

## Chapter 28: Management of Alopecia and Reconstructive Scalp Surgery

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Alopecia is defined as loss of hair or baldness. Although disease or trauma can cause it, the most common type is known as *male pattern baldness*. It affects more than half of the male population (Hamilton, 1951; Norwood, 1973). Alopecia in women is more commonly a diffuse thinning, but occasionally a male pattern type of loss occurs. In the past baldness was attributed to the scalp being too tight or too loose, shampooing either too frequently or not often enough, the presence of too much scale (seborrhea) or too little, and prolonged hat wearing. It is now believed that a combination of factors is responsible for male pattern baldness: (1) heredity, (2) age, and (3) androgen levels. If a man has inherited the genetic susceptibility for male pattern baldness from either the maternal or paternal side of his family and he has normal androgen levels, baldness will result. However, only the follicles that are genetically susceptible will be affected. These follicles have been shown to have increased levels of 5-alpha reductase, which is responsible for the conversion of testosterone to dihydrotestosterone (Orentreich, 1978). Furthermore, it is known that baldness increases with age, and that the earlier it begins, the more extensive it tends to be.

No lotion, balm, or syrup currently exists that a person can apply to his head or take by mouth to prevent hair loss or to cause new growth of hair of sufficient quality to be cosmetically significant. Orentreich (1959) demonstrated that the permanent hair on the sides and back of the head could be moved elsewhere on the scalp to continue to grow as it would have in its original location. The goal therefore of all hair-replacement surgery is to redistribute the patient's remaining hair as naturally and evenly as possible over the bald scalp. The four most commonly accepted methods of hair redistribution are punch grafting, scalp (alopecia) reduction, short flaps, and long flaps.

Before discussing each of these methods of management and offering guidelines for use, the classification of various patterns of baldness, the patient consultation, and hairline aesthetics are considered.

### Classification of Male Pattern Baldness

Hamilton (1951) published the first useful classification of male pattern baldness. This was modified by Norwood (1973), who classified baldness into seven categories plus a variant type. Although such classification is helpful for scientific purposes, in our practice we have simplified the classification of baldness in the following manner (Fig. 28-1):

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| <i>Class I</i>   | Frontal baldness only, with or without an anterior tuft.             |
| <i>Class II</i>  | Frontal and midscalp baldness with <i>no thinning of the crown</i> . |
| <i>Class III</i> | Frontal to occipital (crown) baldness.                               |
| <i>Class IV</i>  | Crown baldness only.   |

Although other patterns of baldness exist, they are quite rare. The importance of this classification is to define the probable *ultimate pattern of baldness*. Once the final size of the donor area and the size of the bald area are known, the patient can be given an accurate appraisal of what to expect from the results of surgery. Most balding men have or will have

a class III pattern. Therefore in the young patient with frontal baldness it is imperative to know whether the baldness will remain stable (quite rarely) or will progress in the future to a class II or class III pattern. Careful evaluation of the crown and midscalp for evidence of any early thinning will help the surgeon to determine a complete operative plan. A young patient with frontal loss often will show slight thinning of the crown (Fig. 28-2). We classify this patient as having class III baldness, since he may lose all the hair in the midscalp.

Once the surgeon has determined that the patient has or will have a class III pattern, he must decide whether or not the fringe hair is stable. The amount of baldness significantly increases and the donor supply of hair decreases as hair loss in the circular fringe proceeds inferiorly. In general, the older the patient and the more baldness that is present, the easier it is to predict the final pattern of baldness. If there is uncertainty concerning whether or not the fringe hair of a young patient will continue to drop, it is best to wait before trying to determine if enough donor material (grafts or flaps) will be available to achieve a satisfactory cosmetic result. The patient returns in a year or more and his balding pattern is reevaluated.

One occasionally sees a patient with fully established baldness limited to the crown (class IV) with all of the anterior hair retained. The size of the bald crown may be small or large, but *no evidence of frontal baldness* will appear.

### **Patient Consultation**

The initial consultation is the most important part of hair-replacement surgery, as it is with any aesthetic procedure. The purpose of the interview is to obtain as much accurate information about the patient as possible. Also, information can be given to the patient about the various procedures available. The more the surgeon knows about the patient, the more he can assess the probable results of surgery. Likewise, the more the patient knows about what to expect from the surgery, the more relaxed and satisfied he is likely to be.

### **Patient information**

We use a cosmetic surgery questionnaire (Anderson and Johnson, 1978) to obtain information about the patient. A booklet describing the various hair-replacement techniques is mailed to the patient, and the patient brings both of these to the office.

Since we perform all of the methods of hair-replacement surgery described in this chapter, our patients are given information about each of these procedures. This includes general information about the procedure, the advantages and disadvantages of each, and a discussion of the specific factors for each patient that enter into the decision. The patient is told about any anticipated postoperative discomfort, limitations of activity, disability, hair coverage while multiple surgical steps are completed, the length of time necessary for cosmetic improvement, any preoperative laboratory tests required, and cost. Each of these factors is covered in the descriptions of individual procedures.

## **Medical evaluation**

Patients are asked about any history of hypertension, cardiovascular disease, previous surgery with any associated problems, diabetes, epilepsy, bleeding problems, allergies to medications, current medications, and scarring problems. If the patient has a history suggesting a potential problem with surgery, he is referred to an internist for evaluation. Any history of alcohol or drug abuse should be explored. Some patients who have been heavy drug users require more postoperative pain medication than is normally prescribed. No alcohol is allowed for 24 hours before or after surgery. Heavy smoking interferes with circulation and may present an increased risk in healing. Patients should be discouraged from smoking for at least 2 weeks before and after surgery.

Any history of excessive bruising, bleeding, or anemia should also be thoroughly evaluated preoperatively. If the patient is taking any aspirin-containing drug, usage is stopped 1 to 2 weeks before surgery. If the patient has diabetes, the disease must be under control. These patients must be evaluated carefully if flap surgery is contemplated because of the possibility of impaired circulation to the flap. If any question exists concerning a potential health risk, the surgeon should refuse to do the procedure unless the problem can be adequately controlled.

## **Psychiatric evaluation**

The psychiatric evaluation is one of the most important aspects of hair-replacement surgery. Even when the surgical results are outstanding, a patient may be dissatisfied if he is not psychologically prepared for the surgery. The two key elements of the psychiatric evaluation are the patient's motivation and his expectations.

Questions to be asked to determine the patient's motivation should include the following:

1. Why do you want hair-replacement surgery?
2. Have you investigated or used another mode of treatment for baldness? If yes, why were you dissatisfied with it?
3. Why do you want hair-replacement surgery now?
4. Whose idea is it to have the surgery?
5. What other cosmetic procedures have you had or would you like to have?
6. Were you happy with the results of previous surgery?
7. Have you ever been treated by a psychiatrist or psychologist?

Patients who are having surgery to please others, who have been dissatisfied with previous cosmetic surgery, or who want the surgery performed immediately should be carefully evaluated. The more thought and consideration that the patient gives to surgery and

the more he is motivated by a desire to improve his appearance without seeking perfection, the more likely he is to be satisfied with the results of surgery.

Questions that explore the patient's expectations from this surgery include the following:

1. What do you think this procedure will do for you?
2. Do you have any idea how you will look when the surgery is completed? (What amount of hair will it take to satisfy the patient?)
3. Do you understand that this procedure is designed to improve your appearance, not to achieve perfection?
4. Do you understand that this procedure might not fully satisfy your expectations?

Patients who desire perfection and have an unusual preoccupation with their appearance are likely to be dissatisfied with the results of surgery. Very often such patients are dissatisfied with a technically excellent result. Therefore as much information as possible should be presented to the patient (including the use of realistic photographs) to give a realistic appraisal of what to expect from the surgery. If there is any question regarding the patient's suitability for surgery after the first consultation, he should be advised to return for another consultation. If the surgeon is still not satisfied with the patient's suitability for surgery, then he should refuse to perform the procedure.

### **Local factors**

Even though the patient is medically and emotionally healthy, he may not be a suitable candidate for surgery. The surgeon should evaluate local scalp factors for each patient before deciding to proceed. The most important of these local factors are the patient's ultimate pattern of baldness and the condition of the donor hair and scalp supply.

#### ***Balding pattern and donor supply***

Young men with minimal thinning of the hairline should be deterred from beginning any type of hair-replacement surgery for three reasons. First, with increasing age they may develop a more extensive loss, especially if there is a family history of this type of hair loss. If more loss will occur later, the hairline would most likely be placed at a higher position to conserve donor supply. Second, these patients often have little if any cosmetic problem after styling their hair. They should be made aware that all surgical hair replacement requires varying degrees of hair styling afterward. Third, in general, the more loss the patient has, the more willing he is to accept the limitations of surgery.

At the other end of the spectrum are the patients with too much balding and too little donor supply area to achieve a satisfactory aesthetic result. Too few grafts scattered over a large bald area look unnatural. This is especially true in patients with dark hair and light skin in whom the contrast produces an unnatural "doll's hair" appearance (tufting). If flaps are to be used, the donor area must be of sufficient size to allow the removal of a flap and still

leave enough hair to maintain a normal appearance. If not enough donor area hair is present to achieve a satisfactory result, the patient should be discouraged from having surgery unless he will be satisfied with a less-than-optimal result.

For patients between these two extremes, flaps or grafts can be used with varying success depending on the other factors involved and the skill and experience of the surgeon. However, since hair loss progresses with age and may appear limited for several years and then accelerate, one must be careful in assessing the ultimate balding pattern. Although scalp reductions combined with flaps or punch grafts can improve the end result for a good surgical candidate, they generally cannot convert a non-candidate for surgery into a candidate.

### ***Hair density***

Hair density is most important when considering punch grafting. A general rule of thumb is that to make the procedure worthwhile the patient should have at least 10 hairs in 4 mm circle. One can mark several 4-mm circles in the donor area with a dull punch dipped in gentian violet and count the hairs in each circle.

If several scalp reductions are to be done in an already borderline candidate with low hair density, the surgeon should consider the possible additional decrease in density that may result from stretching of the donor area. Occasionally the surgeon begins punch grafting the frontal scalp before scalp reductions are done so that the grafts will have maximal density. In most good candidates, however, the density change following scalp reduction is minimal.

In patients with low hair density (see Fig. 28-31) the flap procedure is quite advantageous since no hair is lost in the transfer procedure and the redistributed hair is uniform. The results with flap surgery in patients with low hair density are far superior to those with punch grafting.

### ***Hair color - skin contrast***

The color of hair is less important when flaps are used than when punch grafts are used, since no tufting occurs with the former. With punch grafting, dark hair (especially on light skin) gives a more tufted hairline that does blonde hair, but dark hair usually covers better. Conversely, although blonde or red hair covers less than dark hair, it blends better with the scalp because of less color contrast. Patients with silver, gray, or "salt-and-pepper" hair are excellent candidates since the hair color blends well with their skin color, thereby diminishing the tufted appearance. Therefore hair color can make a difference in the final selection of a surgical candidate. Punch grafting should not be used for a borderline candidate (one with poor density and a large recipient area) with dark hair, although flaps may be satisfactory. The same type of patient with gray or light blonde hair could be a candidate for either punches or flaps.

### ***Hair texture***

Hair texture is important because coarse hair gives better coverage than fine hair. This is especially true of kinky or curly hair since curliness gives the appearance of great density, even when the actual density is quite poor. One must carefully evaluate the donor area of

these patients because the texture can often deceive the surgeon into thinking the hair is quite dense.

Fine hair provides less coverage than coarse hair, and therefore flaps are most frequently used in patients with fine hair because they provide maximal density of hair in the transferred scalp. Of course, straight hair can be curled after grafts or flaps are transplanted to produce an appearance of greater density. Since the hair density with flaps is greater than what can be achieved with grafts, a permanent is usually not necessary but can be done if the patient so desires.

### *Scalp elasticity*

An accurate assessment of elasticity of the scalp is very important for patients undergoing scalp reductions or flaps. By placing his hands on both sides of the scalp and pushing toward the midline, the surgeon can evaluate the mobility of the scalp from side to side. By placing the hands in an anteroposterior direction, the surgeon can determine if the scalp can be stretched in an anteroposterior direction as well. If the scalp is quite tight, scalp reductions may be of limited value. This may be the cause for rejection of a patient in whom other negative factors exist, such as poor hair density and limited donor area. Conversely, a very loose scalp may be the determining factor that makes an otherwise marginal candidate acceptable for surgery. Scalp elasticity is desirable for flaps but not absolutely necessary, since a great deal of the mobilized skin used to close the donor defect comes from the neck.

Tissue expansion can be used to great advantage both in reconstructive as well as aesthetic scalp surgery. The patient must have adequate density in the donor area to allow expansion and removal of a flap (or transplants) and still maintain a good cosmetic result in both the donor and recipient areas. It is used primarily in patients who lack adequate scalp elasticity to do scalp reduction or flaps.

### *Hair styling*

How patients choose to wear their hair after surgery is also of great significance. Patients who want to wear their hair combed back or parted should be discouraged from having punch grafts. With the hair combed back or parted through the grafts, the tufted appearance of the grafts is particularly evident. All patients with grafted hair, therefore, are told that they should comb their hair forward to cover the grafts (see Fig. 28-6, E). With flaps, the patient can wear his hair combed back or parted, since no tufting occurs (see Figs. 28-25, 28-28, and 28-29).

In summary, poor candidates for surgery are those patients who have either very minimal hair loss or very extensive baldness. In patients in whom concern exists that the future pattern of loss may be too extensive to achieve a good aesthetic result, the surgery should be postponed until the ultimate pattern of loss can be more accurately predicted. In other words, one does not try to make a non-candidate into a candidate.

The ideal candidate for punch grafting is a well-motivated, middle-aged patient who has dense donor hair, and enough hair to supply sufficient grafts to solidly replace his current and *future* pattern of alopecia. In general, no more than the anterior one third of the scalp

should be bald. The patient should also be amenable to combing the hair forward to cover the tufting, and he should be willing to accept that the density of the transplanted hair will be less than that of his original hair. He must also accept that the texture of his hair may be permanently altered.

The requirements for flap surgery are far less stringent. The patient should have adequate donor hair to satisfy the needs of both the recipient and donor areas after the surgery. Since there is no change in hair density or texture in the flap and no tufting, fewer styling requirements are necessary with flaps. However, some styling may be necessary. The patient must be willing to accept a more involved surgical procedure as well. Although the hair growth will be altered, the styling requirements will be far less than with transplants.

### **Hairline Aesthetics**

Punch grafting and flap surgery are proven methods of treating baldness. With either method the location and shape of the new hairline in the frontal and temporal scalp are the most important aesthetic considerations in achieving a satisfactory result. If the hairlines is not placed correctly, the results will be unacceptable or even devastating for patient and surgeon alike. Unfortunately, the most common complication referred to our office is poor hairline configuration or placement. This problem can be totally avoided by careful aesthetic planning.

#### **Placement**

The location and design of the hairline are essentially the same whether one is using punch grafts or flaps. With each method the first decision in planning surgery is where to place the hairline. Leonardo da Vinci divided the frontal views of the face into thirds. The lower one third extended from the lower border of the chin to the nasal spine, the middle third from the nasal spine to the glabella, and the upper third from the glabella to the frontal hairline. The first aesthetic rule is never to place the hairline below the superior border of the upper third of the face. In the adult male, hairlines below this point look abnormal.

The second rule is never to place the hairline at a level lower than that which the patient requests. Placing the hairline somewhat above this point is acceptable and often desirable for several reasons. The lower the hairline is placed, the greater the area of baldness that is "created" posterior to the hairline. Often, making the hairline higher and having a smaller bald area with which to deal is preferable. This situation will allow greater density of hair than could be achieved if the bald area were larger. In addition, the degree of baldness in the future may become greater than was anticipated when hair replacement surgery was begun. Thus, in time, "demand" may exceed the supply of available hair-bearing tissue and diminish the end result. Therefore, if one is uncertain as to how much future loss will occur, it is better to err on the side of placing the hairline in a higher position.

The third aesthetic rule is that when the punch-graft technique is used, the hairline can be lowered later one row at a time if one has overestimated the eventual balding pattern. This is more difficult with flaps, but can be accomplished. The patient should therefore be informed of this preoperatively.

## Configuration

The configuration of the hairline is equally as important as its location. Inappropriate hairline design with either punch grafts or flaps is still the most common problem referred to our office. With a few exceptions, the shape of the normal adult male hairline is a gentle convex curve (see Fig. 28-38). Artificially created widow's peaks and other unusual hairlines rarely look natural. The frontal hairline should form an acute angle laterally with the temporal hairline, making a "temporal gulf". The peak of the temporal gulf should be the most superior point of the hairline, and it should never be lower than the midfrontal hairline. In other words, when looking at the patient's profile with the head level (Frankfort horizontal plane), one should see the hairline slant slightly downward posteriorly to anteriorly, *but never upward* (see Figs. 28-27 and 28-38). Whether done with flaps (Fig. 28-3) or punch grafts (Fig. 28-4), "blunting" of the temporal gulf creates an apelike appearance that is quite abnormal and almost impossible to conceal. The surgeon should never be persuaded by the patient to create a hairline that looks unnatural.

The lateral part line is usually located above the junction of the lateral and middle thirds of the eyebrow. The proposed hairline should end at the part line, although it can be placed slightly more medially. It should *never* be placed more laterally than the part line, especially with punch grafts, since this would expose the grafts when parting the hair.

The curve of the hairline should be gentle rather than excessively curved or flat. In designing the hairline, the surgeon must consider whether or not scalp reductions will be done at a later time. If so, the lateral parts of the hairline will be elevated later if the anterior scalp is included in the reduction. With punch grafting one can always place additional grafts in the elevated areas, but with careful planning the need for this can be avoided. With patients who have two Fleming/Mayer (F/M) flaps, reductions are routinely done between the flaps and should not alter the hairline as created.

A "flap" hairline may be created in any of several shapes, contrary to the common misconception that it is always flat. A gently curved hairline can easily be created with the flap (see Fig. 28-30). In fact, as with punch grafting, the curve can be exaggerated. Although we have had a few patients who preferred a slightly flatter hairline, the hairline should conform to the normal range. One can, however, with subsequent reductions, increase the curvature of a flattened hairline. Of course, the hairline should be created with the irregularity described in the section on the F/M flap.

With short flaps another aesthetic consideration is the shape of the junction of the two flaps at the hairline. We design the distal 2 to 3 cm of both short flaps in a straight line so that a notch will not occur at their junction in the frontal hairline (see Fig. 28-34). A notch will occur if two curved flaps join together along a curved line.

The proposed hairline should be carefully drawn on the patient, and then shown to the patient and thoroughly discussed. This step will avoid a great deal of misunderstanding postoperatively. Any areas of disagreement are better dealt with preoperatively.



## **Punch Grafting**

Punch grafting (hair transplantation) is a reliable, safe method of hair-replacement surgery. Since Orentreich first published his experience in 1959, the procedure has evolved and results have improved (Unger and Nordstrom, 1988). Careful patient evaluation and selection combined with meticulous surgical technique are necessary to achieve good results. This section expands on these two principles.

### **Patient evaluation and selection**

At the time of initial evaluation the very basic question of "supply and demand" is critical. The relative size of the bald and donor areas must be thoroughly assessed and discussed with the patient so that reasonable expectations are clearly established. Some men with a very large bald area are not candidates for punch grafting. The young patient in whom the extent of alopecia is unpredictable should wait until the ultimate pattern of baldness is established, usually in the latter part of the third decade, before transplantation is started. This is true even when hair loss is minimal. At the other end of the spectrum, the older patient should not be discouraged from having hair-replacement surgery purely on the basis of age; the technique is just as effective in the older age group.

Patients with class I baldness will have a satisfactory result with punch grafting alone. For those with class II, III, or IV baldness, scalp reductions should always be considered as an adjunctive procedure. If the patient does not have adequate scalp laxity to significantly decrease the size of the bald area, the grafts must be judiciously placed to give the illusion of maximal coverage, concentrating them in the hairline and the part side of the head. We go into more detail on this topic in the section on assessment of the recipient site.

In addition to the size of the bald area and the age of the patient, many local factors must be considered. The density of the donor area must be carefully evaluated. In most cases a patient should have at least 10 hairs per 4-mm graft to achieve a reasonable result. cursory inspection of the donor hair may be misleading. Curly or kinky hair may appear thicker than it really is. Of course, transplanting this type of hair is advantageous when the density is adequate. Patients should be aware that the hair texture may change after punch grafting - transplanted hair may be more coarse and curly.

Dark hair covers better than light hair, but tufting is more apparent because of the contrast with the underlying skin. Although hair may not appear as thick after punch grafting on a blonde or redhead, it may in fact look more natural because tufting, the stigma of hair transplantation, is less obvious and therefore the styling restrictions are less stringent. The ideal hair color is gray or salt-and-pepper (Fig. 28-5).

### **Assessment of recipient site**

Each patient, regardless of age, must be evaluated in light of the ultimate pattern and extent of alopecia. Unfavorable results occur when most of the available grafts are used to achieve the best possible result in a young patient when he has the potential for additional hair loss in the future. The conservative approach is best with a man in his 20s or 30s.

Punch grafting should be avoided in recipient sites with minimal thinning. The surgical insult of placing punch grafts in parts of the scalp with moderate to thin hair may actually induce telogen and defluvium and accelerate the progression of hair loss (Fig. 28-6). These lost hairs are usually replaced about 3 months later. However, they return as finer hairs with less density, and the net gain may be insignificant. A patient should be aware that the surgeon may have to transplant thinning portions of the scalp as if they were bald rather than place a few grafts simply to increase the existing density.

The hairline and the crown are the two most difficult areas in which to achieve good aesthetic results. The hairline should be placed conservatively to preserve grafts (Fig. 28-7); the lower the hairline, the larger the area of baldness that must be transplanted. The lateral hairline grafts should be directed anteriorly and medially. Grafts in the central portion of the hairline are directed anteriorly. The angle and direction of transplant placement are critical. Tufting is most apparent when the grafts are placed at a 90-degree angle to the surface of the skin. If the grafts are positioned at an angle of 30 to 40 degrees relative to the plane of the scalp, hair growth parallels the scalp surface and tufting is less obvious (Fig. 28-8). Small "fill-in" grafts or single-hair transplant as described by Marritt (1984) will refine the front row. The patient should understand that perfection cannot be achieved; styling will be necessary so that the actual hairline is covered.

The crown is the most lax portion of the scalp; therefore in patients with extensive crown or vertex baldness (actual or potential) reduction should be considered. The natural whorl of the crown should be maintained with transplantation. The direction of graft placement will vary as one progresses around the spiral of the crown.

If the supply of donor grafts is not adequate to achieve ideal coverage, the transplants can be strategically placed to give the illusion of maximal coverage. Grafts may be concentrated on the part side of the scalp to comb over portions of the scalp where fewer transplants are placed. These limitations should be thoroughly discussed with the patient before the initial transplant session.

It takes at least four sessions to cover any area (Fig. 28-9). The transplants are positioned so that adequate space exists between grafts to ensure good blood supply. The first two sessions can be done 4 to 6 weeks apart, but subsequent sessions are separated by at least 3 months to allow the establishment of hair growth and adequate blood supply. In areas such as the hairline, where maximal density is desired, six or more procedures may be required.

### **Assessment of donor site**

The density of hair in different parts of the donor scalp varies significantly. Frequently, hair in the superior portion of the donor scalp is thicker than the relatively fine hair inferiorly. Grafts are not taken from the fringe hair that may be lost in future. Wetting the hair will help to determine the border of safe donor tissue. The thickest hair is used at the hairline, in the central portion of the crown, and on the part side of the scalp. Thinner hair, located low in the parietal and occipital donor areas and temporal scalp, can be used in recipient sites where density is not so critical and to refine the front row of the hairline. Fewer grafts are harvested in donor regions with less density to avoid exposure of the underlying scalp.

## **Surgical technique**

Each surgeon develops his own personal approach. The following is our technique: the scalp is prepared with hexachlorophene using a barber's shampoo sink. Hair in the donor site is then cut short (1 to 2 mm), leaving stubble so that the direction of hair growth can be determined as the grafts are harvested. Postoperatively, hair above the donor site is combed down over this region to hide it.

No preoperative medication is given to the patient. Local anesthesia is achieved with 1% lidocaine hydrochloride with epinephrine, 1:100,000. The Dermojet is used to minimize the discomfort of the injections.

A flat power table with adjustable headrest enables the operator to work in a sitting position with the patient prone or supine. A hand-held or power-driven punch is used to cut the grafts and recipient sites. The power-driven punch developed by Monell (1974) provides a technical advantage.

Initially, the entire recipient area is infiltrated with a local anesthetic. After anesthesia is achieved, the individual graft-recipient sites are marked with a hand-held punch, scratching the skin. In most cases 4 mm grafts are placed in 3.75 mm recipient holes. This will vary in later sessions when refining an area or adding fill-in grafts is done. The recipient holes are then cut through the entire thickness of the scalp using the power-driven punch. Keeping the hair wet with normal saline or water during the operation is helpful to avoid catching the surrounding hair in the rotating punch.

If bleeding occurs, hemostasis can be maintained with moderate pressure. The recipient holes are cut at the angle appropriate for each part of the scalp. The hair on top of the head normally grows anteriorly and anterolaterally toward the forehead. Direction of graft placement in the crown will vary as one progresses around the swirl. Usually some residual hair is present for proper orientation. The bald skin is then left in place until the donor grafts are harvested.

With the patient in a lateral or prone position, the donor area is locally infiltrated with the anesthetic solution, starting at the most inferior portion of the donor site. The donor scalp is further injected with normal saline to add turgor to the skin, which makes cutting the grafts at the proper angle without damaging follicles at the edge of the plugs easier. The grafts are cut parallel to the hair shafts as demonstrated in Fig. 28-10 and deep enough to reach the fatty layer beneath the follicles. Sharp punches are an absolute necessity. The surgeon should remove a graft periodically during this step to ensure that the punches are being cut at the proper angle. After all punches are cut, they are delivered by grasping the epidermis with 1.5 mm Castroviejo forceps and then removed by cutting through the fatty layer just deep to the follicles. Covering the grafts with saline solution in a Petri dish keeps them moist.

As demonstrated in Fig. 28-11, incisions are made connecting the donor holes. After interdigitating the superior and inferior edges, the donor wound is closed with a running 4-0 polypropylene suture. The ultimate scarring within the donor area is smaller relative to that resulting when the individual holes heal by secondary intention.

The bald skin is then removed from the previously cut recipient holes. Careful, uniform placement of grafts with consistent direction of hair growth is essential. Gentle pressure will maintain hemostasis. Excessive pressure may rotate the grafts and cause distortion so that the proper direction of hair growth is not maintained. A dressing consisting of Telfa and gauze is placed on the grafted area.

### **Postoperative considerations**

Analgesics are necessary the evening of surgery; pain is common in the donor area. Methylprednisolone is started the day of surgery. This will minimize the edema and ecchymosis of the forehead and eyes when hair replacement has been done in the frontal scalp. By controlling the amount of swelling, the surgeon also minimizes postoperative pain.

The dressing is removed the day after surgery. The patient is instructed to wash the hair daily, obviously being gentle in the recipient area so that the grafts are not dislodged. With frequent shampooing, scabbing and crusting are kept to a minimum. The patient is advised to avoid strenuous activities for 1 week after surgery.

Sutures in the donor wound are removed in 1 week. Crusts that form on the grafts usually fall off in 2 to 3 weeks. The hair in the grafts will fall out about 6 weeks after surgery as the follicles go into telogen secondary to the trauma of surgery. New hair growth starts about 3 months after the procedure, usually progressing at a rate of about 0.5 inch per month.

### **Complications**

Serious complications are relatively few and when they occur are most often a result of poor planning and/or poor technique. A hairline that has been placed too low or is blunted or rounded at the temples can be very difficult to correct. Scalp reductions, coronal incisions with a forehead lift, or excision with repositioning of the grafts will improve the appearance of the hairline, but the ideal result is rarely achieved. Random orientation of the grafts will make styling of the hair almost impossible. These transplants can be cut again and repositioned. These are complications that can be avoided.

Poor hair growth or lack of growth may result from inadequate circulation in the recipient area, but most often it is secondary to placing too many grafts at one procedure, cutting the grafts with a dull punch, failing to keep the grafts moist before placement, or aggressive trimming of the fat on the deep surface of the transplants. If poor growth is caused by inadequate scalp circulation, the surgeon should progress slowly, doing fewer grafts at each sitting as when punch grafting an area of cicatrix.

Stough (1970) has reported intraoperative syncope. This most often occurs when the patient is in the sitting position. The problem of positional syncope can be avoided by doing the operation with the patient prone or supine.

Bleeding during surgery can be troublesome, but gentle pressure will usually provide hemostasis. The occasional site of persistent bleeding can be controlled with a suture or the use of oxidized cellulose gauze.

Arterial or, more commonly, venous aneurysms may form postoperatively. These ecchymotic, compressible lesions usually occur in the donor area but may be found in any surgical field. Frequently, the aneurysm will spontaneously resolve; if the surgeon is concerned about bleeding through the weak vascular wall, the wall can be isolated and tied off on the proximal and distal sides with a sutured ligature.

Arteriovenous fistulas are rare. There is a palpable thrill, and a machinery-like murmur can be heard. These are less likely to resolve and must be excised in most cases.

Although a few cases of infection following hair transplantation have been reported, the excellent blood supply of the scalp makes this an unusual complication. Prescribing prophylactic antibiotics is not necessary. Occasionally inflammation with skin contamination or infection is seen in a single graft; local care is sufficient to treat this condition. Erythema may persist at the margin of the grafts for 2 to 3 months; this always resolves. The final white scar is not conspicuous. Hypopigmentation of the grafts in patients with dark complexions may be permanent.

A decrease in scalp sensation and even numbness always occur after transplantation. In most cases relatively normal sensation gradually returns over several months.

Persistent elevation of the grafts above the surface of the scalp skin ("cobblestoning") can be avoided. The donor scalp is frequently thicker than the recipient skin. If the discrepancy is significant, the scalp in the recipient area can be distended with the injection of normal saline. Cutting the galea will relax the base of the scalp and deepen the hole. If persistent oozing of blood pushes the graft above the surface, a suture placed through the epidermis will keep the transplant in proper position. Cobblestoning can be improved with dermabrasion or shaving the graft skin.

## **Scalp (Alopecia) Reduction**

### **History**

Scalp reduction consists of the serial excision of portions of bald scalp. It is essentially the closure of an elliptic excision with bilateral (or rotation) advancement flaps. Plastic surgeons have used these flaps since the turn of the century to close defects caused by trauma or malignancy and for the staged excision of split-thickness skin grafts of the scalp. Juri (1975) described the use of scalp reductions after placement of two flaps on the top of the head. The reductions were performed between the two flaps as well as within the crown. Scalp reduction was first used for treatment of male pattern baldness by Blanchard and Blanchard (1977). In 1978 Sparkuhl and Stough and Webster presented their experience with scalp reductions at the International Hair Transplant Symposium in Lucerne, Switzerland. Since then, Unger and Unger (1978), Bosley et al (1979, 1980), Alt (1980), and Mayer and Fleming (1980) have modified and refined this technique. Marzola (1984) described his method of extensive scalp reduction, which included ligation of the occipital arteries and stretching of the temporo-parieto-occipital scalp superiorly and anteriorly. He did this on each side as a separate reduction to maintain blood supply to the posterior scalp. Using Marzola's technique, Brandy (1986) performed bilateral ligation of the occipital arteries and bilateral scalp reductions, but this resulted in necrosis and scarring in the occipital scalp in several

patients. A delay following the ligation of the arteries, and later performing the reduction is said to prevent this problem. However, many surgeons have abandoned this procedure because of the risk of extensive necrosis (Unger, 1988). Whether a surgeon performs scalp reduction himself or has a colleague perform the surgery on his patients, scalp reduction should play a vital role in the management of male pattern baldness today in almost every patient undergoing punch grafting or flap procedures.

### **Advantages**

During the consultation, the patient is informed of the advantages of scalp reduction. These include the following:

1. In patients with a partially developed pattern of hair loss, scalp reduction will conserve donor punches for future use.

2. By reducing the bald area in a patient with a fully established pattern of loss, the now smaller bald area can be more densely transplanted.

3. In patients who are borderline candidates for hair replacement surgery, reductions may improve the chances of obtaining a good result. However, the procedures should not be used to try to convert a non-candidate into a candidate.

4. In patients with hair loss from the midscalp to the occipital scalp but with frontal hair present, one or more scalp reductions may preclude the need for punch grafting, especially if the hair is curly.

5. The part line can be elevated to give more ease in hair styling.

6. Subsequent areas of baldness lateral to a previously grafted site or areas of cicatricial alopecia can be removed with scalp reductions.

7. Sparsely punched areas of scalp can be removed with reductions, and good-quality grafts can be transplanted elsewhere to increase density.

8. Scalp reduction done after flap procedures can increase the width of flaps 50% or more and also treat any residual crown loss (see section on F/M flaps).

The disadvantages of scalp reduction will be discussed individually with each reduction pattern.

### **Scalp reductions before F/M flaps**

Scalp reductions prior to F/M flaps are not wise for beginning surgeons unfamiliar with the procedure, except in patients with profound elasticity. A certain amount of elasticity will be lost during the scalp reduction, making it difficult to close the donor area of an F/M flap later. Therefore, we believe surgeons should wait until they have done a large number of flap procedures before doing scalp reductions prior to flap transposition.

However, it is not unusual for us to do one or more scalp reductions prior to rotation of an F/M flap. The purpose of this is twofold. One is that the excision of bald skin reduces the size of the area to be covered with a flap. Of greater importance is the fact that the *donor area* has been expanded by stretching hair-bearing scalp. It is possible in some patients who have very elastic scalps to completely close the posterior and midscalp bald areas prior to flap rotation, though this is not usually the case. The donor area can then be stretched to close the flap donor sites, even when bilateral flaps are used.

### **Advantages of scalp reduction after F/M flaps**

After two F/M flaps have been rotated into position, the remaining bald skin can subsequently be excised using scalp reductions, thereby stretching the flaps by more than 50% in some cases. A flap that starts out 4 cm in width may end up being 6 to 7.5 cm wide. Similarly, in patients who have only frontal baldness that has been treated with one flap, scalp reductions can be done to stretch the flap posteriorly to remove 2 cm or more of balding scalp. Also, scalp reductions can be done in the crown to reduce the bald area and stretch a flap.

### **Other uses of scalp reduction**

#### ***Advancing the hairline forward***

If the scalp is sufficiently mobile in an anterior-posterior direction, an anterior advancement of the frontal hairline can be done with or without a concurrent forehead lift.

#### ***Elevating a blunted fronto-temporal hairline***

A flap (or punch grafted) hairline that has been placed too low can often be raised to a normal level by use of one or more scalp reductions behind the hairline.

#### ***Excision of burned (or otherwise scarred) scalp***

If the scalp has sufficient elasticity, one or more scalp reductions can be done to excise a scarred area of scalp (see Fig. 28-41) without the need of tissue expansion or flaps.

### **Contraindications to scalp reduction**

#### ***Patients with tight scalps***

Scalp reduction is most useful in patients with maximum elasticity, such as those with scalps that wrinkle greatly when both sides of the scalp are pushed medially. Conversely, patients with virtually no elasticity are not good candidates for this procedure because the amount of gain will usually not justify the time and expense involved and the scarring that will result. This group is quite small, being less than 1% of all of the patients we see. Although other authors (Unger, 1988) have reported a small group of patients who achieve little benefit from repeated scalp reductions because the same area of baldness seem to return quickly, we have not encountered this phenomenon in several thousand scalp reductions.

### ***Patients over 50 years of age with only frontal loss***

It is very rare for a patient over the age of 50 with only frontal loss to have significant loss in the midscalp and/or crown in the future. We consider someone in this age group to have a relatively well-defined pattern of loss. This is not the case for a patient in his early to mid 40s with a similar loss pattern because occasionally, these patients may go on to have extensive loss. It is possible that scalp reductions may become necessary later in younger patients with only frontal loss and no loss in the midscalp or crown as their balding pattern extends to the midscalp and crown.

#### **Preoperative considerations**

Patients undergoing scalp reduction are given a preoperative instruction sheet. Preoperative laboratory tests include complete blood count, urinalysis, prothrombin time, and partial thromboplastin time. The surgery is always performed as an outpatient procedure, and no preoperative medication is given. Photography and marking are done before surgery.

#### **Surgical technique**

The use of a power chair-table allows the surgeon to move the patient from supine to a sitting position as needed during the procedure. The procedure is normally done under local anesthesia, but if a patient is extremely apprehensive, intravenous or general anesthesia can be used. If intravenous anesthesia is used, a continuous IV is kept open at all times, and the patient is given from 2 to 4 ml of fentanyl intravenously. Following skin preparation with 3% hexachlorophene and sterile draping, the Dermojet is used to raise several wheals of local anesthetic over the proposed area of ring block. Following this, a 30-gauge needle is used to inject 1% lidocaine hydrochloride with epinephrine, 1:100,000, in a circumferential fashion distal to all areas to be undermined. The same solution is then injected along the proposed lines of incision. The ring block is supplemented with 0.5% bupivacaine hydrochloride for longer postoperative analgesia. After 10 minutes maximal vasoconstriction and the full effect of the anesthetic solution will have been reached, and surgery can begin.

The beginner will find the midline ellipse (Fig. 28-12) to be the simplest pattern, but the more experienced surgeon may prefer the Y or double-Y patterns. One standard reduction uses the Y or double-Y configuration and is performed in the following manner. The right limb of the central ellipse is incised with a No. 10 blade through the galea, parallel to the hair follicles. The inferior Y incision is also completed at this time, and bleeding is controlled with electrocautery. The skin is elevated anteriorly with a double hook where the galea is loosely attached, and the Kahn scissors are used to begin the dissection anteriorly. This dissection is usually quite easy, but care must be taken not to have the scissors tips go through the galea and injure any vessels. Posteriorly, the dissection is more difficult because the galea becomes attached to the fascia over the neck musculature. The dissection should extend beneath the hairline, above the ear and posteriorly to the nuchal ridge. After this side has been completely undermined, the same steps are repeated on the contralateral side.

Surgeons use several methods for estimating the amount of skin to be excised. For the novice the easiest way is to overlap the two edges of the scalp and remove the excess skin so that the edges will just meet. The more experienced surgeon may use his hands on either



side of the head to overlap the flaps and allow blood staining of the overlapped flaps to demonstrate how much flap should be excised.

Once the excess skin has been removed and any residual bleeding controlled with electrocautery, the deep galea may be approximated in a sequential fashion. The galea is approximated using 1-0 polypropylene inverted interrupted sutures along the course of the incision. This usually proceeds from the midscalp forward. Once this area has been closed at the galeal level, the skin edges are approximated with a surgical staple gun. The area next to the apex of the Y is closed in a similar fashion; any further excess tissue is trimmed, and the inferior triangular flap is elevated anteriorly to remove even more tissue in this plane. The galea and skin edges are closed in the fashion previously described.

Before final closure, a Penrose drain is placed in the most inferior portion of one limb of the Y and sutured in place with a surgical staple gun. As the novice becomes more proficient in scalp reduction, moderate amounts of tension can be placed on this closure without necrosis. In this way, large amounts of bald skin can be removed with fewer reductions necessary. The hair is cleansed with saline and dried. A fluff and cling-type dressing is applied.

### **Postoperative considerations**

The dressing is removed the following morning along with the Penrose drain, and the patient's hair is washed and blown dry. The patient may return to work. All patients undergoing scalp reduction are placed on a decreasing dose of methylprednisolone for 5 days postoperatively to minimize any edema, bruising, and pain. Oxycodone hydrochloride is used postoperatively for pain; antibiotics are not routinely used. All clips within the scalp are removed in 12 to 14 days.

### **Galeotomies**

We have never found galeotomies (incisions in the galea) to be effective in significantly increasing the amount of tissue removed at each session. However, they can be useful as an aid in closing an unusually tight wound after overzealous trimming.

### **Scalp-reduction patterns**

#### ***Midline ellipse***

The easiest scalp-reduction pattern for the novice is the elliptic midline closure (Fig. 24-12, B). It has the following advantages:

1. Estimation of the area to be removed is simple.
2. No postoperative anesthesia of the scalp is needed.
3. Effects of any temporary hair loss are less noticeable than with other patterns.
4. A central area of the scalp with insufficient blood supply is not created.

The midline ellipse pattern has many significant disadvantages, and other procedures should be used as soon as the novice has sufficient experience. The disadvantages are:

1. No bald skin is removed in an anteroposterior direction as with the Y closure.
2. Distortion of the remaining bald area occurs, with an unnatural appearance in the posterior portion of the scalp (Fig. 28-13).
3. Less bald skin is excised than with other procedures.
4. Surgical exposure is limited.

### *Lateral (paramedian) reductions*

The paramedian or lateral scalp reduction (Fig. 28-12, D) as popularized by Alt (1980), or the J- or U-shaped flaps popularized by Unger and Unger (1978) have the following advantages:

1. The initial scar is in the lateral position and therefore theoretically is not as visible as other scars.
2. The occipital scar is elevated on at least 50% of the posterior portion of the head with each reduction.
3. The procedure allows the novice greater undermining exposure on the side of the incision.
4. More bald skin can be excised than with a midline reduction.

Disadvantages include the following:

1. Temporary anesthesia is required over the top of the head.
2. The procedure is more difficult to perform than the midline ellipse.
3. Scalp circulation may be impaired if a central island is created, and impaired growth of subsequent grafts may be jeopardized.
4. Distortion of the remaining bald area is the same as with a midline ellipse and greater than with the Y or double-Y pattern.
5. Although exposure is better than with the midline ellipse, it is less than with the Y or double-Y pattern.
6. Less undermining is possible on the contralateral side compared with the Y or double-Y pattern.

### *Y or double-Y pattern*

We have used the Y and double-Y patterns (Fig. 28-12, A and C) in almost all cases since we began performing scalp reductions in 1977. At times we choose a different pattern (especially in revision surgery) when the patient's problem dictates a different approach. Why more surgeons do not use this pattern is bewildering, since the Y or double-Y pattern seems to have definite advantages.

What is the problem that the surgeon is trying to solve in scalp reduction surgery? Ultimately, he is trying to close an oval or pear-shaped defect as a staged procedure with as little distortion of the crown balding pattern as possible. He wants to obtain as much skin removal with the fewest number of reductions as possible. The Y or double-Y pattern provides the following advantages:

1. Excess scalp can be removed in the anteroposterior and lateral-to-lateral phases (Fig. 28-14). Therefore more bald skin is removed than with the midline or paramedian reduction.
2. Very little distortion of the balding pattern occurs, and a more natural hair direction on the posterior aspect of the scalp is produced. Unnatural, axlike scars in the posterior scalp are prevented (Fig. 28-15).
3. The posterior dog-ear is distributed in two places instead of one.
4. Greater ease of undermining is possible with the Y compared with the paramedian pattern because the limbs of the Y are laterally placed. Also, more undermining is possible with this method than with the midline or paramedian pattern because the surgeon has excellent exposure to both sides as well as to the posterior crown.
5. No central island of impaired circulation results.
6. Since more bald skin is removed with each reduction, fewer reductions are necessary with this pattern than with the straight midline reduction.
7. These patterns can be easily varied to accommodate unusual balding patterns. All limbs can be varied in length and angle and adjusted as necessary.

Disadvantages of the Y and double-Y patterns are as follows:

1. For the novice, this procedure is technically more difficult than the midline ellipse or paramedian pattern.
2. The fact that the scar is centrally located is of minimal concern if it is properly closed.
3. Tip necrosis is a possible complication, although it has never occurred in any of our patients, despite the fact that we close a reduction under moderate tension.
4. This procedure may take slightly longer for the beginner to perform since more

tissue is removed.

The double-Y pattern is used in patients who have had grafting done in the frontal region where we do not want to elevate the lateral hairline. The limbs of the anterior T are placed posterior to the grafts (Fig. 28-16). In this way the temporal hair can be stretched without elevating the lateral anterior hairline.

### **Amount of skin excised**

Although the surgeon can usually accurately gauge the amount of tissue that will be excised with a reduction based on the preoperative mobility of the scalp, occasionally more or less scalp is removed than one would expect preoperatively. Fortunately, since a reduction allows the overlapping of flaps, this does not cause a problem.

In most cases from 4 to 5 cm of scalp can be removed with extensive undermining and moderate tension. Occasionally, more can be removed. Maximal undermining and moderate tension in the closures are recommended since this approach can save the patient one or more reductions. With increased tension, however, comes increased pain if the patient does not take pain medication as instructed. All of our patients are given the choice of less tension and possibly one more reduction or more tension and at least one less reduction. All have chosen to have the maximal amount of tissue removed with each reduction.

### **Timing reductions**

In general, we have found little improvement in the elasticity of the scalp after 8 to 12 weeks postoperatively. Therefore, this is the usual interval between reductions. No increase in the elasticity of the scalp develops if several months elapse between procedures.

### **Timing of scalp reductions and hair transplantation**

Reductions can be done before (Fig. 28-17), after (Fig. 28-18), or at the same time as hair transplantation (Fig. 28-19). The advantages of performing the reduction before hair transplantation are listed below:

1. Once all reductions are done, the surgeon can better assess the distribution of the available grafts in the bald area.
2. Dissection is easier before grafting, and there is no danger of injury to any grafts.
3. The transplant surgeon does not have to be concerned with future reductions in allocating the pattern of grafts.
4. The patient often has a dramatic decrease in the size of the bald area, increasing his motivation to complete the procedures.

Disadvantages of performing the reductions first are:

1. Patients are more often apprehensive about scalp reduction than about the more familiar hair transplantation. If this is the case, it is better to begin with anterior grafts and perform the reductions later.

2. The patient does not see any hair growth until the entire reduction process is completed and the transplantation begun.

3. Although each reduction stretches the donor area, the maximal stretch comes at the adjacent bald scalp and fringe. Therefore, we feel that stretching of the donor area is clinically insignificant except in patients with poor donor density.

Occasionally scalp reductions can be done posteriorly while transplantation is done simultaneously in the frontal region. The two procedures can also be alternated 6 to 8 weeks apart. In some patients with mild anterior recession, grafting can be done anteriorly while the crown is being reduced either simultaneously or at a separate session. As previously noted, patients with central loss only can often have the bald area reduced substantially, thus delaying the use of transplants for several years (Fig. 28-20).

Scalp reductions, as they relate to flaps, are discussed in the section on flap surgery.

### **Morbidity**

Since all patients are given methylprednisolone postoperatively, forehead edema and ecchymosis are rare. Pain is greater when more tension is used but can be controlled with postoperative pain medication and the bupivacaine hydrochloride. A feeling of tightness lasts for several days, but pain resolves after the immediate postoperative period.

### **Complications**

Of all the cosmetic procedures we do, scalp reduction has the fewest number of complications.

#### ***Hematoma***

All patients have a Penrose drain placed overnight with any scalp reduction. Only one of our patients developed a hematoma, which occurred 3 days after surgery, after the patient was in a Jacuzzi. This was drained through the wound without any problem.

#### ***Infection***

Only one staphylococcal infection has been encountered. This was in a hospital employee and was confined to a small portion of the incision site. It was drained and treated with antibiotics without sequelae.

## **Cosmetic problems associated with scalp reductions**

### ***Opposing hair direction***

If a large amount of bald skin is removed, hair in the mid- and posterior portions of the scalp will now grow in opposite directions on each side of the incision. To correct this problem several Z-plasties (Fig. 28-21) are performed and the components of the Z-plasty are exchanged, creating a redirection of the hair across the previous scar (Mayer and Fleming, 1980). However, for this procedure to have satisfactory results, the patient must have a good density of hair next to the scar. If the density next to the scar is poor (which is usually the case), punch grafting is the best solution. Trying to "overclose" the area by burying hair (Nordstrom, 1983) maintains this diverse or opposing direction of the hair follicles. This is especially true when sparse hair is present next to the scar. The best way of correcting this problem is to avoid the problem in the beginning by not completely removing all fringe scalp along the suture line. In this way punch grafting will help correct the prominent lateral radiation of the hair by anteriorly directing some central punch grafts. The other means of partially preventing this problem is by using the inverted Y pattern. The surgeon then is better able to elevate the posterior scalp superiorly and maintain a more natural balding pattern in the crown.

### ***Stretching of the bald scalp***

As has been alluded to, the maximal tension in a scalp reduction is placed on the most adjacent tissue. Therefore with a midline reduction the maximal stretch will occur in the bald skin and not in the donor area. The amount of stretching of the bald scalp after reduction has generally been found to be in the magnitude of 10% to 20%, and it has been reported to be as high as 30% to 40% (Unger, 1983). If a paramedian scalp reduction is done, the hair-bearing donor area may be stretched significantly with a subsequent decrease in density. Therefore grafts may be transplanted from these areas before scalp reduction.

### ***Scar healing***

We have had no patients who exhibit poor scar maturation, but this is always possible, and patients should be questioned preoperatively concerning unusual scar formation. With proper wound closure and the tension taken up at the level of the galea with maximal eversion of the skin edges, a good scar is usually attainable. A period of redness and fading of the scar occurs over several weeks, and the patient must be aware of this. When the hair direction can be kept the same on either side of any incision, the result will always be superior. Conversely, even a good scar surrounded by hair growing in opposing directions will appear more prominent, since the hair will always want to part according to its natural direction.

## Scalp Flaps

### History

Scalp flaps have been used for reconstructive purposes for almost a century (Dunham, 1893). Passot (1931) first described the use of small, lateral, temporoparietal scalp flaps with possible cosmetic applications. Lamont (1957) described a similar procedure for cosmetic hair replacement of the anterior hairline, but this report went unnoticed. Harii et al (1974) were the first to describe free scalp flaps to replace cicatricial alopecia in front of the temporal region. This was a one-stage repair undertaken on eight patients, in which a free composite scalp flap was utilized, with anastomosis of the flap vessels to the superficial temporal vessels. One year later, Juri (1975) presented his work on temporal-parietal-occipital flaps in several hundred patients with male pattern baldness. Large temporal-parietal-occipital flaps based on the superficial temporal artery were twice delayed, then used to create a new hairline with the donor area closed primarily. With this flap he created a method, which when properly executed, produces outstanding results and only minor complications. Juri's presentation in 1975 stimulated others including Fleming and Mayer, Kabaker (1978), and Fournier to begin work with this flap. Fleming and Mayer (1981) described a modification of the Juri flap that resulted in a more natural hairline configuration without blunting the frontotemporal recession.

In 1976 Elliott described the use of two temporoparietal scalp flaps of the same type described by Passot for the treatment of frontal baldness (Elliott, 1977). These flaps were smaller than those used by Lamont and therefore could be transposed without any delay. Unfortunately, with this method each flap (one from each side) gives only 1 inch of hair in the frontal region of the scalp, and the hairline configuration is quite unnatural. A similar flap was described by Heimberger (1977). Although Fleming and Mayer (1981) and Stough (1982) described the modifications that improved the hairline and configuration, the indications for its use remain rare.

Nataf et al (1976) and others described superiorly based preauricular and postauricular flaps. As originally described, the postauricular flap provided little advantage over the inferiorly based flap. The preauricular flap was useful only for partial hairline deformities since the flap will rarely reach the midline in most individuals. Marzola (1984) modified this flap by doing extensive scalp reductions before elevating the preauricular flap so as to obtain additional length. The flaps are usually only about 2.5 cm in length, so only with extensive reductions they reach the midline. Further use of Marzola's flap was described by Brandy (1986). Although other variations of Nataf's flap and Juri's flap have been described, they provide little advantage over Juri's original description, and each has its own set of disadvantages.

Fleming and Mayer further modified Juri's flap and combined it with the irregular trichophytic hairline to provide a more natural hairline configuration (1985). In 1982 they described a method of delaying the donor area before rotating a second flap and in 1984 suggested the use of a temporary graft in the donor site (or tissue expansion) to prevent elevation of the occipital hairline. These modifications of Juri's original design have resulted in the Fleming/Mayer (F/M) flap.

In 1985 Fleming and Mayer presented a method for flap reconstruction of the temporal hairline and for reconstruction of cicatricial alopecia. This was a vast improvement over earlier results using transplants placed into the avascular scar tissue, resulting in improved density, a consistent texture and saving of time.

### **The Fleming/Mayer flap (modified after Juri)**

Juri described a temporal-parietal-occipital flap that was 4 cm wide and long enough to cross the entire width of the forehead. It was twice delayed and was based on the superficial temporal artery. The original Juri flap has been modified to create the F/M flap.

Our flap retains four elements of Juri's original design:

1. The flap should be based on the superficial temporal artery.
2. Two delays should always be performed.
3. When possible, the design of the flap should be long enough to cross the entire forehead.
4. The flap design should allow a full-length flap to be taken from the opposite side subsequently without compromise.

In our opinion the flaps designed by Nordstrom (1988) and Stough (1985) do not satisfy requirement 3 and 4 above, and therefore are not an advantage over Juri's original design for most patients.

### **The Fleming/Mayer flap**

Our flap differs from Juri's original flap in the following ways:

1. It varies in width from 3.75 to 4.50 cm.
2. The superior edge of the flap is an irregularly irregular line, which will correspond to the new hairline design.
3. There is no blunting of the frontotemporal recession. Therefore, the hairline does not have a flattened or apelike appearance.
4. Scalp reductions are almost always performed before flap rotation, except in patients with only frontal baldness (no indication of future crown baldness) and in those with an extremely tight scalp.
5. There is less curve in the flap design in most patients than was described by Juri, and the "tail" of the flap is straight.
6. Tissue expansion is often used in conjunction with flap surgery.



7. A skin graft is commonly used to help close the donor area so as not to raise the posterior auricular hairline.

8. A contralateral flap may be delayed at the same time the first flap is delayed.

9. Forehead lifting is done in combination with the flap in most patients, although at a later stage.

### *Flap design*

The inferior edge of the flap starts at a point approximately 3 cm above the root of the helix (Fig. 28-22, B). The superior edge begins 4 cm anterior and superior to this point at an angle 30 to 45 degrees from the horizontal. The flap is centered over the posterior branch of the superficial temporal artery. We locate the posterior branch of the superficial temporal artery with the aid of the Doppler flowmeter. The base of a flap measuring 4 cm in width is centered over this branch. The proposed lines of incision extend posteriorly and superiorly through the temporoparietal region and then curve inferiorly into the occipital region, being 4 cm apart for the entire length of the proposed flap. We must anticipate the total extent of baldness when planning the flap so that the superior edge of the flap is not taken from an area of the scalp in which further hair loss will occur. Adequate length is obtained by measuring the distance from the point of the rotation across the hairline to the contralateral fringe and adding 3 to 4 cm. Since the new hairline will be formed by the distal two thirds of the flap, the design of this portion of the flap should correspond to the shape of the proposed hairline.

### *Surgical technique*

We perform the first two delayed procedures (Table 28-1) in the office with the use of local anesthesia. Occasionally, we supplement this with intravenous anesthesia for the apprehensive patient. For the first procedure (Fig. 28-22, B), incisions parallel to the hair follicles are made for approximately three fourths of the length of the proposed flap and then are closed with a surgical staple gun. One week later at the second delay procedure (Fig. 28-22, C). The tail of the flap is elevated from the underlying tissue to sever the vessels that penetrate the deep layers of the scalp. One week after the second delay (or 2 weeks from the time of the first delay procedure) the flap is rotated into position. This procedure also can be performed in the office operating room with the patient under general endotracheal anesthesia.

Before surgery begins the hairline is drawn with dye and shown to the patient. A natural curve with some frontotemporal recession is created.

The hair is secured with rubber bands; no hair is cut along the lines of the proposed incisions since to do so would prevent immediate and continuous hair coverage. Lidocaine hydrochloride (0.5%) with epinephrine, 1:200,000 is used to locally infiltrate all areas to be undermined. *The flap itself or its base is never injected.*

The flap is elevated in a subgaleal plane and kept moist at all times with saline solution. The hairline incision is then made superficially. Undermining of the scalp beneath the donor defect is done by dissecting the subgaleal plane until the lower limit of the hair-

bearing skin is reached. The dissection then continues subcutaneously as in a face-lift operation. The postauricular skin is elevated to the helical rim. The frontal hairline incision is beveled to correspond to the angle of incision on the superior border of the flap. The frontal skin posterior to this incision is elevated deep to the galea so that it can be rotated posteriorly and inferiorly to aid in closure of the donor wound.

A Jackson-Pratt drain is placed through a postauricular stab wound and the donor wound is closed by approximating the galeal margins with 1-0 polypropylene interrupted inverted sutures and surgical staples to complete the epidermal closure (Fig. 28-23). It is most important that this area not be closed under extreme tension; otherwise, sloughing of hair-bearing scalp may occur. The anterior border of the flap is deepithelialized for approximately 2 mm, the irregularity of the flap is recreated on the forehead skin in an irregular fashion, and the flap is sutured to the forehead skin with a 5-0 polypropylene suture (Fig. 28-24; see Fig. 28-48). Hair will grow from these follicles buried beneath the skin closure, establishing a new hairline and camouflaging the scar. The desired amount of forehead frontal scalp is removed. Penrose drains are placed beneath the posterior margin of the flap, and the remaining incisions are closed with the surgical staple gun (Fig. 28-22, E).

A dog-ear occurs at the anterior margin of the flap at its base because the flap skin is rotated back on itself to create the hairline. Six weeks after the rotation of the flap, the dog-ear will be revised. The dressing consists of Telfa, gauze fluffs, and gauze bandages for 4 to 5 days postoperatively. Care must be taken to avoid pressure on the flap pedicle, which could compromise circulation. The hairline sutures are removed 6 days postoperatively, and the staples are removed approximately 1 week later.

#### *Additional procedures*

If necessary, a second flap may be rotated from the opposite side 2 months after the dog-ear revision on the first side (Fig. 28-22, F). From 3 to 4 cm of bald skin is left between the two flaps, and this is later removed by stretching the flaps and performing scalp reductions (Fig. 28-25). Total or near-total excision of any bald skin in the crown can be accomplished with posterior reductions and further stretching of the flaps (Fig. 28-22, G). Therefore two 4-cm wide flaps will usually replace 12 cm of bald scalp, and occasionally more. When these are combined with occipital scalp reductions, most patients will have total excision of bald skin and replacement with hair-bearing scalp of uniform density. The use of a third (occipital) flap as described by Juri has not been necessary in our experience.

#### *Morbidity*

Eyelid and forehead edema will frequently occur with procedures performed on the frontal region of the scalp. The severity of this problem has been virtually eliminated by the use of short-term oral steroids. The patients are given 24 mg of methylprednisolone on the day of surgery and the dosage is gradually decreased over the next 5 days. The auricle on the donor side may be tender for a few days. Swelling and ecchymosis of the lateral aspect of the neck in the area of undermining will occur as well. The patients are restricted from strenuous activities for 3 to 4 weeks postoperatively.

## *Complications*

We divide complications with the F/M flap procedure into two groups: those occurring in patients with normal scalp circulation and those occurring in patients with compromised or impaired scalp circulation.

**Patients with normal scalp circulation.** The possibility of skin loss does exist but is quite uncommon when proper care is taken. Infection and hematoma can also occur but are easily controlled.

Hair growth may cease in the distal end of the flap, but full hair growth resumes with a few months. Hair growth ceases to a minor extent in the donor area in approximately 5% of patients. Occasionally this can be significant, but full growth always returns if the scalp circulation is normal.

**Patients with compromised or impaired scalp circulation.** Patients who have had previous punch-graft transplantation, scalp reductions, nylon fiber implantation with infection, or a face-lift with interruption of the superficial temporal artery carry a greater risk because of impaired scalp circulation.

In patients with compromised circulation, necrosis of the distal portion of the flap is more common. The area of loss can be excised and replaced with a small flap from the opposite side, sparing the second F/M flap donor area. The incidence of hair loss within the donor area in this group is much higher, although in most instances it is temporary.

## *Advantages*

The F/M flap has several advantages over punch grafts. In patients with frontal alopecia (Class I), a complete result is obtained within a few weeks (Figs. 28-26 and 28-27) as compared with 1.5 to 2 years for punch grafts. In addition, the density of the hair is far greater and more natural (uniform) than with hair transplants. Because flaps avoid the "corn-row" appearance of transplanted hair (Fig. 28-28), many patients who have had flap procedures expose part or all of their hairline (Fig. 28-29). Furthermore, the greater density afforded by flaps makes styling much easier (Figs. 28-30 and 28-31). The temporary hair loss that accompanies punch grafting usually does not occur with flaps, and the hair texture within flaps remains unchanged from that of the donor site. Furthermore, one can part the hair along any part of the hairline, which cannot be done with punch-grafted hair for fear of exposing the corn-row appearance (Fig. 28-32). The cost of flaps is comparable to that of punch-graft transplantation.

The major advantage of the F/M flap procedure is that two F/M flaps combined with scalp reductions give the greatest possible excision of bald skin and replacement with the largest possible amount of uniform, high-density hair.

The hairline scar, if created as described and meticulously closed, will be camouflaged by hair growth through and in front of the scar (Fig. 28-33). Without this refinement in the hairline technique, the scar would be anterior to the hairline. All of the procedures in Figs. 28-25 thru 28-39 were performed with the old regular hairline technique. Although the results

are quite good, the irregular trichophyllic hairline produces an improved appearance (see Figs. 28-48 and 28-49).

### *Disadvantages*

Since the patient needs approximately 6 days off from work, the disability for this procedure is greater than that for hair transplantation. The risk of complications, which can be more serious than those with hair transplantation, should be explained to the patient. Mild erythema of the suture line lasts for approximately 3 months. Some patients may have a hairline that is too dense, though many consider this to be an advantage. Hair direction is changed with this procedure, but hair-styling requirements are fewer than those with punch-graft transplantation.

## **Nondelayed inferior temporoparietal flaps**

### *Flap design*

Temporoparietal flaps are nondelayed, shorter, and narrower than F/M flaps. They do not extend across the entire forehead (Fig. 28-34). It is both desirable and technically simple to include the posterior branch of the superficial temporal artery within the center of the flap to ensure maximal hair-follicle survival. The artery may be located using the Doppler flowmeter.

The flap follows a gentle curve posteriorly and superiorly over the ear and then inferiorly into the parietal or anterior occipital region, depending on the length required. Adequate length is obtained by measuring the distance from the point of flap rotation to a point 1 to 2 cm beyond the midline of the proposed hairline and then adding 3 to 4 cm. The second flap is shorter and thus exposed to less risk of hair loss at its end. Furthermore, making the flaps a little too long is preferable to discovering during surgery that they cannot be joined.

The tail of the first flap is designed to dovetail with the flap from the opposite side at an angle of 45 to 60 degrees (Fig. 28-34). This angle will prevent a part line from being visible at the junction of the two flaps. The base of the flap should be well within the temporal fringe both superiorly and anteriorly to allow for any further hairline recession, especially in young patients. The flap width is from 2.5 to 3 cm and is uniform from base to tail except for the distal bevel.

Our design of the inferiorly based temporoparietal flap differs in several important respects from those described by other authors. Although narrowing the base of the flap and delaying it have been described, we rarely delay these flaps. Moreover, we do not narrow the base, since this could cause flap ischemia and necessitate a delay. Furthermore, the proximal portion of the flap should form a gentle curve, since larger dog-ear is created when the flap is more horizontal in design. The distal 3 cm is designed in a straight line to meet the corresponding straight line from the opposite side. In this way, no notch is created at the hairline from two distinctive curves meeting at the junction of the flaps.

The flaps are transposed approximately 2 weeks apart. Although they could be transferred at the same time, we choose not to do this. If distal necrosis occurs on the first flap, the second flap can be delayed and used as a longer flap to complete the hairline. When necrosis occurs in the second flap, reconstruction is much more difficult.

### *Surgical technique*

The procedure (Table 28-2) is performed in the office operating room suite under light general anesthesia. The skin is prepared with hexachlorophene after the flap has been carefully outlined with a marking solution. The hair may be controlled by wetting it and fastening it with rubber bands; it is never trimmed. All incisions are injected with 0.5% lidocaine hydrochloride with epinephrine, 1:200,000, but the flap itself is never injected. All incisions are beveled parallel to the hair follicles. The flap is then elevated subgaleally and kept moist at all times with saline sponges. At no time should any pressure or twisting force be placed on the flap.

The scalp inferior to the donor defect is undermined beneath the galea to the margin of the hair-bearing skin, and the dissection continues beneath the skin into the neck and postauricular areas as far as necessary to obtain a tension-free closure. In most cases undermining into the neck will be necessary to obtain a tension-free closure even with a small flap. The hairline is incised with an anterior bevel so that this margin will correspond to the bevel cut on the superior border of the flap. At the same time the proposed hairline for the second flap is scored with a scalpel to ensure a symmetric hairline when the second flap is transferred 2 weeks later.

The frontotemporal skin is elevated posterior to the new hairline and deep to the galea so that it can be rotated both posteriorly and inferiorly to aid in closure of the donor wound. The donor area is drained with a Jackson-Pratt drain through a postauricular stab wound, and the margins of the donor defect are closed using 1-0 polypropylene sutures at the level of the galea. Staples complete the epidermal closure of the donor area. The anterior margin of the flap is de-epithelialized along the new hairline for 1 to 2 mm and sutured to the forehead skin using 5-0 polypropylene sutures as described for the F/M flap procedure.

A small dog-ear is produced by the flap rotating on itself to create the new hairline. The dog-ear is closed with 4-0 polypropylene vertical mattress sutures as well as staples. With the flap sutured in place, excess frontal skin is excised without undue tension on the posterior surface of the flap. One or two Penrose drains are placed through this incision before closure with the staple gun, and these are removed with the Jackson-Pratt drain 24 to 48 hours later.

The dressing consists of Telfa fluffs and gauze and is used for 4 days. The patient is instructed to avoid any pressure on the pedicle that could compromise circulation. The hairline sutures are removed 6 days after the procedure; the remaining staples are removed in 12 to 14 days. The dog-ear will frequently resolve almost completely in 2 to 3 months, but it may be revised 6 weeks postoperatively if spontaneous resolution does not occur.

### *Additional procedures*

The second flap can be done 2 weeks or longer after the first flap procedure. The dog-ear may be revised if necessary in 6 weeks but will usually resolve in 2 to 3 months. At the same time the frontotemporal recession can be elevated to be more superior position if needed. The dog-ear is revised by splitting the flap at the junction of the frontal and temporal hairlines and rotating the two cut ends superiorly and posteriorly. After several months the flaps can be stretched with scalp reductions to increase coverage by no more than 25% (Fig. 28-35).

### *Morbidity*

As with F/M flap, tenderness and tightness over the lateral scalp and upper neck usually last for 1 to 2 weeks. Strenuous activities are restricted for 2 weeks postoperatively. Short-term oral steroids have eliminated the forehead and eyelid edema that otherwise occurs when surgery is done in the frontal region of the scalp. Hair within the flap can be used to cover any slight dog-ear until this area resolves or is revised. The patient can return to work 6 days after the procedure.

### *Complications*

Infection, hematoma, and temporary or permanent hair loss are all possible. Necrosis with permanent hair loss whether in the flap or the donor area is the most serious complication. Necrosis occurring in the distal portion of the second flap is more difficult to correct than with the F/M flap because the hair loss occurs in the middle of the hairline. The problem may be corrected by excising the area of alopecia and advancing the flaps medially to obtain complete closure. The area can also be punch grafted, although the cosmetic result is less desirable. Careful handling of the flap, combined with tension-free closure and avoidance of pressure on or twisting of the base of the flap, should ensure that the incidence of this complication is quite low.

As with the F/M flap, the most common complications are poor hairline design, prominent hairline scarring, and donor hair loss with or without necrosis. As previously stated, most of these complications can be avoided with careful planning and meticulous surgical technique.

### *Advantages*

Inferiorly based temporoparietal flaps have certain technical advantages over the F/M flap. Less undermining is usually necessary to close the donor defect, and no delay is normally needed. In addition, less dog-ear formation occurs, and often it resolves spontaneously. This is not usually the case with the F/M flap when a well-defined frontotemporal recession is created. It is technically easier to create a temporal recession with short flaps than with the F/M flap because the flaps are narrower and nondelayed.

Theoretically, because the procedure is technically less extensive, fewer complications should develop with small flaps. However, we believe that the result depends on the experience of the surgeon with both large and small flaps.

## *Disadvantages*

As stated previously, temporoparietal flaps have several minor advantages over F/M flaps. However, they have an important disadvantage. *Two temporoparietal flaps will give only one fourth as much coverage as two F/M flaps.* Therefore for central baldness that is posterior to the flaps one must rely on scalp reduction and punch grafts. In patients with baldness that is more advanced or will be more advanced than frontal baldness, total or near-total hair replacement cannot be achieved with two temporoparietal flaps, which is possible with two F/M flaps followed by scalp reductions.

### **Superiorly based temporal and temporoparietal flaps**

Nataf et al (1976) described superiorly based preauricular and postauricular flaps. As originally described, the postauricular flap (Fig. 28-36) gives little advantage over the inferiorly based flap, since the improvement in hair direction is minimal. The preauricular flap is useful only for partial hairline completion, since the flap will rarely reach the midline. Using Marzola's technique (1984) of four massive scalp reductions including ligation of the occipital arteries and stretching of the temporal scalp superiorly and anteriorly, the surgeon can lengthen the donor area for the flap and at the same time shorten the intertemporal (hairline) distance. When used in this manner, the preauricular flap can reach the midline and beyond if scalp laxity permits adequate reduction before flap rotation. Both preauricular and postauricular flaps leave wide donor scars because of the tension involved in closing a defect in the AP dimension. These scars are quite difficult to conceal.

Because we believe the indications for superiorly based flaps, whether preauricular or postauricular, are quite limited, we refer the reader to Nataf's (1976) and Marzola's (1984) descriptions of their techniques. The preauricular flap (Fig. 28-37) has a base of approximately 2.5 cm and narrows inferiorly. The average length is from 12 to 13 cm. This narrow flap is taken from the preauricular (temporal) hair and rotated anteriorly. It has only one advantage over the other flaps described; the hair within the flap maintains an anterior orientation. This would be desirable were it not for the price one pays for this minor benefit, namely, the following important disadvantages:

1. The F/M and inferiorly based flaps are axial flaps; the superiorly based flap is a random flap and therefore more susceptible to necrosis.
2. The hair at the distal end of the flap (taken from the preauricular hair just above the sideburn) is often of poor quality and density, in contrast to that of the F/M and inferiorly based temporoparietal flaps. Also, as with all short flaps, if distal necrosis occurs with a superiorly based flap, it is central and therefore more difficult to correct.
3. The temporal hairline is pulled posteriorly in order to close the donor defect, and this will appear to be more receded. This does not occur with the other flaps described.
4. If incisions are made along the temporal hairline (as described by Marzola, 1984), these scars may become more apparent with further temporal recession.
5. The donor area can be quite difficult to close because the donor defect is vertically

oriented.

6. The superiorly based flap will rarely reach the midline unless combined with reductions. Punch grafts can be used to complete the hairline, although the result is less acceptable. With Marzola's modification using four or five massive scalp reductions with extensive undermining and ligation of the occipital arteries, the length can be achieved if scalp laxity permits.

7. The most important drawback to this flap is the same as that associated with the inferiorly based temporoparietal flap: even though the hair is directed anteriorly, the patient receives only from 2 to 2.5 cm of hair in the frontal scalp. The remaining area posterior to the flaps must be handled by reductions and/or punch grafting. We feel that the result cannot compare with that obtained by using two F/M flaps for total elimination of baldness.

8. Even with the scalp reductions (assuming there is enough laxity to do this), a major problem will remain with divergence of the hair around the reduction scar posterior to the flaps. This problem is not present with the F/M flap procedure, since the scalp flap in the middle of the scalp eliminates any problem of divergence and requires no styling to cover the crown. The hair is naturally directed over the crown.

#### ***Indications - Superiorly based temporoparietal flap as modified by Fleming and Mayer***

In spite of the disadvantages of other superiorly based flaps, we believe that our modified version of a temporo-parietal flap is *occasionally applicable* to the rare patient who can satisfy the following requirements: (1) the patient must have only mild, fully established frontal baldness and not be a candidate for F/M flaps (see Fig. 28-47); (2) the temporal hairline must be very superiorly and anteriorly placed; (3) good hair quality must be available in the pre-auricular area; and (4) the patient must be willing to undergo tissue expansion.

If the hair direction obtained with the F/M flap were a serious problem, the superiorly based temporoparietal flap would have much more advantage. However, in practice, a change in hair direction rarely presents more than a minor styling problem to the patient and is more than offset by the other advantages of the F/M flap procedure.

#### **Patient Selection**

The procedure selected for the correction of a patient's baldness depends on the surgeon's proficiency with each of these procedures. Since we use all current techniques for surgical hair replacement, including punch grafting, scalp reductions, short flaps, and long flaps, we discuss the advantages and disadvantages of each with the patient during the consultation. After this discussion, the patient decides which of these procedures best suits his needs and desires. (As indicated previously we have a bias toward flap surgery because we feel patients are much more satisfied with this procedure than with plugs.)



### **Frontal baldness only (class I)**

The most important consideration before any surgical hair replacement is to thoroughly evaluate both the entire *potentially* bald area and the entire available donor area. Only a small percentage of bald men will have alopecia limited to the frontal scalp. In general, patients with *fully established* frontal baldness (that is, the baldness will never progress beyond frontal loss) can be treated with either punch grafts (see Figs. 28-7 and 28-8) or flaps (see Figs. 28-16 to 28-28). These patients do not require scalp reduction, *nor is there any benefit from scalp reduction in the frontal region*. The patients who select punch grafting for treatment of frontal alopecia should be willing to accept a possible change in texture of the transplanted hair, and they will also need to style their hair in a forward direction to cover the tufted or "corn-row" appearance along the hairline. The results will be much better in patients with silver, curly, or kinky hair since tufting will be less apparent. Because all of the available grafts can be concentrated in a very small area, the results will be much better than if the grafts were put into a bald area four times as large. The patient should also be aware that it will take from 1.5 to 2 years to achieve a completed result.

For those patients who object to any tufted appearance or change in hair texture or wish to have a more immediate result with greater hair density than can be achieved with punch grafting, the flap procedure is more suitable. Therefore, if the patient has an established pattern of frontal loss only, one long flap can be done with *immediate total replacement of the frontal baldness* (Fig. 28-38). The same amount of baldness can be handled with two short flaps, superiorly or inferiorly based. The surgeon must make sure if superiorly based flaps are used that there will be sufficient length to reach the midline, which is usually not possible, especially with preauricular flaps. Since patients have sufficient hair posterior on the scalp, they will not wish to undergo scalp reduction to obtain a greater length of a preauricular flap. Because we are dealing with frontal loss only in a fully established pattern of baldness, any further loss posterior to the flaps will be very slight, if any, and usually can be treated by scalp reduction with excellent results.

### **Crown baldness only (class IV)**

The same considerations apply to patients with baldness limited to the crown. This area can be covered with punch grafts over a 2-year period, although they do not grow particularly well in the crown. The same area can be treated with a single flap. Patients with silver, curly, or kinky hair are the best candidates for punch grafts in the crown. Other patients will usually be more pleased with the immediate results that can be achieved with the excision of bald skin and replacement with a flap. The improved density, texture, and hair direction achieved with a flap make this procedure advantageous for most patients with crown baldness.

### **Frontal and midscalp baldness (class II)**

Class II baldness is the least common of the four balding patterns described. Scalp reductions occasionally are of some benefit to these patients in decreasing the size of the midscalp. However, since no loss in the crown exists, the benefits will be limited.

Punch grafting will be less satisfactory if reductions cannot be done since the same number of grafts are being placed in an area two to three times as large as in patients with class I or class IV baldness. Local scalp factors (density, hair texture and color, contrast) will play a larger role in a satisfactory result for these patients. Patients with low hair density, dark hair and light skin, or poor laxity of the scalp should be carefully evaluated.

Two F/M flaps can be done on these patients with or without scalp reduction with total elimination of the bald skin with maximal density. The patient will have a full head of hair in 3 months.

We do not believe that short flaps combined with reductions and punch grafting will give as good a result, but these procedures could be done.

### **Frontal-to-occipital baldness**

The overwhelming majority (80%) of patients have or will have *class III male pattern baldness*. In general, patients with this degree of loss are the least satisfied with punch grafts. Because of the large bald area, a compromise must be made with graft placement. One can place more grafts on the part side and along the hairline, with fewer grafts on the opposite side. The crown can be left bald and more grafts concentrated anteriorly. In some patients scalp reduction can improve the situation if enough laxity is present. In the unusually elastic scalp, the reduction capability can be remarkable. However, most of these patients will not be satisfied with punch grafts. Their dissatisfaction becomes even more pronounced when the problem is compounded by negative scalp factors such as low hair density or fine hair.

Two F/M flaps combined with scalp reductions to stretch the flaps eliminate all or most of the crown baldness and are more satisfactory to our patients than punch grafting. This approach is even more important in patients with several negative factors, especially low hair density and fine hair. Since the flap is transferred as one piece, maximal density and uniformity are achieved (Fig. 28-39).

Although short flaps can be used on patients with class III baldness, this approach gives the patient only approximately 1 inch of hair anteriorly and leaves the large bald area posteriorly to be handled with scalp reductions and punch grafting, assuming the patient has enough laxity for reduction (Fig. 28-40). If patients choose flaps as the means to achieve their expectations, it does not make sense to do only anterior hairline flaps followed by reductions and transplants. Therefore in a patient with baldness that is more advanced or will be more advanced than frontal baldness, two temporoparietal flaps, whether inferiorly or superiorly based, cannot achieve the total or near-total baldness excision that can be achieved with two F/M flaps followed by scalp reductions (Fig. 28-41). We believe that in general, the F/M flap, with or without tissue expansion, is the best technique for surgical hair replacement. Inappropriate use of short flaps on patients with extensive baldness will become less frequent as more surgeons gain experience with the F/M flap.

Some patients lack sufficient donor area for a F/M flap but may yet obtain acceptable (if less desirable) results from the use of two short flaps followed by scalp reductions and punch grafting (see Fig. 28-46). Short flaps may also be a more prudent choice for patients who have had punch graft donor scars in the occipital area that will compromise the blood

supply in the distal end of the F/M flap.

Finally, whether we do flaps or punch grafts, we are extremely cautious with the marginal or unsuitable candidate who has extensive baldness with a small and/or poor quality donor supply. The surgeon should not try to convert an unsuitable candidate into a marginal one; the potential complications are too severe. One must always ask whether the final aesthetic result will please the patient.

### **Reconstructive surgery of the scalp**

Most of the principles for the treatment of defects in other parts of the body apply to the use of flaps involving hair-bearing tissue of the scalp. However, special differences do exist in dealing with hair-bearing tissue that must be taken into consideration. Because it is impossible to cover every conceivable combination of injury, defect size, and configuration, we present only our basic approach and philosophy regarding reconstruction of scalp defects. Defects of the scalp may be the result of congenital conditions, trauma, burns, disease, and iatrogenic causes. Because the blood supply to these areas varies according to the cause of the alopecia, the treatment often varies as well. For example, a healed split-thickness skin graft over pericranium will provide quite a different host bed than will the skin in congenital alopecia that possesses normal blood supply and no scarring.

A complete discussion of reconstructive surgery of the scalp is beyond the scope of this chapter. The reader is referred to *Aesthetic and Reconstructive Surgery of the Scalp* by Fleming and Mayer (in press) for an in-depth discussion. The primary surgical reconstructive techniques used for scalp defects today include the following:

1. Simple excision of small areas of alopecia.
2. Hair transplantation when blood supply allows.
3. Excision of alopecia scars with Z-plasty or other small transposition flap closure.
4. Serial excision and advancement flap closure (scalp reduction).
5. Scalp expansion.
6. Transposition flaps:
  - a. Small.
  - b. Large:
    - (1) Temporoparietal.
    - (2) F/M.

### *Simple excision*

Small areas of alopecia or scar tissue can usually be excised. It is important that the incisions be beveled parallel to the hair follicles on either side of the area to be removed. A tension-free closure should be performed with absorbable sutures at the galeal level, and the skin edges should be approximated with nonabsorbable sutures or surgical staples.

Areas of hair divergence can be augmented with several single or double hair follicle grafts.

### *Transplantation*

Hair transplantation has been used for more than 30 years as a method of treating areas of baldness. However, hair transplantation is not a reasonable choice when there is scarring in the recipient areas. Although grafts may grow in the scar tissue, the yield per graft is usually less than in an area of normal circulation. This, coupled with the other inherent drawbacks of hair transplantation such as poor density, a permanent change in hair texture, a corn-row appearance, and the considerable length of time necessary for the completion of the procedure, makes it an infrequent choice. We do use punch grafts in patients with an eyebrow scar that is too large to permit excision without distortion of the surrounding tissue. We use single-hair micrografts to fill in linear scars on occasion.

The only other use of punch grafting an area of scar is on the occasional patient who is not a candidate for other methods of reconstruction or when the patient wants transplants only.

Although many of the problems presented in this section could be handled with punch grafting, we believe better aesthetic results are obtained by moving flaps of normal hair-bearing tissue into the area, without the drawbacks inherent in the punch graft technique. We do not use strip grafts for the same reason.

### *Excision of scar and Z-plasty closure*

See section on scalp reduction.

### *Serial excision and advancement flap closure (scalp reduction)*

The technique of serial excision of the scar tissue with advancement flap closure has been used by surgeons for more than a century for defects caused by trauma or malignancy. The technique of scalp reduction has been described earlier, but a few special considerations are important.

For a patient to be able to benefit from scalp reduction, the scalp must be somewhat elastic, and the greater the elasticity, the greater will be the amount of tissue that can be excised. Because the area of scarring will have contracted significantly during healing, the amount of scalp stretching that can be achieved without expansion may be limited.

The undermining must be extensive if the defect is quite large (usually ear to ear). Galeotomies are of limited benefit except when only a few additional millimeters are needed to close a defect. All the tension must be placed at the galeal level to prevent damage to the hair follicles. It is usually best to wait 10 weeks between reductions.

The 12-year old patient in Fig. 28-42 sustained thermal burns of the scalp, which were skin-grafted. The scalp was quite mobile, so scalp reductions were considered the best solution for her problem. The patient underwent three scar reductions along with a multiple Z-plasty anteriorly and rotation advancement of the posterior scalp to correct the opposing hair direction. Although expanders could have been used on this patient, the elasticity of the scalp afforded similar results without the inconvenience of expansion.

The patient in Fig. 28-43 underwent bilateral short transposition flaps for the correction of baldness. The flaps were placed too low and were of a poor configuration, resulting in a failure to reach the midline and bilateral flap necrosis, which left significant scarring. An anterior advancement allowed both flaps to be returned to the donor site and excision of most of the scar tissue. Another forehead advancement was done 4 months later with excision of the remainder of the flaps. Fortunately, the patient had enough elasticity of the scalp and forehead to permit total excision of the poorly designed flaps and scar tissue, using only advancement without a need for expansion.

#### *Scalp advancement flap closure using tissue expansion*

In contrast to the above examples, many patients with scarring have a very tight scalp that provides little or no reduction capability. In addition, they often have scarring or injury to the arteries of the scalp that can preclude the use of flaps. The only surgical choice in such patients is punch grafting or tissue expansion.

Tissue expansion was first described by Neumann (1957), Radovan (1982) and Austed and Rose (1982) reported the use of tissue expanders for reconstructive purposes. Manders et al (1984) used tissue expanders for the repair of large scalp defects. Since that time several authors, including us (1984), have published articles on tissue expansion of the scalp. We prefer to use tissue expansion only when reductions (single or serial advancement flaps) cannot be used to achieve the same result.

Expanders should be placed as close as possible to the tissue to be excised. If the expander is placed too far away, the intervening nonexpanded tissue tends to prevent the expanded tissue from being advanced fully. In addition, the width of the expander should exceed that of the area to be excised. This allows the expanded tissue to be advanced fully in the direction of the defect without being "held" laterally. However, the expander should be kept well away from very thin scar to prevent necrosis and exposure of the expander.

The amount of tissue expansion achieved should be greater than the estimated amount of tissue needed to obtain complete closure because it is better to have a little excess than to come up short. It is usually possible to expand the tissue by about 50%. If the patient is cooperative and has a relative or friend who is capable, expansion sometimes can be done at home rather than in the office. The expander is usually injected every 3 or 4 days so that the expansion can be accomplished as rapidly as possible. If capillary filling is compromised or

pain is experienced, a little saline should be removed.

Expanders should be placed *before* any scalp reductions, otherwise there may be inadequate scalp elasticity to place an expander, even after one reduction. The following two examples are used to describe some of the principles and results possible with tissue expansion.

The patient in Fig. 28-44 sustained thermal burns of the face, scalp, ears, and neck. These areas had been previously grafted, and the patient had undergone one scalp reduction in the occipital region. The scalp was extremely tight, and there was heavy scar contracture of the neck as well. There were multiple areas of scarring involving several different regions of the scalp. Therefore flaps were not possible and the extremely tight scalp precluded serial excisions. A 100-cc expander was placed beneath the good U-shaped flap posteriorly and expanded over a 4-week period. That expander was then removed and a large (16 x 5 cm) expander could be placed anterior to the scarred area. A partial excision of the scar was done at the same time. Four weeks later the patient developed an infection; it was drained and antibiotics were prescribed. The expander was left in place, and the infection resolved. The expansion was begun again 3 weeks later, and after this expander had been fully inflated the entire occipital scar could be excised (Fig. 28-44, B).

The next patient is a 4-year old female who was struck by a car and dragged along the pavement. As demonstrated in Fig. 28-45, A and B, there was an 8 x 8 cm defect that was covered with split-thickness skin graft on periosteum. The remaining scalp was extremely tight. The defect extended onto the forehead, the lateral canthus of the eye, the right cheek, and the ear.

The first procedure involved the placement of a 100-cc rectangular tissue expander beneath the right temporoparietal scalp. The scalp was extremely tight and would not permit a larger expander. The expansion was carried out to 150 cc of saline 6 weeks later, followed by the placement of a 550-cc expander over the entire right temporoparietal scalp. This expansion was carried out over a period of 5 weeks to 600 cc and the scalp was then advanced to reconstruct the entire defect. The patient is shown postoperatively in Fig. 28-45, C and D.

After several additional procedures to remove scar tissue from the forehead and cheek, the final postoperative result is shown in Fig. 28-45, E and F.

### *Transposition flaps*

Scalp flaps have been used for reconstructive purposes for almost a century. Passot (1931) first described the small lateral temporoparietal scalp flaps.

**Small random transposition flaps.** Before beginning with the larger axial scalp flaps we should mention short random scalp flaps. These flaps generally have a random blood supply and should usually be less than 10 cm in length. An example of this flap is the short temporal flap used for eyebrow reconstruction (Mayer and Fleming, 1989). This flap can be random or can include the superficial temporal artery. Small flaps like this can be taken anywhere in the scalp and may be of many different designs. The following demonstrates how

such a flap can be used.

The patient in Fig. 28-46, A, had a traumatic scar over the frontal scalp involving the hairline. A 10 x 4 cm flap was outlined (Fig. 28-46, B) and rotated into place. Hair follicles were buried at the anterior edge of the flap along the hairline. The patient is shown (Fig. 28-46, C) 2 days postoperatively; the scar has been replaced with a scalp that is normal in texture and uniformly hair-bearing.

**Large transposition flaps.** The two most commonly used large scalp flaps are the temporoparietal flap and the F/M flap. We occasionally use the modified superiorly based temporal flap.

***The temporoparietal flap.*** The inferiorly based temporoparietal flap is used occasionally in the following instances: (1) patients who have a full head of hair without the likelihood of future baldness, and with scar tissue confined to the anterior 1 inch of the frontal hairline or some other small area; (2) patients without a patent superficial temporal artery; and (3) patients with heavily punch-grafted donor sites in whom scarring increases the risk of distal necrosis of a F/M flap.

The patient in Fig. 28-47, A and B, had undergone several punch-graft sessions with multiple scars of the frontal scalp. There was heavy scarring in the occipital donor region. Because the patient had established baldness with minimal future loss anticipated, the scar was removed with two short temporoparietal flaps. The final result is shown in Fig. 28-47, C and D.

***The F/M flap.*** The F/M flap is still the workhorse of reconstructive scalp surgery. The advantages obtained with this flap include the following:

1. Immediacy - The scar is removed, and hair is present the same day.
2. Density - The hair in the new region is as dense as that in the donor area.
3. Uniformity - There is no corn-row appearance; the hairline and other regions of the scalp do not look artificial.
4. Natural hair texture - There is no kinkiness or change in texture as is often seen with punch-grafting.
5. A natural hairline - If the hairline is created in the irregular method described by us, it looks very natural (Fig. 28-48).
6. Greater excision of scar - Two F/M flaps combined with scalp reduction allow the excision of a large area of scarring and its replacement with high-density hair-bearing skin.

### **Temporal hairline reconstruction**

Reconstruction of the temporal hairline is a special consideration. The hair in this area grows in a different direction with an inferior and slightly posterior slant. Fig. 28-48

illustrates the use of a contralateral flap to reconstruct a temporal defect. Tissue expansion could have been used. However, you will note that the hair adjacent to this area of burn alopecia is not of the best quality. A contralateral transposition flap allows us to bring better-quality hair from another area without thinning the already density-poor region, which would have been necessary with tissue expansion.

The patient shown in Fig. 28-49, A and B, sustained a burn over the entire right frontal temporal scalp and forehead 2 years before our consultation. The burn areas had been skin-grafted after the injury, resulting in a large area of alopecia with extremely poor circulation. Fortunately, the scalp on the left side and back of the head was normal. The patient underwent a twice-delayed flap that was based on the opposite (left) superficial temporal artery and extended across the top of the head, curving posteriorly on the right side (Fig. 28-49, C). A template of the right temporal defect is drawn at the end of the flap to correspond to the shape of the defect (Fig. 28-49, D). The donor area is closed by undermining and advancing the inferior and superior borders of the defect. The flap is rotated into place after incision of the proposed hairline and excision of the skin graft (Fig. 28-49, E and F). The hair along the anterior edge is de-epithelialized to hide the scar at the hairline.

### **Summary**

Although many other types of scalp flaps have been described, we have presented several of the most commonly used flaps. In general, we rely heavily on advancement and transposition flaps for scalp reconstruction. We use tissue expanders when flaps cannot be used.

Reconstructive scalp surgery can be very challenging and satisfying, but also quite frustrating when the surgeon realizes that ideal results are seldom achieved. However, the best possible results are achieved when the advantages and disadvantages of each possible procedure are carefully considered before reconstructive surgery is begun. With the advent of a variety of new scalp flap procedures and tissue expansion, a new era in scalp reconstruction has begun.