The Principles and Dynamics of Local Skin Flaps

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II. SELF-ASSESSMENT EXAMINATION

(Select the one best answer.)

1. List four major types of skin flaps.
   a. 
   b. 
   c. 
   d. 

2. Describe the role of the M-plasty in the design of a fusiform excision.

3. List two types of advancement flaps.
   a. 
   b. 

4. List four favorable types of sites to place incisions.
   a. 
   b. 
   c. 
   d. 

5. List two advantages of a Z-plasty.
   a. 
   b. 

   a. 
   b. 

7. Describe the theoretic advantages of a 30° transposition flap over a rhomboid flap.

8. Explain why an M-plasty is often used in a 30° transposition flap.
9. What is the major advantage of a bilobe flap?

10. Draw the designs and closures of the following local skin flaps:
    a. fusiform excision advancement
    b. rectangular advancement
    c. rotation
    d. classic transposition
    e. bilobe transposition
    f. 60° (rhomboid) transposition
    g. 30° (Webster) transposition
    h. fusiform island
    i. subcutaneous turnaround pedicle
11. Describe an application of a rotation flap.

12. List the two types of blood supply than can sustain an island flap.
   a.
   b.
SELF-ASSESSMENT EXAMINATION ANSWERS

1. a. advancement
   b. rotation
   c. transposition
   d. island

2. M-plasty shortens the incision, breaks up the incision, saves normal tissue, and provides some control over the direction of tissue tension.

3. a. rectangular
   b. fusiform

4. a. in an orifice
   b. at an aesthetic boundary
   c. in hair-bearing skin
   d. parallel to favorable skin tension lines (FSTL)

5. a. changing scar direction
   b. lengthening an incision

6. a. creating a longer scar
   b. shortening one dimension

7. A 30° transposition flap better distributes the tension of closure and minimizes tissue protrusions.

8. The M-plasty saves tissue, allows closure without protrusion, and helps break up the resultant scar.

9. The use of a bilobe flap allows the tissue to be moved from a distant location.

10. See the following Figures in the text:
    a. 4 (pg 26)
    b. 16 (pg 38)
    c. 36 (pg 59)
    d. 45 (pg 69)
    e. 49 (pg 73)
    f. 47A and B (pg 71)
    g. 48C and D (pg 72)
    h. 73 (pg 93)
    i. 75 (pg 95)

11. Rotation flaps can be used for resurfacing a large cheek defect or for face-lifts.

12. a. arteriovenous pedicle
    b. subcutaneous pedicle
III. OBJECTIVES

The general objective of this SIPac will be met if the reader gains a working knowledge of the theoretic and technical aspects of flap design as well as acquires the ability to apply local flaps in the closure of skin defects resulting from trauma or the extirpation of cutaneous lesions. Depending on the training situation, the reader should then be able to achieve technical competence in the use of local flaps. Certain specific goals enable the reader to achieve the general objective. These are as follows:

A. Understand the preparations necessary for the use of flaps
   1. Decide when to use flaps
   2. Identify locations favorable to incision placement
   3. Identify areas of tissue excess
   4. Explain surgical antisepsis precautions
   5. Describe anesthetic techniques
   6. Describe suturing techniques

B. Understand the varieties of local flaps
   1. Describe four basic types of flaps: advancement, rotation, transposition, and island
   2. Recognize potential uses for each flap type
   3. Predict the closure of each flap type
   4. Compare advantages of flap types
   5. Design flaps of each type

C. Comprehend the dynamics of local skin flaps
   1. Identify location and direction of flap tissue tension
   2. Describe the direction and degree of tissue compression
   3. Identify methods of modifying the basic flaps

D. Apply knowledge of local flaps to the design of flap reconstruction for specific situations.
IV. INTRODUCTION

Treatment of cutaneous lesions is complex and multifaceted. One of the most powerful methods is surgical excision. Surgery has several advantages: it is fast, it yields the entire specimen for pathologic examination, and if properly performed, it achieves a cosmetically favorable result. While it is true that some lesions have irregular margins and, even if checked with permanent or frozen histologic sections, may still harbor residual tumor, the majority of cutaneous lesions can be safely and totally excised with a high degree of certainty. When the margin is in question, Mohs margins have such a high degree of local control that these defects can be repaired.

For those surgically treated lesions where there is serious doubt about the adequacy of the excision or where undetected local recurrence might result in a fatal outcome, it is advisable to cover those defects with split-thickness or full-thickness skin grafts instead of with local flaps. In such cases the skin graft allows easier inspection and detection of recurrence. Although a good cosmetic result can be obtained with a full-thickness skin graft, the cosmetic result is often not optimal because skin grafts (1) do not match the texture and color of surrounding skin, (2) become stiff and immobile, (3) are devoid of sensation, and (4) are often depressed relative to the surrounding skin. For these reasons, better cosmetic results can be obtained by closure with locally obtained vascularized skin.

This SIPac deals with the use of local skin flaps to create the best possible cosmetic result with the least amount of surgery.

Not all lesions can or should be surgically excised. This SIPac will not deal with that important decision. Our exclusive concern is directed toward treatment of the lesion that has been selected for excision and the subsequent closure using local skin.

This SIPac will be best comprehended if the reader has a generous supply of pencils, erasers, paper, and tracing paper. Actively drawing the concepts described in the following sections will help in understanding them. A mastery of these concepts is essential before applying them to the clinical situation.

In Memorium
Dr. Richard Webster (1918-1994)

Dr. Webster was my fellowship director with whom I spent one long, arduous, incredibly educational year. I probably spent more time with Dr. Webster than I have with any other teacher in my entire life, aside from my parents. I probably learned more from Dr. Webster than I did from any other individual or teacher.

Dr. Webster was a genius of tissue movement and arrangement. I believe he saw and conceptualized appearance and change as well as techniques for change that went beyond and above even the best of the facial plastic surgeons. Some of these techniques, like the 30° transposition flap and the geometric broken-line closure for scar revision were to a large degree originated by Dr. Webster. These have been simplified so that the average physician like you and me can understand them. I am sure that Dr. Webster saw them on some different level. While I know that he studied, thought, and worked very hard at the things that he did, I also know that the kind of evaluation and treatment he was able to formulate came very naturally and spontaneously to him.
Each and every morning I drove Dr. Webster to our surgeries. And every morning I asked him what he thought of the operations we were going to perform and how we were going to do them. Each and every morning he looked at me like I was the world's biggest fool for not knowing. Each and every morning the canvas of a new face would appear on the operating table and each and every morning Dr. Webster painted a new and original masterpiece.

Dr. Webster was an avid and excellent teacher. He loved to teach. He traveled across the country, drove across the state, and did whatever was required to give a lecture. His lectures were enjoyed and appreciated. They were highly attended and always highly evaluated.

It took the facial plastic community a long time to learn Dr. Webster's vocabulary and to appreciate his approaches and techniques. Although his lectures and writings were valuable, his real contributions came through his fellows and his videotapes. The American Academy of Facial Plastic and Reconstructive Surgery Fellowship Program honored many fellows with the opportunity to study with Dr. Webster. All of us learned from him and then went on to teach, each with our own interpretation and style.

Dr. Webster was also instrumental in beginning the Academy's videotape program, the "San Diego Classics in Soft Tissue and Reconstructive Surgery." Almost every facial plastic surgeon has at one time or another seen a large number of these programs. If you have not, you have missed one of the greatest educational opportunities available to you.

That which follows in this SIPac is my interpretation of what I learned from Dr. Webster. In its first edition it was reviewed and approved by Dr. Webster, so I know it is somewhere close to the truth. In this capacity, the most that I can hope is that I have been a good disciple and that I have accurately conveyed the teachings of this remarkable man so that they can live on in the hands of today's facial plastic surgeons and in the faces of our patients.
V. CONTENT

A. General Considerations

1. Patient selection

There are some general considerations that must be addressed before any surgery is performed. Not every patient is a good candidate for surgery. Although the psychiatric considerations are not as strict as they might be for aesthetic surgery, some patient selection must exist. Patients with significant likelihood of adverse psychologic reaction to surgery should be excluded. Some patients are deathly afraid of surgery and if reasonable therapeutic alternatives exist, these should be offered. Patients who are poor anesthesia risks because of severe cardiac disease or other serious medical illness are also not good surgical candidates; they should be offered nonsurgical alternatives when possible. These considerations may appear to be obvious, but they are often neglected.

2. Tissue availability

The next consideration is tissue availability. When incisions and excisions are to be made, two major factors must be taken into account: the location of excess or loose skin (i.e., tissue to borrow) and the optimal location for the necessary incisions. Begin by determining the excision necessary to obtain clear margins. These might be close, as in excising an intradermal nevus, or wide, as as in excising a melanoma. Initial treatment planning should not be violated even at the cost of cosmesis. Planned margins are often drawn onto the skin to help visualize the potential defect. Next, pinch the skin in several directions, trying to feel where the skin is loose and might easily be used to effect a tension-free closure without distortion of local anatomy. For example, consider a small circular lesion of the lower eyelid. The skin is loose in the vertical dimension, but no matter how well planned, loss of skin in this axis would cause shortening of the lower eyelid skin, inferior displacement of the lower lid margin, and possibly even eversion and ectropion. In the horizontal axis the skin is not quite as loose, but with undermining it can be mobilized. Importantly, no significant distortion of tissue results (i.e., the nose does not move laterally nor the ear anteriorly) so this would be the best direction for pulls in this site. Since each anatomic site of each face has its own unique features, it is better to have a thorough understanding of the general principles of tissue movement to enable proper flap selection rather than to memorize the treatments for every individual site.

3. Incision placement

The next factor to consider is the optimal direction and position for placing skin incisions. It is prudent to fully understand the principles of scar revision even before planning a primary skin incision. There are four good places to locate incisions. An incision hidden inside an orifice such as the mouth, the nose, the eyelid, or the ear is ideal, if practical. For example, internal rhinoplasty is superior to external rhinoplasty as long as the desired procedure can be effectively performed intranasally. (In 1998 this example is arguable, but the
general concept is correct.) An incision in the hair or hairline is also favorable. However, beware that some hairlines recede with time and what is favorable today might be catastrophic next year. Boundary incisions are favorable too. There are distinct individual anatomic regions on the face, including the forehead, temple, upper eyelid, lower eyelid, nose, cheek, upper lip, lower lip, chin, neck, and ear. Incisions placed along the boundaries separating one anatomic region from another are extremely favorable. Some of these boundary areas are grooves, such as the cheek-lip groove. Others are not grooved but are still favorable. For example, a rim incision used to explore the orbital floor is cosmetically an excellent incision even though it lies at a nongrooved junction of the lower eyelid skin with the cheek. Finally one may need to make an incision that does not lie in one of these previously listed favorable areas. Such incisions are then designed to fall into or parallel to favorable skin tension lines (FSTL) (Fig 1). Favorable skin tension lines are the wrinkles of age but can be found at any age by asking the patient to go through the motions of facial expression. For example, if an FSTL is needed on the forehead, ask the patient to wrinkle the forehead or raise the eyebrows so you can find the horizontal lines, and ask for a frown to bring out some of the central vertical FSTL. Around the nose, FSTL can be located by frowning, wrinkling the nose, and exaggerated smiling.

4. Incision design

Once a favorable incision site is found, the actual shape of the incision should be considered. One might expect that a long linear or curvilinear incision would be most acceptable, but this is not always so. Recall from the principles of scar revision that a long, straight incision is quickly perceived by the eye, whereas a broken or irregular line is difficult to follow. Therefore, it is advantageous to use a reconstruction with many short incisions joined by acute angles, such as might imitate a geometric broken-line closure. These broken-line closures still follow the principles of FSTL. Incisions should rarely be made perpendicular to the FSTL. Another factor to consider is that all incisions contract; an ideal flap reconstruction will take this into account. If contracture will cause distortion, then lengthening with a Z-plasty or V-Y-plasty may be necessary.
Fig 1.—Favorable skin tension lines. (Reproduced with permission from Grabbe WC, Smith JW (eds): *Plastic Surgery*. Boston, Little Brown & Co, 1968, p. 5.)
5. **Skin preparation**

Presurgical preparation of the patient is crucial. So much has been taught about wound healing and its applications to wound closure that it is difficult to know what technique is best. However, each successful surgeon invariably discovers an effective methodology. The following description is the system that has worked best in our experience. On the face, scalp, and neck, adherence to strict surgical antisepsis is not mandatory because these tissues are highly vascular and resistant to infection. Shaving of hair or extensive preparation with caustic agents is not needed and can be deleterious. Soaps and detergents are bad for wounds. They are effective skin cleaners but are harmful to unprotected tissue. In addition, ten-minute surgical scrubs are also not necessary when simple hand washing suffices. For small to medium excisions of cutaneous lesions, a quick wash with a mild soap suffices. This is then completely washed off with water or saline. A simple application of Betadine solution (not Betadine soap) is optimal. The area is draped with sterile towels, leaving the entire face exposed. This allows the patient to breathe, talk, and see, while giving the surgeon a wide perspective. Hair can be left in the field. Cosmetic surgery limited by overdraping ignores facial symmetry and balance. Before any injections are made, all important marking is performed. It is difficult to determine tumor margins on distorted and discolored tissues and even more awkward to design intelligent cosmetic reconstructions. It is wiser to plan and make errors with a pen than with a knife. Preoperative pictures are routinely taken before preparation and draping and are repeated after the excisions and reconstructions are drawn. Use of photographic documentation is important for the surgeon to continually improve his or her skills by learning from experience.

6. **Anesthesia**

If local anesthesia is being used, it is desirable to use the smallest needle available. One-inch long siliconized 30-gauge needles are now available (MPL Solopack, 1820 W Roscoe St, Chicago, IL 60657. Catalog #P67230 30-1R). They have an advantage in that they inject less anesthetic into the tissue. Discomfort is minimized, since much of the pain of the anesthetic injection comes from the pressure caused by the injected fluids. Xylocaine with epinephrine is the most widely used local anesthetic. In its commercially available form it is buffered to an acid pH which causes pain. However, a freshly prepared mixture of Xylocaine and epinephrine has a neutral pH. Xylocaine 1% with either 1:100,000 or 1:200,000 adrenaline is extremely effective. Stronger concentrations are unnecessary and can be dangerous. Marcaine (0.5%, maximum dose of 10 to 15 cc) is useful for operations lasting more than 45 minutes. Our current practice is to use a 50/50 mixture of Xylocaine 2% with epinephrine 1:50,000 and marcaine 0.75%. This yields a final concentration of Xylocaine 1%, marcaine 0.375%, and epinephrine 1:100,000. At UCSD we call this the Gold Solution and use it for all local injections. Xylocaine provides rapid, excellent anesthesia. Although Marcaine has a slower onset and is not as efficacious, the 4 to 8 hours of anesthetic it provides permits pain-free injections for long cases and leaves the patient with little or no discomfort for several hours after surgery. The epinephrine is necessary to (a) decrease local blood flow and (b) counteract the vasodilation of the Xylocaine and marcaine.
7. Operative technique*

The goals of surgery are to perform the necessary excision and reconstruction effectively, efficiently, and atraumatically. Incisions are most commonly made with a scalpel. Generally speaking, the larger the scalpel blade, the greater the available cutting surface; hence, the use of smaller scalpels is discouraged. A No. 10 blade should be used where possible. No. 15 blades and occasionally some of the smaller Beaver blades are all excellent. When making a series of angulated incisions, a No. 11 blade held in a vertical fashion can also be effective. Where cosmetic reconstruction is important, cautery is unfavorable for incisions. More and more surgeons are making skin incisions with cautery and with lasers. While on the neck, the chest, and the abdomen this practice has not resulted in any obvious compromise to wound healing, such practices are not recommended for facial surgery.

For patients with inherent bleeding disorders, incisions can be made with the laser. This technique presumably compromises the final cosmetic result and is substantially slower than using a scalpel, but in unfavorable coagulopathies may be employed. For very thin skin, such as that around the eyelid, a scissors is an effective cutting tool. While there is some theoretic disadvantage to the crushing injury created, the scissors work well in practice.

Undermining is important for wound closure as well as for tissue rearrangement. There has always been controversy as to the extent of undermining that is optimal. It is our practice to undermine 1 to 2 cm in almost all cases, because we believe that this provides the maximum tissue mobility with minimal compromise to wound healing. Some believe that additional undermining provides additional skin and decreases the tension of wound closure. This has not been our experience. Additional undermining (especially when extensive) compromises blood supply and wound healing and predisposes to hematomas and to infection. For these reasons over-extensive undermining is discouraged.

Hemostasis is an important concept. Small bleeders at the wound edge stop with time and pressure. Larger bleeders can be controlled by cautery, and named vessels by suture ligation. The excessive use of cautery damages tissue and interferes with wound healing; hence, it is advised that nature be given a few minutes to control the small bleeders and that cautery be saved for the larger bleeders that do not contract and clot on their own. We have all witnessed surgeons who make an incision with a scalpel and then literally char both edges of the wound with cautery in an effort to gain total hemostasis. This practice is discouraged, since it compromises wound healing and the ultimate cosmetic result.

Subcutaneous suture placement has several goals: (1) to reduce dead space; (2) to help align respective wound edges; and (3) to reduce tension along the wound closure. The classic subcutaneous closure encompasses small bites of dermis with sutures placed immediately at the wound edge. This is depicted in Fig 2.

* The current technique for subcutaneous suture placement is also described in the Appendix (Laryngoscope 1987;97:501-504).
There are three disadvantages to the classic placement as follows:

1. When sutures are placed immediately at the wound edge, they exert their influence only for a short distance on either side of the suture, which necessitates many stitches along the wound edge. While this varies greatly from surgeon to surgeon, it is customary to place the suture minimally at every 5 to 10 mm along the wound.

2. The suture at the wound edge encompasses the subdermal vasculature supplying blood and oxygen to the wound. Each stitch, therefore, occludes the blood supply, potentially interfering with wound healing.

3. The dermal stitches invariably pull wound edges flat and interfere with the surgeon’s ability to evert the wound edge.

An alternate subcutaneous suture placement has been used by the senior author for several years. It is effective and remedies all of the disadvantages of the classic stitch. As shown in Fig 3, the wound edges are undermined for a minimum distance of 1 cm. The wound edges are everted, and the subcutaneous suture is placed through the subcutaneous tissue and the deeper dermis 8 to 10 mm back from the wound edge. The same thing is accomplished in the apposing tissues. The suture is tied and the tissues pulled together to a degree that eversion of the upper dermal edge is created. The advantages are clear. Fewer stitches are required, the blood supply at the wound edge is not compromised, and a maximum amount of wound eversion is obtained.
Skin closure is critical for a good cosmetic result. The techniques vary from surgeon to surgeon, and no single technique has been proven more effective than another. Certainly, the goals are to align the epidermal surfaces and to create some degree of eversion. This should be done without compromising blood flow to the wound edge and must also be done so that the sutures can subsequently be removed relatively atraumatically. All of the techniques currently used have advantages and disadvantages. Steristrips or other tape dressings have not been popular as they do not reliably maintain perfect wound apposition, and they invariably flatten edge eversion.

Some form of glue, biologic or nonbiologic, holds promise for the future. None, currently available, are widely accepted.

Conventional closure employs interrupted or running stitches using a fine monofilament suture such as nylon or Prolene. Whether these are placed as simple interrupted sutures, vertical mattress interrupted sutures, running sutures, or subcuticular sutures is a personal preference.

Rapidly absorbable skin sutures also are available. Most of these are called fast-absorbing gut. These sutures appear to work effectively, have the tremendous advantage of being absorbable, and hence do not require removal. For the
majority of skin flaps on the face, these sutures are preferred. In certain areas, such as sebaceous skin of the nose or the more slowly healing skin of the torso and extremities, they appear to dissolve too quickly and therefore their use is discouraged. The majority of surgeons using fast-absorbing gut sutures, a technique popularized by Dr. Richard Webster, use it as a locking running stitch, and this practice is continued to date. Stapling is becoming increasingly popular for larger wounds, particularly those in which cosmetic preciseness is not demanded. For facial flap reconstruction, the staple is still too gross and tends not to be used.

Dressings are an important part of wound healing. Occlusive dressings generally give superior cosmetic results but increase the risk of wound infection. For facial wounds, this risk is so low that it can be disregarded, but for body wounds it has to be considered. The ideal dressing has three layers: The first is a non-adherent layer (Opsite is an excellent example). The second is an absorbent layer so that blood and fluids oozing from the wound are absorbed. The third is a pressure layer, and any form of stretchy tape or bandaging material is satisfactory. Interestingly enough, a Band-Aid is the ideal bandage but works only for smaller wounds. Larger wounds can be covered with Telfa, gauze, and tape, and many wounds where pressure is not important are easily maintained by simply covering them with a bacterial static ointment such as Bacitracin, with no other dressing.

Various medications have been suggested to complement wound healing. Use of antibiotic ointment on the wound is discouraged since it does nothing to assist wound healing and is known to cause local allergic reactions. Hydrogen peroxide is an excellent blood cleaner but an even better tissue destroyer; its use is strongly discouraged. Medicaments, such as zinc, vitamin C, vitamin E, and others (provided the patient is adequately nourished), have no proven benefit in wound healing. They also cause no harm. If a patient feels better about using topical ointment, there is no reason not to be supportive. Preoperative, operative, and postoperative antibiotics are recommended for dirty wounds but not for routine, clean surgical wounds.

Finally, a word about tissue handling. The more respect a surgeon has for tissue and the manner in which it is treated, the better the results will be. Sharp knives and scissors are mandatory, and careful, gentle grasping of tissue is a must. The surgeon who repeatedly grabs chunks of tissue, crushing them within a heavy forceps, is doomed to mediocre results. Tissue must be treated with the utmost respect. It does not matter whether you use a skin hook, a Bishop Harmon forceps, or a Brown Adson forceps; it does matter how carefully you use them. With the current concern about transmission of acquired immune deficiency syndrome (AIDS) and hepatitis, skin hooks are used less and less and forceps are used more and more. Forceps can be used gently and effectively and are, without question, safer for the entire operating room staff.
INTERIM QUIZ 1
(SELECT THE BEST RESPONSE-ONE OR MORE FOR EACH QUESTION.)

1. Which of the following are important considerations in the excision of skin lesions?
   a. the patient's psychiatric makeup
   b. the patient's general medical health
   c. the proper "adequate margins" for complete excision
   d. the type of skin lesion

2. List the four favorable sites for incisions.
   a. 
   b. 
   c. 
   d. 

3. Loose skin is best discovered on a face by which of the following?
   a. study of FSTL
   b. past experience
   c. feeling with the surgeon's fingers
   d. trial and error

4. A 1-cm lesion in the occiput is to be excised. How much hair peripheral to the excision should be shaved?
   a. 1 to 5 mm
   b. 5 to 10 mm
   c. 1 to 2 cm
   d. at least 2 cm

5. You wish to make a 1% Xylocaine solution with 1:100,000 adrenaline. The nurse gives you 50 cc 1% Xylocaine and 1 cc of 1:1,000 adrenaline. How much of the adrenaline solution should be added to the 50 cc of Xylocaine?

6. The pain of injection after needle insertion is caused by which of the following?
   a. pressure
   b. acidity
   c. alkalinity
   d. the burning of Xylocaine
7. The authors would probably use which of the following sutures to close the subcutaneous layers of a 3-cm linear facial wound?
   a. 4-0 Vicryl or Dexon
   b. 4-0 chromic gut
   c. 3-0 plain gut
   d. 4-0 nylon
   e. 4-0 silk

8. Skin closure of the wound in question 7 would be with which of the following?
   a. 6-0 nylon suture on a P 1 needle
   b. 5-0 Prolene suture on a P 3 needle
   c. 6-0 chromic suture on a P 1 needle
   d. 6-0 fast-absorbing gut suture on a CE 2 needle
   e. 4-0 Prolene suture on an FS 2 needle

9. Which of the following are medicaments that are helpful in preventing wound infection, but not harmful to tissue?
   a. Betadine surgical scrub
   b. normal saline
   c. hydrogen peroxide
   d. systemic antibiotics
   e. Betadine solution

10. Which of the following is the type of scar that is most difficult for the human eye to recognize?
    a. fine, straight scar
    b. wide, flat scar
    c. fine, contracted scar on a convex surface
    d. hypertrophic scar
    e. fine, broken-line scar
    f. fine, curved scar
**INTERIM QUIZ 1 ANSWERS**

1. a, b, and c. If all these factors are not properly evaluated, the surgeon is asking for trouble.

2. a. in an orifice  
   b. in hair or hairlines  
   c. at the junction of one aesthetic area with another  
   d. in or parallel to FSTL

3. c. Feeling is the best way to discover mobile tissue because every person is different. Let your fingers be your guide.

4. a. Hair is not dirty enough to contaminate scalp wounds, so the minimal margin of shaving is acceptable. This is not to mean that a craniotomy can be done without shaving, nor is it an excuse not to wash your hair. This is just to point out that too much hair is shaved too often.

5. c. A solution of 0.5 cc of 1:1,000 adrenaline mixed with 50 cc of 1% Xylocaine solution will give a final adrenaline concentration of 1:100,000. Actually, the adrenaline solution should be added to 49.5 cc of Xylocaine, but we can ignore this small dilution error.

6. a and b. The injected fluids cause the tissues to be distended, resulting in a pressure pain. The acidity of many stock anesthetics can cause a burning sensation.

7. a. Vicryl or Dexon would be the authors' suture of choice for most subcutaneous closures. Other surgeons use many of the other sutures listed. The pros and cons have been discussed in the text.

8. d. Although any of the sutures except choices c and e might be used, the 6-0 fast-absorbing gut suture has been found most useful by the authors.

9. b, d, and e. Detergents and harsh chemicals are injurious to wounds.

10. e.
B. Advancement Flaps

Advancement flaps include any design in which the skin edges are undermined and advanced directly into the open wound. Two major types of advancement flaps will be discussed: the fusiform excision and the rectangular advancement flap. The classic advancement flap is the fusiform excision, often misnamed an ellipse. A true ellipse has rounded edges; these would be difficult to incise and would surely be prone to protrusions when closed. (Tissue protrusion is the proper terminology for the "dog ear.") A fusiform excision has acute angles at each end and is the design most commonly used for excision of small skin lesions. Much discussion has been devoted to the optimal angle at the ends of the fusiform excision; 30° is the angle commonly accepted by most surgeons. This varies with the skin thickness and elasticity. In thick, nonelastic skin, such as the scalp, angles of less than 30° may be necessary to avoid tissue protrusions, whereas in thinner, elastic skin, such as the cheek, angles as large as 45° to 60° may be perfectly reasonable. The surgeon learns to choose the proper angle by experimentation, judgment, and experience.

1. Fusiform excision

Figure 4 shows the classic design of a fusiform excision for a circular lesion. For practical purposes, the lesions drawn throughout this SIPac will be assumed to include appropriate margins. The angles at either end are 30°; this is the classic fusiform excision.

![Fig 4.—Fusiform excision for circular lesion. Angles of 30° used at either end.](image)

The fusiform excision can be tailored to the design or configuration of the lesion and is particularly well suited for lesions that have a somewhat fusiform shape, such as the one drawn in Fig 5. Notice how much less normal tissue is

![Fig 5.—Fusiform excision for elliptical lesion. Angle of 30° is used at one end and 45° angle at the other. Note how shape of excision can follow curvature of lesion.](image)
removed in this excision than is in the excision of the circular lesion (Fig 4). Although 30° is the optimal angle to avoid tissue protrusions, this angle can be increased in loose, elastic, thin skin or in areas where a slight protrusion might not be seen. The right side of Fig 5 depicts this. If this lesion were on the left side of the forehead, then the 30° angle would be used medially where cosmesis was important, and the 45° angle would be hidden in the temple where the skin has hair to hide the tissue protrusion.

The sides of the fusiform excision need not be perfectly straight. One should create curves that follow the FSTL. Figure 6 depicts a lesion in an area where the FSTL are curvilinear. The fusiform excision is designed so that when closed, the final scar will parallel the FSTL.

Optimal cosmesis results when the final scar lies in an already existing wrinkle. This is shown in Fig 7. The line running through the middle of the diagram represents a forehead wrinkle. As drawn, the lesions lies mostly beneath the wrinkle. It is not sufficient to just perform an excision as drawn in Fig 4 and elevate only inferiorly, thereby advancing only the lower edge up to the wrinkle. Healing would pull the wrinkle down and the scar would then be unfavorable. Preferably, the physician must excise equal amounts of tissue on either side of the wrinkle. This will require excision of additional normal, healthy skin, but the closure will now fall in the wrinkle, producing a favorable scar.
When closing advancement flaps, the question is often asked, "How far should one undermine?" There is no single correct answer. The further one undermines, the greater the risk of bleeding and tissue damage. On the other hand, it is necessary to undermine far enough to allow a relatively tension-free closure. The greater the tension of closure, the greater the likelihood of scar widening. Since the centers of the fusiform excision require greater mobilization, wider undermining is necessary in these areas. There is some experimental and theoretic evidence that undermining more than 2 cm is not useful and may even be harmful.

Fig 8.—Fusiform excision showing area of undermining (stippled area). Undermining should be sufficient to allow relatively tension-free closure and in many areas will require more extensive undermining than shown here. Right, "Cheating" by using 45° angle instead of 30° angle; not much tissue is saved, but ultimate length of scar is shortened. Left, Advantages of using two 30° angles. This is called M-plasty. Area filled by diagonal slashed lines is area saved by using M-plasty. M-plasty saves approximately 50% of healthy tissue that would have to be excised to affect closure for this basically circular lesion.

One of the real problems with the fusiform excision is that for a circular excision, a moderate amount of normal, healthy skin is excised. This can be lessened by increasing the excision angles, but as can be seen on the right side of Fig 8, not much is saved by increasing the angle to 45°. A 60° angle would save even more skin, but the risk of tissue protrusion becomes progressively greater. Another way of reducing normal tissue excision is to use an M-plasty. This is outlined on the left side of Fig 8 and will save about as much normal skin as using a 60° angle, but with no more risk of tissue protrusion than was present with the 30° angles. Approximately half of the healthy skin to be excised with 30° angles is saved with 30° M-plasties. An M-plasty is constructed by placing two 30° triangles side by side. For the less experienced physician, this can be constructed geometrically by halving the distance from A to C and using this as the apex of the smaller 30° triangle. A line is drawn to the midpoint of the circular excision (D). The same design is then repeated on the other side, namely from E to D. A previous publication listed in the bibliography covers M-plasty in more detail. Closing the M-plasty is easily done with a half-buried mattress stitch, which is depicted in Fig 9.
Fig 9.—Closure of lesion in Fig 8. Upper half shows closure of lesion using M-plasties at either end and lower half shows closure if straight 30° angle fusiform excision were closed. Note how much shorter scar is for closure of M-plasty and how concept of broken line is employed here. Area in magnifying glass shows half-buried mattress stitch used to close and to advance tip of M-plasty, thereby further shortening ultimate length of scar.

The M-plasty is called a W-plasty by some. The authors discourage use of this term because it might be confused with a running W-plasty—a technique of scar revision. Another advantage of the M-plasty is that it shortens the straight length of the wound. In Fig 9, the upper half shows the closure of the circular lesion from Fig 8 using 30° M-plasties at both ends. The lower half shows the closure using a regular fusiform 30° angle excision and closure. Note how much longer the lower closure is without the M-plasty. Also note the broken-line or irregular pattern created by the M-plasties. This is cosmetically desirable and is enhanced by advancing the tips of the M-plasties centrally.

One of the central themes of this SIPac is the description of the pulls and pushes created by local tissue flaps. This is called flap dynamics and assists the surgeon in choosing a flap design and predicting its consequences. To demonstrate this, three illustration techniques will be used. First, two large squares of Elastoplast tape have been applied back to back with the two pieces oriented at 90° to each other. When local flaps are designed and closed on this two-layered material and photographed on a grid background, one can visualize not only the compressions, depressions, and protrusions created by the closure but also
the distortion of the edges of the Elastoplast against the background grid. This first model should be practiced by all persons wishing to understand flap dynamics. Elastoplast is not exactly like skin because it is not as elastic and is not attached to underlying tissue. Protrusions and depressions are therefore exaggerated, and this makes an excellent first study model. In the second illustration technique, fresh cadavers were used. Two- to three-centimeter squares were outlined and then incised 1 cm outside the square so that each square of skin could react independently of surrounding tissues. The various flaps were then outlined, excised, and closed. Photographs show the protrusions and depressions as well as the distortions of the surrounding skin square. If fresh cadaver material is available, it is helpful to try these flaps as depicted because cadaver skin resembles the clinical situation more closely than does the Elastoplast model. The results are often enlightening even to the experienced surgeon. Finally, since the ultimate value of these principles lies in their practical application, the use of these flaps will be demonstrated with case examples.

Figure 10 (top) shows the classic fusiform excision on Elastoplast and Fig 10 (bottom) shows its closure. As predicted, the closure shows the pulling in of the top and bottom edges. Using 30° angles, there are no real protrusions. The right and left borders are pushed outward. This should be expected because by pulling the top and bottom together the excess length caused by the curvilinear incision pushes right and left, thereby pushing these borders out. Figure 11 (top) shows a fusiform excision using 60° angles, and Fig 11 (bottom) is its closure. As is seen, there is the same pulling in of the top and bottom. At the two extremes of the fusiform excision there is a significant degree of protrusion and distortion. In fact, this is so severe on the Elastoplast model that the outpushing of the right and left borders seen in the 30° fusiform excision is not present.

Figure 12 shows the design, excision, and closure of a 30° fusiform excision using bilateral 30° M-plasties. This closure shows less distortion of the top and bottom borders. In part, this is because less Elastoplast is excised. If this were the only advantage, it really should not differ from the 60° fusiform closure. However, it does differ because in closing the fusiform excision with M-plasties, the triangular flap of each M is advanced centrally, thereby filling in some of the tissue loss of the defect. There is a little protrusion and depression around the M-plasties. This increases as the M-plasties are advanced centrally. In practice this is typically not a problem. The pushing outward of the right and left sides is not seen here. This, too, is under the control of the advancing M-plasty, since with advancement, the outward push is reduced. With extreme advancement there might even be a pulling seen at these borders. If there is not sufficient tissue for easy flap closure in the vertical dimension and if there is more tissue present laterally, then M-plasty advancement could be used to alleviate closure tension. These changes are under the complete control of the knowledgeable surgeon. In practice, most surgeons who are proficient with M-plasties rarely perform any excisional surgery without using them. Virtually anytime a 30° angle is used, the surgeon should consider whether using two 30° angles, namely an M-plasty, might improve the result.
Fig 10.—Elastoplast model of fusiform excision. Top. Design of the fusiform excision around circular lesion. Bottom. Closure. Note that the top and bottom are pulled centrally and two sides are pushed outward.
Fig 11.—Elastoplast model of fusiform excision using 60° angles. Top, Design of excision. Bottom, Closure. Note that square Elastoplast has now been changed into a rectangle. There is rather severe deformation around 60° angle closure that was not present in 30° angle closure.
Fig 12.—Fusiform excision employing M-plasties. Top, Fusiform excision using 30° angles. M-plasty drawn is using two 30° angles at either side. Center, Excision of lesion. Note that tissue remaining is saved because M-plasty rather than classic fusiform excision was used. Bottom, Closure. By advancing M-plasty centrally, relatively little deformation of the original Elastoplast squares exists. Some protrusions exist in areas around the M-plasty. In tissue, these would flatten with time.
Fig 13.—Fusiform excision on fresh cadaver skin. Top, Design. Angles greater than 30° are used here. Bottom, Closure. Note that top and bottom are pulled centrally and two sides are pushed laterally. Protrusions are present more prominently on side employing original 60° angle. In elastic tissue, even this might be acceptable.
Fig 14.—Fusiform excision with M-plasty on fresh cadaver skin. Top left, Design. Top right, Excision. Bottom, Closure. In this case, M-plasties were not advanced centrally. Therefore, a great deal of pull has been exerted in vertical dimension and outward push as noted in classic fusiform excision is also present here. Note that as this occurs there is little tissue protrusion at apex of angle closures.

Fig 15.—Rectangular advancement flap to close a square defect. Bürow's triangles are used to take up discrepancy in tissue lengths. Note different orientations of two Bürow's triangles and change in orientation of resultant scars. Half-buried mattress sutures are used at tips of advancing rectangular flap.
Figure 13 shows a fusiform design, excision, and closure on fresh cadaver skin. An asymmetry exists in the design; this becomes more obvious after excision and is reflected in the closure. In practice, this error would have been corrected before the scalpel was used. The error was left here to illustrate how attention to even minute detail is critical to the proper execution of this type of surgery. The closure shows the inward pulling of the top and bottom borders. It shows virtually no protrusion at either end of the fusiform excision, and it does confirm the outward push created on the right and left sides of the outlying box. Figure 14 shows the same series for a fusiform excision with bilateral M-plasties. The closure reveals a similar inward pulling of the top and bottom borders. Note that in all these designs, much can be learned by observing the change in the original square’s shape. In all these fusiform excisions, squares are converted to rectangles. There are no significant protrusions at any of the 30° angle closures. These M-plasties were not advanced centrally, so the lateral borders are pushed outward as seen in the classic 30° fusiform excision. This lateral movement associated with the M-plasty can be conceptualized as a V-Y maneuver or a V-V maneuver. If the M-plasty is allowed to be pushed laterally, then it is really a V-Y maneuver, which would elongate the incision and push the two lateral borders outward. If the M-plasties are pulled centrally, then it is similar to a V-V maneuver in which the length of the single linear incision is shortened. The two lateral borders are pulled inward and, of course, less distortion of the square occurs. Advancement of the M-plasties will usually produce slight protrusions at each of the 30° angles, but unless severe, these are normally imperceptible by the second week after surgery.

2. Rectangular advancement flap

The second common type of advancement flap is a rectangular advancement flap which is used to close a square or rectangular defect. These flaps are often small, 1 to 3 cm wide and 2 to 6 or 7 cm long, e.g., used for closing an eyelid defect. However, they can be used in larger proportions (e.g., to resurface a large midline forehead defect). This would be similar to advancing two half forehead flaps. Figure 15 illustrates the classic design of this flap. A square excision is made. Favorable skin tension lines run horizontally and there is little skin excess in the vertical direction (as shown in this diagram), but there is good skin mobility and skin excess in the horizontal dimension. The flap is cut, undermined, and advanced into position. Flap advancement leaves some tissue protrusion of the skin on either side of the rectangular flap. This protrusion can be handled by excision of triangular pieces of skin (Burow’s triangles) as diagrammed. Two designs for triangular excisions are shown, a right-angle triangle and an isosceles triangle. Closure of these different orientations leaves a final scar which can lie either perpendicular to the advancement flap or at an angle to it. Choice of triangular shape used is governed by regional FSTL. Normally, in an attempt to share the pulls of closure, the base of the triangular excisions should be half that of the distance the flap is advanced. In this case, the sides of the defect are 2 cm and the rectangular flap is advanced 2 cm. The bases of the triangular excisions are 1 cm.

A variation of this flap is to use two rectangular advancement flaps, one on each side, as shown in Fig 16. Each of these flaps is only advanced half as far as the single flap design in Fig 15. Although this requires more incisions, it does
decrease the tension on the advancing flaps. Techniques of flap to surrounding tissue equalization are again shown. Since these flaps are only advanced 1 cm each, the triangular defects only have bases of 0.5 cm. Z-plasty is an effective alternate way of sharing the pulls of closure by transposing tissue from flap to outside and vice versa. They can be used as shown at either end. Both designs are equally effective, and the orientation of the Z-plasty lateral limbs should be determined by the direction of the FSTL. Two Z-plasties should not be used at the base of a rectangular advancement flap because the incisions for the lateral limbs narrow the base of the advancement flap. If Z-plasties were performed on both sides of the same flap, the flap blood supply would be seriously jeopardized. Hence, a good design might use one Z-plasty and one triangular excision on each advancement flap. The vertical portion of a rectangular advancement flap often lies perpendicular to the FSTL and can contract. A Z-plasty designed as shown will "break up" this vertical limb of the final scar and make it less apparent. It will also give it some degree of lengthening.

In closing a rectangular advancement flap, several subcutaneous sutures are needed in the advancing edge to relieve the tension of closure. Subcutaneous sutures along each side are rarely needed and if used must be carefully placed to avoid compromising the blood supply. For example, it would be a disaster to use a Z-plasty (or even worse, two Z-plasties) at the base of the flap and then also place large subcutaneous sutures at the flap base, further compromising the blood supply.
Fig 16.—Two rectangular advancement flaps to close square defect. Wide variety of triangular excisions and Z-plasties can be used to take up tissue length discrepancies and to break up and lengthen resultant scars.

Figure 17 illustrates the rectangular flap design on Elastoplast. Figure 15 (top left) shows the basic design and Fig 17 (top right) is after excision and closure. The upper and lower edges have obviously been advanced centrally. There is no distortion of the two lateral borders. There is definite bunching of the edges outside the flap. This is due to the discrepancy in tissue length, namely closing two edges of unequal length. Figure 17 (bottom left) shows the design of the triangular excision to correct these protrusions, and Fig 17 (bottom right) shows this pattern after excision and closure. Nothing has been changed in the distortion of the surrounding tissues, i.e., the outside borders of the Elastoplast. The protrusions next to the flaps are now gone, and whatever discrepancy might be left in the opposing edges can be relieved by distributing the inequities while suturing. Note that four new scars have been added in this process. Unless the surgeon is both lucky and skilled, these scars will lie perpendicular to FSTL; this is an unfavorable prospect. Also, one should not use two Z-plasties at the base of a flap—the reader MUST know why not.
Fig 17.—Rectangular advancement flap on Elastoplast. Top left, Square in center will be excised and then two rectangular flaps will be advanced centrally toward each other. Top right, Following excision. Two flaps have been advanced. Note severe pulling from top to bottom with no distortion from right to left. Discrepancies in tissue length have resulted in protrusions seen here on Elastoplast model. Bottom left, Protrusions are improved by excisions of triangular pieces of tissue as outlined here. Bottom right, Following excision of triangles and after closure. Note improvement in tissue length discrepancies. Final pulls of flap are now readily apparent.

Figure 18 shows the same flaps on the fresh cadaver skin. In Fig 18 (top left) the flaps and protrusion corrections are designed. Note several important features: Two differently shaped triangular excisions are outlined on the bottom. These cause differently oriented scars when closed and should be considered when trying to orient scars to fall in FSTL. On the top, two Z-plasties are drawn. This is not a good design in practice because the flap would have virtually no blood supply. It is done here only to illustrate the dynamics of Z-plasty. Figure 18 (top right) shows the flap after excision. Note that the surrounding "square" is not really square. Figure 18 (bottom left) shows the flaps cut, undermined, and closed before the triangular excisions and Z-plasties were performed.
The right and left borders are pulled centrally. The top and bottom are not altered and there is some discrepancy in the flap sides vs the tissues to which they will be sutured. These are not major problems, but the results will be better with the adjustments as designed. The triangular excisions are made and then closed and the Z-plasties transposed (see Fig 18, bottom right). On the bottom the border is still pulled in, but the sides are unaltered. There are no tissue length discrepancies. On the top, the lengthening caused by the Z-plasties has now pushed the border upward, which is different than the opposite side. The tissue to do this has been borrowed from the horizontal dimension.

Fig 18.—Rectangular advancement flaps on fresh cadaver skin. Top left, Design incorporating two Z-plasties and two different types of triangular excisions. In clinical situations, one would not use two Z-plasties at base of flap (as shown here). Top right, After excision of square defect. Bottom left, Primary closure of advancement flaps without triangular excisions or transpositions of Z-plasties. Bottom right, After triangular excisions and Z-plasty transpositions. Side that was pulled in by rectangular advancement flap is now pushed out by lengthening caused by Z-plasty. Two sides are now pulled centrally. Little problem is encountered in tissue length discrepancy.
Compare the alteration in shape of the surrounding square from Fig 18 (top left) to Fig 18 (bottom right) to see the dramatic inward pulling caused by the Z-plasty. Tissue excesses and protrusions are well absorbed by this technique. Again note the narrow pedicle left between the two Z-plasties, which would almost totally devascularize the advancement flap.

In summary, the rectangular advancement flap is a strong flap for certain situations, but it leaves long scars. If poorly planned, it may not be cosmetically favorable. This flap is an excellent intellectual exercise. In practice it is rarely used for small facial tumors.

3. Patient applications

Thus far, discussion has included a lot of theory. It is now time to look at some actual patient applications. The reader is advised to study each case, draw the local anatomy, and prepare a solution to the case at hand before reading the authors’ solutions. Obviously, there are many ways to approach any lesion, but the solutions used have been chosen for their application of the principles being taught. Actually, when a lesion is to be excised, it is good practice to design two or three different potential flaps and then choose the best one.

The first case is designed to demonstrate some of the disadvantages of skin grafts. The patient in Fig 19 (left) has recurrent basal cell cancer on his temple; this was previously excised and covered with a split-thickness skin graft. Figure 19 (right) shows the area after reexcision of the lesion using frozen-section control. This was a recurrent lesion performed prior to Mohs. It was elected to use a skin graft for cover. Reconstructive surgery can be performed two years later if there is no further recurrence. A full-thickness skin graft was chosen because of its superior cosmetic covering as compared with the split-thickness graft. Before reading further, plan the type of flap you would use to close the donor site.

The graft donor site was mapped out on the excess anterior neck skin as shown in Fig 20. M-plasties were used to decrease the length of the cervical scar. The graft was sutured in place under a bolster dressing as shown in Fig 21. The fusiform neck incision was closed with two straight advancement flaps as shown in Fig 22 (bottom left). Two weeks postoperatively, the graft had a dry, black crust as shown in Fig 22 (top left). This was a superficial slough due to inadequate trimming of subcutaneous fat or from a postoperative hematoma. Superficial sloughs like this should not be debrided since they will usually epithelialize and, as seen 3 months later in Fig 22 (top right), will usually heal nicely. Even at this early stage, one can see the result is cosmetically superior to the old split-thickness skin graft located just anterior to it. The full-thickness graft is not as depressed and has much better color. The neck donor site also healed well but not perfectly (Fig 22, bottom right).
Fig 19.—Epidermoid skin cancer of temple. Status: after excision and split-thickness skin graft, recurrence noted at posterior margin now involving skin graft. Left, Prior to excision. Right, After excision with frozen-section control. Full-thickness skin graft will be used for closure.

Fig 20.—Full-thickness skin graft outlined on neck. Long axis is running horizontally and parallel to FSTL of neck.

Fig 21.—Full-thickness skin graft sutured in place.
Fig 22.—Top left, Graft site 2 weeks postoperatively. Superficial slough present. Top right, Three months later, graft is well healed. Note improved quality of full-thickness graft as compared with older, split-thickness graft. Bottom left, Closure of neck incision. Bottom right, Three-month follow-up on healing of donor site in neck.
The next case is a small intradermal nevus (Fig 23, top left). Before reading further, decide what type of excision you would use, considering the aspects of the site that would be of help in achieving a satisfactory cosmetic result.

The location of the nevus made a fusiform excision design necessary so the resultant scar would lie in the boundary of one aesthetic area with another. Look at the proposed excision (Fig 23, top right). The scar will lie in the boundaries of eyelid with cheek and eyelid with nose. The scar will be curvilinear, as are these boundaries. M-plasties were not needed because the skin here is thin and elastic, and a 45° angle could be used at each end of the fusiform excision. This design, when tested with finger palpation, did not distort the lower eyelid. Figure 23 (bottom) shows the scar 5 months later. The scar is difficult to find and, unless one knew where to look, would not be noticed.

The next case (Fig 24) is a twice-recurrent hemangioma. Before reading further, decide what type of excision you would use to obtain the best cosmetic result.

A fusiform excision was designed. Since the FSTL run vertically on the lip, a horizontally directed excision scar would lie perpendicular to the FSTL and would give a less satisfactory result. However, in designing this excision the physician should not allow the vertical incisions to extend onto the white skin above the vermiliocutaneous junction because an extremely careful reapproximation of this border would be mandatory to prevent an unsightly step-off when healed. To avoid this difficulty, the vertical fusiform excision required a 60° angle superiorly, which is possible because lip skin is thin and elastic. Where muscle was incised, it was carefully reapproximated as a distinct layer. Figure 24 (bottom) shows the resultant scar 2 months postoperatively.

Figure 25 (top left) shows a larger and somewhat more complex case involving cancer of the lower lip and an old scar on the left side of the chin. Before reading further, plan the excision and closure that you would use to achieve the best functional and cosmetic result.

Advancement flaps were chosen for this excision as marked in Fig 25 (top right). Recall that FSTL run vertically on both the lip and chin. One of the potential problems to consider here is scar contracture, which could depress the lip. By closing a wide-angle fusiform excision as designed here, the wound will become lengthened; however, if this is inadequate, a properly placed Z-plasty can be used to augment the length. Another consideration is that a straight scar across a concavity can contract and produce a web. A properly designed Z-plasty can lengthen this scar and prevent webbing. The tension of the Z-plasty closure will be horizontal and, if the Z-plasty is properly placed, will augment the natural depression that occurs approximately halfway from lip to chin. The Z-plasty was not included in the original planning, but it was found to be necessary and was therefore added as is seen in the immediate postoperative view (Fig 25, bottom left). Superiorly, a 60° angle is again used on the lip and will be successful because the skin is thin and elastic. However, the inferior end of the planned fusiform excision would cut directly across the boundary of the lip with the chin, which would be catastrophic. To solve this problem, two incisions are extended laterally in either direction along the boundary of the chin with the lip. The scar on the chin is treated with a fusiform excision
such that the resultant scar lies parallel to the boundary of one aesthetic area with another (the chin with the cheek). An M-plasty was not used here because the lesion itself was basically fusiform, and there was no extra healthy skin at the ends of the excision. The 6-month follow-up is seen in Fig 25 (bottom right). The result of the lip excision would have been better if the wound edges had been better everted in the closure. This and perhaps a little more lengthening would have helped to prevent the depression seen in Fig 25 (bottom right). This scar really lies in the FSTL and not in the boundary of chin with cheek, but it so approximates this boundary that it is acceptable.
Fig 23.—Skin lesion of lower eyelid. Top left, lesion. Top right, Planned excision. Bottom, result 5 months postoperatively.
Fig 24.—Recurrent hemangioma of the lip. Top, Lesion. Vertically oriented fusiform excision will be used. Care will be taken so scar will not cross junction of dark skin with light skin of the upper lip. Bottom, Result 2 months postoperatively.
Fig 25.—Skin lesion of lower lip at vermiliocutaneous junction. Top left, Lesion. Note second lesion on far left side of chin. Top right, Planned excision. Essentially, wide fusiform excision will be used superi­orly with 45° angle, and two advancement flaps will be used inferiorly. Bottom left, Z-plasty added to clo­sure to break up straight line and lengthen scar prophylactically. Bottom right, Result 6 months post­operatively.
INTERIM QUIZ 2
(Select the one best answer.)

1. Figure 26 represents a lesion to be excised with advancement flaps using 30° angles. The dashed lines represent FSTL. Design the excision and then draw the closure.

2. Figure 27 shows basal cell forehead lesion. Design a fusiform excision.

3. Figure 28 show a skin lesion of the lower lip. A full-thickness excision is necessary. Using what you know about M-plasties, design a wedge-type excision (palpation of the tissues suggests this is possible). Make a tracing of this anatomy and lesion, and then do your designing on this tracing. Show FSTL and include the boundaries of one aesthetic area with another.

4. Figure 29 shows a basal cell lesion on the forehead just above the right eyebrow. Trace this lesion and its local anatomy. Design two rectangular advancement flaps with triangular excisions and Z-plasties as needed to obtain the best closure of this defect.

5. An M-plasty is to be used in an otherwise simple fusiform excision. It is believed to be desirable to shorten the length of the scar as much as possible by proper use of the M-plasty. What is this called?
   a. Y-V maneuver
   b. V-Y maneuver

6. If an excision of a 1-cm defect is closed with a single rectangular advancement flap, a tissue protrusion is created at the base of the advancing flap. This is corrected with a triangular excision of skin. As a rule, how wide is the base of the triangular excision?

7. Simple fusiform excisions are not used for all facial lesions. Why?
Fig 26.—Interim Quiz 2, question 1. Skin lesion to be excised by advancement flaps.

Fig 27.—Interim Quiz 2, question 2. Basal cell lesion of forehead.
Fig 28.—Interim Quiz 2, question 3. Epidermoid carcinoma of lower lip.

Fig 29.—Interim Quiz 2, question 4. Basal cell tumor of forehead. Dotted lines show suggested excision.
INTERIM QUIZ 2 ANSWERS

1. The authors' design is shown in Fig 30A and the closure in Fig 30B. If you failed to use at least one M-plasty, you are not yet oriented to its use. The sloping of the final scar must follow the FSTL as shown here. If yours does not, draw a couple of elongated lesions with variously directed FSTL and design their excisions and predicted closures.

![Fig. 30](image)

**A**

![B](image)

**B**

Fig. 30—Interim Quiz 2. answer 1. Excision and closure of lesion diagrammed in Fig 27.

2. Figure 31 (top) shows the authors' excision and Fig 31 (bottom) shows a 3-month follow-up. If you failed to use M-plasties at both ends of this excision, you have failed to understand their use. It is crucial that the final scar run horizontally because that is the direction of the FSTL. A vertically running scar is a cosmetically inexcusable error.
Fig 31.—Interim Quiz 2, answer 2. Top, Excisional design. M-plasties are incorporated. Bottom, Result 3 months postoperatively.
3. Figure 32 (top) shows the design of the excision, Fig 32 (center) shows the immediate postoperative closure, and Fig 32 (bottom) shows the wound 15 months postoperatively. The M-plasty obviously decreases the vertical height of this scar and also keeps the scar from crossing the boundary from lip onto chin. The splaying of the limbs of the M-plasty is intended to parallel the junction of the lip with the chin. The result would be better if the limbs were placed closer to that junction. They have definitely preserved healthy tissue, which helped make this closure possible. The design shown in Fig 25 (top right) would have been preferable and could easily have been adapted to this full-thickness excision. The Z-plasty, which was extremely useful in the closure in Fig 25 (bottom left) would only have been used here if sufficient tissue was present in the horizontal dimension. If the skin was already tight in the horizontal dimension, a Z-plasty to lengthen the vertical scar would have tightened this closure even further and would therefore have been better left for a secondary scar revision, if it was needed. If a Z-plasty was used, it would have only involved the skin side and would not have included the muscle or oral mucosa.

4. This is obviously not the only way to close this defect. A simple fusiform design would normally give a superior result. However, judgment is based on experience; bilateral rectangular advancement flaps were used. Figure 33 (top) shows the surgical plan. The small circle to the left is another lesion and has nothing to do with this particular flap. The triangular excisions are ordinarily designed to fall in the FSTL, and although the one on the right probably does, the one on the left probably does not. The Z-plasty on the left is a good design since there are no vertical FSTL in this area. A better design for the one on the right would have been for the lateral limbs to run in the opposite direction. This would have better paralleled the FSTL in the mid-left side of the forehead. The Z-plasty in the middle of the two flaps is conceptually a good design because it breaks up a scar line running perpendicular to the FSTL and also prophylactically lengthens this scar, which is at severe risk of contracture. However, it has a disadvantage in that it borrows tissue from the horizontal dimension, an area that is already tight, resulting from the design of the skin flaps. This closure is pictured in Fig 33 (bottom). Although this looks good on paper and on the operating table, this flap design leaves a lot of scars, and unless they are neatly hidden in hairlines, boundaries, or wrinkles, the result may not be cosmetically favorable.

5. a.

6. Five millimeters. Normally, a triangular excision that is made in an effort to equalize discordant pulls is half the size of the original excision. This can obviously vary as tissue elasticity varies from site to site, but as a rule it is a good starting point.

7. A simple fusiform excision can be employed in most cases, but there are two disadvantages to its use. First, a straight-line scar is created, and even if it falls into the FSTL, it may not be the most favorable ultimate scar. Second, a fusiform excision (except for minor adjustments with an M-plasty) is not capable of adjusting local tissue pulls and gives. Once a fusiform excision is elected, these tensions are pretty much dictated. For these reasons, a skilled surgeon must master a larger armamentarium of local skin flaps so that he can choose the design best suited to each situation.
Fig 32.—Interim Quiz 2, answer 3. Top, Lesion excised using wedge excision with M-plasties. Apex of M-plasties directed along junction of chin with lip. Center, Closure. Bottom, Result 15 months postoperatively.
Fig 33.—Interim Quiz 2, answer 4. Top, Design of two rectangular advancement flaps using three Z-plasties and two Burow's triangles. Bottom, After excision and closure.
C. Rotation Flaps

A rotation flap is one in which the tissue transfer is brought through an arc into the recipient site. In some cases it may resemble a crooked advancement flap, but it employs a whole different set of dynamics and principles. Figure 34 shows a typical rotation flap to close a triangular defect. It is ideal for closing a triangular defect and, of course, if the FSTL are curvilinear, they may fit a rotation flap better than they do another design. A triangular tissue excision or Z-plasty is often required to equalize the edges of differing lengths, although occasionally the wound can be closed by the principle of halves. Locate the midpoint of the short side and suture it to the midpoint of the long side. Now halve the two crescents on either side of that suture and close them with a stitch in the middle of each side. If you try to close these wounds beginning at one end and progressing to the other, you will often end up with an unneeded tissue protrusion. An important design consideration is to avoid arching a rotation flap with too acute an angle or the blood supply could conceivably be cut off. Rotation flaps usually are relatively large in design and, as outlined in Fig 35, require fairly extensive undermining. If too much tension is found in closure, a backcut can be designed. However, this cuts into the flap’s blood supply and should be done only to relieve excessive flap tension.

A particularly nice design variation is the one shown in Fig 35A, where two rotation flaps are used to close a triangular defect. This would, for the same size defect, require only half as much rotation as the single flap in Fig 34. If appropriate, an M-plasty can be employed at the apex of the triangular defect as shown in Fig 35A. A Z-plasty can be employed as shown on the left side of the lesion in place of the triangular excision shown on the right side. With a wide M-plasty, this now becomes a hybrid between rotation and advancement flaps. A square defect can also be closed using two rotation flaps, as shown in Fig 35B. Normally there are better designs to close square lesions, but on occasion tissue mobility and FSTL might favor this design.

Two rotation flaps can also be used to close a circular defect as shown in Fig 36A. This is often a good choice with favorable resultant scar directions, but some practice, thought, and care are needed in designing these rotations. The tips of the rotation flaps must not be too narrow or they risk necrosis and will not fit together well. Some surgeons solve this by amputating these tips, but in so doing waste tissue. The flap tips must start at least halfway across the circle or they tend to become advancement flaps and generally will be under excess tension. Figure 36B shows the closure of this design. Figure 36C shows the error of starting the flaps too far out on the circle, and Fig 36D shows two flaps that are too narrow at their tips.

The dynamics of rotation flaps are not as easy nor as constant as with the advancement flaps. The Elastoplast model design of a rotation flap and excision of the triangular lesion is shown in Fig 37 (top left and right). The closure demonstrated in Fig 37 (bottom) shows a marked pull right at the end of the rotation flap incision. Much of the protrusion seen at the small triangular excision is a part of this extreme pull. If a longer rotation flap arc had been designed, more Elastoplast could have absorbed some of this pull, thereby decreasing the severe deformity seen here. The slight protrusion and pushing outward of the far right lateral border is an important concept. The triangular excision of the lesion employed a 60° equilateral triangle; therefore, this point involved closing a 60° angle. As previously discussed, one should expect some protrusion if an apical angle greater than 30° is used.
Fig 34.—Rotation flap to excise triangular lesion. Stippled area represents area of undermining; dotted triangle represents triangular excision. Rotation flaps are most appropriate for closing triangular or square defects.

Fig 35.—A, Triangular defect. Note use of M-plasty, Z-plasty, and triangular excision. B, Square defect.
Fig 36.—Closure of circular defect using two rotation flaps. A, Proper design. B, Closure of design shown in A. C, Poor design with flaps started at improper positions. D, Improper design. Flap tips too narrow.

Fig 37.—Rotation flap for triangular excision on Elastoplast model. Top left, Excision of triangular lesion. Top right, Design. Smaller triangle is triangular excision for discrepancy in length of flap. Bottom, Closure with Bürow's triangle excision. Note tremendous pull at end of rotation flap and protrusions of tissue caused by closure of 60° angle at apex of triangular excision.
Figure 38 shows the fresh cadaver demonstration of this flap. The planning and excision are shown in Fig 38 (top left and top right). The triangular excision should take up one quarter to one half of this flap length disparity, and the Z-plasty will cover a similar fraction. The apical angle of the triangular lesion incision is between 35° and 40°, and therefore a protrusion as seen previously on the Elastoplast model should be much reduced. Figure 38 (bottom) shows the closure. Again, the major pull is at the end of the rotation flap incision. This pull should in part be reduced by the push of the Z-plasty; however, in this case the Z-plasty flaps were not transposed. Note how with proper undermining, the pulls are more widely distributed. The original outline in Fig 38 (top left) is a square, and the outline after closure is a rectangle. On the far right side there is no protrusion at the apex of the triangle, but there is some inward pull resulting from the undermining in this area and, of course, from the tension of the rotation flap.

Fig 38.—Rotation flap to close triangular excision on fresh cadaver skin. Top left, Design employing both triangular excision and Z-plasty. Top right, Excision of triangular lesion. Bottom, Closure.
Figure 39 shows the Elastoplast model of two rotation flaps used to close a circular defect. The design and excision are shown in Fig 39 (top left and right) and the closure is shown in Fig 39 (bottom). On the Elastoplast model, the pulls are not really at the end of the rotation flap incisions, they are in the vertical dimension. This is, in part, a matter of design. If one studies Fig 39 (top right), it should be apparent that the way this particular flap is designed the two rotation flaps are not actually being rotated, they are just being advanced together in the middle. This is crucial because if this was applied on a lower eyelid, for example, and the surgeon was expecting horizontal pull, he might be disappointed to find shortening and eversion of the lower eyelid postoperatively.
Figure 40 demonstrates the same design on fresh cadaver skin. Figure 40 (top right) shows the rotation flaps cut but not yet released at their tips. For cutting small flaps, a No. 11 blade is frequently used; leaving the points attached preserves countertraction until all the flaps are incised. Figure 40 (bottom) shows the flaps rotated into position. In this particular case about half of the pull is at the end of the rotation incision, as shown by the inward pulls on the right and left sides. The other half of the pull is shown by the distortions in the upper and lower borders. Therefore, in two different demonstrations of this design, there is a significant pull in the vertical axis. This must be recognized in this flap application. In both demonstrations, all the resultant scars would be favorable for horizontally directed FSTL.

Fig 40.—Two rotation flaps to close circular defect on fresh cadaver skin. Top left, Design. If cuts were made on inside of pen marks for rotation flaps, flaps would be too short and apical angles would be too sharp. Top right, Lesion excised, flaps cut. One can begin to appreciate where pulls on flaps may lie. Bottom, Closure. Note that distortions are fairly evenly distributed in both horizontal and vertical axes.

Rotation flaps are not often used for small facial excisions because in general they require a rather long, curved incision. The key to success with rotation flaps is to make them long because the skin is being stretched in a single curvilinear dimension. Rotation flaps have been used in resurfacing large cheek defects where the incision can be carried back to and behind the ear, and then down as far as is needed onto the neck. This large rotation flap is then advanced up onto the face. Mustardé used this principle in his reconstruction of the lower eyelid and of the cheek. A second example is the face-lift, which is really two cheek rotation flaps modified to suit the needs of tightening the aging facial skin. Thus, the rotation flap principle is important, although the applications may not be frequent.
Figure 41 illustrates the use of a rotation flap to repair a cheek scar. The area for excision in Fig 41 (top left) is an old trapdoor scar that is heaped up. A rotation flap has been designed for its excision. To avoid protrusions at the apex of the closure, an M-plasty is used. A bilateral rotation flap is designed with the submental incision placed medially and the submandibular incision placed laterally. A small triangular excision is planned laterally to alleviate some of the disparity in tissue lengths at closure. The ultimate scar is designed to lie in the boundary of the chin with the cheek. Figure 41 (top right) shows the incisions and excisions and Fig 41 (bottom left) shows the wound immediately after closure. Figure 41 (bottom right) shows the scar 6 months postoperatively. The final scar is too deep, but it does lie in the junction of the chin with the cheek. The M-plasty is not visible nor is there any protrusion, and the two long incisions which allow for tissue rotations are well hidden beneath the mandible.
INTERIM QUIZ 3

1. Assume that a rotation flap is properly designed to close a triangular defect as shown in Fig 34. No triangular excisions or Z-plasties are allowed. The basic problem in closure is obviously whether or not the tissues will stretch sufficiently to allow closure. Assuming they do, the surgeon now must close two edges of unequal lengths. Remember, in this exercise, excisions and transpositions are not allowed. Therefore, how would this best be closed?

2. Look at the lesion in Fig 29. Trace this and design a closure with two circular rotation flaps. Draw the final scar.

3. Figure 42 (top) shows a skin cancer at the anterior hairline of a 50-year-old man with a balding, but stable, hair pattern. Figure 42 (bottom) is a sketch of this to give you some necessary orientation. Think about favorable sites for incisions and design a bilateral circular rotation flap. Compare the advantages of a flap vs a skin graft to close this defect.
Fig 42.—Interim Quiz 3, question 3. Top, Lesion. Bottom, Diagram for orientation purposes.
1. This is closed by the principal of halves. Locate the midpoint of the short side and suture it to the midpoint of the long side. Now halve the two crescents on either side of that suture and close these with a stitch in the middle of each side. If you try to close these wounds beginning at one end and progressing to the other, you will often end up with an unneeded tissue protrusion.

2. Figure 43 (left) shows the authors' design. The most important part of this design is that the two incisions run in the FSTL. The tips of the two flaps are directly across the circle from each other (separated by 180°). The tips of these flaps are perhaps too acute, but this design was intended to insure that the resultant scars would lie in the FSTL. Figure 43 (right) shows the predicted closure. In this design the two major incisions will lie in the FSTL, and the junction between these two will be an oblique, relatively short scar. It is important to be able to predict the final closure of any flap, as this is the only way to predict where the final scars lie.

3. Figure 44 (top) shows the planned excision. The two incisions are designed to lie at the hairline, since this is a better site than the FSTL. In this case, it means that the two rotation flaps are not directly opposite each other. In fact, they are only separated by 90° at their connection to the circular defect. Figure 44 (bottom) shows the wound 6 weeks after surgery. At this point, this is not a superb result, but it is cosmetically superior to a skin graft and will improve considerably with time. Secondly, if the lesion had required excision down to and including periosteum, a skin graft would not have adequate vascular supply and, therefore, could not have been used on the bare bone. Flaps bring with them their own blood supply and are always needed for these deep closures. It is often difficult to get scalp skin to stretch enough to use a flap, even with extended undermining, but a few relaxing incisions.
in the galea will allow the scalp skin to stretch. Be wary, however, because in long flaps galeal relaxing incisions can sever the feeding vasculature, which lies in the supragaleal spaces, and result in scalp loss.

Fig 44.—Interim Quiz 3, answer 3. Top, Planned excision with incisions lying back in hair or in hairline itself. Bottom, Wound 6 weeks postoperatively.
D. Transposition Flaps

1. General

Transposition flaps are those flaps in which a piece of tissue attached at its base is lifted over an adjoining piece of tissue to be placed in its new recipient site. These are extremely useful, important flaps and many examples should already be known to all surgeons. Advantages of transposition flaps primarily involve their great ability to disperse wound tension and tissue distortion over a wide area, thus minimizing deformity and preventing scar widening. Known transposition flaps include the forehead, deltopectoral, rhomboid, and 30° transposition flaps.

Although there are many different designs, the classic flap design is shown in Fig 45. This flap is transposed over the tissue labeled A. The turning point (TP) for the flap is a crucial concept. The circular lesion is excised, and then the flap is cut and undermined. The flap is lifted up, placed, and sutured into its new position, with point A closed to the TP. Closing the donor site may be a problem with a flap of this design. If the flap is large, the donor site may simply be skin grafted. However, if it is possible to be closed primarily, this is aesthetically preferable. With small flaps and proper planning, undermining the edges should allow primary closure. A second potential problem exists at the apex of the donor site, where one cannot close a circular defect, as shown, without producing a protrusion. Therefore, the incision is extended (as shown by the dashed line) to make an acute 30° angle, which can then be closed without protrusions. If the surgeon is adept in using the M-plasty (as outlined with the dotted line), this is the preferred closure. Primary closure using an M-plasty is shown in Fig 45B. In this example, at point B the flap is rotated through 90° and may cause some protrusion. This is unavoidable and should not cause concern. In no case should any backcuts or triangular excisions be made to remedy the situation, as these may jeopardize the blood supply and the viability of the transposition flap. Occasionally, flaps are transposed as much as 180°. These almost always cause protrusion, some of which resolves spontaneously with time but, if still objectionable, can be corrected at a later date. Never succumb to the urge to resect this area of protrusion at the time of initial surgery. Invariably, critical blood supply courses in the protruding tissue and incisions into this area will often leave the flap nonviable.

One of the really difficult decisions in transposition flap design is how long the flap must be to reach its recipient site destination. If one errs on the long side, trimming will save the situation. If one errs by being too short, however, all is lost. In Fig 45A the TP is the critical point. Measure from TP to D at the top of the recipient bed. Point C, at the top of the transposition flap, must be at least this distance (i.e., TP to D). Although this may appear to be easy in this example, look at Fig 46, which is a larger, slightly more complex transposition flap. To gauge the proper dimensions for this design, take a 4 x 4 inch piece of gauze and place one corner on the skin at the TP. Now stretch it to your estimated location of point C. Without releasing it at the TP (i.e., without letting it move or rotate under your finger), bring the far point of the gauze from C to D. The distance from the TP to D should be the same as from the TP to C. If not, readjust and try again. When it is correct, you can mark the actual required location of point C. Repeat the same maneuver to locate point E. The
distance from the TP to F must equal that from the TP to E. This determines the transposition flap dimensions, and the remaining flap lines are easily filled in. Personal preferences differ as to the best aesthetic design for transposition flaps. Some surgeons prefer smooth curves, as in the design shown in Fig 45, while others believe that sharp, acutely angulated corners are preferable. For those who understand the concept of the geometric broken-line pattern described in section A.4, the angulated pattern is believed to be superior.

Fig 45.—Classic transposition flap. A, Stippled area represents tissue to be transposed to fill defect left by tumor excision. To close defect left by transposition flap, 30° angle(s), either one or two (M-plasty), are required. B, Closure using M-plasty (preferable design). Details in text.
2. Rhomboid flap

The following conceptual evolution of transposition flap dynamics has been previously published and is illustrated on videotape. If one follows the examples shown through the sequential changes in design, a solid insight into the dynamics of transposition flaps may be obtained. Figure 47A is a rhomboid transposition flap. The defect to be excised, ABCH, is a rhomboid margin surrounding a circular lesion. The flap CDE is designed so that CD is the same length as AB, DE is the same length as BC, and the angle GFE equals the angle ABC. Classically, with an equilateral rhomboid, this angle is 60°. Figure 47B shows the closure of the rhomboid from Fig 47A. The first difficulty with this design is seen at H where, when the flap is transposed, a 60° angle is closed on itself. Recall that closing a 60° angle primarily risks producing significant protrusion. This is alleviated in Fig 47C where the angle has been changed to 30°. However, for the circular lesion shown, this solution wastes considerable healthy tissue and so is further modified in Fig 47D, incorporating an M-plasty. The second problem encountered with this design is that a flap the same size as the defect is being transposed. One is therefore exerting the same amount of tension on the closure of the donor site as one would have in primarily closing the defect without using a flap. This can be an advantage, for example, if the defect is located close to a critical structure (e.g., an eyelid); the tension of closure is completely transferred to a more distant site. But in many other cases, it is desirable to equalize the closure pulls. To better distribute the tension of closure, a flap half the size of the defect can be cut (e.g., with a 60° defect, a 30° flap is needed) as illustrated in Fig 48A. Careful orientation of this small flap is important. If the surgeon was to cut this flap as shown in Fig 48B,
all the pulls would be horizontal and there would be no benefit from the transposition flap. Alternately, if the surgeon was to orient the flap as in Fig 48C, this would be ideal for sharing the pulls, but the flap base would be so narrow that the blood supply to the flap would be risky. Figure 48A shows the compromise design that both shares the pulls and preserves the flap viability. This is designed by extending line BC downward to the right, as shown by the dotted line. Half the width of the defect (half the distance AC) then determines the flap base GE along this extended line. A triangle with an apical angle of 30° and sides with lengths such that AB is equal to CD and BC is equal to ED is then drawn on the base, and this is the required transposition flap. The flap we have

derived is called a 30° transposition flap, and it is the flap design most frequently used in facial surgery by the authors. Its closure is shown in Fig 48D. By modifying the size of the flap, the surgeon can alter the tensions of closure so that in an area where there is a discrepancy in loose or mobile skin, this can be taken into account when designing the flap. The orientation of the excision and flap is also important. Obviously, the flap as drawn in Fig 48A could have been equally well constructed on the left side of the excision, and the entire flap could be rotated to conform to regional FSTL. When this flap is properly designed, it is oriented to the FSTL (as shown in Fig 48D) for the best cosmetic result. Whatever orientation is chosen, one should avoid final lines of closure that lie perpendicular to FSTL.

Fig 48.—Angulated transposition flaps. A. Classic design of 30° transposition flap, with M-plasty at base. B. Poor design of flap. C. Poor design of flap. D. Closure of flap shown in A, with proper orientation to FSTL.
3. Bilobe flap

Another useful transposition flap is the bilobe flap. Its basic design is shown in Fig 49A. Flap A will be rotated into the defect and is designed to be the same size as the defect, although in mobile tissue it can be made slightly smaller. Flap B will fill the defect made by rotating flap A; it is half the width of flap A and approximately three quarters of its height or length. Since the defect left by flap B is to be closed primarily, its apex is not circular as shown by the dotted line, but is a 30° M-plasty. Many surgeons use a plain 30° angle here, designing the flap with a circular top, and unfortunately discard this tissue. This need not be, and the tip tissue can be left intact and transposed. The bilobe flap closure is shown in Fig 49B. Note how the tissue-preserving M-plasty fits in nicely. Also note that in this bilobe flap design it is crucial to insure a sufficiently wide base for the flap to provide a good vascular supply. The great advantage of this flap is that it allows tissue to be brought in from a more distant site than is possible with a single transposition flap, while still allowing a lot of freedom to distribute the pulls of the closure. It also allows a unique distribution of tension in three different areas, i.e., closure of the defect, closure of the A-flap donor site, and closure of the B-flap donor site. The correct design matches tissue availability and maximizes the surgeon’s ability to distribute closure forces.

![Bilobe flap diagram](image-url)
4. **Z-plasty**

The third common transposition flap is the Z-plasty. Although not really used to close a defect, the previous examples have shown how it is often useful in adjusting the pulls of closure and the directions of final scars. A Z-plasty does the following two things: (1) it alters the direction of tissue tensions and (2) it changes the direction of scar lines. Both of these are gained at a cost, and the surgeon must be equally aware of the Z-plasty's advantages and disadvantages.

Figure 50 shows the typical 60° Z-plasty. The line BC (which initially lay perpendicular to the FSTL) is, after transposition, parallel to the FSTL. This change of direction requires two equally long accessory incisions called lateral limbs. In addition to changing the direction of the incision, the distance BC is lengthened by about 75% in a 60° Z-plasty, 50% in a 45° Z-plasty, or by 25% in a 30° Z-plasty. However, to lengthen this line, tissue must be borrowed from the perpendicular axis so that A to D is simultaneously brought together. The degree of lengthening in the one axis is identical to the degree of shortening in the other axis. A detailed description of the Z-plasty is available in numerous other writings, and the reader who is not familiar with Z-plasty should read these before going further.

![Fig 50. Classic 60° angle Z-plasty. A, Design. B, After transposition of flaps.](image)

5. **Technique**

   a. **Rhomboid flap**

   Figure 51 illustrates the dynamics of the rhomboid flap using the Elastoplast model. This is a rhomboid with all four sides equal in length. The upper angle of the rhomboid is 60° (as is the apical angle of the transposition flap), so that the flap is equal in size to the defect.
Figure 51 (top left) shows the design and Fig 51 (top right) shows the closure. Most importantly, all the tension of the closure lies across the closure of the donor site. None of the tension is shared in the closure of the recipient site, i.e., in the horizontal dimension. Figure 51 (bottom) diagrammatically illustrates the directions and magnitudes of pull in this example. The two solid arrows indicate the pulls as predicted and as shown on the Elastoplast model. The dashed arrow indicates the other axis in which pulls could be, but are not, shared. Also recall that two 60° angles were closed primarily. The first is at the apex of the transposition flap donor site (angle CDE in Fig 47), where a rather significant protrusion is seen. However, part of this is an artifact of the Elastoplast model because of the folding caused by the tension of closure. The second 60° angle closed primarily is at the bottom of the rhomboid. Here the flap is rotated 60°, and the protrusion seen on the Elastoplast is significantly smaller.

Fig 51.—Rhomboid flap on Elastoplast model. Top left, Design. Top right, Excision of rhomboid with 60° transposition flap closure. Note pulls, pushes, and protrusions as described in text. Bottom, Pulls and pushes of flap. Virtually all tensions are involved in closure of donor site as indicated by solid arrows. Only tension involved in recipient site is rotation-stretching pull on transposition flap itself.
Figure 52 shows the same rhomboid flap demonstrated on fresh cadaver skin. Figure 52 (top left) shows the design, Fig 52 (top right) shows the excision, and the closure is seen in Fig 52 (bottom). The outer square is flattened into a horizontally oriented rectangle because of tension being distributed across the closure of the donor site. Virtually none of the tension is shared horizontally in closing the defect. The protrusion at the base of the rhomboid seen here is significant, but the 60° angle of the donor site closure has produced a protrusion that is not as marked. Depending on how the undermining and suturing are performed, the tension of closure may be absorbed primarily at the tip of the transposition flap (point F, Fig 47B) or at the closure of the donor site (C to E, Fig 47B). The direction of the closed incisions is the same in either case, so normally the majority of the tension is transferred to the donor site closure and the tension on the flap is minimized.

Fig 52.—A 60° transposition flap (rhomboid flap) on fresh cadaver skin. Top left, Design. Top right, Excision of proposed lesion. Bottom, Closure. Note that majority of tension of closure is involved in closure of donor site. There is protrusion of skin at bottom 60° angle of rhomboid where 60° angle was closed on itself, and there is second protrusion at apex of donor site where second 60° angle was closed on itself.
Figure 53 shows the Elastoplast model of the 30° transposition flap. Figure 53 (top left) shows the design and Fig 53 (top right) shows the closure. In this example the tension of closure is shared across the donor site (vertically) and across the flap (horizontally). Figure 53 (bottom) shows the tensions diagrammatically, with the solid arrows indicating the magnitude and direction of tension. Protrusion at the M-plasty at the base of the defect is minimal. There is no protrusion created by the closure of the 30° transposition flap donor site. There is also no protrusion at the top of the defect because half the angle is closed by the transposition flap and the remaining 30° is closed on itself. Note how this angle is considerably narrower than the same site in the rhomboid 60° transposition flap closure. These two flaps should be carefully compared.

![Figure 53 - Elastoplast model of 30° transposition flap with M-plasty](image)

Figure 54 shows the 30° transposition flap on the fresh cadaver skin. Figure 54 (top left) shows the design. Fig 54 (top right) shows the excision, and the closure is shown in Fig 54 (bottom). The tensions of closure are well shared. There is no protrusion produced here by closure of the M-plasty, as compared with the definite protrusion in closure of the 60° angle of the rhomboid defect. There is also no protrusion in closing the 30° angle donor site, nor is there any produced by the 30° angle closure at the top of the recipient site.

![Figure 54 - 30° transposition flap on fresh cadaver skin](image)
b. Bilobe flap

The dynamics of the bilobe transposition flap are shown in Fig 55. There are some factors that vary significantly from one bilobe flap to the next, so it is difficult to extrapolate from the single example shown here. The bilobe flap is designed to bring in mobile tissue from farther away than can be done with a simple single transposition flap. With this flap, the distribution of wound tensions can be varied although, of course, this is still dependent on local tissue elasticity and excess bulk. The Elastoplast model of the bilobe flap is shown in Fig 55 (left and right). The pulls of closure are fairly well shared. The left border is pulled in toward the flap because the Elastoplast pulls back toward its original position; skin does this too. The bilobe flap is rotated 90° and a rather obvious protrusion is created where the flap rotates into the defect. An M-plasty was not used because this design is small. The small flap was left short to allow for preservation of its 30° tip extension and, in this case, has worked well.

Figure 56 shows the same demonstration on fresh cadaver skin. Figure 56 (top left) shows the design, Fig 56 (top right) shows the excision, and Fig 56 (bottom) illustrates the transposition and closure. The tip extension on the smaller flap is shown dotted and is again a single angle, somewhat greater than 30°. The tensions are seen to be evenly distributed in this clo-
sure, and this is definitely one of the advantages of this flap design. The angular tip extension on the smaller flap was discarded, in this case, which results in some shortening of the recipient site. This is well demonstrated by the indentation of the skin border just above this flap. Remarkably little protrusion is seen at either the 90° rotation site of the larger flap into the defect or at the closure of the angular tip extension of the smaller flap.

![Diagram](image1)

*Fig 55.* Bilobe flap on Elastoplast model. Left, Design. Right, Excision of circular defect and closure and transposition of bilobe flap. See text for details.

![Diagram](image2)

*Fig 56.* Bilobe flap on fresh cadaver skin. Top left, Design. Top right, After excision of defect. Bottom, After transposition of both flaps. Note that majority of tension of closure is in up-down position, but some of closure tension is also noted in horizontal axis. Note change in original outline of square (top) to distorted rectangle seen here.
c. Z-plasty

The Elastoplast model of the Z-plasty, shown in Fig 57, demonstrates this transposition flap well. The central limb is changed from vertical to horizontal, and there is the anticipated lengthening in the vertical axis. Both points where the $60^\circ$ rotation is closed primarily show protrusions. In thick skin, these would be permanent and one would either have to use a smaller angle or accept this deformity. The protrusions could also be excised at a later date if necessary, but it would be unwise to resect them primarily as this would counteract the lengthening forces of the Z-plasty.

![Fig 57.—Z-plasty on Elastoplast model. Left. Design. Right. After transposition. Note distortion of previously square Elastoplast. It is lengthened along direction of original central limb and is shortened along axis perpendicular to this. There are slight protrusions where $60^\circ$ angles are closed on each other, namely, at end of both lateral limbs. Orientation of central limb has been changed almost $90^\circ$.](image)

The fresh cadaver skin demonstration confirms the findings of the Elastoplast model (Fig 58). Again, the central limb is changed in direction. Although the axis of the central limb is normally changed $90^\circ$, the change may be less or more depending upon the pulls and the tensions of surrounding tissues. Also note that the lateral incision limbs maintain their initial orientation after transposition. As there are two different possible orientations for the lateral limbs in any Z-plasty, their position should be designed to parallel FSTL. When poorly designed, they will cross FSTL perpendicularly and will then be visible. When this flap is used over a curved surface, problems can arise. A web will result from a Z-plasty designed on a concave surface so that the central limb after transposition crosses the concavity. A Z-plasty designed on a convex surface such that the central limb after transposition crosses the convexity will cause an indentation. Finally, the two areas where $60^\circ$ angles were closed primarily show the expected tissue protrusions. In loose skin like this, these are average skin protrusions and generally, particularly with small Z-plasties, they do not cause any difficulty. For optimum cosmesis, Z-plasties on the face are best kept as small as possible.
6. Applications

Now that transposition flap dynamics are understood, let us look at the applications. The authors’ personal preference for transposition flaps is to use angulated rather than smoothly curved flaps. The true rhomboid flap is a 60° transposition flap without attention to the closure of the 60° angle at the base; therefore, we rarely use a true rhomboid flap. That is not to say they do not work. We believe the 30° transposition flap with an M-plasty and all its potential modification is usually a superior flap. Figure 59 shows a skin cancer between the eyebrow and the nose. The lesion itself has been excised. Although there may be excess skin on the eyelid, it is much thinner than the eyebrow and would not be a suitable tissue match. However, the skin on the forehead and glabella is also loose and is a good texture, color, and thickness match. A transposition flap will be designed to use this skin and lie as much as possible in FSTL. Figure 60 shows the design elected and Fig 61 shows the excision just prior to transposition. Take note of the M-plasty, the relative flap width, and the flap base. The flap is cut, undermined, transposed, and closed after proper hemostasis. It is held essentially tension free with two subcutaneous sutures, and then the epidermis is closed with a 6-0 Davis and Geck mild chromic (fast-absorbing gut) running lock-stitch. The closure is shown in Fig 62 prior to being reinforced with Steristrips and then bandaged. For the best result, antitension taping is used for 6 months. Since this patient’s major concern was cancer, not cosmesis, this was not done. Figure 63 shows the wound 2 weeks postoperatively, and Fig 64 shows the wound 6 months postoperatively.
Fig 59.—Lesion located between eyebrow and nose and between forehead and eyelid skin. Lesion is excised and that which is seen represents defect that should be closed.

Fig 60.—A 30° transposition flap will be used. Design is shown here.

Fig 61.—Flap is cut and ready to be transposed.
Fig 62.—Flap transposed and sutured in place.

Fig 63.—Two weeks postoperatively.

Fig 64.—Six months postoperatively.
Figure 65 (top left) shows a skin tumor on the cheek that is already outlined for excision with a 30° transposition flap. Figure 65 (top right) shows it just after closure. This patient wore antitension taping for about 3 months, and Fig 65 (bottom) shows the cheek 5 months postoperatively. Why was this particular orientation chosen, when the cheek has loose skin in all dimensions so any orientation could have sufficed? The reasoning is as follows: Since the FSTL run perpendicularly, the basic orientation of the excision is vertical; therefore, the 30° transposition flap could be taken from in front of the excision or posterior to it. Posteriorly is more favorable since a scar here would be less conspicuous than the same scar in front of the excision. In this location a scar is more easily covered or shaded by hair; and because it is around the side of the face it is less obvious on frontal view. Basically, the closure of a small 30° transposition flap is a geometric broken-line pattern which, with proper healing, will leave a fine, inconspicuous scar.

Fig 65.—Transposition flap. Top left, Skin tumor on cheek. Design is for 30° transposition flap with M-plasty. Top right, After excision and closure. Bottom, Six months postoperatively. On careful examination, the scar can be seen. Can you locate it? It is to the left of the dark pigmented spot in the center of the photograph.
Figure 66 shows the treatment of a larger lesion, with the dotted line representing the necessary margin. This is a middle-aged man, 15 years after having had a successful wide excision, split-thickness skin graft and radical neck dissection for a melanoma of the scalp. Figure 66 (top right) shows the area after excision; a rather large defect exists. There is not a lot of loose skin here because of his prior surgery, and whatever flap is used, it will be necessary to try to "borrow" skin from all surrounding elements. The transposition flap used was designed so that much of the scar would lie in the FSTL around the eye and also at the boundary of cheek with temple. Some of the incision is at the temple hairline and some goes almost back into the hair. The flap was taken from the cheek. Cosmetically, this was less desirable than taking it from the forehead, but it was done for two reasons: First and most important, the skin of the cheek was looser and could better donate skin, whereas use of the forehead skin might not have allowed primary closure of the donor site. Second, the tissue thickness of the cheek better matched the surrounding skin of the recipient area than did the forehead skin. Figure 66 (row 2, left) shows the flap cut and rotated into position. The base of the flap has sufficient width. Note the tension in the vertical dimension.

Figure 66 (row 2, center) shows the flap just after closure, and Fig 66 (row 2, right) shows the flap 1 week postoperatively. A superficial epidermal slough has occurred. Even more extensive undermining to further reduce the tension of the closure would have prevented this. Figure 66 (bottom left) shows the resolution of this 4 weeks later. Antitension taping was then used for about 6 weeks, and Fig 66 (bottom right) shows the scar 6 months postoperatively. To locate the scar, look at the two pigmented lesions just in front of the first tuft of temple hair: they are present in each picture. This is an average result using transposition flaps. We should demand this kind of result from flap surgery because it is this quality that makes surgical treatment cosmetically superior for most skin cancers. A skin graft or simple fusiform excision will rarely yield this kind of result, particularly for medium to large excisions.

The next case illustrates the use of a bilobe flap. The lesion is shown in Fig 67 (top left). Although there is some loose skin around the dorsum of the nose, there is not enough for a primary closure. There is ample cheek skin, but this is of different texture and considerable undermining would be required to get it up onto the nose. The glabella has ample good-quality skin, but it is a little too far away to transfer or transport primarily. Some surgeons might use glabellar skin on an island pedicle, but a bilobe flap is ideal for this purpose. Before reading further, design a bilobe flap to cover the excision site.

Figure 67 (top right and bottom left) shows the flap design. Note that the flap to cover the defect is usually designed to be slightly smaller than the defect, and this will be closed by undermining the skin of the nose. The second lobe is the same size as the defect it will fill. This lobe is taken from the glabella because there is not much excess skin in this region of the nose, but there is
Fig 66.—Transposition flap. Top left, Lesion. Dotted line indicates margin. Top center, Defect after excision. Top right, Design for 30° transposition flap. Row 2 left, Transposition of flap into defect. Along base of flap note tension caused by distance of transposition required for closure. Row 2 center, Immediately after closure. Tension still present, although better distributed with skin closure. Row 2 right, One week postoperatively. Tension has compromised blood supply and superficial slough is evident. Bottom left, Four weeks postoperatively. Wound is healing well. Bottom right, Six months postoperatively.
plenty of excess skin in the glabella. The result is shown 1 year later in Fig 67 (bottom right). The bilobe flap is particularly good when skin needs to be brought from farther away than can be done by simple advancement, rotation, or transposition.
Figure 68 shows another example of the use of a transposition flap to distribute pulls in areas where there is not much excess skin. Figure 68 (top left) shows a lesion in the postauricular area with an outline for a 30° transposition flap. The scar quality is not as important in this location because it is a fairly well-hidden area. However, this is an area where the skin is tightly bound to underlying tissues so that straight advancement or rotation flaps would require extensive undermining. A transposition flap can halve the amount of skin needed to close the defect. The closure of the donor site, likewise, is only half the size of the recipient site and so is not a major problem. Figure 68 (top right) shows the closure 2 weeks postoperatively, with obvious wound tension. Figure 68 (bottom) shows this wound 8 months after surgery. All the scars are oriented in favorable directions except the one under the hair, and this is in fact favorable because it is covered by hair. Perhaps a better design would have been to turn the flap design upside down so that the M-plasty was placed inferiorly, but with the flap still cut posteriorly. For your own education, predict the resultant scar from this design, and see if it would be as favorable.

Fig 68.—Transposition flap. Top left, Large lesion behind ear. A 30° transposition flap is designed. Top right, Two weeks postoperatively, with some granulation and mild separation at wound edges. Bottom, Eight months postoperatively. Widened scar has resulted because of extreme tension on wound. This is well camouflaged in hairline and hidden behind ear and in hair. Result is definitely superior to that which might have been achieved with any kind of skin graft.
INTERIM QUIZ 4

1. How does a transposition flap differ from a rotation flap?

2. Without referring to the text, why is the flap design in Fig 48A superior to either Fig 48B or Fig 48C?

3. Figure 69 shows a small skin lesion of the lateral canthal area. On a tracing of this lesion, design a 30° transposition flap that would repair this defect.

4. Figure 70 shows another nasal tumor. Design a flap to close this.
Fig 69.—Interim Quiz 4, question 3.

Fig 70.—Interim Quiz 4, question 4. Left, Front view. Center, Lateral view. Right, Close-up.
INTERIM QUIZ 4 ANSWERS

1. While it is true that both flaps are rotated into position, the transposition flap is transposed over a piece of intervening skin, while the rotation flap is brought directly into the defect.

2. In the flap shown in Fig 48B, all the pulls are horizontal and there is no benefit from the transposition flap. The flap in Fig 48C is ideal for sharing pulls, but the base is so narrow that the blood supply to the flap is risky. Figure 48A is a compromise that shares the pulls and preserves flap viability.

3. Figure 71 (top) shows the authors' design, with the main closure falling into the crow's-feet about the lateral canthus. A flap taken inferiorly would have a closure perpendicular to the FSTL. Taking the flap from above places the closure in the eyebrow line and pulls the lateral canthus up, an effect often sought in blepharoplasty. Figure 71 (bottom) shows the scar 5 months postoperatively. A weepy crust extends laterally from his lateral canthus. This is not the scar; the scar lies below it. Study the designed flap again and now look for the scar. Notice that there is a little webbing or lateral encirclement at the flap donor site. This improves slowly with time.

Fig 71.—Interim Quiz 4, answer 3. Top, Authors' design for 30° transposition flap. Bottom, Five months postoperatively.
4. The principle of closure here is the same as in the previous question. It should not be necessary to do a two-stage procedure if a one-stage procedure will do, and it does not seem reasonable to scar the forehead if at least an equal (if not superior) result can be achieved locally. Figure 72 (top left) shows the defect. The flap in this case will lie in the horizontal boundary between the cartilaginous and the bony nasal dorsum. To reduce the tension of closure, a reduction rhinoplasty was performed. The dorsum was trimmed with scissors and chisel, curved lateral osteotomies were performed, and the nasal bones were medially fractured. This, combined with undermining, yielded abundant loose skin for the closure, as is seen in Fig 72 (bottom), 15 months postoperatively. Note the difference in the nasal profile.

Fig 72.—Interim Quiz 4, answer 4. Top left, Defect and transposition flap design. Top right, Flap transposed and reduction rhinoplasty performed. Bottom, Fifteen months postoperatively.
E. Island Flaps

An island flap maintains a subcutaneous connection but has all its epidermal attachments severed. It may be moved a considerable distance if based on a vascular arteriovenous pedicle, but only a short distance if based on subcutaneous tissues. These flaps are not true islands, for if they were, they would be a free graft. There are two types of island flaps that are commonly used: fusiform and subcutaneous turnaround pedicle.

The fusiform island flap is shown in Fig 73. This design is good for taking an area of excess tissue and moving it into an area of deficiency. This is done simply by mobilizing the subcutaneous pedicle and moving the fusiform island flap into the defective area, while being certain to avoid transecting the pedicle. With this flap, there may be some local protrusions in the early postoperative period. These tend to disappear with time, although 1 or 2 years may often be needed. A variant of this type is shown in Fig 74. To save tissue, instead of using a simple fusiform excision with M-plasties, two small islands of healthy tissue can be advanced as island flaps instead of being discarded with the central lesion. This works nicely for a square defect. The proper design for this excision with M-plasties would bring the tip of the 30° triangle of each M up to the center of the square defect where they would be sutured together, tip to tip. While many M-plasties do not really require angles as acute as 30°, this design does.

Fig 73.—Island flap showing cutting of fusiform excision which will then be left on subcutaneous pedicle and moved laterally and sutured into new recipient site. Donor site is closed primarily.

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Another useful island flap is the subcutaneous turnaround pedicle flap, shown in Fig 75. Normally, the flap should be approximately one half to three quarters of the size of the lesion. The lesion is first excised. The flap is then incised and undermined at the end farthest away from the lesion, leaving its near end attached to a subcutaneous pedicle. A tunnel is made from the flap donor site to the defect, and the tissues are undermined as shown. The flap is twisted 180° on its subcutaneous pedicle and brought through the tunnel into the defect. The flap can obviously be turned either left or right, and both directions should be tried to see which is easiest and compromises the blood supply the least. Finally, the flap is sutured into its new position and the flap defect closed primarily.

A wide variety of other island flaps based on specific vascular pedicles, such as the supraorbital vessels, have been described, although these have not been found extremely useful in our cases. These flaps, particularly if large, are risky because if the arterial supply is cut, compressed, or kinked, the flap will die. Likewise if venous drainage is impeded, the flap is lost. A local flap will almost always do just as well, with much less risk.
Figure 76.—Subcutaneous turnaround flap. In effort to bring subcutaneous-based island flap farther than is shown in Fig 76, flap can be left attached to subcutaneous pedicle only at one end. Flap is then turned around, brought under tunnel or bridge of skin as depicted here, and sutured in its new position. Donor site is closed primarily.

Figure 76 (top left) shows the preoperative view of a patient who had multiple severe lacerations of the upper lip with some tissue loss and a resultant cosmetic deformity. The initial problem in designing a satisfactory repair is to mobilize tissue to augment the central defect. As shown in Fig 76 (top right), a fusiform island flap can be used to shift tissue of identical quality from a region of relative excess to one of deficiency. The view 10 months postoperatively is shown in Fig 76 (bottom left). The original tissue defect is greatly improved, but several areas of irregular contour remain, especially lateral to the island flap donor site and just anterior to the recipient site. Consequently, two horizontal fusiform excisions were designed, as shown in Fig 76 (bottom left). Note that the vermiliocutaneous junction was carefully preserved. Although the FSTL run vertically on the lip, these horizontal excisions can be performed without objectionable scarring because of the extremely fine, flexible, thin lip skin. Absorbable subcutaneous sutures (such as Vicryl) are used to close the subcutaneous tissues, and if any muscle is incised it can be used to carefully reapproximate muscle to muscle. Permanent suture in muscle often causes a knot that can be felt by patients and is unacceptable. Lip skin itself is closed with
4-0 chromic sutures, which normally fall out in approximately 7 to 14 days and, therefore, do not need to be removed. The postoperative view is shown in Fig 76 (bottom right), 6 weeks after the excisions were made. The patient has shaved his mustache to give us a better view of the final result. Of course, a mustache can serve as excellent camouflage for residual irregularity.

The final example completes this study of local skin flaps. No one is born an expert in the use of skin flaps, but this SIPac should have increased your practical knowledge of them. To become an expert, it is now necessary to try these flaps and then observe your results carefully and over a sufficiently long time period to recognize final results. Remember that every patient is different and every surgeon is different, but if one remains versatile, does not accept poor results and strives for perfection, excellent cosmetic results can be routinely obtained with the use of local skin flaps.

This SIPac has not dealt with appropriate margins, and considerable controversy about safe margins still remains. However, it is extremely clear that certain tumors have a high potential for local recurrence. These include recurrent basal cell cancer, morphea-like basal cell cancer, and aggressive squamous cell cancers. For these three tumor types, Mohs microscopically controlled margins are necessary to eradicate the tumor. This improves the cure rates for these situations to 90% to 95%, and it is our opinion that if the microscopic margins are carefully performed, the defects can and should be closed with local skin flaps.

As one does more and more local skin flaps, one begins to recognize certain common designs that yield good results in each of the facial areas. The following represent some of our experiences.

Forehead lesions do best with fusiform excisions designed in a horizontal fashion. Vertical fusiforms do poorly and should rarely be used. In the glabella and about the temple, transposition flaps seem to give the best results. The cheek is invariably reconstructed with a transposition flap. All facial transposition flaps should be based superiorly, and generally the flaps should be brought laterally to medially. Inferiorly based flaps pull the facial tissues down. Superiorly based flaps will pull the facial tissues up and tend to support the lips, the nose, and the eyelids. Generally speaking, the most important cosmetic tissue is located centrally in the face and, hence, one tries to bring tissue medially from a lateral direction. These principles apply consistently to cheek lesions.

The nose is a difficult area to treat. Small columella lesions often do very well with full-thickness skin grafts from the eyelid. Alar lesions are always difficult and are well treated high in the nose with an auricular composite graft. The ala, near its attachment to the face, is reconstructed with a cheek transposition flap. The dorsum of the nose is best reconstructed with a superiorly based transposition flap. The tip of the nose is reconstructed with a transposition flap from the nasal dorsum, and the nasal dorsum is reconstructed with tissue transposed from the glabella. Often a bilobed flap will bring free glabella tissue down onto the nasal dorsum and even down to the nasal tip.

The lower lip is a common site for skin tumors, and full-thickness excisions are often necessary. The defects are closed with two advancement flaps. Small lip excisions are taken out as a wedge. The incision should not cross the junction of the lip with the chin, and in this area lateral flaring M-plasties, as shown in Fig 30, consistently give good results. If more than half of the lower lip is resected, rectangular flaps can be advanced from the cheeks. This technique was originally described by Bernard, and its refinements and improvements are demonstrated by Richard Webster in one of the San Diego Classic videotapes titled Lip Reconstruction. The lower lip should never be reconstructed with a transposition flap from the upper lip.

Study and practice are required to become a skilled local skin flap surgeon. Almost every facial lesion is best reconstructed with a local skin flap. The surgeon who finds himself using skin grafts and simple fusiform excisions for the majority of his cases is not achieving the best results. In our practices at least 90% of facial defects are closed with local skin flaps.
VI. APPENDIX

HOW I DO IT — HEAD AND NECK AND PLASTIC SURGERY:
A Targeted Problem and Its Solution
SUBCUTANEOUS SUTURE PLACEMENT*
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Subcutaneous sutures have several goals: 1. to reduce dead space; 2. to help align respective wound edges; and 3. to reduce tension along the wound closure. The classic subcutaneous closure encompasses small bites of dermis with sutures placed immediately at the wound edge. (ED. NOTE—This is depicted in Fig 2 of the text.)

There are three disadvantages to the classic placement:

1. The sutures placed immediately at the wound edge exert their influence only for a short distance on either side of the suture, which necessitates many stitches along the wound edge. While this varies greatly from surgeon to surgeon, it is customary to place a suture minimally at every 5 mm to 10 mm along the wound.

2. The suture at the wound edge encompasses the subdermal vessels supplying blood and oxygen to the wound edge. Each stitch occludes the blood supply, potentially interfering with wound healing.

3. The dermal stitches invariably pull the wound edges flat and interfere with the surgeon's ability to evert the wound edge.

An alternative subcutaneous suture placement has been used by the author for several years, has been found effective, and remedies all of the disadvantages of the class stitch. As shown in Figure 2 (ED. NOTE—Fig 3 in text), the wound edges are undermined for a distance of at least 1 cm. After hemostasis, the wound edge is everted and the subcutaneous suture is placed through the subcutaneous tissue and the deeper dermis, 8 mm to 10 mm back from the wound edge. The same is accomplished in the opposing wound tissues. The suture is tied and the tissues pulled together so that they cause an eversion of the epidermal edge.

This has been described by Webster as a technique for scar revision, and when carried out to excess is called extreme eversion. As applied here, the eversion is moderate in nature. Stitches placed in this way have the same effect that a widely placed stitch would have and exert their influence over a greater part of the wound edge. A stitch placed 1 cm back from the wound edge will normally exert an influence at the wound edge over a distance of at least 2 cm and hence decreases the number of subcutaneous stitches needed to pull the wound together. The suture placed through the dermis and tied is well back from the blood supply to the wound edge and therefore should not interfere with the local blood supply and wound healing. Lastly, the suture ensures a significant degree of wound eversion and permits the surgeon to easily close the wound in an everted fashion.

* A modification of the subcutaneous suture placement was published in Laryngoscope (1987;97:501-504) and is reproduced here with permission as the Appendix.
Figure 3 shows the technique applied to a linear wound. (Ed. Note—Figure 3 is not shown in text.) Complications have not occurred as a result of this technique. Even if a small amount of dimpling at the skin is noted above the suture, this recedes and disappears in the ensuing 1 to 3 weeks. Permanent dimpling or permanent eversion generally does not occur. If one wishes to create a permanent eversion or at least a prolonged eversion as described by Webster in the techniques for extreme eversion, the sutures need to be placed at a distance of 5 mm to 10 mm apart and very strongly coapt dermal surface to dermal surface. Even when this is done, permanent healing of dermis to dermis is an uncommon event.

Because the dermal suture is freed from the dermis by reabsorption and reformation of the dermis, a permanent suture is of no value and carries the potential risk of suture extrusion. The polyglycolic acid sutures have been used exclusively and have been found to be effective.

The technique is useful for large wounds such as those employed in neck dissection. In these cases, a 3-0 suture is used and generally encompasses platysma where present, as well as a small bite of dermis. The technique is equally useful in small and delicate wounds made on the face. For these a 4-0 suture is used. Occasionally, on very delicate skin, such as in the periorbital region, a 5-0 suture on a smaller needle has seemed appropriate.

The epidermal closure can be performed in the customary fashion with staples, with permanent suture, or with the rapidly absorbable 6-0 chromic sutures. It should be reported that difficulties have occurred with the rapidly absorbable chromic when used on eyelid skin. On occasion, this has caused an allergic reaction resulting in chemosis of the orbital conjunctiva, a process which has required as long as 6 months to resolve. Additionally, the rapidly absorbable chromic has not done well in the sebaceous skin of the lower third of the nose and also has not done well when used about the mouth where it is moistened by saliva and tends to dissolve too rapidly.

REFERENCES


VII. POSTTEST

1. List the four major types of local skin flaps.
   a.
   b.
   c.
   d.

2. List four purposes for using an M-plasty in a fusiform excision.
   a.
   b.
   c.
   d.

3. In making a rectangular advancement flap to close a square defect, two Z-plasties should be performed at the flap base to avoid tissue protrusions. Is this true or false?

4. A rotation flap is designed to close a triangular defect, and a triangular tissue excision is required to avoid tissue protrusions. If the front edge of the rotation flap is advanced and rotated through 1 cm, what will be the base length of the triangular tissue excision?

5. List four favorable sites to place incisions.
   a.
   b.
   c.
   d.

6. List the advantages and disadvantages of Z-plasty.

7. List six advantages of using local flaps rather than skin grafts.
   a.
   b.
   c.
   d.
   e.
   f.
8. Under what circumstance should a local flap not be used?

9. Compare the advantages of the classic rhomboid transposition flap with those of the 30° transposition flap with M-plasty.

10. One way to begin to think about proper placement of local skin flaps is to be able to accurately predict where the resultant scars will lie. Following this is a list of skin flaps; draw them freehand and then, next to each one, draw the appropriate closure.
   a. Fusiform
   b. Fusiform with two M-plasties
   c. Two rectangular advancement flaps to close a square defect with two triangular tissue excisions and three Z-plasties, one of which is between the two flaps
   d. Rotation flap to close a triangular defect, using a triangular excision to equalize lengths
   e. Two rotation flaps to close a triangular defect, with an M-plasty. Use one triangular excision and one Z-plasty
   f. Two rotation flaps to close a circular defect
   g. Rhomboid flap
   h. A 30° transposition flap, with an M-plasty
   i. A 75° transposition flap, with two M-plasties
   j. Bilobe flap

NOTE: Please place your answers to this last question on the blank sheet following the credit reporting form. This answer sheet should be mailed back to the Academy office along with the Posttest answers.
VIII. BIBLIOGRAPHY


