STATE OF THE ART SURGICAL TECHNIQUE: FOLLICULAR UNIT HAIR GRAFTING

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INTRODUCTION:

The goal in hair restoration is natural appearing results. Improvements in the field of hair transplantation have developed with this goal in mind. The most recent development is the follicular unit grafting technique, which relies upon microscopic dissection to produce grafts each containing a follicular unit, the natural bundling of 1 to 4 hairs, with a minimal amount of non-hair-bearing surrounding skin. For patients desiring surgical hair restoration, proponents of follicular unit grafting advocate the technique's superior results. Detractors point to the technical challenges of performing the procedure, with the need for a staff of trained assistants for the microscopic dissection. What is clear is that this demanding procedure is taking the field of hair restoration the closest to its ultimate goal- undetectability.

TEXT:

The earliest techniques of hair transplantation, as developed half a century ago, utilized unaesthetic plug grafts, 4 mm circles of hair-bearing scalp containing as many as 20 hairs. (1,2) Over the latter half of the 20th century, the size of the grafts became smaller and smaller, in an attempt to approximate the way hair grows naturally on the scalp. Thus, the large plug graft became the hemi-dissected semicircle graft, then onto the quarter graft, and continued to be made smaller and smaller.(3-6)

Unlike those that preceded it, the micro/minigrafting technique, popularized in the early 1990s, has come close to accomplishing the goal of undetectability.(7,8) With this technique, currently utilized by the majority of hair transplant surgeons, micrografts containing 1 or 2 hairs are placed along the hairline, while the remaining areas are transplanted with minigrafts containing 3 to 5 hairs.

Over the past several years, follicular unit grafting has emerged as the most reliable technique for natural appearing results.(9,10) The follicular unit graft consists of a single follicular unit, the way hair grows in the scalp- in tiny bundles of 1 to 4, most commonly 2 and 3 hairs. First described histologically by Headington in 1984, the follicular unit consists of these terminal hairs, surrounded by an adventitial sheath, in which is also contained the sebaceous gland elements and other supporting tissue.(11) The dissection of these individual grafts is performed under a microscope, permitting the excision of all excess non-hair bearing tissue.(12,13)

Transplanting exclusively with these follicular unit grafts theoretically creates the most natural appearing hair restoration. Of course, the follicular unit is merely the building block; a natural appearing result is attained through proper hairline design and other aesthetic considerations.

The dissection and subsequent placement of as many as 3,000 follicular units is a demanding process, utilizing a team of experienced assistants. Proponents of this procedure feel that the extra time and expense required is justified by the improved results and other several significant advantages. Microscopic dissection results in grafts that are smaller, containing a minimum of scalp skin. These grafts can be placed into smaller recipient sites, theoretically allowing for greater hair density, faster healing, and less trauma to already existing hairs in the recipient area. In addition, transplanting grafts with a smaller "cuff" of skin minimizes changes in pigmentation and texture of the recipient scalp. Microscopic dissection of the donor hairs minimizes accidental transection and subsequent demise, with studies confirming as much as a 20% increase in hair yield.(14) Finally, another advantage of microscopic visualization is the ability to accurately identify and separate grafts according to the number of hairs each one contains. Thus, when a 1 hair graft is placed along the anterior-most hairline, only 1 hair, not 2 or even 3 hairs, will grow.

SURGICAL TECHNIQUE

Pre-operative consultation is critical for educating the patient about the progressive nature of male pattern baldness, and for establishing a treatment plan. The number of grafts to be transplanted in a procedure typically ranges from 1600 to 2200, but can go higher or lower, depending upon the demand (amount of bald or thinning scalp that the patient desires to be filled) and the supply of available donor hairs. Patients are advised that, while an acceptable density can be achieved with just 1 procedure for the majority of patients, with progression of hair loss it is likely that a second procedure will be desired in the future.

Most procedures are performed under oral sedation. Hairline design, while beyond the scope of this discussion, is critical for achieving a natural result. With the patient's feedback, the future hairline is marked out; this line will serve as a template for what will be the location of the hairline, which is not a line but rather a broken, irregular transition zone. The administration of local anesthetic to the donor and recipient sites is currently facilitated by the use of The Wand®. This computer-controlled anesthetic injection system permits the administration of anesthetic agent at a slow, controlled rate that is at or just below the threshold level of sensation.

Under sterile conditions, the fusiform-shaped single donor strip is excised from the occipital scalp in the subcutaneous plane just deep to the follicles. The size of the strip is determined by the number of grafts to be transplanted. The density of hairs in the donor region of the scalp typically ranges from 70 to 120 follicular units per cm2, with a median of 80. Therefore, in the typical patient, a 20 cm2 (20 cm in length by 1 cm in width) sized donor strip would be required for a 1600 graft procedure. The donor site defect is closed primarily with a single running 3-0 Prolene suture (Ethicon, New Jersey).

A team of highly trained assistants dissects the grafts from the donor strip. Using the binocular microscope, the single strip is subdivided into thin slivers 2 to 3 follicular units wide. These individual slivers are then further dissected into individual follicular units, excising all surrounding non-hair bearing scalp tissue (see Figure 1 for illustration). The grafts are kept in chilled saline until the time of implantation, separated by hair number. The mean number of hairs per graft is 2.2 to 2.3, with most grafts containing 2 or 3 hairs.

The making of recipient sites is probably the single most important step in assuring a natural result. Critical factors include proper direction of growth, varying density of graft placement, and the irregularity of hair placement along the hairline. The surgeon must make the recipient sites keeping these variables in mind, while minimizing the transection of any existing hairs in the area. For making the recipient sites, a variety of instruments are available; the author prefers the Sharp Point® blades (Ellis Instruments, New Jersey) for their sharpness and size. The 15 degree, 22.5 degree, 30 degree, and occasionally the 45 degree Sharp Point are used for recipient sites for 1 and small 2 hair grafts, larger 2 hair grafts, 3 and small 4 hair grafts, and 4 hair grafts, respectively.

The placement of the grafts into the recipient sites is performed as atraumatically as possible. Jeweler's forceps are the ideal instrument for this purpose. Attention to details, such as using the finest single hair grafts along the front of the hairline, and inserting each graft such that any natural curvature of growth of its hair(s) complements the surgically created recipient site angle, reinforces a natural appearing result. Graft placement is the final step in the hair transplant procedure.

A procedure typically takes 4 to 6 hours to perform, depending upon the number of grafts transplanted. The patient leaves the office bandage-free, and usually returns the next day to have the hair washed. Light exercise and careful hair washing can be resumed on the third day, with full resumption of physical activity permitted at one week. Typically the tiny crusts around the grafts fall off by 7 days, and the donor site sutures are removed at 8 to 10 days.

Like with other forms of hair grafting, the transplanted hairs go through a telogen effluvium stage, falling out by the 3 weeks. As soon as 8 to 10 weeks later (if the patient applies minoxidil to the scalp post procedure), and continuing for the next 4 months, the hairs start to regrow, then continue to do so as hair does elsewhere in the scalp. If desired, a subsequent procedure can be performed as soon as 3 to 4 months later.

RESULTS

Over the past 2 ½ years, the author has performed 495 hair transplant procedures. Follicular unit grafting was the technique utilized in 94% of these cases. Of these 465 cases, 417 were performed on men, 48 on

women. The indication for treatment for the great majority of cases was pattern baldness, with all degrees of hair loss treated. Other indications included the repair of scarring and hairline distortion from prior facial plastic surgery, and trichotillomania.

The number of grafts placed in a single follicular unit grafting procedure ranged from 250 to 3,115 with the great majority of cases receiving between 1600-1800 grafts. The transplanted density approached 30-35 follicular units per cm2, with higher densities achievable, when desired, in areas where 2, 3, and 4 hair grafts were placed closer together. Determining the percentage of transplanted hairs that grew is very difficult to assess, because of the inability to distinguish transplanted from original hairs. It is the impression that this percentage increased over the first 6 months that the follicular unit grafting procedure was performed, reflecting the improvement in technique and accumulated experience of the surgeon and assistants. Currently, it can be estimated that over 90% of transplanted hairs grow.

Telogen effluvium, or the early loss of transplanted hairs, occurred in over 90% of hairs. Regrowth of the transplanted hairs occurred as soon as 8 weeks post-procedure. In almost all cases where patients applied 5% minoxidil once daily starting at 1 week post-procedure, regrowth occurred before 3 months. Most patients who did not reliably apply minoxidil post-procedure required 3 to 4 months before regrowth of hair.

Complications were minimal, and results were exceptionally rewarding. The criteria of an excellent result include both technical and artistic factors. It is the technical factors that are affected by the specific technique utilized, and therefore are the relevant factors to assess. These technical factors include: absence of recipient site skin alterations such as hypopigmentation, dimpling, and scarring; ability to reliably place 1 hair grafts along the anterior-most hairline with 2, 3, and 4 hair grafts placed progressively behind to create a subtle feathering zone; an overall natural, non-grafted appearance; and absence of donor site scarring. Based upon these criteria, excellent to outstanding results are achieved in nearly all patients. Patients are almost universally satisfied with the results of their procedure.

Complications at times did occur, but nearly all could be considered minor and usually resolved with time. These complications included: lower percentage of hair growth than expected in 7 patients, requiring the performance of an additional small procedure to replace the hairs that didn't grow; prolonged scalp erythema of longer than 3 weeks in 1 patient; superficial cellulitis in 2 patients that required a change in antibiotic but that resulted in normal hair growth; excessive "shock" to the original existing hairs in 2 patients, leaving them somewhat thinner for the first 6 to 10 weeks until these hairs started to regrow, and in all cases resulting in a return to full density; and 1 case of partial thickness skin breakdown of less than 4 cm in diameter in the anterior central forelock region after a procedure of 3115 grafts performed in an active cigarette smoker which was subsequently treated with a scar repair and further grafting.

CASE EXAMPLES

Patient 1: 34 y.o. male, with Class 4 Hamilton-Norwood hair loss. Treated with a single procedure of 2200 follicular unit grafts.

Patient 2: 54 y.o. male, with Class 6 hair loss. Treated with a single procedure of 2300 follicular unit grafts.

COMMENT

Follicular unit grafting is an enormously satisfying procedure to perform, with high patient satisfaction and very acceptable results. From a technical perspective, the procedure requires a highly motivated team of assistants, capable of dissecting grafts under a microscope for prolonged periods of time. Switching from traditional micro/minigrafting to the follicular unit grafting required adding 3 assistants to the original 3 that had been sufficient to perform cases without microscopic dissection. Training of these new assistants was facilitated by the use of the microscope because it is easier to visualize the individual follicular units, an observation made by others as well.(14)

With experience and the feedback provided by follow-up of patients, refinements in technique have been made. Extensive dissection of all surrounding non-hair bearing skin has been reduced. By including a slightly larger cuff of tissue around the follicles, hair growth seems to have improved. This is likely due to the greater protection of the follicle from damage from dessication and trauma during the planting the graft. Dessication appears to be the greatest enemy to graft survival, and numerous precautions are taken to

prevent it. The most important step is storing grafts in chilled saline from the time of donor site harvest to implantation. To further assure good hair growth, saline rather than hydrogen peroxide is used to clean the scalp of blood and other debris during the procedure.

Several steps help to minimize scarring in both the donor and recipient site regions. Donor site scarring (width of scar greater than 3 mm) is avoided by suturing under minimal tension with a running 3-0 Prolene placed superficial to the follicles. Keeping the donor strip no wider than 10 to 12 mm minimizes closure tension; the strip can always be made longer to obtain the greatest number of grafts. In addition, a donor site location at or cephalad to the plane along the top of the ears reduces the risk of wide scar formation by avoiding the action of the occipitalis muscle on the healing wound edges.. Hypopigmentation and scarring of the recipient site region is avoided by minimizing the amount of skin around the grafts, but does not prevent the maintaining of a small cuff of subcutaneous fat to improve graft viability, as discussed above. Dimpling of the skin around transplanted grafts is prevented by inserting the grafts to a depth such that its skin is sitting just above, and not flat or below, the surface of the surrounding skin.

The advantages of follicular unit grafting are many. The most important is the natural appearing results with an absence of scalp scarring. Graft yield is significantly increased, while trauma to already existing hairs in areas being transplanted is reduced by the smaller recipient sites that are needed for the smaller grafts. Other advantages of smaller grafts include the more rapid healing, and the ability to place grafts closer together.

Another particular advantage of follicular unit grafting is that the technique does not commit the patient to subsequent procedures in the future, unless further density and/or more extensive coverage is desired. The natural but thin look achieved after just one procedure will be adequate for a large percentage of patients. This makes the procedure ideal for all degrees of hair loss, from early thinning to advanced hair loss, where only a forelock is to be transplanted.(15)

The indications for follicular unit grafting are many, and in the author's opinion, it is the procedure of choice for over 90% of cases. However, there are exceptions when follicular unit grafting may not be better than, and maybe less effective than micro/minigrafting. Individuals with gray, white, blonde, or salt and pepper colored hair are usually best treated with larger minigrafts containing 2-5 hairs. In these cases, the final result is every bit as natural in appearance, and there is less risk of accidental transection of the hairs (which are very difficult to visualize) during the graft dissection process. Women are often best treated with follicular unit grafting, but sometimes larger grafts containing 3-6 hairs are transplanted well behind the hairline to maximally increase density. Finally, in revision cases where large (4-10 hairs) and even very large (10-20 hairs) grafts were previously placed, individual follicular unit grafts are usually needed only along the anterior-most hairline, with minigrafts more effective for filling in the areas between the large and very large grafts. In all of the above examples, the microscope is still used for graft dissection, helping to minimize hair transaction and assuring the highest yield of hair growth.

Practicing in Miami, large minorities of the patients for hair transplantation are of Hispanic or Mediterranean origin. Like Asians, these ethnic groups tend to have darker hairs, and the diameter of these hairs tends to be higher, making it more challenging to obtain a natural appearing result. These individuals with darker, thicker hairs probably benefit the most from follicular unit grafting.

As with any plastic surgery procedure, the minimizing of complications and/or less than excellent results is essential. With growing experience, the author now avoids performing cases of greater than 2400 to 2500 grafts, because of the small but real risk of poor hair growth and/or compromised healing. Working as a team with a combined experience of over 40 years of hair transplantation, consistently excellent results are now attainable.

CONCLUSIONS

The author's initial 2 ½ year experience with follicular unit grafting has proven the technique to be worth the additional labor, effort, and expense needed to perform it properly. For the great majority of individuals looking for the most natural appearing results, follicular unit grafting is the procedure of choice.

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FIGURES

Figure 1. Illustration of the follicular unit grafting procedure. A single donor strip is subdivided into "slivers" 1 and 2 follicular units wide, which are then dissected into individual follicular unit grafts containing 1, 2, and 3 (and the occasional 4) hairs. All dissection is performed under binocular microscopes.

Figure 2. Patient No. 1. Before (a, b) and 8 months after (c, d) 2200 grafts.

Figure 3. Patient No. 2. Before (a, b, c) and 6 months after (d, e, f) 2300 grafts.