

Hair Transplantation: Current Concepts and Techniques

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Because of changes in technique, hair transplanting can now be offered as a reasonable option to more male and female patients who are not responsive to, or likely to benefit from, medical treatment. These changes have also resulted in exceptionally natural-looking results, even after a single session in an alopecic area, or in many individuals with prior and cosmetically unacceptable transplanting results. Current concepts and techniques are described in the article. Possible disadvantages of some of them are also discussed. In particular, the apparent advantages of “megasections” of 3000 or more grafts per session, “dense packing” of more than 40 follicular units per cm² and a new method of harvesting single follicular units directly from the donor area (Follicular Unit Extraction), may not be advantageous as they first seem.

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The basic building block of modern hair transplantation is the intact “follicular unit” (FU). Table I summarizes the definition of the different types of grafts used in transplantation today, based primarily on the number of intact FU they contain, and the type of instrument that is used to make recipient sites for them (Unger and Beehner, 2004). Transplant sessions that consist exclusively of FU (FUT) are ideal for transplantation of areas that are totally alopecic, for individuals who do not want or are not suitable for high hair density objectives, and for those who are not ready to commit to more than one session in any area. This is because a single FUT session in an alopecic area—or an area that is destined to become alopecic—will appear completely natural standing on its own (Fig 1) (Bernstein and Rassman, 1997). Additional sessions are carried out in the same area only for increased hair density.

If multiple-FU grafts (MUG) are utilized, they are used posterior to a hairline zone created exclusively with FU. In general, the larger the MUG used (the more FU in the graft), the greater the density that can ultimately be created, and more importantly, the safer the FU are within the graft from potentially lethal technical mistakes that can be made during graft preparation, storage, and insertion (Unger, 2004a). Once MUG are used, however, with a few exceptions, a single session in an area that is alopecic or destined to become so will not appear sufficiently natural to “stand on its own.”

Combining a hairline created with FU and micro-slit grafts posterior to that is most suitable for patients who (a) want higher ultimate hair density than can be accomplished with FUT if one utilizes reasonable FU densities per session; (b) have persisting hair in the recipient area; and (c) have appropriate long-term donor/recipient area ratios. One exception to the latter is women with female pattern hair loss

(FPHL), who usually have less satisfactory long-term donor/recipient area ratios than males, but who rarely lose all of the hair in their thinning areas and who typically wish to have an appearance of maximum density. It is important to recognize that many women who fail to respond satisfactorily to medical treatment can be improved, and are candidates for modern hair restoration surgery techniques (Unger and Unger, 2003) (Fig 2).

The use of slot grafts or round grafts in portions of the recipient area are indicated when hair density objectives are even higher, the long-term donor/recipient area ratio is judged to be good, and, in most cases, when there is a moderate amount of original hair in the recipient area. Slot grafts are particularly useful in Caucasian patients with white hair (Fig 3). In our hands, the ultimate in density objectives can be achieved with a combination of FU in the hairline zone, double FU (DFU) and triple FU (TFU) posterior to the hairline zone, and round grafts posterior to the DFU and TFU. Posterior to the round grafts, DFU and TFU are continued. Ideal candidates for this type of grafting have the following characteristics: (a) a good *long-term* donor/recipient area ratio; (b) good *long-term* temporal hair density; (c) some hair in the recipient area; and (d) good hair characteristics for hair transplanting. A large majority of patients do not qualify based on the above factors. Therefore, this option is only *offered* to approximately 5%–10% of the patients that the author sees.

The decision as to what type of graft to use in what circumstances is far too complicated to adequately deal with in the space allotted for this discussion. The reader is advised to review the 2004 edition of *Hair Transplantation* (Unger and Shapiro, 2004) for more complete information. It is worthwhile, however, to note here that the noticeability of a graft is not just a function of its size. The less the contrast between hair and skin color, the finer the hair texture; the frizzier or curlier the hair, the larger the graft can be without it being

Abbreviations: FU, follicular unit; DFU, double FU; TFU, triple FU

Table I. Definition of the different types of grafts used in transplanting

Graft type	Hairs	FU	Recipient site	Cut "to size" ^a or cut to "number of hairs" ^b
<i>Micrografts</i>				
Micrograft (general term)	1–4	1 or less	Needle/micro-slit	Cut to "number of hairs"
FU (specific term)	1–4	1	Needle/micro-slit	Cut to "number of hairs"
FF	5–6	2	Needle/micro-slit	Cut to "number of hairs"
<i>Multi-FU graft</i>				
<i>Micro-slit grafts</i>				
DFU	3–5	2	Slit	Cut to "number of hairs" (FU)
TFU	5–8	3	Slit	Cut to "number of hairs" (FU)
QFU	6–12	4	Slit	Cut to "number of hairs" (FU)
<i>Traditional slit grafts</i>				
Small slit graft	3–5	~ 2	Slit	Cut to size
Medium slit graft	5–8	~ 3	Slit	Cut to size
Large slit graft	6–12	~ 4	Slit	Cut to size
<i>Slot grafts</i>				
Small slot graft	6–8	~ 4	Slot	Cut to size
Medium slot graft	8–12	~ 6	Slot	Cut to size
Large slot graft	10–16	~ 8	Slot	Cut to size
<i>Round grafts</i>				
Small round graft	5–8	2–3	Punch	Cut to size
Medium round graft	8–14	4–5	Punch	Cut to size
Large round graft (includes "standard" punch grafts)	14–30 +	6–15 +	Punch	Cut to size

FU, follicular unit; FF, follicular family; DFU, double FU; TFU, triple FU; QFU, quadruple FU.

^a"Cut to size" indicates that the number of hairs in the graft is less important than its size and how well the graft fits into the size of the proposed recipient site.

^bCut to "number of hairs" denotes that the primary concern of the graft cutter is the number of hairs in the graft rather than its size.

readily noticed. As implied earlier, often most importantly, the more the persisting hair in the recipient area, the larger the graft can be without it being noticeable (Unger, 2004a).

"Repairs" of esthetically unsatisfactory "old" hair transplanting are sometimes treated exclusively with FU, or a combination of FU with excisions of part or all of some grafts—or completely untreated alopecic areas. But many of these patients are best treated with combinations of these techniques and larger MUG (Unger, 2004b).

Planning in Hair Transplantation

Male pattern baldness (MPB) and FPHL are progressive disorders. Planning hair transplantation should therefore *ideally* include an allowance for future areas of involvement, by extending the grafting into areas that are still hair bearing but that can be reasonably expected to lose hair in the future (Fig 1). Such an approach potentially avoids a constant and frustrating "chasing" of an enlarging alopecic area (Unger and Beehner, 2004).

Because perfect prognostication of the degree of alopecia that will develop in any patient is impossible, a re-

serve of what is expected to be a permanent hair-bearing donor area should be maintained for as long as possible. In addition, in males, the lateral borders of the transplanted area should be constructed with FU and/or DFU. Should one misjudge the ultimate limits of the MPB, the patient will thereby be left with a larger than usual, but sometimes naturally occurring, soft-bordered isolated frontal forelock (IFF). The latter, because it occurs naturally in some individuals, will appear natural standing on its own (Unger and Beehner, 2004).

Conceptually, we think of the recipient area as consisting of three areas: a frontal, mid-scalp, and vertex area. Typically, we treat only one of those areas during any given session. Transplanting the frontal, as well as mid-scalp areas—in two or more sessions—as far posteriorly as the point where the scalp changes from being more or less parallel to the ground to more or less perpendicular to it results in the individual appearing to have hair from both frontal and lateral views. This should be a minimum objective in most patients. A trial of medical treatment for MPB in the mid-scalp and vertex areas should also be encouraged before a surgical procedure is carried out, especially if there is persisting hair in these areas (Knudsen, 2004). The



Figure 1
“Before” and “After” FUT.

(a) Photograph of a patient before his first hair transplant procedure. The black crayon marks delineate the proposed areas for treatment. Note also the inclusion of lateral areas where some hair persists but can be anticipated to be lost in the future; these areas will be transplanted at the same time as the more obvious areas of alopecia are being treated. (b) This photo was taken 12 mo after the second session of follicular unit transplanting. The first session was carried out in the frontal area and the second was carried out in the mid-scalp area.

vertex area, when transplanted, is nearly always treated only with FU, primarily because of limited donor reserves in most individuals.

The Donor Area

In most patients, the first donor strip is excised from the densest areas of the permanent zone—the areas that are also least likely to be affected by future hair loss (Unger, 2004c). It is approximately 8–10 mm wide, and begins superior to the left ear and ends superior to the right ear. Donor strips for all subsequent sessions are taken such that the scar from any preceding session(s) is included in the center of the new strip. Thus, no matter how many sessions are carried out, only a single scar is ever produced.

A recent and sometimes useful innovation in harvesting donor tissue has been referred to as FU Extraction (FUE) (Rassman *et al*, 2002). A small bore trephine—usually 1 mm or less in diameter—is used to incise around an individual FU to an approximately mid-dermis level. The FU is then gently eased out of its site with a combi-



Figure 2
“Before” and “After” FU/Micro-slit grafting.

(a) A female patient before transplant. The black crayon marks delineate the area to be treated. (b) Nine months after a single session in which follicular units (FU) were used in the hairline zone and double FU (DFU) were used posterior to the hairline zone. The surgical treatment of female pattern hair loss, in appropriately selected individuals, is a worthwhile treatment to be kept in mind if medical treatment fails.

nation of traction and peripheral 27-G needle punctures intended to sever its fibrous attachments. It is an advantageous technique for special circumstances, such as in patients who are prone to develop wider than normal scars or who have such scars and for patients with tighter than average scalps. The concept, unfortunately, currently has several serious problems associated with it and therefore—despite extensive Internet hype—cannot be recommended by the author for routine use in most individuals (Unger and Cole, 2004).

Graft Preparation and Placement

One of the largest changes in the evolution to modern hair transplantation has been the large number of grafts that are characteristically transferred during each session. This has resulted in substantially more hair being transplanted per session—and other important advantages—but has also introduced a much greater potential problem of lethal follicular damage during the production and/or storage and/or placement phase of surgery.

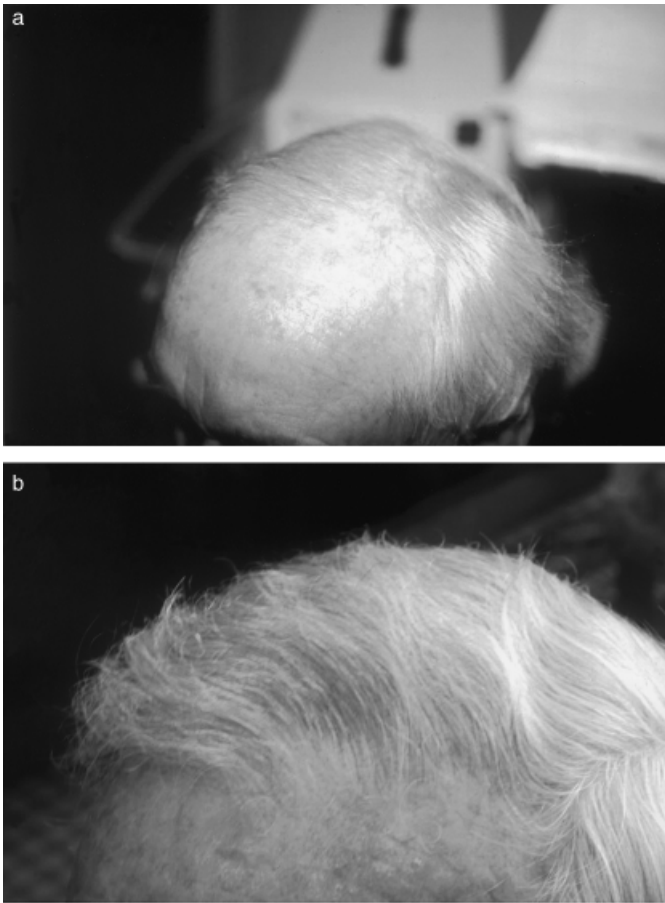


Figure 3
 “Before” and “After” FU/Micro-slit/Slot grafting.

(a) Patient before hair transplant. (b) The same patient 1 y after two sessions of hair transplanting consisting of follicular units (FU) to the hairline zone, double FU (DFU), and triple FU (TFU) posterior to the FU area and slot grafts posterior to the zone treated with DFU and TFU. This combination of grafts is particularly advantageous for Caucasians with white hair, as substantially better density can be produced with it than is possible with follicular unit transplanting (FUT) or a combination of FU and micro-slit grafts.

Space does not allow us to go into all the details of graft preparation, storage, and placement in this chapter, so the reader is referred elsewhere for this information (Rose and Shapiro, 2004). There are several aspects of current techniques that the author believes should be mentioned here:

Once the strip has been removed from the donor area, it is immediately placed in a chilled saline solution. It is then sectioned—much as one would slice a loaf of bread—into “slivers” of tissue that are 1 FU wide for FU and micro-slit

grafts, or 2 FU wide for slot grafts, or three or more FU wide for “round” grafts of various sizes. A stereomicroscope ($\times 6$ magnification) is utilized for the “slivering.” Sub-sectioning of the “slivers” can be performed using the stereomicroscope or lesser magnification, depending on the visual acuity of the technician.

The Recipient Area

FUT Whenever an area is being treated exclusively with FU, we would generally use a density of approximately 20–25 FU per cm^2 per session. Studies showing different rates of hair survival with different FU densities have indicated that when one goes beyond these FU densities, the survival rates tend to drop to what we feel are unacceptable levels (Mayer and Keene, 2004). The results of the second of two studies are summarized in Table II. Recipient sites are generally made with an 18- or 19-G needle with its sharp end bent so as to limit the depth to which it will penetrate the skin or small custom-made blades. As with all types of grafts, incisions are made at the same angle and direction as the original hair in that area.

Within the recipient area, the FU may be transplanted in somewhat greater or lesser densities per cm^2 and they are chosen specifically for the caliber and number of hairs in each of them (Shapiro, 2004). Two FU that are close enough together to fit into a single needle hole may be left as an intact unit during graft preparation in order to increase the number of grafts with four or more hairs and thereby increase the hair density in specific sites. Two individual FU may be placed in a single needle hole for the same purpose. The latter two types of grafts are, respectively, referred to as “follicular families” (FF) and “paired” FU (Harris, 2004; Shapiro, 2004).

The author believes that the recent trend of transplanting 3000 or more FU per session, by some practitioners, should be viewed with some skepticism with regard to hair survival. For example, although each 18-G needle hole may appear small, and typically produces an incision that is “only” approximately 1.2 mm long, 3000 of these incisions will produce a total of 360 cm (12 ft) of incisions in an area that is often no larger than the palm of an average man’s palm. Intuitively, such an approach, as well as FU densities of 30, 40, 50, or more per cm^2 (respectively 3.6, 4.8, and 6.0 cm of incisions in each cm^2 of recipient area) should sound alarm bells until satisfactory hair survival studies are produced by the practitioners who advocate these approaches. Complicating matters is that the advantages of high FU per cm^2 densities and large numbers of FU per session are obvious, whereas their probable cost in hair survival is invisible. For example, if 50 FU per cm^2 results in an 82% FU survival rate, as suggested by Mayer and Keene’s study (Mayer and Keene, 2004) approximately 40 FU per cm^2 will survive and grow. The results of 50 FU per cm^2 will appear to be more than twice as good as 20 FU per cm^2 (with 95% hair survival) but at the possible cost of a 15% higher rate of death of irreplaceable and limited donor hair.

Micro-slit grafting Sites for DFU, TFU, and quadruple FU are made 2–3 mm apart laterally and 1–2 mm apart

Table II. FU survival: Mayer and Keene

Number of 2-haired FU inserted	Number of new FU at 9 mo	Percent survival
20	19	95
30	23	76.7
40	28	70
50	41	82

FU, follicular unit.

antero-posteriorly (Unger, 2004d). After a single session, the total number of FU in the recipient area might be quite similar whether FUT or micro-slit grafting is used—and in most cases, FUT will look better. But the advantage of the mixture of grafts is that a second or third session of micro-slit grafting in the same area can easily double or triple the density in that area, whereas this is not possible with FUT at acceptable FU densities.

Slot grafting Slot grafts sites are spaced approximately 2–3 mm lateral to each other and 1–2 mm apart antero-posteriorly, and are usually prepared in a pattern that is three or four rows deep (Unger, 2004d). Specially, designed “slot punches” are utilized to prepare the recipient sites (Fig 3).

“Round” grafting As noted earlier, in a relatively small percentage of our patients, a hairline will be created with micrografts followed by micro-slit grafts more posteriorly and then a zone of “round” grafts approximately three to four rows deep. The round recipient sites are, in fact, oval shaped because they are cut out at an angle and direction that mimics that of the existing hair and, as implied earlier, the grafts are more square than round. Each site is created approximately one-punch diameter width apart from its neighbor in all directions (Unger, 2004d). It is important to keep in mind that whenever slot grafts or round grafts are utilized, patients are warned to return for a second session in approximately 5 mo, or the grafts may become noticeable. After two sessions of either slot grafts or round grafts in the same area, hair density is usually sufficient such that simply running your fingers through the hair makes any graft noticeability (for example, when the hair is wet and parted through the transplanted area) disappear. Sometimes, a third session is carried out in a slot-grafted area, whereas a third session is virtually always carried out in areas treated with round grafts. A minimum of 5–6 mo is recommended between sessions if they are carried out in the same area.

Conclusion

Modern techniques in hair transplantation have resulted in far more patients being eligible candidates for this type of surgery and the production of remarkably natural-looking results. Unfortunately, not all recent innovations are without likely or acceptable “costs” that may or may not be obvious. Physicians are urged to keep in mind that hair trans-

planting is an option for their male and female patients who have not responded satisfactorily to medical treatment, and for those who had cosmetically unsatisfactory earlier types of hair transplantation.

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