Paparella IV: Section 1: Plastic and Reconstructive Surgery

Chapter 11: Aesthetic and Reconstructive Management of Alopecia

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Alopecia is defined as a loss of hair or baldness. Although it can be caused by disease or trauma, 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, to shampooing either too frequently or not often enough, to the presence of too much scale (seborrhea) or too little, or too 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 5alpha-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.

There currently is no lotion, balm, or syrup (including minoxidil) 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 can be moved elsewhere on the scalp and 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 five most commonly accepted methods of hair redistribution are punch grafting, scalp (alopecia) reduction, tissue expansion, short flaps, and long flaps.

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 it in the following manner:

Class I	Frontal baldness only, with or without an anterior tuft.
Class II	Frontal and midscalp baldness with *no thinning of the crown.*
Class III	Frontal to occipital (crown) baldness.
Class IV	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 of the bald area is 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 young patients 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 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. Young patients with frontal loss often show slight thinning of the crown. We classify such patients as having class III baldness, since they may (and probably will, in time) lose all the hair in the midscalp as well.

Once the surgeon has determined that the patient has or will have a class III pattern, he must decide whether 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 area 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 the fringe hair of a young patient will continue to drop, it is best to wait before trying to determine whether enough donor material (grafts or flaps) will be available to achieve a satisfactory cosmetic result. The patients 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 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 of any aesthetic procedure. The purpose of the interview is to obtain as much accurate information about the patient as possible. Also, the patient can be told 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. This and a booklet describing the various hair-replacement techniques are mailed to the patient, who brings both of these to the office.

Since we perform all 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 procedures, 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, the limitations of activity, any disability, hair coverage while multiple surgical steps are completed, the length of time necessary for cosmetic improvement, any preoperative laboratory tests required, and the 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. Such patients must be evaluated carefully if flap surgery is contemplated because of the possibility of impaired circulation to the flap. If there is any doubt concerning a potential health risk, the surgeon should refuse to carry out 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 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? (How long have you been thinking about having this surgery done?)
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 may 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 practical appraisal of what to expect from the surgery. If there is any doubt about 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, 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 are the patient's ultimate pattern of baldness and the condition of the donor hair and donor 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 will 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 required 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 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 or tissue expansion combined with flaps or punch grafts can improve the end result for a good surgical candidate, they generally cannot convert someone unsuitable 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 ten hairs in a 4-mm circle. Several 4-mm circles can be marked in the donor area with a dull punch dipped in gentian violet, and the hairs in each circle counted.

If several scalp reductions or scalp extensions 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 wishes to begin 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, the flap procedure is quite advantageous since no hair is lost in the transfer procedure and the redistributed hair is uniform. The results of flap surgery in patients with low hair density are far superior to those of punch grafting.

Hair Color and Skin Contrast

The color of hair is less important when flaps are used than when punch grafts are used since no tufting occurs with flaps. With punch grafting, dark hair (especially on light skin) gives a more tufted hairline than does blond hair, but dark hair usually covers better. Conversely, although blond 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 far better with their skin color, thereby diminishing the tufted appearance. Thus, 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 blond hair may be a candidate for either punches or flaps but, because of the low density, will look better with 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 low, eg, in black patients. 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.

In general, most patients with very curly or kinky hair (blacks and whites) show a better result from flaps because of the difficulty of cutting punch grafts in these individuals. With flaps this is not a consideration since an entire section is moved at once.

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 not usually necessary but can be created if the patient so desires.

Scalp Elasticity

An accurate assessment of the 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 will be of no value. This may be the cause of 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. Moreover, patients with a tight scalp but good donor area and density may be suitable for tissue expansion in conjunction with flap surgery (see the section on Tissue Expansion). Excellent 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.

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, or who are very active with sports, should be discouraged from having punch grafts. With the hair combed back or parted through the grafts (and even micrografts), 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. With flaps, the patient can wear his hair combed back or parted since the hair pattern is natural and no tufting occurs.

In summary, poor candidates for surgery are patients who have either very minimal hair loss or very extensive baldness. In patients in whom there is concern that the future pattern of loss may be too extensive to achieve a good aesthetic result, 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 noncandidate 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 the 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 should be willing to accept that the density of the transplanted hair will be much less than that of the original hair. He must also accept that the texture of the transplanted hair will usually be permanently altered. Finally, he should be prepared for at least 1 to 2 years of covering for each of the four basic transplant sessions while the hair grows out, and several "fill-in" procedures later.

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 the flap. However, some styling may be necessary. The patient must also be willing to accept a more involved surgical procedure. Since no hair falls out as with transplants, immediate full-density hair without a texture change will make styling quite easy. The direction of hair growth will change, although this usually causes minimal styling requirements owing to the natural uniformity, density, and texture of the hair.

Hairline Aesthetics

Punch grafting and flap surgery are proved 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 consideration in achieving a satisfactory result. If the hairline 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 punch or flaps are used. 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 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 adult males, hairlines below this point look abnormal.

The second rule is never to place the hairline at a level lower than 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 is the area of baldness "created" posterior to the hairline. Often, it is preferable to make the hairline higher and have a smaller bald area with which to deal. This allows 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 be advised of this preoperatively.

Configuration

The configuration of the hairline is just 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. 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 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*. Whether done with flaps or punch grafts, "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 an unnatural-appearing hairline.

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 the hair is parted.

The curve of the hairline should be gentle rather than excessively curved or flat. In designing the hairline, the surgeon must consider whether 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. In patients who have two Juri flaps, reductions are routinely done between the flaps and should not alter the hairline as created originally.

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. In fact, as with punch grafting, the curve can be exaggerated. Although a few patients prefer a slightly flatter hairline, the hairline should conform to the normal range. However, with subsequent reductions one can increase the curvature of a flattened hairline.

The authors originated the irregular trichophytic hairline that was presented in 1984 and published in 1985. This softens the hairline and creates a more natural appearance.

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. 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 him and thoroughly discussed. This avoids a great deal of misunderstanding postoperatively; any areas of disagreement are better dealt with before surgery.

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. Careful patient evaluation and selection combined with meticulous surgical technique are necessary to achieve good results.

Patient Evaluation and Selection

At the time of initial evaluation the very basic question of "supply and demand" is critical. The relative sizes 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. Young patients 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, older patients 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 experience 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 there is insufficient scalp laxity to decrease the size of the bald area significantly, scalp expansion may be used if the density of the fringe hair is good. Also, 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.

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; the transplanted hair usually is more coarse and kinky.

Dark hair provides better coverage than light hair, but tufting is more apparent because of the contrast with the underlying skin. Although transplanted hair may not appear to be thick in a blond or redhead, it may in fact look more natural because the tufting, the stigma of hair transplantation, is less obvious. Therefore, the styling restrictions are less stringent. White, gray, or salt-and-pepper colored hair is ideal for transplantation.

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 in whom there is the potential for additional hair loss in the future. A conservative approach is best with a man in his 20s or early 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 defluvium and accelerate the progression of hair loss. 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; the lower the hairline, the larger is 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. Small "fill-in" grafts or single-hair transplants, as described by Marritt (1984), refine the front row and make it less abrupt. These "micrografts" do *not* soften a poor job of hairline transplants. 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 always be considered. The natural whorl of the crown should be maintained with transplantation. The direction of graft placement varies

as one progresses around the spiral of the crown.

If the supply of donor grafts is inadequate 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 a minimum of four sessions to cover any one area. The transplants are positioned so that adequate space exists between grafts to ensure good blood supply. The first two sessions can take place 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 or eyebrow, where maximal density is desired, six or more procedures may be required. Of course, as hair loss continues, additional procedures will be necessary.

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 the future. Wetting the hair helps 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. It is often technically difficult to obtain good grafts in black patients or Caucasians with very curly hair owing to the curve of the hair follicles. Therefore, the yield of hair growth is often less than satisfactory.

Surgical Technique

Each surgeon develops his own personal approach. In 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 per cent 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 varies in later sessions when an area is refined or fill-in grafts added. The recipient holes are then cut through the entire thickness of the scalp using the power-driven punch, and spaced exactly 1 graft apart *or slightly less.* 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 varies 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 it easier to cut the grafts at the proper angle without damaging follicles at the edge of the plugs. The grafts are cut parallel to the hair shafts as demonstrated 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 keep them moist.

As demonstrated, 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 considerably smaller relative to that resulting when the individual holes heal by secondary intention.

The grafts are cleansed and trimmed, but always kept moist. Single hairs may be trimmed from the edge of several grafts for "micrografting" of the front hairline.

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 maintains hemostasis. Excessive pressure may rotate the grafts and cause distortion so that the proper direction of hair growth is not maintained. A dressing of Telfa and gauze is placed on the grafted area.

Postoperative Considerations

Analgesics are necessary on the evening of surgery; pain is common in the donor area. Methylprednisolone is started the day of surgery. This minimizes 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 falls 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 or poor technique. A hairline that has been placed too low or is blunted or rounded at the templates can be very difficult to correct. Scalp reductions, tissue expansion, coronal incisions with a forehead lift, or excision with repositioning of the grafts improve the appearance of the hairline, but the ideal result is rarely achieved. Random orientation makes styling of the hair almost impossible. 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) reported intraoperative syncope; this most often occurs when the patient is in the sitting position. The problem of positional syncope can be avoided by performing the operation with the patient prone or supine.

Bleeding during surgery can be troublesome, but gentle pressure usually provides 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 spontaneously resolves; 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 that 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. Prescription of 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 usually inconspicuous. 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 relaxes the base of the scalp and deepens 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 by 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 in conjunction with transplants 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 and colleagues (1979), Alt (1980), and Mayer and Fleming (1980) have modified and refined this technique. 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, which include the following:

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

2. By reduction of 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 a good result. However, the procedures should not be used to try to convert a noncandidate 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 per cent or more and also treat any residual crown loss (see the section on Juri Flaps).

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

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 and HTLV-III. 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 a supine to a sitting position as needed during the procedure. The procedure is normally performed 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 line is kept open at all times and the patient is given 2 to 4 mL of IV fentanyl. After skin preparation with 3 per cent hexachlorophene and sterile draping, the Dermojet is used to raise several wheals of local anesthetic over the proposed area of ring block. Next, a 25-gauge needle is used to inject 1 per cent 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 per cent 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 to be the simplest pattern, but the more experienced surgeon will prefer the Y or double-Y patterns. A standard reduction uses the Y or double-Y configuration. 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 scissor 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 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 the 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 of 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 6 days postoperatively to minimize any edema, bruising, and pain. Oxycodone hydrochloride is used postoperatively for pain; antibiotics are not routinely given. 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, which 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 the Y or double-Y pattern should be used instead. The disadvantages are as follows:

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.
3. Less bald skin is excised than with other patterns.
4. Surgical exposure is limited.

Lateral (Paramedian) Reductions

The paramedian or lateral scalp reduction 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 scalp is elevated on at least 50 per cent 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 creased, and impaired growth of subsequent grafts may be jeopardized.
4. Distortion of the remaining bald area is the same as with the 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 than with the Y or double-Y pattern.
7. Less bald skin is excised.

Y or Double-Y Pattern

We have used the Y and double-Y patterns in almost all patients 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 possible number of reductions. The Y or double-Y pattern provides the following advantages:

1. Excess scalp can be removed in the anteroposterior and medial-to-lateral planes.
2. Very little distortion of the balding pattern occurs, and a more natural hair direction in the posterior aspect of the scalp is produced. Unnatural, axlike scars in the posterior scalp are prevented.
3. The posterior dog ear is distributed in two places instead of one.
4. Greater ease of undermining is possible with the Y than 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 on 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 or paramedian reduction.

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 it is not desired to elevated the lateral hairline. The limbs of the anterior Y are placed posterior to the grafts. In this way the temporal hair can be stretched without elevating the lateral anterior hairline.

Amount of Skin Excised

Although the surgeon can usually gauge accurately the amount of tissue that will be excised with a reduction on the basis of 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, 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 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 our patients are given the choice of less tension and possibly one more reduction, or more tension and at least one fewer 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

Reduction can be done before, after, or at the same time as hair transplantation. The advantages of performing the reductions 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 distribution of grafts.
4. The patient often has a dramatic decrease in the size of the bald area, increasing his motivation to complete the procedures.

The disadvantages of performing reductions first are as follows:

1. Patients are more often apprehensive about scalp reduction than about the 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 transplanting begins.
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 performed 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.

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 bupivacaine hydrochloride. A feeling of tightness lasts for several days, but pain resolves within 8 to 12 hours postoperatively.

Complications

Of all the cosmetic procedures we perform, scalp reduction has the fewest complications.

Hematoma

All patients have a Penrose drain placed overnight with a scalp reduction. Only one of our patients developed a hematoma, which occurred 3 days after surgery, after he 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 middle and posterior portions of the scalp will grow in opposite directions on each side of the incision. To correct this problem, several Z-plasties 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 Bald Scalp. As mentioned, the maximal tension in a scalp reduction is placed on the most adjacent tissue. Therefore, with a midline reduction the maximal stretch occurs 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 range of 10 to 20 per cent, and has been reported to be as high as 30 per cent to 40 per cent (Nordstrom, 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 is carried out.

Scar Healing. None of our patients has exhibited 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 made 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 opposite directions will appear more prominent, since the hair will always want to part according to its natural direction.

Scalp Expansion

History

Tissue expansion was first described by Neumann in 1957. In 1982 the use of tissue expanders for reconstructive purposes was reported. Manders and colleagues (1984) used the tissue expander for the repair of large scalp defects. Argenta and colleagues (1985) described further advances in tissue expansion. The authors have used scalp expansion since 1982 but with narrower indications than those normally cited.

Indications

Our primary use of scalp extension is for cicatricial alopecia. These patients often have multiple areas of involvement that preclude the use of flaps owing to intervening scar. These patients often have cicatricial alopecia due to burns or trauma of the neck skin, which makes closure of a donor defect difficult. Scalp expansion can be used before reduction when the scalp is so tight that reduction without expansion would give minimal results (but only in patients with adequate density of the fringe hair). Finally, scalp expansion can be used before Juri flap rotation to enable the surgeon to close an extremely tight donor area. We have used this technique only in patients in whom it is absolutely necessary. The necessity of multiple injections and a distortion of appearance over a period of several weeks preclude the use of the procedure except in patients in whom it will produce results superior to those from other procedures. Therefore, when it is possible to achieve the same end results with scalp reduction or flaps, we prefer their use to scalp expansion in the above-mentioned circumstances.

Surgical Technique

Since the size and location of scalp defects are so varied, the surgeon must individualize his approach to expansion in these cases. However, there are a few general rules that we follow for all scalp expansions. First, the expander should be placed as closely as possible to the tissue to be excised; if it is placed too far from this tissue, the intervening nonexpanded tissue tends to prevent the expanded tissue from being totally used for advancement. Second, the expander should also exceed the width of the area to be excised. The reason for this is that the expanded tissue can be advanced to a greater distance in the direction of the defect without being "held" laterally. However, the expander should be kept away from very thin scar to prevent necrosis and exposure of the expander.

The shape of the expander varies according to the defect being treated. We prefer the newer expanders with the inflation port within the expander, although it may be impossible to use these in very tight scalps because of the additional height needed for the port.

Often we have expanders custom made (by Mentor). The donor versus the scarred areas vary greatly in different patients, so if a standard expander is used the end result is often compromised. However, we do use our curved design of 20-mL expanders for cases of routine scalp reduction (with very tight scalps) in conjunction with transplants. In general, we inject the expander every 3 to 4 days to accomplish the expansion as rapidly as possible. Finally, if one does not think it possible to remove the scar tissue *totally* with multiple scalp reductions, an expander should be placed *before* any reductions are carried out. Otherwise, after even one reduction, there may be inadequate scalp laxity to place even a small expander.

The incision for placement of the expander should be at the edge of the defect, to prevent any additional scars as well as create direct exposure to the area. (No hair is shaved preoperatively.) The expander should be placed without kinks, and if a reservoir is used, it should be at a convenient location to make injection easy and avoid puncture of the expander itself. A Penrose drain is placed in a dependent portion of the wound before closure and removed the next day. The patient is placed on antibiotics for 5 days and the hair washed with pHisoHex preoperatively.

An example of scalp expansion will best demonstrate our technique adn philosophy of expansion. The patient shown was referred to us after sustaining thermal burns of the face, scalp, ears, and neck. These areas had previously been grafted and the patient had one scalp reduction in the occipital region. The scalp was extremely tight with heavy scar contracture of the neck bilaterally as well. There were multiple areas of scarring over the scalp, which involved several different regions. Flaps were therefore out of the question owing to poor blood supply. Reductions were contraindicated because of the extremely tight scalp. It was possible only to insert a 100-mL expander over the U-shaped hair-bearing skin posteriorly (under general anesthesia). Ten days after placement the expansion was begun, with 15 mL injected twice a week. This was expanded over a 4-week period until the balloon was totally expanded (100 mL). It was extremely difficult (tight) placing even this small expander.

The expander was then removed, a large 16 cm x 5 cm custom expander was placed anterior to this region, and a partial excision of scar was made at the same time. Four weeks after this second procedure the patient developed an infection; this was drained and the patient was placed on antibiotics. The expander was left in place, the infection resolved, and expansion was begun 3 weeks later. Over an additional 3 weeks the expander was fully expanded, the second expander was then removed, the posterior scalp was partially advanced, and another small 100-mL expander was placed over the right temporoparietal region. This third expander was the inflated and excision of the entire right temporoparietal scar was accomplished. Later the patient was to undergo a final scalp reduction posteriorly to remove the remaining small scar in this area, which now would have sufficient laxity to accomplish this.

All the patient's surgery involving placement and removal of expanders was done under general anesthesia. For small, more confined areas in adult patients often this can be done under local anesthesia. In other patients we have placed two expanders at the same time for the same or different areas of the scalp.

Morbidity

The major morbidity in this procedure arises from the cosmetic disadvantage once the expander size becomes cosmetically noticeable. There is some discomfort following this procedure but it is minor. Weekly office visits with reinjection add to the morbidity rate, but family members can often be trained to inject these at home.

Complications

Infection around the expander is the primary complication that can occur. Bleeding should be minimal when there is good surgical technique. Exposure of the implant can occur if it is placed too close to scar tissue. If the expander were to be overinflated it is theoretically possible that one could induce necrosis in a hair-bearing region with permanent hair loss as well. Temporary hair loss, telogen effluvium, is often seen with maximal expansion.

Advantages

The primary advantage of scalp expansion is that it can be used when all other forms of treatment except for hair transplants cannot be employed. It can achieve results similar to those from flaps and scalp reductions, with retention of hair uniformity, normal hair texture, and removal of scar tissue.

Disadvantages

The major disadvantage of this procedure is the need for multiple office visits as well as a long treatment time of several weeks. Furthermore, the cosmetic disadvantage of a large lump on top of the head due to expanded scalp makes this procedure less likely to be used in cosmetic hair replacement when other alternatives are available that produce results superior to those from scalp expansion.

Furthermore, although scalp expansion is not a primary treatment of male pattern baldness, it is an adjunct to transplants or flaps. Therefore, we consider that flaps produce superior results while also forgoing the inconvenience of expansion. The greatest potential of scalp expansion is seen in patients with cicatricial alopecia, in whom scalp tightness or poor vascular supply makes reductions or flap surgery impossible. Expansion can produce outstanding results despite these difficult problems.

Scalp Flaps

History

Scalp flaps have been 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.

It was Juri (1975) who refined and extended flap surgery to make it a relatively safe and very effective procedure for extensive cosmetic hair replacement. Other surgeons (Kabaker, 1978; Lauzon, 1979; Fleming and Mayer, 1981) continued to use this flap with few modifications. Juri (1978) also described a flap for the correction of occipital baldness based on a postauricular or occipital artery.

Elliott (1977) described a short flap similar to that used by Lamont (1957) for the hairline only. This flap is shorter and narrower than the Juri flap and is random rather than axial. We modified the design of the short flap, especially the configuration of the hairline, with fewer indications (Mayer and Fleming, 1982). Ohmori (1980) described a free flap using microvascular anastomosis techniques, but this procedure has little practical application for elective cosmetic surgery at the present time.

On rare occasions a small, superiorly based, preauricular and postauricular flap (Nataf and associates, 1976) is used to reconstruct only the lateral hairline. This flap is usually once delayed, and since in most individuals it cannot reach the midline, it is used only for lateral hairline replacement. Marzola (1983) described his technique to achieve the increased length necessary to reach the midline and beyond.

The authors designed a new flap for reconstruction of the temporal hairline that allows the total removal of scar tissue and immediate reconstruction, with the scalp flap based on the opposite superficial temporal artery (Mayer and Fleming, 1984).

Finally, in 1985 we described a new method of creating an irregular hairline. We use this to create a softer, more natural hairline than that reported by others.

Juri Flap

The Juri is a twice-delayed scalp flap based on the posterior branch of the superficial temporal artery. It has often been suggested that only one delay be performed, but we believe that more experience is necessary before one risks possible flap necrosis with only one delay in an elective cosmetic procedure. In more than 1000 flap procedures (with one exception in a patient who was a heavy smoker and developed complications), we have never had an incident of even partial flap necrosis in a patient who has not had a previous operation. We therefore always advise two delays.

We design our flap in essentially the same manner described by Juri in 1975. Our modifications of this flap are primarily a change in hairline configuration and design. We feel that a well-defined frontotemporal recession creates a more natural appearance than when this area is blunted. Furthermore, in 1984 we developed a means of creating an irregular closure of the hairline that gives a softer, more natural appearance. One should not use scalp reductions before flap surgery to increase the size of the donor area, because this may make a tension-free

closure of the donor defect extremely difficult and may result in severe necrosis and permanent hair loss. We advise that surgeons not perform reductions before flap surgery until they have acquired sufficient experience to know when this is possible.

Flap Design

The inferior edge of the flap starts at a point approximately 3 cm above the root of the helix. 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 located 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 1) in the office with local anesthetic. Occasionally, we supplement this with intravenous anesthesia for apprehensive patients. For the first procedure, 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, 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 can also be performed in the office operating room with the patient under general endotracheal anesthesia.

Table 1. Chronology of Juri Flap Procedure

Office Visit	Day	Procedure	Anesthesia	Return to Work
1	1	First delay: incise three-quarters of flap	Local	Next day
2	8	Second delay: elevate tail of flap	Local	Next day
3	15	Rotate flap	General	After 6 days
4	21	Remove hairline sutures	-	-
5	28	Remove scalp clips	-	-
6	57	Revise dog ear	Local	Next day

7 Second flap may be started 6 to 78 weeks after the dog-ear revision or when necessary.

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 per cent) with epinephrine, 1:200.000, is used to infiltrate locally 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. 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 from approximately 2 mm, and the flap is sutured to the forehead skin with a 5-0 polypropylene suture. 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.

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 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 patient can return to work. 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. From 3 to 4 cm of bald skin is left between the two flaps; this is later removed by stretching the flaps and performing scalp reduction. Total or near-total excision of any bald skin in the crown can be accomplished with posterior reductions and further stretching of the flaps. Thus, two 4-cm side 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 frequently occurs as a result of 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. 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 also occur. Patients are restricted from performing strenuous activities for 3 to 4 weeks postoperatively.

Complications

Complications from the Juri flap procedure may be divided 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. Skin loss is possible but is uncommon when proper care is taken. In more than 1000 flap procedures, only one of our patients, a 3-pack-per-day smoker, had 1 inch of distal necrosis. This was repaired with a small flap from the opposite side. We now insist that all smokers quit smoking for 2 weeks before and after a flap procedure. Infection and hematoma can also occur but are easily controlled.

Telogen or temporary hair loss in the distal end of the flap rarely occurs, but full hair growth resumes within a few weeks. Hair growth ceases to a minor extent in some of the donor area in approximately 5 per cent 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. If an area of loss occurs, it can be excised and replaced with a small flap from the opposite side, sparing the second Juri flap donor area. The incidence of hair loss within the donor area in this group can be greater, although in most instances it is temporary.

Advantages

The Juri flap has several advantages over punch grafts. In patients with frontal alopecia (class I), a complete result is obtained within a few weeks, 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, most patients who have had flap procedures expose part or all of their hairline. Furthermore, the

greater density afforded by flaps makes styling much easier. 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. The cost of flaps is comparable with that of punch-graft transplantation.

The major advantage of the Juri flap procedure is that two Juri 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.* Without this refinement in the hairline technique, the scar would be anterior to the hairline. Furthermore, the irregular hairline that we developed in 1984 softens the hairline to allow a more natural (random) hairline.

Disadvantages

Since the patient needs approximately 6 days off from work, the disability caused by this procedure is greater than that caused by 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 slightly abrupt; this can be softened with single hair grafts if needed. This is rarely requested when the hairline is made in an irregular fashion. Although hair direction is changed with this procedure, hair-styling requirements are fewer than those with punch-graft transplantation because of the superior density, uniformity, and natural hair texture.

Nondelayed Inferior Temporoparietal Flaps

Flap Design

Temporoparietal flaps are nondelayed, shorter, and narrower than Juri flaps. They do not extend across the entire forehead. 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 a Doppler flowmeter.

In our design, this 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, it is better to make the flaps a little too long than to discover during surgery that they cannot be joined.

We design the tail of the first flap to dovetail with the flap from the opposite side at an angle of 45 to 60 degrees, which prevents 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 2.5 to 3 cm and is uniform from base to tail except for the distal bevel.

Our inferiorly based temporoparietal flap differs in several important respects from those described by other authors. Although some have described narrowing the base of the flap and delaying it, we rarely delay these flaps and do not narrow the base, because this can cause flap ischemia and necessitate a delay. Furthermore, the proximal portion of the flap should form a gentle curve since a 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; they could be transferred at the same time, but 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. If necrosis occurs in the second flap, reconstruction is much more difficult.

Surgical Technique

The procedure is performed in the office operating room suite under light general anesthesia (Table 2). 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 percent 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.

Table 2. Chronology of Inferiorly Based Temporoparietal Flap

Office Visit	Day	Procedure	Anesthesia	Return to Work
1	1	First flap rotation	Local or general	After 6 days or earlier
2	7	Remove hairline sutures	-	-
3	15	Second flap rotation and remove clips of first flap	Local or general	After 6 days or earlier
4	21	Remove hairline sutures	-	-
5	43	Revise one or both dog ears	Local	Next day

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 is required to obtain a tension-free closure, even with a small flap. The hairline is

incised with an anterior bevel so that this margin corresponds 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 with 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 deepithelialized along the new hairline for 1 to 2 mm and sutured to the forehead skin with 5-0 polypropylene sutures as described for the Juri flap procedure.

A small dog ear is produced by the flap rotating on itself to create the new hairline, and 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 are removed with the Jackson-Pratt drain 24 to 48 hours later.

The dressing consists of Telfa fluffs and gauze and is worn 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 often resolves almost completely in 2 to 3 months, but may be revised 6 weeks postoperatively if spontaneous resolution does not occur.

Additional Procedures

The second flap can be created 2 weeks or more after the first flap procedure. The dog ear may be revised if necessary in 6 weeks but usually resolves in 2 to 3 months. At the same time the frontotemporal recession can be elevated to a 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, usually by no more than 25 per cent.

Morbidity

As with the Juri 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 performed 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, in either 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 Juri 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 a 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 low.

As with the Juri flap, the most common complications referred to our office 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 by careful planning and meticulous surgical technique.

Advantages

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

Theoretically, because the procedure is technically less extensive, fewer complications should develop with small flaps. However, this is not the case for the novice. We believe that the result depends on the surgeon's experience with both large and small flaps.

Disadvantages

As stated previously, temporoparietal flaps have several minor advantages over Juri flaps. However, they have an important disadvantage. *Two temporoparietal flaps provide only one-fourth as much coverage as two Juri flaps.* Therefore, for central 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, but is possible with two Juri flaps followed by scalp reductions.

Superiorly Based Temporal Flaps

Nataf and associates (1976) reported superiorly based preauricular and postauricular flaps. As originally described, the postauricular flap offers 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 rarely reaches the midline. Using Marzola's (1984)

technique 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.

Since we believe the indications for superiorly based flaps, whether preauricular or postauricular, to be limited, we refer the reader to the descriptions of Nataf and associates (1976) and Marzola (1984). The preauricular flap has a base that is approximately 2.5 to 3.0 cm in width and narrow inferiorly. The average length is 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 Juri 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 usually of poor quality and density, in contrast to that of the Juri and 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 be quite noticeable, may be difficult to camouflage, and may become more apparent with further temporal recession.
5. The donor area can be difficult to close because the donor defect is vertically oriented.
6. The superiorly based flap rarely reaches the midline unless combined with extensive reduction. Punch grafts can be used to complete the hairline, although the result is less acceptable. In 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. It may be necessary to use expanders to obtain adequate results.
7. The most important drawbacks 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 2 to 2.5 cm of hair in the frontal scalp. The remaining area posterior to the flaps must be handled by reductions or punch grafting. We feel that the result cannot compare with that obtained by using two Juri flaps for total elimination of baldness.
8. Even with the scalp reductions (assuming there is enough laxity to do this), a major problem remains with divergence of the hair around the reduction scar posterior to the flaps. This problem is not present with the Juri flap procedure, since the scalp flap in the middle of the scalp eliminates any divergence and requires no styling to cover the crown. The hair is naturally directed over the crown.

In spite of these disadvantages, we believe that this flap is occasionally applicable in the rare patient who can satisfy the following requirements: (1) there must be only mild frontal baldness (never beyond class I), (2) the temporal hairline must be very high superiorly and anteriorly placed, and (3) good hair quality must be available in the preauricular area.

If the hair direction obtained with the Juri flap were a serious problem, the superiorly based temporoparietal flap would be much more advantageous. 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 Juri 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 flap, 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.)

Frontal Baldness Only (Class I) (Never Beyond)

The most important consideration before any surgical hair replacement is to evaluate thoroughly both the entire *potentially* bald area and the entire available donor area. Only a small percentage of bald men *ultimately* have alopecia limited to the frontal scalp. Frontal baldness generally progresses with age. Initially, this can be treated with either punch graft or flaps. These patients do not require scalp reduction, and there is no benefit from scalp reduction in the frontal region. 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 also need to style their hair in a forward direction to cover the tufted or corn row appearance along the hairline. The results are much better in patients with silver, curly, or kinky hair, since tufting is less apparent. Because of all of the available grafts can be concentrated in a very small area, the results are much better than if the grafts were put into a bald area four times as large, especially when combined with micrografting. Patients should also be aware that it takes 1.5 to 2 years to achieve a complete result.

For patients who object to any tufted appearance or change in hair texture, or who wish to have a more immediate result with greater hair density than can be achieved with punch grafting, the flap procedure best fulfills their needs. Therefore, if the patient has an established pattern of frontal loss only, one long flap can be created with immediate total replacement of the frontal baldness. The same amount of baldness can be handled with two short flaps, superiorly or inferiorly based, but with less satisfactory results in the average patient. If superiorly based flaps are used the surgeon must make sure that there will be sufficient length to reach the midline, which usually is not possible, especially with preauricular flaps. Since patients have sufficient hair posteriorly on the scalp, they usually do 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 can usually be treated with scalp reduction, which produces 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 (with or without scalp reductions) or treated with a single flap. As mentioned previously, patients with silver, gray, or curly hair are more pleased with punch grafts in the crown. However, it takes 1.5 to 2 years, and grafts generally do not grow as well in the crown. Also, a large number of crown grafts are usually needed to obtain adequate coverage. Other patients will be more pleased with the immediate results that can be achieved with total excision of bald skin and replacement with a single Juri flap in 6 days. The improved density, hair direction, and natural texture of the flap make this procedure extremely advantageous for 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 are limited.

Punch grafting is 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 III baldness. Local scalp factors (density, hair texture and color, and contrast) 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 Juri flaps can be created for these patients, with or without scalp reduction, to achieve total elimination of the bald skin with maximal density. Patients have a full natural head of hair in 3 months.

We do not believe that short flaps combined with reductions and punch grafting provide as good a result, but these procedures may be performed if desired.

Frontal-to-Occipital Baldness

The overwhelming majority 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 are not satisfied with punch grafts, and their

dissatisfaction becomes even more pronounced when the problem is compounded by negative local scalp factors such as low hair density, fine hair, or a texture change of the hair.

Two Juri 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 in whom there are several negative factors, especially low hair density and fine hair. Since the flap is transferred as one piece, maximal density uniformity is achieved with no hair texture change.

Although short flaps can be used in patients with class III baldness, this approach provides only about 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. If patients choose flaps as the means to achieve their expectations, it makes no sense to create only anterior hairline flaps followed by reductions and transplants. Therefore, in patients 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 Juri flaps followed by scalp reductions. Even with multiple reductions, temple incisions, and movement of lateral scalp anteriorly, the divergence of hair combined with punch grafts does not give as satisfactory a result as two Juri flaps. We believe that the Juri flap is generally the best technique for surgical hair replacement. Inappropriate use of short flaps in patients with extensive baldness will become less common as more surgeons gain experience with the Juri flap.

Some patients lack sufficient donor area for a Juri flap, but may yet obtain acceptable (if less desirable) results from the use of two short flaps followed by scalp reductions and punch grafting. Short flaps may also be a more prudent choice for patients who have had punch graft donor scars in the occipital area that compromise the blood supply in the distal end of the Juri flap.

Finally, whether we create flaps or punch grafts, we are extremely cautious with the marginal or unsuitable candidate who has extensive baldness with a small 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. The final result should look as natural as possible, with the aim of pleasing the patient.