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Fifteen Steps to Pull a Graft

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ABSTRACT

This article describes the 15 steps for a safe and fast follicular extraction using the follicular unit excision (FUE) technique to achieve the highest success rate in this important part of hair transplant process. The choice of the correct equipment, the extraction technique, and the sequence to be followed in the donor area are described in detail to standardize and improve the training of doctors and technicians in follicular extraction.

Keywords: excision, extraction, forceps, harvesting, pull grafts

INTRODUCTION

All stages of hair transplantation using the follicular unit excision (FUE) technique are important for the survival of the transplanted follicular units (FUs)—from punching to extraction, manipulation, and storage, and finally for placement.[1] Assistants are a fundamental part of the team necessary for a successful hair transplant. Their active participation is crucial in harvesting FUs in a fast and efficient way. Of all the components of FUE, the extraction, or graft removal, phase has received the least attention in publications. In the article "Forty Steps to Harvest a Graft," we mentioned that graft extraction is an important step for the success of the surgery.[2] Now we detail each of the steps essential to the process that our experience has shown to increase the success rate in extraction in a fast and efficient way.

Pulling grafts is a process that ideally should be fast and atraumatic. Harvesting without using proper technique can lead to trauma and consequent loss of part of or all of the viability of the FUs. Here we describe the technique we use in which graft extraction is performed with the patient lying down, either in the prone or lateral decubitus position.[3] In cases in which the surgeon prefers for the patient to be seated, the sequence may be different and will not be discussed as it is not part of our routine.

Easy cases do exist. Pulling the grafts can be a simple task even for a beginner. Graft removal is easiest when there is high color contrast between the hair and the scalp, when there are no deep graft attachments, when there is little bleeding, when the skin is firm and resistant to injury (low risk of decapitation even when excessive pressure is applied), when the follicles are also firm and resistant to injury (even if the punch causes friction around the bulb there is no injury), and when consistent and uniform punch excisions are made by the surgeon. However, these cases are the exception rather than the rule. Very often we face challenging cases, and when we do, mastering the 15 steps described below will make it possible to pull quality grafts safely and with a high rate of success.

STEP 1: USE QUALITY LOUPES

Vision and lighting are basic requirements for fast and efficient work. It is unacceptable to carry out such a procedure with only the naked eye. Likewise, while cheap plastic loupes help, they are not comparable to high-quality loupes. Choice of type of loupe can be guided by personal preference. They can be glasses (flip-up), TTL type, or with a helmet. We prefer the helmet loupes with a magnification of 4X to 5X for assistants and 6X for the surgeon and with an LED light attached (Figure 1). Working distance

FIGURE 1. A 6X loupe is used by the surgeon and 5X loupe by the technicians.

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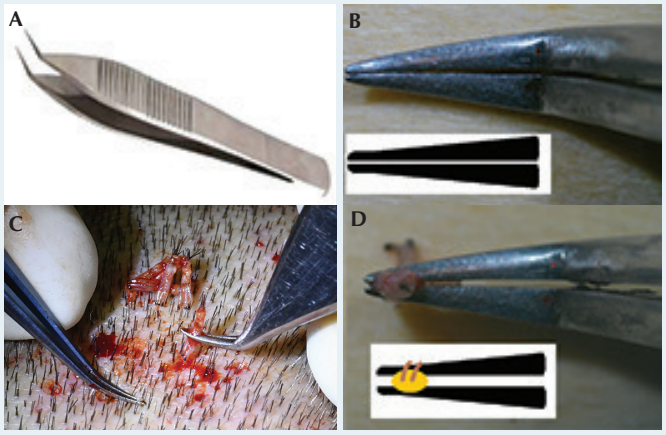
is another factor to consider. Very short distances force the assistant to bend over and get too close to the work field, hindering the movement of the team and producing stress on the neck and upper back. Very long distances force working with outstretched arms, which can also cause discomfort, and in addition produce greater tremor in the image. The working distance depends on the user's height and personal preference; in our practice, we prefer a distance of approximately 300 to 350mm. Before beginning the surgery, the loupe must be perfectly adjusted to the head to allow for the best possible vision.

STEP 2: CHOOSE YOUR FORCEPS

FIGURE 2. We use a curved tooth forceps to pull the epidermis.

The choice of forceps to pull the FUs depends on the personal preference of the surgeon and the assistants. Two forceps are always needed. We use a toothed forceps (0.1mm), slightly curved, to lift the dermis (Figure 2), and a second forceps to extract the graft.

FIGURE 3. *A:* An angled forceps is used to pull one graft at a time. *B:* Closed forceps. *C and D:* Forceps grasps one FU at a time.



These extraction forceps can be angled with a uniform gripping surface, which allows the removal of a single FU at a time (Figure 3). The tip should be positioned at an angle to the surface of the skin to avoid pinching neighboring FUs. Another option is a curved forceps (Forester) with a gripping point only at the tip (Figure 4A). This forceps allows the sequential collection of dozens of FUs (50 or more) (Figure 4, B to D) that accumulate between the two blades. Gathering grafts in the forceps is reserved for the easiest cases, where a detailed observation of each harvested FU is not necessary. A third option is a modified mosquito (ATOE, Cole Instruments) for FU harvest. This instrument was designed to harvest FUs with the patient seated and is partially introduced into the channel created around the excised graft. In our hands, it seems to be less ergonomic and slower than using forceps in patients lying down, and so for these reasons, we do not use it.

FIGURE 4. *A:* Forester forceps for sequential collection of dozens of FUs. *B:* Forester forceps with one graft. *C and D:* Forester forceps with dozens of grafts.

STEP 3: DECIDE WHO WILL PULL THE FUs

The surgeon must harvest some of the grafts during the surgery, particularly when beginning the case and when entering different areas of the donor scalp. If all the harvesting is delegated to assistants, the surgeon will miss details such as difficulty in pulling grafts and identifying possible graft injuries. During the harvesting process, the surgeon can modify the excision technique, if indicated, to minimize partial or total loss of FUs in the removal process.

STEP 4: DETERMINE NUMBER OF ASSISTANTS TO HARVEST

In addition to the surgeon, one or two assistants can simultaneously remove the FUs to speed up the process (Figure 5, A to D).

FIGURE 5. *A:* Assistant is to the left of the surgeon. *B:* Assistant is to the right of the surgeon. *C and D:* Two assistants.

STEP 5: CHOOSE THE BEST POSITIONS FOR TEAM MEMBERS

With the patient lying down, the surgeon is seated behind the patient's head. Usually, but not necessarily, the assistant performing the extraction is on the patient's left (Figure 5A) as the right-handed surgeon excises the FUs from left to right and from bottom to top.[4] An assistant can stay on the right (Figure 5B) according to his/her personal preference and also depending on the region of the scalp with the best view. Thus, during the surgery, the assistant can change sides if it is more convenient. Two assistants can stand to

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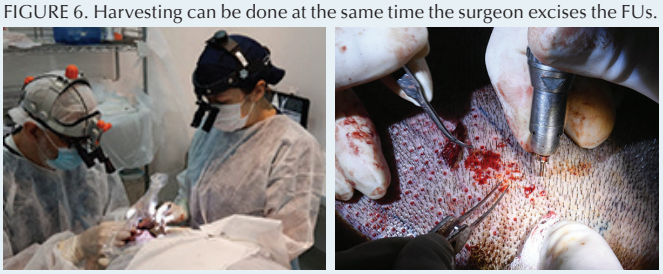
the left and right of the patient for simultaneous harvesting (Figure 5, C and D). The height of the operating table must be adequate for the entire team. Ideally, for smooth simultaneous harvesting, assistants should be of similar heights (Figure 5C). If necessary, decking platforms can be used to compensate for large differences in height of the staff.

STEP 6: DECIDE WHEN TO REMOVE THE GRAFTS

Harvesting can be done at the same time the surgeon excises the FUs (Figure 6). A more experienced assistant will not wait to be called to help with the harvesting. Upon realizing that there is sufficient space that graft pulling will not interfere with the surgeon's excisions, the experienced assistant will initiate the harvesting. If all excisions have already been performed, two assistants simultaneously can help with the harvesting.

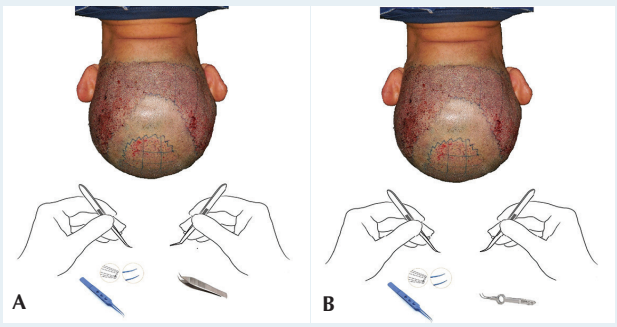
FIGURE 6. Harvesting can be done at the same time the surgeon excises the FUs.



STEP 7: USE PROPER EXTRACTION TECHNIQUE

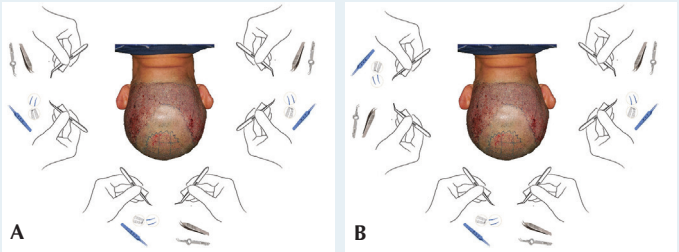
The surgeon, seated behind the patient's head, if right-handed, will hold the toothed forceps in the left hand and the forceps that pulls the graft in the right hand (Figure 7). The toothed forceps grasps the graft near the epidermis and lifts the graft following the hair direction. This is usually sufficient to expose the sebaceous gland above the skin. The second forceps must be positioned at a certain point where traction does not lead to decapitation or tear the follicles. This point varies from case to case and should be identified at the beginning of the operation by trial and error. It is usually located immediately below the sebaceous gland of the FU. Excessive pressure to pull the graft should be avoided, even if it does not cause visible damage. Damage may be more readily visible when inspecting and processing the grafts under the microscope. In addition, there can be microtraumas that are not detected that still may have adverse effects on follicle viability. In particular, the bulb and the bulge areas should not be compressed by the forceps to protect these vital stem-cell-containing areas of the follicles. When there are frequent decapitations, even with proper forceps placement, it may be necessary to deepen the dissection to release the deep attachments.

FIGURE 7. *A and B:* The left hand holds a curved tooth forceps and the right hand holds either an angled extraction forceps or a Forester forceps.



An assistant positioned on the right side similarly holds the toothed forceps with the left hand and the extraction forceps with the right. When the assistant is positioned on the left side, the toothed forceps can be held with the right hand, only if he/she has the skill and strength to extract the graft with the left hand (Figure 8A). Otherwise, the assistant can keep the toothed forceps in the left hand and the extraction forceps in the right (Figure 8B), but this is a less ergonomic way.

FIGURE 8. *A:* An assistant positioned on the left side can hold the curved tooth forceps with the right hand and extract the graft with the left hand. *B:* All team members hold forceps the same way.



STEP 8: USE THE CORRECT NUMBER OF EXTRACTION STAGES

Not all patients' scalps are the same. Some are easy cases with light, deep attachments and grafts can be pulled easily. Others are more difficult to pull and require more skill and effort. The depth of the punch excision has a big influence on the ease of graft removal. When more than half of the graft is already exposed above the skin surface after excision, most grafts can be removed by pulling with a single forceps placed at the lower epidermis (single stage) (Figure 9). If this is not possible, the removal should be done in two stages: one forceps placed at the epidermis lifts the graft, and the second forceps placed deeper pulls the graft (Figure 10).

Three-stage extraction consists of 1) placing a forceps at the epidermis and lifting, 2) placing another forceps below the bulge to lift further, and 3) moving the first forceps deeper on the graft below the second forceps to pull the graft (Figure 11). In cases in which three stages are commonly needed to accomplish atraumatic extraction, the surgeon should consider deepening the incisions. Three-

FIGURE 9. *A to D:* A graft is pulled in a single stage.

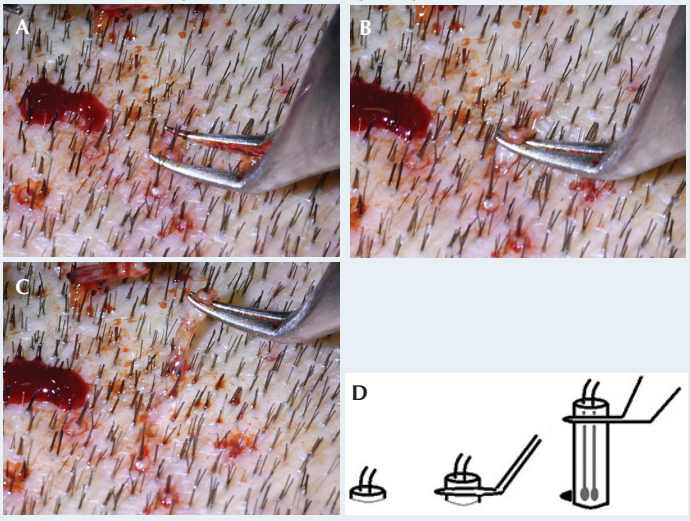


FIGURE 10. *A to D:* A graft is pulled in two stages.

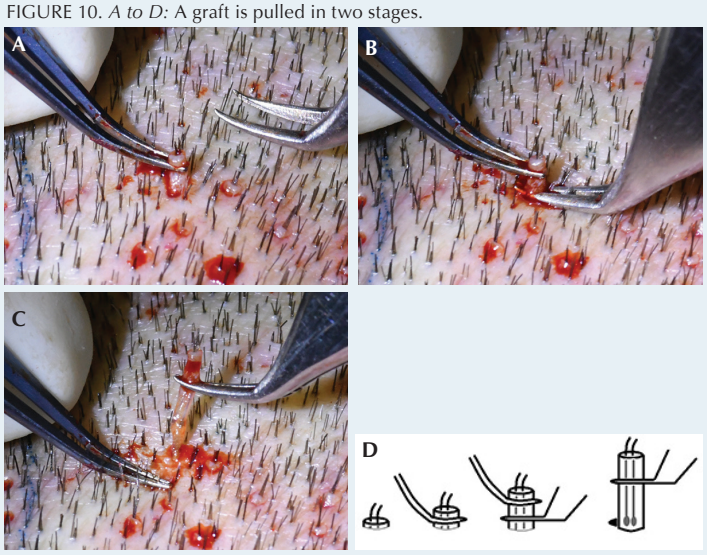
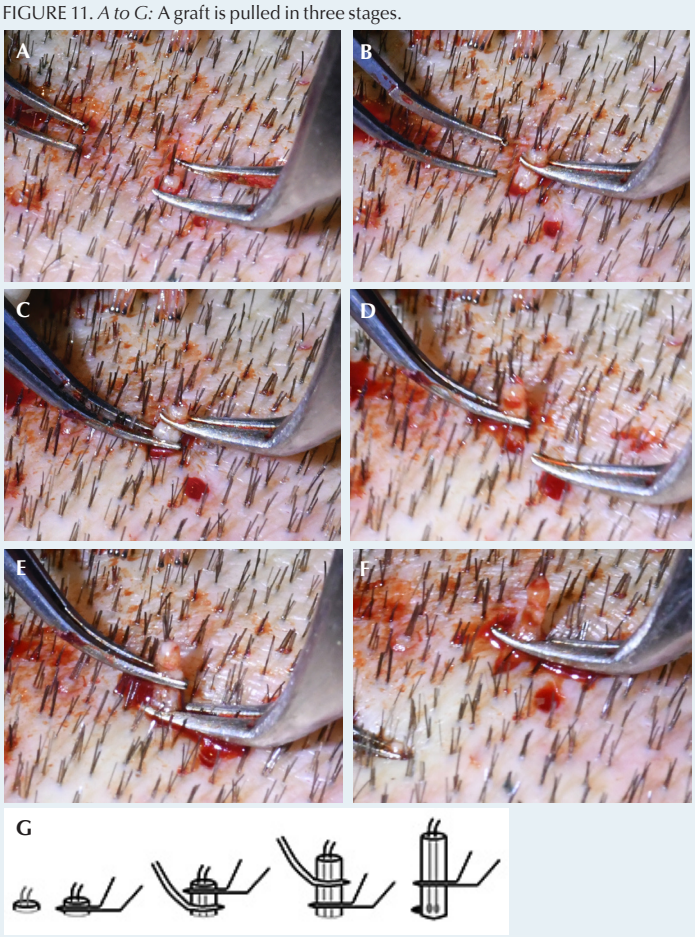


FIGURE 11. *A to G:* A graft is pulled in three stages.



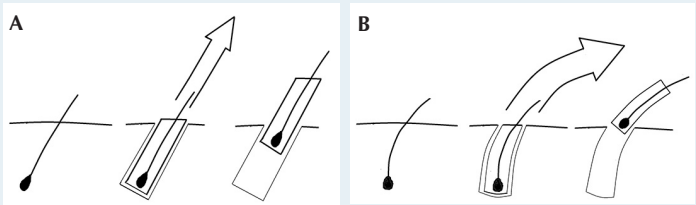
stage harvesting increases the collection time and increases the likelihood of FU injury due to the excessive forceps' pressure needed for extraction.

STEP 9: PULL WITH TRACTION IN THE CORRECT DIRECTION

The traction to remove the graft must follow the direction of the emergence angle of the hair. Pulling in another direction makes removal more difficult and can lead to trauma and even decapitation of the FU.[5]

Only with very straight hair, without any curvature, the traction on the graft must be linear following the emergence angle of the hair (Figure 12A). Curly hair is different. The greater the curve of the hair in the FU, the greater the rotation of the forceps during the pulling of the graft. During graft removal, the forceps is rotated following the curvature of the hair (Figure 12B). This decreases the chance of trauma and hair breakage during removal. This is particularly important in very curly afro hair.

FIGURE 12. *A:* On straight hair, the traction on the graft must be linear. *B:* On curly hair, the traction must follow the hair curvature.



STEP 10: GATHER EXTRACTED GRAFTS

With angled forceps, the grafts are harvested one by one and placed on the scalp, in a place close to the extraction site (Figure 3, A and C). Ideally, they should be placed into a pool of blood and grouped together to protect against drying and graft desiccation. Grouping enables efficient gathering of grafts to place them in storage solution. On the other hand, it is not good to let many grafts accumulate on the scalp because this can obstruct the extraction process, make counting difficult, and delay the separation and processing of grafts. Our routine is to accumulate 50 grafts and transfer them to the storage container. The curved shape of the forceps makes it easy to gather up to 50 grafts for transfer (Figure 4, C and D).

STEP 11: REMOVE GRAFTS IN AN EFFICIENT ORDER

Ideally, adjacent grafts should be pulled in order, so that the distance between grafts being removed is as small as possible. This is efficient. It is also helpful to remove lowest grafts first and move upward to prevent bleeding from extractions from interfering with the visualization of the remaining grafts. During extractions, however, we often come across pools of blood (Figure 13, A to D). Instead of repeated stops to remove blood, it is recommended to follow an uninterrupted sequence of extraction to avoid wasting time. Whenever possible, we accumulate 50 grafts in a pile on the scalp or in the forceps before stopping to remove the pools of blood (Figure 13E). The rule is to extract as many FUs as possible without interruptions and to remove the grafts left behind at the end.

STEP 12: OPTIMIZE COMMUNICATION BETWEEN ASSISTANT(S) AND SURGEON

The harvesting of grafts without proper recognition and reporting of possible graft damage leads to the persistence of excision and extraction errors. An excessive number of injuries can also be due to inadequate extraction technique. Communication among the team members must be continuous to alert to the need for changes in technique. With each withdrawal of 50 FUs, the assistant should report on the number of failures as well as on any injuries, such as partial

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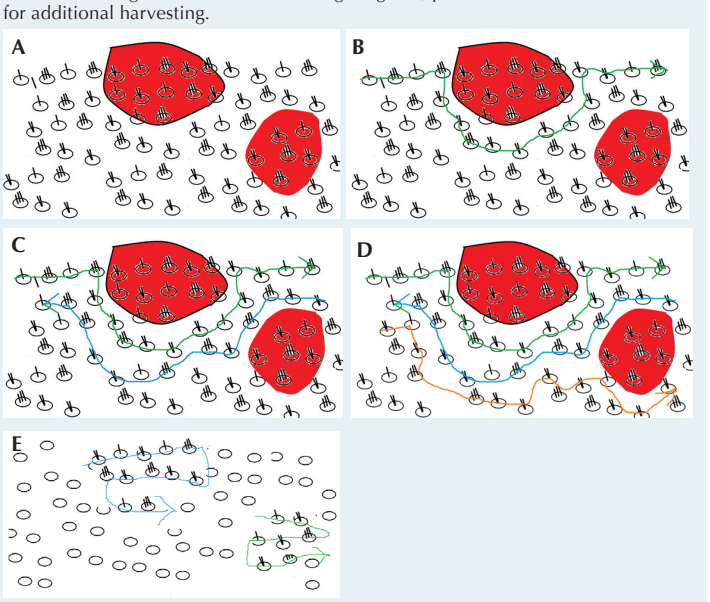
FIGURE 13. *A to D:* Ideally, we must follow an uninterrupted sequence of extraction to avoid wasting time. *E:* After harvesting 50 grafts, pools of blood can be removed for additional harvesting.



or total transections, decapitations, and follicle fractures, and on any difficulties in pulling the grafts. The absence of problems gives the surgeon approval to maintain the current manner of excising the donor area.

STEP 13: OPTIMIZE EXTRACTION SPEED

Pulling FUs one by one is a slower process with, on average, 25 grafts harvested per minute. This approach has the advantage of allowing a continuous assessment of possible injuries and thus maintaining the best technique for the next excisions. Extraction with accumulation of FUs in the forceps is a faster process and up to 60 FUs per minute can be pulled. It is a great option to choose for the easiest cases where it is not necessary to evaluate each FU to identify injuries. Most of the time, however, the surgeon opts for a more thorough removal, while the assistants can be faster by accumulating FUs in the forceps. In easier cases, the surgeon can also opt for the accumulation of FUs in the forceps.

STEP 14: AVOID IATROGENIC GRAFT DAMAGE

Improper harvesting technique can lead to FU trauma. Sensitive regions such as the bulge and bulb must not be compressed. Excessive forceps' pressure can also traumatize the FU. Pulling with excessive force and/or in the wrong direction can lead to decapitation of the FU. Placing the grafts on the scalp or in the storage tub with sudden movement can also cause trauma. Excessive time of exposure to ambient air leads to drying and consequent death of the FU.

STEP 15: USE PROPER EXCISION TECHNIQUE FOR ATRAUMATIC EXTRACTION

The more uniform the punch excisions, the more similar attempts to pull the grafts will be. On the other hand, if the surgeon doesn't have uniformity in depth control, punch insertion angle, and punch centering, some grafts will be easy to pull (deep dissection) in a single stage, and others will be difficult to pull (shallow dissection) requiring three stages to complete harvesting. This lack of uniform dissection results in inconsistencies in graft removal. This makes the extraction more difficult, particularly for inexperienced technicians as the technique must change in every attempt to pull grafts.

Is it hard to pull grafts?

- Check if you have the right forceps.
- Check if the graft was grasped by the tip of the forceps, where the pressure is ideal.
- Check if the graft was grasped at the correct level for that particular area of that particular patient.
- Check if there is pressure enough to pull the graft and not damage it.
- Check if the direction of traction is correct.
- Check if you are following the curvature of the hair.

If everything was done perfectly, but there are still some injuries to the grafts or it is hard to pull FUs, report to the surgeon to dissect the grafts deeper.

Technicians must also pay attention to the differences in pulling grafts in different sections of the harvest zone. Whenever a technician realizes the graft doesn't lift as desired, rather than continue with suboptimal graft removal, this should be reported to the surgeon, who should then adjust the excision technique.

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Co-editor's note: This is Dr. Mauro Speranzini's sequel article to "Forty Steps to Harvest a Graft" (reference 2 above), which outlined key steps for a successful hair restoration procedure. Here, he expertly details how to efficiently assist in the extraction process.

The task of efficiently pulling out grafts from the skin is as important as excising them correctly. Maximizing the amount of 2- and 3+-hair grafts will increase the yield of hairs per graft, subsequently increasing the overall density. By incorrectly pulling or "plucking" a tethered graft, the number of viable grafts decreases, and can also result in damaged, incomplete, and/or denuded follicles. The author's recommendations herein not only apply to FUE but should also be considered when doing long hair FUE or body hair FUE.

In long hair FUE, teamwork between the surgeon and the assistant is paramount. With synchronized movements, the assistant needs to anticipate and follow the surgeon's

steps, finding the excisions in a random but predictable pattern. As he or she pulls the long hair graft, special care to the orientation of the hair is to be taken in order to avoid entanglement. Dr. Roberto Trivellini has designed a special cylinder with a slit opening in order to insert the long hair grafts and keep them moist. If no container is to be used, placing the grafts in solution is of vital importance, but this may decrease the speed of extraction.

I believe it is essential to follow Dr. Speranzini's recommendations on how to properly pull FUE grafts. Like the surgeon, the assistant plays an important role in properly obtaining the grafts, which will help to increase the possibility of a successful hair transplant procedure. *—Dr. Luis Nader*

Invited Commentary

Marco Barusco, MD | *Port Orange, Florida* | drbarusco@tempushair.com

Similar to Dr. Speranzini's "Forty Steps to Harvest a Graft," published in the March/April 2021 *Forum*, this article, "15 Steps to Pull a Graft," is a great and detailed review of the intricate process of pulling an FUE graft that has been scored by the surgeon. By dissecting these processes in their exquisite details and explaining each one, Dr. Speranzini is able to highlight the complexity and the attention to detail that they require. The work done by our assistants cannot be overemphasized, and a well-trained team makes our lives as surgeons much easier and enables us to deliver great and consistent results to our patients. I shared the article with my staff and every single one of them—from the most experienced to the most novice—found important tips and points that they will now incorporate into their routine.

Thank you, Dr. Speranzini. Another job well done!

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Congratulations to Mauro Speranzini for a great article. This article discusses issues that are very important to hair surgeons practicing FUE. Though I agree with the author in many respects, I would like to comment on Step 15, which discusses proper excision being essential for atraumatic extraction. This is something I greatly relate to. As the extraction of hair follicles is a follow-up action accompanying the punching of the hair follicles, the quality of the punching greatly affects the extraction process.

The surgeon must perform, to some extent, standardized and uniform punching in order to immediately make adjustments upon unsatisfactory graft acquisition. In particular, punching depth control seems to be one of the most important factors. This is ever more so true for multi-FU grafts because the horizontal width of the hair follicles is larger toward the bottom than it is seen from the skin surface.

If the punching depth is too shallow, capping occurs. If slightly deeper, but still too shallow to be pulled out smoothly, then hair follicles may have to be grasped too strongly with the forceps causing crushing injury.

With a slight increase in the depth, the surgeon may reach a section where scored grafts can be gently pulled out without follicular injury. I call such a depth the "safe punching depth" (SPD). SPD varies from patient to patient, from surgeon to surgeon, and from site to site. Within this SPD, consistent and stable punching motions should be performed. If follicular damage increases as you go deeper than the SPD, this is called an unsafe punching depth, which is not recommended to be reached.

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Dr. Speranzini's "15 Steps to Pull a Graft" is a well-written, diligent, lucid paper on one of the most vital steps of the hair transplantation procedure. While we agree to the detailed documentation of the breakdown of each sub-step of the extraction process to increase the efficiency and the final yield, in our practice, we differ in two areas:

1. We do not encourage the accumulation of up to 50 grafts during the collection of the scored grafts.
2. Maintaining hemostasis is extremely important for clean and efficient work, so if there is oozing, we will correct this before proceeding with the excision and extraction. ■