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2006 Annual Meeting
 Call for Abstracts
 Deadline:
 February 10, 2006

New Instrumentation for Three-Step Follicular Unit Extraction

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When we published the technique of follicular unit extraction (FUE) in 2002, Dr. Rassman and I described a 2-step process for this new hair transplant procedure.¹ The first step was to use a sharp, circular instrument to separate the follicular units from the surrounding tissue and then to remove them from the scalp using fine forceps. The success of the hair restoration varied from patient to patient, so we developed a simple test (the FOX Test) to see which patients were good candidates for this type of procedure. Hair transplant patients that were FOX 1 had virtually no transection (damage) to follicles during their removal and those with worse FOX ratings exhibited more transection, with FOX 5 patients having excessive damage during the extraction.^{1,2}

The 3-step technique for FUE is based upon Dr. Harris's concept of using a blunt instrument to prevent damage to follicles during the process of separating the follicular unit from the surrounding donor tissue. The three steps are:

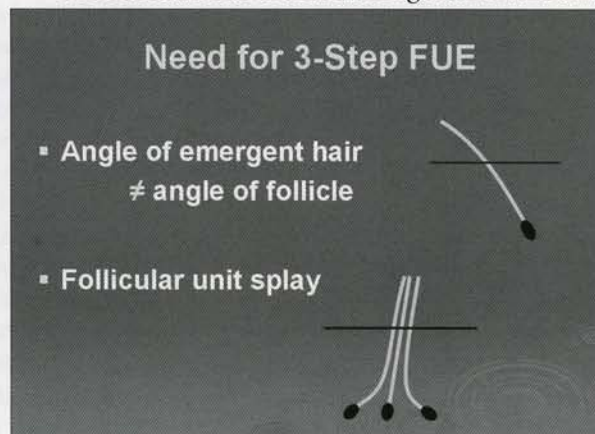
1. Scoring: Using a sharp punch
2. Blunt dissection: Using a dull instrument
3. Extraction: Using fine forceps^{3,4}

The 3-step procedure decreased the amount of transection in virtually all hair restoration patients and thus enabled a greater number to be classified as FOX 1. However, the 3-step procedure introduced a new problem with FUE, that of buried grafts.⁴

Why Use a 3-Step Technique?

The need for the 3-step procedure has two basic anatomic underpinnings (Figure 1). The first is that the angle of the hair that sticks out above the surface of the skin is not the same as the angle of the hair follicle below the skin's surface. In addition, the angles differ from follicle to follicle. Therefore, it is literally impossible to exactly align the cutting instrument with the hair follicle as it passes into the depths of the dermis.

The second issue is that although the follicles in the follicular units are gathered or grouped



on the surface (Figure 2) and in the mid-dermis (Figure 3), as they sit deeper into the skin they spread outward so that by the time they enter the subcutaneous fat they have become random (Figure 4). Therefore, a cutting instrument that easily fits around the follicular unit on the surface of the skin (Figure 2) will cut the root of the follicles as it passes into the fat (Figure 4).

A solution to the problem is to use an instrument that would pass around the follicular units and essentially gather up the follicular bulbs that are spread out

Figure 1. The anatomic features of the follicular unit that make blunt dissection important.

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Three-Step FUE

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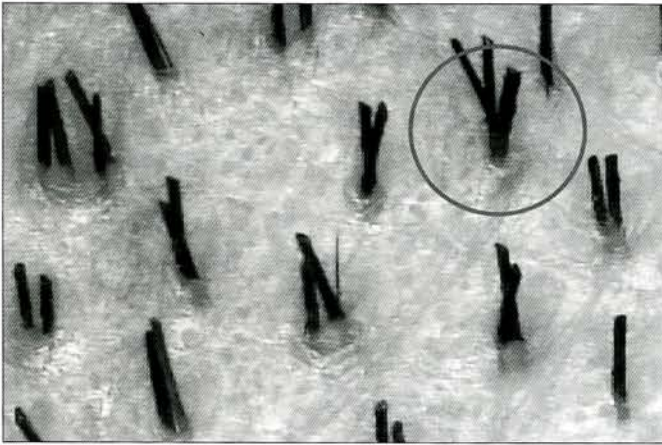


Figure 2. Follicular units well demarcated on the surface of the scalp.

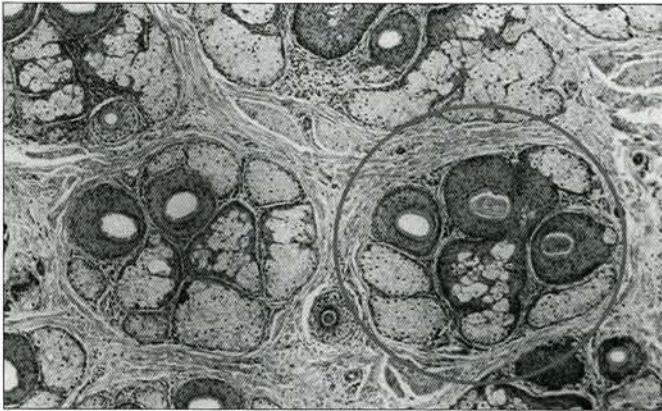


Figure 3. The punch fitting neatly around a 3-hair follicular unit at the level of the mid-dermis.

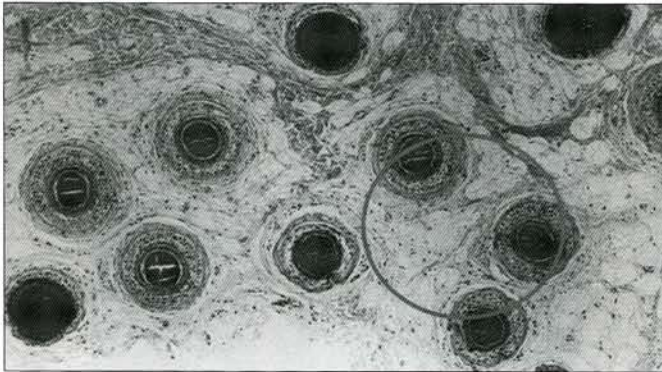


Figure 4. The punch transecting the bulbs of the follicles in the fat.

in the fat.³ We used a prototype instrument that could be used for the blunt dissection step, and we examined 40 hair transplant patients in our study to confirm this hypothesis. We looked at 20 grafts extracted from the donor area of each patient. One side was done with 2-step FUE and the opposite side with 3-step FUE. Using a stereo-microscope at 10x, we evaluated the size of the follicular units and the amount of follicles lost through transection.

In interpreting the results, one first needs to define a few terms. The *graft yield* is simply the number of grafts obtained versus the number of attempted extractions. This is actually a deceptive number because if you extract only one hair from a multi-haired follicular unit that would still be called a graft (this convention is used by many hair trans-

plant doctors performing FUE). What is more valuable information is *hair yield*. The hair yield is the number of intact hairs obtained versus the total number of hairs in the follicular unit that one is attempting to extract (Figure 5).

As an example, in a case where only one intact hair was obtained from a 3-hair follicular unit, the graft yield would be 100%, whereas the hair yield (which is really the more important measurement) would be only 33%.

The results of this study showed that for the 2-step technique the graft yield was reasonable, 92%, but the hair yield was only 74%. With the 3-step procedure, it was 98% and 93%, respectively, so there was a really significant improvement with the 3-step technique in maintaining intact hair follicles (Figure 6).

Although this 3-step procedure is superior to a 2-step procedure in avoiding follicular transection and in preserving follicular units, there was a greater incidence of buried grafts.

Validation of 3-Step FUE

Calculations

- Graft Yield = $\frac{\# \text{ grafts}}{\# \text{ extractions}}$
- Hair Yield = $\frac{\# \text{ intact hairs obtained}}{\text{total hairs in FU}}$

GY = 100%
HY = 33.3%

Figure 5. Defining graft yield and hair yield to accurately communicate the results of FUE.

Results of 3-Step FUE Validation

	2-Step	3-Step	Δ
Graft Yield	92%	98%	+6%
Hair Yield	74%	93%	+19%

Figure 6. Results of the study used to validate the advantages of 3-Step FUE.

Buried Grafts

Buried grafts occur when grafts are inadvertently pushed into the subcutaneous tissue during FUE. These grafts can be left alone, but they may develop into cysts that would eventually need to be removed. If they're not completely buried, the grafts can sometimes be extracted using a small instrument called a Schamberg extractor (the instrument used by Dermatologists to remove blackheads). In the more common situation, you must extend the incision slightly so that the buried graft can be grasped with forceps. We use a No. 11 scalpel blade for the incision. Removing buried grafts, although not difficult, is extremely time-consuming. If one has a buried graft rate over a frac-

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Three-Step FUE

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tion of a percent, it becomes a significant logistical problem for the hair transplant surgery.

The incidence of buried grafts can be reduced by avoiding the nuchal area (the lower part of the scalp) where the angle of the hair is very acute and the skin has more resistance to the punch. Another trick is to clip the hair very short (less than 1mm) before extracting, as a trapped hair will push the graft deeper into the scalp. One can also make the sharp cut slightly deeper and the dull dissection more superficial. On occasion, changing the angle of both the sharp and/or blunt instrument can minimize the incidence of buried grafts. Reverting back to a 2-step procedure works well in select hair transplant patients, particularly those with very coarse hair. Finally, you can optimize the blunt-tip design.

New Instrument Design

We looked at a number of different designs for the blunt-edged instrument. The first design we tried was a beveled edge. When beveling the edge inward, we found that the constricting lumen pushes down on the graft, so this clearly was not the answer. We tried placing the bevel on the outside surface, but the width of the wall was a problem with this configuration as well.

Going back to basics, we tried a more simple design: a cylindrical tube. It was easy to make, the edge didn't wear down, and it was reusable. The problem with a cylinder, however, was that the flat edge also pushed the grafts into the subcutaneous space. We tried to vary the wall thickness with the idea that if the wall of a simple cylinder was thin enough, it could dissect the follicular unit from the surrounding tissue without pushing the grafts into the fat. The problem was that these instruments were too fragile.

We added a bull nose edge to one end of the cylinder with the idea that a rounded edge would make blunt dissection possible without the necessity of having to make the wall too thin. We used two techniques to create this rounded edge. One was an acid bevel (also called electro-polish), which made only a minor modification to the edge. The second was the more conventional mechanical grind and polish. This turned out to be the technique of choice for the manufacturing of the tool.

The next step was to try to determine the appropriate internal and external diameter. We used a 1mm Miltex punch for the scoring step (the 1mm Miltex punch is actually a 0.9mm outside diameter punch). For the blunt dissection phase, we found that a larger punch would fit into the opening of the scored area, since the skin that was separated from the graft stretched to make the hole slightly wider.

We found an internal diameter of 1.37mm to be optimal for the blunt instrument, as this fit nicely around the top of the scored follicular unit and could accommodate units of up to 4 hairs. With an outside diameter of 1.5mm, the instrument would have a wall width of 0.064mm (2.5 thousandths of an inch), which was thick enough to give the instrument stability, yet still small enough to fit into the wound (Figures 7 and 8).

We inserted the notched end into a Versi handle with about 7mm of the blunt-tipped end exposed (Figure 9). One

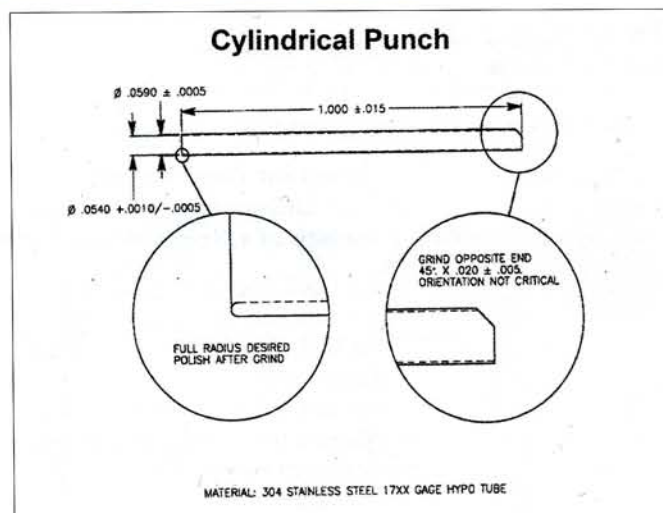


Figure 7. The specifications of the Cylindrical Punch.

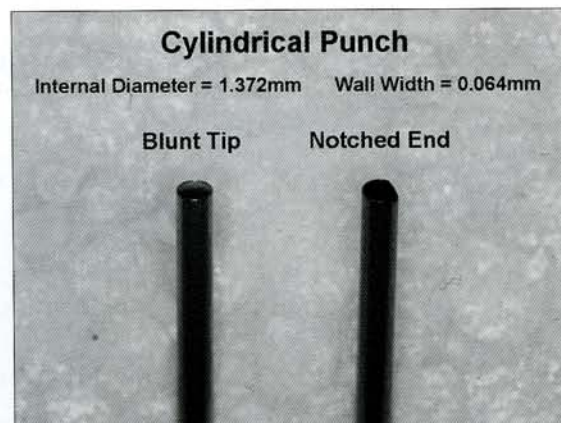


Figure 8. Detail of the two ends of the Cylindrical Punch.

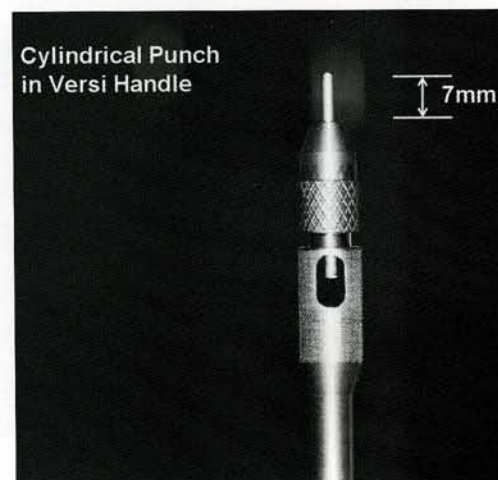


Figure 9. Cylindrical Punch in Versi handle.

can shorten this end to 4mm or 5mm and use the handle as a "stop," that is, a depth control, but it makes it slightly more difficult to control the angle.

We found that the incidence of buried grafts decreased significantly with the new instrument—from about 9% to 1.8% with the new device. However, we still found significant variability between hair restoration patients, making pre-procedure testing (FOX Test) still useful.

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Three-Step FUE

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Conclusion

Performing FUE with a 3-step technique allows the hair restoration surgeon to minimize follicular transection and keep follicular units intact. A disadvantage of the 3-step technique over a 2-step process is the increased incidence of buried grafts. This can be reduced by modifying extraction technique and using an instrument that is specifically designed to facilitate the blunt-dissection step of the process. The 3-step technique, using customized instrumentation to avoid transection, is just one more step in the evolution and refinement of FUE. ✧

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