, accepted mathematic theory relates to a plane surface and assumes that the size of the flap will not alter. This theory is faulty, however, because it does not take into consideration the viscoelastic properties of skin, which are additional aids to the surgeon. If the planning is not accurate, skin stretching and patience will make up for geometric and trigonometric deficiencies.

**Conclusion**

Success in using local flaps is directly related to knowledge of such flaps, careful planning, good technique, and experience. Wide excision in skin cancer is a valuable rule. The creation of the defect is of primary importance; closure is a secondary event. When the defect has been created, the surgeon should choose a flap of adequate size and shape to achieve wound closure without tension. Hemostasis should be meticulous. In large flaps, suction drainage is used. Even in smaller flaps this method is becoming more popular because of availability of mini suction drains.
References—With Key References Annotated


Although relatively minor facial surgery may seem routine to the surgeon, for the patient it can represent a major emotional experience. Fear of hospitals, concerns about possible skin cancer, uncertainty about the quality of the surgical result, and dread of local anesthesia may cause considerable anxiety.

**Patient Examination and Evaluation**

**PRESURGICAL PATIENT CONSULTATION**

Good patient management begins with a frank and informative office consultation as the plastic surgeon reassures the patient about the chances of successful removal of the lesion and the expectations of a good result. By expressing a sincere desire to
make this experience as comfortable as possible, the surgeon can do much to allay the patient’s apprehension.

The patient should understand the proposed method of reconstruction and the technique of anesthesia to be used, since local flap reconstruction on the face is often performed with the aid of local anesthesia, usually on an outpatient basis. It is important to fully educate the patient about what to expect. Surgeons often assume that their patients are more knowledgeable about the various aspects of surgery than they actually are. It is better to begin with a clean slate, assuming that the patient knows nothing and explaining every aspect of the surgery as clearly and simply as possible.

What “aids” should we use in this patient education process? I always try to provide any materials that may help to give the patient an accurate idea of what is in store for him or her. Pictures of previous patients who have had similar problems (if appropriate permissions have been obtained) are always helpful in providing the patient with a realistic idea of what to expect. Books or articles may also serve the same purpose. However, some patients do not like looking at surgical procedures.

The lesion and the proposed reconstruction should be thoroughly discussed with the patient. I often draw the lesion and the reconstruction to show the patient more graphically what will be done. This drawing exercise seems to make the patient more confident in my ability to manage his or her problem.

A discussion of the healing process is also important. I explain that healing takes time—not days, not weeks, but months. Scar maturation is explained, again stressing that scars take several months to mature or to become soft, flat, and pale. At this point in the discussion it is always wise to point out that different people form scars in different ways. Some will always develop excellent scars that heal imperceptibly; others will have exactly the opposite reaction, and this healing process is not related to the surgeon’s technical ability. In a patient with pale skin, freckles, and red hair, there is the possibility of a permanently red or hypertrophic scar resulting from any incision, and this potential scarring problem needs to be clearly explained to the patient. The same concerns are true for an African American patient but are less than for the patient just described. It is also easier to discuss the possibility of hypertrophic scarring with African American patients, because they are generally aware of the healing characteristics of their skin.

Asian and Middle Eastern patients may not be as aware of their tendency to produce unsatisfactory scars, since this is not as pronounced a problem for them as it is in the other two patient groups described. This can become a problem postoperatively if potential scarring problems are not fully discussed with these patients before surgery.

Children are the final group who may produce unsatisfactory scars and thus there may be related cosmetic concerns. Unfortunately, there is an impression among the
general public that children form good scars. This is not always the case. Time spent clearly explaining and discussing this with the parents is well invested. This discussion should be carefully documented to avoid possible problems in the future.

In the presurgical interview I emphasize that surgeons are very careful individuals, but infection or hematoma is always a possibility in any surgical procedure, and as a result further surgery may be necessary. There may also be numbness and/or pain in the area of the wound. Increasing pain and swelling without redness are signs of hematoma, and the patient should return to the office immediately. A similar scenario with inflammation and sometimes throbbing pain suggests infection, especially if there are red lines on the skin indicating lymphatic involvement—again, this is a reason to contact the office.

When a patient asks me, “How long will the operation be?” I usually answer, “As long as I need to give you a good result.” To stop at this point will annoy many patients. I follow this up with a time that is slightly longer than I anticipate. All of this should be discussed in a serious fashion, but with concern; one should not be flippant.

A further area to be discussed is a bad result. I try to give an accurate assessment of the possibility of this occurring, but I strive to be reassuring. If I have never had a problem with a particular technique, I tell this to the patient. If I have had a complication (or complications), I tell the patient and explain why this occurred, how it was handled, and the outcome. If the need for further surgery is likely, the patient is informed and the reason for this is fully and clearly discussed.

It is wise to be very open with the patient in terms of experience with his or her problem: numbers treated, complications, and end results. The surgeon should discuss how much pain may be associated with the procedure and what analgesic agents may be prescribed. It is advisable to determine which medication, from past experience, best agrees with the patient. Drug allergies should be noted.

If the lesion is malignant, the surgeon needs to discuss the long-term outlook and the need for further management. If there is a possibility of recurrence this must be explained, with an accurate estimate of the likelihood and what further treatment modalities might be required.

Above all in this presurgical meeting, it is essential to be honest with the patient, allowing him or her ample time to get to know the surgeon and to ask questions. Kindness and compassion go a long way in building patient confidence. In my own practice the medical social worker is available to talk to the patient as required. My senior operating room nurse is also in the office on consulting days, and she can give the patient significant support. Many patients are less inhibited about asking her questions about pain, dressings, and end results. In such an environment the patient usually feels comfortable and understands the concept of team management.
**Patient Management Factors**

When we are evaluating patients for flap surgery, there are a number of factors to be considered, including the patient’s medical condition, skin quality and quantity, age, potential scarring problems, previous irradiation, and surgical intervention. Obviously, we try to obtain the best result for every patient, but there may be factors that render this impossible. That is why the initial interview is so important in providing an opportunity for full discussion of these issues.

**Medical Problems**

A complete medical history should be taken. Because aspirin or aspirin-containing compounds may cause undue bleeding, the patient is asked to discontinue using these from 10 to 14 days before surgery. Allergy to epinephrine or other drugs should be established and noted. If a patient is excessively worried immediately before surgery, or if a history of hypertension or myocardial ischemia is a factor, a mild sedative such as diazepam (Valium) may be prescribed.

Some patients have medical problems that may have an adverse effect on the reconstructive process. Systemic disease such as diabetes and the systemic problems seen in smokers can be particularly troubling. A diabetic patient, particularly if unstable, has a greater chance of wound infection and once again good stabilization of the wound is imperative and there is certainly an argument for the use of prophylactic antibiotics. However, it is absolutely essential that these concerns be voiced to the patient or parent.

It should be clearly explained that smoking has an adverse effect on wound healing. A heavy smoker who has been exposed to the effects of smoking for a long period may have significant vascular problems. Thus procedures that work in a nonsmoker may not be successful in a heavy smoker. The problem then is what to do. Certainly, the patient must be warned that there is an increased risk of unsatisfactory healing. The wound or wounds should be handled with more care, reducing stress on the wound as much as possible, and follow-up appointments should perhaps be more frequent.

**Skin Quality and Quantity**

One of the significant features to be factored into the planning and use of facial flaps is the patient’s skin quality and quantity. When the skin is plentiful, it is easier to plan reconstruction, there is less likelihood of failure, and scar formation is more satisfactory.

Although there is not a great deal of good evidence that sun damage is harmful to skin—other than the significant factor of predisposing one to skin cancer—there is always concern about healing. Flaps should be planned more carefully to ensure a satisfactory blood supply, and the patient needs to be warned that wounds may break down and scars may be of a poor quality.
AGE

Age is also an important consideration. Local flaps are easy to use in an older patient but much less so in children, because excess skin is not available. Scarring and distortion caused by rearrangement of local anatomy also is more of a problem with children. In such a situation tissue expansion can be useful. It often makes the impossible possible. Older skin has a tendency to heal better than the skin of a young person. An older patient also has more skin available, thereby facilitating the planning and execution of local flaps. Because there is a greater abundance of skin, it is easier to design a flap and to move the flap into the area of reconstruction than in a younger patient whose skin is tight and probably will not stretch as well as more mature skin. To choose the flap to use, the surgeon must gauge the tension of the skin of the area from which the flap will be constructed. If it is easy to bring the planned flap’s edges together with one’s fingers, then this is going to be a relatively safe and easy flap to perform. This ensures that it will be possible to use the flap and close the donor site and end up with a satisfactory result.

Another feature of flaps is that the reconstruction may be obtained in what one might term as a gradual technique. This is where the tension is shared along the area of flap movement; the best example of this is the bilobed flap as opposed to a rotation flap. With the gradual technique exemplified by the bilobed flap, the leading portion of the reconstruction is safer, and in certain situations this may well be the flap of choice in a younger person, whereas in an older adult with loose skin, a single transposition or rotation flap would be the technique of choice.

SCAR QUALITY

In some patients the potential quality of the scar can often be determined before carrying out the procedure. As mentioned earlier, this is particularly true in patients with red hair and freckles, patients with increased skin pigmentation and darker skin, and in children, although to a lesser extent. What can be done when scarring problems occur in these patients? Careful suturing, avoidance of hematoma, and the use of many small sutures (subcutaneous, subcuticular, or multiple individual skin sutures), early suture removal, and massage following suture removal are all helpful strategies. Some surgeons recommend a pressure dressing over the scar. This may be a good idea in adults; however, young children will pull this type of dressing off and older ones will probably not comply. Massage with a cream to prevent friction is probably best, but no guarantees should be given. Unfortunately, it is not possible to change the inherent characteristics of the patient’s reaction to a skin incision.

Hypertrophy of the scars on the mediastinum, vertical neck, cheeks, and low transverse neck area is always of concern. These areas are unpredictable, and there is always a greater potential for hypertrophy in African American skin or in the pale, often freckled skin of redheaded patients. Individuals with these skin characteristics must have this problem carefully explained to them, and this discussion must be noted on the patient’s chart.
SENSATION PROBLEMS
Loss of sensation may arise when one uses a flap, particularly a large flap. If this is not explained to the patient, he or she may be very concerned about this situation. Therefore the patient must be assured that sensation will probably come back in the area. It is absolutely essential that all possible complications be discussed frankly and openly.

PRIOR RADIATION THERAPY TO THE AREA
Care must be taken with the patient who has had radiation to the area in which the surgery is to be performed, since there may well be decreased skin vascularity in that region. Flaps that should work without problems may fail. If there is concern, a preexcisional delay is appropriate. Excision can then be carried out after 10 to 14 days. There is one consolation in this situation: patients who have had radiation to an area rarely have hypertrophic scarring.

LIFESTYLE CONSIDERATIONS
It is often much easier for an older patient to adapt to following instructions and thus not compromise any reconstruction. With a child it is much more difficult to impose these rules and, unless there is good parent supervision, it is not uncommon to have a return visit to the office with separation of the wound edges or a more significant complication. It is essential to have a simple but comprehensive discussion with the parents. In addition, secure dressing and splinting may be used to prevent any untoward postoperative problems.

Preoperative Care
Meeting with the patient before the procedure provides a further opportunity for the surgeon to clearly explain what is going to be done, provide reassurance, and establish a good rapport with the patient. In young children this rapport is important for the child as well as the parents. Parents tend to see the surgeon as a more caring and understanding individual, and it allows them to be more confident about the quality of the surgeon looking after their child. It is just as important to have a satisfactory presurgical meeting as it is to meet postoperatively. Any questions the patient may have relating to the preoperative instruction sheet can be clarified at this meeting.

The surgeon should be available in the operating room as soon as the patient is on the table and should again introduce himself or herself to establish that the person in whom the patient has placed trust is actually present and will perform the surgery. Gentle reassurance at this time will probably bring its reward in a calm patient with reduced systolic blood pressure during the procedure.

The patient’s allergies are checked against the preoperative record. The position of the lesion is checked against the operating list and the patient’s chart notes. Careful,
## Preoperative Instructions

You are currently scheduled for ______________________________ surgery, with ____________________________ ________________ on __________________. At least one week before the surgical date you will have an appointment scheduled with the doctor.

At this time:

1. Your doctor will discuss your upcoming procedure and answer any questions or concerns that you may have.
2. A nurse will go over presurgical instructions. At this time you will also sign a surgical consent form.
3. A physician will ask you questions about your medical and surgical history. Please inform him/her if you are taking any medications, including prescription, nonprescription, or herbal remedies.
4. If you are having your procedure done in the office with sedation, you must have a medical clearance filled out and signed by your family doctor or cardiologist. This form must be completed and brought with you at the time of your presurgical visit. It may also be faxed before this time.
5. If you are having IV sedation for your surgery, you must bring a separate check or cash on the day of surgery to pay the anesthetist. This fee is not included in your estimate.
6. You must stop taking aspirin, blood thinners, vitamin E, and any antiinflammatory medications at least 10 days before surgery. Please carefully review the list of medications to avoid.
7. You must stop smoking for ______________ before surgery and ______________ following surgery. Smoking can increase surgical complications.
8. SinEcch (Arnica montana), a homeopathic medication, vitamin C (1000 mg), and bromelain can be taken as suggested to facilitate healing and decrease bruising and swelling following your surgery.
9. You must arrange for a responsible adult to drive you home from the surgical center. Please arrange this in advance.
10. The Surgical Scheduler will give you the time of your surgery and when to be at the office. Please remember that this is subject to change.

**ON THE DAY OF SURGERY:**

1. Take nothing to eat or drink after midnight the night before surgery. You may take ______________________________ the morning of surgery with a small sip of water. You may brush your teeth.
2. Do not wear contact lenses.
3. Do not wear any makeup or facial or body lotion or oils.
4. No alcohol for 24 hours before surgery.
5. Leave all jewelry and valuables at home. Any toe rings and body piercing must be removed.
6. If you wear dentures, please wear them on the day of surgery.
7. Wear comfortable, loose-fitting clothing, preferably a shirt that buttons down the front, sweat pants, and slip-on shoes.
8. If you are having a procedure done that involves any area above the neck, wash your hair the night before. Use a cream rinse. Do not use any hair spray, gel, or mousse products.
9. If you are given prescriptions for medication at your preoperative visit, they must be filled and brought with you the day of surgery.

If you have any questions, please call the office. Thank you.
unhurried preparation by the resident or nurse, with a full explanation of all move-
ments, can further calm the patient. Particular care is taken to avoid irritation to the
patient’s eyes or spillage of cleansing solutions into the nose or mouth. The operat-
ing table is placed in the reverse Trendelenburg position to initiate some postural
head and neck hypotension.

At this point the proposed excision and projected reconstruction are designed. Since
this planning is done on the patient’s face with a marking pen, the procedure must
be explained beforehand, with particular emphasis on the fact that the patient will
feel the pen as it traces the surgical plan. The patient should also understand that lo-
cal anesthetic infiltration will follow flap planning, with resulting deadening of the
involved area. If a resident or colleague is present in the operating room, discussion
about alternative methods of reconstruction may take place while the patient is be-
ing prepared for surgery. Reasons for this conversation should be mentioned to the
patient and inquiries made as to whether this talking causes any concern. Many pa-
tients enjoy such a discussion, because it is evidence that the surgeons are interested
in and concerned with their medical problem.

At this time some patients will ask for tactile reassurance and may wish to hold a
nurse’s hand. This request should be granted quickly and pleasantly. The patient
may ask to have music or, if music is being played, he or she may wish to have it
turned off. These are reasonable requests and should be granted.

**Administration of Anesthetics**

**LOCAL ANESTHETIC INFILTRATION**

The local anesthetic agents used almost universally are lidocaine hydrochloride (Xy-
lcaine) and epinephrine. The concentration varies; for small areas, 1% lidocaine
and 1:200,000 epinephrine are used; for large areas and for children, 0.5% lidocaine
and 1:400,000 epinephrine are advisable. If a patient is sensitive to epinephrine, only
lidocaine should be used. An additional drug that may be useful is hyaluronidase
(Wydase, Wyeth Laboratories, Philadelphia, PA). One ampule is added to 20 ml of
local anesthetic solution. This agent appears to aid the diffusion of the lidocaine,
resulting in a less painful injection and more rapid and extensive anesthesia. It also
allows nerve blocks to be executed more efficiently because of the spreading effect.

Unless the area to be anesthetized is limited, a 20 ml syringe should be used, thus ob-
viating the need for refilling. The needle does not have to be unduly fine, but it
should be sharp. Introducing the needle through the skin should be done with
thoughtfulness and care. The surgeon should explain the procedure to the patient
and again give reassurance. The skin is pinched in the area of the injection site; then,
with the index finger and the thumb, it is stretched tight, which produces skin
blanching and enables the needle to be pushed rapidly and vertically through the
skin with minimal pain. If the local anesthetic is injected very slowly, with concomi-
tant explanation or conversation on the surgeon’s part, this can be a virtually pain-
less procedure. It is important to observe the patient’s facial reaction; if there is any
sign of pain, the surgeon should stop injecting the anesthetic and wait a few minutes before continuing.

**Regional Nerve Block**

If possible, anesthesia should be produced by regional nerve block. This technique affords rapid regional anesthesia with less pain than would result from injection around the surgical site. Painless local infiltration of lidocaine and epinephrine to obtain vasoconstriction in the area to be resected is then possible.

**Technique**

*Anatomy of Facial Sensory Nerves*

---

**Supraorbital Nerve**  Much of the forehead can be anesthetized by infiltration of the supraorbital nerves, which are located at the junction of the central and medial thirds of the supraorbital rim. The needle should be introduced just below the eyebrow, the target being the edge of the supraorbital rim. If hyaluronidase is used, accurate location of the nerve is not necessary; the lidocaine will spread rapidly and block the nerve.

**Infraorbital Nerve**  The infraorbital foramen is located at the junction of the central and medial thirds of the infraorbital rim. The infraorbital nerve exits from the foramen at a point 0.5 to 1 cm below the rim; here there is a concavity lying under the
overhang of the rim. The needle should be placed directly into the area and the anesthetic infiltrated as described earlier. It is a mistake to move the needle around in this area; this increases discomfort without a corresponding increase in effectiveness. Satisfactory anesthesia is produced after administration of 0.5 to 1 ml of the anesthetic solution (probably the hyaluronidase helps in this respect). An alarming local phenomenon may occasionally be observed at this point: sudden and intense blanching over the area of distribution of the infraorbital nerve. Instant anesthesia is associated with this loss of color. Presumably it results from a “direct hit” on the nerve, causing profound vasospasm in all the vessels it controls. This can be painful as the needle contacts the nerve; this should be explained to the patient before the event.

With this block, anesthesia is obtained in the cheek, the ipsilateral half of the upper lip, a variable amount of the side and tip of the nose, and the upper alveolus and teeth on the injected side. Under normal circumstances, deadening will occur within 5 minutes. It is possible to perform the same block through the upper buccal sulcus. Perhaps because of previous dental procedures, most patients find the latter approach more frightening. Further local anesthetic and vasoconstrictors can be injected into the area to be excised. The main reason for this is to obtain a more bloodless field. The addition of hyaluronidase prevents severe distention and distortion.

**Mental Nerve** The mental nerve exits its foramen in the mandible 1 to 1.5 cm above the lower rim in the region of the canine premolar teeth. The foramen lies approximately on a vertical line drawn through the supraorbital and infraorbital foramina. An injection through the skin to block this nerve can be painful. In contrast, an intraoral approach can be almost painless. The method to be used is carefully explained to the patient before the injection.

The surgeon stands behind the patient’s head, and the index finger is placed down into the lower buccal sulcus just medial to the oral commissure. The lip is pulled downward and outward to stretch the lower buccal sulcus to the blanching point if possible. The needle is pushed quickly through the mucosa and the slow injection begins. Again, anesthesia is rapid. This block will anesthetize the corresponding half of the lower lip, alveolus, and teeth, as well as a varying portion of the cheek.

**DIRECT LOCAL INFILTRATION**

As can be appreciated from the previous description, much of the face can be comfortably anesthetized with nerve blocks. In some areas, however, direct infiltration is necessary. This may be done beginning in an area anesthetized by a nerve block. The secret to this approach is very slow infiltration; in addition, a large volume of anesthetic agent should be used. The latter will dissipate rapidly because of the hyaluronidase but will ensure adequate anesthesia and good vasoconstriction. Another essential ingredient for patient comfort is time. The lidocaine and epinephrine must be given time to work to maximal effect. A minimum of 5 minutes for injection and at least 5 minutes of waiting can convert an unpleasant experience into a surprisingly comfortable event. The surgeon may even want to mark the proposed exci-
tion and reconstruction, inject the area, and go for a cup of coffee or dictate for 10 to 15 minutes. The reward for this approach is a maximal level of anesthesia and vasoconstriction—an ideal operative field. This time allows the surgeon to further converse with the patient and set his or her mind at ease. Only when anesthesia is tried and tested should the surgery begin.

**EYE ANESTHESIA**

Surface anesthesia can be obtained on the eye by means of a topical agent such as proparacaine 0.5% (Ophthaine, Squibb Pharmaceuticals, Princeton, NJ). The procedure is explained to the patient, who should be told that there may be a stinging sensation. The patient looks to the side, the eyes are held open, and two or three drops are introduced onto the sclera. These drops must not be delivered from a height, because this can cause an unpleasant sensation; the dropper should be placed close to the sclera. Effects of the anesthetic are evident in a few minutes.

**INTRANASAL ANESTHESIA**

After infraorbital nerve block, intranasal anesthesia is produced by a combination of local anesthetic injection and packing with cocaine-soaked gauze (the latter procedure ensures anesthesia and mucosal vasoconstriction). The packing is prepared by placing 5 ml of a 10% solution of cocaine in a container of ribbon gauze or cotton-tipped applicators. An attempt is made to introduce the solution into all areas of the mucosa. A wait of 10 to 15 minutes is advised to obtain the optimal effect. Correct head-up posturing of the patient is very important to ensure a bloodless operative field.

**Intraoperative Care**

If there is any concern whatsoever about the viability of the flap at the time of surgery, it should simply be put back into its previous position and then the reconstruction can be repeated within a few days. This in fact is delay of the flap. In some patients who are known to have compromised local vascular perfusion, a form of delay may be carried out before the reconstruction; this is often determined at the time of surgery. For effective delay, one would wait for 10 to 14 days before carrying out the planned reconstruction.

For patients of all ages, local anatomic landmarks, such as the temporal hairline and eyebrows, must be preserved because a poorly planned flap will alter the position of a mobile landmark and therefore cause obvious asymmetry.

If the patient becomes nauseated or light-headed during surgery and shows signs of fainting, the head of the table should be lowered and adequate time allowed for recovery from this condition before surgery is continued. The surgeon must be careful not to press on or traumatize the eyes; this can be very disturbing. The patient’s mood should be gauged as surgery progresses. If he or she wants to talk, this should
be encouraged; if not, the surgeon should be prepared to operate in silence. The operating room should be an area where tension is minimal, apart from some very challenging periods of difficult dissections. At the completion of the procedure, all blood should be cleaned away. Special care needs to be taken to clean the patient’s hair and ear canal; if the latter is forgotten, the patient may complain of reduction in hearing. A neat, tidy dressing is applied to allow the patient to appear in public with minimal embarrassment. This also gives the impression of a neat and tidy surgeon, which adds to patient and family satisfaction.

If the procedure is taking longer than had been estimated, it is wise to inform the parents or loved ones and make certain they are reassured if there is no concern. What is difficult to decide is what to do when there are significant complications that are extending the length of surgery. If the problem is not a significant one, I ask that someone convey a message to the relatives. If there is a very significant problem and I can spare the time, I go to talk to the family. It is essential that we show ourselves to be caring and understanding individuals who want to do the best for the patient.

Postoperative Care

At the completion of the procedure, clear (preferably written) instructions should be issued to the patient. A prescription for an analgesic is given with an explanation of the specific amount and how often it needs to be taken. The patient should be cautioned against taking aspirin-containing compounds, and the reason for this should be explained, with emphasis on the fact that they may cause bleeding and hematoma. An appointment for the first postoperative visit is given together with a note of an emergency telephone number. Follow-up of a patient who has had a local flap performed is extremely important. The main problem with local flaps is vascularity; we may have concerns in an older patient or a diabetic patient, or because of the anatomic area being reconstructed. All these complications should be presented to the patient and the relatives. The surgeon must emphasize that no problem is too minor to discuss with him or her or the staff at any time postoperatively. All necessary telephone numbers are provided. Special emphasis is placed on explaining the extent and duration of the anesthesia and the consequent danger of burning the lips with hot liquids such as coffee or tea. If any oozing of blood occurs, the patient is detained for observation until it stops. A description of the surgery, the reconstruction, the dressings to be used, and postoperative instructions should be discussed with family members. They should be given time to ask questions. Any concerns the surgeon has must be voiced to the relatives, particularly if complications are possible or if there is an unexpected diagnosis. Honesty in this area is imperative. This aspect of care should not be left to the assistant.

References

Postoperative Instructions
[Phone Number]

1. In the first 24 hours after surgery:
   • Do not drive or operate machinery.
   • Do not consume alcohol, tranquilizers, or sleeping medication.
   • Do not make important decisions or sign any important papers.
   • Do not stay home alone. You must have a responsible adult with you.
   • You may experience dizziness, sleepiness, and muscle aches after surgery.

2. You are advised to go directly home from the clinic. Restrict your activities and rest for a day. Resume light to normal activity according to how you feel and what the doctor advises.

3. Increase fluid intake after surgery. We recommend a half-glass of fluid every half hour while awake and you are not nauseated. Allow your appetite to dictate food intake. Greasy and spicy foods are not advised.

4. Take your medication as directed. When taking pain medications, you may experience dizziness or drowsiness. Do not drink alcohol or drive while taking pain medications.

5. Resume your daily prescription medications.

6. Dressing care: ____________________________________________________________
   ________________________________________________________________________
   ________________________________________________________________________

7. You may shower: __________________________________________________________

8. Please call the doctor at [phone number] if the following occurs:
   1. Fever over 100 degrees Fahrenheit by mouth.
   2. Pain is not relieved by medications prescribed.
   3. Swelling around incision.
   4. Increased redness, warmth, and hardness around the incision site.
   5. Blood-soaked dressing (small amounts of oozing may be normal).

9. Special instructions:
   ________________________________________________________________________
   ________________________________________________________________________

10. Call the nurse directly at [phone number] for an appointment ___________________________.
    If you cannot reach the nurse at the above-listed phone number, call [phone number].
A smooth forehead with a gently arched eyebrow suggests youth and serenity. A lowered eyebrow, accompanied by forehead furrows and glabellar pleats, declares the progress of time. The boundaries are the hairline above and lateral to the forehead and, inferiorly, the eyebrows, supraorbital rims, and glabellar region. The inferolateral extent is determined arbitrarily at the level of the lateral end of the eyebrow. To reconstruct this area, surgeons must be knowledgeable about the nerves, blood supply, and musculature, but more important, they need an appreciation of what can be referred to as “fixed aesthetic structures,” such as the eyebrows and the lateral hairline. The position of these must be respected at all times to achieve optimal results.


**Anatomy**

![Anatomical diagram showing blood vessels and muscles of the head and neck](image)

**SKIN**

**Appearance**

The forehead skin of a young person is usually smooth, although some individuals have an overactive frontalis muscle that causes the formation of transverse wrinkles. Similarly, corrugator and procerus muscle overactivity will produce vertical frown lines in the glabellar area. With age, these lines become more pronounced and may well influence the choice of reconstructive procedures for the forehead.

**Color**

The color of the forehead skin is often slightly paler than that of the nose and considerably paler than that of the malar region. This coloring may be altered by sun exposure.

**Texture**

The skin texture of the forehead is smooth and often shiny, although it varies from one person to another. The skin thickness is fairly uniform; the glabellar skin is somewhat thinner and certainly more pliable than that covering the rest of the forehead. The full thickness of the main forehead area supplies a stiff, fairly thick layer for reconstruction. These textural characteristics are of importance when the forehead is being used for distant reconstructive procedures. For example, on the nose it is an advantage because it gives support; on the eyelid it is a disadvantage because it is too thick.
MUSCULATURE
This region includes the frontalis, procerus, and corrugator muscles. These muscles usually provide symmetrical movement to the forehead, but they are also capable of producing an asymmetrical appearance, as in the quizzical raising of one eyebrow that is second nature to many individuals. Asymmetry of the vertical frown lines may also exist in the glabellar area.

NERVE SUPPLY
Sensory nerves are the supraorbital and trochlear from the trigeminal nerve (fifth cranial nerve). The motor supply is from the frontal branch of the facial nerve (seventh cranial nerve). It is important to know the approximate position of the facial nerve. Although the size, shape, and sometimes the position of the zygomatic arch may be different in different racial groups, the facial nerve is always in the same position both transversely and vertically. The nerve lies on a line between the lobule of the ear and a point just lateral to the lateral end of the eyebrow. If this line is not kept in mind, the nerve will be injured during procedures performed in the temporal and facial area.

BLOOD SUPPLY
The anterior branches of the temporal, supraorbital, and trochlear vessels provide the blood supply to the forehead.
LYMPHATICS
The area just above the root of the nose drains into the submandibular group of lymph nodes. The remainder of the forehead and temporal region drains into the superficial parotid lymph nodes. These nodes, which lie just anterior to the tragus, are located on or deep to the parotid fascia.

Aesthetics
The forehead is an obvious area of the face that can be covered by hairstyling in women, but camouflaging is not usually possible to the same extent in men, particularly if they have male-pattern baldness. Thus serious consideration must be given to any transgression of this area for reconstruction. If a lesion is excised from the forehead, the method chosen to fill the resulting defect must be carefully planned. The hairline should not be altered except in the most minor way. The eyebrows should not be displaced, and the frontal branch of the facial nerve should be spared unless resection is necessary for complete tumor removal. Similarly, the sensory nerves should not be wantonly sacrificed, even though recovery of sensation is usually complete.

Placement of Forehead Incisions

Ideally, the lines of minimal relaxed tension are chosen for scar position. In the forehead these lines are transverse; in the glabellar region they are vertical. If scars are placed in a frown line, the aesthetic result is quite acceptable. It is not always possi-
ble to choose the ideal scar line, and often the scar may be at right angles to the minimal relaxed tension lines (that is, vertical). With careful suturing, however, the results with vertical scars are often good, particularly if they are later revised with a W-plasty. Scars running diagonally on the forehead are often the least satisfactory and may defy adequate revision. Occasionally it may be necessary to resort to a Z-plasty. However, this may introduce the problem of bunching up, such as “trap-dooring” and “pincushioning,” within the scars of the Z flaps (see Chapter 10).

When raising flaps on the forehead, the surgeon should make all incisions vertically through the skin. We are all familiar with the pincushion effect of windshield injuries of the forehead in this type of trauma in which the skin is cut tangentially, raising small flaps. Even with careful incision placement, the pincushion effect may occur, particularly with round flaps; this may be caused by circumferential scar contracture. The introduction of angles into a flap (for example, the Limberg flap) prevents the pincushion effect from occurring (see Chapter 10), although the mechanism by which this happens is not known.

**Areas of Tissue Availability**

The natural mobility of the scalp allows the forehead skin to be rotated to close defects. Because the hairline and eyebrows form rigid boundaries on the forehead, care is taken in the planning of these flaps to prevent gross hairline irregularities. The skin for reconstruction lies within this demarcated area and must be moved around carefully to avoid disrupting these landmarks. The temporal region has loose skin transversely and vertically; thus flaps can be moved within the constraints of its boundaries.
Areas to Be Reconstructed

The surgical options for forehead reconstruction are local flaps or skin grafts. Because of the color and texture of the transplanted skin, neither full-thickness nor split-thickness grafts provide satisfactory donor material, although reasonable results may still be obtained when these grafts are used for complete forehead resurfacing. Even in that situation a thin, vascularized free flap is by far the best solution. The forehead can be divided into four areas:

1. The main forehead area
2. The supraeyebrow area
3. The temporal region
4. The glabellar region

It is convenient to consider the most suitable reconstruction in relation to these divisions, because the flaps of choice are different for each region.

Main Forehead Reconstruction

Factors to Consider

In the forehead region, scars, skin color, and texture are important considerations because the forehead is relatively flat, with few light and shade patterns; therefore any contour changes or alterations in skin color are quite obvious. Contour irregularities are highlighted in tangential light; unfortunately, room lighting is usually overhead or directed laterally from the wall area. Flaps should be the same thickness as the excised skin to prevent pincushioning. Hairline and eyebrow symmetry should also be maintained. Scars should blend into natural skin lines. If possible, the frontalis muscle should not be damaged, because a palsy or muscle dysfunction is easily noticed.
Scalp Rotation

When possible, if the hairline will not be significantly disturbed, rotation of the scalp is an ideal solution to many forehead defects. This reconstruction is particularly satisfactory when the scalp is moved from a posterior to an anterior direction in bald men because it reduces the bald area. The figure below illustrates this principle.

In most instances, it is possible to assess the ability to perform a scalp rotation by estimating the looseness of the scalp. Glabellar laxity is determined by digital pressure. The scalp can be picked up with the fingers; if there is excess scalp, reconstruction is simple. In addition, the overall rotational movement of the scalp on the periosteum assessed by the examining hand will give an idea of how much advancement can be obtained. This movement is judged by placing the fingertips on the scalp and pushing it in all directions. The amount of movement suggests how easy it will be to redistribute the scalp after the resection.
Unilateral Rotation Flap

Resection of a lesion above the eyebrow makes forehead reconstruction difficult; any miscalculation in the reconstruction will elevate this natural landmark and cause facial asymmetry. The supraorbital basal cell carcinoma shown in the illustration above presents such a problem. The first move is to triangulate the excision with the base medially.

A triangular defect of this type can be closed with a rotation flap raised above the pericranium. This flap is based on the temporal vessels together with some occipital vascular input, and it must be raised radically in the lateral area.
The rotation should be effortless, and suturing should be without tension. Any tension will elevate the eyebrow and may compromise the blood supply of the tip of the flap. If closure is not adequate, a back cut can be made at the most posterior extent of the flap (see p. 8). Such a cut allows greater ease of advancement, and in most cases this posterior secondary defect can be closed directly without difficulty.

In the early postoperative phase, an obvious scar and contour irregularities are present. With time, this situation improves and a very acceptable result can be obtained, with maintenance of eyebrow position.

**Problems**

Potential problems include hematoma under the flap, and tightness and ischemia of the flap leading to eventual necrosis if flap tension persists. The hematoma must be released and, if necessary, a drain is inserted. I strongly advise placing a drain during surgery, together with the application of a padded pressure dressing postoperatively. If the flap has not been well planned and is tight, the circulation will be compromised. If this situation occurs, the sutures should be removed and the flap allowed to recover. A further attempt to move the flap can be made in 1 or 2 days with a generous back cut to allow more mobility. Within reason, there should be no fear of flap necrosis as the tension across the base of the flap is reduced. Incisions within the hairline may not heal perfectly; there may be associated alopecia requiring later excision and resuturing. Anesthesia or hypoesthesia of the rotated portion of the forehead may occur; this condition will improve with time but may never be completely normal.
Aiding Scalp Closure

*Galeal Scoring*  Despite preoperative estimates, closure may sometimes be difficult, even with the use of a back cut. In this situation, the technique of galeal incisions or scoring can be most useful. At 0.5 to 1 cm intervals, parallel to the leading edge of the flap, the galea is incised, preserving the underlying vessels. If these cuts do not give enough movement, additional galeal cuts at right angles to the previous ones are made to allow increased flap stretching. More cuts may result in more ischemia.

Scalp Stretching  Occasionally, in large scalp defects, the phenomena of creep and stress relaxation may be used to achieve closure. These two principles are based on the viscoelastic properties of skin: When placed under constant tension for a long enough time, skin stretches. When the tension is discontinued, the skin does not return to its original length; it has become permanently stretched. For closure of a large scalp defect, this stretching phenomenon is accomplished by placing two large hooks or rakes on the leading edge of the flap and pulling forcibly for at least 5 minutes.

This may also be achieved by placing sutures so that they almost close the defect. The flap is then left to stretch for some time because of the biomechanical properties of creep and stress relaxation. Suturing between the previously placed sutures will often allow safe closure.
Skin Grafts  As a last resort for closure, a secondary defect may be accepted and a split-thickness skin graft applied. Grafting is possible only if the flap has been raised above the pericranium, because skin grafts do not “take” on bare skull bone. This solution is not particularly desirable from an aesthetic viewpoint and, fortunately, the need for it is a rare eventuality. If local flaps are not available, the cortical bone is removed and the cancellous bone is covered with moist dressings to form granulation tissue, which will allow skin graft coverage. The alternative is a scalp flap.

Scalp Transposition Flap

This 50-year-old woman had a large basal cell carcinoma that was eroding the frontal bone but not invading the dura.
The resection is outlined; the planned reconstruction is with a large scalp transposition flap from the posterior area of the scalp.

A full-thickness resection of the basal cell carcinoma was carried out; this included the scalp and underlying cranium. The dura was exposed.
The defect was reconstructed with bone dust harvested from the posterior skull and covered with Surgicel. A large transposition flap based on the left temporal vessels was raised posteriorly and used to cover the defect. The defect was reconstructed with a split-thickness skin graft.

Good anterior closure has been achieved. The lateral dog-ear will be trimmed later as necessary.

The message from this case is to carefully plan the flap and its rotation using a sponge or swab. Basing the flap on a secure blood supply is essential.
The postoperative result is shown. Further reconstruction will be carried out by scalp expansion to reconstruct the skin-grafted area.
Worthen Rotation Flap

When large unilateral defects involving virtually the whole hemiforehead result from tumor resection, the concept advanced by Worthen may be used. This technique has been applied to the right hemiforehead and upper eyelid nodular hemangioma, illustrated in this patient.

The surgical plan called for resection of the lesion and reconstruction with a forehead rotation flap. The diagram shows the proposed surgical approach and illustrate mobilization of the forehead rotation flap, as well as the planned dog-ear resection.
The vertical height of the forehead in the midline is approximately equal to the horizontal width of the hemiforehead just above the eyebrows.

An incision completely within the hairline, or one initially in front of the hairline and then within the hairline down to the temporal region, will allow rotation of the whole of the remaining forehead.

It can be seen that to again achieve good coverage of a secondary defect after excision of the lesion, scoring has begun. As can be seen in later photographs, this will allow a flap that seems inadequate to easily close the defect that has been created and to achieve a nice reconstructive result.
The vertical edge of the flap becomes the horizontal suture line. In this technique, two rotational movements are being used: the loose scalp of the temporal area is being stretched, and the lateral scalp areas on both sides are being advanced. A full-thickness scalp graft is used to provide an eyebrow (see p. 64).
Some asymmetry of the eyebrows and the hairline may occur, but this is usually acceptable when compared with the original problem.

**PROBLEMS**

Careful preoperative assessment and planning are the secrets to success for this procedure. If the hairline is low, the flap will not be large enough to close the defect. Wide undermining of adjacent scalp will be necessary for closure, but it will be under tension, and necrosis of skin edges or parts of the flap may result. Even if healing occurs, the hairline and eyebrows may be distorted. Scoring of the galea transversely will gain flap length, and this may provide less tension in the closure. Care must be taken not to cut deeper than the galea to prevent the vascular supply from being transected.
Anterior-Posterior Scalp Rotation Flap

The penetrating squamous cell carcinoma was dissected with liberal skin margins, together with underlying full-thickness cranial bone resection. The postexcisional defect can be seen. The dura was exposed.

A large transverse rotation flap was elevated. The defect was reconstructed without tension. The lesson to be learned from this is that the flap must be large and must be dissected extensively to allow closure without tension. If there are problems with closure, the galea should be scored vertically to expand the flap size.
This patient had a squamous cell carcinoma of the left frontotemporal region. An anterior-posterior scalp rotation flap was planned.

Vertical scoring of the pericranium and galea was performed to lengthen the flap. This allowed the flap to be brought forward without tension. This lack of tension is well illustrated by the excellent perfusion when the defect was closed. In scalp flaps, if there is any suggestion of tension in the closure, it is sometimes useful to use a back cut in the posterior end of the incision (see Chapter 1).
Bilateral Transverse Forehead Advancement Flaps

This patient was first seen with the difficult problem of a large midforehead basal cell carcinoma. The transverse laxity of her forehead was assessed (see p. 53). It seemed possible to use bilateral flaps to close the defect. The lesion was resected with good clearance, and the transverse advancement flaps were elevated.

With wide dissection laterally, sufficient lateral laxity was obtained to allow closure with minimal tension. Excision of Burow’s triangles may be necessary to gain additional advancement (see p. 14).
**Bilateral Rotation Flap**

When scalp mobility is insufficient to obtain defect closure with one flap, bilateral rotation flaps may provide the solution. This method has been applied in this patient with recurrent forehead basal cell carcinoma after surgery and radiotherapy.

The defect was triangulated (the base being inferior) in a frown line, and the lesion was resected in this particular case with the underlying outer table of skull.
Chapter 3  Forehead Reconstruction

Posteriorly based bilateral scalp rotation flaps were raised above the pericranium and rotated anteriorly to close the defect. A dog-ear will often appear at the superior angle of the triangle and needs to be trimmed to avoid a standing cone deformity. In rare instances, bilateral back cuts may be necessary to facilitate closure. Again, these can usually be closed directly. The scars are in a fairly good position, but the forehead is denervated.
Because these rotation flaps are bilateral, symmetry is maintained and the result is acceptable, especially after time has elapsed and the scars have matured.

**PROBLEMS**

The problems associated with bilateral flaps are similar to those encountered with unilateral flaps. If both flaps are unduly tight, bilateral necrosis may occur, resulting in a larger secondary defect.

The flaps must be raised with care; it is possible to carry the lateral incisions too far posteriorly, thus depriving the scalp of circulation above these incisions. The surgeon must always stop before reaching the occipital vessels, and a generous vertical back cut is performed if necessary. Vertical galeal scoring may help with closure. Suturing under tension without trying to achieve closure and waiting a short while may produce enough stretch to allow safe wound closure.
SUPRAEYEBROW RECONSTRUCTION

The area above the eyebrow is difficult to reconstruct, because the slightest error in judgment will lead to eyebrow displacement and noticeable asymmetry. A skin graft is not acceptable because of the obvious pale, matte skin patch appearance it creates. In the past, a full-thickness forehead skin graft of half the dimension of the defect was taken from the same position on the other side with the thought that both eyebrows would be raised and symmetry maintained. Unfortunately, this skin also became pale, and the result was unsatisfactory.

Island Flap

The island flap provides an ideal solution for reconstructing the supraeyebrow area and meets the requirements of flap selection: replacement of like tissue with like tissue without creating distortion of normal anatomic landmarks.

This patient illustrates the effective use of island flaps in this area. The patient had a supraeyebrow basal cell carcinoma, and excision of this lesion left a significant defect. Direct closure of this defect would have caused unacceptable elevation of the patient’s eyebrow.
An island of skin with a subcutaneous pedicle was incised to just above the perios- 
teum and, based on the superficial temporal vessels, could be raised and tunneled 
under the forehead skin to close the raw area. The pallor of the flap is due partly to 
manipulation, but in addition, epinephrine was used to reduce bleeding.
The donor site was closed with a small scalp rotation flap. This gave a good result without distortion of normal anatomic features.

This type of island flap need not always be raised on known vessels; it can be constructed on a subcutaneous pedicle based on a transposition flap design. This has been shown to be a safe and satisfactory flap. There must be absolutely no tension on the pedicle, and the tunnel to the excisional defect must be generous in the extreme. It may be possible to close the secondary defect as an ellipse and end with a scar in a frown line.

**PROBLEMS**

The island is planned carefully on a known vascular pattern. Sometimes a definite vessel will be included in the pedicle. Ischemia will occur if the pedicle is too long, under tension, or constricted within its tunnel. As with any other flap, serious vascular impairment requires placement of the flap back in its original position with the hope that it will survive. Because the flap is circular, it may pincushion.
Hatchet Flaps

The use of hatchet flaps, described by Emmett, is shown below. When a lesion is excised in a circular fashion, the triangles of skin that would have to be excised laterally to convert the circle into an ellipse can be used in closure of the defect. It is from these that hatchet flaps are constructed.

The hatchet flap is basically a V-Y advancement flap. The shaft of the hatchet provides a skin pedicle in addition to the subcutaneous pedicle. If the skin pedicle is sacrificed, the hatchet flap becomes a kite flap.

If it seems there will be problems with mobilization of the flap, the “handle” of the hatchet should be divided.

This patient had a nevus above the left eyebrow; its excision created a small but significant defect. A small raw area in this region can be a considerable reconstructive problem, requiring the addition of tissue. Simple closure would cause deformity and asymmetry because of the resulting eyebrow displacement.
To produce a minimal amount of scarring, the reconstruction must come from the supraeyebrow region.

The flaps are raised as bilateral triangles on subcutaneous pedicles situated immediately under the flaps, but they also have small skin pedicles.
As dissection proceeds around the flaps, medial movement is facilitated and closure is possible without tension.
As the bases of the triangles are approximated, the resulting defect is closed directly without tension. Closure is achieved in a V-Y fashion.

The position and contour of the eyebrow are maintained. Vascular insufficiency has not been encountered.

**PROBLEMS**

Hatchet flaps seldom become ischemic, but this possibility exists if they are sutured under tension and subsequent compromise of the pedicle circulation occurs.

This approach produces multiple scars; if healing is not good, these may be obvious and require revision or dermabrasion. If flap loss were to occur, another local flap reconstruction would be necessary.
Rhomboid or Limberg Flap

The rhomboid principle can be adapted to forehead and anterior scalp resections in bald men. It may be possible to reconstruct small defects with single rhomboid flaps, but this is not usually the case. From the viewpoint of tension and vascularity, it is much better to spread the load. In the upper forehead superficial squamous cell carcinoma, a triple rhomboid (hexagonal) excision is planned. The three projected rhomboid defects can then be reconstructed with three rhomboid flaps. As illustrated on p. 17, the feasibility of success is determined by pinching the skin in the area of the projected rhomboid. If the fingertips can be brought together comfortably with the intervening skin between them, the reconstruction is possible.
After hexagonal excision of the lesion, the three rhomboid flaps based on the component rhomboids of the hexagon are planned.

The rhomboid flaps are incised and then elevated. The elevation should be complete; to achieve adequate transposition, undermining should be taken beyond the bases of the flaps.
When the flaps are transposed, there should be minimal tension on them. Should tension occur, further lateral dissection under the bases of the flaps is necessary.

Closure of the secondary defects is often difficult; again, this may require some scalp undermining to prevent undue tension in the closure. The flaps are pale because of epinephrine infusion.
The result in this exposed area is very acceptable.

**PROBLEMS**

The disadvantage of this use of the Limberg technique is the multiplicity of scars. There is no possibility of placing these in ideal lines, and one cannot always achieve scars as good as those obtained in this case. The lack of pincushioning (trapdooring) is a feature to be noted. If any type of circular flap is used, this problem would most certainly occur.

This procedure should be attempted only by those experienced in the use of rhomboid flaps. There is a delicate and narrow line between outstanding success and disastrous failure, particularly if the pericranium has been sacrificed. The all-too-familiar sequence of tension, ischemia, necrosis, exposed bone, and “where do we find another flap?” results from a failed flap procedure in the forehead.

The most significant problem resulting from this technique is the many scars it produces. These scars are aesthetically and oncologically undesirable. In cancer excision, it is best to produce the simplest scars possible. Nonetheless, in carefully selected cases such as the one illustrated here, this procedure can yield acceptable results.
RECONSTRUCTION OF TEMPORAL SKIN DEFECTS

The margin for reconstructive error in the temporal area is small because it has well-defined, obvious anterior and posterior boundaries, the lateral end of the eyebrow and the temporal hairline. Any distortion of these natural landmarks is obvious and unacceptable. In addition, the lateral canthal area can be distorted by an ill-planned reconstructive procedure that can result in obvious asymmetry. The surgeon should also be familiar with the facial nerve distribution in this area.

Rhomboid or LLL Flap

The rhomboid flap, or the LLL flap of Dufourmentel, can provide an ideal solution for reconstructing the temporal area, provided care is taken with the position of the hairline and the lateral end of the eyebrow.

LLL Flap (or Rhomboid Flap) on Temporal Area

In the basal cell carcinoma shown here, an LLL flap reconstruction was performed. This patient had a basal cell carcinoma involving the lateral eyebrow and temporal area. Primary closure of the defect in any direction would cause deformity of the eyelid or the eyebrow. To obviate this problem, an LLL reconstruction was planned. It should be noted that the planning results in a slightly narrower flap with a more acute closure angle.
The planned rhomboid excision is completed and the LLL flap incised.

The flap is transposed without difficulty into the rhomboid defect. Again, undermining beyond the base of the flap has been performed. Some surgeons zigzag the hairline incision, as shown in the inset (*center, above*). They feel that it improves the quality of the scar in this area.

The defect is closed without tension or undue distortion of natural anatomic landmarks.
Double Rhomboid Flap

If the lesion is large, it is convenient if possible to establish a long defect composed of two rhomboids, one adjacent to the other. This defect is oriented in such a way that a forehead and a cheek rhomboid and a temporal rhomboid can be constructed. The defect can then be closed without disturbing the anterior and posterior boundaries of the area. The various possible permutations of rhomboids are shown here. The defect may be closed with flaps $d$ and $a$ or flaps $c$ and $b$. 
In choosing a flap for reconstruction, the plastic surgeon should be aware of tissue availability (see Chapter 1) and should use the flaps that will cause the least disturbance of anatomic landmarks. The thicker upper skin is replaced with temporal skin, and the lower area receives the slightly thinner lower temporal skin.
After excision of the basal cell carcinoma, the plan for this patient is to close the postexcisional defect with the two rhomboid flaps: one of thick upper forehead skin and one of thinner skin from the upper temporal area.

These flaps are widely undermined until they can be transposed in an effortless fashion. If this is difficult, further undermining of the scalp will help to achieve closure.
If the undermining has been sufficient, the flaps should lie comfortably, without tension, and the donor defects close almost automatically.

The flaps have been sutured in position and the donor defects closed with minimal trimming and adjustment of skin. If there is oozing under the flaps, a small suction drain can be placed; this is a universal rule with flaps of all varieties.
The aesthetic result is usually satisfactory with no displacement of normal features.

**PROBLEMS**

The Dufourmentel flap is complex to design and is rarely chosen over the much simpler rhomboid flap. Both have the advantage of being predictable and geometrically conceived. Unfortunately, both flaps have the disadvantage of producing many scars. However, it is amazing that hypertrophic or stretched scars are rarely seen. If any errors in planning are made, there may be difficulty in rotating the flap into the defect or in closing the donor site. Usually this problem can be overcome by wider undermining or modification of the flap.
GLABELLAR RECONSTRUCTION

Because the skin in the glabellar region is mobile, relatively large defects may be closed directly, especially in a vertical direction; this is related to the lines of minimal relaxed tension. If a defect stretches to the medial end of the eyebrows, however, direct closure will cause approximation of the eyebrows. In addition, removal of excess skin above and below this area would necessitate a long scar running up onto the forehead and down onto the nose. The reconstruction must maintain the medial ends of the eyebrows in a good position; also, it should not interfere with upper lid function. Closure of a defect in this area is challenging and necessitates the use of a single transposition flap in case of small defects or several if the defect is of significant size.

Rhomboid Flaps

The defect that will be created by the required excision of this moderately large basal cell carcinoma of the glabellar area is such that direct closure would result in unacceptable advancement of the medial ends of the eyebrows.
The tumor is excised as a rhomboid, and a superior rhomboid flap is used to close this defect.
The flap donor site closes directly because of the transverse laxity of the forehead.

The postoperative result after 6 months shows good scar resolution and a satisfactory reconstruction without significant disturbance of local anatomic features.
Multiple Transposition Flaps
Rhomboid transposition flaps are satisfactory on the forehead provided that the skin is available and the donor scar is in a good position. Tissue steal is shared by using bilateral flaps in large defects. The principle, which is fundamental to all midline reconstructions, requires that the eyebrows always be moved in a symmetrical fashion to preserve facial harmony.

The cases presented here illustrate the usefulness of geometric flaps in large defect closure.

Multiple Rhomboid Flaps for Glabellar Reconstruction

This patient had a malignant melanoma that was excised several years previously. The resulting large raw area was covered with a split-thickness skin graft. The patient wished reconstruction, and thus our imaginations were significantly taxed. Five rhomboid flaps were used: two from the forehead laterally, two from the upper eyelids, and one from the central region of the nose.
The shield-shaped defect has been created by excision of the old skin graft. The five rhomboid flaps—\(a, a', b, b', \text{ and } c\)—are incised.

The forehead rhomboid flaps are elevated, their bases undermined, and their rotation is assessed. The ease of closure of the donor defects is also evaluated.
The forehead donor site defects are closed directly, and the forehead rhomboid flaps are rotated down medially and sutured into position. The upper eyelid rhomboid flaps based inferiorly are incised.

These thin upper eyelid flaps are transposed to close most of the lower portion of the glabellar defect. The donor sites on the upper eyelids are closed directly, as in a blepharoplasty. The nasal bridge rhomboid flap is incised and elevated.
The nasal bridge rhomboid flap is sutured into position without tension, and the defect is closed completely.
It can be seen in the early postoperative phase that even with maximal swelling there has been little or no distortion of the eyebrows or eyelids and the flaps lie comfortably to close this large defect.

**PROBLEMS**

Poor flap design may cause distortion of natural anatomic features such as the eyebrows, canthi, and eyelids. Multiplicity of scars is a disadvantage, and the mixing of various types of skin can result in a poor aesthetic result. However, as in the last case illustrated, there may be no other reasonable alternative. As will be emphasized throughout this book, planning and imagination are essential.

**Management of Complications**

The forehead does not contain a great deal of excess skin; thus some degree of tension is present in many forehead reconstructions. If this tension is excessive, flap necrosis and its resulting disastrous consequences may occur, the worst being exposure of bone.

Epidermolysis is the most benign of the ischemic complications. It is managed conservatively, in effect through inactivity. The area is exposed, and becomes dry and demarcated. The crust that forms gradually flakes off. Unfortunately, epidermolysis usually results in pale, flat scarring.
Full-thickness skin loss with preservation of subcutaneous tissue is managed with debridement and dressings until skin grafting can be performed. If possible, later excision of the scarred area with direct closure is performed.

Full-thickness loss with exposure of bone presents a considerable problem. Leaving the bone to sequestrate is miserable for the patient, and demoralizes both the patient and the physician. Total removal of the outer cortex with exposure of the diploe, with frequent dressings being applied until healthy granulation tissue appears, and later skin grafting is acceptable, but these measures are not always completely successful.

Often the best solution to full-thickness loss is a local transposition flap with direct closure of the donor site or closure by means of a skin graft. This procedure produces an immediate reconstruction and allows time for reflection on future management. The use of scarlet red gauze dressings in this situation has resulted in rapid healing. Even more amazing, this has been achieved when these dressings are applied to skull bone devoid of periosteum (see Chapter 10).

With good planning and experience, the surgeon can minimize tension and ischemia and avoid complications, except in rare instances. If the defect is large, application of a VAC apparatus can lead to early formation of granulation tissue. This allows grafts to be applied much earlier.

In lateral forehead and scalp advancement, the horizontal incision along the lower forehead—if it extends far enough laterally and is deep enough—can divide the frontal branch of the facial nerve, potentially causing frontalis palsy. If bilateral frontalis palsy results from bilateral rotation flaps, it seems of little concern to most patients, some of whom are very content to lose their forehead wrinkles!

---

**Surgical Techniques of Choice**

For general forehead reconstruction, rotation flaps are secure and aesthetically acceptable. If additional flap length is needed, the arc of rotation can be increased with a back cut. Further movement is gained by galeal scoring. In dire situations, the size of the back cut may be increased and a skin graft inserted. Moderate alterations in the hairline are usually acceptable to both surgeon and patient. In the supraeyebrow, temporal, and glabellar areas, some degree of imagination is necessary. The flaps outlined in this chapter have been designed to cause minimal alteration of anatomic landmarks and therefore are recommended.
## Choosing the Best Option for Forehead Reconstruction

<table>
<thead>
<tr>
<th>Anatomic Area</th>
<th>Problem</th>
<th>Special Considerations</th>
<th>Flap of Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main forehead area</td>
<td>Contour changes and alterations in skin color are obvious</td>
<td>Hairline and eyebrow symmetry should be maintained; frontalis muscle should not be damaged if possible</td>
<td>Rotational scalp flap from posterior to anterior</td>
</tr>
<tr>
<td>Supraeyebrow area</td>
<td>Slightest error in judgment leads to eyebrow displacement and noticeable asymmetry</td>
<td>Skin grafts are totally unacceptable because of patchwork appearance</td>
<td>Island flap</td>
</tr>
<tr>
<td>Temporal region</td>
<td>Limited margin for reconstructive error</td>
<td>Well-defined anatomic anterior border (lateral eyebrow) and posterior border (temporal hairline) should be preserved</td>
<td>Rhomboid flap</td>
</tr>
<tr>
<td>Glabellar region</td>
<td>Maintenance of the medial ends of eyebrows in a good position and noninterference with upper eyelid function are essential in reconstruction</td>
<td>Relatively mobile region, therefore primary closure may be preferred, unless it causes long vertical scars extending to forehead and nasal dorsum and unacceptable advancement of the medial ends of the eyebrows</td>
<td>Rhomboid flap</td>
</tr>
</tbody>
</table>
### Rationale

Especially good for males with baldness

Ideal solution for reconstruction; replacement of tissue with like tissue without creating distortion of normal anatomic landmarks; should be planned carefully on a known vascular pattern

Inferiorly based, slightly narrower lateral rhomboid flap with a more acute closure angle should be preferred

Flap donor site closes directly because of the transverse laxity of the forehead and postoperative scarring is satisfactory without significant disturbance of local anatomic features

### Second Choice

Laterally based unilateral rotation flap

Worthen rotation flap

Bilateral rotation flap

Multiple rhomboid flaps

Hatchet flap

Kite flap

Double rhomboid flaps

Multiple transposition flaps

### Caveats

Galeal scoring parallel to the leading edge of flap

Scalp stretching to use the viscoelastic properties of skin

Closure under tension may be disastrous

Ischemia of island flap may occur if the pedicle is too long, under tension, or constricted within its tunnel; replacement of ischemic flap to its original position may salvage the problematic flap

Inferiorly based rhomboid flap places the donor site closure line to temporal hairline, which can be further camouflaged by zigzag closure

Errors in preoperative planning in multiple transposition flaps lead to distortion of natural anatomic features, such as eyebrows, canthi, and eyelids

Multiple scars and the mixture of various types of skin may result in poor aesthetic result
References—With Key References Annotated

Nose Reconstruction

Thou canst tell why one’s nose
Stands i’ the middle of one’s face?
Why, to keep one’s eyes of either side.

WILLIAM SHAKESPEARE
King Lear

His nose, that feature of the human face
That changes most, is growing to a point;
The countenance is sinking into mysterious depressions,
The outlines are thickening.

HONORÉ DE BALZAC
Beatrix: Claude Vignon

Occupying the most prominent position of all facial features, the nose presents a challenging reconstructive problem for the surgeon. Noses vary in size and shape and in ability to function. Some noses allow for clear breathing, whereas others are almost totally obstructed. The cause for nasal obstruction may also vary; it may be truly mechanical, as in posttraumatic airway obstruction, or it may be the result of an allergic rhinitis, or lateral weakness causing valving. The nose has a complex surface contour and a skin covering that lacks uniformity in texture, color, and appearance.

The contour of the nose varies from area to area. The lines of minimal relaxed tension are vertical in the glabellar area (frown lines) and transverse over the remainder of the nose. Transversely across the bridgeline, the nose is convex. A vertical cross section through the midline may be concave or convex, or it may even alternate.
along its line from one to the other. The sides of the nose are concave but tend to be convex toward the rims. If the alar rim is considered in an anteroposterior plane, it is convex. Junction areas such as the nose-cheek, nasolabial, alar-lip, and columellar lip regions have their own characteristic form that must be preserved in any reconstructive endeavor.

**Anatomy**

**SKIN**

In the glabellar area, the skin is thin, pale, and pliable and may contain a significant element of eyebrow skin, depending on the position of the medial ends of the eyebrows, whereas the skin covering the bony skeleton and the sides of the nose is usually pale, thin, and of matte texture.

The skin in the nasal tip area exhibits considerable variation. It is always thick, but in some individuals, particularly men, this skin is much thicker; it is soft and oily, with a shiny surface. Frequently the pores are wide and obvious, and the color may appear pink, deep red, or even slightly purple. The skin color changes with age; in older patients it is often more lightly colored. Telangiectasia and the presence of hair may be evident in varying degrees. Slight rhinophyma frequently occurs, as do comedones. In black patients the skin is shiny, and hairs and pores are less obvious; the skin color is slightly darker than on the rest of the face.

The alar rims may be thickened and rather spongy or, in women, sharply etched and refined. The form of the columella is variable; it may hang low, exposing the vibrissae, or it may be retruded and not visible on profile.

The nose is lined with hair-bearing squamous epithelium.

**MUSCULATURE**

The muscles of the nose are the procerus, compressor naris, and depressor septi. The procerus muscle arises from the nasal bone and inserts into the glabellar skin. It produces the transverse wrinkles at the nasal bridge. Extending from the maxilla lateral to the incisor teeth to the nasal bridgeline, the compressor naris muscle compresses the nasal aperture. The depressor septi muscle arises from the maxilla above the incisors and inserts into the septum. It helps to widen the nasal aperture.

**NERVE SUPPLY**

All muscles are supplied by the upper buccal branches of the facial nerve. Skin sensation is provided from the ophthalmic nerve through the infratrochlear and the external nasal branches, and the infraorbital branch from the maxillary nerve.
Studies of the blood supply of the face show that there are multiple vessels, particularly in the midline and in the temporal area. It can be seen that flaps for nasal reconstruction can be raised certainly down to the medial canthal area and probably beyond. It is our custom (relying on these dissections) to base midline forehead flaps below the medial canthal area if so required. The anatomic reasons for adopting this policy are presented in the following pages. This means that there is never a problem in getting the forehead tissue down to the nasal tip, to the columella, and to the alar bases. Keeping this vascular anatomy in mind, surgeons can have a high degree of confidence in using midline forehead flaps for nasal reconstruction.
These dissections and the preceding ones, performed in our cadaver laboratory, clearly demonstrate the frontal, nasal, and maxillary vasculature in the midface area. There is an abundant network of vessels that allows long flaps and even narrow flaps to be accurately elevated with a superior or inferior base. This anatomic study has allowed us to raise skin flaps on a very narrow pedicle. This in turn provides greater flap mobility.

The alar region and the lower part of the septum are supplied by the alar and septal branches of the facial artery. The dorsum and the lateral areas are supplied by the dorsal nasal branch of the ophthalmic artery and the infraorbital branch of the maxillary artery. Venous drainage is provided by the anterior facial and the ophthalmic veins.
USE OF DOPPLER IMAGING FOR FLAP PLANNING

It is important to study the vascular supply of flaps to be used. The use of Doppler imaging has become an essential part of flap planning. This can accurately map out the vascular supply.

The regional vascular pattern has also been well displayed using radiologic studies. Cadaveric dissection studies are also useful for understanding these vascular patterns. Our region of interest has been in the orbitonasal area.

After the cadaver studies, vessel injections have illustrated the nasal vessels very clearly. The findings in this study have allowed us to change the design of the forehead flap for nasal reconstruction.
Vessel injections reveal a very rich anastomosis between the cheek paranasal and frontal vessels.

The base of the flap can be safely situated in the medial canthal area or below. This allows the nasal tip and columella to be reconstructed without tension. Since appreciating this anatomic arrangement, we have found nasal reconstruction to be much less stressful.
**LYMPHATIC DRAINAGE**

The external nose drains to the facial lymph nodes lying in relation to the anterior facial vein. The anterior part of the nasal cavity drains to the submandibular glands. The remaining portion of the intranasal area drains to the upper deep cervical nodes. The posterior part of the nasal floor drains to the parotid lymph nodes.

**Aesthetics**

The nose is a very positive facial feature, and any change in its shape, color, or skin cover is obvious. Therefore no effort must be spared to maintain its normal appearance. The surgeon must carefully choose a method of reconstruction, bearing in mind skin color, texture, and nasal topography.

**Placement of Incisions**

The incisions should follow natural lines if possible; they should be vertical or transverse, as required, in the glabellar area and vertical in the main nose area or along the junction of the lateral nose and the cheek. It is important that no incisions be placed across concavities. Bridling caused by scar contracture will occur and will require later revision, usually by Z-plasties.
**Areas of Tissue Availability**

To reconstruct nasal defects, the surgeon can use local flap tissue available in the following six facial areas: (1) nose, (2) forehead, (3) glabellar region, (4) retroauricular region, (5) cheeks, and (6) neck.

Many ingenious methods have been devised to transport skin to the nose from the areas of availability. The method selected should produce the best nasal form and contour, and provide the closest match in skin color and texture. It should not deform the area from which it is taken.

**Areas to Be Reconstructed**

In considering options for nasal reconstruction, it is convenient to divide the nose into several distinct areas: the medial canthal region, the side of the nose, the nasal tip, and the columella. Partial and total composite nose reconstruction should be considered separately. The nasal contours are of such complexity that each site presents a unique challenge. Many options exist for reconstructing each of these regions. An unwise choice of procedure, however, can pose significant problems later.

**Medial Canthus**

Non–hair-bearing skin is essential for reconstructing the medial canthal area. This skin must be contoured into the biconcave form of the canthal region. A flap may have to be long and wide in cases in which the medial ends of the eyelids also need to be reconstructed.

Although full-thickness skin grafting can give reasonably good results in this area, it cannot be used if the full thickness of skin must be sacrificed down to and including the periosteum to effect resection of a tumor or if trauma causes a similar defect. A skin graft will not take if it is applied directly to bone. In such a situation, a glabellar skin flap is the treatment of choice.

**Glabellar Flaps**

The glabellar donor area contains an abundant source of skin for resurfacing nasal defects. Because the skin in this area is thin, it provides a good color and texture match for the upper nasal area. The glabellar flap can be transferred in the following three ways: as a rotation flap, as a midline transposition flap, and as an island flap. The last two types are more flexible, and they can be enlarged and contoured as required.
The classic glabellar flap is a rotation flap that incorporates a V-Y advancement in the glabellar region. The use of this technique is demonstrated here; the illustration shows a patient with a basal cell carcinoma of the medial canthus and a glabellar flap outlined for closure.

The lesion is resected in a triangular fashion. The flap is designed and raised at the level just above the glabellar musculature.
The movement of the flap is part rotational, part transpositional. Trimming may be necessary.

The donor defect is closed without difficulty and with only slight distortion of the medial end of the right eyebrow.
Although the classic glabellar flap is the time-honored method of reconstruction in this area, it has some defects and is not the method of choice. In this patient the result looks fairly good, but close examination reveals some eyebrow hair in the medial canthal area.

For cases in which larger flaps are used, a superior Z-plasty is planned. This approach has the advantage of increased movement of the flap toward the involved canthus as the secondary defect is closed by transposition of the Z-flaps. The scars are usually acceptable, but there is always a risk of increased deformity when scar complexity is increased.

**Problems**

In many patients eyebrow hair is present in the glabellar region, and the rotation of this skin moves the hair-bearing area down into the medial canthus. This is unacceptable. Unfortunately, the thickness of the glabellar skin is greater than that of the skin removed from the medial canthal area, and this causes some convexity in this...
region (rather than the natural concavity). This can be a bonus if nasal bone needs to be removed; the resulting defect is neatly filled by the flap bulk.

When the medial ends of the upper and/or lower lids require reconstruction, the design of the glabellar flap does not allow the required lid reconstruction to be accomplished satisfactorily. The reason is that the flap dimensions are fixed; the flap is not readily extensible. Also, the thickness of the skin is unsatisfactory for lid reconstruction.

**FINGER FLAP**

A midline transposition flap, or finger flap, is probably the most versatile approach to reconstruction of the glabellar region and is the method of choice. This flap can be used in the reconstruction of a defect after excision of a medial canthal basal or squamous cell carcinoma.
The finger flap has a simple design and allows transfer of non–hair-bearing relatively thin skin by suitable transposition. The secondary defect is closed directly with ease.

If the flap has any skin excess, it will be exhibited as a standing cone in the inferior rotation area. The excess can be trimmed without difficulty and without compromising the blood supply of the flap.

The result of any reconstruction produced by this method is usually excellent. If the medial portions of the upper and lower lids require reconstruction, a longer and perhaps slightly wider flap can be raised and incised to create a fork. The limbs of the fork are then set into the lid defects, as shown in this patient.

**PROBLEMS**

Although the midline transposition flap allows for ease of reconstruction, the skin is often somewhat thick for use as eyelid skin, and this may be noticeable on close inspection. In some cases, a straight-line scar in the glabellar-nasal bridge concavity may result in a bridle deformity because of contracture along its length. Should this deformity occur, it will require later Z-plasty to ensure satisfactory contouring.
Glabellar Island Flap

The glabellar island flap can be used instead of a transposition flap, with the same indications for its use. Although the procedure is interesting and elegant to perform, it takes longer and has little to recommend it over direct transposition. In addition, it cannot be used for eyelid reconstruction. The only advantage of this flap is its lack of skin deformity (for example, a standing cone). Again, a medial canthal defect has been created by excision of a basal cell carcinoma. The principle for design of this flap is the same as that of the Barron-Emmett flap; the flap has a random subcutaneous pedicle extending from the undersurface of the flap down to the point of rotation. In the case shown, the pedicle is based on the right supraorbital vessels.
For extensive and long flaps, it is probably wise to include some of the supratrochlear vessels in the pedicle if possible. A tunnel is created in the glabellar area to allow the flap to be drawn down and transposed into the defect. This tunnel should be spacious to prevent compression of the pedicle.
The donor defect is closed directly with excision of triangles of skin superiorly and inferiorly.

The result shows that the flap has contoured well to the concavity of the medial canthal area. Skin color and texture match are good, and the vertical forehead scar is aesthetically acceptable. There is no distortion of local anatomy.

**PROBLEMS**

The pedicle forms an obvious swelling in the nasal bridgeline area. Fortunately, in most cases this swelling will subside with time. The procedure is slightly complicated, and there is an element of risk because of vascular insufficiency; this is not present in the direct transposition flap. As the flap is turned through 90 degrees and taken through the subcutaneous tunnel, the pedicle may be compressed and occluded, a problem that may become compounded by postoperative swelling. There may be more of a tendency for the island flap to “trapdoor” because of its circular design. Most significant is the fact that the procedure takes a longer time to perform, which is always an important consideration.
Central Forehead Flap

This 6-year-old child was diagnosed with hypotelorism at birth; he also has asymmetry of the lower eyelids. With time the condition has become more noticeable, particularly the underdevelopment of the nasal bridgeline and the hypotelorism.

This is explored through a bicornal approach. The narrow nasal bridgeline can be seen.
The frontonasal complex is removed and the significant posterior narrowing of the interorbital area can be clearly seen.

A central osteotomy is performed in the frontonasal region and the orbits are moved apart. A cranial bone graft is placed in the interorbital region.

After the application of a further cranial bone graft to give more nasal protrusion, the orbit and nasal skeleton are placed back in position and the frontal area is reconstructed. Shortage of skin necessitates that a release be carried out to accommodate the reconstructed frontonasal skeleton. A significant defect results from this maneuver.
To reconstruct the nasal bridgeline, a midline forehead flap is designed and turned down to provide adequate nasal coverage.

A satisfactory end result is achieved.
With time, the frontonasal orbital area has receded and the patient requests correction. This is performed using hydroxyapatite cement.

Despite some facial asymmetry, the patient at 12 years of age is pleased with the end result.

This case illustrates that the soft tissue problem has to be understood when assessing the skeletal deformity. In this case, I had not anticipated that there would be such a large full-thickness nasal defect after augmentation with the cranial bone graft. This then required the introduction of a local flap to cover the enlarged nasal skeleton.
PROBLEMS

There are few problems related to reconstruction in this area. The success and security in using flaps from the forehead area have greatly increased as a result of our vascular injection studies. Taking into account the information gained from these investigations, flaps can be designed with narrower and larger bases, which in turn allows reconstruction to be performed with less tension and fewer complications.

Surgical Technique of Choice

The most versatile flap is undoubtedly the finger flap. This is a transposition flap. It is reliable and extensile, and the skin color and texture provide a good match for the medial canthal area. The finger flap can be well contoured to the complex curvature of this region.Trimming, shaping, and splitting do not compromise its robust blood supply. Although in some instances the thickness of the flap may be a disadvantage, occasionally it may be a blessing. For example, when a radical resection of deep basal cell or squamous cell carcinomas is required, the underlying nasal bone and mucosa may be sacrificed. In this situation, a thick flap with underlying subcutaneous tissue totally fills the resulting deep defect and obviates a contour deformity. In addition, there is no need to be concerned about nasal lining. It would appear that the intranasal defect—that is, the undersurface of the flap—becomes covered with mucosa, and this healing process has no effect on the external contours of the flap.
LATERAL ASPECT OF THE NOSE

This region is flat or slightly concave, but it is bounded by a convexity anteriorly and a concavity posteriorly. Its inferior margin is the alar rim, which is mobile, convex, and easily distorted. These natural boundaries should be respected; transgression with alteration of their distinct topographic features is unpardonable because nasal asymmetry will inevitably result.

Full-Thickness Skin Graft Versus Local Flap

The lateral aspect of the nose is sometimes viewed as a cosmetic unit. As such, it can be reconstructed with a full-thickness graft, which sometimes gives an excellent result. This illustration shows such a reconstruction with postauricular skin from the recommended donor site. The result is unacceptable, particularly when the ipsilateral side of the nose is considered; this area had a similar defect reconstructed with a local bilobed flap. Nasal skin, especially in male patients, usually defies a good match with a skin graft; the nasolabial area has been recommended as a good nasal skin donor site, but in practice it has not proved satisfactory.
Cheek Advancement Flap
Cheek advancement flaps are ideal for resurfacing the nose-cheek junctional area. The flap is raised at the subdermal level with minimal subcutaneous fat. This thin flap then provides good cover both from a textural and color perspective. Some subcutaneous fixation may be indicated at the nose-cheek junction to achieve a satisfactory concavity in this area. As will be seen in the case presented, removal of inferior and superior Burow’s triangles laterally at the flap base greatly helps in advancement and contouring.

This patient has a recurrent, postradiation basal cell carcinoma in the right nose-cheek region. It is difficult to estimate where the edges of the lesion are.
A resection is carried out under frozen-section control. This involves the lateral aspect of the nose and the anterior cheek region.

A large cheek flap is elevated and hemostasis established. To gain anterior movement of the flap, Burow's triangles are resected from the preauricular and anterior mandibular skin. As these are closed with sutures, the flap automatically advances into the correct anterior position.
After extensive undermining laterally, it is possible to close the defect without undue tension.

In the long term, a very satisfactory result has been achieved. He has no functional problems and no recurrence of the tumor.
NASAL-CHEEK DEFECTS
Lateral Advancement Flap

These are similar to the flaps presented in the previous case. In this patient it will be possible to pay more attention to the cutaneous anatomy. The flap on the right side will be composed of nasal skin, and it will be advanced to the left nasal-cheek junction with excision of Burow’s triangles at its base. On the left side the flap will be cheek skin and again it may require excision of Burow’s triangles. This is only known when the flap is raised and advanced—in this case they were not necessary. The junction line for the flap edges is estimated to be at the left cheek-nose junction. It is important not to commit to a complex design unless this is absolutely necessary. This case is a good example of this philosophy.

When a defect is created in the lateral aspect of the nose, and continues into the cheek area, then this must be shared between cheek and nose for reconstruction.
To advance the cheek into a satisfactory position, it is necessary to elevate a fairly extensive flap and transpose this flap into the nasal-cheek groove.

This, of course, is a very versatile flap that moves easily. It is the nasal aspect that one must judge carefully, and this is in relation to how much movement can be achieved in the skin over the nasal bridgeline once it has been elevated and advanced into the cheek area. Burow’s triangles required excision on the right flap base, but not on the left side of the nose. It is desirable to have the suture line joining the two flaps in the nasal-cheek concavity.

This has been achieved in this patient. He has a rather nice result.
**V-Y Advancement Flap**

The V-Y advancement flap is used when the flap movement required to reconstruct the defect is small. It is based on the underlying tissue and requires lateral mobilization to obtain forward movement. The important point is not to compromise the area of the base. The mobility comes from the depth of the pedicle. The dissection is taken down to the underlying muscle or fascia all around the island. It is this freed-up block of soft tissue that allows the flap to be moved into the defect. As with all flaps, there should be no tension. Careful preoperative planning and care in elevation are essential points to ensure flap success.

This patient presented with a basal cell carcinoma of the right nasolabial alar base area. The plan is to resect the lesion and reconstruct it with a V-Y advancement flap.

After resection, the island flap is elevated.
The triangular flap fits nicely into the alar base area and preserves the nasal anatomy. Note the concave design at the medial edge of the flap.

The postoperative result shows maintenance of the alar base in its current position in relation to the cheek, thus preserving the symmetry of the nasal tip area.

**Problems**

This is an elegant reconstruction, but it should be noted that its movement is limited and good judgment is required. The pedicle should be handled very carefully. In the long term, the island may pincushion above the surrounding skin. One solution in the long term should this occur is to remove the skin, then the subcutaneous tissue, and return the skin as a full-thickness skin graft.
Banner Flap

In small defects the transverse skin laxity of the nasal bridgeline can provide the tissue necessary for the flap shown here, which was used to reconstruct a lateral nasal defect resulting from excision of a basal cell carcinoma. The banner flap, first described by Masson and Mendelson, is virtually a small finger flap. The amount of skin available is judged by transversely pinching the skin between the index finger and thumb. Skin availability decreases as the nasal tip is approached. A trial run of the transposition can be affected by using a strip of gauze in place of the skin flap; this will indicate the necessary width and length of the flap.
The flap is designed by continuing the medial excision edge vertically. It is made a little longer than necessary and is pointed to allow later comfortable closure of the inevitable dog-ear of the donor site. The lateral incision is taken vertically down to the superior resection edge.

The flap is elevated just above the nasal musculature. The transposition is checked, and the vertical defect is closed directly. After it has been trimmed, the flap is sutured into place.

This results in an inferior standing cone, which must be removed in such a way that the base, and thus the blood supply, of the flap are not compromised. This patient did not wish the nodular nevus to be removed.

PROBLEMS

Although the banner flap is basically simple to design, some surgeons seem to find difficulty in removing the dog-ears without compromising the pedicle base. Dog-ears should always be removed lateral to the flap base—this does not interfere with the pedicle. As with all rounded flaps, there may be a tendency toward pincushioning. As the lower third of the nose is approached, less tissue is available and only small defects can be closed.
Rhomboid Flap

On initial consideration it may seem that there is not enough loose skin available on the nose to design a rhomboid flap. This is often not the case particularly in the glabellar area.

In this patient with a basal cell carcinoma on the upper part of the lateral side of the nose, the excisional defect can be converted into a rhomboid.
The nasal skin is squeezed between the fingers to find where the excess lies.

The skin excess lies transversely on the root of the nose, and it is this region that is used to construct a rhomboid flap.

This is comfortably transposed to close the postexcisional defect, and the donor site is closed directly.
This patient’s basal cell carcinoma of the right alar region is resected.

On consideration, it seemed that a rhomboid flap could be designed in such a way that the defect would be closed and the donor scar would be contoured around the alar base.

The rhomboid flap goes easily into the defect, and the donor site is reduced in size. The end result is shown, with the flap sutured into position and the donor site closed. It can be seen that another small lesion was removed anteriorly. In addition, the donor site could have been better contoured around the alar base.
On the upper portion of the side of the nose vertically, again skin is available. In this case a rhomboid flap is used to reconstruct the extremely complicated area of the nasolabial, supraalar base, and alar rim. The flap can contour effectively into this complex surface anatomy with minimal elevation of the nostril rim.

It is necessary in a case like this to thin the flap in the area that will lie in the natural concavity on the side of the nose.
In some elderly patients there may be enough skin laterally, almost in the bridgeline area, to close postexcisional defects inferiorly and medially without skin tightness. In all of the patients presented in this section, there has been no distortion of the normal nasal anatomy and no further surgical adjustments.

**PROBLEMS**

The rhomboid flap is limited by the amount of skin available on the nose. The banner flap is less complex to design. On the other hand, there is undoubtedly less pin-cushioning with the rhomboid flap.
Chapter 4  Nose Reconstruction

Extended Glabellar Flap

This patient has a basal cell carcinoma on the right side of her nasal tip. This is excised, and an extended glabellar flap is elevated and used to close the defect.

The closure is satisfactory without any alteration of the nasal anatomy. This surprising end result is achieved with a degree of nasal shortening.
A very satisfactory long-term cosmetic result is achieved.

**PROBLEMS**

The disadvantage of the extended glabellar flap is the somewhat limited rotation obtained. If rotation is not sufficient, the alar rim will be pulled up and nasal asymmetry will result. As the illustration shows, this asymmetry is not very noticeable when the defect is toward the midline. There is also the conceptual problem of raising such a large area of skin to close a relatively small defect. Despite these objections, this type of flap is safe and certainly should be considered for lateral nasal resurfacing. There is a degree of nasal shortening but because these procedures are being performed on older patients whose noses have lengthened with age, the nose may end up looking more attractive.
Bilobed Flap

The bilobed flap, an old and ingenious type of reconstruction, can be used to repair defects virtually anywhere, but it is best suited to the lateral aspect of the nose and the sole of the foot as mentioned elsewhere. It is basically a method of transferring tissue through 90 to 180 degrees with a minimum of rotation, dissection, and disturbance of regional anatomy. Without careful design the results will be unsatisfactory.

An excess of nasal skin is present high in the middle of the nose or high on the lateral aspect of the nose. This skin can be used for lower nasal reconstruction. Defects toward the midline of the nose may be reconstructed with laterally based flaps. Unless they are small and situated toward the midline, lateral defects must never be closed with laterally based flaps. Flaps constructed in this way lie across the cheek-to-nose concavity and will obliterate this normal anatomic contour, thus creating a deformity that defies later satisfactory correction.

Flap Design

This bilobed flap design is the most commonly used for nasal reconstruction. However, as seen in the case, this design can be modified as required.

The defect is created and, depending on its position, the situation of the flap base is chosen. The flap for reconstructing the defect usually lies with its midaxis at 45 degrees to that of the defect; the flap is slightly smaller than the defect. To close the secondary defect, a flap is taken from the loose skin donor site (bridge of the nose midline or lateral); its axis lies at 45 degrees to flap 1 and 90 degrees to the defect axis, and the flap is somewhat smaller than the secondary defect. This is well illustrated in this basal cell carcinoma lying just above the right alar rim.
The flap is widely undermined to its base and beyond.

Flaps 1 and 2 are transposed to close the defects; this transposition should be possible with little effort.

The donor site of flap 2 is closed directly. It is frequently necessary to trim the flaps as they are inserted into the defects. Any dog-ears are carefully trimmed, with care being taken to avoid traumatizing the flap base, thereby avoiding interference with the blood supply.

Large defects can be closed in this way without distortion of the anatomy. Poor flap design will cause tenting across the nasal cheek line, sometimes with pincushioning of the flap pedicle, a situation that cannot be corrected. It is possible to rotate each flap 90 degrees and in effect rotate tissue through 180 degrees. Such a maneuver becomes necessary when the defect is situated closer to the midline. This is illustrated well in the following case where the lesion is closer to the nasal tip.
Bilobed Flap: 180-Degree Transposition

In this patient with a basal cell carcinoma on the right lateral aspect of the nasal tip, the two flaps are each transposed 90 degrees. With wide undermining of the base of the flaps, the reconstruction is easily accomplished and there is rarely any problem with vascularity or flap inset.

This flap is in effect a double 90-degree flap transfer. If it is thought of in this way, the design will always be correct. If there is deviation from this concept, the reconstruction will not be as accurate or acceptable. With good planning, there will be no need for trimming. The concept is to “spread the load.” Each flap is slightly smaller than the defect it has to reconstruct—this allows the third defect to be closed directly. Despite this, the base for the flaps is wide and thus the blood supply is good. I have never seen vascular compromise in this flap. Finally, for some reason I do not quite understand, there is rarely any trapdooring of any area of this flap. Most important in this flap design is that each bilobed flap travels through 90 degrees.
The bilobed flap settles nicely into the defect, and the long-term aesthetic result is very satisfactory.
Laterally Based Bilobed Flap

The patient shown here has a basal cell carcinoma on the side of the nasal tip area. Care must be taken in planning a laterally based bilobed flap. The flap base must be maintained on the side of the nose, but undermining should be generous.

The remainder of the procedure is as described on p. 141. The result is most pleasing.
Modifications on the Bilobed Flap

The following two cases demonstrate other examples of the bilobed flap; it can be seen that there are very slight variations, but the end result is always satisfactory. The flaps are well vascularized, and they seem always to heal in a very satisfactory fashion. There is no doubt that, when indicated, this will give one of the best results in the reconstruction of nasal skin defects.

This patient has a recurrent basal cell carcinoma on the left side of the nose. Previous infection and radiation therapy have compromised the area.

Because of the situation described above, the lesion is removed with a wide resection using a modified bilobed concept.
A cheek flap is elevated to close the perinasal defect.

Depending on the laxity of the contralateral side when it is dissected up, this can contribute to reconstructing the contralateral bony bridge defect.

The end result is shown with a small left advancement to close the defect superiorly.
This patient has a basal cell carcinoma excised from the left alar region anteriorly. A modified bilobed flap is planned for the reconstruction.

It is advantageous to have a vertical line on the midpoint of the dorsum of the nose since this heals well with an almost imperceptible scar.
Bilobed and Glabellar Finger Flap Combination

A bilobed flap may be conveniently used with other flaps to reconstruct complex contour defects. A case in point is a patient with basal cell carcinomas in both medial canthal areas.

Reconstruction is planned to close the left side with a bilobed flap from the nasal bridgeline and the right side with a glabellar finger flap.
The lesion on the left medial canthus is excised, and the bilobed flap is widely elevated.

With the loose skin now available, the flap virtually falls into place.
The lesion on the right side of the nasal bridgeline is resected, and the finger flap is elevated.
The flap can be rotated easily into position.

The flap is sutured in place with closure of the secondary defect and no resulting deformity. **NOTE:** It is only in the face that such liberties can be taken with flap design. In other areas this would probably result in a “vascular disaster.”
PROBLEMS

If the flaps are made too small, particularly too narrow, the alar rim may be distorted. If wide undermining of the flap base is not performed, there may be inadequate rotation and again distortion will result. Because the flaps are rounded, pin-cushioning can occur. However, on long-term follow-up this has been much less of a problem than would have been imagined. The nature of the flap design inevitably leads to a long and complex scar; fortunately, the scar heals well on the nose and has never been a problem for the patient or surgeon.

Nasolabial Flap

A lateral nasal reconstruction (favored by inexperienced surgeons) is the nasolabial flap. It is simple to design, rapid and elegant to execute, and the donor site scar is in a good position. But the long-term result is usually aesthetically unacceptable unless it is used in the correct anatomic area—pin-cushioning can be a considerable problem.

This patient has a basal cell carcinoma on the side of the nose and another in the nasolabial area.
When the tumors are excised, the dog-ear of the lower lesion lies in the nasolabial fold.

This excess of skin can be used to construct a superiorly based nasolabial flap that can be swung up and medially through 90 degrees to close the superior defect.
Unfortunately, cheek skin is not the same as nose skin; thus often there are texture and color differences, especially in men. These problems do not improve, even after many years, although the scars do settle extremely well.

The important point in the design of the flap is that its base lies in the nose-cheek concavity; thus the nose-cheek contour is preserved. A similar flap used lower down on the cheek will be unsatisfactory, as demonstrated in the next example.

The incisions are well contoured into natural lines of the nasolabial area, and the flap does not cross a concavity.
If the nasolabial flap is used low on the nose, the result is usually disastrous. This is well illustrated by the result after excision of a basal cell carcinoma of the alar rim base area. The pedicle is based low and lateral, and the nose-cheek concavity is obliterated.

The same problem occurs when a bilobed flap is based in the nasolabial area. In some men, when an inferior flap is used, hair-bearing skin will be transferred to the nose—a situation to be avoided!
The nasolabial area provides an abundant supply of skin and subcutaneous tissue to reconstruct defects on the lateral aspect of the nose in the area superior to the nostril sill. There is sometimes a little tendency to obliterate the alar base–cheek region. This can be made less of a problem if the upper end of the donor site is sutured deeply into the alar base region. This will bring the flap much more medially and more of the flap will be sacrificed distally. This is of no concern and allows a much better alar base–cheek anatomy to be reconstructed. Also, trimming of subcutaneous fat can help with the contour correction. If one wants to be absolutely sure not to produce pincushioning, then a rhomboid flap can be planned to reconstruct the alar rim defect. This flap, because of the angles of it, is much less likely to pincushion.

This basal cell carcinoma is excised, and the flap is based high on the side of the nose with a consequently smaller transposition.
The high-based flap avoids the nose-cheek concavity but creates another problem.

This flap almost always pincushions and looks extremely ugly.

Two-stage nasolabial flaps are possible but unnecessary. They should be used only in exceptional circumstances (for example, when a larger area is to be reconstructed). Again, in men, hair-bearing skin may be transferred to the nose (see p. 161-164).
Nasolabial Island Flap

The procedure of taking an island flap from the nasolabial region is elegant to perform. The expected defect after excision of this basal cell carcinoma is measured and drawn on the non–hair-bearing part of the nasolabial area. An assessment of pedicle length with a strip of gauze is necessary to ensure that the flap will be long enough to reach and adequately cover the defect.

The flap is incised through the skin except at the supramedial area, where the incision is taken only to the subdermal region. The flap is elevated at its required depth. Between the island and the nasal defect, the intervening skin is elevated at the subdermal level to form a tunnel.
The tunnel is now checked to see that it is spacious enough for passage of the flap and the pedicle. The latter is raised off the underlying facial muscles and divided laterally and medially, based superiority on the lateral piriform rim.

Inspection of the subcutaneous pedicle will reveal the presence of small vessels. The flaps are truly perforator flaps. Location of the artery with the Doppler probe will identify the supply vessels. This is a technique that can be used to change a pedicled flap into a perforator flap as required.

The tunnel is now checked to see that it is spacious enough for passage of the flap and the pedicle. The mobility of the pedicle is assessed. The skin island can now be taken comfortably through the tunnel and sutured into the defect.
The flap donor defect is closed directly along the nasolabial line.

The reconstruction is satisfactory. The nasolabial scar is of good quality and the local anatomy has not been disturbed. What is most significant is the lack of trapdooring of the island flap in this case.
PROBLEMS

The nasolabial island flap gives a nice reconstruction, but it may slightly obliterate the nose-cheek concavity because of the bulk of the subcutaneous pedicle.

In addition, the flap may pincushion, as illustrated by the result in this patient after a nasolabial island flap was used to reconstruct the defect resulting from resection of an alar rim basal cell carcinoma.

Reconstruction of Choice

For small defects the simple banner flap is ideal, although in some regions with double contour reconstruction, the rhomboid flap may be more satisfactory. In larger defects the surgeon need look no farther than the bilobed flap. The only possible complication that may occur, apart from one caused by poor design, is pincushioning, a defect that may require later revision. All other flaps are either too complicated or may cause problems that are difficult to solve.
**Nasal Tip**

In the nasal tip area the skin is smooth, red, thick, and sebaceous, especially in men. These characteristics make the area unsuitable for replacement with full-thickness skin grafts, even those described as “ideal” from the postauricular or nasolabial area. Only neighboring nasal skin usually will suffice. In some men the tip skin may be hair-bearing to a variable degree. If nasal skin is not available, it is necessary to use either a forehead or a cheek donor site.

**Nasolabial Flap**

Two-stage nasolabial flaps may be used, especially if the alar rim and nasal lining need to be reconstructed.

This approach is used for reconstructing this defect resulting from the excision of a basal cell carcinoma involving both the outer and inner aspects of the alar rim.
In this situation the flap is designed and elevated based superiorly. To determine whether the flap is of adequate length before making incisions, the surgeon can simulate the flap with a strip of gauze and accurately estimate the required flap dimensions.

Underlying fat is taken because volume may be necessary to ensure that there is tip symmetry after reconstruction has been completed.
The tip of the flap is rotated, skin inward, and sutured to the intranasal edge of the defect to provide lining. The flap is then derotated; as this occurs, the flap can be sutured to the outer edge of the defect to give full-thickness rim reconstruction.

The pedicle is left open; the nasolabial donor site is closed directly.
In 10 to 14 days the pedicle is divided, the flap is inset, the excess of pedicle is trimmed, and the nasolabial donor area is reconstructed with the residual flap base. The result is satisfactory, but the wrong skin is on the tip of the nose.

**Problems**

The nasolabial flap is not recommended for men unless no other type is available. This is because frequently the distal end of the flap is composed of hair-bearing skin. This leads to the inconvenient and unpleasant consequence of having to shave the nose.
Rintala Flap

The Rintala flap can be advanced directly downward to resurface nasal tip defects. It has the advantage of providing the most similar type of skin to resurface the nasal tip. Initially, I was skeptical about using this flap and the quality of the end results because it is a long random advancement flap. However, with time, I have come to realize that it is a very useful flap that allows a one-stage reconstruction of the nasal tip, and it reconstructs the nasal tip with nasal skin. It is an easy flap to design and execute, and thus far has always been successful. In short, I have come to like it for nasal tip reconstruction.

Rintala Advancement Flap

Flap Design (Above the Eyebrow)

Use of the Rintala flap is illustrated in the resection and reconstruction of a nasal tip basal cell carcinoma.
The flap is raised with skin and subcutaneous tissue to allow advancement and to eliminate the dog-ears that inevitably develop, Burow’s triangles are excised bilaterally, lateral to the base of the flap.

The flap is advanced down the nose to close the defect. A disagreeable degree of tension in the flap always seems to be present at this point. This is noted as blanching, but this tension soon relaxes.
Use of this flap may result in slight nasal shortening. This is not always a bad effect—especially in an older patient, whose nose may droop slightly with age.

*Flap Design (Below the Eyebrow)*

It is possible to place the triangular resections at the base of the Rintala flap on the area just above the medial canthus.
This will give a good result, but there may be a little tightness of this scar after healing takes place, and occasionally a Z-plasty will be required in the concavity superomedial to the medial canthal area. This should be used with care and judgment making sure that there is no undue medial lid elevation.

Apart from the possible medial lid problem, as yet unseen, this is an excellent reconstruction for the nasal tip, and the slight shortening produced in the older patient is again greatly appreciated.

**Problems**

The Rintala flap has several disadvantages. It may be difficult to achieve sufficient advancement with this flap. There may be some ischemia of the distal end of the flap, which could progress to flap necrosis, delayed healing, and possible scarring. This is present to a slight degree in the first patient shown here. Another slight problem is
that the glabellar tissue transferred to the nasal bridgeline may cause an excess soft tissue mass in this area. However, many of these flaps have been used and the problems have been minimal, most being related to scarring but even this has not been significant. Most important, the patients have been very satisfied with the end result.

This flap can be used for lesions at any level on the central dorsal line.

**Bilobed Flap**

*Nasal Reconstruction*  The bilobed flap works well for tip defects of any size, although very small defects can be satisfactorily reconstructed with a banner flap.

Use of the bilobed flap is demonstrated in this case of basal cell carcinoma of the nasal tip. In contrast to the lateral nasal bilobed flap, the rotation for the bilobed flap is always through 180 degrees, with each flap rotating 90 degrees; thus undermining must be adequate.
The result can be very good, without any disturbance of nasal anatomy. The result, shown 1 year postoperatively, illustrates how well the nasal scars settle.

**PROBLEMS**

The problems associated with nasal defect reconstruction are similar to those elsewhere (that is, scarring, flap loss, deformity). The special significance in this area is that the nose is so noticeable. Obvious scars, trapdooring of skin, and changes in skin texture and color assume more importance when they occur on the nose. Loss of skin will necessitate a large reconstructive procedure because it may well cause asymmetry, raising of the nostril rim, and/or deviation of the nose—all difficult problems to deal with.
Other Techniques

Triangular kite flaps (both unilateral and bilateral), advanced vertically or transversely, have been used in the nasal tip area to reconstruct small defects. Unfortunately, because of the lack of soft tissue underlying the skin, significant flap movement is difficult to attain. These techniques should be avoided because they result in multiple complex scars.

Direct Transverse Closure

One useful technique with supratip defects is to convert the circular defect into a long transverse ellipse.

The direct transverse closure should be used only in small to medium-sized defects; some undermining is usually necessary. In a long nose, the aesthetics of the nose are improved by the shortening obtained.
This procedure achieves direct closure of the defect and an aesthetically pleasing nasal shortening. This is particularly acceptable to women, but it should not be overdone.

**Surgical Technique of Choice**

The bilobed flap is reliable, easy to perform, and, if correctly designed, does not deform the nose. In addition, it supplies the right kind of skin.

The Rintala flap is satisfactory when there is a midline defect, but ischemia could be a problem. The two-stage pedicled nasolabial flap may have some place in reconstruction of nasal defects in women. It is useful in both sexes when skin and lining are required but beware of hair-bearing skin.
COLUMELLA

The columella, normally fairly bulky, is covered with hairless skin and lies at a lower caudal level than the alar rims. It is a somewhat complex anatomic structure located in a position where it is difficult to transfer tissue. Many complex methods of reconstruction, some multistage, have been developed. Only the simpler and more reliable techniques will be considered here.

Nasolabial Flap

The nasolabial flap is useful in women as a two-stage procedure.

This patient has an aggressive but superficial squamous cell carcinoma involving the central portion of the lip, the columella, and the tip of the nose.
A superiorly based right-sided nasolabial flap is raised and tubed. One edge of the tube is sutured to the septal defect, and the other edge is sutured to the contralateral side of the septum and also onto the tip of the nose. The left nasolabial flap is used to reconstruct the central portion of the lip. Within 10 to 14 days, the right flap is divided; the left flap is incorporated into the total repair on the left side. Note that in men, using a nasolabial flap may transfer hair-bearing skin onto the nose. Although it is possible to perform such a reconstruction using the nasolabial skin as an island, this is not recommended because the pedicle may be compressed, which could result in the ultimate loss of the flap.
Although there is some deformity of the paranasal areas and some asymmetry of the nasal tip, with moderate scarring in the nasolabial region, the reconstruction is reasonably satisfactory.

After this reconstruction, there is a scar in the nasolabial region with some obliteration of the natural contours.
Fork Flaps

Fork flaps may be used in patients with cleft lip. There is an excess of prolabium and cleft lip scars. Use of fork flaps narrows the prolabium and allows scar revision to be accomplished at the same time. In patients with normal lips this would not be considered, because the closure of the donor sites of the vertical fork flaps would produce unacceptable scarring of the upper lip.

Alar Rim Flaps

The use of alar rim flaps, an often disregarded method, was initially described by Harold Gillies. It is a one-stage procedure that transfers non–hair-bearing, well-matched skin to the columella. Especially in men, the alar rims can be wide. It is thus possible to take flaps based on the midline tip area and swing these around to insert them into the defect on the columella. The defect is created; the whole width of the columella should be taken to allow easier insertion of the rim flaps.
The flaps swing around easily to close the defect; the alar rim donor sites are closed directly.
With alar rim flaps the columella can be built up with minimal scarring. For larger defects the surgeon would be forced into using a nasolabial flap or a composite graft from either the helix or the lobule of the ear.

**PROBLEMS**

Columellar reconstruction is extremely difficult and many techniques have been tried. Small tube pedicles were raised on the hand and arm. These were then transferred to the nose. After attachment, complex fixation devices were placed on the arm and the head to hold the flap in place. The best techniques are nasal rim flaps, but these leave scars. The alar rim transfer can be satisfactory, depending on the shape and size of the rims. The midline technique is very good, but only women and the occasional man can use this because of the mustache hair. Some male patients are willing to have this and then shave the columella. An alternative is to use depilatory agents or laser.
Central Prolabial Advancement Flap for Columella

In women, the central portion of the prolabium can be raised together with the existing columellar skin. This long advancement flap is based on the nasal tip and can be advanced to provide significant columellar lengthening, allowing a more prominent nasal tip to be formed. This can be further improved by inserting a crushed or contoured auricular cartilage graft. The donor site is in the central area of the columella, and as with all midline scars, healing is excellent. Unfortunately, in men this flap contains hair, but some men are willing to have this procedure performed and then deal with the residual hair.
**Complex Nasal Reconstruction**

Complex nasal reconstruction is defined as reconstruction of the whole nose or part of the nose. It frequently requires restoration of nasal lining together with specialized areas of the nose, such as the columella, the nostril rim, or the alar base. Reconstruction usually necessitates importation of skin from extranasal areas of availability. Most of this skin supply comes from the forehead and the nasolabial area. The methods used to supply nasal lining will be considered first, and then the techniques for supplying skin cover will be discussed.

**Nasal Lining**

The nasal lining presents a very specific problem and thus can be examined separately. The four basic ways to supply nasal lining are as follows:

1. Skin/mucosal graft
2. Local in-turned flaps
3. Nasolabial flaps
4. Cheek axial flaps

**Skin Graft**

When a flap (usually forehead) is being prepared for nasal reconstruction, a skin graft can be placed under that area of the flap where lining will be required.

**Problems**

The skin graft is a simple way of providing lining, but it involves two problems: deficiencies of skin take and contraction of the skin graft. An additional disadvantage is that immediate reconstruction cannot be accomplished because skin graft take is not sufficiently reliable; thus the skin graft method is used infrequently. Similar problems are found with mucosal grafts. However, they do have the advantage of being moist. The other problem is that there is not much mucosa available.
Local In-turned Flap

The local in-turned flap is used particularly in total or subtotal nasal reconstruction.

This patient has a malignant melanoma of the left side of the nose and will require a full-thickness resection.

The planned closure is a Herbert in-turned skin flap for lining, a bilobed flap for external cover, and a sliding triangular nasolabial flap to restore the normal anatomy of the alar base area.
The full-thickness defect is created, and the planned flap is raised based on the piriform aperture; the flap will be turned in to reconstruct the mucosal defect. This can be dissected subperiosteally up to and over the edge of the nasal rim. Further mobility can be gained by dissecting under the periosteum on the inner aspect of the lateral wall of the nasal cavity. This is rarely required, but it is good to know!

The blood supply along the edge of the piriform aperture is adequate to vascularize these flaps. Important technical points are to raise the flaps laterally at the subdermal level and as the piriform edge is approached to go vertically through the fat to the periosteum (if required). The periosteum is incised and can be dissected off the lateral rim of the piriform fossa. This dissection allows medial shift of the flap; otherwise, mobility is not sufficient to allow suturing without tension in the midline.

When a secondary reconstruction is being performed, there is a continuous skin mucosal pedicle, albeit with a scar on it. Although this scar extends across the total base of the pedicle and in theory should cause flap blood supply problems, in practice this does not occur.

In immediate reconstruction, the local in-turned flap can be used if the resection has not been taken down to the periosteum of the piriform edge. If this condition is met, the in-turned flap is used as a skin island and is usually safe, but the reconstruction is less satisfactory; the pedicle is too far laterally.

Gradually by suturing, the intranasal defect is closed securely.
The triangular flap is raised on a subcutaneous pedicle and moved medially to be sutured around the alar region in the nose-cheek groove; the secondary defect on the cheek is closed directly (V-Y principle).

The skin defect on the nose will be closed with a bilobed flap. The distal portion of the second flap will be trimmed when the required size has been determined.
Because the flap has been widely undermined, closure is achieved without difficulty or tension. The placement of a small suction drain is recommended.
After some initial pincushioning, the flaps settle and the result is satisfactory.

**PROBLEMS**

If the cheek is tight, it may not be possible to raise a large enough flap to provide sufficient lining. Failure to handle the pedicle properly will result in ischemia and flap necrosis. Pincushioning of the skin reconstruction may occur.
**Nasal Alar Rim Reconstruction**  
Nasolabial Flap and Schmid Forehead Flap

Nasolabial flaps are usually best used when the lining defect is not overly extensive in the vertical dimension, although in loose-skinned individuals a larger amount of skin can be harvested from the nasolabial region with direct closure of the donor site.

The patient shown here has a full-thickness resection for basal cell carcinoma. Lining is provided by an island nasolabial flap and cover using a Schmid forehead flap (see p. 188).

The nasolabial island is elevated on its medial subcutaneous pedicle, turned over, and sutured into the mucosal defect.
The nasolabial donor site is closed with a sliding island flap. Note the V-excision of the medial edge of the flap to fit better on to the edge of the piriform aperture.

The donor site is closed directly.
Schmid Forehead Flap

The alar reconstruction is covered with a Schmid forehead flap.

These flaps may be taken on skin pedicles or as islands. For short flaps, the latter is satisfactory. For longer flaps, it is thought that a skin pedicle will give slightly better vascular security. Undoubtedly, the retention of the skin is advisable; it adds bulk to the pedicle, probably provides a better blood flow, and makes the care easier for the patient.

PROBLEMS

As with the previously described local in-turned flap, ischemia can occur. I do not think that the in-turned flap used in this technique is as mobile as the flap based on the intranasal lining. The advantage of the forehead flap is that it can be used when the nasal rim requires reconstruction. The Schmid flap is excellent and reliable. This is a reconstruction that must be handled with extreme care at each step of the way. There is no margin for error. All flaps must be well vascularized. If this is not the case, they should be delayed and the reconstruction deferred.
In this patient who has a congenitally short nose, nasolabial flaps will be used together with a central island flap. The former will lengthen the nasal lining and the latter the skin.
An incision is made through the nasal skin and the septum. This incision is continued posteriorly until the required length of the nose is obtained. This may have to be determined by pulling down the alar rims with a double hook. The planned nasolabial flaps are elevated to reconstruct the intranasal defect.

One flap is used to reconstruct the septal defect on the corresponding side and also the lining of the nasal dome.
This is completed by turning in the contralateral nasolabial flap to complete the septal and lateral mucosal reconstruction.

Skin cover is provided by a midline forehead island flap.
On the tenth postoperative day or later, if the surgeon has any concern, the nasolabial pedicles are divided. The unused portion of the pedicle is returned to the nasolabial area. Judgment is used as to whether this is required or not. The skin defect on the lateral side of the nose is closed.
The result is satisfactory.

**PROBLEMS**

Because of concern about flap vascularity, the nasolabial flap is usually taken with a generous layer of subcutaneous tissue. The resulting flap is bulky and will often occlude the airway; trimming can be performed later. Unfortunately, if local tissue is used to reconstruct this problem, the available methods are limited, but with good planning and careful technique, the result can be quite acceptable.
Cheek Axial Flap and Forehead Flap for Nasal Reconstruction

Nasolabial flaps are successful because they are axial flaps, but as mentioned previously, this was not truly appreciated until the excellent anatomic studies of Herbert and Harrison, which demonstrated that there is a predictable vascular axis situated in the lower third of the piriform aperture. This allows relatively large flaps to be raised from this area as islands based on this very specific vascular axis.

This procedure is planned for a patient with a basal cell carcinoma of the alar rim area requiring a full-thickness resection.

The island is raised and turned in to reconstruct the mucosal defect.
Knowledge of axial flaps has added greatly to the security and versatility of lining reconstruction. However, it has introduced a complication: how to manage the secondary defect. If this defect is closed directly, the alar base–cheek area is obliterated; once lost, it is difficult, if not impossible, to recreate. A method has been devised to deal with this interesting and difficult problem. From the caudal end of the cheek defect in the nasolabial area, a triangular island flap with a central subcutaneous pedicle is raised.

With adequate mobilization, this flap can be advanced and its leading edge sutured deeply with nonabsorbable sutures, which ensures a good alar-cheek concavity when the reconstruction is completed. In effect, this is a V-Y maneuver; the limb of the Y is closed directly in the nasolabial line. There is no doubt that this reliable method of obtaining lining without producing a significant secondary deformity is the one of choice.
In the case illustrated here, external skin cover is provided by a midline forehead flap.

Although initial pincushioning of the flap has occurred, it will eventually settle to give a satisfactory result. Once again, it is emphasized that the midline forehead scar is rarely a problem.

**PROBLEMS**

The reconstruction can be bulky as shown above. It will improve with time but defatting may be necessary. This must be performed radically; thus the vascular status should be assured. To be absolutely safe, two stages of defatting can be performed.
Surgical Technique of Choice

The technique chosen depends on what is left after resection or what is available in the secondary deformity following reconstruction elsewhere. Usually in-turned flaps are employed because of shrinkage and problems of “take” associated with skin grafts.

Nasal Skin Reconstruction

Only rarely is tissue from areas other than the face sought for nasal skin reconstruction. However, with the advent of free vascularized tissue transfer using microvascular surgery and the increase in its reliability, this modality of reconstruction may be used more frequently in the future. The only contraindication to this—and it is a significant one—is that skin from elsewhere is rarely compatible with facial skin.

The forehead is the time-honored donor site. It can be used in various ways, depending on the size and position of the area to be resurfaced and whether the resurfacing is total or subtotal. Skin expansion in the forehead region has added another significant tool for the reconstruction of the nose (see Chapter 9).

Total Reconstruction

The relatively thin, but stiff, non–hair-bearing skin of the forehead provides an excellent medium for nasal reconstruction. The color and texture of this skin is an ideal match. Lining will have been provided by one of the methods described in the previous sections, and on most occasions skeletal support will not be inserted at this point (this will come later, if required).

Forehead Flap

Reconstruction of the total nose requires more skin than may be estimated on initial examination. The clue to planning for nasal reconstruction is to remember the dimensions 3 by 3, referring to the total amount of skin required, which should be 3 inches (7.6 cm) wide and 3 inches (7.6 cm) long. Conveniently, most hemiforeheads, depending on the position of the hairline, are close to these specific dimensions. A bone graft for skeletal support may be inserted at this time, but it is probably wise to leave this until the soft tissue reconstruction has settled and sound vascularity has been established.

The simplest method is the up-and-down forehead flap, based on the contralateral hemiforehead; the vessels are the supraorbital and the supratrochlear. The midline vertical incision is long enough to allow the required hemiforehead to be taken down to the nasal area. The length of this incision determines the position of the scalp incision, which should be placed at such a point to allow 3 inches of scalp above the superior extent of the midline incision to provide a pedicle of adequate width.
This point is well illustrated in a patient with multiple squamous cell carcinomas of the nose requiring radical resection. All planning can be done with gauze. If care is taken, the flap should be of satisfactory length and size and the vascularity should be satisfactory.

The flap is raised and the pericranium is left intact. The hemiforehead is transposed to the nasal area. If any tension is present, the midline incision may be extended. This allows the forehead flap to open out and lengthen.
By pinching the lower edge of the flap in the midline, the surgeon can obtain the configuration of the alar margins and the columella. Some strategically placed non-absorbable sutures can maintain this arrangement. The flap is now sutured into the defect. One useful technique at this point is to suture the undersurface of the flap laterally to any remaining skeleton. This is accomplished by drilling holes in the nasal bones and piriform aperture edge, and by inserting nonabsorbable sutures through these holes to give good apposition of the undersurface of the flap to the nasal bones. In particular, this suturing is advised to ensure a good nose-to-cheek contour. The eyebrow on the side of the flap donor site is hitched up to the pericranium with fine nonabsorbable sutures. This prevents eyebrow ptosis, which gives an asymmetrical appearance to the eyes.
The raw area of the forehead is covered with a split-thickness skin graft, either immediately or in a delayed fashion.
The flap is left attached for 2 to 3 weeks; it is then divided and the unused portion is returned to the forehead.

The nose is contoured by thinning the flap superiorly to achieve a reasonable result.

**Problems**

The problems with this reconstruction are the vascular supply and the possibility of having to delay the flap. A bulky flap requires trimming and a forehead skin graft. The latter is no longer a problem because tissue expansion has provided a method that supplies enough skin to do the reconstruction and also to close the residual defect (see Chapter 9, Tissue Expansion).
Forehead Flap and Local In-turned Flaps

This patient has a secondary nasal reconstruction after resection of the nose for a squamous cell carcinoma. The technique used is similar to that presented on pp. 198-201. Lining is provided by in-turned local flaps sutured in the midline.

The planned flap is of generous proportions. A surprisingly small amount of paranasal skin needs to be used for mucosal reconstruction.
The forehead flap is elevated, as described previously. If planned correctly, flap transposition to the nose can be achieved without tension.

The edges of the flap are sutured to the raw edges of the nasal defect. The forehead is covered with a split-thickness skin graft.
Within 10 to 14 days the pedicle is divided and returned to the forehead. The result is reasonably satisfactory, and the patient does not wish any further surgery. It should be noted that the right-sided telecanthus was present before the surgery and resulted from the excision of the penetrating squamous cell carcinoma of the naso-orbital region.
Galeal Frontalis Flap

The galeal frontalis flap originated in China. Thus far it has been used infrequently for nasal reconstruction. Undoubtedly, with experience, it will be used more often and with time its value will be assessed. This flap has the advantage of leaving the forehead unscathed.

This patient requires secondary nasal reconstruction after nasal resection for squamous cell carcinoma.

The nasal lining is provided by in-turned paranasal flaps. The septal mucosa is incised in the midline and dissected down on either side of the septum. The edges of the lateral flaps are sutured to the edges of the septal mucosal flaps to give an internal nasal reconstruction.
A segment of galea and frontalis, as wide as necessary, can be raised as a flap, extending almost to mid-skull and based on the supratrochlear and supraorbital vessels. The dimensions of the flap are similar to those of the skin forehead flap described in the previous section. Nasal support is provided by immediate bone grafting; this is usually taken from the outer table of the skull.
Immediate skin cover is not advised because oozing from the flap is difficult to control. Thus in 24 hours one of the two large postauricular full-thickness grafts can be used to provide skin cover for the reconstructed nose.

These grafts can be taken from the frontal or temporal area; they are wired into position in the frontonasal area. More recently, the main graft is stabilized with a screw. This is convenient, and the graft is solidly fixed, but more important, as the screw is seated in place, it allows accurate positioning of the nasal tip. As the screw is placed deeper, the nasal tip advances farther. This reconstruction is covered with the galeal frontalis flap.
The advantages of this method are the lack of obvious scars, no forehead skin grafts, and a thin nasal skin cover. At this time a tissue expander can be placed. This will allow skin expansion and later a more satisfactory nasal reconstruction.

**PROBLEMS**

In this technique there is always concern about flap vascularity and the take of skin grafts. Undoubtedly, there is less bulk in the reconstruction, unless tissue expansion is used. This is probably best when used in patients who have problems with anesthesia.

**Reconstruction of Choice**

With the present state of knowledge, the forehead flap is the most reliable method and can give an excellent reconstruction. Unfortunately, the forehead needs to be grafted. This situation has been largely solved with the use of tissue expansion. After the skin has been stretched, the amount required for nasal reconstruction can be taken and the defect closed directly without a skin graft. The Chinese method has many advantages but must be considered a topic of debate at present.
SUBTOTAL RECONSTRUCTION

It should be possible to reconstruct a partial nasal defect without creating an appreciable donor site deformity. The areas chosen are chiefly the forehead and the nasolabial area.

Forehead Flap

This patient needed partial nasal reconstruction after having had a nasal resection and skin grafting for squamous cell carcinoma.

A diagonal forehead flap is planned. From a vascular viewpoint, this is a perfectly safe flap.
The scarred area of the nose is excised. The forehead flap is elevated and taken down to cover the nasal defect.
In 10 to 14 days, the pedicle is divided, the unused portion of the flap is returned to the forehead, and the superior portion of the flap is used to resurface the midline raw area that has resulted from excision of the previous full-thickness glabellar skin graft.
The result of this two-stage procedure is reasonably satisfactory.

**PROBLEMS**

The forehead flap should always be a very safe flap, and because the defect is limited, the end result should be good. If there is ischemia, a delayed procedure should be done.
Schmid Flap

Schmid has described an interesting and useful technique designed to minimize forehead scarring and to transfer thin, soft skin to the alar area.

This patient requires a subtotal nasal reconstruction of skin and lining. The Schmid flap is considered to be the best option.

The flap requires an initial delay of 7 to 10 days for complete security, but it can be used as an immediate reconstruction if this is absolutely necessary. The delay should consist of complete raising of the pedicle from its base to the area to be transferred (but not including that area).
Clinical judgment is used as to whether the defect behind the pedicle should be closed and the pedicle left free or whether the pedicle is placed back on the donor site and sutured in position. Any adverse changes in vascularity strongly indicate a conservative approach.

The flap is based on the supratrochlear vessels and is taken horizontally above the eyebrow to the temple area between the hairline and the lateral end of the eyebrow. The pedicle may be tubed, but this is not usually advised. Because the forehead skin is stiff and the pedicle narrow, tubing may compromise the blood supply. It is better to leave the pedicle untubed and raw posteriorly or, for hygiene purposes, to split-thickness skin graft the raw posterior area. Recently pigskin has been used to cover the raw area of pedicles. This provides a dry cover for as long as 3 weeks.

At the distal temporal end of the flap, a pocket is created by scissor dissection. This pocket must be slightly larger than the nostril defect in order to allow for contracture.
A full-thickness or split-thickness skin graft is inserted into the pocket to cover all the raw areas.

A gauze pack is inserted to prevent hematoma and to facilitate skin graft take.
In 10 days the gauze is removed and the distal end of the flap is opened along the lateral edges of the pocket. When this end is opened, there should be skin graft on the flap and on the forehead.

The flap is transferred to the nose; its distal end will reconstruct the nasal tip and the alar defects.
This flap is left for 10 to 14 days and then divided. The unused pedicle is sacrificed and the nasal tip area is trimmed to provide a satisfactory contour.

The result should be good, with satisfactory nasal contour, little forehead scarring, and only slight donor deformity. Bilateral flaps can be used for total nose reconstruction, but this is only possible in older patients with a loose forehead.

PROBLEMS

The blood supply of the Schmid flap is somewhat precarious; thus careless handling of the pedicle or failure to delay may cause flap ischemia and necrosis. Occasionally, because of forehead anatomy, it may not be possible to obtain sufficient skin for nasal reconstruction and primary closure. If so, a different method should be chosen.
Washio Flap

Washio has described a method of nasal reconstruction with the postauricular skin carried as a flap. Indications for use of this flap are alar defects and heminose defects, especially in children. Even in adults, enough skin may be obtained from the postauricular and mastoid area to resurface one-half of the nose. Using this method, skin may be transferred with no donor site defect and no visible scars. In addition, the skin color and texture are a good match for facial skin.

In this patient, the Washio flap is used to reconstruct a congenitally absent heminose.

The nostril is initially reconstructed with a local turned-down nasal skin flap. The left medial canthus is repositioned correctly medially and vertically.
Repositioning of the medial canthus is achieved using a Z-plasty technique; the upper Z-flap is taken from the upper eyelid. The medial canthus is in effect the lower flap of the Z-plasty. This is dissected up with the medial canthal ligament until the latter can be placed in its correct position. Having achieved this, the canthus is wired in position using a transnasal canthopexy technique. The skin on the lateral aspect of the nasal bridge is turned down to cover the lateral skin (based on the lateral nasal wall) and is turned medially. This reconstructs the lateral wall of the nose; the outer aspect is raw.

The Washio flap is designed after the temporal vasculature has been mapped out with the Doppler apparatus. The temporal artery and its branches are marked on the skin.
The flap is drawn so that enough postauricular skin will be available for the reconstruction. The concept is similar to the up-and-down forehead flap in that the central incision opens and lengthens the flap.

The postauricular and mastoid skin is carried on the end of the flap. The base of the flap is on line between the tip of the helix as it inserts into the face and the temporal hairline vertically above this point. Here the flap is at least 3 inches (7.6 cm) in width. Incisions are then made in the temporal scalp to ensure that the posterior branches of the temporal vessels are included in the flap. Delay is not required but may be considered necessary for vascular security in some cases; this will be determined by skin color.
Chapter 4  Nose Reconstruction

The midline incision is usually conservative and will not allow the postauricular skin to reach the midline.

The flap is raised at a subfascial level.
By incising vertically, the surgeon is able to lengthen the flap. To ensure vascular safety, this incision is made with transillumination of the flap; in this way all vessels can be seen and preserved.

The postauricular skin now lies on the nose without tension.
The postauricular skin is then sutured in position to reconstruct the nose.

Between 2 and 3 weeks after the initial procedure, the flap is divided and the unused portion returned. The postauricular defect is always capable of being closed directly. There is no need to skin graft the raw area; dressing is satisfactory until the unused pedicle is returned. Pigskin can be used to resurface the flap pedicle and the donor site. The advantage of this technique is the absence of donor site scars and the transfer of thin skin that is a fairly good color match for the nose.

These photos show how far the Washio flap can be moved. The postauricular skin has been carried to a defect on the lateral aspect of the nose on the contralateral side after excision and radiotherapy for recurrent adenocystic carcinoma of the ethmoid sinus.
The lining for the defect is provided with an upturned nasolabial island flap. It can be seen that the forehead had been used for reconstruction in the past and thus was no longer available as a flap.

The result of this procedure is satisfactory in terms of reconstruction of this difficult area.

PROBLEMS

The Washio flap must be handled with great care to ensure that the blood supply is sufficient to maintain the postauricular skin. Accurate Doppler mapping is helpful, delay is advised, and tension must be avoided. If these measures are not followed, necrosis of the distal end of the flap and loss of the total reconstruction may result.
NECK SKIN

The transfer of neck skin to the nose is a useful technique, especially with extensive facial burns and/or forehead scarring and loose neck skin.

This patient has a full-thickness nasal tip defect and a forehead hemangioma. The trauma had been self-inflicted, and the psychiatrist advised against using the forehead.

A long-tubed pedicle is raised on the neck, its ends being placed vertically below the earlobes. The pedicle is made as wide as possible but still allows for direct donor site closure.
In 10 days one end can be delayed; then, after 7 to 10 days this end is taken up to the nose. Downturned flaps are used to reconstruct nasal lining. The neck tube is then opened and used to reconstruct the skin defect.

In 2 to 3 more weeks the pedicle is divided at a level that allows enough tissue for total reconstruction of the defect and the flap is inset. The remainder of the pedicle is sacrificed. In subsequent procedures the nasal reconstruction can be sculptured as dictated by the thickness of the subcutaneous tissue of the flap.
A satisfactory result can be obtained with good nasal contour, skin color, and texture.

**PROBLEMS**

This long flap must be delayed at least once. If not, ischemia and necrosis will result. The neck scar may be very satisfactory, but in other situations it may be red, broad, and obvious. These problems should be carefully explained to the patient before embarking on this procedure.
Nasal Reconstruction in Elderly Patients

Finally, it is important to point out that age is no barrier. In this chapter, children and adults of all ages have been shown.

This patient is in her eighties. She had ignored the squamous cell carcinoma that was destroying her nose. The surgical plan is to deal with this lesion by removing all of the skin of her nose with the involved underlying tissue.

A well-planned central forehead flap with a base on the medial eyebrow gives a very good result. The pedicle is divided and inset under local anesthesia. It should be noted that the raw area in the upper part of the forehead is allowed to heal spontaneously.
In this area the result of this is usually a very acceptable scar, as can be seen in this postoperative photograph.

**PROBLEMS**

The only potential and significant problem is loss of the flap. This is unusual but if it does occur, the flap is removed and another method of reconstruction is chosen. Occasionally the skin may be lost, but some subcutaneous tissue is maintained, and a skin graft can be applied to gain healing and allow time to plan future surgery. The usual reason for flap loss is poor planning often related to inexperience.

**Surgical Technique of Choice**

Undoubtedly, the forehead flap is simple, rapid, and reliable, but it does have the disadvantage of leaving a scar. With more experience, the Washio flap may become the method of choice for defects up to heminose size. This has been the case in my own practice. The skin is plentiful and thin. Color and texture are very good, and no donor scar results. However, it is not the most robust of flaps in terms of vascularity; thus it must be planned carefully and subsequently handled with care. The situation now is that tissue expansion can be used to provide extra skin and also to act as a delay measure. This has made nasal reconstruction less complex. Now most nasal reconstructions can be performed using expanded forehead skin (see Chapter 9).
## Choosing the Best Option for Nasal Reconstruction

<table>
<thead>
<tr>
<th>Anatomic Area</th>
<th>Problem</th>
<th>Special Considerations</th>
<th>Flap of Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial canthal</td>
<td>Should be reconstructed with non–hair-bearing skin</td>
<td>Glabellar donor area contains an abundant source of skin for reconstruction of medial canthal area</td>
<td>Midline transposition flap (finger flap)</td>
</tr>
<tr>
<td>region</td>
<td>Available skin must be contoured into the biconcave form of the canthal region</td>
<td>Glabellar flap can be transferred as a rotation flap, a midline transposition flap, or an island flap</td>
<td></td>
</tr>
<tr>
<td>Side of nose</td>
<td>Different topographic features of skin and distinct natural boundaries should be respected; otherwise, nasal asymmetry is inevitable</td>
<td>Choice of reconstructive method should be based on size of defect</td>
<td>Banner flap or rhomboid flap</td>
</tr>
<tr>
<td>Nasal tip</td>
<td>Smooth, red, thick, and sebaceous nature of nasal tip skin necessitates reconstruction of this area with only neighboring nasal skin</td>
<td>Both topographic features and nasal length should be considered in reconstruction</td>
<td>Bilobed flap</td>
</tr>
</tbody>
</table>
# Chapter 4  
**Nose Reconstruction**

## Rationale

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Second Choice</th>
<th>Caveats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to perform, reliable, skin color and texture provide good match</td>
<td>Rotation flap</td>
<td>Brings skin of glabellar region with eyebrow hair down into the medial</td>
</tr>
<tr>
<td>for medial canthal area, but the skin is often somewhat thicker for use</td>
<td></td>
<td>canthus</td>
</tr>
<tr>
<td>with eyelid skin</td>
<td>Glabellar island flap</td>
<td>Pedicle forms an obvious swelling in the nasal bridge line area</td>
</tr>
<tr>
<td>A straight-line scar in the glabellar-nasal bridge concavity may result</td>
<td></td>
<td>Pedicle may be compressed and occluded in subcutaneous tunnel</td>
</tr>
<tr>
<td>in a bridge deformity</td>
<td></td>
<td>because of rotation on axis and postoperative swelling</td>
</tr>
<tr>
<td>Possible because of transverse skin laxity of nasal bridgeline</td>
<td>Cheek advancement flap</td>
<td>Extremely useful, but it must be secured in the concavity of the</td>
</tr>
<tr>
<td>Provides tissue necessary to reconstruct a lateral nasal defect</td>
<td></td>
<td>nose-cheek junction</td>
</tr>
<tr>
<td>The banner flap is easy to design, but some surgeons have difficulty</td>
<td>Nasolabial flap</td>
<td>Simple to design, rapid and elegant to execute, donor site scar is in a</td>
</tr>
<tr>
<td>removing dog-ears without compromising the pedicle base</td>
<td></td>
<td>good position</td>
</tr>
<tr>
<td>Rhomboid flap is limited by the amount of skin available on the nose,</td>
<td></td>
<td>Long-term result is usually aesthetically unacceptable unless used in</td>
</tr>
<tr>
<td>but the probability of pincushioning is less with a rhomboid flap</td>
<td></td>
<td>the correct anatomic area</td>
</tr>
<tr>
<td>compared with a banner flap</td>
<td></td>
<td>Pincushioning can be a problem</td>
</tr>
<tr>
<td>Flap must be designed with extreme care or the result will be unsatisfactory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Could be conjoined with other flaps for complex reconstructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliable, easy to perform, and if correctly designed, does not deform</td>
<td>Rintala flap</td>
<td>Can give very good result; if there are concerns about blood supply,</td>
</tr>
<tr>
<td>the nose</td>
<td></td>
<td>flap can be delayed (this has never been necessary)</td>
</tr>
<tr>
<td>Two-staged pedicle nasolabial flap</td>
<td></td>
<td>It is a long, random advancement flap; this may result in flap necrosis,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>delayed healing, and scarring, this is unusual</td>
</tr>
<tr>
<td>Triangular kite flap</td>
<td></td>
<td>May have some place in reconstruction of nasal defects in women</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Should be avoided, because this flap results in multiple complex scars</td>
</tr>
</tbody>
</table>

*Continued*
### Choosing the Best Option for Nasal Reconstruction—cont’d

<table>
<thead>
<tr>
<th>Anatomic Area</th>
<th>Problem</th>
<th>Special Considerations</th>
<th>Flap of Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columella</td>
<td>Columella is a somewhat complex anatomic structure located in a position where it is difficult to transfer tissue</td>
<td>Columella is normally fairly bulky and covered with hairless skin</td>
<td>Midline lip advancement flap</td>
</tr>
<tr>
<td>Complex nasal</td>
<td>Necessity of restoration of nasal lining along with specialized areas of nose, such as columella, nostril, rim or alar base</td>
<td>Reconstruction usually necessitates importing skin from extranasal areas of availability</td>
<td>In-turned flaps</td>
</tr>
<tr>
<td>Total</td>
<td>Three-dimensional reconstruction of total nose is a considerable surgical challenge</td>
<td>Reconstruction of the total nose requires more skin than may be estimated on initial examination</td>
<td>Forehead flap</td>
</tr>
<tr>
<td>Subtotal</td>
<td>Should be possible to reconstruct a partial nasal defect without creating appreciable donor site deformity</td>
<td></td>
<td>Forehead flap</td>
</tr>
</tbody>
</table>
Chapter 4  *Nose Reconstruction*

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Second Choice</th>
<th>Caveats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Especially useful for cleft cases with an excess of cleft lip scars; scars are satisfactory</td>
<td>Nasolabial flap</td>
<td>Useful in women as two-stage procedure</td>
</tr>
<tr>
<td>Unacceptable scarring of upper lip in noncleft patients</td>
<td>Fork flap</td>
<td>Satisfactory result, but scars a problem</td>
</tr>
<tr>
<td>Preferred for nasal lining because of shrinkage and problems of “take” associated with skin graft</td>
<td>Alar rim flaps</td>
<td>Especially for men with wide alar rims</td>
</tr>
<tr>
<td>Most reliable method, can give excellent reconstruction</td>
<td>Forehead flaps</td>
<td>Time-honored donor site, can be used in various ways, depending on size and position of area to be resurfaced</td>
</tr>
<tr>
<td>Simple, rapid, and reliable</td>
<td>Washio flap</td>
<td>Method of choice for defects up to heminose size</td>
</tr>
<tr>
<td>Does have disadvantage of leaving a scar</td>
<td>Tissue expansion</td>
<td>Provides extra skin, acts as a delay measure, and makes nasal reconstruction less complex</td>
</tr>
<tr>
<td>Skull bone graft—full thickness is preferred, fixed with a screw</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
References—With Key References Annotated

Blair VP. Total and subtotal reconstruction of the nose. JAMA 85:1925, 1931.

The authors describe the V-Y rotational nasal flap. The flap is rotationally based on the side of the nose with a triangular extension into the glabellar area. It is done in one stage and in most cases leaves an almost invisible scar with no depression or mismatch of color as with skin grafts. Seventeen such patients have been treated with this method since 1968.


Fujiwara M. One-stage reconstruction of an alar defect using a bilobed nasolabial-nasal tip flap based on the aesthetic subunits in Orientals: case report. Aesthetic Plast Surg 28:13, 2004. *The author reports on a method for the one-stage reconstruction of a lateral nasal defect, including a full-thickness defect of the ala, using a bilobed flap composed of nasolabial and nasal tip skin. The author concludes that this flap is useful for restoring an alar defect.*


Golcman R, Speranzini MB, Golcman B. The bilobed island flap in nasal ala reconstruction. Br J Plast Surg 51:493, 1998. *The authors employed the bilobed island flap for nasal ala reconstruction in 21 patients after excision of malignancy. The authors concluded that the length of the lobes (proximal and distal) in a bilobed island flap should be equal to the defect; the width of the proximal lobe compared to the defect and the distal lobe compared to the proximal lobe should be progressively narrower.*

Goldman GD. Kakinuma et al. A composite nasolabial flap for an entire ala reconstruction. Dermatol Surg 28:870, 2002. *The authors present a study of a composite nasolabial flap applied for reconstruction of an entire alar defect in a patient. They conclude that their design of a composite flap has been used with success in the repair of an entire alar defect with cosmetically and functionally good results, minimizing scars in the donor area and the resulting operation. This composite nasolabial flap is thought to be the best choice of a flap for an entire alar defect reconstruction.*


Harii K. Reconstruction of traumatic short nose with iliac bone graft and nasolabial flaps. Plast Reconstr Surg 69:863, 1982. *The authors studied two nasolabial flaps and an iliac bone graft used in one-stage reconstruction of a traumatized short nose. One flap filled the lining defect, whereas the other covered the skin defect. The two flaps were simultaneously transposed as subcutaneous pedicle flaps, and this enabled easy mobilization of the flaps. An L-shaped iliac bone graft placed between the two flaps could maintain an unobstructed airway and the shape of the nose.*


The authors describe Washio's retroauricular tissue for reconstruction of external nasal defects along with their recent experiences in elderly patients, in whom the risk of reconstruction after excision of a malignant growth is high. The authors present seven reconstructions, six after excision of malignant disease, together with their ideas about how to maximize its possibilities.


Ivy RH. Repair of acquired defects of the face. JAMA 84:181, 1925.


The authors performed a composite nasolabial flap for reconstruction of an entire alar defect in a patient. They conclude that their composite flap design was successfully used to repair an entire alar defect with cosmetically and functionally good results, minimizing the donor area and the resulting operation scars. This composite nasolabial flap is thought to be the best choice of a flap for an entire alar defect reconstruction.


Kazanjian VH. The repair of nasal defects with the median forehead flap: primary closure of the forehead wound. Surg Gynecol Obstet 83:37, 1946.


The authors analyze different methods of nasal tip reconstruction, which leads to the development of an algorithm for repair based on the size, depth, and location of tissue loss. The authors conclude with an algorithm developed for nasal tip reconstructions based on the size and location of tissue defect. Both the recipient and donor sites were analyzed for aesthetic results and complications.


The authors evaluate the usefulness of the inferiorly or superiorly based nasolabial flap for unilateral or bilateral reconstruction of local extrarot and intrarot defects. They conclude that the nasolabial flap is a useful procedure for reconstruction of moderate-sized oronasal defects because of its simple elevation, proximity to the defect, and versatility.

Lejour M. One-stage reconstruction of nasal skin defects with local flaps. Chir Plast 1:254, 1972.


This is a study of the history of plastic surgery throughout the centuries including the history of rhinoplasty. The Indian Koomas first and later the Italian surgeons found valid solutions to the problems caused by partial loss of the nasal pyramid. However, the idea of rebuilding, with a single forehead flap, the tip and columella while at the same time providing a lining of skin for the newly formed nose goes back to the middle of the nineteenth century.


The authors describe their experience with the Washio retroauricular temporal flap for nasal reconstruction in 12 patients, together with their modifications to simplify the planning and raising of the flap. They conclude that the Washio retroauricular flap is an excellent technique for difficult nasal reconstruction in young patients.
The authors discuss modifications from the traditional bilobed flap design, including minimizing the angle of transposition between lobes, thinning of the flap, basing the pedicle on the lateral aspect of the nose, and creating the lobes of the flap to be of equal diameter to the defect. They conclude that the modified bilobed flap is an excellent choice for reconstruction of defects of the lower nose because of the good skin match and low incidence of complications.
The authors identify refinements in forehead flap nasal reconstruction that consistently provide better aesthetic and functional results. They conclude that the predictability of the techniques in providing excellent results in patients undergoing nasal reconstruction decreases the need for revision procedures and helps patients and surgeons achieve desired outcomes.
Tagliacozzi G. De Curtorum Chirurgia per Insitionem. Venice: Gasper-Bindoni, 1597.

The authors discuss the retroauricular free flap and its potential indications, advantages, drawbacks, and technical variants. They conclude that, thanks to its excellent color and texture match with the nose integuments, this flap enjoys optimal integration in the centrofacial area.


The authors studied 400 consecutive surgical wounds on the nose for wound management. The most commonly used flap was the bilobed double transposition flap, which is especially useful for reconstruction of defects on the lower third of the nose. The authors conclude that although the standard design often results in tissue protrusions or pincushioning, improvements in the design are outlined to achieve the best results for defects on the nose.

Probably more than any other area of the face, the cheeks exhibit a greater variation in appearance from person to person. However, full, rosy cheeks do not remain so forever. With aging, the cheeks change in character; they begin to sag, with alterations in color and shape. The changes wrought by age, however, have their consolations: more skin is available for the reconstructive procedures that are more frequently required in this age group.
Anatomy

SKIN

Because of its color and texture variation, the Caucasian cheek offers one of the greatest challenges in reconstruction. The skin over the malar area is thick, highly colored, and shiny; in many people there is an almost telangiectatic appearance in this region. The preauricular skin is pale and thin and of a matt surface texture. The lower cheek skin is less pale than the preauricular skin and not as red as the malar skin; it is intermediate in texture. With age, the skin may become more yellow, although in some individuals the malar skin becomes redder, often with a shade of purple. In men, the beard area must be carefully observed. All of these factors should be considered when flaps are being planned. The wrong skin in the wrong place will mar an otherwise excellent result.

MUSCULATURE

Under the skin lies the investing fascial layer of the head and neck area, the superficial musculoaponeurotic system (SMAS). This fascial layer is located between the skin and the deeper structures, such as the parotid gland, the facial nerve branches, and the muscles of the face. In the neck it is continuous with the platysma muscle.

Deep to this layer lies the parotid gland and its duct, the facial nerve branches emerging from the gland, and the superficial layer of facial muscles. These muscles are the orbicularis oculi, levator labii superioris alaeque nasi, levator labii superioris, levator anguli oris, zygomaticus major and minor, depressor anguli oris, depressor labii inferioris, and orbicularis oris. The deep muscle group consists of the masseter and buccinator.

NERVE SUPPLY

Motor Nerves

All of the superficial muscles are supplied by branches of the facial nerve (seventh cranial nerve). The buccinator obtains its motor nerve supply from the lower buccal branches of the facial nerve.

The masseter muscle is supplied by a branch of the anterior trunk of the mandibular nerve, which originates from the third division of the trigeminal nerve (fifth cranial nerve).
Sensory Nerves

The sensory supply of the cheek is provided largely by the trigeminal nerve. The area from the nose-cheek junction to the line joining the oral commissure to the temporal hairline at the level of the lateral canthus is supplied by the second division through the infraorbital nerve (second division of the fifth cranial nerve). The area lateral to this one, extending to the tragus but not incorporating the ear and stopping short of the inferior border of the mandible, receives sensation from branches of the mandibular nerve (third division of the fifth cranial nerve). The remaining small lower cheek area and the ear are supplied by the anterior cutaneous nerve of the neck and the greater auricular nerve. These originate in the cervical plexus (second and third cranial nerves).

**Blood Supply**

The arterial supply is largely from the external carotid artery with a contribution from the transverse facial artery, which, like the facial artery, is a branch of the external carotid artery. Venous drainage is mainly by way of the anterior facial vein.

**Lymphatic System**

The cheek area is abundantly supplied by a lymphatic drainage system that ends in the parotid nodes, the nodes surrounding the facial vessels, and the submandibular nodes. All of these ultimately drain into the cervical nodes.
Aesthetics

Because of the color and textural variations of facial skin, it is easy to have a poor skin match after flap transfer if due care is not taken. Pale, matt skin in a ruddy, polished area is obvious and will remain so. This difference in skin color and texture may be even more striking in the summer, when skin color changes with exposure to the sun. Hair-bearing skin transferred to non–hair-bearing areas could pose a distressing problem to the patient. Therefore thought must be given to the planning of flaps to prevent these problems from occurring. The surgeon should be constantly studying the aesthetic pattern and variations of the face. In reconstruction of the cheek, one important consideration that often may be neglected is to make the thickness of the flap as close as possible to that of the defect. In this way, major contour deficiencies may be avoided.

Placement of Incisions

Scars on the cheek may be obvious, and therefore, if possible, they should be placed in the lines of minimal relaxed tension or in the aging lines (see Chapter 1). If planning is satisfactory, few transverse stresses will be placed on the incisions. The resulting scars are narrow and lie in the natural lines of the face, well camouflaged. Occasionally this ideal situation of scars lying in exactly the correct line may not be possible. This fact must be explained to the patient and, if necessary, secondary revision can be performed at a later date. Frequently, Z-plasties or W-plasties may be used.
**Areas of Tissue Availability**

Local skin can frequently be used to reconstruct cheek defects. The flaps require rotation or advancement of lower facial or preauricular loose skin, which becomes more abundant with aging. The neck is another useful region outside the face. Neck skin is plentiful, has good color and texture, and is easy to move. The forehead may also be used, but only in cases of dire necessity. Generally, results with forehead flaps are poor because of the pale color and matt texture of the skin. Any significant forehead donor area requires a skin graft that leaves a large cosmetic deformity.

**Areas to Be Reconstructed**

There are several distinct areas in the cheek that have their own particular anatomic characteristics. In each area the skin is different and the contours are unique. For reconstructive purposes the cheek has been divided into the following areas: lateral, lower cheek, malar, supramedial, and alar base–nasolabial. Each region will be considered individually from all points of view.

**Rotation Flap**

The rotation flap allows closure of a triangulated defect. The design is simpler than the transposition flap, but undermining and mobilization are more extensive.

The defect is triangulated with the base laterally or superiorly. If the base is lateral, the skin is rotated from the lower part of the cheek. If the base is superior, the rotation is from the preauricular area. Note that a Burow’s triangle has been outlined inferiorly to deal with the standing cone that will develop at that area because of the skin rotation.
The squamous cell carcinoma has been resected. Only after a frozen-section report of total excision will the area be formally triangulated.

The inferior rotation flap is *widely elevated* in the face-lift plane.

If the flap design and the undermining have been adequate, closure of the postexcisional defect can be achieved without difficulty and, more important, without tension.
If the base is superior, the rotation is from the preauricular area. As the flap is rotated and sutured into position, excess skin will remain on the cheek side of the flap and result in the development of a standing cone at the end of the arc of rotation. This excess of skin is trimmed as a triangle based toward the flap; in this way the flap itself is not violated. The original vascularity is left undisturbed.

The defect is closed. The Burow’s triangle has been removed, and the incisions contour well into natural lines on the face and neck.

**Problems**

As with the transposition flap, any rotation of preauricular skin anteriorly is a mistake. In men, the margin of the hairline will be altered.
Bilobed Flap

The bilobed flap can be used for small to moderate-sized lateral cheek defects; undermining and mobilization are less extensive than with the rotation flap, but scarring is more extensive. This flap allows rotation of skin through an arc of up to 180 degrees. The surgeon should judge the practicality of using this flap by assessing how much skin is available in the area from which the second flap will come.

The defect is created and flap 1, which is smaller than the defect, is outlined; the axis of the flap is at a 45- to 90-degree angle to the axis of the defect, as dictated by the skin transfer. Flap 2—a slightly smaller flap—is drawn, again at a 45- to 90-degree angle to the axis of flap 1.
Chapter 5  Cheek Reconstruction

The defect is created and the flaps are transposed. Any necessary trimming is performed, and defect two is closed directly. Note the excision of excess skin (dog-ear) inferiorly.

**PROBLEMS**

As with the preauricular transposition flap, the bilobed flap may provide poor skin distribution. More significant is the extensive scarring that results from this procedure in the lateral cheek region. This scaring is obvious and unacceptable; worst of all it is difficult, if not impossible, to improve. An additional problem results from the “pincushioning” effect that occurs in some cases and makes the reconstruction very obvious. A second procedure to defat the flaps is required to correct the problem, but it is not always entirely effective.
Frequently, as depicted here, the hairline may be altered in a way that cannot be camouflaged in the future, a problem particularly for male patients.

**Rhomboid Flap**

The rhomboid flap can be used to close defects similar to those already discussed. Its geometric design makes it more rigid than some flaps, but it allows for very exact planning. The planning of the rhomboid flap is very similar to that undertaken for the transposition flap.
The operative plan is to remove the lesion as a rhomboid and reconstruct the defect with a rhomboid flap.

This young patient has a basal cell carcinoma of the right nasolabial fold.

The operative plan is to remove the lesion as a rhomboid and reconstruct the defect with a rhomboid flap.
The lesion is excised, and the inferiorly based rhomboid flap is incised.

The rhomboid flap is moved into the defect.
The rhomboid flap with closure of the donor site is shown. There is no evidence of tension in the closure.

**PROBLEMS**

Poor redistribution of skin and a complex scar pattern mar this type of reconstruction. As with rhomboid flaps in other areas, pincushioning is not usually a problem.

**Surgical Technique of Choice**

The most practical reconstruction in most cases is an inferiorly based rotation flap. In areas closer to the malar region, a laterally based rotation flap may give a very satisfactory result. In some female patients, the preauricular transposition flap may be satisfactory; it should be used only in patients who have pale, thin skin on all areas on the side of the face. This flap requires less experience in flap planning than the rhomboid flap. Thus the margin for error is greater.
LOWER CHEEK RECONSTRUCTION

The lower cheek is a very obvious area of the face, and therefore scars and contour irregularities are easily noticed. If incisions are taken over the body of the mandible, the resulting scars often stretch, they may become indrawn, and are difficult to correct. In men, this region is the beard area, so hair-bearing skin is required for its reconstruction.

The loose skin of the neck is a fruitful region for obtaining local flaps. In planning such flaps, the concavity of the neck and the convexity of the area overlying the body of the mandible must be considered. A vertical scar on the neck will contract and cause a band. A similar scar over the mandible will show the problems already mentioned. The neck skin may be slightly paler than the skin on the lower face, and in men this skin will often contain less hair.

The excess of skin in the lower face is again posterior and inferior. All local flaps must come from these areas.

**Rhomboid Flap**

Even large defects can be closed with rhomboid flaps taken from the neck. Accurate closure of the rhomboid defect will always be possible without difficulty, providing that the initial planning is correct.

It is better to plan the flap with a donor site that will be closed with a vertical scar. Thus the rhomboid flap is positioned with the 120-degree angle situated caudally, as was done in this patient with a basal cell carcinoma of the lower cheek. Unless the defect is very large, closure with a rhomboid flap is usually possible.
After excision of the basal cell carcinoma, the posteriorly based rhomboid flap is transposed into the defect. The neck donor site is closed directly without difficulty as the flap is transposed to reconstruct the defect. Rarely is any undermining required.
The rhomboid flap is successfully integrated into the face without contour problems, and the scar is quite acceptable.

PROBLEMS

The scar associated with the rhomboid flap is complex, and if there is a healing problem, it can be obvious. The vertical mandibular scar can become indrawn, and the resulting contour change can make the scar noticeable and difficult to improve. Fortunately, this is not a common problem.
Transposition Flap

The transposition flap is indicated for defects similar to those described for the rhomboid flap. Planning is somewhat simpler, and a length of gauze can be used in place of the flap to assess dimensions and rotation.

In effect, this is a rhomboid flap without angles, as can be seen in the reconstruction used for this patient to correct a defect left from resection of a basal cell carcinoma of the cheek. The method of assessment of flap availability is exactly the same, with the thumb and index finger being used to demonstrate laxity.

After the flap has been rotated and sutured into position, a standing cone develops at the upper part of the flap base. This should be resected and closed directly. (For a more detailed description of this flap, see pp. 269 and 270.)
In this particular case, perhaps as a result of the size of the flap and the age of the patient, the flap has contoured well into the face. No pincushioning has occurred, and the scars show little evidence of contracture. There is some degree of color and texture variation in relation to the surrounding skin (see p. 256).

**Problems**

The problems with the transposition flap are the same as those with the rhomboid flap, namely, the complex scar and the vertical scar running over the mandible. The transposition flap has the additional risk of pincushioning. When this occurs, the subcutaneous fat of the flap must be thinned, a procedure that may not be entirely successful.

**Inferiorly Based Rotation Flap for Cheek Reconstruction**

Fairly large defects of the lower face can be closed by using a rotation flap, but the surgeon needs to undermine and mobilize more neck skin than is necessary for the rhomboid or conventional transposition flap. The eventual scar is less complex, yet it does extend over the mandibular body and may be obvious in this area because of stretching or hypertrophy.
In preparation for the use of a rotation flap, the surgeon triangulates the defect. The flap design is taken down to the neck. As in all neck-to-face flaps, care must be taken to avoid damage to the mandibular branch of the facial nerve. As a precaution, the surgeon must be certain to dissect above the platysma. If the facial vessels are seen, then the nerve is nearby. As the flap rotates upward, an excess of skin develops on the outer edge of the skin incision.
After suturing of the flap is complete, the excess should be trimmed in a direction away from the flap base.

**PROBLEMS**

The rotation flap has not been a very satisfactory type of reconstruction. It always seems to result in a degree of downward pull. In addition, the flap often pincushions, and the *vertical* neck scars may become obvious because of transverse stretching. Planning for rotation flaps is not as positive and secure as for transposition flaps.

**Surgical Technique of Choice**

The rhomboid flap is now considered to be the procedure of choice. Planning is accurate and the scar is acceptable. The transposition flap is very similar to the rhomboid flap in terms of basic concept, but pincushioning is encountered more frequently because of its round design.

The rotation flap, often used in the past, does not always transfer skin as efficiently as the transposition flap. In addition, because of the more extensive undermining required, there is a greater chance of damaging the mandibular branch of the facial nerve.
**Malar Region Reconstruction**

The malar region is a difficult area to reconstruct. It has a convex contour and is highlighted by illumination from any direction. Therefore scars are obvious and contour defects stand out very clearly. The skin texture in this area is smooth and shiny; the color is often red and telangiectatic. The skin is not usually hair bearing, a characteristic that precludes the use of skin from distant areas of the face that do contain hair. In addition, there are several distinct landmarks—lower eyelid, lateral canthus, and temporal hairline—that should not be disturbed in any reconstruction.

**Rhomboid Flap**

The rhomboid flap may be used for small defects. It has the distinct advantage of allowing the excision defect to be placed so that the rhomboid flap can have skin of exactly the correct color and texture. This is constructed as described on p. 254.

This patient has a basal cell carcinoma of the right cheek. The lesion is outlined for a rhomboid resection to be reconstructed with a rhomboid flap.
The resection is completed.

The rhomboid flap is elevated and brought around into the rhomboid defect.
The flap is sutured into position and the donor site closed directly. There is no vascular compromise.

The early postoperative result is satisfactory. The scar is acceptable at the moment but should give a very good result over time.
Double Opposing Rhomboid Flaps

This patient has a basal cell carcinoma that involves the skin of the right cheek, the subcutaneous tissue, the buccal mucosa, and the alveolar ridge intraorally.

Resection of the cheek is en bloc and includes skin, subcutaneous tissue, muscle, oral mucosa, and teeth. The underlying alveolus is the method chosen to close the defect on the inside surface of the cheek to achieve intraoral closure. The inner aspect of the cheek will be closed with an opposed mucosal rhomboid flap. In this way there is no overlap of flap edges.

The full-thickness defect is shown.
Intraorally, a mucosal/rhomboid flap is elevated and sutured into position to close the defect. The flap donor site is closed directly. On the cheek, a rhomboid flap is elevated opposing the design of the intraoral flap. This is sutured into place without tension.
Healing was without problems and the end result is aesthetically acceptable. There was no recurrence of this lesion at the 5-year follow-up. The patient has full function.

**PROBLEMS**

Only small facial defects can be dealt with using the rhomboid flap, and the complicated scar can be very obvious in the cheek area. The lower lid and canthus may be pulled down slightly.
Modified Bilobed Flap
The standard bilobed flap is usually an excellent choice for reconstruction of small defects resulting from resection of basal cell carcinomas. It is not appropriate for large defects because of the extensive scarring and potential change of the hairline or beardline if large flaps are raised. There can also be problems with this flap when there are two basal cell carcinomas in the same area. These can be reconstructed by using a modified bilobed flap.

A modified bilobed is planned in this patient who had two basal cell carcinomas on the left cheek. The lobes of the flap (2 and 3) will allow excision of the two basal cell carcinomas. Lobe 2 is actually the residual excess of lateral skin between the two areas of excision. The base of the lobes is kept intact.
The bases of lobes 2 and 3 are then combined to create a single lobe and lobe 1 is left intact. The result is a modified bilobed flap; this combined flap can be used to close the defect and the second defect is then closed with a miniflap constructed from the lateral medial dog-ear of lobe 1. The defect resulting from the transposition of lobe 1 is closed directly. The result is shown.

**PROBLEMS**

The scar associated with the bilobed flap is complicated in design, and if it becomes hypertrophic as it is pulled inward, it becomes obvious and difficult to correct and pincushioning of the flaps may occur. Perhaps even more problematic is the possibility in male patients of bringing hair-bearing skin into a non–hair-bearing area. Both the bilobed and rhomboid flaps tend to bring paler skin from the lower face into the ruddy malar area, thus making the reconstruction obvious.
Transposition Flap

The transposition flap is planned by using a length of gauze to determine the correct flap length and width and the feasibility of direct closure of the donor site.

After planning the flap for this patient, it is elevated. It rotates effortlessly and is comfortably sutured into position. Note that the donor site scar becomes larger as a result of the superior dog-ear resection.
At the end of the procedure, the flap is situated nicely on the cheek. The donor site is closed directly.

With time, the scars have settled very well. There will be further improvement over time.

**Problems**

The patient shown here demonstrates the problems that can be encountered with the transposition flap. The area of available skin tends to leave a donor site at right angles to the ideal minimal tension lines in this region. Furthermore, the color of the flap may differ from the color of the skin it replaces, and flap pincushioning may occur. In this case, the reddish skin of the cheek is placed in the area where the skin is thinner and paler.
Inferior Cheek Rotation Flap

The indications for this flap are related to the position of the defect. The defect can be situated at any area within the scope of the rotation of the inferior cheek flap. The more posterior the arc of rotation, the less noticeable will be the scar. Anteriorly, there will be a possibility of banding as the scar passes over the body of the mandible.

In this patient with basal cell carcinoma of the cheek, the flap has to be raised lower down in the cheek. This is not a problem; it simply requires planning to allow the anterior edge of the flap to lie in the nasolabial fold.

Inferiorly the problems of the rotation flap relate to any change in position of the oral commissure of the upper lip. In this patient, an inferiorly based cheek flap will be used. Note the triangular excision outlined on the neck; this indicates the planned excision of the dog-ear of excess skin that will appear as the flap rotates anteriorly.

In addition, the dissection has to be extensive enough to allow the flap to come around into position without any tension.
The inferior horizontal triangle of skin mentioned earlier is to be resected, and a nicely fitting flap will be obtained.

The flap elevation is wide, and closure is tested with the use of hooks. The Burow's triangle is excised posteroinferiorly. This, together with the wide elevation, allows tensionless closure without disturbance of the local anatomy. Note the slight lower lid ectropion.

It is unfortunate that there is a scar running from the nasolabial area to under the ear; however, with careful suturing these will usually heal satisfactorily. This patient can use makeup to camouflage the scar.
Lateral Cheek Rotation Flap

The lateral cheek rotation flap is used for defects of virtually any size. It transfers skin based on the loose region in the preauricular area and sometimes from the lower face and neck. The laxity allows medial movement of lateral cheek skin. The larger the defect, the more extensive the undermining and mobilization required. In some cases, prior expansion of the area is indicated.

In this patient, the defect is triangulated and a lateral cheek flap designed for closure. The flap must be of adequate size; if it is not, the lateral end of the lower eyelid will be pulled down, which can cause problems ranging from a slight increase in scleral show to frank ectropion.
In medium to large defects, such as the one created in this patient who had a bulky, exfoliating malignant melanoma excised, the cheek flap incision runs laterally, upward, then down in the preauricular area, and continues inferiorly into the neck as required.

**PROBLEMS**

In a defect such as this it is necessary to elevate a very large cheek flap; in fact it will not only be raised from the cheek, it will also be raised from the neck. When the rotation has been carried out, there will be a bunching up of skin on the posterior neck and this will have to be excised as a triangle. In addition the flap should fit without tension. The most susceptible area, if there is tension, would be the lower eyelid, since it is relatively unsupported. There are two things which will help this. First, extensive flap undermining, as mentioned earlier. Second, it is wise to suture the undersurface of the flap to the periosteum of the infraorbital rim. This will form solid area which will support the upper medial portion of the flap and in most cases will maintain a satisfactory lid height. Even with this there may be a small degree of retraction and slight ectropion; this is actually seen in this patient.
Cheek Advancement Flap
The cheek advancement flap, which is raised in the face-lift plane, can be very large. Once again, resection of a neck dog-ear provides additional rotation. This being the case, it is an excellent choice for reconstruction of large cheek defects of the upper region. The level at which the flap is elevated ensures good vascularity; thus complications are rare, and scars are ideally situated.

In this patient, the whole cheek is elevated in the face-lift plane.
When enough advancement has been gained, medial closure can be achieved. The remainder of the flap incision is closed. The donor defect is closed by advancement.

Adequate flap closure is tested by pulling on the flap with hooks. A large excision involving the cheek and lateral nose can be closed with a cheek advancement flap. This is more feasible in an older patient with lax skin. In this case, the patient’s squamous cell cancer is removed, creating a sizable defect on the nose and cheek.

The cheek advancement flap is elevated and pulled forward to make certain that closure can be achieved. This forward movement produces superior and inferior dog-ears at the lateral base of the flap. The flap is inset and the dog-ears are excised. There may also be some deep subcutaneous suturing at the cheek-nose junction.

When enough advancement has been gained, medial closure can be achieved. The remainder of the flap incision is closed. The donor defect is closed by advancement.
of temporal and preauricular skin, and drains are inserted. The resulting dog-ears on the cheek, at the base of the vertical incision, and on the neck require excision, as they usually do with this technique. This latter maneuver, together with moderate undermining in the area, can increase the range of rotation, and this results in less tension in the medial closure area.

The deep surface of the flap is anchored to the soft tissue, including the periosteum over the malar area and infraorbital rim. The postoperative result shows satisfactory contours of the cheek, and the rim of the lower eyelid is undisturbed. Note the nose and lid position. Although this procedure helps prevent dragging down of the eyelid, there is still scleral show.

**PROBLEMS**

With this technique there may be minimal pulling down of the lower lid; this is often a problem that does not merit correction. Apart from this, no difficulties have been encountered with the advancement flap.
Combined Cheek Rotation Transposition Flap

In the upper cheek area, a standard cheek rotation flap may have a vertical deficiency that can cause a degree of lower lid ectropion. To avoid this, a transposition element is introduced into the flap by the addition of a temporal extension.

In this patient, a cheek rotation flap is used to reconstruct what seems at first glance to be a relatively small defect.

Despite the size of this defect, in the cheek region a large flap with the temporal extension is necessary to achieve a satisfactory anatomic and functional reconstruction.
The long-term result of the reconstruction is shown. This is satisfactory in meeting the anatomic, aesthetic, and functional goals.

**PROBLEMS**

In men, some shifting of hair-bearing skin to a non–hair-bearing area will occur. The sideburn will need to be trimmed or shaved higher to disguise this problem. As shown on p. 283, after excision of a large portwine stain, hair-bearing skin has been shifted to partially resurface this patient’s lower eyelid, a situation that required later excision and replacement with a full-thickness skin graft. Another problem is the thickness of cheek skin. This is partly intrinsic to the skin, but there is also a layer of fat that should be trimmed with caution before definitive reconstruction. Poor flap design may cause some degree of ectropion of the lower lid. If the undermining and the dimensions of the flap are inadequate, requiring suturing under tension, ischemia and loss of the tip of the flap may result. Hematomas can produce the same effect, and it can cause pincushioning associated with fibrosis, a problem that usually resolves to some extent with time.
Surgical Technique of Choice

If it is well-designed, the rotation flap is an excellent form of reconstruction for a cheek defect. The patient presented on pp. 278-279 shows a unique situation. She had a basal cell carcinoma that extended through the cheek from the skin to the mucosal covering intraorally. Because of the extent of the cheek involvement, it was decided that this should be excised as a full-thickness rhomboid, and to reconstruct this, a rhomboid flap would be designed on the cheek and used to cover the cheek defect. To have some bulk to the cheek, the buccal fat pad was released and allowed to come down into the defect. Once this had been done, a rhomboid flap was designed inferiorly on the mucosa, as opposed to the superior design on the skin. When this was transferred, it reconstructed the buccal defect very comfortably, and the arrangement made for very good healing. The donor site on the buccal aspect of the cheek was closed directly. This gives an excellent full-thickness reconstruction of the cheek, not just in terms of cover, but also in volume. The patient had no resulting functional problems, and has had no recurrence on long-term follow-up.
LATERAL CHEEK RECONSTRUCTION

In men, the beard area and the sideburns are anatomic features that definitely should not be altered. Additionally, pale preauricular skin should not be placed in more highly colored areas. The tragus should not be changed in position and shape. Fortunately, the lateral cheek is a region where direct closure is usually possible, especially in older patients. Undermining the skin, as in a face lift, produces a generous amount of skin for reconstruction. Occasionally, this is not the case and a local flap is used.

Preauricular Transposition Flap

In this technique the excess of preauricular skin is judged by pinching it between the thumb and index finger. The surgeon can use a length of gauze to simulate the proposed flap and to help him or her decide whether it is suitable for closure of the defect. This flap is indicated when there is enough skin laxity and absence of hair to provide skin cover and donor site closure.

Note the looseness of the preauricular skin and the absence of hair, which must be assessed. The skin flap is then designed, elevated, and transposed to close the cheek defect. The transposition can be through any range up to 90 degrees.
The superior end of the base of the pedicle develops a standing cone deformity that requires trimming; care is taken not to compromise the width of the pedicle. Trimming is used on the cheek without encroaching on the base of the flap. The donor site is closed directly.

**PROBLEMS**

Preauricular skin is thin and pale. Thus it is different from the remainder of the cheek. The latter is thick, highly colored, and in men it is hair bearing. The flap is somewhat obvious when compared with the more florid skin over the malar eminence. It was previously thought that with time this skin would become similar to cheek skin. Experience has shown that this is not the case.
SUPRAMEDIAL CHEEK RECONSTRUCTION

The supramedial cheek area is difficult and fascinating to reconstruct because of its anatomic complexity. Several significant anatomic landmarks and important functional structures are located in proximity to one another. The skin in this area is thin and non–hair bearing. The medial canthus, the punctum, the caruncle, and the medial end of the lower lid all lie just above this region and can be deformed if the flap is insufficient and tight, or if any skin loss occurs. The resultant scarring and contracture can cause obvious ectropion and troublesome epiphora. The patient may experience bouts of conjunctivitis.

To reconstruct the supramedial cheek area, surgeons can use skin lateral or superior to the defect. Occasionally, when the defect is small, donor tissue may be taken from an inferior position.

Lateral Rotation Flap

The lateral rotation flap can be used to close defects of any size. It is extensile in that the preauricular and neck skin can be mobilized as necessary to obtain the required shift of skin.

Feasibility for using this flap should be assessed by pushing the cheek skin medially and superiorly with all the fingers of the hand; the expected success of the flap is judged according to the movement of the skin and the excess amount that develops in front of the fingers. If this excess is at least equal to the defect, reconstruction with a lateral rotation flap should be possible.

This patient requires a large rotation flap to close a defect resulting from excision of a nodular portwine stain. The technique used is similar to that described on pp. 273-277.
The defect is triangulated with the base superior. An incision is made laterally and taken down the preauricular area, around the earlobe, down the neck, and a skin flap is fashioned. The incision and undermining continue until the defect can be closed comfortably. Note that it is not necessary to use a back cut. Usually, a small drain is inserted under this type of flap to prevent hematoma.

With this technique large defects can be reconstructed with satisfactory results. This patient did not wish to have any further surgery.
A scar parallel to the eyelid margin is not a desirable feature. It may be obvious and cause lid edema or slight ectropion in elderly patients. The flap should be taken to the eyelid margin, taking care to insert enough skin in a vertical dimension to avoid lid retraction.

Hair may be transferred to a non–hair-bearing area, as shown in this patient. The horizontal segment lateral to the canthus contains hair follicles. This area will be resected some time in the future. Hematomas should be prevented at all costs. They cause tension and may lead to ischemia and loss of the tip of the flap. A flap that is too small to effect comfortable closure may cause similar problems. To prevent cheek sagging and ectropion, suturing the undersurface of the flap to malar periosteum is strongly recommended.
Inferior Rotation Flap
The inferior rotation flap is an alternative to the lateral cheek flap or central forehead flap. It can be used for medial lid and lateral glabellar defects. The flap is rotated upward and is anchored to the periosteum with nonabsorbable sutures. By using the planning method described for the lateral rotation flap, surgeons can judge the amount of excess skin available for upward movement.

In this patient, the defect is triangulated and the flap is planned so that it rotates upward along the nasolabial fold.
The flap is elevated, and the incision is taken far enough to allow the rotation to proceed and to obtain comfortable defect closure without displacement of the lower eyelid. With a view to preventing this, a few well-placed nonabsorbable sutures are taken from the undersurface of the flap to the deep tissue and the periosteum of the infraorbital rim can be helpful. A dog-ear or Burow’s triangle is excised from the caudal end of the incision to allow further rotation.
The line of defect closure falls comfortably within the nasolabial line and is aesthetically very acceptable, although there is a slight distortion of the palpebral aperture medially.

**PROBLEMS**

All the anatomic features of the inferior rotation flap suggest that it should be an ideal flap. The rotation is in good line, and in older patients plenty of tissue should be available.
In reality, despite its popularity, this type of superior rotation flap is a poor one. Gravity works against it. Pincushioning often results and emphasizes the nasolabial fold, causing facial asymmetry. Even if the flap is well planned, the scar parallel to the lid margin may cause lid edema and ectropion, as described earlier. However, in elderly patients, it is a rapid and secure method to use. The upper suture line often lies on the infraorbital rim. If, by necessity, it were to be placed higher, the undersurface of the flap should be anchored to the infraorbital rim. If this does not achieve a satisfactory result, I would not hesitate to drill a few holes in the infraorbital rim and use this to secure the undersurface of the flap.
**Advancement Flap**

The advancement flap can be used to close medium-sized defects. It is advantageous to use because it involves a more limited dissection than the rotation flap to obtain the required amount of skin advancement for defect closure. It should be emphasized, however, that careful assessment must be carried out to ensure that there is enough loose skin to close the excisional defect without causing ectropion.

In this patient, the excision is planned as a square or rectangle. Two parallel lines were drawn along the line of the nasolabial fold from the sides of the defect.
The lesion is excised, and the long flap between the lines is designed and elevated.

Advancement is judged by gently pulling on the flap with hooks to determine whether the defect could be closed comfortably. Note the excess skin lateral to the flap base (shown using hooks).
As the flap is sutured, excesses of skin appear on either side of the flap base. These standing cones are excised as the so-called Burow’s triangles.

The scars situated in the nasolabial line are not particularly noticeable. Perhaps because of the square design of the flap, pincushioning does not occur.
Horizontal Advancement Flap

A transverse advancement flap is used in this patient with a Merkel cell tumor to close a postexcisional defect in the supramedial portion of the cheek.

Apart from being broader, the flap is planned in exactly the same way as the preceding flap—the advancement flap. The lateral margins of the flap are placed under the lid margin and in the line of the nasolabial fold. The excess skin at the base of the flap is estimated as triangles.

The defect is created by resection of the tumor, and the cheek advancement flap is elevated with excision of Burow’s triangles at its base.
This technique allows excellent advancement of the flap to be achieved with the creation of acceptable cheek contours.

The nasal portion of the defect is closed with a vertical midline forehead flap. The great advantage of this method to reconstruct the medial defect is the reduced amount of dissection required to close the defect compared with that needed for a large cheek rotation flap.

**PROBLEMS**

No problems have been encountered with these advancement flaps. In this case, the deep surface of the flap should be anchored to the zygomatic periosteum to prevent sagging and ectropion of the lower lid. A drain must also be placed under the flap to prevent hematoma.
Vertical Triangular Island Advancement Flap

The vertical triangular island advancement flap is a large kite flap that can be used in the supramedial cheek area, but it is better suited for a defect located slightly lower than the ones being discussed in this section. It is also best reserved for smaller defects. The flap has the advantage of requiring very limited dissection and manipulation to obtain significant skin advancement.

In this patient, the excision is planned as a square with no compromise of the tumor clearance. A triangle is drawn on the nasolabial line from the inferior side of the square. The length of the triangle is approximately twice the length of the side of the square.
The lesion is removed and the triangle incised down to subcutaneous fat. In most older patients, the amount of advancement of the triangle on this subcutaneous pedicle is sufficient to gain closure.

The secondary defect is closed in a V-Y fashion.
In this patient, the V-Y advancement principle is used in the lower part of the cheek. The only area of concern is the alar base; this could become displaced laterally from the lateral pull resulting from the reconstruction. A pigmented basal cell carcinoma is removed from the paranasal area. It is possible to plan a transverse triangular island flap to be advanced in a V-Y fashion to permit satisfactory closure of the excisional defect. This is a nice flap to use on the cheek; it must be mobile and of the required size. The donor site can easily close directly.
After excision of the lesion, the transverse triangular flap is incised down to the underlying subcutaneous tissue.

The flap is mobilized on its subcutaneous pedicle until the required medial movement can be achieved.
The closure is in a V-Y fashion, with care taken to be sure that the medial edge of the triangular flap is in the nose-cheek junction. A satisfactory aesthetic result is obtained.

With adequate mobilization and deep fixation to the periosteum, or to bone if necessary, the result is very acceptable.

**Problems**

Pincushioning of the flap may occur, but this usually settles spontaneously. If it does not settle, the resulting island of skin can be difficult to correct and may require several episodes of fat contouring. Use of a very fine suction cannula is advised for this; the standard technique is employed with great care. No other problems have been noted.
The nasolabial transposition flap is a useful flap that may be applied for closure of defects of the upper cheek. The donor site of the nasolabial fold is plentiful. This tissue excess increases with age. The flap is based superiorly and is transposed at 90 degrees to close the defect. The donor site is closed directly.
PROBLEMS

Bunching of the flap and some flattening of the nasolabial fold are possible problems resulting from the use of this technique (as seen on p. 270). Nevertheless, when indicated it can be a useful reconstructive approach. The scars resulting from the nasolabial transposition flap are oriented almost at right angles to the ideal skin lines on the face, and therefore they are obvious. The island can pincushion and thus cause an obvious and unattractive contour defect. For these reasons this procedure is rarely indicated.

Surgical Technique of Choice

The straight advancement flap followed by the vertical triangular advancement flap has given the best results in reconstructing the supramedial cheek area. The scars are in an ideal line and therefore not particularly noticeable. The dissection is more limited than with the other methods. Perhaps because of these factors, there has been almost no morbidity associated with these flaps. However, not all patients are suitable for this approach, and it may be necessary in some to use the lateral rotation flap despite its potential problems. Again, it is emphasized that deep nonabsorbable sutures should be placed to maintain the medially shifted material in its new position.

The latter method is excellent for large defects. For the surgeon with experience in using advancement flaps, this approach to large defects may also be substituted, as shown effectively in the patient on pp. 293-294.
ALAR BASE: NASOLABIAL REGION RECONSTRUCTION

One concern associated with reconstruction in the nasolabial area is the likelihood of distortion of the alar base. Worse still is the possible obliteration of the complex surface anatomy of the alar base–cheek area. All methods that involve importing bulky flaps or skin-grafting procedures tend to cause these problems. These methods should not be used and thus will not be considered here. Only two methods are worthy of consideration: the nasolabial triangular advancement flap and the perialar crescentic advancement flap.

Nasolabial Triangular Advancement Flap

If the defect lies just lateral to the alar base, the reconstruction must be performed in a manner that places no lateral tension on the alar base; otherwise it will be displaced laterally. The chosen method must not interfere with the natural lines of the alar base–cheek junction. If this should occur, the symmetry of the nose would be affected in a most obvious way. The triangular advancement flap fulfills these criteria and requires very little dissection.

The excision is planned as a wide crescent, as dictated by the pathology of the lesion. In this patient, the planned method of reconstruction was to use a triangle lying along the nasolabial line.
The defect is created, and the flap is elevated as an island on a subcutaneous pedicle.

The medial edge of the flap must be fixed deeply in the groove between the alar base and the cheek. This can be accomplished by direct suturing to deep tissue.
In an alternative procedure, the medial edge is anchored by a suture passed from the medial edge of the triangular flap, under the nose, to exit at the contralateral nasolabial area. The suture is tied tightly enough and kept long enough to create a symmetrical alar base region.

It is not necessary to perform much contouring of this new flap because the concave leading edge of the flap fits neatly into the convex medial edge of the defect.
The early result is shown. This defect heals quite satisfactorily.

The small donor site is closed in a V-Y fashion.

The early result is shown. This defect heals quite satisfactorily.

**PROBLEMS**

It may not be possible to use this flap in large defects because of the difficulty in obtaining enough skin in the transverse dimension. Apart from this limitation and a moderate amount of pincushioning that occurs occasionally, it is an excellent method of reconstruction that ensures good preservation of the complex anatomy of the region.
Perialar Crescentic Advancement Flap

First described by Webster, the perialar crescentic advancement flap is undoubtedly one of the most ingenious methods of local skin movement ever devised. With this method, superior and inferior dog-ears are excised in such a way as to enhance flap advancement. The concept is similar to that of Burow’s triangles. Larger defects can be reconstructed with this type of flap than with the triangular advancement flap.

This recurrent basal cell carcinoma just lateral to the alar base is excised and closed with the perialar crescentic advancement flap.

The basal cell carcinoma is widely excised.
Long ellipses, which are in effect triangles (see p. 306), are excised above and below the defect. The superior excision runs along the junction of the nose and the cheek, often as high as just below the medial canthus. The lower excision extends along the nasolabial line as far as is necessary.

The cheek skin is undermined until enough advancement is obtained to close the defect with gentle traction on the flap edges using skin hooks.
Suturing is begun superiorly. As the long lateral skin edge is approximated to the shorter medial skin edge, the cheek flap automatically advances, and the defect is closed. Minimal trimming is required. It is probably best to use some deep sutures to give additional support to the advancement flap.

PROBLEMS

No problems have been encountered with this clever procedure. The scar line is long, but it falls into the natural line of the nose-cheek junction above and the nasolabial line below; thus it is rarely, if ever, a problem. The alar base-cheek relationship is beautifully preserved.

In some patients a slight flattening of the nasolabial fold will occur, leading to a very small degree of asymmetry. The perialar crescentic advancement flap can be used in younger patients to produce a very satisfactory cosmetic result.

Surgical Technique of Choice

Both methods described here have a place in reconstruction of the nasolabial region. A small defect in this area can be adequately dealt with by the triangular advancement flap. The scarring is complex but usually blends in well, especially in elderly patients; however, some pincushioning may occur.

The ingenious perialar crescentic advancement flap is a pleasure to use because large defects can be closed with minimal cosmetic deformity. Once the important principle of flap design underlying this method is understood, it can be applied elsewhere.
LATERAL TO ALAR BASE RECONSTRUCTION

The region lateral to the alar base can be somewhat difficult to reconstruct because most methods—such as rhomboid, bilobed, rotation, and transposition flaps—tend to produce donor scars that lie across the lines of minimal relaxed tension. As a result, the scars may appear very obvious.

Inferior Advancement Flap

The inferior advancement flap will close fairly large defects. This technique, which is identical to the one used for the patient shown on pp. 290-292, is recommended for reconstructing defects lateral to the alar base region.

PROBLEMS

Apart from a slight deepening of the nasolabial fold, this method of reconstruction has been without problems and the scars lie in the correct biomechanical position.
**Choosing the Best Option for Cheek Reconstruction**

<table>
<thead>
<tr>
<th>Anatomic Area</th>
<th>Problem</th>
<th>Special Considerations</th>
<th>Flap of Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral cheek</td>
<td>In men, the beard area and sideburns are definite anatomic features that should not be altered; The tragus should not be altered in position and shape</td>
<td>Pale preauricular skin should not be placed in more highly colored areas</td>
<td>Inferiorly based rotation flap</td>
</tr>
<tr>
<td>Lower cheek</td>
<td>If the incisions are taken over the body of the mandible, the resulting scars often stretch, become indrawn, and are difficult to correct; in men, hair-bearing skin is required for reconstruction; a vertical scar on the neck will contract and cause a band</td>
<td>Very obvious area of the face, and therefore scars and contour irregularities are easily noticed; in planning these flaps, concavity of the neck and convexity of the area overlying the body of the mandible must be considered</td>
<td>Rhomboid flap</td>
</tr>
<tr>
<td>Malar region</td>
<td>Because of a convex contour, and highlighted by illumination from any direction, scars are obvious and contour defects stand out very clearly; lower eyelid, lateral canthus, and temporal hairline should not be disturbed as distinct landmarks</td>
<td>The skin is not hair bearing, a characteristic that precludes the use of skin from distant areas of the face that do contain hair</td>
<td>Lateral cheek rotation flap</td>
</tr>
<tr>
<td>Supramedial</td>
<td>Inappropriate scarring on contracture can cause obvious ectropion and troublesome epiphora; patient may experience occasional conjunctivitis</td>
<td>Several significant anatomic landmarks; medial canthus, punctum, caruncle, and medial end of the lower lid lie just above this region; these anatomic structures can be displaced if the flap is insufficient and tight, or if any skin occurs</td>
<td>Straight advancement flap or vertical triangular advancement flap</td>
</tr>
<tr>
<td>Alar base–nasolabial area</td>
<td>Concern should be the likelihood of distortion of the alar base and possible obliteration of the complex surface anatomy of the alar base</td>
<td>All methods that involve importing bulky flaps or skin-grafting procedures tend to cause distortion of complex surface anatomy of the alar base</td>
<td>Nasolabial triangular advancement flap or perialar crescentic advancement flap</td>
</tr>
</tbody>
</table>
### Rationale

<table>
<thead>
<tr>
<th>Allows closure of a triangular defect; design is simple</th>
<th>Preauricular transposition flap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning is accurate and the scar is acceptable</td>
<td>Transposition flap</td>
</tr>
<tr>
<td>Can be used for defects of virtually any size; the longer the defect, the more extensive the undermining and mobilization required; in some cases, prior expansion of the area is indicated</td>
<td>Rhomboid flap; bilobed flap</td>
</tr>
<tr>
<td>The scars are in an ideal line and therefore not particularly noticeable; the dissection is more limited than with the other methods; lower morbidity</td>
<td>Lateral rotation flap</td>
</tr>
<tr>
<td>Especially good for small defects of this area</td>
<td>Deep absorbable sutures should be placed to maintain the medially shifted material in its new position; excellent method for large defects</td>
</tr>
</tbody>
</table>

### Second Choice

<table>
<thead>
<tr>
<th>Preauricular transposition flap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilobed flap; rhomboid flap</td>
</tr>
<tr>
<td>Transposition flap</td>
</tr>
<tr>
<td>Rotation flap</td>
</tr>
<tr>
<td>Rhomboid flap; bilobed flap</td>
</tr>
<tr>
<td>Transposition flap</td>
</tr>
<tr>
<td>Lateral rotation flap</td>
</tr>
</tbody>
</table>

### Caveats

- Should be performed only on women patients who have pale, thin skin on all areas on the side of the face; requires less experience, has a greater margin of error
- Complex scar pattern
- Pincushioning is encountered more frequently than with rhomboid flaps because of its round design
- Does not always transfer skin as efficiently as transposition flaps; because of the more extensive undermining required, there is greater chance of damaging mandibular branch of facial nerve
- Only small defects can be dealt with; complicated scarring
- Color of the flap may differ from that of the skin it replaces; flap pincushioning; leaves the donor site at right angles to the ideal minimal tension lines
- Deep absorbable sutures should be placed to maintain the medially shifted material in its new position; excellent method for large defects
References—With Key References Annotated


The author studied 27 male patients who had been treated surgically for basal cell carcinomas of the temple and cheek. Reconstruction was achieved by local skin flap: Limberg rhomboid flap for the temple, cheek transposition flap for the anterior portion of the cheek, combined preauricular and postauricular transposition flaps for the middle part of the cheek, and advancement flap or flaps with Burow’s triangles for tumors of the preauricular region. The author discusses the principles and practical points of each flap.


Loeb R. Tempero-mastoid flap for reconstruction of the cheek. Rev Lat Amer Cir Plast 6:2, 1962.


The authors have modified the traditional rhomboid transposition flap technique by eliminating the creation of the rhomboid defect and directly transposing the flap into the original postexcisional defect. These changes allow maximum flexibility in flap design and minimize normal tissue loss. The authors conclude that the use of a modified rhomboid flap in the reconstruction of the periorbital area offers ample versatility in flap design and minimal normal tissue loss. Functional and cosmetic results are satisfactory in the vast majority of cases.


The ear is sometimes disregarded in discussions of facial harmony, but people are quick to notice ears that protrude, that are malformed or missing, or in other ways call attention to themselves. Because of this subtle awareness of the aesthetics of ear size, shape, and position, the artistic closure of ear defects is an important consideration for the surgeon in planning reconstruction.
**Anatomy**

Ear skin is thin, pale, and shiny. It adheres closely to the underlying cartilage on the anterior aspect until the helical rim is reached. In this area the skin is pink, soft, and often matt in texture. From superior to inferior aspect along the rim, the amount of subcutaneous tissue (and consequently the excess skin) in relation to cartilage increases, culminating in an earlobe composed totally of skin and subcutaneous tissue. The earlobe is often red, matte, and soft; the skin in this region is fairly thick. On the posterior aspect of the ear, the skin is thicker. More subcutaneous tissue is present and blood vessels are abundant. The skin is much less adherent to the cartilage. In the mastoid area, the skin is pale and thick.

The configuration of the external ear is complicated and merits careful study.
The structure of auricular cartilage is equally complex.

**Musculature**

**Extrinsic Muscles**

*auricularis anterior*  
Arises from the lateral edge of the epicranial aponeurosis and inserts into the spine of the helix

*auricularis superior*  
Originates from the epicranial aponeurosis and inserts into the upper part of the cranial surface of the auricle by a thin, flat tendon

*auricularis posterior*  
Arises from the mastoid portion of the temporal bone and inserts into the conchal eminence

**Intrinsic Muscles**

*helicis major*  
Lies on the anterior margin of the helix; arises from the helical spine and inserts into the anterior border of the helix

*helicis minor*  
Covers the crus helicis

*tragicus*  
Lies on the lateral surface of the tragus

*antitragicus*  
Arises from the outer part of the antitragus and inserts into the tail of the helix and antihelix

*transversus auriculae*  
Lies on the back of the ear over the conchal eminence

*obliquus auriculae*  
Lies on the back of the ear and over the conchal eminence; extends to the triangular eminence

Both groups of muscles have little or no function in humans.
NERVE SUPPLY

Motor Nerves

*extrinsic muscles*  The auricularis anterior and superior muscles are supplied by temporal branches of the facial nerve. The auricularis posterior muscle is supplied by the posterior auricular branch of the facial nerve.

*intrinsic muscles*  These muscles of the lateral aspect are supplied by the temporal branches of the facial nerve. The ones on the posterior aspect are supplied by the posterior auricular branch of the facial nerve.

Sensory Nerves

Sensation is supplied by the greater auricular and lesser occipital nerves from the cervical plexus, the auriculotemporal branch of the mandibular nerve, and the auricular branch of the vagus nerve.

BLOOD SUPPLY

The arteries include the following: (1) the posterior auricular branches of the external carotid artery, which supply the posterior surface with some small branches extending to the lateral aspect, (2) the anterior auricular branches of the superficial temporal artery, which supply the lateral surface, and (3) a branch from the occipital artery, which adds to the supply to the posterior surface. The veins accompany the arteries.

LYMPHATIC DRAINAGE

The upper half of the cranial surface, the whole margin of the ear, and the posterior wall of the external auditory meatus drain to the upper deep cervical nodes and the mastoid lymph nodes. These nodes lie superficial to the mastoid insertion of the sternomastoid muscle.

The lobule of the ear and the floor of the external meatus drain to the superficial cervical lymph nodes; these nodes are situated along the external jugular vein superficial to the sternomastoid muscle. The middle ear drains to the deep parotid lymph nodes.
**Aesthetics**

Because the ear protrudes from the side of the head, it is a prominent feature and any change in it is easily noticed. After alteration of one ear, the changed ear can be compared with the other for symmetry.

**Placement of Incisions**

The irregularities of the ear surface necessitate careful placement of incisions. If possible, incisions should not be taken across concavities; any scar contracture in this situation will cause obvious deformity. It is preferable to place the incisions within folds, where they are hidden from view. The incision shown (dashed line) should be handled with care, because on healing there may be a slight change in the position and shape of the tragus.
Areas of Tissue Availability

There are limited options for flaps in ear reconstruction, and the indication for each of the available flaps is clear. If a resection is large, it is difficult to obtain a very satisfactory result. Extra skin is available along the rim of the ear and in the postauricular area. For many reconstructions, it is necessary to import skin from non–hair-bearing areas around the ear.

Many ear lesions are handled either by elliptical excision and direct closure or by wedge resection. Posterior defects can almost always be closed directly. Large tumors may require either partial or total ear amputation. Superficial lesions, if extensive, may require excision and grafting. With a situation such as this, there is little call for local flaps. These flaps must be planned carefully to avoid ischemia or secondary ear deformity resulting from the flap donor site. Occasionally, small kite flaps, rim advancement flaps, or postauricular transposition flaps may be used on the rim of the ear.

Areas to Be Reconstructed

The area to be reconstructed may vary from part to all of the ear. A partial defect may consist of skin, skin and cartilage, or the defect may be full thickness. The ear, a cartilaginous appendage covered by skin, is a frequent site for cutaneous malignancy because of its prominence and resulting exposure to the sun and other elements. The convolutions of the ear are complex, as becomes clear when a total ear reconstruction is being undertaken. Not only are there multiple convexities and concavities, but also the cartilage shows areas of varying thickness.

Rim Defects

If there is a rim defect and it is judged that wedge resection with direct closure is not appropriate, or if small triangular kite flaps moved along the rim from above and below the defect are unsuitable, an advancement of the rim may be performed.
**Rim Advancement**

Although rim advancement may seem somewhat hazardous, it is a perfectly reliable method of reconstruction. This procedure makes use of the excess of soft tissue available around the edge of the ear.

A lesion present on the rim is excised, with the full thickness of the rim being taken. This leaves an unsightly defect if closed directly; thus the reconstructive method of choice in this situation is a rim advancement flap.

From the inferior portion of the defect, the rim is incised to the upper part of the lobule. The latter is soft, mobile, and extensile. These factors allow the rim to be advanced and the defect to be closed.
**Rotation Advancement Flap**

Rim advancement for ear defect closure may be performed as demonstrated previously, but there is the potential for distal necrosis if only the rim is used to close the defect. A variation of the described reconstructive procedure is shown here, and this certainly ensures excellent vascularity of the rim of the ear. The approach is exactly the same as shown on p. 319, but the postauricular skin is elevated. This whole flap is rotated superiorly and medially to close the postresection defect. This is a more secure procedure from a vascular point of view.

In this patient, a basal cell carcinoma in the superior portion of the rim of the left ear is outlined to provide adequate clearance.

The rim of the ear is resected along with skin surrounding the lesion. This most secure technique consists of rotating the rim together with the postauricular skin dissected from the posterior aspect of the ear.
To ensure adequate vascularity, the rim is incised anteriorly almost to the lobule. Dissection is then performed in a posterior direction at the level of the perichondrium.

The posterior flap, which now contains the rim of the ear, is moved superiorly. Direct closure of the rim defect can be achieved, as can the anterior incision. This has proved to be a very secure method of reconstructing rim defects of all sizes. Closure with this technique can be achieved even when the tumor is of a significant size. There is no doubt that the ear is smaller, but not to a significant degree. So far, there have been no complaints from our patients.
In this patient, the lesion occupies 25% of the ear rim. This can still be reconstructed with the rim rotation technique without causing a great deal of ear deformity.

The resection is planned providing adequate clearance and the rotation of the rim is outlined. It should be noted that the rim incision is slightly shorter than that in the previous patient example.
The lesion has been excised; the edge of the anterior and posterior skin has been rotated and as can be seen there is closure without tension.

The long-term result, without any further surgery, is satisfactory. There is no evidence of notching of the rim. The example shown of the rim rotation technique provides a nice result in the long term with very satisfactory healing.

**PROBLEMS**

Distal necrosis of the flap may occur, but it is very unusual and would be minimal. Some distortion and shortening of the lobule may occur, and, if both lobules are closely inspected, asymmetry may be noted. This is not a significant problem; ears tend to be viewed independently. If the patient insists, asymmetry can be corrected.
ANTERIOR CONCHAL DEFECT

Lesions arising on the thin anterior skin of the concha involve the perichondrium, and thus adequate excision usually requires the removal of underlying conchal cartilage. The defect may be closed with a skin graft, but a local flap is quicker and gives better results in skin color, lack of contraction, and reestablishment of contour. The postauricular “revolving door” flap is ideally suited for this repair.

Postauricular Revolving Door Island Flap

Described by Masson, the postauricular revolving door island flap is one of the most elegant reconstructive procedures in head and neck surgery. It is ideal for defects of the conchal area; the larger the defect the better, because this allows a larger pedicle, a more secure flap, and total conchal replacement with flap skin.

This patient had a neurofibroma of the concha of the right ear.
The neurofibroma is excised together with the underlying conchal cartilage.

The ear is then pulled forward and an island of skin is outlined, partly on the mastoid area and partly on the postauricular region.
An incision is made around this island, and the flap is raised posteriorly and anteriorly. The skin is incised through to the anterior surface of the ear; the posterior skin elevation stops at the ear-mastoid groove. This vertical attachment becomes the pedicle—the hinge of the revolving door. The island is freed a little superiorly and inferiorly.

This posterior island can then be rotated like a revolving door, and the conchal defect is reconstructed.
The postauricular defect is closed directly.

After this procedure, the ear looks almost completely normal.
The use of this flap is also suitable for closing a smaller conchal defect following excision of a basal cell carcinoma. This patient had a basal cell carcinoma in the upper pole of the left ear. This was excised together with the underlying cartilage and even in this position it was possible to bring in a revolving-door flap to close the defect and obtain a very satisfactory aesthetic result.

This patient had a very similar situation, but the basal cell carcinoma was in the lower portion of the ear.
Again, the revolving door flap can be developed in this position and rotated to achieve very adequate closure.

It can be seen from the three preceding cases that this is a very versatile flap in terms of size and position. In a large number of flaps performed in this way, we have had no healing problems of any kind and no loss of flaps. A further advantage is that it can be performed very quickly.

PROBLEMS

Only two main problems may be encountered with this technique: flap necrosis, which may occur when small defects are being reconstructed, and infection. Although necrosis has not been encountered with this type of flap, if it occurred, it would be handled by frequent dressings and debridement or by wedge excision. Infection requires antibiotics. If chondritis occurs, it can be painful, may require debridement, and takes some time to eliminate. Occasionally hematoma may occur. If it does, the sutures are removed and the hematoma is expressed. These complications are rare.

Another problem is that the surgeon must thoroughly understand the operation; fortunately, after using the technique, the surgeon will readily appreciate the simplicity of the concept.
PARTIAL EAR DEFECT

Trauma and tumor excision are the primary causes of partial ear loss; this usually occurs in the middle ear area. In an older patient a partial ear defect might be treated by a wedge resection, with approximation of the edges of the ear. In the younger person, however, the cupping of the ear resulting from this approach would be aesthetically unacceptable, and thus a more complete reconstruction is performed. If the patient has a full-thickness loss of rim, antihelical fold, and a variable amount of concha, this can be reconstructed only by a flap. The postauricular flap is the best solution for this problem.

Postauricular Flap

The postauricular flap is a two-stage procedure, yet it is a rapid method of reconstructing a difficult defect. The bulk of the flap allows total reconstruction frequently without the necessity for a cartilage graft.

After creation of the defect, a flap is planned, based on the edge of the hairline. The breadth of the flap is equal to that of the defect; the length is such that it will reconstruct the anterior surface, the rim, and posterior surface.
The flap is raised completely down to the postauricular fascia.

If sufficient skin is left anterior to the flap in the postauricular area, the free edge of this skin is sutured to the posterior edge of the ear defect over a portion of thick rubber or silicone tubing. If this is not possible, petrolatum gauze is simply placed under the flap after it has been attached to the ear skin.
The free margin of the postauricular flap is sutured to the anterior free skin edge of the ear defect.

In 10 days, the base of the flap is divided and the remainder of the flap is used to resurface the posterior part of the ear.
The ear defect is totally reconstructed by the flap being sutured to the posterior surface of the ear. A postauricular raw area results from division of the flap.

In some patients it is necessary to cover the raw donor area with a skin graft. If the defect is small, it will heal spontaneously, or, alternatively, mastoid skin is undermined and advanced.
This patient lost a portion of the lower helical rim as a result of trauma. The treatment used was the postauricular flap reconstruction technique.

PROBLEMS

If the edge of the hairline comes close to the conchal mastoid groove, the flap may be short and a skin graft may need to be added to the posterior reconstruction. A further procedure involving flap defatting may be necessary to have an optimal aesthetic result, with a smooth helical rim. Flap loss from ischemia may occur, but this has not been observed. This is a safe and satisfactory method of reconstructing the defect.
UPPER POLE EAR DEFECT
Temporalis Fascia Flap

For an upper pole defect it is essential to supply vascularized cover, and the tempo-
ralis fascia flap is used for this. The skeleton of the ear is formed from carved costal
cartilage. Resurfacing can be achieved with a split-thickness skin graft. It is probably
advisable to use a thick graft to prevent too much contracture.

This child presented with posttraumatic loss of the upper third of the ear. The par-
ents wanted to have a reconstruction carried out. Through a vertical temporal inci-
sion, the temporalis fascia was elevated, based inferiorly. It is important that a gener-
ous amount of fascia be elevated, because it is always possible to sacrifice any excess
during the reconstructive process. The scalp wound was closed with suction drainage.
A portion of costal cartilage was harvested and was carved to the dimensions of the missing portion of the ear, together with the three-dimensional anatomy. This was sutured to the remaining ear cartilage with nonabsorbable sutures. The fascial flap, which was tunneled under the bridge of skin between the donor site and ear, was placed over the ear cartilage graft.

The temporalis fascia flap was trimmed and then used to cover the cartilage graft. The skin of the edge of the ear defect was gently elevated and a temporalis fascia flap sutured into position with the skin of the ear overlapping the sutured area.
A thick split-thickness skin graft was harvested and placed over the reconstruction and sutured into position. Several small punctures were made with a No. 11 blade to allow drainage of blood from under the graft. The temporal area was drained with a small suction drain and a light dressing was applied.

At the 6-month follow-up, it can be seen that the ear is slightly short in the vertical dimension, but the contours of the ear are satisfactory.
**Total Ear Resurfacing**

A discussion of total ear reconstruction is not within the scope of this book. It is reasonable, however, to address the significant problem of skin cover when the total ear cartilage is exposed. An eventuality such as this is rare, but when it occurs, ingenuity is required. Any cover must be thin and must preserve ear contours; local skin flaps cannot fulfill these criteria. In such a situation, the temporalis fascia flap may be used to advantage.

This boy had an arteriovenous malformation of the ear and postauricular area. It was a high-flow, high-shunt lesion that required resection.
A total resection of the lesion was planned; the auricular cartilage, which is never involved in the malformation, would be retained and covered with an inferiorly based temporalis fascia flap.

After control of the main arterial input was gained in the neck, complete excision was carried out, and the auricular cartilage was left without perichondrium on its anterior and posterior surfaces.
A vertical incision was made upward from the ear in the temporal area and the skin elevated widely. The temporalis fascia was exposed, and a flap, based inferiorly, was lifted. The dimensions allowed the ear to be covered completely anteriorly and posteriorly.

The well-vascularized fascia was turned down and sutured around the edges of the defect.
The area under the fascia was drained, because hematoma results in flap failure. Once the fascia had ceased oozing, it was covered with a full-thickness skin graft.

This approach gives a reasonably good ear contour.
PROBLEMS

Potential problems resulting from this method of reconstruction include loss of fascia, loss of skin graft, hematoma under the graft, and failure of the graft to take. (The delayed method of grafting largely obviates the last complication.) It takes almost 1 year for the reconstruction to settle and for the swelling to go down. In some cases, an additional procedure is required to effect elevation of the ear from the side of the head. This is a good reconstructive method, because the only alternative is total resection and the fitting of a prosthetic ear. This can also be used if the reconstruction fails or is unsatisfactory.

Choosing the Best Option for Ear Reconstruction

<table>
<thead>
<tr>
<th>Anatomic Area</th>
<th>Problem</th>
<th>Special Considerations</th>
<th>Flap of Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rim defects</td>
<td></td>
<td>Small defects can be managed by wedge resection and primary closure</td>
<td>Rotation advance-flap</td>
</tr>
<tr>
<td>Anterior conchal defect</td>
<td>Lesions on the thin anterior skin of concha involve the perichondrium, and thus adequate excision usually requires removal of conchal cartilage</td>
<td>Local flap is quicker than skin grafting and has better skin color match, lack of contracture, and reestablishment of contour</td>
<td>Posterior “revolving door” island flap</td>
</tr>
<tr>
<td>Partial ear defect</td>
<td>In an older patient, primary closure of the middle ear area may be advisable, but in younger patients primary closure causes cupping of the ear</td>
<td></td>
<td>Postauricular flap</td>
</tr>
<tr>
<td>Total ear resurfacing</td>
<td>Significant problem when ear cartilage is exposed</td>
<td>Any residual cover must be retained and ear contours must be preserved</td>
<td>Temporalis fascia flap</td>
</tr>
</tbody>
</table>
LOBULE
The lobule can be reconstructed from small neck flaps or postauricular flaps. The
former are preferable, but they produce more obvious scarring. If possible, trim-
mming of the contralateral lobule for symmetry is the method of choice.

TUBE PEDI CLES
Small neck tube pedicles can be used for rim reconstruction. This method is becom-
ing less popular for the following reasons: it is time consuming because the tubes
must be moved over a considerable distance, and the procedure produces fairly exten-
sive neck scarring. Occasionally the result is satisfactory, but in most instances the
skin color and the contours of the reconstruction do not resemble those of a normal
ear. In severely burned patients, this may be the only technique available.

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Second Choice</th>
<th>Caveats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotating the rim together with</td>
<td>Rim advancement</td>
<td>Distal necrosis of flap may occur, but</td>
</tr>
<tr>
<td>postauricular skin dissected from</td>
<td></td>
<td>this is very unusual and necrosis would be minimal</td>
</tr>
<tr>
<td>the posterior aspect of the ear</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The longer the flap the better, because</td>
</tr>
<tr>
<td></td>
<td></td>
<td>this then allows a larger vertical pedicle, a more</td>
</tr>
<tr>
<td></td>
<td></td>
<td>secure flap, and total conchal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>replacement with flap skin</td>
</tr>
<tr>
<td>Safe and satisfactory method of</td>
<td>Grafting of</td>
<td>Skin grafting of temporalis fascia flap is necessary</td>
</tr>
<tr>
<td>reconstruction</td>
<td>a flap donor site may become necessary</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
References—With Key References Annotated


preauricular area, the intertragal notch, and the postauricular area. Helical rim advancements and their variations are the workhorse for repairing and restoring the natural arch of the helix. Retroauricular two-stage pedicle flaps with or without a cartilage graft will provide a nice cosmetic result for larger defects involving the helical rim. The authors conclude that it is most important that the surgeon know the wound, know the patient, and know that the simplest closure is often the best one.

The authors describe a method for reconstructing helical rim defects together with primary donor site closure by Z-plasty. They conclude that this technique can be considered a single-stage repair modality for the reconstruction of helical rim defects within primary donor site closure.
The authors discuss basal cell carcinoma of the auricle and the challenge it presents in both excision and reconstruction to the clinician. Case reports discuss and illustrate the use of controlled excision with assessment of margins and reconstruction using chondrocutaneous advancement flaps and multiple Burow’s triangles.
The authors describe the use of the postauricular (revolving door) island pedicle flap in the treatment of aggressive tumors of the concha. They conclude that the postauricular island pedicle flap is well suited for conchal reconstruction because of its proximity to the defect. The flap was transferred from posterior to anterior toward the concha, followed by primary closure of the retroauricular donor site.

The authors present a new method of earlobe reconstruction using a doubled-over Limberg flap, which they have used in six ears. They conclude that this technique produces a good-looking earlobe, which needs defatting after 3 to 4 months and suffered minimal necrosis at the tip of the folded flap in three cases. There was no earlobe shrinkage on long-term follow-up.


The authors performed six fresh adult male cadaveric dissections of the retroauricular area. They conclude that the flap seems to be a truly fasciocutaneous flap with small, questionable superior and anteroinferior muscular contributions, and an inclusion of the rather small posterior auricular muscle. As reported in other studies, blood supply to the area seems to be derived from the PAA.


More than any single feature, eyes that sparkle and are free of lines and the signs of fatigue express youth and vivacity. The eyelids should frame the eyes without puffiness, drooping, or hooping. The primary importance of the eyelids is functional; they protect the cornea and contribute to tear drainage. In this respect, the upper lid is vital. Absence of this lid exposes the cornea, resulting in ulceration, scarring, and blindness. Absence of the lower lid causes epiphora and conjunctivitis but little else, apart from the gross aesthetic defect. During waking the upper lid closes over the cornea when one blinks. During sleep, Bell’s reflex comes into play: the globe rotates upward and the cornea is protected under the upper lid.
Anatomy

SKIN
The eyelid skin is thin and usually pale; the upper lids are paler than the lower lids. With age, transverse wrinkles develop, indicating an excess of skin vertically. The subcutaneous layer is thin, and immediately under this lies the orbicularis oculi muscle layer. Deep to this muscle lie the tarsal plates—thin, elongated plates of connective tissue that are approximately 2.5 cm long. The tarsal plate of the upper eyelid is ovoid and larger than that of the lower lid; its maximal height is 10 mm. The levator palpebrae superioris is attached to its superior margin. The tarsal plate of the lower eyelid is smaller; its maximal height is approximately 5 mm. The orbital septum extends from the orbital margin to the tarsal plates. The ends of the tarsal plates are attached to the medial lateral orbital margins by the medial and lateral palpebral ligaments.

The conjunctiva lines the lids and the fornices, and runs over the sclera to the cornea; the conjunctiva joins the cornea at the limbus.

MUSCULATURE
The orbicularis oculi muscles close the upper and lower lids. The levator palpebrae superioris muscle and Müller’s muscle elevate the upper lid.

NERVE SUPPLY
The upper half of the conjunctiva is supplied by the ophthalmic division of the trigeminal nerve (fifth cranial nerve) and the lower half by the maxillary division.

The orbicularis oculi muscle is supplied by the facial nerve (seventh cranial nerve).

The levator palpebrae superioris receives its nerve supply from the oculomotor nerve (third cranial nerve).

BLOOD SUPPLY
The blood supply to the eyelids comes from the medial palpebral branches of the ophthalmic artery and the lateral palpebral branches of the lacrimal artery.
**LYMPHATIC DRAINAGE**

The lateral portion of the eyelids and the lateral canthus drain to the superficial and deep parotid nodes. The medial portion of the lids and the medial canthal area drain to the submandibular lymph nodes.

**CANTHAL REGIONS**

**Medial Canthus**

The skin around the medial canthus is very thin; a fine layer of subcutaneous tissue lies between it and the nasal bones. The canthus itself is complex and contains the caruncle and the puncti for the upper and lower canaliculi. Injury of these structures frequently results in stenosis of varying severity with resulting epiphora and, at times, conjunctivitis. The medial canthal ligament is attached to the nasal bones and secures the medial canthus in position; it is composed of a superficial layer and a deep layer. The lacrimal duct and sac lie medial and caudal to the canaliculus, behind the infraorbital rim.

**Lateral Canthus**

The lateral canthus is less complex. Its ligament is a two-layered condensation of periorbitum that is attached to the lateral orbital rim and holds the lateral canthus in place. The periorbitum connecting the medial and lateral canthus inferiorly forms a sling for the orbital contents. This sling is referred to as Lockwood’s suspensory ligament.

**Aesthetics**

The palpebral openings are symmetrical. Their shape, which is usually oval, is aesthetically pleasing. Any disturbance of the palpebral anatomy can cause a less satisfactory shape and result in facial asymmetry. The canthal areas are attractive and vary with racial characteristics. Again, these regions are symmetrical, and therefore any variation in them is noticeable and aesthetically displeasing. Eyebrows and eyelashes are positive features that enhance one’s appearance. If the eyebrows or lash lines are harmed in any way or displaced, the result may be disastrous both aesthetically and functionally; if displacement should occur, a functional problem may result. These aspects of this complex area must be kept in mind when reconstruction is planned.
Function

The eyelids have two basic functions: eye protection and tear drainage. Normally the lids are open during the day and closed at night. The cornea is protected by the upward rotation of the eye (Bell’s reflex). During waking the orbicularis is usually relaxed and the levator keeps the lids open; during sleep the reverse occurs.

Tears are drained into the puncta by a dynamic lacrimal pump mechanism. During blinking negative pressure in the canaliculi draws the tears from the eye into the lacrimal system. This is largely the function of the lower canaliculus. In paralyzed or reconstructed lids, this pump mechanism is damaged and epiphora results.

Placement of Incisions

Ideally, incisions are made along the lid line transversely and in the crow’s-feet lines laterally. Vertical lid incisions may contract and deform the lid margin. Unfortunately, in lid reconstruction the position of the incisions is determined by the lesion to be excised.

In the medial canthal area, horizontal incisions are better than vertical ones. Both types of incisions may create problems, because the area is biconcave.
**Areas of Tissue Availability**

In older patients the upper eyelid skin is excessive; thus it is a good source of flaps for lower lid reconstruction. It is conveniently placed, and offers good texture and color match. Forehead skin may be used but only as a last resort; this skin is too thick and pale. Skin from the glabellar area is better; it is used frequently in the medial canthal region. Lower lid reconstruction is often accomplished with cheek or nasolabial skin.

**Areas to Be Reconstructed**

From a standpoint of reconstruction, the lower lid and upper lid will be considered separately. I will also separately discuss the problems of skin replacement and full-thickness reconstruction. The medial and lateral canthal areas will be examined individually, and the complexities of reconstruction in these regions will be defined.

**LOWER EYELID RECONSTRUCTION**

In lower eyelid reconstruction the aim is to form a lid of adequate height with a stable edge. Mucosa should not escape over the lid margin into the skin area.

Many techniques can be used to reconstruct the lower lid. However, this discussion will be limited to examining the flaps that have produced consistently good aesthetic and functional results.

**Lower Eyelid Skin Defect Reconstruction**

Although full-thickness skin grafts may be used to resurface full-thickness skin defects, the most uniformly secure method is to use a skin flap from the upper lid.
Unilateral Tripier Flap

A skin defect on the lower lid can be conveniently reconstructed with this upper lid flap. Its proximity and security make it an attractive reconstructive choice.

The unilateral Tripier flap was used to repair the ectropion in this patient with Treacher Collins syndrome.
The defect in the lower lid is created, and a flap of corresponding dimensions is outlined on the upper lid. If two thirds of the length of the upper lid is required to perform the reconstruction, a single pedicle is sufficient. The flap is lifted with the underlying orbicularis muscle until it can be transposed easily down into the lower lid. The inclusion of the muscle into the flap ensures that vascularity is maintained.

In some instances in which the lateral canthus is to be elevated, the lower lid incision joins the lower incision of the pedicle and the flap is directly inset. In this way the canthus is slightly elevated, a desirable effect for this patient because it combats the antimongoloid slant that is part of the syndrome. Some experts recommend the use of a tie-over dressing. This technique is unnecessary when the orbicularis has been incorporated in the flap. When the pedicle is not directly inset, it must be divided and trimmed 10 to 14 days after the initial procedure.
Bilateral Tripier Flap

When the whole lower lid is to be resurfaced, a bilateral Tripier flap is used.

The flap is raised in exactly the same manner as the unilateral flap. The pedicles are left intact; in 10 to 14 days they are divided and trimmed.
PROBLEMS

Flap failure resulting from ischemia is a rare occurrence. This has happened only when the orbicularis oculi muscle has not been included in the flap. It is difficult to imagine anything more than a partial necrosis occurring in a myocutaneous flap. Slight pincushioning may occur, making the reconstruction obvious. When this flap is used for paralytic ectropion, the bilateral pedicles may be left undivided to act as a sling to support the lax lower lid.

PARTIAL EYELID RECONSTRUCTION

In reconstructing part of a lid, a stable edge should be produced and the height of the lid should be preserved. The shape of the palpebral fissure and the lateral canthus should not be altered if at all possible.

Lower Eyelid: Cheek Advancement Flap

When the defect is subtotal, a rotation flap from the cheek produces the simplest and quickest reconstruction.
After the defect has been produced, an incision is taken out from the lateral canthus horizontally; it should be inclined in a cranial direction to prevent any pulling down of the lid and resulting ectropion. Initially the length of the incision is limited, and the lateral canthal division (described below) is performed.

The incision is extended further laterally if additional length is required for closure. Long lateral incisions are rarely necessary. The skin is undermined at the suborbicularis level, onto the temporal area. At this point, advancement is limited; to obtain the required skin shift, the lower limb of the lateral canthal ligament and the orbital septum are divided with sharply pointed scissors.
After this division, it is easy to move the whole lid medially to close the defect.

Occasionally a lateral Z-plasty will be used to increase the length of the incision and diminish any tension along the scar.

A decision is now made about lining. If the defect is extensive or if it lies in the lateral half of the lid, lining will probably be necessary. Although buccal mucosa will provide good conjunctival replacement, the best cover and support are provided by the chondromucosal graft from the nasal septum, as described by Mustarde. The technique for taking this graft is similar to the method used for a submucosal resection of the nasal septum. The low incision, however, is made through nasal mucosa and cartilage. The septal submucosal dissection is performed on the contralateral side of the cartilage. When the required extent of the dissection has been completed, further incisions are made through the mucosa and cartilage to provide a graft of adequate size. If a large chondromucosal graft is required, an incision is made around the alar base. Retraction of the base will give better exposure of the septum, although this is rarely necessary. The graft is then sutured to the raw area on the inner aspect of the flap.
Vertical suturing of the eyelid is performed in layers, with 6-0 plain catgut used for the conjunctival and subconjunctival layers, 4-0 chromic catgut for the tarsal layer, and fine monofilament nylon for the skin.
Care is taken to align the eyelid margin accurately, matching the gray line and the lash line on both sides of the incision.

Closure of the defect and medial movement of the flap can be achieved without tension.
A Z-plasty at the outer end of the temporal incision to relax the flap has been described by McGregor. This maneuver is never indicated for this particular reason; the real indication for this approach is to equalize the excess skin build-up above the lateral canthal incision as the cheek flap advances medially.

When used for this purpose, the Z-plasty works well and improves the aesthetic result, as can be seen after wedge excision of this basal cell carcinoma of the lower lid.

It is interesting to note that by dividing the inferior limb of the lateral canthal ligament, some large defects in the central eyelid region may be closed without any significant lateral canthal skin incision.
PROBLEMS

It is rare to encounter problems of any kind with this eyelid reconstruction. Occasionally there may be slight notching of the lid margin, but this can usually be avoided by accurate suturing in the region. Slight sagging of the lateral portion of the reconstructed lid may result for a number of reasons. The lining of the flap may have shrunk, or perhaps lining was not used and should have been. The lateral incision may have been directed caudally rather than cranially. This action and a failure to anchor the undersurface of the flap can cause a dragging force on the lid, with resulting lateral ectropion. If this deformity occurs, it can be released and a skin graft or small Tripier flap inserted.

TOTAL LOWER EYELID RECONSTRUCTION

The requirements presented in the previous section for a partial lower lid reconstruction apply even more forcibly in total lower lid surgery. The surgeon must aim for correct height and a stable lid margin. There should be a deep conjunctival fornix. Good canthal positioning is important. A lid that conforms to the curvature of the globe is ideal.

Several methods can be employed for total eyelid reconstruction using the upper lid, the forehead skin, the nasolabial skin, or the skin over the cheek area as a rotation flap. Unless the surgeon has had extensive experience in eyelid surgery, it is best to select an approach that does not interfere with the upper lid. Significant disturbance of upper lid anatomy may cause serious functional problems that can ultimately result in corneal exposure or abrasion with the attendant complications. For this reason the method of cheek rotation flap and chondromucosal graft described here is recommended.
Forehead Flap

In the elderly patient, particularly when prolonged anesthesia is considered inadvisable, when there is some worry about the possibility of hematoma, when there has been irradiation to the cheek, or when the cheek and neck skin is tight, the surgeon may opt simply to use the forehead to reconstruct the lower lid in a two-stage procedure known as the Fricke flap. A total excision of the lower eyelid is performed. Reconstruction of the tarsal conjunctival lining and support system is carried out with a composite chondromucosal graft from the nose, as shown here. Because of the thickness of the forehead skin, a buccal mucosal graft may be quite satisfactory.

After the graft has been carefully sutured in place, a supraeyebrow forehead flap is raised; this flap has the correct dimensions for resurfacing the lower lid. The flap should be raised only at skin level, without frontalis, to obtain as thin a flap as possible.
The flap is taken down and sutured into position to effect a skin reconstruction of the lid. The pedicle is left untubed, and a split-thickness skin graft is placed on the raw area of the forehead.
In 10 to 14 days, the pedicle is divided and returned to the forehead area. The remainder of the lid reconstruction is then performed.

**PROBLEMS**

The skin of the forehead is much thicker than that of the lower eyelid, and the color tends to be lighter. Even after attempted thinning and placement of Z-plasties around the edge of the flap, pincushioning of the flap occurs in almost every case.

This problem can be clearly seen in the postoperative photograph.
The pincushioning may also have the effect of turning skin in toward the cornea and causing some abrasion. The surgeon must be very careful to look for this possible effect at all postoperative visits. The forehead flap does have the virtue of being a rapid and relatively atraumatic procedure that can be done under local anesthesia if necessary.

To obviate the need for a skin graft on the forehead, a tissue expander could be placed in such a position as to allow the skin flap to be harvested without leaving a significant donor scar.

**Cheek Rotation Flap and Chondromucosal Graft**

Three necessary components contribute to a total lower lid reconstruction: skin, support tissue, and lining. Undoubtedly, in our experience, with all of the available techniques for total lower eyelid reconstruction, the simplest and most consistently successful method is a cheek rotation flap for cover and a chondromucosal graft for support and lining. With careful planning and execution, few problems are encountered.

Most patients requiring this type of surgery are older and have cheek skin that is lax. The amount of skin available for rotation is determined by using the fingers to push the skin from the malar area toward the nose. If the skin is tight, an alternative method of surgery should be considered.

This patient with a basal cell carcinoma involving the entire rim of the right lower eyelid requires a total lid resection.
Once the eyelid has been resected, the chondromucosal graft is harvested. The graft must be large (it can be trimmed as necessary), but there is a tendency to underestimate its size. To obtain a large enough graft, it is wise to incise around the alar base to get good exposure of the septum. The graft is taken by means of a low incision in the septum through the mucosa and the septal cartilage.

The mucosa on the other side is extensively raised, and a large composite graft is provided by incising through the mucosa and septum.
After the graft is taken, the septal cartilage is trimmed to leave a fringe of mucosa surrounding the central island of cartilage. The cartilage is thinned. This thinning may make the graft slightly convex on the cartilage side, providing it with a better contour for lid reconstruction. The graft is sutured to the conjunctiva with 6-0 plain catgut.
The cheek flap is designed. The incision goes laterally and upward; it then runs vertically in front of the ear into the neck as required. The flap is next raised at the face-lift level. Elevation extends down into the neck to make maximum use of the skin laxity in this area. Hemostasis is established.
With the use of a hook, the flap is gently pulled medially; it should not be forcibly dragged into position. If the flap is tight and defect closure is difficult, the incision is carried further into the neck and more extensive undermining is performed. The incision length and undermining is sufficient when the flap can be rotated effortlessly. Failure to check for pull on the flap may result in suturing under tension, with ischemia of the flap tip and loss of the reconstructed lid as possible consequences.

The flap is now rotated into position. It is sutured to the upper edge of the graft with running 6-0 plain catgut sutures. The undersurface of the flap is anchored to the periosteum and soft tissue over the zygoma with nonabsorbable sutures. Anchoring prevents ptosis of the flap and subsequent ectropion. Excess skin will remain in two areas: at the base of the vertical cheek suture line (because closure of the V defect leaves an inferior standing cone) and in the neck at the inferior posterior edge of the incision. Both of these areas must be trimmed. Suction drainage and pressure are important to prevent hematoma.
PROBLEMS

The most serious complication is flap loss because of ischemia, resulting from poor flap design, tension in closure, and hematoma. Infection is rare unless flap necrosis has occurred. Once necrosis is present, reconstruction is difficult. A bilateral Tripier flap or a nasolabial transposition flap offers the best solution.

Ectropion may occur if the flap is too tight in a vertical direction or because of skin laxity or a lack of flap stabilization to the zygomatic region.

These conditions all result in a downward pull, as shown to a small extent in this illustration. This would be corrected by a wedge resection and Z-plasty with vertical closure. Another quite different cause of ectropion is partial composite graft take, with resulting fibrosis and vertical contracture of the new lid. For a similar reason, there may be entropion, or turning in of the skin, which may cause irritation and abrasion of the cornea. These problems require the addition of tissue, either skin or mucosa, depending on the region involved.
Forehead Flap

This little girl has a high-flow vascular malformation of the lower eyelid, and the total lid thickness is involved.

The angiogram clearly shows the lesion.
A total resection of the lower eyelid is performed. This includes complete removal of the vascular malformation. To reconstruct the eyelid, a full-thickness midline forehead flap is elevated. The donor site is closed directly. The flap is trimmed and its undersurface is grafted with oral mucosa, and the composite flap is then sutured into the total lower eyelid defect.
Postoperatively there was considerable swelling that gradually settled over time. At no point was there any concern about the condition of the eye itself in that there were no problems with exposure or irritation, although initially eye ointment was prescribed.

In the long term, after one minor revision, this patient has a stable eyelid and no problems of exposure. The aesthetic result is acceptable.
**Problems**

One of the problems associated with lower eyelid reconstruction is the bulky lid. This was seen at one part of this young girl’s procedure (pp. 371-373), but after defatting of the lid, her appearance was satisfactory. Lack of support of the lid conjunctiva can be a problem, particularly if there is vertical scarring of the lid. Fortunately, in this patient there was abundant fat in the flap, and this prevented scarring. Should this be a problem, the lid can be released and a conchal cartilage graft can be placed with stabilization onto the infraorbital rim. However, it is important that the conchal cartilage graft be contoured by scoring to achieve the curvature required to keep the lid in its correct position in relation to the globe. Another problem can be in-turning of the edge of the lid with irritation of the eye. Thus it is important to make certain that the lining is adequate and that only mucosa is chosen, since this is the closest that one can get to the conjunctiva.

**Cheek Flap for Total Lower Eyelid Reconstruction**

This 64-year-old patient has a squamous cell carcinoma of the lower eyelid and presents with cervical node involvement. The incisions for the resections are marked on her face. The cheek flap is elevated, and the lower eyelid is resected completely.
A total parotidectomy and a modified neck dissection are performed.
The internal lamella of the lower eyelid is reconstructed with a nasal-septal graft of cartilage and mucosa. The cheek flap is placed back into its natural position in preparation for closure.
The wounds are closed with suction drainage.

The patient is seen 5 years after her resection; there has been no recurrence.

**Surgical Technique of Choice**

The rotation flap is most satisfactory for partial or complete lower lid reconstruction. The flap is simple to design, and the skin color and texture are a good match for the normal lower lid skin. With good planning, correct execution, and efficient hemostasis, few complications should arise.
**Upper Eyelid Reconstruction**

Because the skin of the upper eyelid is thin and supple, satisfactory replacement can be obtained from only a few areas. A flap from the forehead is too thick and the color is unsatisfactory. Skin defects only are best managed with full-thickness skin grafts from the other upper lid or from the retroauricular area. Split-thickness grafts should never be used unless no full-thickness donor sites are available. These grafts contract; in addition, they are pale in color, have a matte texture, and appear as obvious patches of foreign skin. After full-thickness resections, it is only necessary to reconstruct a lid that is three fourths of the original length. The lid must never be short vertically; any significant defect of closure may cause corneal drying and ulceration.

**Partial Upper Lid Reconstruction**

In partial upper lid reconstruction, the lid should not be tight. Its height should be adequate to ensure closure of the palpebral tissue. There should be no notching of the free margin. This margin should be stable, with mucosa contained within the inner surface of the lid.

**Resection and Closure With a Lateral Advancement Flap**

This patient presented with a congenital anomaly of the central portion of the upper eyelid. The deficiency of the lid prevents total closure and tends to result in irritation of the eye under various climatic conditions. The plan for this patient is to dissect the scarred area, lengthen the internal lamella, and close the defect with a sliding flap.
The skin is excised as a wedge and a release of the internal lamella is carried out.

The lateral incision is made from the lateral canthus out to the temporal area; further freeing of the internal lamella is carried out.

The plan is to advance the flap medially, but a vertical releasing incision is necessary to achieve that, and this is converted laterally into a Z-plasty.
A rather extensive dissection is necessary to get adequate movement of the skin and to allow underlying subcutaneous tissue to move medially and close the defect. Satisfactory closure is obtained with this sliding flap, and a lateral Z-plasty allows length to be gained; this also allows correction of the lateral dog-ear.

**PROBLEMS**

The upper eyelid is the essential lid, and its function must be preserved at all costs. The lower lid, on the other hand, is expendable—a patient can function without it, although aesthetically this would be unsatisfactory and there would be considerable tearing.

In the case presented, care was taken in reconstruction of the upper lid. A lateral axial incision was made that allowed the lid to move medially. Second, the axial resection was carried out with straight, sharp, pointed scissors; this is much more advisable than using a scalpel. The lid was disrupted as little as possible and closed in layers with good fixation medially. As one can see from the photograph (left), the eye is perfectly healthy with no evidence of inflammation of the conjunctiva. This is an indication of excellent function.
Upper Lid Reconstruction With an Island Flap

As a result of previous trauma, this patient had the left eye enucleated, and there was significant shortening as a result of scarring of both the upper and lower eyelids. The combined lid problem made it impossible for the patient to retain a prosthesis.

The operative plan is to release the ectropion of the upper eyelid and reconstruct the defect with an island flap of skin and subcutaneous tissue from the lateral temporal area.

The flap is raised as a medially based island.
The upper lid is released; the flap is elevated and sutured into the defect with the skin turned inward, and the donor site is closed directly. The external cover of the lid is provided by a full-thickness postauricular skin graft.

This reconstruction allows the patient to retain her prosthesis. She does not wish any further corrective surgery and is pleased with the end result.

**Problems**

As can be seen from this reconstruction, the upper lid is inadequate because there is no muscular function, and there is a hollowing of the lid. This could be improved by placement of fat as a free graft or tissue from the cheek of the frontal area, deepithelialized but vascularized. The position of the lateral canthal ligament could be improved, and this in turn would improve the position of the globe. Another factor that would help would be to place a bone graft into the floor of the orbit to raise the prosthesis; however, as mentioned above, the patient did not wish any further surgery.
**Lid Switch Flap**

If the edges of the lid defect cannot be brought together for primary closure, tissue must be imported. One method of doing this is the lid switch flap.

In this technique, one fourth of the lower lid is used to reconstruct the upper lid defect. The lower lid is closed directly. The width of the upper lid defect is measured, and a pentagonal wedge flap of half that width is drawn out on the lower lid.

With the eye protected with a teaspoon or a specialized eye shield and the lid margin held with hooks, the medial edge of the wedge is cut with straight iris scissors. Using a hook to keep the flap under tension, beginning at the apex of the wedge, the surgeon cuts through the lateral edge with a scalpel. The incision stops approximately 5 mm from the lid margin to prevent injury to the marginal vessels, which lie 3 mm from the free margin of the lid. The flap can be rotated on its pedicle to close the upper lid defect. This is very similar to the Abbé flap in lip surgery.
The lower lid is closed directly. Suturing of the flap into the upper lid and closure of the lower lid defect are performed in layers.

If nonabsorbable Prolene or nylon subconjunctival sutures have been used for deep closure, the ends of the sutures should be covered with tape identifying which end is which, to allow easy identification for suture removal.
A Frost suture may be used to splint and protect the pedicle for 2 or 3 days. In 10 to 14 days the little vascular pedicle is divided.

The lid switch flap also may be used for larger defects. In such cases, the flap is correspondingly larger and is based on a small cheek rotation flap fashioned in the standard manner by means of a lateral canthal incision. The rotation flap closes the lower lid defect. This procedure will be discussed further in relation to total upper eyelid reconstruction.
Although the lid switch flap can provide excellent results in skin color, texture, lid anatomy, and function, it is not a technique for the inexperienced surgeon.

Inaccurate planning of the flap may result in an insufficient amount of tissue to adequately close the defect. Lack of care in approaching the lid margin may damage the blood supply and cause flap necrosis. Tight suturing around the pedicle at the margin of the lower lid can strangle the vessels in the pedicle, likewise leading to flap necrosis. Irregularities may occur at the rim of the upper lid, with entropion or ectropion and corneal irritation from the eyelashes.
Upper Lid Rotation Flap

An alternative to the lid switch flap is the upper lid rotation flap. This technique is also used for defects ranging from one-fourth to one-half the lid length. The best way to plan the procedure is to stand at the patient’s head, look down, and consider the upper lid as the lower lid. In this way, both the planning and the performance of the procedure are made much easier.

This patient has a basal cell carcinoma involving the full thickness of the medial third of the left upper eyelid.

The projected resection is fashioned as a standard pentagonal wedge.
With the eye protected by means of a teaspoon, the upper lid is resected with straight iris scissors. Teaspoons are very useful as eye protectors; these come in various sizes and shapes. Coffee spoons can be extremely useful for protection of a child’s eye, whereas larger spoons can be used for an adult. Use of a spoon ensures safe, effective protection during eyelid procedures.

An incision is made through the lateral canthus extending out onto the temporal area.
The upper limb of the lateral canthal ligament is divided with sharp pointed scissors.

When this maneuver is performed, the lid can be moved medially to close the defect. If any tension is present, the lateral incision is extended. However, this incision rarely extends far into the temporal area.
As with the rotation flap in lower lid reconstruction, a temporal Z-plasty can be done, but this is mainly for cosmetic reasons and adds little or nothing to the lid advancement. The edges of the defect are closed in layers.
The result can be aesthetically and functionally excellent.

**PROBLEMS**

Few problems are encountered with an upper lid rotation flap. However, some problems should be considered, at least in theory. If the defect is too large, the upper lid can be unduly tight. Fortunately, the flap will usually stretch with time. Entropion and corneal irritation may occur. Upper lid ptosis also may occur, but normally this is a temporary phenomenon.

**Surgical Technique of Choice**

Because the upper lid rotation flap is simple to design, uncomplicated to perform, and produces an excellent aesthetic and functional result, it is the reconstructive method of choice. The secret to performing this technique is in the planning process; the surgeon needs to consider the upper lid as though it were the lower lid, and then plan the surgery accordingly. If it makes it easier for the surgeon, he or she can sit at the top of the table, and then the upper lid becomes the “lower lid.”
Total Upper Lid Reconstruction

The upper lid is of paramount importance, both aesthetically and functionally. This structure is essential for corneal protection, because without its cover, the cornea dries and ulcerates and scarring and blindness result. Reconstruction of an upper lid is a matter of urgency. The other important attribute of the upper lid is its ability to open and close. If possible, this movement should be maintained. Because the lower lid is much less important functionally, it can be used as a source of reconstructive material.

Simultaneous Cheek Rotation and Total Lower Lid Switch Flap

As mentioned in the preceding discussion, the lower lid has a less important functional role than the upper lid. Therefore, when the total upper lid has been sacrificed, the lower lid can be used in its entirety to provide a satisfactory upper lid reconstruction.

This patient has a large squamous cell carcinoma of the upper lid.

After total upper lid resection is performed, the operative plan is outlined on the lower lid and cheek. The whole of the lower lid will be taken, with the lower punctum and the medial canthal area being left undisturbed.
The required amount of skin is drawn out, and the lateral part of the incision is taken to within 5 to 7 mm from the lateral lid margin in the region of the lateral canthus. A standard cheek rotation flap is drawn out on the cheek. This flap must be planned to be large enough to reconstruct the lower lid.

The lower lid flap is cut with straight iris scissors and scalpel, maintaining the lateral pedicle. The cheek flap is widely elevated, as described earlier. At this point the lid flap and the cheek flap are temporarily rotated into their final positions. This allows the excess cheek skin under the lower lid excision to be estimated. Then the required wedge of skin is excised.

A composite chondromucosal graft is taken from the nasal septum. With the large amount of tissue required, it is usually necessary to incise around the alar base to give better exposure to the septum.

This graft is sutured in position, as described for lower lid reconstruction.
At this point the lid and cheek flap are temporarily rotated into their final positions. This allows the excess cheek skin under the lower lid excision to be estimated. When this has been done, the calculated wedge of skin is excised.

The lower lid is rotated to form the upper lid, with the medial end of the lower lid becoming the lateral end of the upper lid. The levator muscle is sutured to the orbicularis muscle.
As this is done, the cheek flap rotates to close the cheek defect. Care should be taken to anchor the undersurface of the flap to the malar area and to prevent sagging of the reconstructed lower lid. The upper lid pedicle is left in situ for 2 or 3 weeks to ensure good vascularity of the lid; after this time, the pedicle is severed.

Excellent aesthetic and functional results can be achieved with this procedure.

Problems

The vascularity of the transferred lower lid may be a problem. If significant ischemia occurs, with necrosis of the new upper lid, further upper lid reconstruction is urgently needed. Solutions to this problem are limited and unsatisfactory both functionally and cosmetically. Concurrent loss of the cheek flap, resulting in an eye without lids, is another possibility. Immediate closure with a mucosa-lined forehead flap would be the solution to this horrifying complication. After healing has occurred, further procedures would be used to refine the lids.
Two-Stage Lower Lid Switch and Cheek Rotation Flap

The advantage of this technique of total upper eyelid reconstruction is its safety. Because the repair is done as a two-stage procedure, the vascularity is much less tenuous. In addition, the two stages allow for more trimming and a more refined reconstruction.

After resection of the upper lid, the lower lid is incised, either medially or laterally, until it can be swung up and sutured to the lateral or medial half of the upper lid defect. The position varies according to which side of the lid has been divided.
It is important to spare the punctum. In this way the lid is based on a much wider pedicle than with the conventional lid switch flap. The levator muscle is attached to the orbicularis oculi muscle over as wide a distance as possible. The raw areas are closed by suturing the conjunctiva to the skin.

The position of the lid pedicle is such that it covers and protects the cornea during the 2 weeks it is left attached. At that time the amount of lower lid required to totally reconstruct the upper lid is marked on the lid.
Thus upper lid reconstruction is completed. If possible, the levator is identified and sutured to the tarsal plate.
Chapter 7  Eyelid and Canthal Region Reconstruction

The lower lid is reconstructed by the conventional cheek rotation flap and chondromucosal graft method described earlier.
With an extended lateral canthal incision, the cheek flap is elevated in the face-lift plane and rotated medially to resurface the skin of the lower lid. The inequality of the lateral temporal incision is dealt with using an unequal Z-plasty technique.

Excess skin at the base of the vertical incision on the cheek is removed as a dog-ear.
PROBLEMS

Vascularity is not a problem for the upper lid reconstruction; however, as with all large cheek rotation flaps, ischemia can be a problem involving reconstruction of the lower lid. If ischemia does occur, then the lower lid reconstruction will fail and a forehead or nasolabial flap with mucosal lining will be necessary for the subsequent reconstruction.

Reconstruction of Choice

Only the two-stage method of reconstruction should be considered because of its secure vascularity. There is little likelihood of losing the upper lid reconstruction if the pedicle is kept wide. Even if the lower lid reconstruction is lost, the eye is protected by the new upper lid. The entire area can then be allowed to heal before reconstruction of the lower lid begins once more.

RECONSTRUCTION OF THE MEDIAL CANTHUS

The medial canthal area has been included with the discussion of the eyelids because excision in this region frequently extends to the lids, occasionally involving sacrifice of the full thickness of the lids, lacrimal puncta, and canaliculi. In the medial canthus, incomplete excision of carcinoma can result in later extension of the cancer into the ethmoid sinuses, and from there to the cribriform area, with resulting intracranial invasion. In removing superficial lesions, excision of the periosteum is also recommended, particularly if there is any suggestion of subdermal involvement. If periosteal involvement is noted, underlying nasal bone should be resected. It is true that skin grafts allow early detection of recurrence, but their use may lead to initial inadequate tumor excision, because the surgeon will tend to leave a base of periosteum on which to place a skin graft, since without periosteum a graft will not take. It is more logical to resect down to bone or to include bone to get one layer ahead of the tumor; in this situation a skin graft cannot be used. The defect is reconstructed with a local flap.

When the excision has been completed, the canthus must be reconstructed. It should be placed in the correct anatomic position and fixed to bone. Failure to do this leads to obvious asymmetry. At this stage it is probably unwise to perform a complicated lacrimal reconstruction. Such reconstruction may not be necessary, because epiphora may not be a problem in the long term. The possibility of tumor recurrence exists. It is much better to adopt a wait-and-see policy. If all is well and reconstruction is indicated, lacrimal reconstruction can be performed later.
Medial Canthal Defect: Partial Medial Canthus Reconstruction

*Glabellar Island Flap*

The medial canthal area must be carefully reconstructed to prevent any aesthetic or functional problems.

This patient has a basal cell carcinoma in the lateral aspect of the right side of the nasal bridge line extending into the eyelid skin and coming close to the medial canthus. There is an obvious concern about the possibility of distortion of the medial canthal anatomy.

To prevent any displacement of the medial canthal area, a glabellar island flap is raised and is brought down to the area of resection.
The donor site of the flap is closed directly and the flap is inset.

The flap has settled into position very nicely; there is no trapdooring, and the medial canthus is in the correct position.

**PROBLEMS**

This is a secure flap to use, but it is essential that a wide pedicle be maintained to ensure viability. The flap is based on the glabellar musculature—as with all flap—any sign of flap ischemia requires replacement of the flap with later reconstruction. Pin-cushioning of the flap is always possible and should be corrected at a later date.
Bilobed Flap

In this patient, a small basal cell carcinoma is removed from the lateral aspect of the nose on the left. This defect is below and medial to the medial canthus. Direct closure is considered, but when assessed, this would result in medial ectropion.

The resection is completed and a bilobed flap is designed. The lobes of the flap can be transposed easily to support the medial canthal area, and the defect caused by movement of the first flap is closed by a small flap moving from the dorsum of the nose down into the defect. This gives a totally stable reconstruction of the medial canthal area.
It is of interest to note that the patient has a small basal cell carcinoma medial to the right medial canthus, and this is resected.

Once this has been resected, the defect is closed using a transposition flap from the midline glabellar region. These three transposed flaps heal well, give a good reconstruction of the nasal area, and provide good support to the medial canthi.

**PROBLEMS**

As always in the eyelid area there can be pulling down of the lid. If a flap of adequate size is provided, the likelihood of this problem developing is greatly reduced. If it occurs, however, it must be addressed, probably with release and full-thickness skin grafting. As always, pincushioning is a possibility. Also there may be bad scars. Fortunately most of these patients are older, and this rarely occurs.
**Split Finger Flap**

The split finger flap may be used when the side of the nasal bridge line, including the periosteum and sometimes bone, and the medial ends of both eyelids have been sacrificed.

This patient has a penetrating basal cell carcinoma of the medial canthal area. The planned excision and the split finger flap are outlined. The flap is planned slightly wider and larger than the standard finger flap.
The tumor is resected with underlying bone and the ethmoid sinuses. The entire medial canthus and the medial ends of the upper and lower lids are sacrificed. The medial conjunctival pocket is reconstructed by mobilization of the conjunctiva to the limbus, if necessary. The conjunctiva is sutured horizontally and provides lid lining.
The flap is then rotated into the defect and split at its free end until the correct position for the new medial canthus is obtained. The forehead defect is closed directly.
Using an incision on the other side of the nose, the noninvolved nasal bone is exposed. Two drill holes are made in this area, and a wire is passed through to the area of the medial canthus. Here the wire is threaded through the deep layer of the flap and taken back out the second of the two holes. Gentle tightening of the wire brings the new canthus securely into its correct position and ensures the correct biconcave contour in this area. The flap is then sutured onto the eyelid defects. Some trimming is necessary to deal with the potential dog-ear on the nose.

Rarely is any secondary contouring surgery necessary.
These photographs show the recommended resection for a penetrating basal cell carcinoma in the medial canthal region. Again, the nasal bones and ethmoid sinuses are sacrificed. The defect is covered with a diagonal forehead flap. It should be noted that the thick forehead flap fits snugly into the bony defect, and thus the potential contour deficiency is well filled, giving a good aesthetic and a good functional result.

**PROBLEMS**

The flap may be bulky and require later thinning, but this occurs rarely, because underlying bone has been resected. Displacement of the medial canthal attachment can occur and reattachment may be necessary.
COMPLEX RECONSTRUCTION

Frequently tumor resection will result in a defect that requires medial canthal reconstruction together with full-thickness lid reconstruction. The lower lid is involved more frequently than the upper lid. This situation calls for a combination of flaps. Again, the lacrimal drainage system is sacrificed. The medial canthal ligament may also be resected and may require reconstruction.

Forehead Flap and Cheek Rotation Flap

A defect such as the one just described will require a complex reconstruction that uses a combination of techniques. The cheek and the forehead bear the brunt of these reconstructive efforts.

This patient has an extensive postradiation recurrence of a medial canthal basal cell carcinoma.
The planned skin excision—together with underlying nasal bone, infraorbital rim, lacrimal apparatus, and ethmoid sinuses—is drawn out. Medial cover will be with a median forehead flap.
The excision is completed, with the expected defect in the right nasal cavity. This requires a complex reconstruction.
A lateral canthal cheek incision is made with division of the lower limb of the lateral canthal ligament; this allows the cheek and the lower eyelid to advance medially.

A transnasal canthopexy is performed as described earlier. The medial end of the lower lid is fixed into its correct position by the transnasal wire.
A small excess of cheek on the inferior aspect of the defect, caused by the cheek rotation, is excised.
The forehead flap is swung down and sutured into position. Alternatives to this procedure would be the glabellar flap or an island flap from the forehead in the midline. These procedures are performed exactly as described in an earlier chapter.
Initially lower lid edema is present and the forehead finger flap is very bulky. With time all areas settle in a satisfactory fashion. It has not been necessary to perform any secondary surgery.

**Problems**

Epiphora may occur because of sacrifice of the canaliculus, but this complication is uncommon. Therefore the surgeon should not strive unduly to obtain primary lacrimal drainage. It is rarely successful and should be left for a future date, when the area has settled and the risk of tumor recurrence has receded. It is more important to establish the correct medial canthal position. Unless a secure canthopexy is achieved, it may be displaced later and result in an unsightly telecanthus, which will require a secondary correction. Such a procedure is more difficult than a primary medial canthopexy. Pincushioning of the forehead flap may occur, and thinning may be necessary.
RECONSTRUCTION OF THE LATERAL CANTHUS

In the lateral canthal area, the correct topography of the region is a basic consideration in planning reconstruction. The lateral canthal position needs to be reestablished, both vertically and horizontally.

Lateral canthal defects rarely occur. However, when they do, they pose a significant reconstructive problem because of the absence of local flap donor sites possessing the same type of skin as the lateral canthal and lid regions. If possible, a full-thickness skin graft is used. If bone is exposed, it is necessary to use a local flap. If only the lower portion of the lateral canthal area needs to be reconstructed, a standard cheek rotation flap or a rhomboid flap provides a good result.

Forehead (Fricke) Flap

The forehead, or Fricke, flap is easily planned and rapidly executed. It can replace the lateral canthal area, or it may be split to form the canthus and a portion of the lids.

This elderly patient had an extensive basal cell carcinoma of the lateral canthal area. The flap is based laterally and consists of skin lateral to and above the eyebrow. Occasionally it may be a one-stage procedure, but more often it is performed in two stages.
Chapter 7  Eyelid and Canthal Region Reconstruction

The lesion is excised radically in all dimensions. A portion of the lateral orbital rim is removed. The flap is elevated, its length being that required to accomplish a satisfactory canthal and lid reconstruction. The flap is split at the end to allow a more normal canthus to be formed.

It is usually possible to mobilize enough conjunctiva to resurface the inner aspect of the flap. If this is not possible, then a free buccal or nasal mucosal graft is used. With such a thick flap, support of a chondromucosal graft is not necessary. The flap (and if necessary the graft) is sutured in position. The donor site can rarely be closed directly. Because the basal cell carcinoma is slow growing, a rapid tissue expansion of the flap donor site could be carried out to allow direct closure of the skin defect. This would distort the eyebrow, and the raw area would then need to be covered with a skin graft.
In many cases, the flap is inset directly and no further procedure is required. In other cases, when a pedicle remains, this is divided in 10 to 14 days, and the unused portion of the flap is returned to the forehead. This man does not wish to have the lateral canthal area opened.

**Orbital Exenteration and Reconstruction**

*Orbital Exenteration*

For surgeons who are not experienced in this area, this is often a daunting situation to be faced with. However, the reconstruction is not a significant problem. In this case, a scalp flap is rotated to cover the exposed cranium, and the orbit can be reconstructed with split-thickness graft. The eye and eyelids are replaced with a composite eye and eyelid prosthesis. This can be attached either to spectacles or to an osteointegrated framework. This will achieve a very acceptable reconstruction of a difficult anatomic area.

This patient had multiple basal cell carcinomas and had undergone radiation therapy to the left orbit. The operative plan was to totally resect the left orbit and its contents, and to resect the skin of the nose.
One can see the planned extent of the resection of the lids and surrounding soft tissue and the underlying bone that is required. Most, if not all, of the nasal skin will be resected. Because of the patient’s previous radiation therapy, this will present a considerable problem in reconstruction.

The orbital resection is completed and a right-sided galeal frontalis flap is elevated (right).
The forehead incision is closed. The orbit is skin grafted, as is the nose. A right cheek advancement flap is used to close the paranasal defect following resection of the basal cell carcinoma in this area.

The galeal frontalis flap is now rotated and placed into the orbital defect to provide a vascular lining.

The forehead incision is closed. The orbit is skin grafted, as is the nose. A right cheek advancement flap is used to close the paranasal defect following resection of the basal cell carcinoma in this area.
Despite the patient’s previous radiation therapy, the skin graft has taken well on the galeal flap and on his nose. He has been supplied with spectacles and an orbital prosthesis that allows him to function relatively normally.

**PROBLEMS**

The skin of the forehead, which is thick, obviates the need for lid support but produces a very obvious, bulky reconstruction. In many individuals the forehead skin is paler than the skin of the lids, which is another reason for a poor reconstruction. The donor site is unsatisfactory; if this site is closed directly, the eyebrow position and shape are distorted. If grafted, the pale, matte, depressed skin graft causes a very obvious cosmetic defect.

**Surgical Technique of Choice**

In summary, lateral canthal reconstruction is not very satisfactory when both lids are involved. Fortunately, this is not an area that frequently requires reconstruction. Lower lid defects can be closed with local cheek flaps. For more extensive areas the forehead flap should be considered. Staged excision or the use of a tissue expander followed by removal and direct closure using the expanded skin will provide a good end result.
### Choosing the Best Option for Eyelid Reconstruction

<table>
<thead>
<tr>
<th>Anatomic Area</th>
<th>Problem</th>
<th>Special Considerations</th>
<th>Flap of Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower eyelid</td>
<td></td>
<td>The aim is to form a lid of adequate height with a stable edge; mucosa should not escape over the lid margin into the skin area</td>
<td>Cheek rotation flap lined by oral mucosa</td>
</tr>
<tr>
<td>Upper eyelid</td>
<td>Because the skin of the upper eyelid is thin and supple, satisfactory replacement is hard to achieve</td>
<td>The upper lid must never be short vertically</td>
<td>Upper lid rotation flap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Height should be adequate to ensure closure of the palpebral tissue</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>There should be no notching of the free margin</td>
<td></td>
</tr>
<tr>
<td>Medial canthus</td>
<td>Excision of this region frequently extends to the lids, occasionally involving sacrifice of the full thickness of the lids, lacrimal puncta, and canaliculi</td>
<td>Incomplete excision of carcinoma of the medial canthus can result in later extension of the cancer into the ethmoid sinuses, and from there to the cribriform area, with resulting intracranial invasion</td>
<td>Split finger flap</td>
</tr>
<tr>
<td></td>
<td>Epiphora may occur because of sacrifice of the canaliculus</td>
<td>Reconstruction of lacrimal drainage is better left for a future date, when the area has settled and the risk of tumor recurrence has receded; unfortunately, this is often unsuccessful—insertion of cuffed drainage tubes of various materials has not been helpful in most cases</td>
<td>Forehead flap and cheek rotation flap</td>
</tr>
<tr>
<td>Lateral canthus</td>
<td>Lateral canthal defects are rare, but when they occur, they pose a significant reconstructive problem because of the absence of local flap donor sites possessing the same type of skin as the lateral canthal and lid regions</td>
<td>The lateral canthal position needs to be reestablished, both vertically and horizontally</td>
<td>Forehead (Fricke) flap</td>
</tr>
</tbody>
</table>
### Rationale

<table>
<thead>
<tr>
<th></th>
<th>The flap is simple to design, and the skin color and texture are a good match for the normal lower lid skin.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Satisfactory for partial or complete lower eyelid reconstruction</td>
</tr>
</tbody>
</table>

### Second Choice

| | Unilateral or bilateral Tripier flap |
| | Forehead flap |

### Caveats

| | For lower eyelid skin defects |
| | For total lower eyelid reconstruction. Forehead skin is thicker and its color is lighter |

| | Simple to design, uncomplicated to perform, and produces an excellent aesthetic and functional result |
| | The secret to performing this technique is in the planning process; the surgeon needs to consider the upper lid as though it were the lower lid and then plan surgery accordingly |

| | Lid switch flap |
| | Simultaneous cheek rotation and total lower lid switch flap |
| | Two-stage lower lid switch and cheek rotation flap |

### Caveats

| | Alternative method for partial defects |
| | Alternative methods for total upper lid defects |

| | The flap may be bulky and require later thinning; displacement of the medial canthal attachment can occur, and reattachment may be necessary; suitable for relatively simple defects |
| | Suitable for complex reconstructions; thinning of the forehead flap may be necessary |

| | Easily planned and rapidly executed; can be split to form the canthus and a portion of the lids |
References—With Key References Annotated

The authors present their study of recurrent penetrating midface cancer resulting from basal cell carcinoma, squamous cell carcinoma, adenocystic carcinoma, and chondrogenic and osteogenic sarcoma. Over a 2½-year period, 10 patients were operated on successfully. Five cases are presented with a follow-up of more than 2 years.
The authors report on a series of six patients with moderate-sized defects of the lower eyelid that were managed using a combined flap repair. The combined flap marries a horizontal rotational and a temporal Z-plasty flap for repair of moderate-sized lower eyelid defects. The authors conclude that the combined flap appears well suited to the overall anatomic configuration of the lower eyelid and lateral periorbital region.

The authors describe simple principles for constructing the bilobed flap in the periorcular region. The results in a prospective series of 23 consecutive patients are presented. All patients achieved satisfactory functional and aesthetic results with the use of this technique. The authors concluded that these simple principles achieve consistently good results and allow the surgeon to use this flap with greater confidence.


Morax J. Une greffe avec pedicule vasculaire en deux cas d’epitheliome ulcere de tangle nasal des paupieres et de la face. Ann Oculist, 1926.


The authors describe a series of patients who have undergone a medial canthal reconstruction with a rhomboid flap. They conclude that the rhomboid flap is an effective, quick, and simple technique for medial canthal reconstruction. It provides excellent cosmesis and is associated with minimal complications. It can be modified according to the nature of the periorbital skin and the location, size, and depth of the defect.


The authors propose a new method for closure of skin and orbicularis muscle in the repair of marginal defects of the lower eyelid. They conclude that this method is simple and has the following advantages over vertical closure: it follows relaxed skin tension lines, allows closure of the anterior lamella in the opposite direction from the posterior lamella, and leaves an infraciliary scar rather than a vertical scar extending down the cheek.
Sullivan TJ, Bray LC. The bilobed flap in medial canthal reconstruction. Aust N Z J Ophthalmol 23:42, 1995. The authors describe the use of a bilobed flap, which allows for optimal reconstruction in this area. They recommend this technique as an excellent means of repairing all types of medial canthal defects. The technique allows reconstruction to be performed in a single stage with rapid rehabilitation and minimal morbidity.

Teske SA, Kersten RC, Devoto MH. The modified rhomboid transposition flap in periocular reconstruction. Ophthal Plast Reconstr Surg 14:360, 1998. The authors have modified the traditional rhomboid transposition flap technique by eliminating the creation of the rhomboid defect and directly transposing the flap into the original postexcisional defect. These changes allow maximum flexibility in flap design and minimize normal tissue loss. The authors conclude that the use of a modified rhomboid flap in the reconstruction of the periocular area offers ample versatility in flap design and minimal normal tissue loss. Functional and cosmetic results are satisfactory in the vast majority of cases.

Tripier L. Du lambeau musculocutane en forme de pont applique a la restauration des paupieres. Rev Chir 4, 1890.

The lips are a sensory tactile organ, used in food intake and articulation of speech. Further, they are a principal feature of facial expression, indicating pleasure, distain, surprise, and pain. The standard for beautiful lips varies among ethnic groups, but symmetrical, mobile, soft lips are always attractive, drawing the gaze of the observer.

**Anatomy**

The skin of the lip is soft and pink; the lower lip skin has a higher content of yellow pigment in it. The mucosa varies from individual to individual, but it is identical on the upper and lower lips.
MUSCULATURE
The basic muscle of the lip is the orbicularis oris. The surprising complexity of its anatomy has been revealed in recent studies.

The muscle decussates in the midline of the upper and lower lip, but it also has a decussation at the commissures. In addition, there are bands of muscle fibers in the lip margins that decussate only at the commissures. These fibers are more prominent in young children. In the philtral area vertically oriented muscle fibers can be seen in relation to the philtral columns.

Other muscles act on the lips. These are the buccinator, levator anguli oris, depressor anguli oris, levator labii superioris, depressor labii superioris, and zygomaticus major and minor. The risorius is a narrow bundle of muscle fibers that arises from the parotid fascia and is inserted into the skin of the angle of the mouth. It retracts the angle of the mouth to give a somewhat unpleasant grin.

NERVE SUPPLY
The sensory nerve supply is from the infraorbital nerve, the second division of the trigeminal nerve.

The motor nerve supply to the muscles is provided by the lower buccal and mandibular branches of the facial nerve.

BLOOD SUPPLY
The arterial supply is from the superior and inferior labial arteries, which arise from the facial artery.

The venous drainage is through the superior and inferior labial veins, which drain into the anterior facial vein.

LYMPHATIC DRAINAGE
The lymphatic drainage is to the submental nodes and to those nodes around the vessels at the edge of the body of the mandible.

The upper lip and the lateral segments of the lower lip drain to the submandibular and facial lymph nodes. The central portion of the lower lip drains to the submental nodes. These nodes lie on the surface of the mylohyoid muscle between the anterior bellies of the two digastric muscles.
Aesthetics

The lips are normally symmetrical in form and function, with the philtrum and the Cupid’s bow contributing to this delicate symmetry. The mucosa is not sharply divided from the skin but is separated by the white roll area that is highlighted along the mucocutaneous junction. In the male the upper lip and the central portion of the lower lip are hair bearing. This is not so in the female, although many women have very fine silky hairs on the upper lip.

Placement of Incisions

If possible, all lip incisions should be vertical. At the commissure, scars extending horizontally toward the cheek are acceptable.

Perialar incisions are well hidden and will allow the lip to be opened like the page of a book when a vertical midline incision is included in the approach. The lower lip can also be swung out with a combination of a central incision to the lip chin fold, and a continuation incision, which curves around the chin area.

Areas of Tissue Availability

The lips can be reconstructed with cheek tissue obtained by advancement or by transposition from the nasolabial folds. The neck has been used as a rotation flap, and distant flaps from the scalp, forehead, and cheek have been employed frequently.
Areas to Be Reconstructed

In discussing lip reconstruction, we will consider defects of the mucosa and the skin first; then we will review methods for reconstructing full-thickness defects of varying sizes in the upper and lower lips. The commissure will be considered separately in view of its complexity; it poses considerable difficulties, because there is a contralateral normal commissure for comparison.

Reconstruction of Lip Mucosa

The vermilion tends to be a neglected area. Defects in this region may be reconstructed with flaps or grafts. Mucosal grafts do not always take well and tend to lack the necessary bulk when the defect is of a significant depth. Mucosal flaps, on the other hand, frequently contract to produce areas of excess mucosa. Mucosal repairs must be handled with care and accuracy.

Rotation Flap

Small to moderate defects that cannot be closed directly without causing deformity must be reconstructed with neighboring mucosa used as a flap. The defect is triangulated and mucosa can be rotated in to close the raw area (as in the standard rotation flap method described in Chapter 1). There is no secondary defect; mucosa is plentiful and can be stretched.

Problems

Pincushioning may occur because of contracture along the suture line. This contracture causes lip deformity and makes further correction necessary; the prominent area is excised or thinned. Another significant challenge is posed by the fact that the exposed dry mucosa is pale and the wet mucosa is a deeper color. The wet mucosa also tends to become crusted and is not a good color match when advanced externally.
V-Y Advancement Flap
The V-Y advancement technique is used to fill small lip deficiencies, especially in a secondary cleft lip deformity. The area to be augmented is marked out; from this, a long V is drawn with its apex toward the buccal sulcus. The lines are incised and the mucosa within the V is elevated at a deep submucosal level. The V is closed as a Y until the defect is well filled by the resulting mucosal advancement. It is advisable to overdo this advancement to allow for later reduction in the bulk of the flap. If this is not done, there may be partial recurrence of the initial deformity.

Problems
It is not uncommon for this flap to be made too small in terms of the length of the V. If this is the case, advancement will be inadequate and the defect will not be filled out. Similarly, if the defect is not overcorrected, the result will become inadequate over time. Contraction lines may occur on either side of the V, with resulting labial notches.

Triangular Island Advancement Flap
The triangular island advancement flap is particularly indicated when the defect extends to the mucocutaneous junction.

This patient has an electrical burn of the lower lip.
When the defect is square (for example, after resection of a small hemangioma), the oral edge of the square is made the base of a triangular island flap.

The island flap is raised on a submucosal pedicle and then advanced to close the defect.
The donor area is closed in a V-Y fashion. This dissection need not be too extensive, since the submucosal tissues are extremely lax.

The result shows a slight deficiency of mucosa, which usually improves with time.

**Problems**

If the pedicle is made too narrow, ischemia of the flap with subsequent necrosis could occur. With proper planning, this is not seen. There may be small grooves on the lip margin on either side of the flap because of scar contracture. These may be corrected by excision and small Z-plasties. Also, wet mucosa will dry out and flake when advanced externally; applying an ointment such as petrolatum jelly will help relieve this dryness.
Transverse Triangular Island Advancement Flaps

Transverse triangular island advancement flaps are designed using a principle introduced by Kapetansky, who described “pendulum” island flaps based on the orbicularis muscle. These were used to fill the central lip deficiency in the bilateral cleft. When the cleft is minor and a total re-repair of the lip is not being contemplated, island flaps, based on submucosal pedicles, can be designed. The technique is mainly applied to the upper lip because of its use in the cleft lip deformity. However, it can also be employed in the lower lip as a double or single advancement flap.

The flaps are raised on both sides of the deficient area, with the bases of the triangles facing each other. The area between the flaps is resected.
When the pedicles have been mobilized sufficiently, the triangles are moved together and the bases are sutured to each other. Laterally, there is a V-Y closure. This arrangement gives central bulk to the lip with lateral grooves. The resulting lip margin closely resembles the normal anatomic situation of a central tubercle with gentle valleys on either side.

**PROBLEMS**

Technical problems may result from making the flaps too small and thus having too little bulk for the central tubercle. If the pedicle is overmobilized, flap ischemia and necrosis may result. I have not encountered this unfortunate situation.

**Surgical Technique of Choice**

There is no single method of choice for localized lip mucosal reconstruction. Each technique has its individual merits and can be applied according to specific indications.
EXTENSIVE LOWER LIP MUCOSAL DEFECT RECONSTRUCTION

Factors to Consider

If there is an extensive defect of the lower lip mucosa, it is usually advisable to excise the mucosa of the entire lower lip and then resurface it with intraoral mucosa or tongue. In this way lip cover is uniform in color and texture.

Mucosal Advancement

Where only mucosa is to be supplied and bulk is not required, the mucosa is simply advanced, usually without undermining. The mucosa is sutured to the skin of the lip with a fine running absorbable suture. Unfortunately, this tends to reduce exposed lip volume.

PROBLEMS

The mucosa covering the lips is unique. When intraoral mucosa is transferred to the lips, it never becomes true lip mucosa. To prevent drying, scaling, and flaking from occurring, the area must be kept lubricated with petroleum jelly or lanolin at all times.

Tongue Flap

When some muscle has been excised, a bulkier reconstruction is required. In such a situation a tongue flap is used.

The original tongue flap was described by Guerrerosantos et al; in this case the dorsum of the tongue was used to reconstruct the lip and this has continued to be the most popular reconstructive technique. This approach is contrary to the basic principles of reconstruction outlined earlier, which state that, if possible, like tissue should be used to replace like tissue. The color of dorsal tongue mucosa is not the same as that of the lip, and its texture is rough rather than smooth. In fact, an upper surface tongue flap on the lip always looks like tongue; it does not change or improve with time. To overcome this problem, the undersurface of the tongue has been used. The undersurface is smooth, without papillae, and its color is a more satisfactory match for the lip.
This patient has a hemangioma of the lower lip that has caused color change and lip enlargement. The postexcisional defect may be part or all of the length of the lower lip. It consists of mucosa, submucosa, and often a layer of orbicularis.
A suture is placed on either side of the tongue, and the required flap is outlined on the undersurface. A flap of the required size is elevated, based anteriorly. The thickness of the flap is that required to reconstruct the lip.
The posterior edge of the flap is then brought forward and sutured to the cutaneous border of the defect; it is also sutured laterally. The raw area on the undersurface of the tongue remains, with no attempt at closure.

The tongue flap is left attached to the lip for 10 days and then is divided. At this point it is important to make sure that enough tongue mucosa is transferred to generously close the residual defect. In this way an adequate resurfacing is obtained. Failure to transfer sufficient mucosa will result in a thin, pincushioned ridge of tongue mucosa.

The incision on the tongue is closed with a continuous absorbable suture. If there is significant induration, causing difficulty in closure, the defect may be left unsutured and will close spontaneously.
A reasonably normal looking vermilion can be obtained. Scaling of the mucosa because of drying can be seen in this case.

PROBLEMS

As long as the undersurface of the tongue is used, the color match and mucosal texture are good. This patient illustrates the poor result obtained when the upper surface of the tongue is used. It is possible that the flap may be torn from the lip in the immediate postoperative phase, but this has never happened in my experience. The inferior surface flap actually lengthens the tongue and allows more movement of the tip during the reconstructive period before flap division.
In the immediate postoperative phase, a potential problem in the dentate patient is biting through the flap with the incisors. This can be prevented by using bilateral acrylic molar bite blocks, which ensure an anterior open bite sufficient to allow protection of the tongue flap pedicle. The blocks can be cemented onto the lower molar teeth before surgery.

The use of this technique is illustrated by a case in which half the lower lip mucosa has been replaced with a dorsal tongue flap following an electrical burn.
EXTENSIVE UPPER LIP MUCOSAL DEFECT RECONSTRUCTION

Factors to Consider

Fortunately, it is rarely necessary to reconstruct a large mucosal defect on the upper lip. Since this area does not have the same exposure to weather conditions as the lower lip, premalignant and malignant change is uncommon. The reason for reconstruction is usually to complete a total lip reconstruction rather than resection of mucosal malignancy. Significant lip mucosal defects are very difficult to reconstruct. The amount of mucosa is limited, and advancement from the intraoral area onto the lip is not possible, since it would cause an ugly in-rolled deformity of the lip anterior with associated drooling. Tongue flaps tend to pull off readily because the tongue is in a less normal and less comfortable position when attached to the upper lip.

Tongue Flap

The mucosa of the upper lip can be reconstructed with tongue mucosa, but the standard undersurface flaps cannot be used in this situation.
It is advisable to use anteriorly based lateral flaps. The thickness will vary with the depth of the defect.

The flaps are swung up and initially sutured end to end. This mucosal bridge is then sutured to the lip margins anteriorly and posteriorly to reconstruct the defect. The tongue donor sites are closed directly.
In 10 days the pedicles are divided, and the flaps are trimmed and inset into the lips. The small raw areas on the tongue are closed with a few sutures.

**PROBLEMS**

In upper lip reconstruction the tension on the tongue flap is much greater than the tension involved in lower lip resurfacing. Suturing the lateral edges of the tongue to the lip helps to stabilize the reconstruction and prevent separation of the flap. Usually some of the upper surface of the tongue is included in the reconstruction. Forming a Cupid’s bow is a very difficult task. If the cupid’s bow can be made, it suffers from the deficiency seen when this structure is created by skin mucosal contouring in a cleft lip patient. No white roll is present, and there is a very sharp and artificial-looking junction between the skin and the vermillion.
UPPER LIP RECONSTRUCTION

The upper lip has a complex symmetry that is difficult to reestablish after resection. In males, hair-bearing skin must be used. The alar base area and the nasolabial region should not be disturbed. The commissure position should not be altered. Any reconstruction should not cause lip shortening or tightness.

Skin Defects

Perialar Crescentic Advancement Flap

If the defect lies on the lateral third of the lip, it can be dealt with by means of the perialar crescentic advancement flap described by Webster. This cleverly conceived advancement flap will close fairly large defects without causing deformity of the alar base, the lip, or the oral commissure. The defect should be triangulated with the base superiorly. However, the long axis should not be vertical; if this were so, any closure would tend to lengthen the lip. Instead, the long axis lies diagonally.

From the lateral end of the triangle base, an ellipse of skin is outlined on the paranasal area. If a large shift is required, excision of a wider ellipse is planned. As the ellipse is made wider, the outer edge of the flap becomes longer and more shift of cheek skin into the lip is obtained (see Chapter 1). Excision of the potential dog-ear inferiorly on the lip at the apex of the triangular excision may be planned at this point.
The planned amount of skin is now excised.

The cheek is undermined until the skin can be advanced comfortably with a hook to close the defect without tension.
Suturing commences at the superior part of the ellipse; as the long outer line is joined to the shorter inner line, the cheek flap automatically advances. With this movement the triangular defect is closed. The suture line lies in a very satisfactory position on the nasal cheek line, below the alar base and at an angle on the lip. This ensures that there is no significant shortening of the lip.

This method can also be used for lesions situated lower on the lip.
The position of the triangle chosen for excision should be noted. This permits closure of the defect without lengthening or shortening of the lip or distortion of the alar base area.

The cheek is undermined in the face-lift plane extensively enough to allow the flap to be advanced without tension; closure of the defect presents no problem.
Modification of Perialar Crescentic Advancement Flap

In some instances, when the lesion lies close to the mucocutaneous junction, the technique needs to be modified, as seen after excision of the upper lip basal cell carcinoma shown on pp. 452-453.
The basal cell carcinoma is outlined. Both superior and inferior ellipses are planned; the latter is taken around the commissure.

The lesion and the planned amount of normal skin are excised.
The cheek is undermined to a degree sufficient to allow closure.

After satisfactory trimming of the skin, closure is obtained in the nasolabial line.
This gives a good result with little distortion of normal anatomy.

In this case, a further advancement of the cheek into the nasolabial line was used.
The purpose in keeping the two small portions of skin laterally is that the line along the nasolabial fold can be broken up using these, or as in this case, it can simply be contoured into the nasolabial fold.

The result is satisfactory and the oral commissure is undisturbed by this maneuver.

PROBLEMS

Few difficulties are associated with this elegant technique. Occasionally, when a relatively large defect is reconstructed, the nasolabial fold may be partially obliterated, but this does not cause problems and does not require correction. In some individuals the cheek skin is more highly colored and thicker than is usual; as a result, this skin may be obvious when advanced into the lip. For some males the advanced cheek area may not be hair bearing, and this may draw attention to the reconstruction.
Two-Stage Nasolabial Flap

The nasolabial area is a useful donor site for flaps used to reconstruct lip skin, especially for large defects. The skin is plentiful, and in males it is hair bearing.

The two-stage nasolabial flap is ideally suited for reconstruction of the defect resulting from excision of the basal cell carcinoma of the upper lip illustrated here.

The flap is based superiorly and made long enough and wide enough to resurface the lip defect.
The flap is lifted just above the facial muscles. Deep dissection should be avoided to ensure that facial nerve branches are not divided.

The flap is transposed medially to close the lip defect. The nasolabial defect is closed directly. A small Burow’s triangle is removed to deal with the dog-ear skin excess.
The flap is left in position for 10 to 14 days and then divided and inset. The unused portion of the flap pedicle is returned to the nasolabial area, trimmed and inset to restore normal contours.

This photo shows how well this flap provides hair-bearing skin for an individual who wears a mustache.
PROBLEMS

Few problems are encountered with the two-stage nasolabial flap. The flap may pincushion and require trimming. In a female patient there may be a color and texture difference between the reconstructed lip and the normal lip skin. Some asymmetry of the nasolabial areas may be noted. In most instances the scars are not a significant problem.

Surgical Technique of Choice

If the defect is small enough and in a convenient position, the perialar crescentic advancement flap is best. It is a one-stage procedure, and the scars lie in a good aesthetic position, directly in the lines of minimal relaxed tension. When the defect is large, deep, and complex, the two-stage nasolabial flap is the method of choice. It is particularly appropriate when the defect is located toward the center of the lip, since cheek rotation to this area is not possible.

Bilateral Nasolabial Flap

In this patient with a squamous cell carcinoma of the upper lip, columella, and membranous septum, a wide excision is necessary, as illustrated.
After resection, the long bilateral nasolabial flaps that have been drawn out are used for the reconstruction. One flap is employed to reconstruct the defect in the upper lip.

The other is elevated, folded, and sutured to the raw edges of the septum to form the columella.
With this two-stage procedure a good result was obtained in reconstruction of this complex defect of columella and lip. No further surgery was necessary in this patient.

When an island flap is used, it is important that it be of the proper size and shape, and it should not be under tension. To achieve the latter requirement, it is important to dissect the pedicle of the flap fairly radically so that a satisfactory inset can be achieved. After the 3-week period, at which time the flap is divided, it should require only a very minimal adjustment of the mucocutaneous area of the upper lip or it may need no adjustment whatsoever—just a simple division of the pedicle with adjustment of the mucosa on the upper and lower lips.

**Problems**

It is possible to have a vascular catastrophe with an island flap; this is usually caused by stretching of the pedicle. If the flap is done carefully, there should be no problems of any kind, but the pedicle of an island flap is fragile. Twisting of the pedicle should be avoided; this also leads to ischemia. Pincushioning sometimes occurs, but it is difficult to forecast. One has to wait until the situation declares itself; then it necessitates elevating the flap and thinning it or scoring it until the flap is flattened out. Sutures can be used from the undersurface of the flap onto the subcutaneous tissues, again to obtain flattening. The flap should be of the correct size and should not be under tension. Any dissection around the pedicle to position the island in better position must be performed accurately, preferably with magnification.

If there is evidence of ischemia, then it is better to place the island back in position and come back another day to carry out the reconstruction. If problems are anticipated with the pedicle, the inset should be such that there is no strain on the pedicle. This may not look particularly good at the time of completion, but when the
pedicle is divided, the flap can then be inset in a more satisfactory way, since it will have achieved a good blood supply from the inset area. If these precautions are taken, it is extremely unlikely that flap loss will occur.

Full-Thickness Defects of the Upper Lip
As with replacement of skin, symmetry should be achieved with as little disturbance of the surrounding anatomic features as possible. In most individuals a quarter of the lip can be sacrificed and the defect can be closed directly without difficulty. In others, such as persons with lax lips, even larger defects may be closed in this fashion. If it is judged impossible to close the defects without causing lip distortion, then a flap is used.

Abbé Flap for Central Lip Reconstruction
The Abbé flap, or lip switch flap, was first described by Sabattini, Stein, Buck, Estlander, and later by Abbé. However, as often happens, the originator’s name was lost in antiquity. Despite attempts to rename this the Stein flap, it has remained the Abbé flap. This flap can be used to reconstruct as much as one third of the upper lip.

The lower lip is always lax and can supply a flap of one quarter of its length to reconstruct defects of the upper lip. The Abbé flap offers immediate replacement of the total lip anatomy.

This patient presented with an interesting problem. He obviously had a bilateral cleft lip, but the central element of the lip was not included in the repair. The repair has given him a very nice nose, but the prolabial segment is lying under the base of the columella. This has little value, apart from its being used to resurface the basal part of the columella. The vermilion is sacrificed.
A standard Abbé flap is used to loosen up the upper lip and to repair the central defect which is causing the shortening of the lip. This is a standard Abbé flap, which includes all layers of the lower lip. The narrowness of the pedicle should be noted. This allows excellent, accurate insertion of the flap into the defect. As long as there is little tension on the vascular bundle, there should be no problem with blood supply.

The skin of the nose is used to resurface the lower quarter of the columella. The vertical scar of the lip and the underlying muscle and mucosa is excised. A rectangular Abbé flap is taken from the lower lip and placed into the defect, being sutured in layers.

This close-up shows the problem very clearly.
The flap pedicle is divided and the upper lip trimmed. It can be seen that the end result at 1 year has given this patient a full upper lip that relates very well to the lower lip, and a columella of normal length. The nose has satisfactory contour. The only problem which is seen with this flap is that the hairs grow upward; that is, in a reverse position from the standard mustache hairs. The lateral view shows a very good relationship between the nose, upper lip, and lower lip.
The Abbé flap is also used after resection of this squamous cell carcinoma of the upper lip.

The projected upper lip defect is assessed, and a flap of sufficient dimensions to close this defect is drawn on the lower lip. The rotation point of the flap is chosen on the basis of convenience, usually to leave the largest oral opening during the period of lip adherence.
The upper lip resection is completed. The lower lip flap is totally incised on the side away from the pedicle, and the position of the labial artery is noted. On the other side the lip is incised until only a small cuff of subcutaneous tissue and muscle surrounds the vascular pedicle. This is not the standard approach but allows a more satisfactory positioning of the flap.

This makes for very easy rotation of the flap into the upper lip defect.
Closure is performed in layers. The mucosa of the upper and lower lip is closed with an absorbable suture, and this is followed by suturing of the muscle and the skin. Care must be taken in suturing around the pedicle, since blood flow may be compromised. Persistent cyanosis calls for mandatory suture removal in this area. Then the flap color should revert to normal.

A wide adhesive tape is placed under the chin and run up to the cheeks to support the chin and keep the lips together. The pedicle is divided after 10 to 14 days. Any necessary trimming is carried out at this time.
Abbé-Estlander Flap

When the flap is being used to reconstruct a defect that requires partial commissure reconstruction, it is known as the Abbé-Estlander flap.

The method is essentially the same as described previously, except that the medial pedicle becomes the commissure. Often immediate postoperative asymmetry is noted and later adjustment is then necessary.
Abbé Flap Reconstruction in a Cleft Lip Patient

Sandwich Abbé Flap

In a cleft lip patient, either unilateral or bilateral, where there is significant transverse shortage and scarring of the lip, the Abbé flap is the reconstructive method of choice. In the past, a classic Abbé flap was used. The disadvantage of this is that the lower lip functional muscle is injured, as is the central portion of the upper lip. As a result of this, the Abbé flap does not function. To prevent this unsatisfactory situation, for more than 30 years the sandwich flap has been used.

The Abbé flap is used to provide bulk to the upper lip when it is transversely deficient and tight because of previous surgery. In addition, the flap should be able to provide a prolabial segment to the upper lip when necessary.

It is vital to remember that in most cases, particularly bilateral cases, there has been no attempt to reconstruct the orbicularis in the upper lip. Therefore the first thing is to open up the lip, dissect down to the orbicularis, particularly releasing its attachments from the undersurface of the nose and columella, and then to reconstruct the muscle by interdigitation of the muscle in the midline of the defect.

Next, the sandwich flap is elevated on the lower lip. This consists of skin and mucosa, leaving behind the intact lower lip orbicularis muscle. This sandwich flap covers the muscle of the upper lip, and reconstructs the central portion of the upper lip. This, of course, is divided 2 to 3 weeks later. This reconstruction provides a truly functional upper lip.
With this technique the upper lip is released through excision of the old scar using a vertical incision. The orbicularis muscles are dissected out and all scar tissue is removed. The muscles can then be brought together and sutured. The muscles may be interdigitated if the lip is short.
No Muscle in Flap

On the lower lip, an Abbé flap is elevated. This is two layered, consisting of mucosa and skin. The orbicularis muscle is left untouched. The vessels are dissected out, leaving only a thin cover of submucosal tissue. The flap is turned up and sutured in place. There is ample room for feeding and speaking. The pedicle is divided 2 to 3 weeks after surgery and the raw areas are sutured, after which function and sensation are excellent. Rarely is any further surgery required.
This approach has revolutionized Abbé flap surgery for our cleft team, and no longer do we approach an Abbé flap as a technique that has to be done to give a larger lip but at the expense of function. There are no functional deficits.

**PROBLEMS**

By incorrectly positioning sutures or by direct trauma to the vessels during dissection of the flap, it is possible to injure the vascular pedicle and to cause vascular occlusion. This will result in flap necrosis. If the surgeon clearly understands the vascular anatomy, it is unlikely that the pedicle would be damaged in this fashion. The flap should be cut on the side opposite that chosen for the pedicle; this allows the exact position of the labial vessels to be noted. This enables safe incision of skin, muscle, and mucosa on the other side of the flap to be performed with the formation of a very narrow but secure pedicle.
Perialar Crescentic Advancement Flap

The perialar crescentic advancement flap was described in detail earlier in this chapter and in Chapter 1. Its use in the reconstruction of a large upper lip defect is presented. This patient has an adenocystic carcinoma of the minor salivary glands in the left cheek–upper lip area.

A wide excision is planned in the perialar crescentic fashion.

The full thickness of the lip and cheek is excised down to and including the maxillary periosteum.
The mucosa in the apex of the upper buccal sulcus is incised, and the cheek is elevated further laterally.

The remainder of the lip and cheek can now be easily advanced medially to close the defect.
The closure should be performed in layers. Do not forget the muscle.

The result is good, without distortion of the lip, cheek, or nose.

This technique can also be used to provide a more satisfactory reconstruction when the primary problem is confined to the lower lip.
Perialar Crescentic Advancement Flap to Reconstruct a Full-Thickness Upper Lip Defect With Preservation of the Orbicularis Oris Muscle

When the lesion is a vascular malformation confined to the vermilion the orbicularis muscle can be kept intact, which gives satisfactory stabilization of the alar base. As the perialar crescentic area is closed, the lip moves medially, and a very adequate reconstruction can be performed.

This patient presented with a vascular lesion of a significant size on the left side of the upper lip. The plan was to remove this completely, but to obtain the best aesthetic result, it was decided to combine the excision with a perialar crescentic advancement flap to aid in medial movement of the lip. If muscle is cut, it must be sutured back together.
The Abbé flap design on the lower lip is an alternative reconstruction that was considered. The plan is executed and a very satisfactory result obtained. Note the improved appearance of the nose.

_Bilateral Perialar Crescentic Advancement Flaps_

For a defect of one third of the lip length, a single flap may be used. If the defect is larger than one third, it can be reconstructed by means of a bilateral variation of the Webster principle, as demonstrated in this patient with a leiomyosarcoma of the upper lip. A bilateral perialar crescentic advancement technique is planned for closure.

The Abbé flap design on the lower lip is an alternative reconstruction that was considered.
Just over half of the lip is excised, along with portions of the alar bases, the nostril sills, and the base of the columella.

The crescentic excision is wider and lower in this case; it is taken around the right alar base, and the attachment of the orbicularis muscle to the alar base is divided to obtain more medial advancement.
A similar mobilization is performed on the contralateral side. It may also be necessary to free the mucosa in the buccal sulcus and undermine the cheeks further. The result is a full-thickness cheek flap. Following this maneuver, the remnants of the lip are advanced to close the defect.

The lip is sutured in layers.
A slight tightness of the upper lip is noted in the final result, but the lip relationship is reasonably satisfactory. The result is reasonably good, but not as ideal as that achieved by the sandwich Abbé flap (which could be considered at a later date).

**PROBLEMS**

With bilateral perialar crescentic advancement flaps, the lip is not augmented and the position of the commissures is changed, which results in a smaller mouth opening. The diminished mouth size can be a significant problem for patients who wear dentures. In addition, an obvious tightness of the upper lip occurs, although this improves slightly with time. If a sandwich Abbé flap is used, there must be a wide muscle dissection, taking care not to injure the nerve supply. This provides satisfactory central bulk to the lip.
Reversed Karapandzic Flap

For reconstructing large upper lip defects that exceed one third of the lip length, a lower lip sharing procedure may be used if the more conventional techniques are not available. This approach has the advantage of using like tissue for filling the defect. The repair is based on a principle published by Karapandzic in 1974. With this technique incisions are made around both commissures to provide full-thickness flaps equal to the width of the lip. The initial incision is made through the skin. The muscles are divided by a mixture of blunt and sharp dissection with preservation of the nerve and vascular supply. Thus the segments advanced to form the lip are well vascularized and functional. In upper lip reconstruction, unlike reconstruction of the lower lip, the mucosa is incised along the buccal sulcus. It is now possible to advance the segments and reconstruct the lip. The reconstructed lip is usually somewhat tight. This method will be discussed in more detail in the section on lower lip reconstruction, where the results from this approach are much better.

The reversed Karapandzic method is chosen for this patient, who had a Merkel cell tumor excised from the upper lip and the columella.
After excision, the lip is reconstructed with reversed bilateral Karapandzic flaps. The reconstruction was tight and not aesthetically satisfactory. Soon after the procedure the patient succumbed to distant metastases from the aggressive Merkel cell tumor; thus long-term follow-up was not possible.

**PROBLEMS**

Tightness of the upper lip and an inability to rotate the commissures adequately are the main problems associated with this approach. The lip tightness is combined with a small mouth aperture, which can cause problems for denture wearers. It may be necessary to perform a commissurotomy at a later date to widen the mouth.

**Surgical Technique of Choice**

Undoubtedly, the best results are obtained from the Webster method. The lip is not as tight as with other procedures, and the aesthetic result is superior. Moreover, the flap does not involve the lower lip, with the resulting possibly ugly scar created by the Abbé flap donor site.
TOTAL UPPER LIP RECONSTRUCTION

Total upper lip reconstruction is an extremely difficult problem with no truly satisfactory solution. The aesthetics of the reconstruction result are suboptimal, as is the function. The tissue necessary to achieve symmetry and normal anatomy and function is not available.

Fortunately, total upper lip reconstruction is rarely required. Several methods are available, and all involve the use of nasolabial tissue. Simple nasolabial flaps based inferiorly or superiorly can be used, or more formal fan-type flaps (Gillies) can be employed.

The flaps are based on an inferior medial pedicle; they are full-thickness cheek flaps that include the mucosa. Considerable care is taken at the pedicle area to avoid traumatizing the vessels around the commissures. A conscious effort is made to maintain a subcutaneous pedicle that is wider than the skin or mucosal pedicle.
After the flaps have been incised, they are rotated medially to form the upper lip. The donor defect is closed directly after excision of superior dog-ears of excess skin.

The mucosa is reconstructed by advancement. Use of a tongue flap is too hazardous in this situation; it would probably become detached.

Frequently it is necessary to employ distant flaps, such as the deltopectoral flap, or preferably free tissue transfer for adequate reconstruction. In men, once the bulk of the lip has been supplied, skin cover can be exchanged for a narrow scalp flap, which provides hair-bearing skin. From this, a mustache can be grown to disguise the reconstruction and make up for any discrepancy between the lips. Recently attempts have been made to supply function by tunneling flaps of vascularized and neurotomed platysma or frontalis into the lip. It is too early to assess the results of these procedures.
LOWER LIP RECONSTRUCTION

Symmetry, normal contours, and normal function are the goals in lower lip reconstruction. Poor lower lip function causes embarrassing drooling and can produce faulty vocal articulation.

Skin Defects

As with the upper lip, skin defects of the lower lip may be closed directly, by skin grafting, or, if the defect is deep and extensive, by reconstruction with an inferiorly based nasolabial flap or a rotation flap. The results of this approach are usually good, but there is a tendency for these flaps to pincushion and to defy revisional surgery for this problem.

Inferiorly Based Nasolabial Flap

This patient has a basal cell carcinoma of the lower lip. This is excised and reconstruction planned with an inferiorly based nasolabial flap.
The flap is elevated, taking care not to damage facial nerve branches. It is transposed to the lower lip and sutured into position. The donor defect is closed directly.
The result is good. The mouth is symmetrical, the lip level is horizontal, and only slight pincushioning of the flap is present. The patient has no desire to have the latter corrected.

**Problems**

With an inferiorly based nasolabial flap, the main disadvantage is pincushioning. This makes the scars more obvious. However, the color match is reasonably good.
Small Full-Thickness Lip Defects
Small full-thickness defects of the lip are usually simple to reconstruct. The height of the lip must be maintained, and there should be no mucosal notching.

Direct Closure
If the defect is less extensive than a third of the lip, direct closure in layers is possible and will give an excellent result.

Problems
Occasionally a notch may occur in the free vermilion edge. In reconstructions for carcinoma this irregularity should be accepted and later corrected after the fear of recurrence has subsided. Complex scar lines should be avoided in cancer resections, since they make follow-up difficult. In nonmalignant conditions a Z-plasty is performed to lengthen the mucosa and thus maintain the anteroposterior lip convexity.

Large Full-Thickness Defects
In reconstructing large full-thickness defects, the surgeon should be careful not to make the lip too tight. The lower lip would then have a reversed relationship with the upper lip. The lip should be functional and of the correct height.

Reversed Abbé Flaps
Abbé flaps (see pp. 462–464 for an in-depth description) can be taken from the upper lip to reconstruct lower lip defects. However, these flaps can only consist of one third of the upper lip and thus cannot fill large lower lip defects. If the lower lip defect is in the commissure area, a reversed Abbé-Estlander flap is used; again, the medial free margin of the upper lip flap is inserted into the lateral edge of the lower lip defect.
Bilateral Abbé Flaps

Bilateral Abbé flaps are planned to augment this tight total lower lip reconstruction after cancer resection.

The flaps incorporate the philtral columns, and the vascular pedicles are located on the lateral edges of the flaps. The position of the vessels is noted on the medial incision, which completely divides the lip. This knowledge allows a narrow pedicle to be created laterally with complete security.
The narrow pedicle permits greater ease of rotation from upper to lower lip: as the flaps are rotated into the lower lip, the laterally placed pedicles move medially.
The lack of bulk makes the period between reconstruction and pedicle division more comfortable for the patient and provides enough opening for fluids and semisolids to be introduced into the mouth. All lip incisions are closed in layers.

The pedicles are divided in 7 to 10 days. The donor site scars are remarkably inconspicuous, and upper lip distortion is minimal.

**Problems**

As with the conventional Abbé flap, problems may arise from pedicle compression. However, if planning and surgery are executed carefully, this has never been a problem with the reversed technique.
Karapandzic Technique

The Karapandzic technique can be used to reconstruct up to three quarters of the lower lip. It is simple, quick to perform, and results in a functional and aesthetically acceptable lip.

The plan for the procedure is outlined for this carcinoma of the lower lip. It consisted of resection followed by reconstruction with bilateral modified Karapandzic flaps.

The resection is completed and the position of the vessels noted.
This flap can also be made as an island flap.

Incisions are made transversely from the base of the postexcisional defect on both sides. These extend around the commissures into the upper lip; with the use of scissors they are maintained equidistant from the free lip margin. The orbicularis muscle fibers are spread apart longitudinally, in the line of the skin incision, down to the submucosal layer. The nerves and vessels are maintained intact. The mucosa is incised for 1 to 2 cm from the edge of the defect.

After this maneuver the edges of the defect can be approximated without tension.
The lip reconstruction is sutured in layers.

The result is a competent, sensate, fully functional lower lip with a slightly reduced oral stoma. If necessary these flaps can be used as islands based on the vessels that supply them. The vascular supply to these flaps is well illustrated on p. 493.
Unilateral Karapandzic Flap
It is possible to use the Karapandzic flap unilaterally. When a large defect is being reconstructed, it is necessary to reconstruct the mucosa. An inferior tongue flap based on the tip of the tongue gives a nice cover for this.

This patient presented with a squamous cell carcinoma of the lower lip infiltrating the muscle. This involves almost two thirds of the lower lip.

It was decided to resect this with a full-thickness excision of two thirds of the lip. The lip mucosa is resected from the residual third. A unilateral Karapandzic flap with a small base on the upper lip that contained the labial vessels was used to reconstruct the defect. A mucosal flap is elevated from the undersurface of the tongue.
The flap is rotated into place. Note the narrow pedicle.

The flap raised from the undersurface of the tongue increases the length of the tongue.
Early and late photographs show that the lip is perfectly adequate in size and shape as well as function. The tongue flap used to reconstruct the lower lip is of a slightly different color and texture when compared with the normal upper lip.

The donor defect is closed, and the flap provides a nice reconstruction of the lip.

Early and late photographs show that the lip is perfectly adequate in size and shape as well as function. The tongue flap used to reconstruct the lower lip is of a slightly different color and texture when compared with the normal upper lip.
Modified Karapandzic Flap

When the lesion lies lower on the lip and does not involve the lower lip margin, an octagonal wedge resection is planned and the reconstruction is achieved by Karapandzic flaps. Inferiorly on the chin area there is a direct closure of the inferior extension of the resection. Once again, if the muscles are dissected out and are reconstructed as a separate layer, this ensures that a good aesthetic and functional result can be achieved.
Chapter 8 Lip Reconstruction

Bilateral Karapandzic Flap

This relatively young woman exhibits an excellent functional and aesthetic result following full-thickness lower lip resection for squamous cell carcinoma and reconstruction with modified Karapandzic flaps.
This patient had a squamous cell carcinoma of his lower lip that required resection of just over half of the lower lip. This was repaired by the Karapandzic technique, and at rest, the result is very satisfactory.

The most important aspect of the lips is function, and one can see that he can open his mouth wide and can totally control his lower lip, so eating and drinking pose no problems for him.
Lower Lip and Cheek Reconstruction

When the lower lip is involved laterally and the defect extends onto the cheek, the postexcisional defect is considerable; it consists of lip and cheek. Thus a more complex reconstruction is required. A single Karapandzic flap will close most of the lip defect, but a cheek and commissure reconstruction still needs to be done.

This patient had a recurrent squamous cell carcinoma of the lip commissure and cheek. Initially, a Karapandzic flap and a Webster cheek advancement flap reconstruction was planned initially; however, on further consideration, the latter was changed to a rhomboid flap.

After excision of the lesion, the single Karapandzic flap is used to reconstruct the whole lower lip and the rhomboid flap is chosen to close the resulting lateral lower lip–medial cheek defect.
The intraoral mucosa in the cheek area is reconstructed directly, and the skin defect is repaired with the rhomboid flap.

This result is early, but it is satisfactory and will improve with time, especially in symmetry. Lip function is good.
PROBLEMS

If a single Karapandzic flap is used, asymmetry of the commissure results. Therefore this method is not recommended. However, as can be seen from the patient shown here, when one flap is used to close a defect resulting from excision of a squamous cell carcinoma, the situation improves with time.

This patient has a squamous cell carcinoma of the lower lip. It is possible to preserve approximately half of the lower lip on the right side, and this will be rotated around to fill most of the postexcisional defect, using the Karapandzic technique. Fortunately, it is possible to retain a small amount of the lower lip on the left side, which leaves the commissure intact and therefore closure is tight. It does allow the commissures to be maintained, although their position is altered.
If the defect is more than three quarters of the lip length, this is not the method to use, since it results in a lower lip that is too tight, with an overhanging upper lip. Even in ideal circumstances there is some reduction in the size of the oral stoma. Patients with dentures must be instructed in how to remove and insert these appliances so that the least amount of strain is put on the lip. It is striking, however, that the aesthetic result of this rather poor reconstruction has improved greatly with time, and the function is satisfactory.

**Surgical Technique of Choice For Lower Lip Reconstruction**

Undoubtedly, the best choice in this group is the Karapandzic method. This technique is easy to perform and provides excellent results—it produces a lip that has sensation and orbicularis function from the first postoperative day. Although the oral stoma is reduced, this rarely, if ever, causes significant problems. The cosmetic result is excellent in that the scars are not too obvious, the mouth is symmetrical, and the nasolabial folds are unchanged. There is no evidence of pincushioning of the flaps. The vermilion area is normal because it has been left undisturbed. In fact, the long-term results for many of the patients reveal little evidence of surgical intervention. This is the strength of the procedure, followed closely by the ease with which it can be performed.
Total Lower Lip Reconstruction

Total lower lip reconstruction varies only in degree from partial reconstruction, but the degree is significant. Since the Karapandzic method cannot be used, there is little possibility of having a truly functional and sensate lower lip. As with the upper lip, total lower lip reconstruction presents a considerable problem. In some ways it is more significant because oral competence depends greatly on a functional lower lip of an adequate height, having good muscular function and adequate sensation.

Webster Cheek Advancement Technique

The original description of the Webster cheek advancement technique implies that it fulfills the criteria stated above, and on first encounter it seems ideal for total lower lip reconstruction. The problems of the tight lower lip and the overhanging upper lip, which were so ugly and characteristic of the earlier cheek advancement procedures such as the one described by Bernard, appear to have been solved with this method. However, as will be seen later, it flatters to deceive.

The patient shown here had an extensive lower lip squamous cell carcinoma that required a total lower lip resection. The Webster method of reconstruction was planned.
The total lower lip is resected from commissure to commissure along the lower limit of the buccal sulcus.

Horizontal incisions extend laterally from the commissure and from the base of the lower lip defect; they divide the orbicularis but maintain continuity of the buccinator and its nerve supply. If the flaps formed by these incisions were simply pulled together, the typical tight lower lip and excess upper lip, which has spoiled so many lower lip reconstructions, would result.
To prevent this situation from occurring and to advance the lower lip while stretching the upper lip laterally with resultant flattening of the upper lip, four Burow’s triangles are excised. These are situated above and below the lateral end of the flaps and allow medial advancement to take place as the triangles are closed. The triangles are as wide as they can be to still allow closure without tension. Care is taken not to damage facial nerve branches. The mucosal incision is less extensive than the skin incision.

It is then possible to advance the bilateral flaps and suture them end-to-end in layers.
Some degree of tension in this suture line always exists. The superior and inferior triangles close as a result of the advancement and are sutured in layers. The vermilion border is recreated by mucosal advancement or, preferably, with a large inferiorly based tongue flap that is divided in 10 to 14 days. The tongue flap is used to provide continuity of mucosal cover and good vascularized tissue for the central flap junction area.

As shown here, the lower lip is somewhat tight, with a reversal of lip relationships.
PROBLEMS

The Webster cheek advancement flap results in a tight lower lip and a bulky upper lip. Lower lip function is poor, resulting in less competence than is desirable. No procedure can adequately improve this situation; however, the tongue flap has overcome the mucosal deficiency so characteristic of this type of reconstruction. After initial enthusiasm for the Webster method, as with the Bernard method, it is now seldom used because of the problems outlined on p. 509. It does not meet the ideal criteria for lower lip reconstruction.

Bilateral Fan Flaps

These fan flaps are constructed bilaterally, as illustrated for the unilateral fan flap.

They are rotated on their pedicles and sutured end-to-end without tension.
Bilateral fan flaps provide a lip of adequate bulk; the vermilion is supplied by a tongue flap, which is divided in 14 days. The donor defect can be closed directly without difficulty.

**PROBLEMS**

A lip created from fan flaps has little muscular function and poor sensation. It also tends to be pincushioned bilaterally. Even in the best reconstruction, there is always a degree of tightness with an excess of upper lip. In the past, when the vermilion was reconstructed by simple mucosal advancement, there was a problem with ischemia and delayed healing, with eventual notching where the four suture lines met in the midpoint of the reconstructed lip. This problem has been obviated by the use of the tongue flap, which, in addition to adding bulk for the vermilion, increases the vascularity of that area. Since the tongue flap has been used, ischemia and necrosis in this region has not been a problem. There is bilateral ablation of the nasolabial folds.

**Surgical Technique of Choice**

Undoubtedly, the bilateral fan flap and tongue flap reconstruction gives the best lower lip. This method brings in new tissue for lip reconstruction. The result is a lip that is bulkier and less tight than with other methods. Unfortunately, however, there is no ideal method for producing a sensate mobile lower lip to give normal competence to the mouth.
**COMMISSURE DEFORMITY**

Commissure deformity often results from division of an old electrical burn or post-traumatic contractures. Reconstruction of the commissure is complex, both aesthetically and functionally. The normal contralateral commissure remains for comparison with the reconstruction; unfortunately, asymmetry is common. Poor muscle reconstruction results in drooling and excoriation of the corner of the mouth.

**Mucosal Defects**

*Rhomboid Flaps*

The position of the new commissure is marked to allow for some overcorrection. Division of the contracture forms two raw areas that are approximately two rhomboids, making the mucosal rhomboid flaps the obvious choice for reconstruction.
These flaps are constructed on a 120-degree angle (as described in Chapter 1). The flaps are transposed laterally to reconstruct the angle.
The donor sites are easily closed by direct suturing.

Recently some aggressive splinting techniques have been introduced that may reduce the necessity for surgical correction of commissure contraction. It would be hard to imagine that we have seen the end of this problem.

**PROBLEMS**

By and large, the results are satisfactory. Some contracture may take place because of the multiple suture lines, resulting in pincushioning and a partial recurrence of the deformity. Irregularity of the mucocutaneous junction also may occur, and this problem may be difficult to correct.

*Tongue Flaps*

If the mucosal defect is thick in the region of the commissure (for example, resection with skin flap reconstruction), tongue flaps can supply an adequate reconstruction. A flap based anteriorly on the side of the tongue can be raised and split to be inserted into the anterior portion of the commissural defect. In 10 days the flap is divided and inset into the apex of the commissure.

Another method is to raise two long posteriorly based flaps from the side of the tongue. These are rotated and sutured into the raw areas on the lips. Again, these flaps are divided in 10 days.

**PROBLEMS**

Tongue flaps are bulky; the color and texture are different from the normal lip mucosa. There may be crusting on exposure. The method is technically difficult and should be used only in very unusual circumstances, as described next.
Full-Thickness Defect of Commissure

*Double Skin and Mucosal Rhomboid Flaps*

The results of this technique have been consistently satisfactory as compared to other techniques. Commissural lesions can be excised so as to create rhomboid defects on the upper and lower lips.

This patient had a basal cell carcinoma of the oral commissure. From the 120-degree angles, rhomboid flaps were planned.

The defect was created and the rhomboid flaps were raised. These flaps may consist of skin only or skin and mucosa if necessary.
Chapter 8  Lip Reconstruction

The 120-degree angles are moved together and sutured to form the commissure. Some adjustment may be necessary to place the commissure in the desired position.

The defects on the lip and the cheek were closed directly after the commissure was formed. Raw edges remained on the reconstructed upper and lower lips; these raw areas were closed with mucosal advancement or mucosa rhomboids, as described earlier.
Although slight pincushioning has occurred, symmetry and function are both good.
Double Skin Rhomboid Flaps and Tongue Flaps

In this patient double rhomboid defect was created by excision of a recurrent squamous cell carcinoma of the commissure.
After excision, a full-thickness commissure defect was created. Rhomboid flaps were raised and rotated to close the defect and form the commissure.
The flap was trimmed to obtain the ideal shape and position.
From the lateral side of the tongue, a flap was elevated, split in the midline, rotated, and used for the mucosa of the lips and commissure.
Ten days later the pedicle was divided, with the patient under local anesthesia.

**PROBLEMS**

Generally, the results of this technique are satisfactory. However, it is sometimes difficult to achieve a satisfactory skin vermilion junction. In addition, a slight blunting of the commissure often occurs. These problems can be partially corrected later by a secondary procedure.

Apart from loss of definition of the commissure, pincushioning of the flaps, and occasional loss of competence at the oral angle, this has been a good method of reconstruction.

**Surgical Technique of Choice**

If buccal mucosal flaps can be used, these are preferable to tongue flaps, because the latter involves a two-stage procedure that is technically more difficult. Having said this, it is easy to suture the flaps in place and then divide them. It is inconvenient to have to do this. Only where significant bulk is required should tongue flaps be considered.
# Choosing the Best Option for Lip Reconstruction

<table>
<thead>
<tr>
<th>Anatomic Area</th>
<th>Problem</th>
<th>Special Considerations</th>
<th>Flap of Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial lip mucosa</td>
<td>Mucosal grafts do not always take well and tend to lack the necessary bulk</td>
<td>No single method of choice for lip mucosal reconstruction</td>
<td>Rotation flap</td>
</tr>
<tr>
<td></td>
<td>Mucosal flaps frequently contract to produce areas of excess mucosa</td>
<td></td>
<td>V-Y advancement flap</td>
</tr>
<tr>
<td>Extensive lower lip mucosal defect</td>
<td></td>
<td>If there is an extensive defect of the lower lip mucosa, it is advisable to excise the entire lower lip mucosa and then resurface it to end up with uniform color and texture</td>
<td>Mucosal advancement flap</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tongue flap (undersurface)</td>
</tr>
<tr>
<td>Extensive upper lip mucosal defect</td>
<td>Amount of mucosa is limited and advancement from intraoral area onto the lip is not possible</td>
<td>Standard undersurface flaps of tongue cannot be used for the upper lip</td>
<td>Anteriorly based lateral tongue flaps</td>
</tr>
<tr>
<td>Upper lip skin defects</td>
<td>Upper lip has a complex symmetry that is difficult to reestablish</td>
<td>In men, hair-bearing skin must be used</td>
<td>Perialar crescentic advancement flaps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The alar base area and the nasolabial region should not be disturbed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The commissure position should not be altered</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reconstruction should not cause lip shortening or tightness</td>
<td></td>
</tr>
<tr>
<td>Partial reconstruction of the upper lip</td>
<td>As with replacement of skin, symmetry should be achieved with as little disturbance of surrounding anatomic features as possible</td>
<td>Up to one sixth of the lip can be closed directly</td>
<td>Perialar crescentic advancement flap (unilateral or bilateral)</td>
</tr>
</tbody>
</table>
### Chapter 8  *Lip Reconstruction*

<table>
<thead>
<tr>
<th><strong>Rationale</strong></th>
<th><strong>Second Choice</strong></th>
<th><strong>Caveats</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Can be used for closure of fairly large defects without causing deformity of the alar base, the lip or oral commissure</td>
<td>Abbé flap</td>
<td>Pincushioning may occur</td>
</tr>
<tr>
<td>One-stage procedure</td>
<td>Abbé sandwich flap</td>
<td>Defect needs even connection</td>
</tr>
<tr>
<td>Scars lie in good aesthetic positions</td>
<td>Abbé-Estlander flap</td>
<td>Contracture of lines may result in labial notches</td>
</tr>
<tr>
<td></td>
<td>Reversed Karapandzic flap</td>
<td>Flaps should be planned large enough to supply bulk for the central tubercle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applicable where only mucosa needs to be supplied and bulk is not required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Undersurface of tongue should be preferred for better color match and mucosal texture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presence of greater tension on the tongue flap in upper lip reconstruction necessitates suturing the lateral edges of the tongue to the lips</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In perialar crescentic advancement flaps, the defect should be triangulated with the base superiorly; however, the long axis should lie diagonally rather than vertically, so as not to cause lip lengthening</td>
</tr>
</tbody>
</table>

Abbé flaps cause ugly scars in the lower lip  
Tightness of the upper lip and an inability to rotate the commissures adequately are the main problems associated with a reverse Karapandzic flap

*Continued*
Choosing the Best Option for Nasal Reconstruction—cont’d

<table>
<thead>
<tr>
<th>Anatomic Area</th>
<th>Problem</th>
<th>Special Considerations</th>
<th>Flap of Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total upper lip</td>
<td>Extremely difficult problem and no truly satisfactory solution</td>
<td>Almost all reconstruction methods involve the use of nasolabial tissue</td>
<td>Nasolabial flaps Fan-type flaps</td>
</tr>
<tr>
<td></td>
<td>Both aesthetically functional results are suboptimal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large full-thickness lower lip</td>
<td>In reconstruction of carcinoma of the lower lip, some irregularities of free vermillion edge should be accepted; they are corrected later, after the fear of recurrence is past</td>
<td>Surgeon should be careful not to make the lip too tight</td>
<td>Karapandzic method</td>
</tr>
<tr>
<td>Total lower lip</td>
<td>There is little possibility of having a truly functional and sensate lower lip</td>
<td>Oral competence depends greatly on a functional lower lip of an adequate height, having good muscular function and adequate sensation</td>
<td>Bilateral fan flap with tongue flap</td>
</tr>
<tr>
<td>Commissure defects</td>
<td>Complex reconstruction, both aesthetically and functionally</td>
<td>The normal contralateral commissure remains for comparison with reconstruction; unfortunately, asymmetry is common</td>
<td>Double rhomboid mucosal flaps</td>
</tr>
</tbody>
</table>
### Chapter 8  Lip Reconstruction

#### Rationale

These are full-thickness cheek flaps that include mucosa.

Easy to perform, provides excellent results, a lip with sensation and function.

Although oral stoma is reduced, this rarely, if ever, causes significant problems.

Scars are good, mouth is symmetric and nasolabial folds are unchanged.

This method brings in new tissue for lip reconstruction.

Lip is bulkier and less tight than other methods.

One-stage procedure with satisfactory results.

#### Second Choice

Distal flaps, e.g., deltopectoral scalp flaps for hair replacement in men.

Reverse Abbé flap.

Fan flap.

Webster cheek advancement technique.

Tongue flap.

#### Caveats

Abbé flap causes upper lip scarring, limited skin available in upper lip.

With fan flap, the lip may have a degree of sensation but little or no muscular function is present.

Webster method results in poor lip function; less competence than desirable.

Tongue flap should be preferred in cases in which significant bulk is required.
References—With Key References Annotated


The authors present a surgical technique for reconstruction of the lower lip and both commissures, which they applied in a patient with a huge squamous cell carcinoma of the total lower lip and part of the upper lip. The authors conclude that the technique is simple and is one stage. It provides complete support to the reconstructed lower lip and commissures.


The authors look into the corners of the lips and mouth to more clearly understand the compensatory nature of its reconstruction. When any procedure is probably going to alter form and function, the surgeon must be aware of the various trades and select the reconstruction that provides the greatest net gain. The authors conclude that only by having knowledge of the effects on normal function and estimating the resultant deformity can we adequately compensate for major lip and mouth tissue loss.


Buck G. History of a case in which a series of plastic operations were successfully performed for the restoration of the right half of the upper lip and adjacent portions of the cheek and nose. Trans Med Soc State NY, 1864.


Estlander JA. En ny operationsmetod att atersralla en forstord lapp ellekind. Finsak Lak-Sall SK Handl 14:1, 1872.


Estlander JA. Méthode d’autoplastic de la joue d’une lèvre par un lambeau emprente a l’autre. Rev Meds Chir 1, 1877.


The authors report on seven patients with advanced squamous cancer of the lower lip whose defects were reconstructed by the gate-flap technique. The authors conclude that this method affords satisfactory total reconstruction of the lower lip. Better results may be obtained if more attention is given to details such as the thickness of the pedicles, the opening of Stensen’s duct, and advancement of the mucosa to form the vermilion. Late distortion due to scar contracture can be corrected by defatting and W plasty.


Chapter 8  Lip Reconstruction


The authors studied the orbicularis oris muscle using electrical stimulation. The different muscular components are defined at the time of operation for repair of the cleft. By wide dissection and differential rearrangement, these muscular components can then be brought into their normal position. The authors conclude that not only is a better cosmetic and functional result achieved immediately, but they also suggest that some common growth deformities will be avoided.
Chapter 8  Lip Reconstruction


Author discusses the importance of lips in terms of location, function, and aesthetics. Reconstruction of the upper lip presents the surgeon with one of the greatest challenges. Author concludes that total upper lip reconstruction is a frequent and demanding procedure, and its difficulty is related to the size and the site of the loss of the aesthetic subunits such as the Cupid’s bow and the philtral columns.


Smith F. Some refinement in reconstructive surgery of the face. JAMA 120:352, 1942.


Stein SAW. Laebedannelse (Cheiloplastik) udført paa en ny methode. Hospitalsmiddelelser (Copenhagen) 1:212, 1848.


The authors call attention to a previously described method of closing certain common surgical defects of the lower lip. Advancement flaps are used from one or both sides, resulting in a staircase configuration. The authors discuss the advantages, disadvantages, and applications of the method.

The author examines crescentic subcutaneous pedicle flaps prepared on the area lateral to the alar base to cover the skin defects in and around the philtrum. In one patient, a combination of the lateral lip advancement flap and the crescentic subcutaneous pedicle flap was applied to the skin defect on the lateral lip and philtrum. In another patient, a combination of two crescentic subcutaneous pedicle flaps was applied to the skin defect within the philtrum. The author concludes that both methods were successful.


Tagliacozzi G. De Curtorum Chirurgia per Insitionem. Venice: Gasper Bindoni, 1597.


Tschopp HM. Reconstructive surgery after severe animal bite injuries of the head and neck area. Chir Plast 7:88, 1983.


The authors describe reconstruction of the upper lip resulting in a hair-bearing area and a non-hair-bearing lining in two cases of full-thickness lip defects. A unipedicled neck flap was used in one case and a bipedicled neck flap in the other, both composed of hair-bearing and adjacent non-hair-bearing areas. The authors determined the neck flap has the advantages of providing the two layers of the lip, and the reconstructed lip is not too thick and is mobile and pliable, and the hair resembles lip hair in color, density, and quality.


probably the most significant recent advance in local flap surgery has been the introduction of tissue expansion. Although the initial clinical application of this technique was performed in 1957, when Neumann placed a rubber balloon subcutaneously behind the ear, this method of reconstruction lay fallow for almost 20 years until 1976, when Radovan and Austed used specifically designed implants for this purpose. Since that time, tissue expansion has become an important tool for most plastic surgeons; it now plays a key role in a wide variety of reconstructive procedures. Tissue expansion has been an extremely useful and reliable addition to my practice and as such is used frequently and almost always successfully. Whenever there is concern about the ability of a local flap to ensure safe defect closure I always consider tissue expansion as a reliable and safe solution to this problem. It makes surgery much easier because it supplies an abundance of skin and subcutaneous tissue.

This technique harnesses the biomechanical forces of creep and stress relaxation. By gradual expansion using a saline-filled silicone expander, skin can be stretched and recruited for reconstruction of defects large and small. The important aspect of management is to understand that this is a case of stretch versus blood supply. With time and proper management, the potential for expansion is virtually limitless.
There is no doubt that the head and neck region is the site in which tissue expansion is most commonly used. This technique has allowed local flaps to be employed with less tension and more security, something that is particularly desirable in this area. Tissue expansion has permitted much less complicated reconstructions to be performed. What is not often appreciated is that this technique also includes elements of the delay phenomenon. Advancement flaps with excision of bilateral basal Burow's triangles now provide a simple solution to cheek defects. Rotation flaps on the scalp and face no longer present significant problems of planning. Using the tape advancement method or the sponge rotation technique described on p. 538, it is easy to estimate and subsequently distribute the excess skin or scalp that has been obtained in the expanded area.

**Anatomic Considerations**

It is important not to lose sight of the unique anatomic areas of the face when it is decided to expand facial skin and subsequently use this skin excess. In the male the position of the beard area must be remembered. This should not be expanded and used to close a defect in a non-hair-bearing area. It is exceedingly important that this be remembered in the male child, who will have beard skin in the future. It is also essential to consider the skin color and texture of the areas to be replaced, any previous scar, and the local anatomy, such as the eyes, nose, and lips. In reconstruction, like should be replaced with like. The looseness of the skin must be considered together with the forces that may be generated over the region.

**Basic Principles and Mechanisms**

To use tissue expanders most effectively, one must understand the expansion process. As the expander is inflated, the skin undergoes two biomechanical changes: creep and stress relaxation, representing the viscoelastic properties of tissue. As discussed earlier, creep is the process whereby a constant increasing force gradually lengthens the skin. Stress relaxation takes place when a constant force stretches the skin; it then relaxes and a further increased force may be applied to gain additional lengthening. When creep and stress relaxation act together, the result is a considerable gain in skin area that remarkably produces no permanent histologic alterations in the skin or in hair follicle position, size, or architecture. With care and observing for any signs of ischemia, vascularity is not impaired.

Plastic surgeons have long been familiar with the phenomenon of tissue expansion without necessarily understanding its mechanism of action. This is well illustrated by the often observed situation of a wound that is tight when being closed but at the end of closure is not tight any more. Another example of this phenomenon can be seen when the skin is sutured to gain partial closure and subsequently, after waiting, it is then possible to insert further sutures that will allow closure without tension and without compromise of vascularity. This has been used in excision of large nevi, either at the time of the surgery or a few days later.
When the skin is expanded, it elongates by stretching, but in fact, the expansion process also promotes the formation of new skin. Without this new skin formation, retraction would occur in many cases. There is an increase in epidermal mitotic activity over the first 24 hours; this returns to normal over the next 2 to 5 days. When the expander is deflated, the mitotic activity decreases and then stabilizes at normal after approximately 4 weeks.

Hyperpigmentation may be noted during expansion as a result of increased melanocytic activity. The reason for this is unknown. After removal of the expander and completion of reconstruction, this problem usually resolves.

Histologic studies reveal a thickened epidermis and flat rete pegs after tissue expansion. It is in the dermis that most changes occur. The dermis increases in thickness as a result of greater collagen content, but this change does not compromise the result, because the dermis and subcutaneous tissues are subsequently thinned. This thickening lasts for approximately 36 weeks. The tensile strength of the skin decreases in relation to the thinning of the dermis, which is in response to the expansion process.

When the expansion ceases, there is a period of consolidation that is controlled by the implant. In addition, there may be fat necrosis, muscle atrophy, and widening between the hair follicles in relation to the expander. These changes will resolve after the expander is removed and do not compromise the functional or cosmetic result. A capsule always forms around any implant and this also happens with an expander. The capsule increases over time, reaching a maximum at 3 months. However, in clinical practice this long period of expansion is unusual, particularly in the head and neck region. Histologic evaluation of the capsule reveals collagen in the inner layer surrounded by a layer rich in blood vessels. Saxby noted that this results in an increase in surviving flap length of nearly 150%. However, we know from our clinical experience that much more expansion than this can be achieved by patient self-expansion. This is because the viscoelastic properties of the skin are harnessed much more efficiently by these frequent stresses caused by volume increase.

Insertion of a tissue expander is, in effect, a delay technique that appears to increase the blood supply of the surrounding tissues; thus it is extremely rare to lose any part of an expanded flap. This situation parallels that seen with a standard flap delay. The blood supply from the deep tissue is cut off and the vascularization of the area is from the surrounding skin. Because the stretching process is gradual, it allows the vascular supply to improve over time. This delay phenomenon ensures the success of tissue expansion and of flap survival.

The delay phenomenon also works to the surgeon’s advantage in compromised situations, such as in patients who have undergone radiation therapy and in smokers. Rather than insert an implant that would immediately stress the vascularity and lead to skin necrosis and implant exposure, the surgeon uses the tissue expander to permit slow and gradual adaptation to the situation. The blood supply is thus gradually and intermittently stressed, but usually responds in a satisfactory fashion and, once again, rarely does ischemia occur if care is taken.
Prolonged Versus Rapid Expansion

There are two types of tissue expansion: prolonged and rapid. Prolonged expansion takes place over 1 to 6 weeks, whereas rapid expansion is accomplished in the operating room. These approaches can be combined. With the prolonged technique, more skin can be created and large defects can be reconstructed. The flaps used will be large and adequate for reconstruction, and the donor defect should be easy to close. In the rapid expansion technique the expander is inserted as soon as possible to accomplish as much repeated expansion as possible by small and frequent fillings of the expander. The defect is created and the expanded flap is used to close it. It is often wise to use a combined technique, and this requires experience. Immediate expansion should fill the created defect but should not overstretch the skin. In some patients, the volume created is sufficient but in most patients, gradual expansion is necessary. The decision as to which technique to use depends on many things, such as an estimate of skin vascularity, skin laxity, a good clinical reason for rapid skin gain, and a cooperative patient.

Skin Vascularity

It is important to consider the rapidity of expansion and the vascularity of the skin; these tend to work in opposition. As the tissue expander is filled, the skin becomes tight and may become pale; this is caused by vessel compression. A wait of 2 to 5 minutes will allow the viscoelastic skin properties to come into play; the skin stretches and relaxes, the vessels open up, and the normal skin color returns. Should this not happen, the volume of fluid in the expander is decreased until the pallor is gone. It is quite acceptable to wait 10 to 15 minutes and then perform a further expansion with the same monitoring for tension.

It is not possible to give a time for expansion—this is one of the most important statements in this section. It depends on several factors—anatomic area, looseness of skin, size of expander, hospital or office expansion, home expansion by patient, and patient acceptance of discomfort. All of these considerations need to be discussed with the patient before placing the expander. As expansion is continued, good clinical judgment is necessary to assess how rapidly the expansion should proceed.

Types of Expanders

The expander, an inflatable device consisting of a silicone envelope with either a remote or integral injection port, is the basic tool used for stretching the tissue. Expanders are available in three basic shapes: rectangular, round, and crescent. Custom expanders can be made by the companies when required; this is expensive and rarely necessary. External dimensions of length, width, and volume are variable. Usually the shape is important both for volume and for the required reconstruction. Ex-
expanders for head and neck reconstruction are usually relatively small apart from those used in the scalp, but expander size, shape, and volume will vary depending on the expansion site and reconstruction requirements. The size and shape of the expander should simulate the size and, to some extent, the shape of the flap cutaneous territory and also of the size and shape of the area to be reconstructed. A careful and accurate preoperative plan is essential. This determines the shape and size of the expander or expanders. If this is not accurately assessed it can lead to disappointment and frustration for both surgeon and patient.

**Injection Ports**

Injection ports are either incorporated directly into the shell (integral port) or connected by a closed tube system (external or remote port). The remote port is designed for placement just below the skin surface for ready identification by palpation. The integral port is located by direct palpation or with a magnetic finder.

**Integral Port**

The expander with an integral port is the traditional approach used by many colleagues because it avoids additional dissection for port placement, and the patient is not inconvenienced by the palpable port site. In the standard type of tissue expansion, filling valve placement is planned to permit easy filling. The valve is located using a magnetic device placed on the skin. The filling valve should not be located in an area in which there is overlying pressure to avoid possible exposure of the dome, which would necessitate removal of both the filling port and expander. Fortunately, this rarely happens. However, when flap tension is excessive, the increased profile of the expander with the integrated port may not allow safe expander filling and will require use of a distant port.

**External Port**

An expander with an external (remote) port requires a tunnel between the port site and the expander to accommodate the connecting tube. The port is placed in a subcutaneous position or may be located outside the skin. With a remote port, a needle can be inserted into the port transcutaneously to accomplish expansion. When the port is exteriorized, a direct puncture is used to fill the expander. The patient, the patient’s family, or a local physician can participate in the expansion process so that the patient does not have to make frequent visits to the plastic surgeon.

Because the connecting tube exit point from the skin is also an entrance portal for bacteria, there have been concerns that this exteriorized port will increase the risk of infection. However, in our experience, use of a long tunnel between the expander edge and the connecting tube exit point through the skin has never been associated with infection.
Personal Experience With the Exteriorized Port

The biggest problem in tissue expansion is the necessity for the patient to return at intervals to have the expander filled; timing must be mutually convenient for both the surgeon and patient. Some have dealt with this by having a nurse, partner, or resident fill the expander. Worst of all, the process can be painful and one must strive not to overfill, although there is a tendency to do this to reduce the number of visits required. This is a help to the surgeon, but not altogether satisfactory for the patient. To make the whole situation less of a problem and safer, we have totally changed our approach to all tissue expansion over the past 25 years.

When the expander is placed, the filling valve is not buried but is left on the skin surface. The filling tube, which is connected to the expander, is brought through a separate stab wound; this tube is then connected to the filling valve. After this procedure, the patient and the relatives are instructed in the inflation process by our clinic nurse. They are provided with saline solution, syringes, and sterile pads to wipe the filling dome. The first filling is supervised, and they are then further advised on skin tension, patient discomfort, and blanching of the skin. They are assured that the blanching passes off quickly within a few minutes, but if it does not, the expander is deflated until the area becomes pink once more. A relative is taught how to measure the increasing size of the expander and how to compare this with the defect to be created. The latter will have been drawn out for the patient or parent and the design can be freshened with a marking pen.

The patient and relatives are then introduced to bioengineering principles—we are not afraid to use the terms creep and stress relaxation to allow them to understand how quickly skin will stretch, and after this, the skin will relax and release the pressure on the skin blood supply. In this way they can easily understand that small amounts of saline solution can be injected frequently. Usually we advise that this injection process be performed twice a day; however, patients will often self-expand or have relatives expand the skin more frequently. They are also taught to assess how much advancement relative to expansion can be expected using the method of placing a sponge or a thread from one side of the expander area to the other. The proximal end of the thread, which will be at the thread base, is moved laterally and is stabilized. The distal end is then moved laterally and distally. In this way, the amount of advancement to be obtained can be measured. If it is insufficient, further expansion is indicated (see p. 545). When it is determined that the expansion is sufficient, preparations are made for reconstruction. Of course, the “pattern of events” timetable cannot be the same for all patients; some require more supervision and reassurance. Also, there may be vascular problems such as compromise of skin circulation necessitating some deflation.

The gains obtained from this regimen include much quicker expansion with less discomfort; fewer complications, since the classic high-volume expansions are avoided; and consequently there is a great reduction in fear and discomfort. This approach has been particularly satisfactory in children, who are more relaxed and less fearful because the parents are performing the expansion. We recommend that this process be introduced to children as a game rather than a medical procedure.
To date there have been no infections, probably because this process is done out of hospital or office, and there is no increased incidence of expander exposure nor insufficient expansion. At present, the standard technique is not used unless the patient or parents wish otherwise. So far, no patient has opted for the classic management.

Advantages of the Exteriorized Port

I adopted this approach to tissue expansion for several reasons:

- It is more convenient for patients who, in our practice, frequently travel long distances, sometimes from other states or other countries.
- This approach is much less expensive all around—less time off work, less doctor/nurse involvement, less travel expense, and more rapid expansion.
- It takes the responsibility off another surgeon in some other part of the state or country who may be asked to provide expansion.
- Because of daily expansion, the time to completion is greatly reduced and often the final expansion volume is larger.
- As one would expect, there is less pain and discomfort, even when the expansion is larger than required. It is expected that the patient will be given antibiotics, but this is probably not necessary.
- Another very important aspect is that we do not have lots of patients coming to the office to have their expansion performed. This is a very significant timesaver in our very busy practice.

The classic burying of the filling port can be used, but the patient must accept frequent office visits, a longer period to achieve the required volume, increased incidence of complications, varying degrees of discomfort and added cost. For children, tissue expansion can be frightening and their fear may increase with each visit.

Tissue expansion has been an effective, reliable addition to our flap surgery practice. In the past 5 years, we have operated on 39 patients with a mean age of 30.1 years (minimum 1 year; maximum 80 years) using tissue expansion with a total of 53 expanders placed.* The distribution of expanders by anatomic site is shown below.

*Over the years, many more cases have been treated in this way, but these cannot be included, since I changed institutions and this information is no longer available.

<table>
<thead>
<tr>
<th>Tissue Expansion by Anatomic Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region</td>
</tr>
<tr>
<td>Cheek and neck</td>
</tr>
<tr>
<td>Forehead</td>
</tr>
<tr>
<td>Scalp and temporal area</td>
</tr>
<tr>
<td>Trunk</td>
</tr>
<tr>
<td>Extremity</td>
</tr>
</tbody>
</table>
The average expansion time after tissue expander insertion is 43.98 days (minimum 7 days; maximum 85 days), which is significantly shorter than the expansion times usually reported in the literature. The number of follow-up visits during the expansion period was 1.97, with a standard deviation of 0.23. In our series there is a statistically inverse correlation between the area of the expander and development of complications. As the area of the expander increases, the risk of complications decreases.

**Expander Design**

Manufacturers’ charts provide extremely useful information about their expander sizes and design relating to the size and shape of the area into which the expander will be placed and the amount of skin required to fill the defect that will be produced. A simple measurement will often suffice, together with observing the shape of the area. It is wise not to encroach on the region to be resected; this makes measurements and planning a little more difficult.

The surgeon must consider the reconstructive technique and the local skin laxity in terms of size of the expander to be placed. Several sizes and shapes should be available to choose from. The surgeon elevates the skin through a small incision and then estimates the size and volume of the subcutaneous pocket. The chosen expander may be ideal, or one of a different size may be necessary. The expander should then be filled until there is blanching and then be slightly deflated to ensure that the skin color returns to pink. It is wise to put a suction drain in place to prevent the unlikely occurrence of a hematoma. This is the surgeon’s choice.

A number of manufacturers’ specification charts are shown on pp. 541 and 544. I have no particular preference regarding manufacturers, but this information allows me to have a wide array of shapes and sizes to choose from. Occasionally it is necessary to have a custom-made expander. I have found all of the companies to be most helpful, so the surgeon should not hesitate to discuss a particular problem or design concept with the manufacturers.

Expanders may be designed with soft or stable bases. The thicker silicone wall of the stable base expander produces unidirectional expansion away from the base, thereby focusing the force on the cutaneous territory. It is of some concern that relatively sharp edges of the “base plate” may perforate the skin—a disaster! The stable base also assists in positioning the implant beneath the flap territory. The soft base permits expansion in all directions, neutralizing the force on the cutaneous territory by expanding into the soft tissues. I used whatever was indicated in each case.

The surface of the expander may be smooth or textured. The textured surface is claimed to allow capsular ingrowth into the device surface, thereby inhibiting migration during the expansion process. This is doubtful at best, and with good technique
and experience, it plays a very small part in decision-making as do types and positioning of expanders. Expander design may require specific modifications for head and neck reconstruction.

### SIZE AND SHAPE

The main characteristic of the expander that is important in planning is base size and shape. This determines whether the expander can be placed in the area to be expanded. Volume is less important, since skin can be expanded as per requirements if the expansion is performed slowly enough in terms of volume injected. Viscoelastic properties of the skin and the expander are all important in this technique. *Prolonged blanching is bad. Expansion by a slow and careful technique is almost unlimited and should always be safe and successful.*

#### Round Tissue Expander

<table>
<thead>
<tr>
<th>Volume (cc)</th>
<th>A Diameter (cm)</th>
<th>B Projection (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>11.3</td>
<td>5.9</td>
</tr>
<tr>
<td>550</td>
<td>13.4</td>
<td>5.8</td>
</tr>
<tr>
<td>700</td>
<td>14.6</td>
<td>6.7</td>
</tr>
<tr>
<td>850</td>
<td>15.0</td>
<td>7.2</td>
</tr>
<tr>
<td>1000</td>
<td>15.5</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Courtesy Mentor Corporation.

<table>
<thead>
<tr>
<th>Volume (cc)</th>
<th>A Diameter (cm)</th>
<th>B Projection (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>6.2</td>
<td>3.6</td>
</tr>
<tr>
<td>100</td>
<td>7.9</td>
<td>2.8</td>
</tr>
<tr>
<td>200</td>
<td>9.6</td>
<td>4.1</td>
</tr>
<tr>
<td>300</td>
<td>10.6</td>
<td>5.0</td>
</tr>
<tr>
<td>400</td>
<td>11.2</td>
<td>5.5</td>
</tr>
<tr>
<td>500</td>
<td>12.2</td>
<td>6.2</td>
</tr>
<tr>
<td>600</td>
<td>13.2</td>
<td>6.5</td>
</tr>
<tr>
<td>700</td>
<td>15.0</td>
<td>6.1</td>
</tr>
<tr>
<td>800</td>
<td>15.2</td>
<td>6.4</td>
</tr>
<tr>
<td>900</td>
<td>15.2</td>
<td>7.6</td>
</tr>
<tr>
<td>1000</td>
<td>15.3</td>
<td>8.4</td>
</tr>
</tbody>
</table>

Courtesy Silimed, Inc.
Rectangle Tissue Expander

<table>
<thead>
<tr>
<th>Volume (cc)</th>
<th>A Length (cm)</th>
<th>B Width (cm)</th>
<th>C Projection (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>6.9</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>100</td>
<td>6.6</td>
<td>5.1</td>
<td>5.6</td>
</tr>
<tr>
<td>250</td>
<td>10.4</td>
<td>7.3</td>
<td>5.6</td>
</tr>
<tr>
<td>400</td>
<td>10.6</td>
<td>9.3</td>
<td>6.6</td>
</tr>
<tr>
<td>550</td>
<td>13.7</td>
<td>7.1</td>
<td>7.7</td>
</tr>
<tr>
<td>700</td>
<td>15.0</td>
<td>8.0</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Courtesy Mentor Corporation.

<table>
<thead>
<tr>
<th>Volume (cc)</th>
<th>A Length (cm)</th>
<th>B Width (cm)</th>
<th>C Projection (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>5.1</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>50</td>
<td>3.8</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>100</td>
<td>6.0</td>
<td>4.6</td>
<td>5.3</td>
</tr>
<tr>
<td>105</td>
<td>8.7</td>
<td>4.1</td>
<td>3.3</td>
</tr>
<tr>
<td>160</td>
<td>11.0</td>
<td>5.1</td>
<td>3.8</td>
</tr>
<tr>
<td>200</td>
<td>6.0</td>
<td>5.0</td>
<td>7.0</td>
</tr>
<tr>
<td>205</td>
<td>9.5</td>
<td>5.5</td>
<td>4.0</td>
</tr>
<tr>
<td>250</td>
<td>9.6</td>
<td>5.9</td>
<td>5.0</td>
</tr>
<tr>
<td>320</td>
<td>14.1</td>
<td>6.2</td>
<td>4.7</td>
</tr>
<tr>
<td>400</td>
<td>13.6</td>
<td>5.5</td>
<td>5.6</td>
</tr>
<tr>
<td>500</td>
<td>15.8</td>
<td>6.9</td>
<td>5.1</td>
</tr>
<tr>
<td>600</td>
<td>18.0</td>
<td>5.0</td>
<td>7.0</td>
</tr>
<tr>
<td>640</td>
<td>18.0</td>
<td>8.0</td>
<td>5.0</td>
</tr>
<tr>
<td>700</td>
<td>28.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>720</td>
<td>15.2</td>
<td>7.3</td>
<td>6.3</td>
</tr>
<tr>
<td>800</td>
<td>18.5</td>
<td>8.7</td>
<td>5.7</td>
</tr>
<tr>
<td>1000</td>
<td>20.2</td>
<td>8.0</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Courtesy Silimed, Inc.
## Crescent Tissue Expander

![Crescent Tissue Expander](image)

<table>
<thead>
<tr>
<th>Volume (cc)</th>
<th>A Length (cm)</th>
<th>B Width (cm)</th>
<th>C Projection (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>9.0</td>
<td>5.7</td>
<td>2.7</td>
</tr>
<tr>
<td>100</td>
<td>11.0</td>
<td>6.9</td>
<td>3.7</td>
</tr>
<tr>
<td>200</td>
<td>14.6</td>
<td>7.5</td>
<td>4.3</td>
</tr>
<tr>
<td>300</td>
<td>16.5</td>
<td>10.3</td>
<td>4.7</td>
</tr>
<tr>
<td>400</td>
<td>18.2</td>
<td>11.4</td>
<td>5.2</td>
</tr>
<tr>
<td>500</td>
<td>19.6</td>
<td>12.4</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Courtesy of Mentor Corporation.

<table>
<thead>
<tr>
<th>Volume (cc)</th>
<th>A Length (cm)</th>
<th>B Width (cm)</th>
<th>C Projection (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>5.1</td>
<td>2.1</td>
<td>2.1</td>
</tr>
<tr>
<td>25</td>
<td>6.0</td>
<td>2.7</td>
<td>2.6</td>
</tr>
<tr>
<td>50</td>
<td>6.8</td>
<td>3.5</td>
<td>3.3</td>
</tr>
<tr>
<td>100</td>
<td>8.1</td>
<td>4.3</td>
<td>3.5</td>
</tr>
<tr>
<td>150</td>
<td>8.7</td>
<td>4.6</td>
<td>4.1</td>
</tr>
<tr>
<td>200</td>
<td>9.3</td>
<td>4.9</td>
<td>4.7</td>
</tr>
<tr>
<td>300</td>
<td>10.1</td>
<td>5.6</td>
<td>5.8</td>
</tr>
<tr>
<td>400</td>
<td>11.4</td>
<td>6.2</td>
<td>6.5</td>
</tr>
<tr>
<td>700</td>
<td>13.4</td>
<td>7.8</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Courtesy of Silimed, Inc.
Elliptical Tissue Expander

<table>
<thead>
<tr>
<th>Volume (cc)</th>
<th>A Length (cm)</th>
<th>B Width (cm)</th>
<th>Normal Projection (cm)</th>
<th>C Projection (cm)</th>
<th>Maximum Volume (cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>6.0</td>
<td>4.0</td>
<td>2.3</td>
<td>4.5</td>
<td>75</td>
</tr>
<tr>
<td>50</td>
<td>8.0</td>
<td>5.0</td>
<td>2.5</td>
<td>5.3</td>
<td>150</td>
</tr>
<tr>
<td>75</td>
<td>10.0</td>
<td>6.0</td>
<td>2.1</td>
<td>6.0</td>
<td>225</td>
</tr>
<tr>
<td>150</td>
<td>12.0</td>
<td>7.0</td>
<td>3.2</td>
<td>7.2</td>
<td>450</td>
</tr>
<tr>
<td>250</td>
<td>14.0</td>
<td>8.0</td>
<td>4.5</td>
<td>9.0</td>
<td>750</td>
</tr>
<tr>
<td>125</td>
<td>15.0</td>
<td>5.0</td>
<td>3.3</td>
<td>6.5</td>
<td>375</td>
</tr>
</tbody>
</table>

Courtesy Mentor Corporation.

<table>
<thead>
<tr>
<th>Volume (ml)</th>
<th>A Length (cm)</th>
<th>B Width (cm)</th>
<th>C Projection (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>6.1</td>
<td>2.1</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Courtesy Silimed, Inc.
It is not the case that one shape fits all. This must be carefully considered in the initial planning. Size is important, as is shape. If the area to be expanded is of a distinctive shape and size, the expander must be of the required width and capable of expansion to the required volume to provide enough skin to close the postexcisional defect. In some cases there may be more than one expander placement as closure is obtained in stages. Also in some defects more than one expander may be required and the shapes may differ, depending on the defect size and shape.

**Overview of Basic Technique**

**STAGES OF TISSUE EXPANSION**

1. Examine the area to be expanded in relation to the defect to be reconstructed.
   - What is the type, quality, and quantity of the skin? Will it match the area to be reconstructed, such as hair-bearing, color, and texture?
   - Is the skin suitable for expansion?
   - Is the area free of scars with no previous radiation and no infected wounds?
2. Measure the defect to be created.
3. Relate this size to the skin to be expanded—it should be slightly larger.
4. Decide on the type of reconstruction to be performed (such as advancement flap), flap design, donor site, and method of closure.
5. Decide on the pattern for resection of the lesion or the scarred area.
6. Insert the expander with the external filling valve in a convenient area. The external filling valve can be hidden under clothing, since the tubing between the expander and valve can be left long. This also applies to the drain tube, if one is used.
7. Begin filling the expander to initiate skin stretching without blanching, basically allowing the expander to fill the subcutaneous defect.
8. As expansion nears completion, assess the skin area in relation to the potential defect and begin to plan the design of the flap that will best fill the postexcisional defect. This can be assessed with a sponge (a swab is used in some parts of the
world) or with the inch tape, as mentioned earlier. A combination is advised—the more measurements the better. The sponge technique is good for demonstrating transposition or rotation flaps. The inch tape is very accurate in planning advancement flaps.

When the skin expansion seems sufficient, measurements are taken, and if there is enough skin, the appropriate flap is planned. Depending on the area of the proposed defect, the anatomic region, and the patient’s size, a complete resection/flap reconstruction is performed, or a staged procedure is chosen. If there is difficulty in fitting the flap to the defect, the undersurface can be scored to enlarge the flap or excised to shape the flap as required. Because of the expansion process, this is a delayed flap and it can be handled as required with little fear of failure. In some cases the flap is advanced but does not allow complete excision of the affected area. Another expander is placed under the advanced skin to allow further expansion to be performed when the flap is considered to be stabilized.

**PLANNING**

Any flap used must obey basic rules: it should be large enough to fill the defect, and there should be no significant tension and thus no ischemia. In other words, planning is of similar importance as it is for any flap, expanded or not. There should be a good blood supply and minimal tension in the suture lines.

There is no doubt that tissue expansion has been a significant addition to local flap surgery in the head and neck region. It is important, however, to realize that this needs preplanning. The head and neck area contains many specialized tissues that must be matched correctly to achieve optimal aesthetic reconstruction. It is necessary to give thought to the size and shape of the defect, the skin, contours and the overall anatomy around the proposed defect, particularly facial hair. It is only then that the position, shape and size of the expander can be determined, because expander placement is dictated by the position and size of the area to be reconstructed.
Regional Characteristics as Related to Tissue Expansion

**SCALP**

Obviously all defects within the boundaries of the scalp should be reconstructed by hair-bearing tissue. The tissue expander should be placed in a position that will fulfill this requirement. Sometimes there will be a secondary defect that will require grafting. This should be placed in an area that can be covered by hair. If not, an expansion can be performed subsequently to close this secondary defect.

**FOREHEAD**

In this area the expansion must be confined to non–hair-bearing forehead. Unfortunately, direct advancement flap or flaps must be used when the area is large, and
The skin of the cheek is somewhat unique, especially in the Anglo-Saxon face, since it tends to be pink or red in the prominent areas and less so elsewhere. It is this situation that on occasion disappoints the surgeon but most times does not cause the patient concern. The best flap in this location is a postexpansion rotation flap where skin color is uniform. This flap will give an excellent result.

It is important to consider the male cheek, with its lateral and inferior hair covering. The surgeon must remember in cheek expansion in male children that this area will subsequently have beard growth. When placing the expander, this should be taken into consideration and, if possible, the expander should be placed at the junction of the hair-bearing and non–hair-bearing skin. This should be the chosen site, whether the defect is medial or lateral on the cheek. This is a compromise but is the best reconstruction for this situation.
There is always some concern about expansion in the neck. The patient may have thoughts about strangulation, and the surgeon may have concerns as well. Initially I was concerned, but with experience I learned that this is much less of a problem than I had imagined. The neck skin is usually slack, especially in older patients, and it is relatively thin. These two characteristics allow significant expansion to be achieved in a short period. As yet I have not had any concern in neck expansion, nor have the patients. Undoubtedly, however, there is a degree of discomfort and some apprehension for these patients. They must be reassured and seen frequently to alleviate their fears. Once again, self-expansion poses less concern for them.

A careful examination of the area to be expanded should always be undertaken together with estimating the defect to be reconstructed. The skin adjacent to the area to be expanded should be of normal quality and loose enough to allow the uninflated expander to be placed without overlying tension. There should be no scarring or any type of infection in the area. If there is scarring, the blood supply may be compromised and this area is better avoided if there is to be rapid expansion.

With good planning and careful surgery it is rare to have any significant problems. The following section on decision-making discusses the critical planning that is needed in each area when tissue expanders are used to facilitate the transfer of local flaps in the head and neck area.
Decision-Making in Different Areas of the Head and Neck

SCALP

This is one of the areas that frequently requires expansion. It is important to assess the pattern of the hair, especially in the male where there may be varying degrees of baldness. In the female the direction of hair growth needs to be considered and the expansion should be related to that, if possible.

Size and Shape of Defect

When the size of the defect is large, more than one expander may be necessary. Even then, total reconstruction of the non–hair-bearing area may not be possible and a second expansion may be necessary. There is no direct rule as to when another expander or expanders should be inserted. It is advisable to ensure that all the incisions are well-healed and that the expander is placed well away from relatively fresh scars. In most cases, two courses of expansion will be enough. The only problem that may result after this is spreading of the scars. Further revision may be required but there will be no guarantee given that this will be successful.

Expander Position

The expander should always be placed under the most dense area of hair growth and also where the scalp is most mobile. It should, on most occasions, be of a size that will expand as much of the area as possible. This makes for ease of reconstruction because of the size of the expanded scalp. Another reason is that the bigger the flap the safer it is from a vascular standpoint.

Expansion

The expansion plan is to make a flap that is larger than required. To assess this, the technique described earlier is used. If the patient, parent, or relatives are controlling the expansion, this will be done daily and the expansion will be fairly rapid. It is essential that those who are expanding the device be educated about how to expand, the possible complications, knowing how to measure scalp gained, and when to call for help. The last statement may be the most essential.

Flap Design

A surgical sponge (or swab) is extremely useful. This can simulate the flap whether the planned movement is transposition, advancement, or rotation. Keeping the
gauze on the base of the expanded area and moving the rest of the gauze around to simulate these methods of reconstruction as an estimate of how the flap will move can be obtained, and the best method is chosen. In addition, this gives information as to the size of the flap. If any of this is insufficient, expansion is continued.

It seems obvious that any flap design should provide cover for the defect created and also allow the donor site to be closed directly. This would certainly be ideal and for small defects this is usually achieved. There are, however, instances where a secondary defect can be acceptable. A defect in the anterior area of the scalp needs to be reconstructed but this may be at the expense of creating a posterior non–hair-bearing region. This is acceptable because the posterior area can be covered with hair grown long or with a hairpiece.

**FOREHEAD**

This is a region that requires reconstruction from time to time. It is an obvious area in which skin grafts produce an unacceptable result. This was frequently seen in “the old days” when intraoral postcarcinoma resection defects were reconstructed with a forehead flap and the resulting defect of the forehead was reconstructed with a split skin graft.

As mentioned earlier, one or two expanders are placed under the normal forehead skin. When enough expansion has been achieved, again assessed by the “tape technique,” the reconstruction can be performed. The area of skin grafting is excised and expanders are removed. The defect is then closed with one or, if necessary, two advancement flaps. Laterally at the base of the flaps Burow’s triangles are removed. This makes for easier and more extensive medial movement of the flaps. This is not the most satisfactory of reconstructions but it is better than a skin graft.

On some occasions, when the defect is small and more laterally placed, an expander can be placed under the lateral forehead skin. At completion of the expansion, a rotation flap based superiorly can be moved medially to reconstruct the postexcisional defect.

**NOSE**

Tissue expansion has been very useful in nasal reconstruction. The classical forehead rhinoplasty has been simplified by the fact that a great deal of skin can be made available even in foreheads which, in the past, could not provide a satisfactory reconstruction.

The expander is placed in the center of the forehead, its vertical dimensions are those of the forehead without encroaching on the hairline. When expansion is com-
pleted, virtually any part of the nose or the total nose can be reconstructed. The tissue is available, the end result depends on the skill of the surgeon.

If it is considered necessary the medial cheeks can be expanded to bring in cheek skin for lining reconstruction. What is often not realized is that expanders are also “delayers” of flaps. As a result of this, the flaps are always safe and can be moved on small pedicles; also, the flaps are thinned by the expanders. Thus, all aspects of the nose can be reconstructed.

The expander also gives vertical length to the central forehead and, as a result of this, the amount of non–hair-bearing skin is increased. This situation allows a non–hair-bearing columella to be reconstructed—a result greatly appreciated by the patients, especially the females!

Another benefit is that the donor site on the forehead can usually be closed directly. If there is a small superior raw area that cannot be closed, it should be left to heal spontaneously. The results are almost always very satisfactory with only a small hidden area of scarring.

**CHEEK**

In this area, tissue expansion is ideal, it can be accomplished relatively rapidly; rarely are there any complications, and flaps can be developed with somewhat concealed scars. When a resection is contemplated for whatever reason, be it neoplastic, post-traumatic or congenital, the expander is placed in the area of maximum skin availability. The flap will be of rotation or advancement design. The former is best because it is easier to hide the scars, depending on the position of the defect. Technically, this is relatively easy: the expander is placed into the cheek and a slightly larger expansion is performed. This is measured using the techniques presented in this chapter. Any suggestion of insufficient tissue availability requires further expansion. Frequently, the defects are medial or superior—they are triangulated and the expanded skin is measured, the expander is removed and the rotation or advancement flap is used to close the defect. As with almost every flap a small suction drain is inserted. When designing these flaps and their subsequent expansion, the texture and color of the cheek skin in various areas needs to be taken into consideration to achieve the best cosmetic result.
OTHER REGIONS

It is often advantageous to expand areas of facial skin that in the past were used as local flaps. This allows better reconstruction and lessens the donor site problems. This is well illustrated in lip reconstruction, where excision of a lesion would involve a flap from the cheek. This may well have given a nice lip appearance, but at the expense of a tight, possibly obvious cheek defect.

With the development of tissue expansion, these problems should no longer arise; it is simply a question of thinking about the technique available. In an ear reconstruction, whether congenital or traumatic, the skin may be tight and thus any reconstruction would be compromised. Insertion of a tissue expander allows the ear cartilaginous skeleton or a silicone framework to be inserted into a pocket that is loose and may have an increased vascularity as a result of the expansion.

It is important to keep this technique at the forefront of reconstructive procedures; it can make reconstructions easy and safe. On some occasions, it makes what seemed impossible, possible. The message is “think expansion when considering defect reconstruction.”

POSTOPERATIVE CARE

This must be explained in detail to the patient. They can shower or bathe but as with other day-to-day behavior, they should be careful not to traumatize the area over the expander. This externalized filling port is not a contraindication to showering and so forth. Care should be taken not to disconnect the valve in the external filling situation. It is interesting that this has never happened. Should this happen the expander is refilled as soon as possible. Once again, attention must be paid to possible skin ischemia. If the skin becomes translucent or if there is expander exposure, they must return immediately to the office. This is an emergency and will require the reconstruction to be performed a soon as possible if the volume is satisfactory. No further expansion should be attempted. Any signs of infection, redness, or purulent discharge require immediate attention.
PATIENT EXAMPLES

EXPANDED FOREHEAD FLAP FOR NASAL RECONSTRUCTION

This technique has helped greatly in all aspects of flap surgery. It is particularly suited to nasal reconstruction because it increases the skin available, decreases the risk of flap loss, and reduces the complexity of reconstruction. The forehead is rapidly expanded as has been described earlier and overexpansion is aimed for. The reason for this is that it provides plenty of skin for the reconstruction and allows the donor defect to be closed directly.

Use of the expanded forehead flap in nasal reconstruction is well illustrated in this child, who lost part of her nasal tip as a result of a dog bite. Since this is a young patient with a very tight forehead, it was decided to use a tissue expander to have enough skin to reconstruct the tip and columella. The more skin we can produce in relation to the defect, the better. Using an external port, the parents expanded her forehead very satisfactorily.
Chapter 9  Tissue Expansion

The nasal tip was reconstructed using the expanded skin. The columella, the tip and the medial portions of the alar rims were formed. It should be noted that only a very small base is required to vascularize such a flap. This is partly a result of the tissue expansion, which acts as a delay phenomenon. In the past there has been a tendency to maintain a wide base. Unfortunately, this can result in more significant scarring, and there can be considerable problems in terms of blood supply as the flap is turned around and downward to reconstruct the tip and columella. With the narrow base placed on the medial end of the eyebrow, there is much less stress on the vascular supply to the distal end of the flap.

The pedicle has been divided. The defect in the glabella area has been repaired, and the distal end of the pedicle, which has formed a satisfactory nasal tip, has been inset.
The results are seen 2 years postoperatively. The reconstruction is satisfactory, and she has open airways on both sides of the nose.
CHEEK EXPANSION FOR NOSE AND LIP RESURFACING IN A SEVERELY BURNED PATIENT

This 11-year-old girl had sustained very severe facial burns in the past. Another plastic surgeon had done some excellent reconstructive work on her but referred her for further treatment. Her desire was to have an improvement of her lips and possibly around the paranasal areas and the eyes. Eventually, of course, a more satisfactory nose will need to be reconstructed. Expanders were placed in both cheeks, and family members carried out the expansion.

The required expansion achieved after 1 month can be seen.
The interim result is seen; the expanded skin was used to resurface the nose and lips. A nasal reconstruction is planned.

**Expanded Skin for Orbital Reconstruction**

This young man sustained a significant facial trauma in an automobile accident. He had received excellent treatment elsewhere. The eyelid skin was used to reconstruct the orbital area following debridement and exenteration in that region; soft tissue cover was supplied with a free tissue transfer. Despite this, however, the end result was not entirely satisfactory, and when he presented, the first thing he wanted to achieve was to have the pale skin of the free flap removed. To do this, a tissue ex-
pander was inserted. Since he came from another part of the country, it was very convenient for him to be able to carry out the expansion himself. He was taught how to measure whether there was sufficient skin or not. When he returned, he certainly had enough skin to allow closure of the defect after excision of the skin of the free flap. The tissue expander was removed.

The skin of the free flap was excised and the tissue expander removed. The expanded flap was advanced to close the defect.

The early postoperative result is shown.
Expanded Cheek Flap for Reconstructing a Full-Thickness Skin Loss on the Face

This patient was shown in Chapter 10 to demonstrate the use of scarlet red. Using this substance, it was possible to get reasonably quick healing of his full-thickness skin loss area, but there was a significant area of scarring. He then presented for further reconstruction.

A tissue expander was placed, and the patient expanded it over a period of 2½ weeks. The planned excision is drawn out on his cheek.
The advancement of the expanded cheek flap is seen.

The postoperative result shows that there was still a small superomedial area of scarring. To deal with this, a further tissue expander was placed, again with an external filling port. This provided enough skin to enable us to excise and close the remaining area and then perform a reconstruction with an advancement flap. All expansion was carried out by the patient or his wife.
NECK EXPANSION TO RECONSTRUCT A HEMANGIOMA DEFECT

This 3-year-old girl presented with a resolving hemangioma of the left side of her face.

Once this had completely resolved, a tissue expander was placed in her neck region, which was the only part of the left side of the face that was not badly scarred. Expansion was carried out by her parents.
It can be seen that the lower part of the scarred area was nicely reconstructed.

At a later date, another tissue expander was inserted, allowing further expansion to be achieved, again by the parents.

She subsequently has had one more expansion, and her resurfacing procedures are almost complete; all expansion has been performed by the parents.
NECK EXPANSION TO COVER BURN SCARRING ON THE NECK

This young woman had old burn scarring on her neck, and it was felt that two tissue expanders would be required to provide an optimal result. All expansion was done by relatives. The preoperative appearance shows that there is a lack of definition in the neck following the healing of her neck burn.

Placement of two expanders gave her the best reconstruction. This was achieved by self-expansion.
This has given her a relatively good result. She is able to fully extend her neck without any particular effort. The scar is still resolving, but in the long term should provide her with a very good result.
PROBLEMS AND COMPLICATIONS

Complications may occur with tissue expansion. The cavity may become infected and expansion must be terminated. The expander may become exposed; usually this requires removal of the expander, but in some cases expansion may be slowly increased using small amounts of fluid. This can only be done in patients who understand expansion and appreciate the mechanics of the situation. Usually, it is probably best to terminate the expansion. Occasionally it is possible to proceed and use the expanded skin to perform a partial or complete reconstruction as required, but this is unusual and risky.

One of the problems of an expanded flap is the fibrous capsule generated by the implant. This is especially thick where the edges of the expanded flap meet the subcutaneous tissue. When using the flap, these edges can be trimmed and the capsule can be scored in whatever direction is suitable to flatten the flap. This is usually a bloody maneuver because of the increase in small blood vessels in relation to the expansion and the resulting capsule.

The expander is a foreign body and, as with all foreign materials, there can be complications. These are infection, exposure, or capsule formation, and these may occur separately or in combination. Very rarely can expansion be continued in the presence of such complications, and this is where common sense and clinical judgment should come into play. If sufficient expansion has been achieved, then it is reasonable to go ahead with the planned reconstruction, taking all measures to ensure that this can be done safely. If these conditions cannot be met, the reconstruction should be aborted. One can live to fight another day. Pride should not be allowed to overcome good clinical acumen.

If this advice is remembered, the surgeon can make proper use of this wonderful technique, which has allowed us to perform reconstructions that were not available in the past and to perform them safely.
References—With Key References Annotated


To evaluate the histologic changes attendant on tissue expansion in the guinea pig, self-inflating implants were placed in the dorsal subcutaneous space and the tissue response was sequentially studied at periods ranging from 1 to 18 weeks. This study supports the hypothesis that tissue expansion results in a net gain of donor tissue.


The aim of this study was to determine the effect of controlled tissue expansion on the surviving lengths of random-pattern skin flaps elevated in expanded tissue. The results of this work demonstrate that in addition to providing increased surface area with controlled expansion, flaps raised in expanded skin have a significantly augmented surviving length.


This paper reviews a small series of patients who had tissue expansion using small volume expanders with an external valve. The complications with small expanders are discussed. The external valve is shown to be satisfactory and free from infection in this series.


This study employed eight young pigs to evaluate the effect of hyperinflation of this type in rapid expansion performed on 10 consecutive days. It is concluded that the cycled hyperinflation technique may shorten the time period of the whole reconstruction procedure but may produce an aesthetic deformity and flap necrosis.


The use of tissue expanders having external reservoirs is presented. The advantages of this technique are reduced operating time, ease of injection into the reservoir, lack of pain for the patient, early detection of reservoir or filling tube junction leakage, and lack of complications associated with the reservoir. This procedure is not recommended on at least theoretical grounds for breast expansion, where a permanent implant is to be inserted.


Tissue expansion has been shown to induce angiogenesis and ischemia on the overlying skin. The authors therefore investigated the hypothesis that vascular endothelial growth factor (VEGF) was expressed in expanded tissue. The results showed clearly an increased number of cells that fixated VEGF antibody on the site of expansion. Cell counts revealed that the numbers of cells expressing VEGF were statistically higher in expanded tissue than in nonexpanded tissue. Before expansion skin specimens did not express VEGF. These findings are the first to show the presence of a growth factor in expanded tissue. They open a field of research on the biologic explanation of tissue-expanded angiogenesis.

The high number of reconstructive dilemmas brought about by more aggressive treatment of congenital malformations and burns has created the need for large quantities of donor skin for local coverage. Tissue expansion with external ports has become part of the authors' surgical armamentarium. There are several advantages to this technique: less tissue dissection, painless injections, shorter operating time, and early detection of leaks.


Soft tissue expansion finds use for overcoming a shortage of tissue, for obtaining skin with special desirable qualities, for creation of flaps otherwise not possible because of the resultant donor site or limited vascularity, for creation of flaps with functioning muscle and overlying soft tissue, and for minimizing flap donor-site problems. Careful planning should include patient counseling, optimal incision placement, and time for a gradual, complete expansion. The surgery can often be performed under local anesthesia and expansion is tolerated well.


Over a 24-month period, 33 expanders were placed in the extremities of 18 patients. The infection rate and complication rate in the upper extremity and above the knee was only 6%. Overall, 23 of the 33 expansions, or 70%, were taken to completion with a successful advancement of expanded flaps. Complications occurred in 30% of patients, all eventually requiring removal of the expander.


A study to assess the effects of an intraluminally placed tissue expander in the rabbit jejunum was performed. The possible applications of this technique are discussed.


Breast reconstruction after a radical mastectomy using the temporary subcutaneous tissue expander is described. The main principle of this method is recovery of the amount of lost tissue through expansion of the remaining chest skin to large proportions and filling of the breast envelope with a smaller permanent mammary implant. Contralateral round dermal mastopexy with simultaneous nipple enlargement, contralateral subcutaneous mastectomy through a similar round dermal mastopexy, and reconstruction of the nipple are discussed.


Survival of island flaps after tissue expansion has been studied. In clinical practice this technique would provide a larger flap for reconstruction and the possibility of direct closure of the donor site. In addition, the observed increase in vessel caliber should facilitate the free tissue transfer of expanded flaps.


In this report, molecular mechanisms leading to enhancement of skin surface area are reviewed, and possible applications are discussed.
CHAPTER 10

Problems and Complications

Healing is not a science,
But the intuitive art of wooing Nature.

W.H. AUDEN

One should never impose one’s view on a problem;
One should rather study it,
And in time a solution will reveal itself.

ALBERT EINSTEIN

Fortunately, local flap problems occur infrequently if the flap design and local vascularity are satisfactory. For example, planning a local flap in an area in which full-dose radiation therapy has been given could potentially cause flap failure because of compromised vascularity. Such factors must be weighed in the planning process. A more likely problem, and one that is associated with lack of experience and/or bad planning, is having insufficient skin and underlying tissue to reconstruct the defect without tension, resulting in flap ischemia. It is these two situations, together with the wrong choice of flap, that are most often associated with postflap deformity or worse—loss of the flap or portions of it.

Perhaps the most difficult problem facing the surgeon when one is confronted with a lesion to be excised or with an existing facial defect is what and how much to do. The latter is often related to the pathology of the lesion to be excised. Obviously, cosmesis is a significant consideration, but function must also be assessed. Loco-regional anatomy is an important aspect of decision-making. There are some areas where a full-thickness skin graft will give an excellent result compared with that achieved by a local flap. Color, texture, and safety of technique, together with short-term and long-term function, must be considered. If there is any doubt whatsoever
about the completeness of the excision of a malignant lesion, a local flap should not be used. In this situation a reconstruction should not be performed; a dressing is applied, and the surgeon waits a few days until a definitive pathology report is available. At this point the decision is to proceed with reexcision and reconstruction or reconstruction alone.

Loss of a local flap can be disastrous for the patient and surgeon. Particular care is required in planning the flap in relation to blood supply, judging skin laxity, and appreciating flap skin color and texture compared with that of the recipient areas and the presence of hair in the donor area. Normal anatomy and visible landmarks such as the eyebrows, hairline, and alar base must be respected. The branches of the facial nerve must be protected, especially in the temporal and submandibular areas. An excellent reconstruction with a resulting paralysis is a poor trade-off. A good working rule for avoiding this is to raise facial flaps in the face-lift plane. The medial canthus and the lacrimal apparatus must be preserved; they should be resected only if this is necessary for tumor clearance.

One further rule that seems common sense but is often violated is that the surgeon should not use a flap of a different skin texture or color. These seem to be elementary concepts, but it is amazing how often they are neglected. Even more incredible, but seen from time to time, is the movement of hair-bearing skin into a nonhairy area!

**Causes of Flap Failure**

Flap loss is a serious complication that almost always results from a design or a technical error. Reasons for flap failure are listed in the box below.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using a small flap to fill a big hole</td>
<td>Design fault</td>
</tr>
<tr>
<td>Hematoma</td>
<td>Technical error</td>
</tr>
<tr>
<td>Suturing the wound under tension; failing to use a back cut; making a pedicle too short</td>
<td>All technical errors</td>
</tr>
<tr>
<td>Damaging the blood supply</td>
<td>Technical error</td>
</tr>
<tr>
<td>Making the flap extend outside its blood supply</td>
<td>Design fault</td>
</tr>
<tr>
<td>Failing to consider previous therapy, such as old scars or areas that have been irradiated</td>
<td>Design fault</td>
</tr>
</tbody>
</table>

With experience and care, all these errors are preventable.
Problems and Solutions

Almost all complications of local flaps result from errors in judgment, planning, and execution.

Tumor Recurrence

One of the worst complications is tumor recurrence; this results from a failure to think in biologic terms and a desire to make the defect fit the flap. In malignant skin lesions the main aim of the operation is to excise the tumor with adequate margins. If a flap is to be used, there should be no compromise in the resection. The lesion should always be widely excised. Even a basal cell carcinoma should be given 0.5 cm margins, except when it occurs on the eyelid. (Rarely do eyelid skin basal cell carcinomas extend into and over the lid margin.) Fortunately, on the lids the tumor–normal skin junction is readily seen. The required skin resection margins are outlined and the flap is planned in such a way as to ensure that the rules mentioned above have been respected.

The area around the planned excision should be examined to determine whether there is enough skin to provide a flap of sufficient size to reconstruct the defect and allow the donor site to be closed directly. This is ascertained by examining the area of proposed flap harvest; the skin laxity is judged by lifting it between the thumb and index fingers and marking this width. This maneuver provides an estimate of skin looseness and availability. Only after these criteria have been satisfied, the tumor has been completely excised, often verified by frozen section, and the defect has been created should the surgeon definitively select a method of flap reconstruction and plan the design for the reconstruction. The defect can then be modified to fit the chosen flap reconstruction. With this technique local tumor recurrence is rare, and the reconstruction should be satisfactory, oncologically and aesthetically. The surgeon must always consider the local vascularity, not hesitating to use Doppler imaging for reassurance.

Pincushioning

Pincushioning can occur with local flaps. When a crescent-shaped or circular scar contracts, a constrictive force develops on the inner aspect of the curve. This is inherent in the healing process. As the almost inevitable constriction and shortening of the scar increase, the soft tissue within the curvature, which is relatively increased as a result of the process, bunches up and a protrusion of skin and fat results, creating a pincushioning effect. With time, the scar will soften and stretch. This may be helped on some occasions by massage. Unfortunately, the problem usually persists.
The frustrating aspect of pincushioning is its inconsistency in terms of size and shape. This deformity cannot be corrected until the scars are mature, approximately 12 to 18 months after surgery.

Correction is difficult. The old flap is elevated by excision of the previous scar. The undersurface of the flap is thinned by defatting and occasionally, if indicated, light scoring on the undersurface. A series of multiple Z-plasties can be performed on the wound edge, the number and size of which depend on the particular anatomic situation and its size. The Z-flaps are widely elevated, transposed, and sutured into position. This technique will frequently correct the contour problem. Unfortunately, further variable pincushioning may occur within the scars of the Z-plasty flaps. This may or may not resolve, and can pose a difficult problem to solve. Excision and direct closure is probably best.

In some larger flaps, after as much flattening as possible has been achieved, the undersurface can be sutured onto the subcutaneous tissue to obtain further correction. Care should be taken to prevent dimpling. This is usually a result of placing the suture too close to the undersurface of the skin.
TRAPDOORING

Trapdooring occurs when contracture of the scar causes heaping up of tissue within the flap boundaries. It is a deformity that can also occur with geometric flaps (for example, the rhomboid flap). Fortunately, this is an infrequent problem; it is difficult to correct trapdooring completely.

The flap is raised, the excess fat is trimmed off, and the flap is returned to its position. If possible, the flap can be sutured onto the defect using underlying subflap sutures as described above. In this technique, multiple fine nonabsorbable sutures are placed on the undersurface of the flap and are then attached to the subcutaneous tissue. As they are tied the flap is flattened out. Care must be taken not to overtighten; otherwise dimples will occur on the skin surface. Occasionally, Z-plasties may be required around the flap but this must be done carefully to avoid even more surface irregularities. These should be reserved to areas where lengthening of the wound is indicated. This is not as effective in this situation as in the round flaps.

WOUND CLOSURE

In flap edge closure, as with closure of straight incisions or oval excisions, undermining of surrounding skin with advancement may allow this to be accomplished without tension. It should not be necessary to do this if planning has been adequate. When undermining needs to be performed, this should be done on the edges of the defect not on the base of the flap. The latter could result in flap loss. Wide undermining around the defect should allow tensionless closure. A drain may be indicated in this situation.
FLAP TOO SHORT
It is very satisfying to perform a geometric flap, such as a rhomboid flap. This flap is relatively simple to design; thus it is easier to determine whether it will provide sufficient tissue to accurately reconstruct the defect. Unfortunately, in other flap designs this may not be the case unless the surgeon exercises care. It is quite possible to design a rotation flap that is too short in the very area where cover is essential. This can be avoided by first plotting the design of the flap by using a thread or tape as the leading edge of the flap and then performing the rotation. If this advanced edge will not comfortably reach the most distant point of the proposed defect, the design of the flap is wrong, and the situation needs to be reassessed. This is a particularly important assessment to make on areas that are not flat.

FLAP TOO SMALL
When the flap is too small, it may be possible to obtain closure by undermining around the defect to allow advancement of the edges of the wound. The final solution may be to replace the flap and to obtain closure with a skin graft. With careful and correct planning, this situation should not arise—this is a failure of judgment.

SKIN TOO TIGHT
The looseness of the skin must be assessed by lifting up the skin between the fingers and the thumb. It is very important to judge the whole area or all areas of potential flap harvest. The tightness of the skin around the defect can be quite variable. If the area is tight, the surgeon should proceed with caution. It may be advisable to make a slightly larger flap, but this will result in a larger skin defect. In such a case a rotation flap may be better adapted to the area than a transposition flap—again a question of judgment. A back cut may be necessary to obtain that last bit of movement that allows closure without tension.

ISCHEMIA
If the flap shows signs of ischemia, one can wait and observe the flap for 10 to 15 minutes to see if this may be caused by vessel spasm. Initially there is pallor that gradually passes off and the flap becomes pink. A warm, moist sponge applied to the flap may improve the circulation. This signifies that all may be well with the blood flow into the flap. If there is no improvement and the flap becomes blue, all sutures should be released and the flap should be replaced onto the donor site, the raw area is dressed, and repair is delayed for a few days. The question of how long one should wait before replacing the flap in its original position varies from surgeon to surgeon. As mentioned previously, it seems reasonable to wait 10 to 15 minutes.
HEMATOMA
Hematoma must be avoided; if it occurs, early evacuation should be performed. There should be no hesitation in initial placement of a drain; this may simply be a portion of rubber band secured by a suture or it may be a commercially available suction drain. Hematoma is an enemy to be eliminated!

When a hematoma occurs after surgery without compromise of flap circulation, early evacuation of the hematoma is essential, with ligation of the bleeding vessel or vessels and closure, often with drainage. Delay is deadly!

CIRCULATORY DISTRESS
When a flap looks as though it is in circulatory distress (cyanosed with a sluggish or absent capillary refill), action must be taken. If this is caused by the presence of a hematoma, sutures should be removed, the hematoma evacuated, hemostasis established, and resuturing performed as discussed previously.

If suturing is too tight in one area, a few sutures can be removed. If these measures are unsuccessful, then all sutures should be removed and the flap returned to its original area. With what amounts to a “delay,” the flap will probably recover and can be used another day, a situation that is preferable to total flap loss. If planning has been wrong (and this should not occur), the defect is skin grafted, and after healing has occurred, the situation is reassessed for reconstruction.

RADIATED TISSUE IN THE AREA
If radiation therapy has been used in the region previously, this presents a problem. Skin and subcutaneous tissue become less vascular and may be stiffer and more difficult to use. If flaps are to be used, they should be based on a vascular pedicle that is absolutely secure. When in doubt, Doppler imaging can be invaluable for investigating and finding the dominant vascular supply to a flap.

All plastic surgeons should have a handheld Doppler apparatus in the office setting, and it is imperative to have it in the operating room. Without this aid, the surgeon may be figuratively “driving in the fog” without any fog lights—a disaster waiting to happen.

Furthermore, no tension should be present on the suture lines. If these conditions can be met, the results will be superior to those achieved with skin grafts. Failure to provide sufficient vascular support to the flap frequently results in flap necrosis.
Flap Failure

Flap failure is always a possibility, fortunately with good planning, well-designed flaps, and experience, this is a rare occurrence. There are basically three possible treatments:

1. Debride and allow to heal.
2. Apply a skin graft.
3. Use another flap.

If the onset of necrosis is recent, within a day or two, the dead flap can be removed and another flap can be used if there is sufficient skin available. If this is not the case, debridement and skin grafting is a possibility. This would be chosen if the defect is large. It might be necessary to dress the wound to obtain a satisfactory granulating surface that will accept a graft.

If the defect is relatively small in an area in which contracture would not be a significant problem, spontaneous healing can be encouraged by frequent dressings without any further type of surgical management. If necessary, a subsequent reconstructive procedure can be performed. In cases of partial necrosis, one should take a conservative approach and wait for spontaneous healing to occur, with later rehabilitation by scar revision or flap reconstruction.

In many cases the whole flap may not be lost and the area of necrosis is such that frequent dressings to allow spontaneous healing with later scar revision may be the best course. In our practice, a gauze called scarlet red ointment dressing has proved to be undoubtedly the best dressing for inducing epithelialization and healing in wounds where, in the past, we would have used skin grafts.

If the defect is large, it is probably best to perform a split-thickness skin graft to get rapid healing and to plan a more formal reconstruction, which can be performed at a later date. It is important that the split skin graft overlies the edges of the defect and is sutured to the normal skin. This ensures a “take” to the very edge of the defect. In some cases of total flap failure, debridement and dressings will produce an acceptable result; these measures would only be used if there were no possibility of causing significant deformity by scar contracture. If the end result is not satisfactory, a simple scar revision may be sufficient to deal with the problem.

The Role of Skin Grafts

For facial reconstruction, if the conditions are suitable (for example, a clean wound with no infection, or a wound in a vital area) a local flap reconstruction should be carried out whenever possible. It is essential, however, that the situation be carefully analyzed. If there is any contraindication to immediate anatomical reconstruction (for example, doubtful viability, gross contamination with foreign materials, extensive loss of tissue, or poor condition of patient), it is wise to clean up, debride as indicated, and apply a split skin graft. This tactic should also be used in a skin cancer.
case if the surgeon is doubtful about the completeness of the excision and the pathologist is also unsure of this on frozen section examination. In other situations, debridement, dressing, and delayed skin grafting may be the wisest course to pursue—discretion before valor!

**Split-Thickness Skin Grafts**

In the past split-thickness grafts were used when large defects required reconstruction, and they were excellent for this task in terms of cover, but the cosmetic results were poor in most cases. With advances in tissue expansion and improvement in flap design and usage, grafts are required less frequently. When there has been no preparation with expansion and the defect is too large for a local flap, split skin grafting is used. This is usually a temporary measure but sometimes, often at the patient’s request, no further surgery is undertaken.

It is important to make a mental decision that no skin grafts should fail, though this may not always be the case. To achieve this, graft care should be meticulous. The graft should be of medium thickness and of the required size—possibly a little larger so that there is some laxity when it is sutured in place. Ensuring hemostasis in the recipient area should be done as meticulously as possible. When the graft is applied, it should overlap the wound edges and suturing maintains the overlap. The sutures should be extra long to comfortably function as tieovers; 3-0 or 4-0 silk is the most secure material. Multiple sutures should be placed around the graft to provide uniform pressure when they are tied over the flavine wool. Before placing the latter, a layer of petrolatum gauze should be placed over the graft. This facilitates separation when the dressing is taken down; there is less tendency to dislodge the graft. It is also a good idea to place standard sutures between the tieovers—this may help with the edge “graft take.” Sometimes sutures may be taken through the graft onto the underlying raw area; this provides further stabilization. The graft should stay supported for 10 days. With this careful technique there should be complete graft take. In grafts to the limbs, there may be a need for elevation and immobilization. This decision is made in terms of graft size, defect position, and upper or lower limbs. It is always wise to be safe and overprotective.

In the past the grafted area was covered with a large dressing, but this is no longer the case. By far the best cover is to use a light crepe bandage to promote early exposure. The pressure dressing is usually removed at 5 days. This allows the area to dry and crust and results in quicker and more secure healing; it also seems to cause fewer problems than were seen in the past.

**Full-Thickness Skin Grafts**

Particularly in the facial region full-thickness skin grafts are used when indicated. Probably the most frequent area is that of the eyelids. Other regions are treated in this way when local flaps are not available, such as in certain skin conditions, and postburn scarring in the donor site.
The full-thickness graft must be handled extremely carefully since it does not take as readily as a split-thickness graft and often the grafted area is significant in terms of cosmesis and/or function (for example, nose, eyelids, and lip). The site of the graft harvest for facial defects is the postauricular region. Once the graft has been harvested, it is then defatted. This is best managed by placing it over the index finger, skin down, with stretching using the thumb and middle finger. The graft is rapidly defatted using sharp scissors, preferably curved, without damage to the undersurface of the skin. The recipient site is prepared, with a focus on achieving hemostasis.

The graft should fit accurately—edge to edge into the defect, it is acceptable to have a very slight excess of skin covering the raw area. Suturing is again with tieovers, but fine edge-to-edge suturing between graft and defect border should also be done to achieve the best aesthetic result. Once again, petrolatum gauze or Xeroform gauze is used with a flavine wool bolus for tieover pressure. With care, these full-thickness grafts rarely fail. Once the dressing is removed, the graft should be exposed unless there is concern about patient compliance. Occasionally, in the case of a large resection, the groin may be used as a donor site for this type of graft.

**COMPOSITE GRAFTS**

**Nose/Ear**

Occasionally, composite grafts will be used, and the very best situation in which to use such a graft is when a portion of the nasal ala needs to be replaced following a full-thickness injury. The edges of the wound are freshened and a triangular portion of skin is excised from above the defect. This is not absolutely necessary, but it certainly increases the area of contact for the skin portion of the composite graft and consequently gives more chance of complete healing. This is drawn out on the ear before performing any excisions. Once the posterior portion of skin has been excised in continuity with the edges of the rim defect, this is removed, together with some of the intranasal skin. The defect is accurately assessed using a paper pattern. This is then transferred to the ear rim and marked out. Once this has been done, the donor site is carefully measured to see if it accurately represents the nasal defect. Shape is taken into consideration when judging what area of ear should be used. The ear wedge is removed, and the ear is reconstructed. Usually this is by direct closure. This tends to give a little cupping to the ear, but it is acceptable when related to the complex reconstruction of the nose.

The nose is again inspected to make sure that there is no remaining area of tumor on the nose. The composite graft is then taken to the nasal defect. Some trimming of the full-thickness portion may be necessary. **NOTE:** Hemostasis is essential at the recipient site.

The composite graft may need a little trimming, but once the size is correct it is carefully sutured in position with multiple sutures. In most composite grafts, when possible, an attempt is made to improve the blood supply to the graft by deepitheli-
alization of the recipient wound edges. I will occasionally put a very tiny dressing over the ear but, by and large, I would prefer to have the area exposed. It is rare to have this reconstruction fail, and the aesthetic results are usually very good, although it must be accepted that a small adjustment, for example on the alar rim, might be necessary. The wonderful thing is that the color and texture of this graft is very similar to the normal nasal situation.

**Lip**

Another area where it may be worthwhile to try a composite graft is on the lip. The usual scenario is a bite by an animal or a human where the portion of lip has been recovered. Once again, meticulous debridement is performed with careful hemostasis on the lip. The amputated portion is very carefully sutured back in position. It is always reasonable to try this to achieve as natural an anatomic situation as possible. Should this procedure fail, the graft is removed, the edges of the defect are carefully trimmed, and layered closure can then be performed. This may result in tightness of the lip with a poor relationship to the uninjured lip.

**Miscellaneous Tricks and Innovations**

**REPAIR OF A TORN EARLOBE**

The torn earlobe may seem a simple problem to deal with, but there is a difference between simply “dealing with it” and performing a reconstruction. If a reconstruction is to be performed, both the shape of the lobe and its total anatomical reconstruction must be ensured.

Frequently, in cases corrected using the standard technique, there is a residual aesthetic problem. Subsequent shortening of the scar around the convexity of the earlobe will produce notching. This is aesthetically unacceptable. In addition, there is a vertical area of weakness in relation to the scar, although this can be overcome by repiercing in another region of the lobe. Thus the standard technique is not entirely satisfactory.

This situation can be easily dealt with: the edge of the reconstruction is broken up by incorporating a Z-plasty on the edge of the lobe. This is full thickness, and actually, as expected from geometric principles, the lobe is slightly lengthened in the reconstructed area. This simple adjustment of lobule reconstruction has produced very satisfactory end results from both a functional (earring insertion) and aesthetic point of view. The follow-up of this technique is approximately 5 years; there has been no recurrence of the split in any of the treated cases.

The adjustment of the lobe is small but is greatly appreciated by the patient or, in the case of children, the parents.
This woman presented with an almost completely split earlobe, with only a few millimeters of skin at the edge of the lobe. She wished to have this repaired.

The area of the split has been demarcated with a marking pen and a Z-plasty has been drawn out. The posterior flap is based superiorly, and the anterior flap is based inferiorly.
The area of the split lobe is resected as a wedge.

The flaps have been elevated and are interdigitated. The posterior flap has been raised anteriorly and brought forward. The anterior flap has been brought downward and backward.
The flaps are now sutured into position.

The result is shown. I do not make a hole for the earring in the scarred region. I allow everything to settle and then make a fresh hole.

**Scarlet Red to Aid Wound Healing**

Scarlet red is a fat-soluble azo dye (o-tolylazo-o-tolylazo-beta-naphthol) that has been incorporated into gauze to act as a dressing material and has been a considerable aid to spontaneous healing of significant-sized full-thickness defects. It was first used to promote epithelialization in 1906. Unfortunately, although first compounded
in 1882, this product is almost unknown in the United States; it is available in Canada. Scarlet red can be used to propagate healing of partial thickness injuries, but more surprisingly, areas of full-thickness skin loss can heal with minimal hypertrophic scarring when this dressing is applied.

In our practice over the past 15 years scarlet red ointment dressing has been placed on split-thickness donor sites and areas of full-thickness skin loss. To dress the donor site, a portion of scarlet red gauze is placed on the wound and allowed to dry. This is left undisturbed until the gauze falls off; at which time the wound has epithelialized. Our most common regimen for full-thickness skin loss is to perform dressing changes as described above every other day or at longer intervals if healing is progressing well. The site is covered with a dry absorbent dressing, such as ABD pads or 4 × 4 pads, followed by Kerlix gauze on the extremity.

Initially split-thickness skin graft donor areas, mainly on the thighs, were treated. These quickly dried and healed within a week, which was about half the time for healing with a standard dressing regimen.

What was more startling and exciting were the results when this gauze was used on full-thickness defects, especially those which were infected. Employing a dressing regimen of daily applications of scarlet red–impregnated gauze, covered by absorbent dressings carried out by the patients there have been amazing results. The wounds contracted and epidermal replacement occurred; the raw areas gradually decreased in size and healed spontaneously. This was an amazing situation, because virtually all of these areas were being prepared for skin grafting and in none of them was this necessary.

Undoubtedly, this is a material, though old-fashioned, that is worth further study, since it is achieving something that has not occurred with the use of any other compounds. Many of the alternatives have been said to have these qualities, but in our hands none have been successful, certainly not living up to their reputation. The significance of this is that initially all of us using scarlet red were very skeptical. We now use this in all our skin graft donor sites and also in areas of full-thickness skin loss. At present we do not know exactly what size defect is too large and too deep for scarlet red gauze to be of benefit. This is one of our ongoing clinical studies. It is, of course, a difficult project to carry out; however, most of our patients would prefer this rather than grafting. Unfortunately, this is probably not a project that can be investigated in the experimental animal. It is ongoing clinically, and at some point we can hopefully provide results that unequivocally support our present impressions.

Scarlet red is a simple method for promoting healing in the difficult wound. It is inexpensive, dressings can be changed by the patient, and frequently areas that would be doubtful skin graft recipient sites are healed spontaneously. This has been an old-fashioned but worthwhile treatment regimen in our practice with excellent outcomes.
**PERSONAL EXPERIENCE**

A total of 98 cases were treated in all areas of the body: face, ear, neck, breast, upper and lower limbs, scrotum, abdomen, trunk, buttock, and perineum. Of these cases, four patients had undergone prior radiation therapy and two had exposure of previously placed methylmethacrylate. The length of treatment varied from 1 week to 4 months for complete healing. The complications were few—6.1%: 5.1% stopped treatment because of pain and 1% had a skin reaction that was painful. The tables below show the patients who required further treatment and the duration of treatment.

### Patients Requiring Further Treatment

<table>
<thead>
<tr>
<th>Treatment Required</th>
<th>Percentage of Patients (N = 98)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cautery of overgranulation</td>
<td>1.0</td>
</tr>
<tr>
<td>Changed dressing type</td>
<td>3.1</td>
</tr>
<tr>
<td>Grafting</td>
<td>1.0</td>
</tr>
<tr>
<td>Flap/tissue coverage</td>
<td>1.0</td>
</tr>
<tr>
<td>Recurrent disease/malignancy</td>
<td>3.1</td>
</tr>
<tr>
<td>Formal debridement</td>
<td>2.0</td>
</tr>
</tbody>
</table>

### Duration of Treatment

<table>
<thead>
<tr>
<th>Percentage of Patients (N = 98)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 week</td>
</tr>
<tr>
<td>2 weeks</td>
</tr>
<tr>
<td>3 weeks</td>
</tr>
<tr>
<td>1 month</td>
</tr>
<tr>
<td>6 weeks</td>
</tr>
<tr>
<td>2 months</td>
</tr>
<tr>
<td>3 months</td>
</tr>
<tr>
<td>4 months</td>
</tr>
</tbody>
</table>
PATIENT EXAMPLES

A selection of cases, which exemplify the complications of wound healing in anatomically difficult areas and difficult healing problems following radiation, are presented. The reader will note that the cases featured are not limited to the head and neck but include other anatomic areas to show the widespread application for this substance.

This man, who was referred from elsewhere, had a basal cell carcinoma removed from his left lower eyelid and this was corrected using a cheek flap. Approximately 25% of the flap necrosed. The appearance of the wound is shown as it was when the patient presented to our department.

A scarlet red dressing was applied and complete healing was evident at 6 weeks. Later reconstruction was achieved by tissue expansion and an advancement cheek flap (see Chapter 9).
This 42-year-old man had a moderately high-flow vascular malformation of his lateral abdominal wall. In combination with the vascular surgeons, this was widely resected.

Because of significant bleeding, the wound was left open and packed with scarlet red. The appearance of the wound is shown after 3 weeks. No further treatment was required.
This 59-year-old man presented with a raw area on his left arm following excision and radiation for fibrosarcoma. It was debrided and a VAC dressing was applied. Following the VAC treatment, scarlet red was applied.

The wound appearance is shown at 9 months (left). Complete healing is evident at 12 months (right).
This patient’s defect was caused by excision of a dermatofibrosarcoma protuberans followed by radiation therapy. A split-thickness skin graft was only partially successful.

Scarlet red was applied, and complete healing was achieved in 3 weeks. The long-term result is shown (right).
This patient exhibited a postradiation ulcer.

The appearance of the ulcer is shown after 3 weeks of scarlet red dressings (left). After 5 weeks, it is almost completely healed (right).
**RECONSTRUCTION OF COCAINE FISTULAS OF THE PALATE**

This subject has been included here because this reconstructive problem is close to the facial area, and it is a problem that may well become even more significant in the future as the number of cocaine addicts increases. In some ways, it is related in terms of causation, tissue damage, and difficulty in closure to the postradiation defects seen on the face, and is a similar challenge in relation to repair. Without a reconstruction based on good vascularity, the chances of a successful reconstruction are close to zero. Apart from the related inconvenience and physical problems caused by this, there is the social stigma associated with this defect.

The problem that confronts the surgeon is whether the patient has given up the habit or not; blood or urine tests are advised. The reconstruction is complex, and once it has been carried out, there is little else that needs to be done in terms of repair. It is essential that there be no further exposure to cocaine, and this must be strongly presented to the patient.

Because ischemia is the cause of the problem, all aspects of the reconstruction must be well vascularized. The problem in the past was that this requirement could not be met, and the results were poor; the fistula almost always recurred.

The defect size is variable, but it usually involves a third to a half of the bony palate. The method of reconstruction has been designed to supply as much vascularized material for the closure as possible.

Surgery is performed in two stages with the patient under general anesthesia. A Dotts mouth gag is inserted, which allows excellent exposure of the total length of the palate.

An alternative method is free tissue transfer. Compared with this technique, however, there are more associated complications.
After 10 to 14 days the two medially based palatal flaps are raised, turned inward, and sutured together in the midline to close the nasal layer. There should be no tension on this suture line. The tongue flap of the required dimensions is now raised from the dorsum of the tongue, based anteriorly. The defect on the dorsum of the tongue

The first procedure is a delay; this entails a lateral full-thickness incision on the hard palate just medial to the teeth. This includes undermining the hard palate mucoperiosteum with an elevator. Next the flap is replaced and the incision closed. A significant delay of the mucoperiosteum has been achieved. A similar procedure is performed on the contralateral side.
is closed directly with 4-0 catgut. This flap must be of large dimensions because the defect width is that of the fistula in addition to the two lateral defects resulting from the inturning of the palatal flaps to achieve closure of the nasal layer. The tongue flap is now turned upward, based anteriorly. The posterior edge is sutured to the anterior edge of the palatal defect and the lateral edges of the flap are sutured to the edges of the palatal defect. This insertion of the flap fills the anterior two thirds of the palatal defect.

This is now left in position for 3 weeks. Then the posterior aspect of the tongue flap is divided, it is scored on the raw area to allow it to spread out and the remainder of the raw area on the oral aspect of the palate can now be closed.

It has been very satisfying to be able to reconstruct this defect, which in the past has defied closure. Once again, it drives home the essential lesson that vascularity is so important in all reconstructive surgery. These figures illustrate the size of the palatal defects and the width of tongue mucosa required to achieve successful closure.
PATIENT EXAMPLES

This patient has a large hard palate fistula from cocaine usage. It is closed with the two-stage method described.

Moderate cocaine usage has caused a hard palate fistula in this patient. The two-stage method is used for closure.
This patient’s moderate cocaine usage has caused a hard-palate fistula. The two-stage method is used to achieve closure.

**Conclusion**

In experienced hands, a traumatic or postresection defect reconstructed initially with local flaps gives by far the best result. Certain rules must be observed: complete debridement of nonviable tissue and debris, accurate assessment of the blood supply, careful control of bleeding, well-considered reconstruction, and closure without tension. A drain should be used if there is any chance of postoperative oozing. It is important to obtain healing by first intention; otherwise the effort has been wasted and perhaps compromised.
References—With Key References Annotated


The authors analyzed the effect of topical dimethylsulfoxide (DMSO) on skin flap viability. Necrotic flap edges were recorded during the follow-up period for each patient, then excised and weighted in a blind manner. The authors conclude that the application of DMSO reduced skin flap necrosis and improved outcome of surgical flaps.


The authors investigated the effect of warm ischemia time on neovascularization of axial-pattern flaps. They demonstrate that neovascularization was enhanced after 90- and 180-minute warm ischemia times. They concluded that short ischemia time in free flaps may be an attributable factor in late flap failures as a result of pedicle obstruction.


Two cases of scarlet red allergy are presented and documented by patch testing. Discussion is oriented to alert clinicians to the recognition and treatment of this potential complication.


In a large randomized animal model, the authors tested whether skin flap survival may be improved by local heat preconditioning and induction of HSP 70. They conclude that the necrosis and apoptosis rate of skin flaps could be reduced significantly with local heat preconditioning. Their results suggest that ischemia-related wound healing complications could be diminished with local heat application, a simple and noninvasive method of preconditioning.


The authors discuss the neurovascular “kite” flap as a well-established procedure for single-stage reconstruction of soft tissue defects in the thumb. They conclude that postischemic necrosis of the flap due to poor inflow is a rare, but potential, complication. A technique of arteriovenous supercharging is described that they used successfully to salvage such an ischemic flap.


The authors present several studies that show the effectiveness of classic local IP by predamping the flap pedicle. They conclude that the use of a tourniquet to induce limb ischemia before flap ischemia could provide a new, alternative, noninvasive remote IP protocol, although late remote IP might be effective only in muscle flaps.


Nasal inhalation (“snorting”) of cocaine causes profound effects on the upper respiratory tract in addition to the well-known nasal septal perforation. Septal necrosis can be accompanied by bleeding, development of granulation tissue, ulceration, and sinusitis. There are few reports of extensive sinonasal tract osteocartilaginous necrosis from cocaine abuse. Five patients with this complication are presented, which must be distinguished from other destructive midface lesions such as Wegener’s granulomatosis and polymorphic reticulosis.


A case of palatal necrosis secondary to cocaine abuse in a female patient is presented. Extensive necrosis also involved the cartilaginous and bony septum and paranasal sinuses. A review of the other cases of palatal necrosis reported in the world literature is also presented; these demonstrate a greater incidence in female users. The various presenting conditions of cocaine abuse encountered within the head and neck region by the otorhinolaryngologist are discussed.


Forty-six patients had split-thickness skin grafts harvested from the upper inner thigh. Calcium alginate (Kaltostat) and scarlet red dressings were applied to each half of the wound. Dressings were changed after 10 days and healing of the donor site was assessed. Scarlet red was shown to be significantly better than Kaltostat in the healing of split-thickness skin graft donor sites when assessed at 10 days.


The authors examine sternocleidomastoid and trapezius muscle flap studies, which have elucidated patterns of arterial and venous anatomy to allow for improved flap design. They conclude that locoregional flaps remain a useful tool for head and neck reconstruction and often provide unique characteristics not available with free flap reconstruction. A sound understanding of vascular anatomy and recent basic science discoveries will significantly improve success of locoregional reconstruction.


Three cases of a centrofacial destructive process associated with chronic nasal abuse of cocaine are reported. This complex is a rare entity involving sinonasal tract necrosis after cocaine abuse. This cocaine abuse complex should be included in the differential diagnosis of centrofacial midline destructive processes in young patients as the first diagnostic possibility. A management strategy for these patients is suggested.


Six cases that required soft tissue replacement in the central midface are presented. There were no flap losses and it is concluded that this is an excellent method for providing soft tissue in these situations.


A patient with perforation of the nasal septum and palate and collapse of the nasal dorsum is presented. The destroyed anatomy was reconstructed by using standard surgical techniques.


The authors explored the ischemia/reperfusion phenomenon in skin flaps by first investigating the vascular anatomy of murine dorsal skin and then designing a suitable murine dorsal skin flap model. Twenty flaps were subjected to 8 hours of ischemia and subsequent reperfusion, and their mean survival was 43% (26).

In pedicled composite flaps, critical perfusion-induced capillary flow motion, which develops only in muscle, is calcium mediated and maintains adequate nutritive perfusion not only in muscle but also in skin and periosteum, probably by blood flow redistribution.


The authors investigated nicotine’s acute vasoconstrictive properties, which diminish blood flow and increase the risk of flap necrosis. Transcutaneous electrical nerve stimulation (TENS) was effective in reducing necrosis in random skin flaps in rats. Therefore the authors decided to test the efficacy of TENS to reduce necrosis in the presence of nicotine. They conclude that TENS was effective in the reduction of necrosis in this flap model.


This prospective, randomized, controlled study compares DuoDERM E (DE) with scarlet red (SR) in the treatment of split-skin graft donor areas.


This article describes the case of a man whose chronic cocaine snorting resulted in erosion of the mid-facial anatomy and recurrent sinus infections. Previously published case reports specific to this problem are presented, as are the oral, systemic, and behavioral effects of cocaine abuse.


The authors describe common complications and their underlying mechanisms seen in facial reconstruction with local flaps as well as their treatment or prevention. The authors conclude that learning how to prevent complications and how to manage them when they occur are as important as learning how to perform any given surgical procedure.


The authors present six patients who required reconstruction of full-thickness defects of the cheek and underlying maxilla. They preferred to use a technique employing local cervicofacial rotation advancement flaps. The advantages of this technique include an excellent color match and placement of the line of closure in natural junction zones of the face. Problems that must be dealt with include correction of ectropion and revision of the lower portion of the nose. An alternative means of reconstruction consists of using a prosthesis together with a regional pedicle flap. Careful monitoring of the soft tissue margins, evaluation possible cranial nerve involvement, and the use of postoperative irradiation therapy are important therapeutic considerations.


The authors demonstrate the effect of an adeno-associated virus (AAV) vector delivering vascular endothelial growth factor (VEGF)165 in two widely recognized in vivo flap models. They conclude that the therapeutic effect of AAV-VEGF on flap survival was confirmed by histological evidence of neovascularization in the formation of large numbers of CD31-positive capillaries and alpha-smooth muscle actin-positive arterioles, particularly evident at the border between viable and necrotic tissue. These results underscore the efficacy of VEGF-induced neovascularization for the prevention of tissue ischemia and the improvement of flap survival in reconstructive surgery.
A
Abbé flaps
  bilateral, 489-491
  for lower lip skin defect reconstruction, 488-491
  problems associated with, 491
  reversed, 488
  scarring caused by, 525
  for upper lip skin defect reconstruction
    in cleft lip patient, 469-470
    no muscle in flap, 471-472
    technique, 462-467
Abbé-Estlander flap, 468
Advancement
  description of, 13
  mucosal, for lower lip defects, 438
Advancement flaps
  bilateral transverse forehead, 67
  central prolabial, 179
  cheek, 123-126
  direct, 14
  forehead, 67
  horizontal, 293-294
  inferior, for lateral to alar base reconstruction, 309
  lateral, 126-127
  nasolabial triangular, 302-305
  perialar crescentic; see Perialar crescentic advancement flap
  rim, 319
Rintala; see Rintala flap
rotation, 320-323
straight, 30
supramedial cheek reconstruction using, 290-299
transverse triangular island, 297-299
triangular
  nasolabial, 302-305
  transverse, 297-299
  vertical, 295-296
vertical triangular, 295-296
V-Y; see V-Y advancement flaps
African Americans, hypertrophic scars in, 34
Age of patient, 36-37
Alar base–nasolabial region reconstruction
  nasolabial triangular advancement flap, 302-305
  perialar crescentic advancement flap for, 306-308
  recommendations for, 310-311
Alar rim
  description of, 102
  reconstruction of
    bilateral nasolabial flaps for, 189-193
    cheek axial flap and forehead flap, 194-197
    Schmid forehead flap for, 188
Alar rim flaps, 176-178
Anatomic landmarks, 43
Anesthesia
  direct infiltration, 42-43
  eye, 43
  intranasal, 43
  local anesthetic infiltration, 40
  regional nerve block, 41-432
Angular artery, 103
Anterior conchal defects, 324-329, 342-343
Anterior-posterior scalp rotation flap, 65-66
Anttragicus, 315
Areas of tissue availability; see Tissue availability areas
Asian patients, 34
Auricularis anterior, 315
Auricularis posterior, 315
Auricularis superior, 315

B
Back cut, 29
Bad results, 35
Banner flap, 130-131, 160
Bell's reflex, 350
Bilobed flaps
cheek reconstruction using, 248-250, 267-268
description of, 24, 139, 141-142
design of, 139-140
glabellar finger flap and, 147-151
laterally based, 143-146
malar region reconstruction using, 267-268
medial canthus reconstruction using, 404-405
modifications on, 144-146
nasal tip reconstruction using, 169-170
nasal-cheek defects reconstructed using, 139-142, 143-151
180-degree transposition, 141
scars caused by, 268
Blood supply
to cheek, 243
to ear, 316
to forehead, 49
to lips, 430
to nose, 103-104
Buccal artery, 103
Burn scars, 557-558, 564-565
Burow’s triangles, 14

C
Canthal regions
aesthetics of, 349
lateral; see Lateral canthus
medial; see Medial canthus
Canthopexy, transnasal, 414
Central forehead flap, 117-120
Central prolabial advancement flap, 179
Cheek
anatomy of, 242-243
blood supply to, 243
lymphatic system of, 243
in males, 548
motor nerves of, 242
musculature of, 242
nerve supply of, 242-243
sensory nerves of, 243
skin of, 242, 548
tissue expansion in
for full-thickness skin defect of face, 560-561
patient examples of, 557-558, 560-561
principles of, 548, 552
Cheek advancement flap
lateral aspect of nose reconstructed using, 123-125
malar region reconstruction using, 275-277
Webster
disadvantages of, 525
Karapandzic flap and, 501
total lower lip reconstruction using, 505-509
Cheek axial flap, 194-197
Cheek reconstruction
aesthetics of, 244
alar base–nasolabial region
nasolabial triangular advancement flap, 302-305
perialar crescentic advancement flap for, 306-308
recommendations for, 310-311
areas for, 244
bilobed flap for, 248-250
incisions, 244
lateral, 281-282, 310-311
lateral to alar base, 309
lower
description of, 254
inferiorly based rotation flap for, 258-260
recommendations for, 310-311
rhomboid flap for, 254-256
transposition flap for, 257-258
lower lip reconstruction and, 501-504
malar region; see Malar region reconstruction
nasal-cheek defects; see Nose reconstruction,
nasal-cheek defects
preauricular transposition flap for, 281-282
rhomboid flap for, 250-253
rotation flaps for
description of, 244-247, 253
inferior, 286-289
inferiorly based, 258-260
lateral, 281-285
supramedial
advancement flaps for
advantages of, 290
description of, 290-292
horizontal, 293-294
transverse triangular, 297-299
vertical triangular, 295-296
inferior rotation flap for, 286-289
lateral rotation flap for, 283-285
nasolabial transposition flaps for, 300-301
recommendations for, 310-311
tissue expansion for, 560-561
tissue availability areas for, 244
Cheek rotation flaps
forehead flaps and, for complex medial canthus
reconstruction, 411-417
malar region reconstruction using, 271-274, 278-280
total lower eyelid reconstruction using, 365-370, 374-377
total lower lid switch flap and, for total upper eyelid reconstruction
  simultaneous, 392-395
  two-stage, 396-401
Children
  lip mucosa defects in, triangular island advancement flap for, 433-435
  partial ear defect in, 330-334
  scars in, 34
  temporalis fascia flap in, 335-337
Chondromucosal graft and cheek rotation flap
  for total lower eyelid reconstruction, 365-370
  for total upper eyelid reconstruction, 393
Circular flap, 19
Circulatory distress, 575
Classic glabellar flap, 109-111
Cleft lip, sandwich Abbé flap reconstruction of,
  patient examples of, 591-592
  technique for, 588-590
Columella reconstruction
  alar rim flaps for, 176-178
  central probalial advancement flap for, 179
  fork flaps for, 176-178
  nasolabial flap for, 173-175
  problems associated with, 178
  recommendations for, 232-233
Commissure defects
  full-thickness defects, 514-521
  mucosal defects, 511-513
  recommendations for, 524-525
  rhomboid flaps
    double skin, 514-521
    mucosal, 511-516
    tongue flap, 513
Complications
  circulatory distress, 575
  flap too short, 574
  flap too small, 574
  functional, 3
  hematoma, 362, 575
  ischemia; see Ischemia
  pincushioning; see Pincushioning
  radiation therapy–related, 575
  skin tightness, 574
  tissue expansion, 566
  trapdooring, 19, 573
  tumor recurrence, 571
  wound closure, 573
Composite grafts, 578-579
Conjunctiva
  buccal mucosa for, 357
  description of, 348
Consultation, presurgical, 33-35
Creep
  definition of, 5
  principles of, 534
  for scalp closure, 56
  stress relaxation and, 534
Crescent tissue expanders, 543
Crescentic advancement flap
  description of, 25
  perialar; see Perialar crescentic advancement flap
Cupid’s bow, 431
D
Defect; see also specific defect
  presurgical examination of, 7
  triangulation of, 8, 12
Delay phenomenon, 534-535
Depressor septi muscle, 102
Diabetes mellitus, 36
Direct advancement flaps, 14
Direct local infiltration, 42-43
Direct transverse closure, 171-172
Dog-ears
  in bilateral rotation flap, 69
  description of, 9, 30-31
  flap construction using, 31
  resection of, 30
Donor skin, 7-8
Doppler device, 15, 575
Dorsal nasal artery, 103
Double opposing rhomboid flaps, 264-266
Double rhomboid flap, 18
Double skin rhomboid flaps, 514-521
Dufourmental flap
  flap types, 20-23
  history of, 20
  problems associated with, 88
  single, 22
  temporal skin defects reconstructed using, 82-88
E
Ear
  anatomy of, 314-316
  blood supply to, 316
  lymphatic system of, 316
  musculature of, 315
  nerve supply to, 316
  skin of, 314
  tissue expansion in, 553
Ear lobule reconstruction, 343
Ear reconstruction
aesthetics of, 317
anterior conchal defects, 324-329, 342-343
composite grafts for, 578-579
incisions, 317
lobule, 343
partial ear defect, 330-334, 342-343
postauricular flap
description of, 330-334
revolving door island, 324-329
reasons for, 313
rim defects
recommendations for, 342-343
rim advancement flap for, 319
rotation advancement flap, 320-323
tube pedicles for, 343
temporalis fascia flap for, 335-337
tissue availability areas for, 318
total ear resurfacing, 338-343
upper pole ear defect, 335-337

Earlobe
assessed using, 314
torn, repair of, 579-580

Elderly, nose reconstruction in, 228-229

Elliptical tissue expanders, 544

Epidermolysis, 96

Epiphora, 417

Expanders; see Tissue expanders

Extended glabellar flap, for nasal-cheek defects, 137-138

External carotid artery, 316

External injection ports, 537-540

Eye anesthesia, 43

Eyelid
anatomy of, 348-349
functions of, 347, 350
lymphatic system of, 349
musculature of, 348
skin of, 348

Eyelid reconstruction
aesthetics of, 349
chek rotation flaps for, 355-361
incisions, 350

lower
defatting of eyelid associated with, 374
partial, 355-361
problems associated with, 374
recommendations for, 424-425
skin defects, 351-355
total
chek rotation flap for, 365-370, 374-377
chondromucosal graft and cheek rotation flap for, 365-370

F

Facial artery, 103

Fainting, 43

Fan flaps, 509-510

Fibrous capsule, from tissue expansion, 566

Finger flap
glabellar, with bilobed flap for nasal-cheek defects, 147-151
medial canthus reconstruction using, 112-113, 121, 406-410
split, 406-410

Fixed aesthetic structures, 47

Flap; see also specific flap
dog-ears used to construct, 31
failure of, 370, 376
planning considerations, 569-570
skin tightness around, 374
too short, 374
too small, 374

Flap movement
back cut, 29
dog-ears, 30-31
W-plasty, 28
Z-plasty for; see Z-plasty

Forehead
advancement flaps of, 67
anatomy of, 48-50
blood supply of, 49
glabellar laxity assessments, 53
individual variations in, 47
laxity assessments, 53
lymphatics of, 50
musculature of, 49
nerve supply of, 49
skin of, 48
tissue expansion in
for nasal reconstruction, 551-552, 554-556
patient example of, 554-556
principles of, 547-548, 551

Forehead flaps
central, 117-120
cheek axial flap and, for alar rim reconstruction, 194-197
cheek rotation flap, and for complex medial canthus reconstruction, 411-417
disadvantages of, 229
island, 189-193
lateral canthus reconstruction using, 418-420
nose reconstruction using
forehead tissue expansion for, 554-556
subtotal, 209-212
Schmid; see Schmid forehead flap
total lower eyelid reconstruction using, 362-365, 371-374

Forehead reconstruction
aesthetics of, 50
areas of tissue availability, 51
complications of, 96-97
epidermolysis secondary to, 96
full-thickness skin loss, 97
glabellar region
considerations for, 89
recommendations for, 98-99
rhomboid flaps for, 89-96
incisions for, 50-51
ischemic complications of, 96
lines of minimal relaxed tension, 50-51
main
bilateral transverse forehead advancement flaps, 67
considerations for, 52
recommendations for, 98-99
rotation flaps for
anterior-posterior scalp, 65-66
bilateral, 68-70
indications, 97
unilateral, 54-55
Worthen, 61-64
sculp closure methods, 56-57
sculp rotation for, 53
sculp transposition flap, 57-60
supraeyebrow
considerations for, 71
hatchet flaps for, 74-77
island flap for, 71-73

recommendations for, 98-99
rhomboid flap, 78-81
temporal defects
considerations for, 82
recommendations for, 98-99
rhomboid flap for, 82-88
Fork flaps, 176-178
Four-flap Z-plasty, 28
Fricke flap
description of, 362
lateral canthus reconstruction using, 418-420
Frontalis palsy, 96
Frown lines, 101
Full-thickness skin grafts
fitting of, 578
indications for, 577-578
lateral aspect of nose reconstructed using, 122
lower eyelid skin defect reconstructed using, 351
nasolabial skin for, 2
postauricular harvesting of, 578
scarlet red for wound healing after harvesting of, 581
Full-thickness skin loss, in forehead reconstruction, 97

G
Galeal frontalis flap, 205-208
Gillies three-point suture, 27
Glabellar area
reconstruction of
considerations for, 89
recommendations for, 98-99
rhomboid flaps for, 89-96
skin in, 102
Glabellar flaps
classic, 109-111
extended, 137-138
finger, 147-151
island, 114-115, 402-403
medial canthus reconstruction using, 108-112
Glabellar laxity, 53
Gradual technique, 37
Grafts
composite, 578-579
local flaps versus, 2
skin; see Skin grafts

H
Hatchet flaps
problems associated with, 77
supraeyebrow reconstruction using, 74-77
Healing; see Wound healing
Helicis major, 315
Helicis minor, 315
Hemangioma, 562-563
Hematoma, 362, 575
Herbert in-turned flap, 181
Hyaluronidase, 40
Hypertrophic scars, 34, 37

I
Incisions
- cheek reconstruction, 244
- ear reconstruction, 317
- eyelid reconstruction, 350
- forehead reconstruction, 50-51
- lip reconstruction, 431
- nose reconstruction, 107
- presurgical placement of, 7

Inferior advancement flap, for lateral to alar base reconstruction, 309
Inferior cheek rotation flaps, 271-272
Inferior labial artery, 103
Inferior rotation flaps, for supramedial cheek reconstruction, 286-289

Infiltration
- direct local, 42-43
- local anesthetic, 40

Inflammation, 34-35
Infraorbital artery, 103
Infraorbital nerve block, 41-42
Injection ports
- external, 537-540
- integral, 537

Integral injection ports, 537
Intranasal anesthesia, 43
Intranasal defect, 121
Intraoperative care, 43-44

Ischemia
- description of, 574
- in forehead reconstruction, 96
- in total lower eyelid reconstruction, 369

Island flaps
- description of, 14-16
- forehead, 189-193
- glabellar, 114-116, 402-403
- nasolabial, 157-160, 461
- partial upper eyelid reconstruction using, 381-382
- postauricular revolving door, 324-329
- problems associated with, 73, 461
- subcutaneous pedicle for, 14-15, 72
- supraeyebrow reconstruction using, 71-73

triangular advancement flap
- lip mucosa reconstruction using, 433-437
- transverse, 436-437
- upper lip reconstruction using, 461

K
Karapandzic flap
- advantages of, 504
- bilateral, 499
- lower lip skin defects reconstructed using, 492-500
- modified, 498-500
- problems associated with, 503
- reversed, 481-482
- unilateral, 495-497
- upper lip skin defects reconstructed using, 481-482
- Webster cheek advancement flap and, 501

L
Labial arteries, 430
Labial veins, 430
Lacral artery, 348
Lateral advancement flap, for nasal-cheek defects, 126-127
Lateral canthus
- anatomy of, 349
- reconstruction of
  - forehead flap for, 418-420
  - orbital exenteration, 420-423
  - recommendations for, 424-425

Lateral cheek
- reconstruction of, 281-282
- rotation flaps, 273-274

Lateral rotation flap, for supramedial cheek reconstruction, 283-285
Lateral to alar base reconstruction, 309
Levator palpebrae superioris, 348
Lid switch flap
- lower, with cheek rotation flap for total upper eyelid reconstruction
  - simultaneous, 392-395
  - two-stage, 396-401
- partial upper eyelid reconstruction using, 383-386
Lidocaine hydrochloride, 40
Lifestyle considerations, 38
Limberg flap; see Rhomboid flap
Line of maximal tension, 10
Lines of minimal relaxed tension
- definition of, 6
  - for forehead reconstruction, 50
  - in glabellar area, 101
  - transposition flap, 12
Lip
anatomy of, 429-430
beauty of, 429
blood supply to, 430
lymphatic system of, 430
musculature of, 430
nerve supply to, 430
Lip reconstruction
aesthetics of, 431
commissure defects
full-thickness defects, 514-521
mucosal defects, 511-513
recommendations for, 524-525
rhomboid flaps for
double skin, 514-521
mucosal, 511-516
tongue flap for, 513
composite grafts for, 579
crescentic advancement flap for, 25
incisions, 431
lower
cheek reconstruction and, 501-504
mucosal defect reconstruction, 438-443,
522-523
skin defects
Abbé flaps for
bilateral, 489-491
for central lip reconstruction, 462
for lateral lip reconstruction, 465
reversed, 488
description of, 485
full-thickness, 488-500, 525-525
inferiorly based nasolabial flap for, 485-487
Karapandzic technique for
description of, 492-494
modified, 498-500
unilateral, 495-497
tongue flap for, 438-443
total
bilateral fan flaps for, 509-510
description of, 505
recommendations for, 524-525
Webster cheek advancement technique for, 505-509
mucosal defects
commissure deformities, 511-513
of lower lip, 438-443, 522-523
recommendations for, 522-523
rotation flap for, 432
tongue flaps for, 438-446, 513
upper lip, 444-446, 522-523
V-Y advancement flap for, 433
tissue availability areas, 431
tissue expansion for, 553, 557-558
upper
Abbé flap for
in cleft lip patient, 469-470
no muscle in flap, 471-472
technique for, 462-467
Abbé-Estlander flap, 468
mucosal defect reconstruction, 444-446,
522-523
nasolabial flap for
bilateral, 459-462
two-stage, 456-459
partial, 522-523
perialar crescentic advancement flap for,
447-455
bilateral, 477-480
full-thickness skin defect reconstruction,
473-480
modification of, 451-455
with orbicularis oris muscle preservation,
476-477
problems associated with, 455
reversed Karapandzic flap for, 481-482
skin defects, 447-462, 522-523
full-thickness, 462-482
total, 483-484, 524-525
LLL flap; see Dufourmental flap
Local anesthetic infiltration, 40
Local flaps
advantages of, 2
design considerations for, 3
disadvantages of, 3
functional complications of, 3
principles for, 3
skin grafts versus, 2
Local in-turned flap
forehead flap and, for total nose reconstruction,
202-204
nasal lining reconstruction using, 181-185
Lockwood's suspensory ligament, 349
Lower eyelid reconstruction; see Eyelid reconstruction, lower
Lower lip reconstruction; see Lip reconstruction, lower
Lymphatic system
of cheek, 243
of ear, 316
of eyelids, 349
of forehead, 50
of lips, 430
of nose, 107
Malar region reconstruction
  cheek advancement flap for, 275-277
description of, 261
modified bilobed flap for, 267-268
recommendations for, 280, 310-311
rhomboid flap for
  description of, 261-263
double opposing, 264-266
rotation flaps for
  cheek, 271-274, 278-280
  inferior cheek, 271-272
  lateral cheek, 271-272
problems associated with, 274
transposition flap for, 269-270
Markings on patient's face, 40
Masseter muscle, 242
Medial canthus
  anatomy of, 349
  excisions of, 401
  skin of, 349
Medial canthus reconstruction
  bilobed flap for, 404-405
central forehead flap for, 117-120
complex
  description of, 411
  forehead flap and cheek rotation flap for, 411-417
description of, 108, 401
finger flap for, 112-113, 121
split, 406-410
glabellar flaps for
  island, 114-115, 402-403
  simple, 108-112
partial, 402-410
recommendations for, 230-231, 424-425
split finger flap for, 406-410
Medical history, 36
Mental nerve block, 42
Middle Eastern patients, 34
Midline transposition flap, 112-113
Mucosal defects, of lip
  commissure deformities, 511-513
  lower lip, 438-443, 522-523
recommendations for, 522-523
rotation flap for, 432
tongue flaps for, 438-446, 513
upper lip, 444-446, 522-523
V-Y advancement flap for, 433
Musculature
  of cheek, 242
  of ear, 315
  of eyelids, 348
  of forehead, 49
  of lips, 430
  of nose, 102

N
Nasal lining
  local in-turned flap for, 181-185
  nasolabial flaps for, 186-187
  skin grafts for, 180
Nasal tip reconstruction
  bilobed flap for, 169-170
direct transverse closure for, 171-172
nasolabial flap for, 160-164
problems associated with, 170
recommendations for, 230-231
Rintala flap for, 165-169, 172
triangular kite flaps, 171
Nasolabial flaps
  alar rim reconstruction using, 189-193
columella reconstruction using, 173-175
inferiorly based, for lower lip skin defect reconstruction, 485-487
island, 157-160, 461
island forehead flap and, 189-193
nasal lining reconstruction using, 186-187
nasal tip reconstruction using, 160-164
nasal-cheek defects reconstructed with, 151-157
problems associated with, 164, 461
supramedial cheek reconstruction using, 300-301
transposition, 300-301
triangular advancement, 302-305
Nasolabial skin, 2
Neck
  nose reconstruction using skin from, 225-227
tissue expansion in
    patient examples of, 562-566
    principles of, 549
Nerve(s)
  of cheek, 242-243
  of ear, 316
  of forehead, 49
  of lips, 430
  of nose, 102
Nerve blocks, 41-42
Nose
  anatomy of, 102-107
  blood supply to, 103-104
contour of, 101-102
lymphatic drainage of, 107
musculature of, 102
nerve supply of, 102
skin of, 102
tissue expansion in, 551-552
Nose reconstruction
aesthetics of, 107
columella
alar rim flaps for, 176-178
central prolabial advancement flap for, 179
fork flaps for, 176-178
nasolabial flap for, 173-175
problems associated with, 178
recommendations for, 232-233
complex, 180-197, 232-233
composite grafts for, 578-579
in elderly patients, 228-229
flap planning for, 105-106
forehead tissue expansion for, 551-552
glabellar flaps for
island, 114-115
simple, 108-112
incisions for, 107
lateral aspect of nose
cheek advancement flap for, 123-125
full-thickness skin grafts, 122
lining of nose; see Nasal lining
medial canthus
central forehead flap for, 117-120
description of, 108
finger flap for, 112-113, 121
glabellar flaps for
island, 114-115, 402-403
simple, 108-112
recommendations for, 230-231
nasal tip; see Nasal tip reconstruction
nasal-cheek defects
banner flap for, 130-131, 160
bilobed flap for
description of, 139, 141-142, 160
design of, 139-140
glabellar finger flap and, 147-151
laterally based, 143-146
modifications on, 144-146
extended glabellar flap for, 137-138
lateral advancement flap, 126-127
nasolabial flap for
columella, 173-175
description of, 151-157
island flap, 157-160
nasal tip, 160-164
nasal-cheek defects, 151-160
rhomboid flap for, 132-136, 160
V-Y advancement flap, 128-129
neck skin used for, 225-227
skin, 197
subtotal
forehead flap for, 209-212
recommendations for, 232-233
Schmid flap for, 213-217
Washio flap for, 218-224, 229
tissue availability areas for, 108
tissue expansion for, 551-552, 557-558
total
description of, 197
forehead flap for
local in-turned flaps and, 202-204
up-and-down, 197-201
galeal frontalis flap for, 205-208
recommendations for, 232-233
O
Obliquus auriculae, 315
Older patients, 36-37
Ophthalmic artery, 348
Orbicularis oculi muscle, 348
Orbicularis oris muscle
anatomy of, 430
perialar crescentic advancement flap with
preservation of, 476-477
Orbital exenteration, 420-423
Orbital reconstruction, 558-559
P
Palate, cocaine fistula in
patient examples of, 591-592
reconstruction technique for, 588-590
Partial ear defect, 330-334, 342-343
Partial upper eyelid reconstruction, 378-380
Patient
age of, 36-37
examination of, 33-38
honesty with, 35
markings on face of, 40
medical history-taking, 36
presurgical consultation with, 33-35
Pedicle, for island flaps, 14-15, 72
Perialar crescentic advancement flap
alar base–nasolabial region reconstruction
using, 306-308
bilateral, 477-480
Piriform aperture, 182
Postauricular flaps
  - partial ear defect reconstructed using, 330-334
  - revolving door island flap, 324-329
Posterior superior alveolar artery, 103
Postoperative care, 44-45
Preauricular transposition flap, 281-282
Preoperative care, 38-40
Presurgical consultation, 33-35
Problems; see Complications
Procerus muscle, 102
Prolonged tissue expansion, 536
Proparacaine, 43

R
Radiation therapy, 38, 575
Rapid tissue expansion, 536
Reconstruction; see also specific reconstruction
  - gradual technique of, 37
  - markings on patient’s face, 40
  - Rectangular tissue expanders, 542
  - Regional nerve block, 41-42
  - Reversed Karapandzic flap, 481-482
Rhinophyma, 102
Rhomboid flaps
  - cheek reconstruction using
    - description of, 250-253
    - lower, 254-256
    - malar region, 261-266
    - circular flap versus, 19
    - commissure defects reconstructed using, 511-521
    - designing of, 16-17
double
  - illustration of, 18, 23
  - temporal skin defects reconstructed using, 84-88
double opposing, 264-266
double skin, 514-521
Dufourmental flap; see Dufourmental flap
  - glabellar reconstruction using, 89-96
  - history of, 16
  - malar region reconstruction using, 261-266
  - nasal-cheek defects reconstructed using, 132-136, 160
  - pincushioning and, 19, 81
  - problems associated with, 81, 136
  - scars caused by, 81, 256
  - single, 22
  - supraeyebrow reconstruction using, 78-81
  - temporal skin defects reconstructed using, 82-88
  - triple, 19
Rim defects
  - recommendations for, 342-343
  - rim advancement flap, 319
  - rotation advancement flap, 320-323
  - tube pedicles for, 343
Rintala flap
  - above the eyebrow, 165-167
  - below the eyebrow, 167-168
  - nasal tip reconstruction using, 165-169, 172
  - problems associated with, 168-169
Risorius, 430
Rotation, of skin, 8-11
Rotation flaps
  - advancement, 320-323
  - anterior-posterior scalp, 65-66
  - bilateral, 68-70
cheek
  - chondromucosal graft and, 365-370
  - description of, 244-247, 253
  - eyelid reconstruction using
    - partial, 355-361
    - total, 365-370, 374-377
  - forehead flaps and, for complex medial canthus reconstruction, 411-417
  - inferior flaps for, 271-272
  - lateral flaps for, 273-274
  - lower cheek reconstruction using, 258-260
  - malar region reconstruction using, 278-280
  - for forehead reconstruction, 54-55, 61-66, 68-70
  - inferior, for supramedial cheek reconstruction, 286-289
  - inferiorly based, 258-260
lateral, for supramedial cheek reconstruction, 283-285
line of maximal tension, 10
lip mucosa reconstruction using, 432
planning for, 9-10
problems associated with, 247, 274
scalp, 65-66
transposition flap versus, 11
upper lid, for partial upper eyelid reconstruction, 387-391
Worthen, 61-64
Round tissue expanders, 541

S
Scalp
closure of, in forehead reconstruction, 56-57
stretching of, 56
tissue expansion in, 547, 550-551
Scalp rotation flap
anterior-posterior, 65-66
for forehead reconstruction, 53
Scalp transposition flap, 57-60
Scar(s)
with bilobed flaps, 268
burn, 557-558, 564-565
in children, 34
with hatchet flaps, 77
hypertrophic, 34, 37
patient education about, 34
quality of, 37
with rhomboid flaps, 81, 256
suture effects on quality of, 37
variations in, 34
Scar revision
after forehead reconstruction, 51
W-plasty for, 28, 51
Scarlet red ointment dressing
indications for, 580-581
patient examples of, 560-561, 576, 583-587
personal experiences using, 582
wound healing using, 580-587
Schmid forehead flap, for nasal reconstruction
alar rim, 188
nasal flap and, 186
subtotal reconstruction, 213-217
Sensation problems, 37
Sensory nerves, of face, 41-42
Skin
advance of, 13-14
age-related changes in, 6
biomechanics of, 4-5
of cheek, 242, 548
creep, 5
do of ear, 314
expansion of; see Tissue expansion
of eyelids, 348
of forehead, 48
of medial canthus, 349
of nose, 102
in older patients, 36-37
quality and quantity of, 37
rotation of, 8-11
stress relaxation, 5
transposition of, 11-12
vascularity of, 536
viscoelastic properties of, 5, 56
Skin cancer, 2
Skin grafts
full-thickness; see Full-thickness skin grafts
indications for, 576-577
local flaps versus, 2
nasal lining reconstructed using, 180
scalp closure using, 57
split-thickness, 577
Skin recruitment, 7
Skin stretching, 7
Skin tightness, 574
Smoking, 36
Split finger flap, for medial canthus reconstruction, 406-410
Split-thickness skin grafts
indications for, 577
scarlet red use in donor sites for, 581
Straight advancement flap, 30
Stress relaxation
creep and, 534
definition of, 5
principles of, 534
for scalp closure, 56
Subcutaneous pedicle, for island flaps, 14-15, 72
Superficial musculoaponeurotic system, 242
Superior labial artery, 103
Supraperior eyebrow reconstruction
considerations for, 71
hatchet flaps for, 74-77
island flap for, 71-73
recommendations for, 98-99
rhomboid flap for, 78-81
Supraorbital artery, 103
Supraorbital nerve
anatomy of, 49
esthetic block of, 41
Supratrochlear artery, 103
Surgeon
discussions with patients, 33-35
goal of, 1
Surgical planning

- age, 36-37
- defect examination, 7
- donor area examination, 7
- importance of, 569
- incision placement, 7
- medical history-taking, 36
- skin quality and quantity, 36
- skin recruitment, 7
- tissue availability areas, 6

T

- Tarsal plates, 348
- Temporal region reconstruction
  - considerations for, 82
  - recommendations for, 98-99
  - rhomboid flap for, 82-88
- Temporalis fascia flap, 335-337
- Tissue availability areas
  - for cheek reconstruction, 245
  - definition of, 6
  - for ear reconstruction, 318
  - for eyelid reconstruction, 351
  - for forehead reconstruction, 51
  - for lip reconstruction, 431
  - for nose reconstruction, 108

Tissue expanders

- base for, 540
- characteristics of, 536-537
- complications associated with, 566
- crescent, 543
- description of, 5
- design of, 540
- elliptical, 544
- filling of, 538
- injection ports
  - external, 537-540
  - integral, 537
- insertion of, 535
- rectangle, 542
- round, 541
- size and shape of, 536-537, 541-545
- surface characteristics of, 540

Tissue expansion

- anatomic considerations for, 534
- anatomic site-based approaches to, 539
- in cheek
  - for full-thickness skin defect of face, 560-561
  - patient examples of, 557-558, 560-561
  - principles of, 548, 552
  - complications associated with, 566
  - consolidation period after, 535
  - delay phenomenon associated with, 534-535
  - dermal changes secondary to, 535
  - in ear, 553
  - factors that affect, 536
  - fibrous capsule created by, 566
  - flap design considerations, 550-551
  - in forehead
    - for nasal reconstruction, 551-552, 554-556
    - patient example of, 554-556
    - principles of, 547-548, 551
  - history of, 533
  - hyperpigmentation of skin during, 535
  - mechanisms of, 534-535
  - in neck
    - patient examples of, 562-565
    - principles of, 549
  - in nose, 551-552
  - in orbital reconstruction, 558-559
  - planning of, 547-553
  - postoperative care, 553
  - principles of, 533-535
  - prolonged, 536
  - rapid, 536
  - in scalp, 547, 550-551
  - stages of, 545-546
  - “tape technique” for assessing, 551
  - time required for, 539-540
- Tongue flap, for lip mucosal defect reconstruction
  - commissure, 513
  - lower lip, 438-443
  - problems associated with, 513
  - upper lip, 444-446
- Total ear resurfacing, 338-343
- Tragicus, 315
- Transnasal canthopexy, 414
- Transposition, of skin, 11-12
- Transposition flaps
  - lower cheek reconstruction using, 257-258
  - malar region reconstruction using, 269-270
  - midline, 112-113
  - nasolabial, 300-301
  - preauricular, 281-282
  - problems associated with, 270
  - rectangular shape of, 12
  - rhomboid, for glabellar reconstruction, 92-96
  - rotation flap versus, 11
  - scalp, 57-60
- Transverse facial artery, 103
- Transverse island triangular advancement flap, 436-437
- Transversus auriculae, 315
- Trapdooring, 19, 573
Triangular advancement flaps
island, for lip mucosa reconstruction
description of, 433-437
transverse, 436-437
nasolabial, 302-305
transverse, 297-299
vertical, 295-296
Triangular kite flaps, 171
Triangulated defect
of cheek, rotation flap for, 245
description of, 8, 12
Trigeminal nerve, 49, 243
Tripier flap
bilateral, 354
unilateral, 352-353
Triple rhomboid flap, 19
Trochlear nerve, 49
Tube pedicles, for rim reconstruction, 343
Tumor recurrence, 571

U
Undermining, 573
Upper eyelid reconstruction; see Eyelid reconstruction, upper
Upper lid rotation flap, for partial upper eyelid reconstruction, 387-391
Upper lip reconstruction; see Lip reconstruction, upper
Upper pole ear defect, 335-337

V
Viscoelastic properties of skin, 5, 56
V-Y advancement flaps
in classic glabellar flap, 109
description of, 13
hatchet flap as, 74
lip mucosa reconstruction using, 433
nasal-cheek defects reconstructed using, 128-129
problems associated with, 129, 433

W
Washio flap, for subtotal nose reconstruction, 218-224, 229
Webster cheek advancement flap
disadvantages of, 525
Karapandzic flap and, 501
total lower lip reconstruction using, 505-509
Worthen rotation flap, 61-64
Wound closure, 573
Wound healing
patient understanding of, 34
scarlet red ointment dressing for, 580-587
smoking effects on, 36
W-plasty, 28

Z
Z-plasty
in cheek rotation flap, 360
Dufourmental flap closure by, 20
in forehead reconstruction, 51
four-flap, 28
for pincushioning correction, 572
principles of, 26
technical tips for, 27
in torn earlobe reconstruction, 580
transverse limb of, 26
in Washio flap, 219