

FUE Research Committee Chair's Message

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FUE hair transplant surgery has gained popularity in the last few years among hair transplant patients and surgeons. We have been witnessing the emergence of many new techniques and devices which many claim can improve the quality and feasibility of FUE hair transplant procedures. The ISHRS has established its FUE Research Committee to find answers to the most critical questions regarding FUE transplantation, such as: How does FUE compare to other hair transplant procedures? What is the short- and long-term destiny of these grafts that look different from what we used to see? What happens to transected follicles? What are the best techniques of performing FUE procedures that guarantee the optimum results? Although these questions are quite familiar to us as we deal with them on a daily basis, their answers have been lacking in substance due to insufficient scientific data.

In this issue, I would like to present the first of two parts of the fine work of our FUE Terminology Subcommittee whose primary goal is to have a standardized language related to FUE transplantation. This facilitates the investigators in different centers to communicate more efficiently. The members of the FUE Terminology Subcommittee include Drs. Jose Lorenzo (Chair), John Cole, Jean Devroye, and Robert True. The document that is being presented to you is the result of many hours of hard work of the Terminology Subcommittee. It has been presented, speculated, and re-examined by the entire FUE Research Committee before its final draft.

This article is unique in its kind, but we believe it is not perfect. We invite the leaders in the field, and all surgeons who perform FUE on a regular basis, to help improve it. If you have any comments or suggestions about any of the items in the article, you can contact directly the Chair of FUE Terminology subcommittee, Dr. Jose Lorenzo, at joselorenzo@injertocapilar.com.

Standardization of the terminology used in FUE: part I

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Anatomy

The definition of follicular units, according to Headington (1984), is:

*"The follicular unit (FU) of the adult human scalp usually consists of two to four terminal follicles and one or rarely two vellus follicles, the associated sebaceous lobules, and the insertions of the arrector pili muscles of the terminal follicles. At superficial dermal levels follicular canals may or may not join each other, although it is common to find two or three hair shafts within a single canal at the level of the infundibulum. The vellus follicle of the follicular units may remain separate or may be joined to the confluent infundibula of the terminal follicles."*¹

Follicular Group, Follicular Family, Follicular Cluster, or Follicular Bundle (Figure 1): These are defined as clusters of hair in the scalp that exit the skin in close proximity to each other and are separated by a gap from other clusters of hair. The follicular group may consist of more than one follicular unit in a tightly packed distribution on the surface of the skin. In complex donor areas consisting of multiple large bundles or closely aligned bundles, the number of separate bundles obscures individual interpretation and leads to variable individual assessment.



Figure 1. Follicular family.

Sub-Follicular Group Graft: This is a graft extracted from a follicular group where a portion of the follicular group remains in the donor area.

CTS: connective tissue sheath

ORS: outer root sheath

IRS: inner root sheath

DP: dermal papilla

Splay (Figure 2): This describes divergence of follicles from one another, typically occurring at the lower one-third of the follicular unit. The degree of splay is widely varied from no splay to substantial splay. Splay may involve one follicle within a group or all follicles within a group.



Figure 2. Splay.

Anchor System of the Follicular

Units: This defines the structures that impede the extraction of the follicular group from the surrounding tissue. The follicular adherence includes the sebaceous gland, and the insertion of the arrector pili muscle, the attachment of the dermis, and the connections between the CTS and the surrounding adipose tissue.

Tethering: This is the term to describe the attachment of the connective tissue sheath and outer root sheath to the surrounding adipose of a follicle. In most individuals, the strength of this attachment is very weak, so we can extract the graft once we cut the superior anchor system, but in others, it is quite strong, requiring more tension during extraction.

Hypopigmentation: This is the name given to the loss of skin color caused by loss of melanin, loss of the hue from individual follicles, and the loss of circulation from the skin surface during the healing process. Following the harvesting process from the scalp or body, the extraction sites often heal by secondary intention. The surface area of hypopigmentation (commonly named white dots) can be extremely variable depending on different factors, such as skin or hair color, and the tools used for the extraction. Based on experience, hypopigmentation is more common in the inferior part of the donor area of the scalp, chest, and abdomen, and less noticeable on the traditional recipient area of the balding scalp, legs, and beard.

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Figure 3. Capping.



Figure 4. Small cap of tissue obtained.

Transection

Capping or Topping (Figures 3 and 4): This occurs when, after incising a targeted graft and attempting to remove it with the forceps, we obtain a small cap or top of tissue (epidermis and dermis) with no terminal hair follicles, which remain in the donor site. In most cases, this is due to not having achieved sufficient depth with the punch to liberate the graft. In other instances, this may occur when sub-optimal force, or when improper forceps placement is applied to the graft during the extraction process. On occasion, a telogen or vellus hair may be removed within the cap during this process.

Pluck (Figure 5): This is one or more than one terminal hairs removed by pulling out a follicular group with a forceps with the aim of the removal of viable follicles from the donor area that can be inserted in the recipient area. A pluck could comprise one or more naked follicles devoid of all components of the connective tissue sheath (CTS), outer root sheath (ORS), and inner root sheath (IRS) and dermal papilla (DP), or a fraction of the CTS, ORS, and IRS. In some instances, only the IRS remains. Generally, when the distal portion of the ORS is left in the donor area as a result of a pluck, the DP also remains in the donor area.



Figure 5. Pluck hair.

Broken or Fractured Follicle(s) (Figure 6): The broken or fractured follicle(s), as opposed to transection, retains both ends of the hair with a separation of a follicle into two, or more, pieces due to stress at some point along the length of the follicle.



Figure 6. Broken follicle.

Paring or De-Sheathing (Figure 7): These are grafts where the CTS, ORS, and perhaps the IRS are slashed in a longitudinal fashion by the cutting edge of a sharp punch.



Figure 7. Paring.

Splitting (Figure 8): This is the action of separating with the punch *in vivo* (or *in situ*) a portion of the follicles from a group (follicular family or follicular unit). The extracted graft will contain fewer follicles than are in the group. Splitting can be produced deliberately or unintentionally

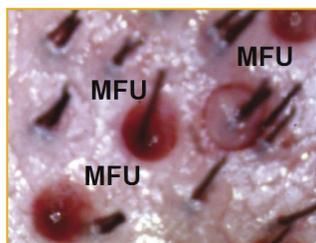


Figure 8. Splitting from a follicular family.

Partial Follicular Family Harvesting (Figure 9): This involves the entire process of harvesting (i.e., splitting and then extracting) a fraction of a follicular unit such that one portion of the follicular unit is harvested from the donor area while the other portion of the follicular unit remains in the donor area. It's also called "vertically split harvesting" or "vertically cut harvesting."

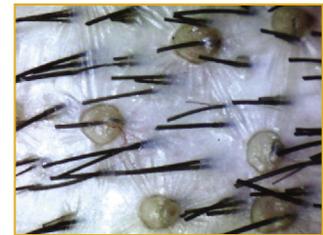


Figure 9. Portion of follicular units remaining in the donor area after PFFH.

Individual Group Harvesting (Figure 10): This involves harvesting an intact group of follicles based upon their proximity and position as they exit the epidermis consisting of one or more than one follicular unit at a time.



Figure 10. Graft containing more than one follicular unit at a time.

Transection (Figures 11 and 12): Term used to report any microscopically visible breakage of a follicle anywhere along its entire length. A graft could be a completely transected graft when all of the follicles are cut transversally or a partially transected graft when one or more follicles are cut leaving one or more intact follicle.



Figure 11. Total transection.

External Dissection (Figure 13): This action details how a graft is divided under the microscope into singles or groups containing fewer follicles than the original intact group, for example, to be used in or near the front hairline.



Figure 12. Partial transection.

Graft Cleaning: This refers to the removal of the transected part of a follicle from an FUE graft under the microscope.

Trimming: This refers to the removal of the dermis and other undesired perifollicular tissues of an FUE graft under the microscope with the aim of making the graft slimmer. The advantage of trimming is to make a graft fit into a smaller recipient site or to reduce the volume of tissue inserted into recipient sites so that volumetric expansion of the recipient area or ridging is minimized.

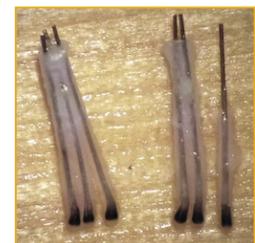


Figure 13. External dissection under microscope.

Different Techniques Employed

Follicular Unit Extraction: The concept of FUE was first published in the tabloid newspaper "The Sun Herald" in Australia on October 15, 1995. It was an advertisement for Dr. Woods & Dr. Campbell's top-up microsurgical technique where the donor extraction was done one follicular unit at a time (Figure 14).

In the advertisement, the concept of FUE was actually described as "Hair Follicle Single Unit Extraction," which accurately depicts the pure idea of the technique: one follicular

unit at a time. Drs. Bill Rassman and Bob Bernstein officially described the term FUE in 2002 as “the removal of individual clusters of follicles from the donor area using a sharp dissecting punch or trephine.” In the original article, the grafts were harvested using a 1.0mm sharp trephine.²

In strict terminology, the term “follicular unit extraction” is inappropriate and misleading because it is a histological term rather than an accurate anatomical surgical term. More appropriate would be the term FIT (Follicular Isolation Technique), but the use of FUE has prevailed and the term is too difficult to eradicate today

Follicular Isolation Technique: Also known as FIT, Dr. Paul Rose derived this term to more appropriately describe the procedure commonly referred to as FUE in 2002. The term FIT includes the possibility that a graft does not always get all the follicles of a follicular unit or it might include follicles in more than one follicular unit. It is possible that during removal the surgeon may extract, intentionally or not, one or several follicles, leaving behind a viable hair in the donor site. Alternately, the surgeon might extract more than one intact follicular unit. Therefore, the preferred term by the early pioneers in FUE was “follicular isolation” rather than “follicular unit extraction.”

Cole Isolation Technique (CIT): Developed by Dr. John Cole, CIT is a follicular extraction technique that incorporates a variety of highly sharpened, thin wall punches along with a precise depth control mechanism. The goal of CIT is to minimize the follicle transection rate by varying the punch diameter, limiting depth, modifying punch geometry, and altering tangential forces. The objectives of CIT are to match donor harvesting methods to the individual physical characteristics of each patient along with overall goals of both short- and long-term patient planning. CIT may involve harvesting a portion of a follicular group or intact follicular groups.

Harris Safe Technique: The method introduced by Dr. James Harris in 2004 is both a manual and mechanical method of graft harvesting. Initially, the method consisted of using a sharp punch to score the dermis of the skin followed by deeper dissection with an unsharpened dull, or blunt, punch developed by Dr. Harris, which he called a two-step method. Following the second step, the graft is removed with a pair of forceps. Subsequently, Dr. Harris attached his unsharpened punch to a rotating drill. With the mechanical version, the surgeon may perform the procedure in a single step.

Body Hair Transplant: Donor follicles are harvested from any region of the body except the traditional scalp donor area. Body hair includes all hair inferior to and inclusive of the neck and beard. Body hair has an unpredictable and variable yield.

Beard Hair Transplant: Donor follicles are harvested from the beard area on the face and neck of a patient. Beard hair transplants have a higher mean yield than other sources of body hair and a much faster rate of growth than other sources of body hair.

Woods Technique: This is the original term given to Follicular Unit Extraction by Drs. Ray Woods and Angela

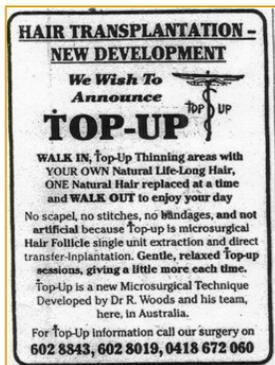


Figure 14. Advertisement in *The Sun Herald*.

Campbell. Even though they never published their results or shared their experience with other physicians, they can be considered an essential part in the development of the FUE technique based on their Internet publications.

Fox Test: This refers to a test procedure performed when a physician wants to confirm that a patient is a good candidate for FUE. Drs. Bill Rassman and Bob Bernstein coined the term in their 2002 paper that described the FUE procedure.

Motorized and Robotic Devices

Powered Cole Isolation Device (PCID) (Figure 15): This programmable device developed by Dr. John Cole allows for a more precise control of rotation, oscillation (and the duration of both), speed, rate, and arc of oscillation.

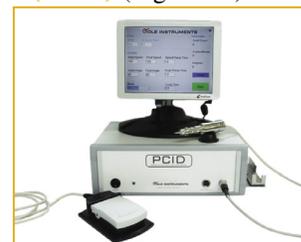


Figure 15. Powered Cole Isolation Device.

Harris Safe System (Figure 16): Developed by Dr. James Harris, this follicular extraction device utilizes an unsharpened, dull, or blunt punch (0.8-1.2mm) with full rotation at variable speeds and a fixed depth stop.



Figure 16. Harris Safe System.

NeoGraft® (Figure 17): This is a motorized rotating extraction device utilizing a sharp punch with both negative and positive pressure mounted on a right-angled handpiece. Negative pressure allows the surgeon to suck the graft into a collection chamber and keep the operating field clear of blood. A deep incision is required to loosen the graft enough to allow the weak suction to remove the graft from the donor site. Grafts may also be removed using a pair of forceps. The grafts can be inserted in the recipient area using positive pressure.



Figure 17. NeoGraft.

The NeoGraft is similar to the Calvitron, originally conceived by Dr. Pascal Boudjema. The term Omnigraft is primarily used in Asia for this device.

True Device (Figure 18): Aseptico Porta-Tip – AEU-03SS and Osada SH28S handpiece. This is a rechargeable rotary hand engine with variable speed control and autoclavable handpiece that Dr. Robert True uses. He inserts



Figure 18. True device.

Cole Instrument Serrounded punches varying in size from 0.8 to 1.25mm. A silicone collar is fitted onto the punch and adjusted for precise control of incision depth.

Alphagraft (Figure 19): This is another FUE device that uses a rotating sharp punch to harvest follicles from the donor area.



Figure 19. Alpha-graft.

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Devroye Device (Figure 20): Developed by Dr. Jean Devroye, this FUE battery powered device uses an oscillating sharp punch controlled by a very sensitive foot pedal. The device allows very short punch oscillation.



Figure 20. Jean Devroye device.

Feller Device (Figure 21): Designed by Dr. Alan Feller, this is an oscillating battery powered FUE device with sharp internal diameter cutting edge punches.



Figure 21. Feller device.

ARTAS System (Figure 22): Developed by Restoration Robotics, this robotic FUE device uses a two-step process where a V-shaped sharp punch (Figure 23) first pierces the skin followed by an unsharpened rotating punch, which penetrates deeper into the tissue to liberate the graft. This is an “automated” system that evaluates follicular unit density, hair angle, and proper depths of sharp and unsharpened punch insertion, based on the physician input data. With that information, the device has the capability to suggest the target units and align the system with the proper direction for dissection. Grafts are harvested while using a tension device developed by Restoration Robotics. The graft is then removed with a pair of forceps.



Figure 22. ARTAS System.



Figure 23. Tip of the ARTAS punch.

References

1. Headington, J.T. Transverse microscopic anatomy of the human scalp. A basis for a morphometric approach to disorders of the hair follicle. *Arch Dermatol.* 1984(Apr); 120(4):449-456.
2. Rassman, W.R., and R.M. Bernstein. Follicular unit extraction: minimally invasive surgery for hair transplantation. *Dermatol Surg.* 2002; 28:720-728. ♦

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