ORIGINAL ARTICLE

Estimating the Number of Lifetime Follicular Units: A Survey and Comments of Experienced Hair Transplant Surgeons

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BACKGROUND Quantitative estimates of the yield of follicular units (FUs) containing likely "permanent" hair for hair transplanting have been only theoretically estimated.

OBJECTIVE To clarify the number of likely permanent hair follicles in potential donor areas.

METHODS AND MATERIALS Thirty-nine highly experienced surgeons were surveyed and estimated the number of FUs containing "permanent" hair in hypothetical 30-year-old male patients with varying hair densities and destined to develop Type V or VI male pattern baldness (MPB).

RESULTS Patients with average hair density and destined to develop Type V MPB were estimated to yield an average of 6,404 FUs, 4,963 FUs with below average density, and 7,904 FUs with above-average density. When Type VI MPB is anticipated, estimated mean harvest yields are 5,393 FUs with average density, 4,204 FUs with below-average density, and 6,661 FUs with above-average density.

CONCLUSION There are a finite number of FUs containing permanent hairs in any patient. The results of this survey provide a guideline that should be helpful in avoiding inappropriately aggressive goals such as creating overly dense or overly anterior frontal and temporal hairlines without regard for a cautious evaluation of the limitations of likely long-term donor/recipient area ratios. We present useful guideline numbers that can help physicians choose appropriate surgical goals.

[Correction added after online publication 7-Jan-2013: the number of surgeons in the methods section was updated.]

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This article is intended to be a cautionary tale. Despite extraordinary improvements in hair restoration surgery (HRS) over the last 20 years, the ethical foundation and the importance of sound medical judgment when approaching a young patient should still be based on reasonable worst-case scenarios rather than best ones. Unfortunately, the aforementioned improvements have encouraged a dramatically changed paradigm of marketing in which there is an increasing emphasis on satisfying young patients' goals. The latter should be, but are not, tempered by an awareness of the likely long-term consequences of the choices being made–especially with regard to appropriate limitations imposed by the finite supply of "permanent" donor area hair. To help clarify those limits, we conducted a survey and tabulated the answers of 39 of some of the world's most experienced practitioners of HRS, with a collective personal experience of more than 900 years. (See Appendix 1 for a list of practitioners.) A review of other aspects of donor area harvesting has been added to elaborate on optimal long-term donor area management.

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The Survey

The experts were asked the following questions:

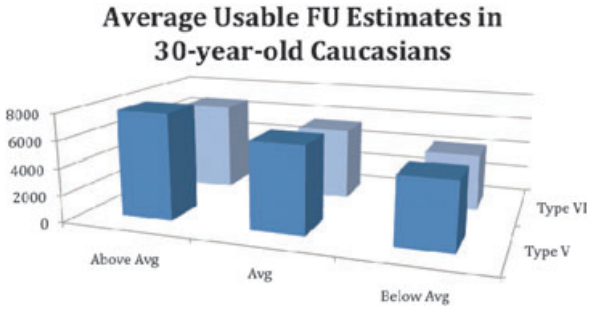
Keeping in mind that over the years the hairs closest to the upper, lower, and anterior borders of the fringe will be lost, how many follicular units (FUs) containing very likely permanent hairs can be harvested from:

a) a 30-year-old patient who you believe is destined to develop Type V male pattern baldness (MPB) and has:
   1) higher than average donor area hair density?
   2) average hair density?
   3) less than average hair density?
b) Same questions, but for a patient who you believe is destined to evolve to Type VI MPB.

The statistics generated from this survey (Figure 1) helped us to establish guidelines for approaching a young Caucasian male patient with various degrees of hair loss, rather than imposing scientifically valid and dogmatic rules for all physicians and patients. In particular, even in the published reports that might be used to help define average hair density, significant variation exists. (Limmer finds an average of 90 FUs/cm^2, Headington 100 FUs/cm^2, and Jimenez 75 FUs/cm^2), most likely because of discrepancies in enumeration methodology, scalp location of measurements (unlike HRS donor areas, often limited to the occipital area), and racial differences in patient populations studied.[1–3] Even within the Caucasian population, deviations in FUs and hair density occur in individuals with different hair colors and calibers and at different levels in the fringe hair. Despite the absence of a universal numerical definition of average hair density, we believe the results of the survey are meaningful, coming from the combined experience and wisdom of the respondents, to whose discretion the determination of average hair density was left. At the minimum, if your forecasted number of FUs containing permanent hairs in patients with the characteristics noted in the survey questions exceeds the reported ranges, it would be wise at least to reconsider your estimates.

Results

On average, our respondents believed that donor areas containing average hair density would typically yield approximately 6,404 "safe" FUs when the forecast was for the patient to develop a Type V pattern and 5,393 "safe" FU with a Type VI pattern. It was believed that above-average hair density in the presenting donor areas would probably yield an average of 7,904 (Type V) or 6,661 (Type VI) "safe"



	Above Avg Density	Avg Density	Below Avg Density
Type V	7904 (3,000-12,000)	6404 (2,000-10,000)	4963 (1,000-9,000)
Type VI	6661 (2,000-10,000)	5393 (1,250-9,000)	4204 (500-8,000)

Numbers represent mean of each category with range in parentheses

Figure 1. Average usable follicular unit (FU) estimates in 30-year-old Caucasian men.

FUs. Below-average hair densities would probably provide a patient with only 4,963 FUs (Type V) or 4,204 FUs (Type VI) throughout his lifetime. Despite Types V and VI Hamilton/Norwood MPB differing primarily in the presence or absence of a "bridge" of hair traversing the midscalp, only eight of the 39 respondents felt that the yield of FUs containing "permanent" hair follicles would be the same with either pattern of future hair loss. The majority of physicians surveyed apparently felt that the Type VI pattern would provide fewer such FUs over the course of a patient's lifetime because of commonly lower fringe hair density in patients with Type VI than in those with Type V.

Discussion

One of the authors (WU) has published and spoken extensively on the acceptability of some young patients for HRS, adding always that appropriate long-term planning is necessary in such instances.[4] He especially advised against using higher graft densities than 30 FUs/cm^2 and creating overly youthful anterior hairlines because those mild restrictions produce "economic" graft consumption and because 25–30 FUs/cm^2 and more-mature hairlines can be expected to produce substantial cosmetic improvements in most patients if the surgical technique employed produces good hair survival (Figure 2). He thought that it would be a rare practitioner of HRS who would inappropriately exceed those recommendations, and if he or she did so, they would quickly realize their error and change their approach in future patients. He was wrong. Instead, in this era of the Internet, more young men are being encouraged to recreate the low hairlines of their teenage years and to re-establish the hair density of their youth without regard for a cautious evaluation of the limitations of their likely long-term donor:recipient ratios. Too many physicians striving to build a following, sponsor websites or establish blogs that strongly advocate dense hairlines and temporal "peaks" that are advanced aggressively and in which 2,500–

Figure 2. (A) The recipient area is outlined with a grease pencil and then (B) prepared with Betadine solution to reveal the true extent of hair loss in the frontal and midscalp areas of the patient. (C) A photograph taken 12 months after the second of two sessions; the first to the frontal area and the second to the midscalp area. A total of 4,244 FUs had been transplanted at 25 FUs/cm^2. The hair has been parted through the frontal area and combed back for critical evaluation. (D) A photograph taken 5 years after the preoperative photographs with the hair parted in the midline for critical evaluation. Hair density has decreased slightly, in pace with some hair loss in the donor area from which grafts were taken and loss of any preexisting hair in the recipient area before transplanting. Nevertheless, good hair density persists in this young man.

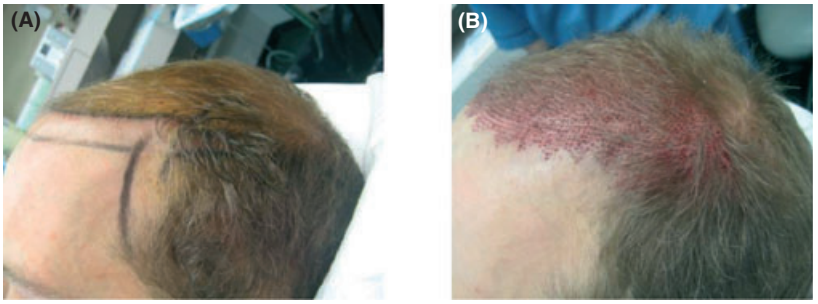


Figure 3. (A) A grease pencil was used to outline two hairline options. The more-anterior option was what the patient wanted and had seen on the web sites of several practitioners of hair replacement surgery. After an explanation as to the number of follicular units (FUs) with likely permanent hair in them and the likely eventual severity and extent of male pattern baldness he should expect to develop over his lifetime, he wisely chose the more-superior hairline and a density of 30 FUs/cm^2. (B) The intraoperative photograph clarifies what was treated with 2,568 FU. That number of grafts, used at the same FU density, would have been necessary to transplant only the area between the two proposed hairlines if the more inferior hairline shown in (A) had been chosen. Transplanting has included lateral hair-bearing areas that were expected to eventually lose original hair.[4]

4,000 FUs are concentrated solely within an anterior recipient area fringe (Figure 3). Although the short-term improvement can be remarkable and therefore can encourage eager young patients to follow suit, for many young men, the long-term consequences in the donor and recipient areas will eventually be shocking because of the unforgiving progression of hair loss throughout the scalp. Nobody is more aware of these consequences than those who have been transplanting hair for 2 decades or more. They learned their lessons the hard way, with the gradual exposure of punch graft scars in donor areas whose hair eventually was lost or became sparse enough to reveal those scars with the hair wet or even dry. The total loss of transplanted hair that had been removed from donor areas that eventually became alopecic was less common but even more problematic when it occurred. In brief, what initially looked wonderful became increasingly more dreadful with the passage of time, and experienced practitioners of HRS learnt that the great determiner should not be what we *can* do but what we *should* do with the limited number of FUs with permanent hair that every patient has.

More than 20 years ago, one of the authors (WU) began noticing the early signs of those potential problems in patients he was seeing in consultation for repair work, as well as in a few of his earliest patients. As a consequence, he undertook a study involving 328 men aged 65 and older. He looked for areas within their persisting fringe hair that contained eight or more hairs/4-mm-diameter circle. From his findings, he constructed a safe donor area (SDA), within whose borders more hairs would be more likely to persist than in those areas outside of it in 80% of men aged 65–80[5] (Figure 4A). Because hair loss in MPB progresses centripetally from the superior, inferior, and anterior borders of the fringe hair, by implication, hairs closest to the borders were the least likely to persist for the patient's lifetime, whereas those within the densest hair in the SDA were more likely to persist. Later, he (and others) began recommending not only that the first donor area strip be taken from the densest hair-bearing fringe area, but also that any subsequent strip(s) include the scar from any prior donor area harvest(s) to obtain the hairs that were most likely to survive for the patient's lifetime from each harvest.[6] That approach also results in only one donor area scar, running through the densest fringe hair, regardless of the number of sessions. For example, three strips that are an average of 10 mm wide and that are harvested that way would consume only a 30-mm-wide zone in the middle of the SDA—that is 70 mm wide in the occipital area and 80 mm wide in the parietal areas.[5] Thus, a large margin of safety would be present within the SDA if the

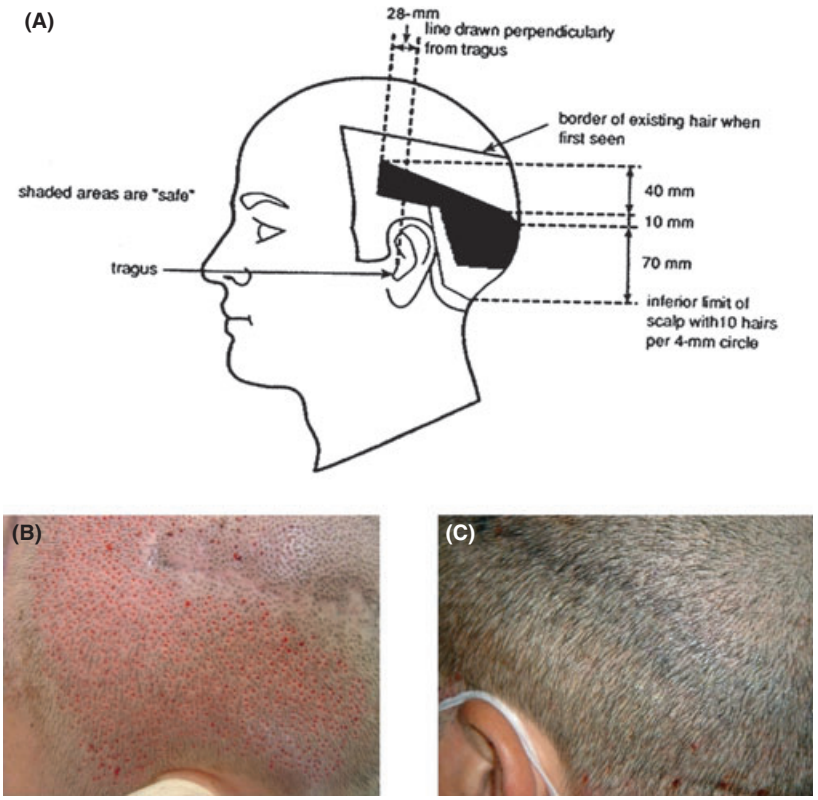


Figure 4. (A) A schematic of the safe donor area (SDA) for 80% of patients younger than 80, as determined from a study of 328 men aged 65 and older. The height of the SDA is 70 mm in the occipital region, 80 mm (70 + 10 mm) in the parietal region, and 50 mm (40 + 10 mm) in the temporal region.[5] (B) An intraoperative photograph of FU extraction (FUE) performed by another surgeon to treat areas of male pattern baldness, as well as to camouflage a wider-than-usual donor scar. FUE would typically be performed or planned for after the last hair transplant for the latter purpose. The small red dots are the donor sites after the grafts were extracted. (C) Nine months after the FUE. Grafts were inserted into the scar, which is now cosmetically insignificant.

individual were destined to have a narrower SDA than the 80% of patients suggested by the above-noted study. Additionally, it is not simply the size of the SDA, but also the gradually decreasing caliber and number of hairs even within that area (and indeed the entire area of fringe hair) that is important in long-term HRS planning; hence the "added value" of the survey results presented in this article.

One further matter deserves comment: Nearly all of the data from the survey were obtained from HRS who, for the most part, harvested FUs using elliptical strip excisions, although a few of them included additional FUs obtained from a subsequent FU extraction (FUE) procedure. (These latter estimations did not result in any marked diversion of yields from those who performed exclusive strip harvests.) An alternative school of thought is that FUE harvesting may somewhat expand the useful donor area because all of the hairs peripheral to the borders of the SDA are not going to be lost. For example, after the central region within the SDA has been maximally harvested using FUE or a strip technique, FUE might be used to "cherry pick" the two- or three-hair FUs that exist throughout the remainder of the fringe hair. The rationale of the "cherry picking" relates to the general belief (albeit never scientifically validated) that, in advancing MPB, three-hair FUs first become two-hair FUs and then 1-hair FUs before being miniaturized to cosmetic insignificance.

The obvious caveats to this "fringe of the fringe" harvest are ultimately increased sparseness of persisting peripheral fringe hair because of the removal of the two- to three-hair FUs that would have provided more hair density if they had not been harvested, punctate scars left by the FUE that may become exposed if hair surrounding those FUs is subsequently lost, and possibly greater rates of nonpermanent transplanted hair obtained from these peripheral regions. Notwithstanding those possible downsides, the authors believe that this combination of strip and FUE has a future with regard to increasing total "safe" FUs and hair numbers. FUE could also be used for a last session to put FUs into any wider-than-usual strip scars that occur in a small percentage of patients, rendering it cosmetically inconsequential (Figure 4B, C).

Conclusion

Just as the SDA represents a generality that cannot be reliably depended upon for any particular individual, data from this survey are not applicable to every young patient presenting for HRS. Nevertheless, this article will remind readers of the SDA while at the same time also adding new data from a survey of experts that reflects the consequences of the expected loss of some hairs within its borders, as well as outside of them. It is therefore hoped that it will encourage a reduction of inappropriate promotion of teenage-level hairlines and densely packed frontal areas that can result in a ticking aesthetic time-bomb for patients and a medicolegal time-bomb for some of the promoters of those objectives.

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Appendix I

List of Practioners

Beehner, M., Cooley, J., Cotterill, P., Eisenberg, E., Elliott, V., Epstein, E., Farjo, B., Farjo, N., Gandelman, M., Gillespie, J., Haber, R., Harris, J., Hasson, V., Hwang, S., Jimenez, F., Kabaker, S., Keene, S., Knudsen, R., Limmer, B., Mangubat, A., Marzola, M., Martinick, J., McAndrews, P., Mayer, M., Nusbaum, B., Parsley, W., Pathomvanich, D., Perez-Meza, D., Pitchon, M., Puig, C., Rassman, W., Reed, W., Rose, P., Shapiro, R., Tycosinski, A., Unger, R., Unger, W., Vogel, J., Wong, J.

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