Revision Surgical Hair Restoration: Repair of Undesirable Results

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Surgical hair restoration has been performed as a treatment for male pattern hair loss for more than 40 years. Although techniques have changed dramatically over the past several years, making it possible to achieve natural-appearing results, there are still many patients with unacceptable outcomes. These patients may have had procedures performed in the past with antiquated techniques or performed recently with substandard techniques. The causes of unfavorable results can be classified into one of three categories: technical errors, poor planning, or complications. The results in these patients can be dramatically improved through a number of different reparative surgical techniques. The majority of these techniques can be performed in an office outpatient setting. More than 40 patients unsatisfied with previous surgical hair restoration have been treated with the different techniques reviewed in this article. All patients had successful outcomes with significant improvement in appearance. Despite the increased challenges when performing reparative surgery, outcomes were favorable in all patients, with small to significant improvements in appearance achieved. Some of these challenges include the limited supply of donor hairs, reduced scalp laxity, and theoretically reduced vascularity due to scarring and transected blood vessels, and patient skepticism. Furthermore, the few complications that occurred were minor and correctable, including one case each of poor hair growth associated with extensive small graft (consisting of one to four hairs) transplanting, and of scalp scarring associated with the removal and primary closure of a large number of "plug" grafts (typically grafts 3 to 4 mm in size consisting of seven or more hairs) in a single procedure. (*Plast. Reconstr. Surg.* 104: 222, 1999.)

Overview

The goal of surgical hair restoration is simple: restore the individual's hair to a natural appearance. If restoration is performed properly, the results are virtually undetectable. Technically, the process of transplanting hair from one part of the scalp, the donor area, to another part, the recipient area, is straightforward. The challenge in these procedures is in achieving a result that appears completely natural and satisfies the patient. For many reasons, the outcomes of surgical hair restoration fall short of success. It is for these many reasons that the author has organized his approach to repairing the undesirable, unacceptable results of hair restoration.

Reasons for Failure

The causes of unfavorable results in surgical hair restoration can be divided into three categories as listed in Table I. These categories are technical errors, poor planning, and complications.

The most common of the technical errors is the use of a poor or obsolete technique by the surgeon. Outcomes include a pluggy appearance, an abrupt dense hairline, misdirected growth of transplanted hairs, pitting and ridging, cobblestoning, and compression effect. Probably the most common outcome of technical errors is nonaesthetic hairline design, position, or both.[1,2] Scarring of the donor site, due usually to its poor management, is another technical error. This scarring sometimes is associated with the "one-case mentality," whereby the surgeon, looking to maximize the number of grafts harvested from the first procedure while disregarding the need for procedures in the future, resects as large a strip as possible of donor tissue, increasing the demands for a perfect layered closure of the donor site. Visible scarring can also occur with scalp reduction or scalp flap surgery.

In the category of poor planning, the most

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TABLE I
Categories of Causes of Undesirable Results

Technical errors
Poor technique
Obsolete/antiquated technique
Poor planning
Inadequate preoperative counseling
Not anticipating future hair loss
Not individualizing the procedure for the patient
Complications
Unpredictable patient characteristics
Hypo/hyperpigmentation
Scarring of recipient site
Some cases of scarring of donor site

common error lies in the surgeon failing to anticipate the total amount of hair that will need to be transplanted to manage the present, as well as future, hair loss.[2,3] This failure can result in the premature depletion of available donor hair before the completion of the hair restoration process.[4] Another result can be the creation of a hairline that perhaps is appropriate for the age and hair loss pattern (i.e., degree of temporal recession) of the younger individual at the time of hair restoration, but inappropriate for the older individual with progression of balding. Positioning of the hairline (i.e., its distance at the midline from the nasion and the degree of lateral recession) and the allocating of available donor hair for managing present and anticipated future hair loss are two steps along the hair restoration process that must be planned for before any surgery is performed.

Another of the poor planning errors is the failure to educate the patient on the progressive nature of balding, the need for several hair restoration procedures, and what the patient can expect in terms of appearance (e.g., hair density) after a single, and subsequent, procedure(s). In most cases, the *uninformed patient is a disappointed patient.*

A different type of error of planning is the failure to individualize the procedure(s) for the specific patient. In favor today is the performance of megasession follicular unit transplant sessions (the transplanting of 1000 to 2000-plus graft units each containing the natural bundling of one to four, occasionally five, terminal hairs with the associated sebaceous lobules and the surrounding adventitial collagen).[5] Although follicular unit transplantation creates excellent results in the majority of patients, this procedure is not ideal for all patients. Pure follicular unit transplantation can result in some patients in a final density that does not meet expectations. Factors such as the curl, color, and texture of hair, donor site density and availability, and patient expectations assist in the selection of different graft sizes. And although hair grafting is the most appropriate procedure for the great majority of patients, some patients are better treated with, and would choose, if offered, a different or additional procedure, such as scalp reduction or scalp flap surgery.

Finally, some undesirable results can be classified as caused by complications. These complications are usually the result of patient characteristics, most of which are unpredictable. These results include some cases of recipient and donor site scarring and hyperpigmentation or hypopigmentation.[6]

Unique Considerations When Performing Reparative Surgery

There are significant challenges when performing reparative surgical hair restoration procedures. A scalp that has been previously operated on has certain limitations. Theoretically, circulation can be compromised as a result of scarring and from the transection of one or more important blood vessels. Main branches of the occipital and postauricular vessels could have been transected during prior harvesting with deep dissection of donor tissue, and branches of the supraorbital, supratrochlear, and superficial temporal vessels could have been transected when grafts large in size or number were previously transplanted. Compromised circulation, manifest as venous congestion and/or as the absence of bleeding in the recipient areas, theoretically increases the risk of scalp necrosis and poor growth of transplanted hair. Performing scalp flaps in these cases can also be difficult, as there is a limit on flap length. Because the distal end of a temporoparieto-occipital flap traverses a previous hair graft donor site scar, two short temporoparietal flaps must be used instead of the single temporoparieto-occipital flap to reconstruct a hair line.

Scalp laxity is often reduced after previous hair restoration surgery. This puts limits on both the amount of bald scalp that can be excised in a reduction and the width of a donor strip that can be excised in hair grafting. Donor tissue for grafting is further limited because hair has been previously excised from the donor areas. Resources are limited not only

in the amount of donor tissue available for harvest but also in terms of the amount of enthusiasm and trust that the patient has in the whole hair restoration process. These patients are often skeptical and can hold onto previous misconceptions created by unrealistic prior counseling. In all these cases, patients must be properly counseled and the trusting doctor-patient relationship reestablished.

Materials and Methods

Surgical Techniques

The techniques that can be used in revision hair restoration improve appearances by one of three mechanisms: adding more hair, redistributing previously transplanted hair, or removing previously transplanted hair (see Table II). In most cases, the goal of the use of these different mechanisms is in achieving a more uniform distribution of hair. Sometimes this outcome is accomplishable with just one technique, but often several techniques are used. These techniques are now presented.

Removal of grafts (see case report 1). Indications for removal are the patient who regrets ever having had hair restoration surgery, and who desires a bald scalp. This technique can be combined with graft retransplantation.

Technique highlights are as follows. (1) The previously placed grafts are excised by a circular or elliptical hole punch of similar size (see Fig. 1). (2) Closure is performed in a single layer for punch defects less than 3 mm in diameter or in a layered manner for larger punch defects. The author's suture preference is 5-0 chromic gut (Ethicon, Somerville, N.J.) subcutaneously, and 5-0 Ethilon nylon (Ethicon) simple interrupted to reapproximate the everted skin edges. The axes of lines of closure with each individual donor defect must be favorably aligned so that the wound tensions everted on surrounding donor defects favor closure under reduced, rather than increased, tension (i.e., a sagittal axis of closure is adjacent to a coronal axis of closure). This important concept is illustrated in Figure 2. (3) There is no need for suturing small donor defects 1.5 mm or less in diameter. These will contract naturally. (4) The technique is usually best performed in a staged process because of limited scalp laxity. Typically, no more than 40 to 50 large punch grafts are excised in a single procedure. Second and subsequent procedures can be performed at 6- to 10-week intervals. (5) Sutures can be removed in 6 to 7 days.(6) Laser resurfacing has been used with some success to minimize postoperative scarring and hypopigmentation. CO_2 or erbium laser resurfacing can be performed as soon as 6 weeks postoperatively.

TABLE II
Mechanisms of Reparative Techniques

Adding more hair
Further transplantation
Scalp flap surgery
Redistributing previously transplanted hair
Graft retransplantation
Punch reduction
Removing previously transplanted hair
Graft removal
Other
Scalp reduction
Scar revision

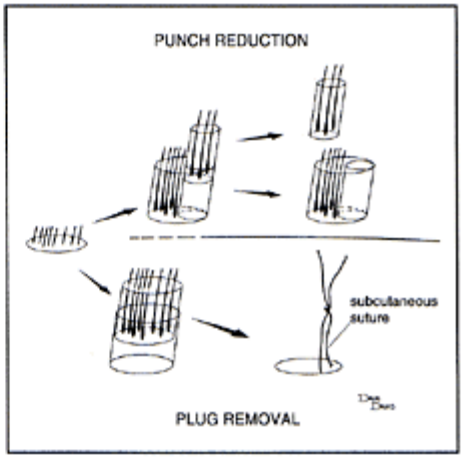

FIG. 1. Techniques of punch reduction (*above*) and plug removal (*below*). Refer to text for details on the techniques.

Graft retransplantation. Indications include poor position or location of grafts. The method is similar to that of the graft removal technique, except that instead of discarding of the excised graft material, it is retransplanted.

Technique highlights are as follows. (1) The approach is similar to that for graft removal. The excised graft material is retransplanted either into another part of the scalp or in the same area but into a recipient site of different shape or direction. (2) The recipient sites may be slits or holes. (3) When reimplanting into a hole, the diameter of the recipient site must be

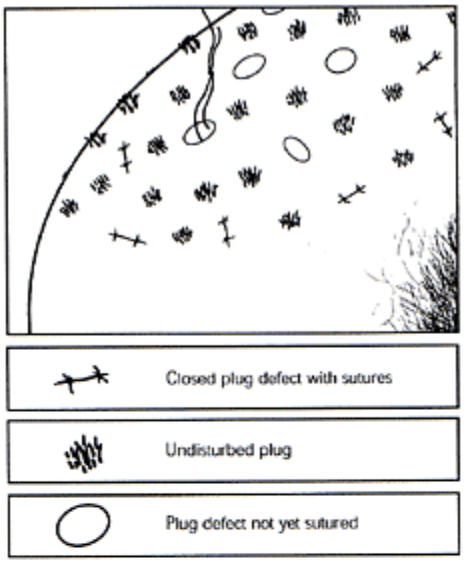

FIG. 2. Technique of removal of plug grafts. Plug grafts are removed with a punch, and the defects are closed in a layered manner. The axes of closure must be favorably aligned so that wound tensions on adjacent defects are reduced. As shown, the sagittal axis of closure of one defect favors a coronal axis of closure on an adjacent defect. Not all plug grafts are removed in a single procedure.

slightly smaller than the diameter of the punch used for graft excision (i.e., a 3-mm diameter punch excised graft placed into a 2- or 2.5-mm-diameter recipient site).[7] (4) To maintain the integrity of the hairs in the graft that is to be retransplanted, the punch for removal is inserted parallel to the direction of the hairs to a depth just beyond the follicles. The graft is then gently extracted and, if necessary, excised just below the follicles.

Punch reduction (see case report 2). Indications are a pluggy appearance due to large punch grafts; an unnatural, thick hairline density; or both. This technique may be combined with the graft retransplantation technique.

Technique highlights are as follows. (1) There is no need for suturing closed the defect when created by a punch 1.3 mm in diameter or smaller.[8] (2) The periphery of the plug graft is included in the excised material to avoid "donutting," which can occur when the central aspect of the graft is excised (Fig. 1). (3) The excised material can be inserted in a new recipient site, either adjacent to the existing plug graft that has just been reduced in size, or in another area of the scalp. (4) Similar technique highlights as with the graft retransplantation technique.

Further transplantation (see case reports 2 through 4). Indications include inadequate density, abruptly thick hairline, and pluggy appearance. This technique can be combined with the punch reduction technique.

Technique highlights include (1) the ability to maximize donor tissue availability by (a) using a single-bladed knife to avoid the transection of valuable follicles that can occur when using a multibladed knife, and (b) closing in a multiple-layered fashion. (2) Use of appropriate sized grafts is necessary. (a) When repairing the pluggy appearance of large punch grafts, the intervening spaces are filled in with grafts of the same or slightly smaller size. (b) When softening the abrupt hairline, micrografts (one to three hairs) and small minigrafts (three to four hairs) are placed in front to feather the hairline, and small minigrafts and sometimes slightly larger grafts (four to six hairs) are placed so as to make the hairline appear irregular. (3) The technique minimizes trauma to surrounding previously placed grafts. (4) In cases of previous extensive grafting, especially with large punch grafts, the number of grafts that are placed with each procedure must be moderate. This approach will avoid any sequelae of impaired circulation, including significant telogen effluvium and even scalp necrosis that most commonly occurs in the central anterior scalp typically 6 to 8 cm posterior to the hairline.

Scar revision. Indications include scarring along the donor site and scalp reduction scarring.

Technique highlights are as follows. (1) Excise as much donor site or scalp reduction scar that scalp laxity permits. Layered closure is performed by using 2-0 and 3-0 Vicryl (Ethicon) for the deep and subcutaneous closure, and 2-0 Prolene (Ethicon) for the everted skin edge closure. (2) In donor site scars, undermining of the surrounding tissue is minimized so as not to reduce hair density, which can be especially pronounced along the caudal side. (3) Any hair grafts harvested from donor site scar tissue are transplanted. (4) In cases of visible donor site scarring in which excision of the scar is not possible, hair grafts may be transplanted into the scar. Many times, a small number of grafts strategically placed into the

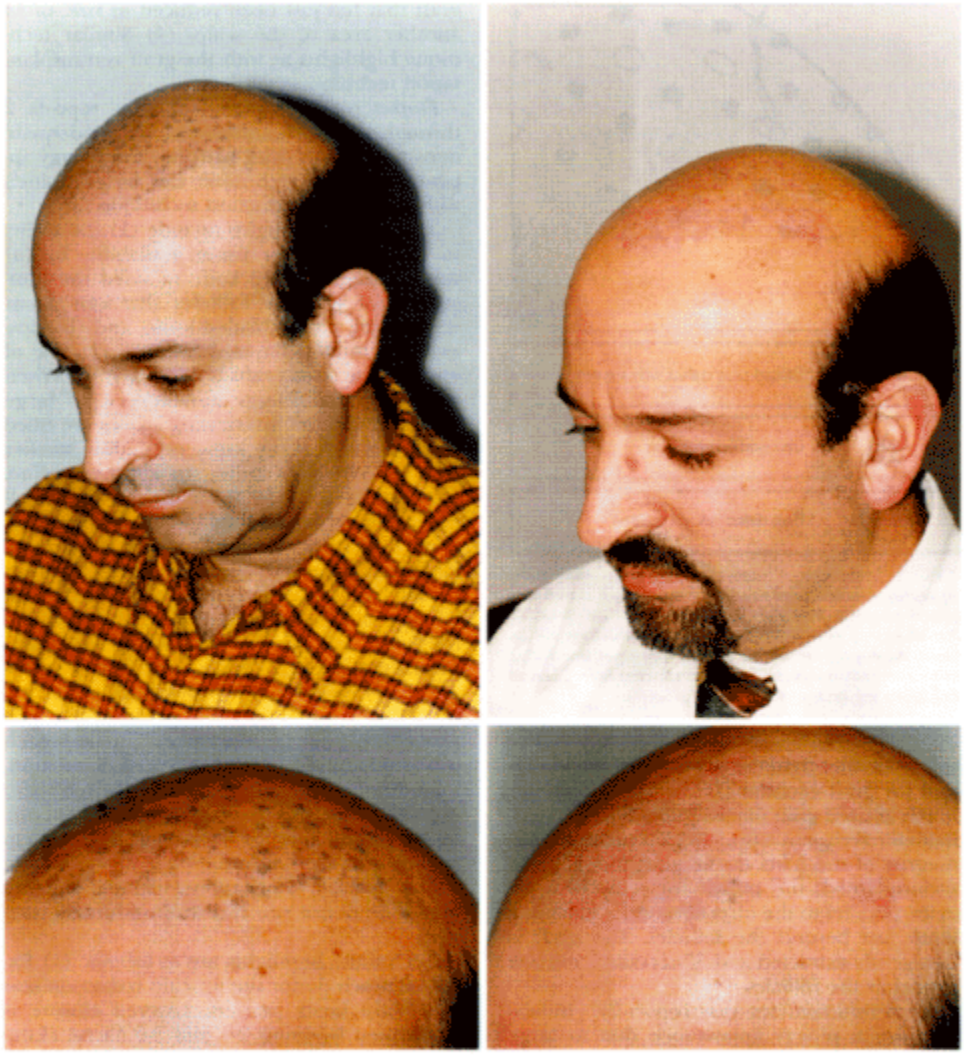

FIG. 3. Before (*left, above* and *below*) and 3 months after the fourth procedure (*right, above* and *below*). Note that one more procedure will be necessary to remove the few remaining grafts.

donor site scar can dramatically improve the appearance.

Scalp reduction. Indications include scalp scarring from previous surgery, usually scalp reduction; unnecessary or unnatural-appearing isolated grafts in the crown or midscalp region[9,10]; and insufficient supply of donor hair for grafting a previous scalp reduction scar and the surrounding alopecic scalp of the midscalp, vertex, or both. Adequate scalp laxity is a necessity.

Technique highlights are as follows. (1) All visible previous incisions, hair grafts, or both, are excised. (2) The defect is closed in layers. (3) The most common design is Mercedes shaped, but any design may be used. (4) Any previously transplanted hair grafts obtained from the excised scalp may be retransplanted.[7,9]

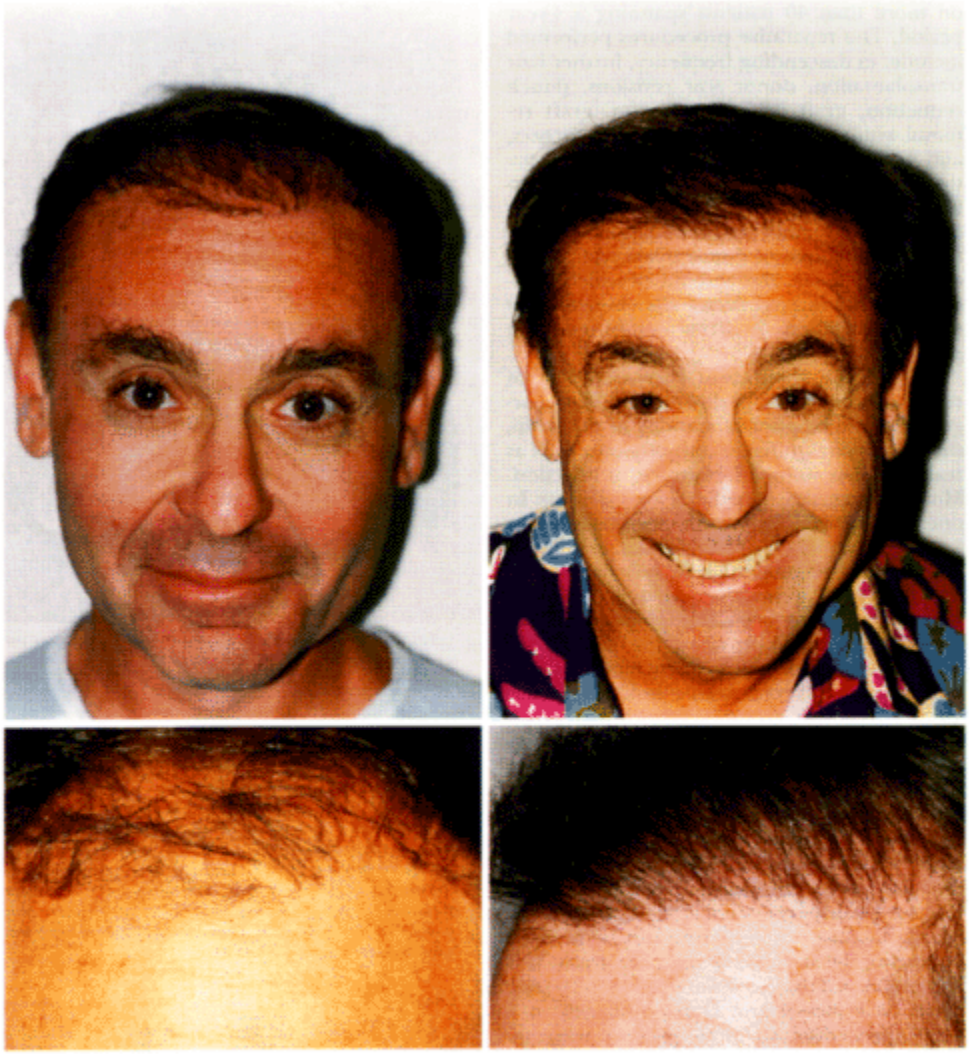

FIG. 4. Before (*left, above* and *below*) and 10 months after the second procedure (*right, above* and *below*).

Scalp flap surgery (see case report 5). Indications include insufficient hairline density from previous grafts, pluggy appearance from a previous grafting, or the patient's desire for a dense hairline in a short period of time.[1]

Technique highlights include the following. (1) Short (temporoparietal) flaps must be used when occipital donor site scarring crosses what would be the distal aspect of a long (temporoparieto-occipital) flap[11] The design of these different flaps is beyond the scope of this article. (2) Delay procedures are usually necessary. (3) Any previously transplanted grafts obtained from that portion of frontal scalp that is to be discarded may be retransplanted.

RESULTS

The author's experience with revision hair restoration includes more than 70 procedures

on more than 40 patients spanning a 4-year period. The reparative procedures performed include, in descending frequency, further hair transplantation, donor scar revisions, punch reduction, graft retransplantation, graft removal with primary closure, scalp flap surgery, and scalp reduction. In the majority of patients, more than one procedure was performed (e.g., donor scar revision almost always occurs with further transplantation because the excised ellipse of donor tissue typically includes scar tissue, the amount of which is reduced with a layered donor site closure; graft retransplantation is often combined with punch reduction).

Despite the theoretical increased risk of complications when performing revision surgery because of prior alterations in the scalp, there were no significant complications such as scalp necrosis, wound dehiscence, or infection. Minor, correctable complications did occur. In one case, poor hair growth resulted when a large number (250) of micrografts were transplanted into 18-gauge needle holes along the hairline where previously more than 450 4-mm punch grafts had been transplanted; on the subsequent procedure when the micrografts were transplanted into recipient sites made by a 16-gauge solid-core needle hole, there was much better hair growth, probably a result of the increased bleeding in these larger recipient sites. Hypopigmented scarring occurred in one case after 140 4-mm punch grafts were removed and closed under significant tension in a single procedure on an African-American patient. Subsequent CO_2 laser resurfacing produced a moderate improvement in appearance due to the hyperpigmentation that occurred during healing. This scarring can be avoided by staging the removal of the plug grafts. It is recommended that no more than 40 to 50 plug grafts be removed and closed primarily in a single procedure so as to prevent scarring. There were a few minor complications, such as cyst formation and graft "popping."

Overall, patient satisfaction was high. Some case examples are presented to illustrate the variety of procedures performed.

Case Reports

Case 1

Case 1 is a 44-year-old man 15 years after a transplantation of 210 4-mm plug grafts (Fig. 3, *left, above* and *below*). He requested the removal of the grafts to allow him to have a smooth, bald scalp, and the repair of donor site scarring.

Fig. 5. Close-ups of before (*above*) and 1 year after the second procedure (*below*).

Four staged procedures were performed, involving complete removal of 40 to 48 plugs per procedure, at 3- to 6-month intervals. This number of grafts removed, per procedure, is the maximum number that avoids creating excessive tension on the defect closures. The 4-mm punch defects were closed in a layered manner, with 5-0 chromic gut (Ethicon) to reapproximate the subcutaneous layer, and one or two interrupted 5-0 Ethilon (Ethicon) to reapproximate the everted skin edges (Fig. 3, *right, above* and *below*). The pattern of closure is illustrated in Figure 2. The removed 4-mm plug material was divided in half, then retransplanted into 1.8-mm holes along the donor site scars.

Case 2

Case 2 is a 52-year-old man 20 years after 150 4-mm plug transplants (Fig. 4, *left, above* and *below*). He wanted a more natural appearance.

Two procedures were performed, each involving the punch reduction of 30 to 40 punch grafts along the hairline region, supplemented by further grafting with approximately 150 micrografts in front of the hairline, and 250 to 300 three- and four-hair maxi-micrografts placed in slits and 1.3-mm holes between the hairline grafts (Fig. 4, *right, above* and *below*).

Case 3

Case 3 is a 32-year-old man 2 years after 1200 micrografts containing three and fewer hairs apiece (Fig. 5, *above*). He was dissatisfied with density. Although the author has no photo-

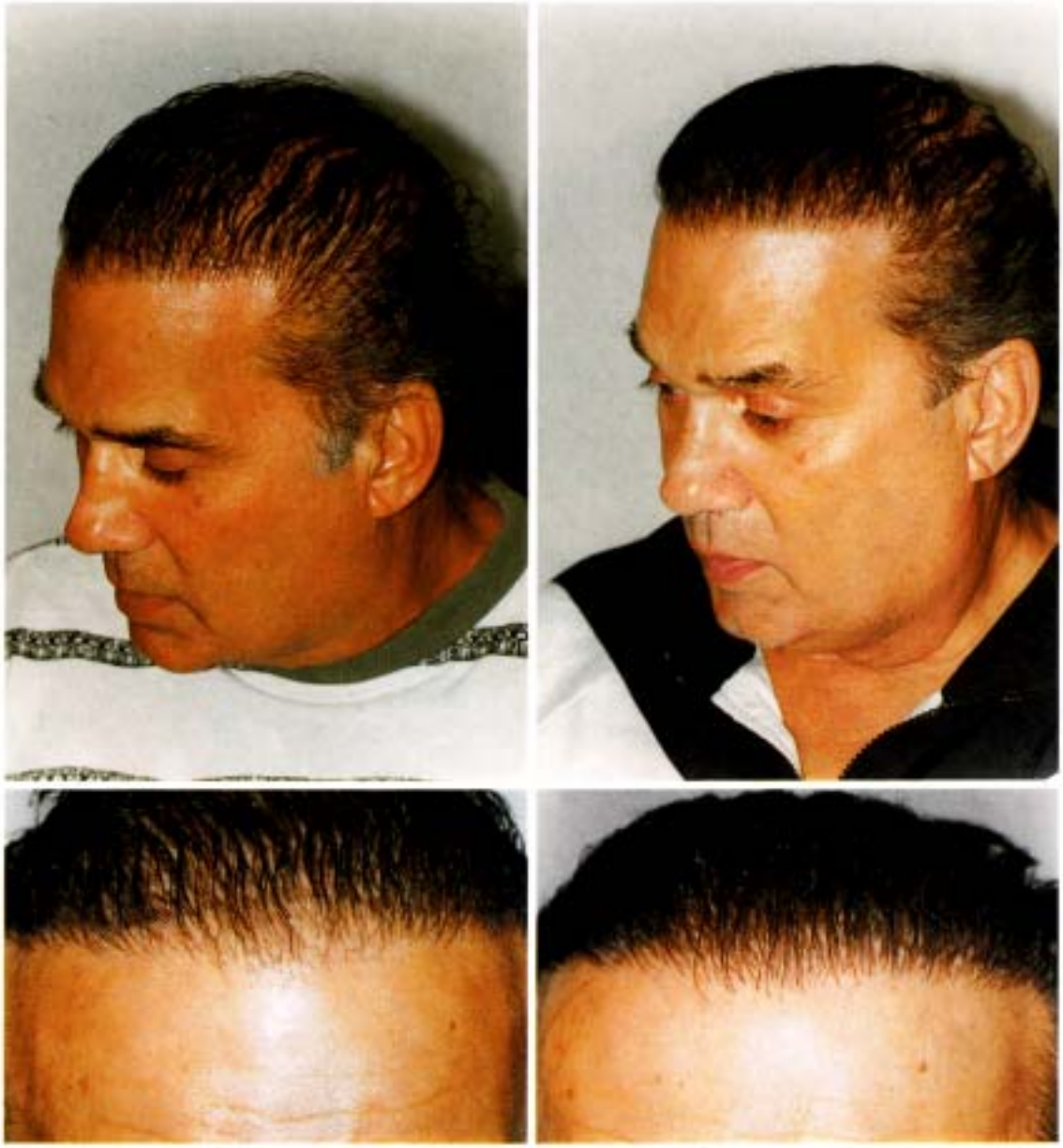

FIG. 6. Before (*left, above* and *below*) and 8 months after (*right, above* and *below*).

graphs documenting the extent of the patient's hair loss before the first procedure (because it was performed elsewhere), the patient is disappointed with the density outcome for two reasons: he was provided with unrealistic preoperative counseling, and the transplanting of exclusively one- to-three hair micrografts in this patient with fine light colored hairs has resulted in a very low density appearance.

Two procedures were performed each of 950 to 1000 grafts, with two-thirds of the grafts containing three to four hairs to increase density. All recipient sites were slits (Fig. 5, *below*).

Case 4

Case 4 is a 61-year-old man 2 years after multiple transplant procedures of mostly 2-mm and larger grafts (Fig. 6, *left, above* and *below*). Despite the transplanting of micrografts in the most recent procedure, the hairline appears abrupt. The insufficient density 2 cm and further behind the hairline resulted in an artificial-appearing absence of progressive thickening of the hair density. Poor hairline design resulted in blunting of the frontotemporal regions. He desired a more natural appearance.

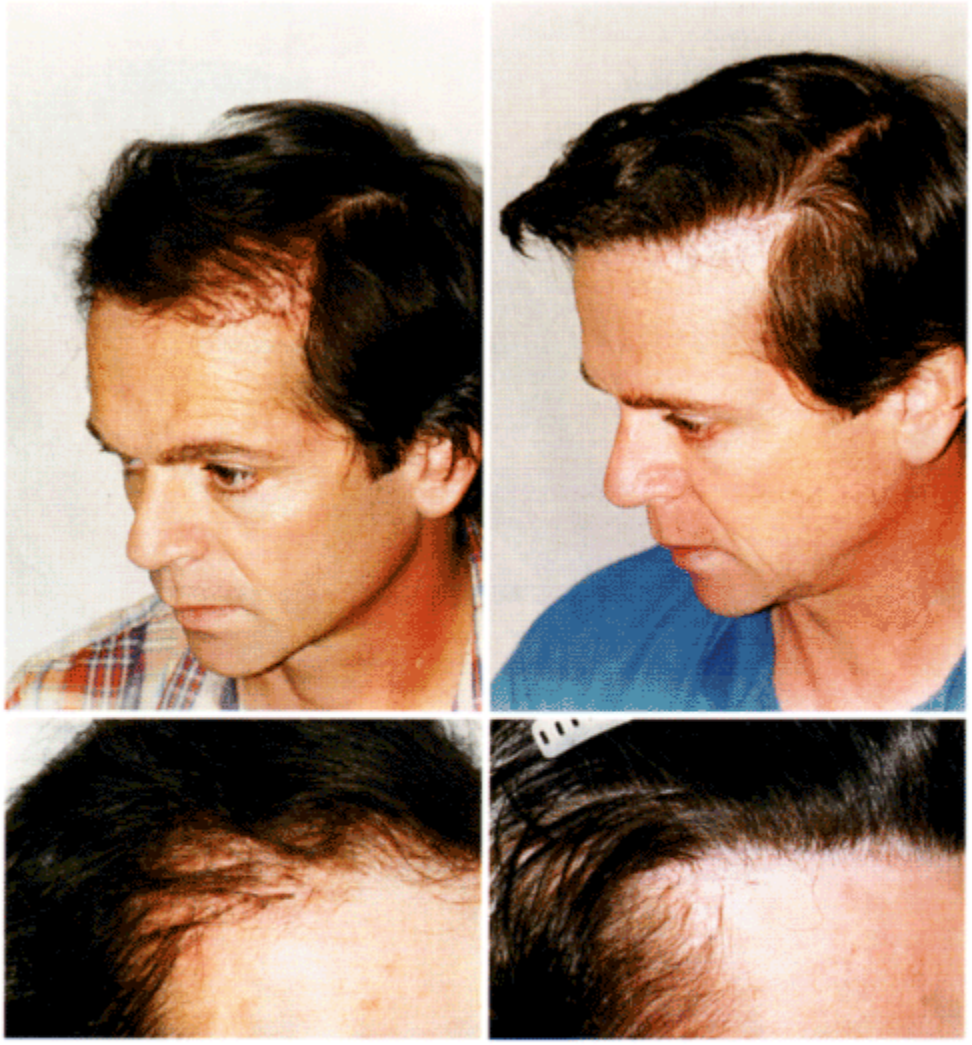

FIG. 7. Before (*left, above* and *below*) and 3 years after the second flap surgery (*right, above* and *below*).

A single procedure of 420 grafts was performed, harvested from a single strip of occipital scalp. The grafts were cut from between scar tissue, and the donor site was closed in a layered manner. Of the 100 micrografts placed in the frontal region, half were used to create a widow's peak, giving the appearance of significant lowering of the central hairline to accommodate the low lateral hairline. The remaining 320 grafts, small minigrafts containing three to five hairs, were placed into slits between existing hairs along the frontal and midscalp region (Fig. 6, *right, above* and *below*).

Case 5

Case 5 is a 47-year-old man 10 years after 90 4-mm plug grafts transplanted into bilateral frontotemporal recessions (Fig. 7, *left, above* and *below*). Progressive hair loss has resulted in a pluggy appearance in these areas. He desired maximal hairline density.

Because of the hair density desired, and because the hair loss process was essentially limited to 4 to 5 cm of frontotemporal recession, the decision was made to perform scalp

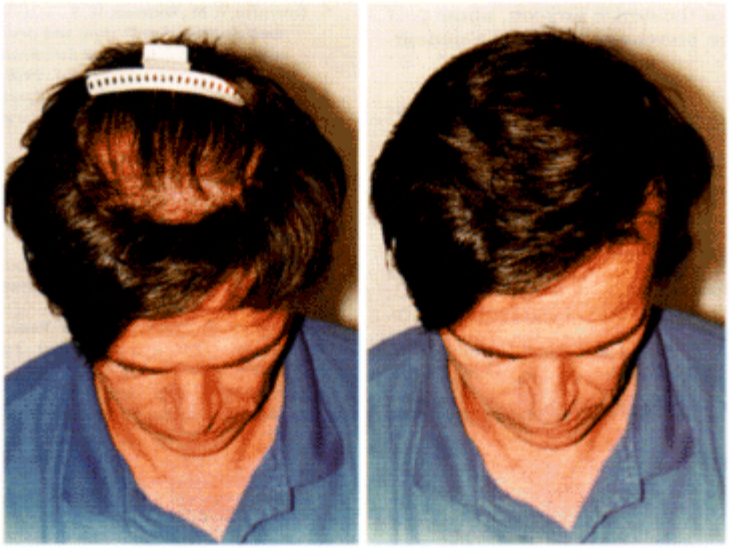

FIG. 8. Some minimal hair loss behind the flaps (*left*); however, proper styling permits an aesthetic appearance (*right*).

flap surgery. The previous donor site scarring in the occipital regions made it necessary to perform two temporoparietal flaps, rather than a single longer temporoparieto-occipital flap. These flaps were performed in a nondelayed manner at a 4-month interval. The plug grafts located in the discarded frontotemporal skin were divided, then retransplanted into midscalp slit recipient sites (Fig. 7, *right, above* and *below*).

A total of 200 micrografts transplanted in front of the flap 6 months preceding the completion of the second flap serve to soften the hairline. Donor site scarring is minimal, and although there has been some minimal hair loss behind the flaps (Fig. 8, *left*), proper styling permits an aesthetic appearance (Fig. 8, *right*).

CONCLUSIONS

The above case examples illustrate some of the procedures that can be performed in revision surgical hair restoration. The techniques presented in this article can be used in different combinations to repair the undesirable results of previous hair transplant surgery. Before setting out on a plan of action, patients must be informed of potential limitations and given realistic expectations. Keep in mind that some of these patients are appropriately discouraged and skeptical, given the failure of the work they had performed previously to attain the results they desired or expected.

Performing revision hair restoration can be very challenging. In most cases, the all-important resource, namely donor hair, is in short supply, the result of previous surgery. The surgeon is confronted with the difficult decision of how best to proceed. The goal with most of these patients is to achieve the most cosmetically appealing, natural-appearing hair restoration. Strategic placement of any available donor hairs and redistribution of already transplanted hairs can make a major impact on appearance. In every case the author has encountered, there are at least a minimal number of harvestable donor hairs, most commonly in the supra-auricular region.

When performing revision hair restoration surgery, it is often necessary to use more than one technique. This approach is particularly true when there is a corn-row appearance attributable to previously performed large punch grafting, for which the goal is to restore a more uniform distribution of transplanted hairs. This outcome is achieved by performing punch reduction of the large hairline plugs, then filling the empty spaces between the remaining grafts that have been reduced in size by retransplanting the excised punch graft material, transplanting newly harvested grafts, or both.

Performing revision hair restoration can be immensely rewarding. Certainly, this type of

work is not for the novice surgeon, whose goal should be the prevention of creating undesirable results.

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