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Critical Thinking and Quality Control in Graft Preparation and Placement

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It is about time that the contributions of Emina Vance to our specialty were acknowledged. Textbooks, workshops, articles, teaching all the time, Emina has boundless energy. She delivers always with a smile and good humour. Below is her detailed common-sense approach to just about every aspect on hair transplants from "go to whoa!" In other lead articles, your editors have featured new ways doing things and new ideas that are coming through, but here is a detailed handbook on how to do the operation well. Please read and enjoy. —MM

Note: Emina Vance obtained her medical degree from the University of Belgrade (Yugoslavia, 1989). In 1991, she immigrated to Canada where she began to work in hair restoration as a technician. In 1997, she joined Pierre Amelotte International (PAI) working with Dr. Vance Elliott, among other physicians, and for the following seven years, Emina assisted in surgery and performed training, assessment, and quality control of the PAI medical across the United States and Canada. In 2004, she joined Dr. Samuel M. Lam's team as a coordinator for the Lam Institute for Hair Restoration (Dallas, Texas). In 2011, Emina was with Restoration Robotics as Director of Training and Professional Education, helping launch a training program for the ARTAS® system. In 2012, she returned to Dallas to join Dr. Lam's practice. Emina, the 2010 recipient of the Distinguish Assistant Award, is author of "Hair Transplantation 360 for Assistants," and has been the co-director of the Hair Restoration Cadaver Workshop in St. Louis for the past eight years.

Note: The following figures are reprinted with permission from Jaypee Brothers Medical Publishers: Figures 2, 4, 7.1, 9, 10, 11, 12.3, 13, 16.3 and 16.4 (E.K. Vance, *Hair Transplant 360 for Assistants*, Volume 2, 2nd Ed. New Delhi, India, 2016)

Performing quality control means continuously measuring the "product and process" against established standards in order to ensure a result that meets or exceeds a consumer's expectations. Although quality control is an important aspect of any practice, it has rarely been addressed in a systematic way in our field. This may be because hair restoration started slowly and the gold-quality standards were easily shared and upheld in a small community. However, as hair restoration gains more popularity and the field grows rapidly, the need for a more methodical approach to quality control is necessary. This article will attempt to define standards, outline the characteristics and actions that can uphold them, and, most importantly, provide guidelines for critical thinking.

Standards

Although every human tissue and healing are somewhat unpredictable and unique to an individual, quality results are generally defined as transplanted hairs surviving at or above 90%, and the results looking natural and undetectable. It is worth mentioning that survival rate is based on qualitative evaluation since counting transplanted hairs is done only in small studies.

Every aspect of the procedure if planned or executed poorly could affect graft survival and/or naturalness of the results. Although tissue handling is mostly done by surgical assistants and donor harvesting and recipient site creation by physicians, these aspects of surgery are closely intertwined. For example, the most common factors determining if transplanted hair will survive are intact follicular units, well-hydrated tissue, and atraumatic handling of the grafts. The other factors affecting graft survival are oxygenation and blood supply, which could be compromised during recipient site creation or even during donor harvesting. As follows, quality control should be a team effort of constantly paying attention to details and evaluating everybody's work.

Because of the complexity of the subject, this article will uniquely focus on tissue handling and its effect on hair transplant results. More specifically, it will address how the graft preparation and placement can affect graft survival and naturalness of the results.

Hair Transplant Forum International Volume 26, Number 5

Hair Transplant Forum International is published bi-monthly by the International Society of Hair Restoration Surgery, 303 West State Street, Geneva, IL 60134 USA. First class postage paid at Chicago, IL and additional mailing offices. POSTMASTER: Send address changes to Hair Transplant Forum International, International Society of Hair Restoration Surgery, 303 West State Street, Geneva, IL 60134 USA. Telephone: 1-630-262-5399, U.S. Domestic Toll Free: 1-800-444-2737; Fax: 1-630-262-1520.

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President's Message

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It is my great pleasure to announce that the 24th World Congress of the ISHRS will be held from September the 28th to October the 1st, 2016, at the Caesars Palace Hotel in Las Vegas. This World Congress is the largest scientific meeting on hair restoration surgery, where world experts gather and share their experience, knowledge, techniques, and inventions. This is the meeting that you should not miss.

The meeting space this year is the highest grade, and the hotel provides rooms and service of top quality with special discounted prices. Our esteemed Program Chair, Dr. Marcelo Pitchon, prepared the comprehensive program perfectly. He invited world-famous basic scientists for the scientific lectures. You will enjoy the most up-to-date topics from molecular biology to clinical treatments for hair loss. The Program Committee has worked hard on the selection of abstracts and will offer an innovative day-by-day program with many great workshops, symposiums, and general sessions.

One of the most important things in a medical congress is to ensure freedom of discussion. We can influence each other and raise each other through open discussion. To achieve this goal, the ISHRS will keep an open-hearted atmosphere of free discussion.

After intense study and hot debate during the Congress, you can enjoy the nightlife in a city that offers top-notch shows, entertainment, and world gastronomy. You can also enjoy adventures in the nature of the desert—the Grand Canyon—and the Colorado River of emerald green.

The ISHRS recently changed the name of the Annual Scientific Meeting to the World Congress of the ISHRS. Over 700 participants from 77 countries attend the Congress. With the recent forming of hair restoration surgery societies in Greece, Switzerland, Pakistan, and Paraguay, the ISHRS's Global Council now consists of over 20 regional societies. As the leading organization in the field of hair restoration surgery, the ISHRS has promoted science, research, and education throughout the world.

The ISHRS takes a stand against surgery by unlicensed personnel. Faculty members of the World Congress are physicians with high ethical standards. Surgery delegation and legal compliance have been critical issues in hair restoration surgery for many years. We certainly don't want this to damage the integrity and prestige of the ISHRS. The Society encourages our members to act lawfully. The Board of Governors of the ISHRS promotes high practice standards and takes a stand against practice paradigms that encourage the unlicensed practice of medicine in hair restoration surgery.

The ISHRS is an educational society, however, and not a policing society. The Society won't punish a member other than to remove membership privileges, but it will lead the way by advocating to protect patients through maintaining and promoting best practices for surgical safety, physician ethics, continuing education, and the promotion of science in hair transplantation treatment.

We would like to share the wonderful World Congress of the ISHRS with all of you. Please join us!♦

Co-editors' Messages

Mario Marzola, MBBS Adelaide, South Australia editors@ISHRS.org

We hope the year is progressing well for all of you dear readers. There is so much awful news around that first of all we hope you are safe, well, and free to live your life in peace. It is at these times that we can reflect on how lucky we are to practice our chosen profession and express our ideas freely. Part of that freedom of expression is to send in your thoughts and experiences for publication. We thank those who have done so. Sometimes there is a logjam of articles needing to go to press, so we apologize if there has been a delay. There may be modifications needed to the articles, or other reasons for the delay, but we strive to keep everyone informed. Please remind us if your article has not received attention. Especially exciting for us are contributions from newcomers and from so many different countries around the world.

The lead article by Emina Vance in this edition is full of common-sense ideas and advice designed to eliminate any danger to the grafts in their journey from donor to recipient. There are many links in the chain of that journey, each one very important. It matters not how perfect the harvesting or the placing has been if the graft desiccates along the way. Read this article, involve your assistants, and keep it for future reference.

A big welcome to the Hair Restoration Society of Pakistan,

our newest member of the ISHRS Global Society. As we all know, there is so much to be gained by the practitioners of a country coming together in a society and getting to know like-minded colleagues, sharing and helping to solve concerns that may be particular to that country. In addition, at the Global Council even more sharing and problem solving is available. If your country is small, amalgamate with countries around you like Dr. Damkerng Pathomvanich has done in Thailand. The Asian Association of Hair Restoration Surgeons has been a great success in bringing that area of the world together with two yearly scientific meetings and workshops.

The Meetings and Studies column is very full in this edition. The dearly held idea of the ISHRS as the promoter of high-class and frequent education opportunities is a reality. Well done to all the organizers and teachers who gave their time and expertise to make this happen.

And now to the biggest hair show on Earth, the 24th World Congress of the ISHRS in Las Vegas coming up September 28–October 1. What a great combination. See you there! ♦



Robert H. True, MD, MPH, FISHRS New York, New York, USA editors@ISHRS.org

I would like to congratulate my co-editor, Dr. Mario Marzola, for doing the heavy lifting on putting together this issue of the *Forum*. It is indeed wonderful to see submissions from members from all parts of the world. For me, one of the most important parts of this edition is Dr. Brad Wolf's *Cyberchat*, which contains some very thoughtful discussion about donor management and limitations with FUE—be sure to read it!

This has been a great year of regional meetings. I have had the pleasure of attending and being on faculty at four. It might seem like a lot, but I love learning and I learned something new and valuable at each one I participated in. There were several others I wish I could have attended. I know firsthand that our membership all around the world is engaged in meaningful research and

education. It will be exciting to see all that coming together at the World Congress in Las Vegas.

As Dr. Marzola and I near the end of our three years as *Forum* editors, I am feeling a little wistful. It has been a lot of work, but I would gladly do it over again. Dr. Marzola and I owe a debt to all of you who have contributed and in particular we must recognize our valuable team: Victoria Ceh, Cheryl Duckler, Brad Wolf, Sara Wassserbauer, Nicole Rogers, Jeff Donovan, Henrique Radwanski, Marco Barusco, and Tim Carman. Thanks to each and all. ♦



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Mission: To achieve excellence in medical and surgical outcomes by promoting member education, international collegiality, research, ethics, and public awareness.

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- Articles should be written with the intent of sharing scientific information with the purpose of progressing the art and science of hair restoration and benefiting patient outcomes.
- If results are presented, the medical regimen or surgical techniques that were used to obtain the results should be disclosed in detail.
- Articles submitted with the sole purpose of promotion or marketing will not be accepted.
- Authors should acknowledge all funding sources that supported their work as well as any relevant corporate affiliation.
- Trademarked names should not be used to refer to devices or techniques, when possible.
- Although we encourage submission of articles that may only contain the author's opinion for the purpose of stimulating thought, the editors may present such articles to colleagues who are experts in the particular area in question, for the purpose of obtaining rebuttal opinions to be published alongside the original article. Occasionally, a manuscript might be sent to an external reviewer, who will judge the manuscript in a blinded fashion to make recommendations about its acceptance, further revision, or rejection.
- Once the manuscript is accepted, it will be published as soon as possible, depending on space availability.
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- A completed Author Authorization and Release form—sent as a Word document (not a fax)—must accompany your submission. The form can be obtained in the Members Only section of the Society website at www.ishrs.org.
- All photos and figures referred to in your article should be sent as *separate* attachments in JPEG or TIFF format. Be sure to attach your files to the email. Do NOT embed your files in the email or in the document itself (other than to show placement within the article).
- Images should be sized no larger than 6 inches in width and should be named using the author's last name and figure number (e.g., TrueFigure1).
- Please include a contact email address to be published with your article.

Submission deadlines:

October 10 for November/December 2016 issue

December 5 for January/February 2017 issue

January 5 for March/April 2017 issue



Notes from the Editor Emeritus

Robert S. Haber, MD, FISHRS Cleveland, Ohio HaberDerm@gmail.com



As a Clevelander, it's been an interesting summer. The Cavaliers (basketball) brought the first championship to the city in more than a half century, and the Indians (baseball) are in first place! So from a sports perspective, Cleveland is on the world stage, perhaps representing the high point of the summer. But we also hosted the U.S. Republican National Convention, where Donald Trump was nominated for U.S. President, and there was lots of discord and some violence in the city. Most residents stayed as far away as possible for safety's sake. So from a political perspective, Cleveland was also on the world stage, but perhaps representing the low point of the summer. And while Cleveland remains a relatively unknown city in general, a good part of the world at least now knows we exist!

And as I write this, Hillary Clinton has just made history as the first female nominated for U.S. President by a major party. But regardless of one's political persuasion, the United States is faced with the two most unpopular presidential candidates in our history, and that is problematic. Across our nation, an ideological divide is growing, intolerance and bigotry is being fomented, and everyone seems on edge. And across the globe, horrible violence is occurring in multiple countries against innocent people, by people who are using religion as an excuse for their actions. And no one is immune to the violence, as members of every faith and race have been victims of these acts.

Those of us not capable of such violence cannot fathom what goes on in the mind of those who are. We prefer peace and co-existence. This week an Egyptian Muslim physician is visiting me, watching a Jewish physician operate mainly on Christian patients. The faiths of those involved are irrelevant, and that's the way it should be. And I am always so appreciative of the ISHRS, where Jews and Christians and Muslims and Buddhists and Atheists and others primarily fight about whether sharp punches are better than dull punches, and whether strip surgery is better than FUE. Because at the end of the day, we commingle in friendship that is not dependent on our religion, politics, or nationality. We are a microcosm of the world, and an example of how diversity thrives when intolerance is not given any room to grow. Let's keep it that way!

At the risk of identifying myself as a "dinosaur," I am proudly still performing almost exclusively strip surgery (FUT). I have the surgical skills necessary for FUE, and I own an ARTAS® robot, but less than 5% of my cases are FUE. Why? Because my strip results are good, my donor scars are good, and my patients are happy. And so I simply have not needed to increase my FUE

volume. Sometimes I feel like a restaurant owner who does not accept credit cards. Everyone else does, I'm told, so why don't I? Because if my tables are full every night, there is no need to change. As long as my surgical table fills each year with strip patients, I expect FUE will remain infrequent. And in my opinion, FUE, while a superb procedure when performed competently and ethically, remains a procedure in development, and too many practitioners are ignorant of the fine points required for success. I am fortunate that I can follow changes and advancements in

FUE technique and instrumentation, postponing increasing my FUE volume until others have made the mistakes that I will be able to avoid.

An unusual occurrence happened this week. A female patient arrived the morning of surgery with very high anxiety. Anxiety is of course common, and

most of us are skilled in ameliorating this problem by carefully reviewing the procedure, its risks and benefits, and how we would handle any problems. For this patient, she believed that since her consult a few months earlier she had experienced significant additional hair loss, was worried about her appearance if hair loss continued, and she was very concerned about shock loss. On exam, she had excellent donor density and a small area of visible thinning requiring surgery. I reviewed all this and more, but even after 30 minutes of discussion, she was still visibly anxious, and she stated that she was "terrified" of having the surgery. I had never heard a patient say that to me, and for me that made the decision easy. I simply could not perform an elective cosmetic procedure on a terrified woman. I also did not threaten her with the loss of her full surgical fee, even though it was my right to do so, as in my opinion that would have constituted coercion on my part. I kept a small percentage to help defray the costs of the day, and refunded the balance. The cost to me of having to do something like this once every 5-10 years more than offsets the costs of an unhappy patient.

The world community will be known by how it handles the crisis of intolerance facing us. The United States will be known by how we handle the upcoming political season. Cleveland will be known by how we handle the events of this summer. And each of us will be known by how we handle the small adversities that face us and our patients, hopefully with dignity and compassion.

See you in Las Vegas! ♦

Critical Thinking & Quality Control *from front page***Critical Thinking**

Critical thinking is a process comprised of observation, analysis, and critique with the intention for improvement. It implies awareness, self-evaluation, and team spirit. To achieve quality results, you need to be aware of what action leads to a specific result and to apply critical thinking in order to uphold specific quality standards of the tissue and/or process.

1. Desiccation

Desiccation is the number one reason for the death of a hair follicle. Several studies have demonstrated that graft dehydration considerably diminishes graft survival. The most alarming results came from the study performed by Gandelman involving 12 patients and 120 grafts that were left on a surgical glove for 3 minutes to dry, then they were implanted into a bald scalp.¹ After 12 and 24 months, none of the patients demonstrated hair growth. In 2007, Dr. Michael Beehner allowed grafts to dry for 16 minutes and rehydrated half of them. Interestingly, his study revealed that dried grafts can be rehydrated, and their survival rate is almost equal to wetted grafts (80% survival for dried and 84% survival for wetted grafts), which runs counter to Gandelman's original findings. More research should be undertaken on this important subject. (Dr. Beehner will present his unpublished study at the 2016 World Congress in Las Vegas, Nevada.)

The first sign of tissue/grafts drying out is the loss of luster. Well-hydrated tissue looks glossy, while dehydrated tissue looks dull. Figure 1 shows hydrated and slightly dried grafts side-by-side making the subtle difference between the two appearances more obvious. There are many variations on how to approach graft preparation, for example, by using different cutting surfaces, by spraying or dripping solution on tissue, by grouping grafts or transferring them one at a time, etc. There are as many scenarios in which tissue can dry. Figure 2 shows a pile of grafts grouped during graft dissection and the graft on the very top of the pile drying out in spite of the fact that the grafts below are hydrated. Similarly, grafts can be neatly stored in a Petri dish yet piled high so that some grafts protrude out of the storage solution as shown in Figure 3. Using the right quantity of storage solution can be challenging since too much fluid can make grafts float around and disturb their arrangement while too little can make them dry. Sometimes there are indirect signs that the tissue may be drying out, such as noticing the tongue blade drying around the area where the grafts are dissected as shown in Figure 4.

Grafts can also desiccate during graft placement. Commonly, assistants would "load" grafts onto their gloved finger, grasp them from their finger, and place them into recipient sites. Ideally, the assistant should load as many grafts as she or he can place in 3 minutes. To preserve moisture, the assistant should keep the loaded grafts together. However, a novice assistant may get ambitious and load too many grafts or an experienced assistant can be faced with challenges that can slow down placement such as bleeding or popping (Figure 5). In addition, warm room temperature, air blowing over the work area, and an assistant's hands being extra hot can all create conditions that cause grafts to dry. Some practices use a Telfa pad or Microfoam tape to load grafts. Caution needs to be given not to spread out grafts as shown in Figure 6.

In conclusion, tissue needs to be kept hydrated, which can be done by keeping it immersed in a storage solution when stored



Figure 1. This set of photographs shows the difference in appearance between hydrated grafts (left) and grafts that are starting to desiccate (right).

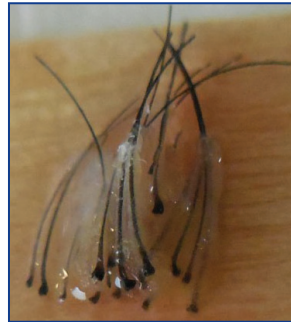


Figure 2. During graft dissection, if grafts are piled on the dissection surface, it is important to pay attention to the grafts sitting on the top of the pile. In the image, the graft on the top of the pile is looking dull and fuzzy, demonstrating signs of drying.



Figure 3. During graft sorting, if grafts are grouped and piled for more efficient counting, it is important to pay attention for the signs of drying of the grafts on the top of each pile. It is a common practice to have a minimum of fluid in the Petri dish so that grafts do not float and disturb the pile. However, always be mindful to have a sufficient level of storage solution to keep all grafts well hydrated.



Figure 4. An indirect sign of graft drying can be observed when the tongue blade appears dull and dry. The area around the tissue seems to be recently hydrated since the fluid reflects light, but the rest of the tongue blade looks dry and could soak the fluid away from the tissue.



Figure 5. This photo shows the common practice of loading grafts on the back of the finger ready for placement. There is no ideal number of grafts to load, but the rule should be as many as an assistant can place in 3 minutes. In addition, to protect them from drying, the grafts should be sprayed frequently.



Figure 6. This photo shows grafts loaded on a Telfa pad ready for placement but already starting to dry out. The assistant is looking through the grafts, picking and choosing which graft to place, and how to grasp it correctly, yet she is unaware that the grafts are being exposed to air and drying.

and by dripping or spraying storage solution on it when being handled during graft preparation and placement. It is worth mentioning that grafts also need to be kept hydrated during FUE extraction. If too many follicular units are dissected and hundreds are awaiting extraction, the treated area should be covered with moist gauze. Furthermore, during the extraction, grafts should be promptly hydrated instead of collecting them in big numbers before being transferred into a storage solution.

Analyzing Causes of Poor Growth

Case 1

The patient in Figure 7.1 demonstrates poor growth in the middle and right side of the central forelock. Often times, if the midline area of the central forelock exhibits suboptimal growth, it may be due to compromised blood supply. Densely packed or deeply made sites can cut blood vessels and compromise blood supply and graft growth. However, this patient shows suboptimal growth on the right side of the forelock, which may indicate that some additional factors have contributed to poor growth. Looking at the notes taken during the procedure, we know that it was a somewhat difficult FUE case, which tells us that the grafts were possibly more fragile. If poor graft survival was present in the entire recipient area, the conclusion may have been that the grafts were fragile and more susceptible to damage during handling. Further analysis points to the assistant who placed grafts on the right side of the patient.

On closer examination of the way the assistant in question works, we discovered that during placement she was sorting through her grafts for a longer period of time than usual, leaving them to possibly dry out on her hand. She was experienced in placing grafts obtained from a strip, which are often chunkier, so when exposed to FUE grafts, she was picking through, searching for “better” (i.e., chunkier) grafts to place in the most strategic areas. Although her thinking and methods were good, she neglected to notice that the act of spreading grafts during her selection process made the grafts dry faster. With hindsight, she should have taken fewer grafts at the time or hydrated them more often during graft placement. This could also have been a situation in which the assistant was rough handling grafts during placement. Nevertheless, if that were the case, the poor growth would be more consistent, visible in all the patients, and always in the area where the assistant in question placed.

Case 2

On a side note, a physician friend of mine was faced with consistently sparser growth on the left side of the patient’s hairline. After examining all the assistants’ work and not finding the explanation, the physician noticed that she was the reason for the unexpected result. During recipient site creation, it was awkward as a right-handed surgeon to reach over the patient to make sites on the left side. Accordingly, fewer sites were made, but on the right side of the patient’s hairline, the physician spent more time

making sites, packing them more densely and consequently causing the discrepancy in hair density. Similarly, because of the need to reach over the patient’s head when creating recipient sites, a right-handed novice physician might create recipient sites at a higher angle on the left side of the hairline and ultimately make the result look sparser. It is worth mentioning the importance of keeping detailed documentation regarding the name of the assistants working on each patient, as well as any unique characteristics of the tissue, sites, or ease and length of dissection and placement.

Case 3

The patient in Figure 7.2 demonstrates overall poor growth that might be due to sparse graft distribution or to damage done to tissue during graft preparation and/or placement. In comparison, the patient in Figure 7.3 shows sparse growth behind the hairline. On closer examination, you can see that his hairline improved and grew in well, indicating good graft survival. Nevertheless, larger 3- and 4-hair grafts were placed too far apart, which indicates poor graft distribution and poor planning on the physician’s part. Error in estimation of the area to be transplanted or the yield from the donor tissue is not uncommon. When faced with graft “shortage,” as probably happened with the patient in Figure 7.3, the physician could have harvested additional tissue or split 3- and 4-hair grafts in order to better cover the posterior scalp and blend transplanted hairs with the patient’s existing hair in the midscalp.

2. Transection

The most common damage done to the tissue during graft preparation involves transection, and during graft placement it is crush injury. Transection refers to the damage done to the hair follicle by cutting through its structures. First and foremost, transection directly impacts graft survival. There are several studies showing that intact follicular units survive better than transected ones. Kim and Choi performed a study in which they divided hair follicles into two and three parts and horizontally cut them at different levels: upper one-third, upper two-thirds, bottom one-third, bottom two-thirds, upper one-half, and bottom one-half. The study demonstrated no growth when transplanting the upper or bottom one-third. When transplanted, the upper two-thirds survived at 60% and the lower two-thirds at



Figure 7.1. This patient is 10 months out of his procedure. He is demonstrating poor growth in the middle and right side of the central forelock. As explained in the text, this was due to the assistant’s mistake.



Figure 7.2. This patient is 12 months out of his procedure. He is demonstrating overall sparse growth, which may be due to either too few grafts transplanted or to tissue damage done during graft preparation or placement.



Figure 7.3. The small image in the corner shows the patient before the procedure and the large photograph, 13 months after the procedure. Although his hairline is improved, he demonstrates poor growth behind the hairline. As explained in the text, this was due to the physician’s mistake.

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80%. Furthermore, when hairs were transected at the midshaft and then transplanted, 40% of grafts survived when the bottom half was transplanted and only 20% when the upper half was transplanted.¹ Mayer performed a comparable study with similar results but also noticed that the upper two-thirds produced hairs of finer diameter while the bottom two-thirds produced hairs of a normal diameter.² Swinehart examined the importance of the bulge area in follicle regrowth and found that transection at the bulge produced 46% survival for the upper segment and 47% for the lower segment.³ These studies suggest that hair follicles that are partially transected should be implanted since they could potentially survive. However, all studies favor intact grafts and unanimously show that not transecting hair follicles is vital to graft survival. Figure 8 shows transected grafts in relationship to their survival.

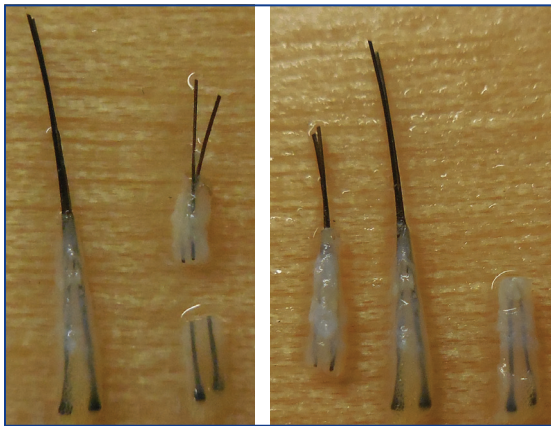


Figure 8. Transection at top or bottom one-third of the graft (*left*); transection at top or bottom two-thirds of the graft (*right*).

Due to the diminished graft survival of the transected hairs, critical thinking during graft preparation is essential. No matter how careful you are, some degree of transection always occurs and the question is often raised whether to keep a transected hair or to discard it. Figure 9 shows five grafts that can be trimmed and sorted as follows: starting from the left, graft #1 has two transected hairs, both at an insufficient length for survival and should be discarded. Graft #2 has one hair that equals one-third of the full hair-shaft length, which is insufficient for survival and needs to be discarded. Graft #3 has one intact hair and two transected at the upper half, which are unlikely to survive. The hairs could be trimmed away in order to obtain a “clean” single-hair graft, but a novice assistant may risk transecting the only good hair in the process, so further judgment is required. If this graft is kept as is and considered as a single-hair graft, it should not be placed in a hairline because

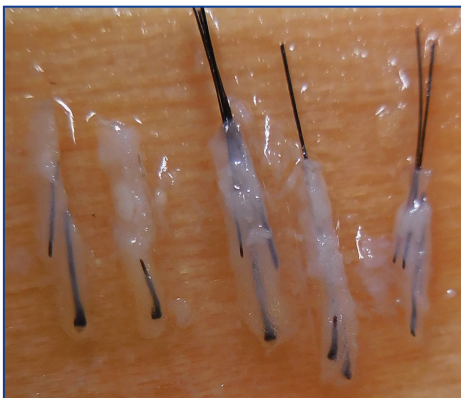


Figure 9. Transected grafts: starting from the left, only grafts #3 and #4 have one intact follicular unit each. The other three grafts (grafts #1, #2 and #5) contain fragments of transected follicular units, which diminishes their chance of survival. (Please refer to the text for a more detailed explanation on the trimming and sorting of transected grafts.)

one of the two transected hairs may grow causing this graft to look “pluggy.” If this is only one out of hundreds, it may go unnoticed, but if several of these grafts are placed into the hairline, the end result may look unnatural. As follows, if kept untrimmed, graft #3 should be placed in a less strategic place, not in the front of the hairline and not where hair density is essential. Graft #4 has one intact hair and one transected comprising less than the bottom one-third of the graft. The transected hair should be trimmed away because, if implanted, it may cause a foreign-body reaction and thereby an unnecessary sequela. Similarly, fragments of transplanted hairs should be removed during dissection because, if implanted, they too could cause a foreign-body reaction. Graft #5 has three transected hairs: two hairs on the left comprise only the upper half (and, accordingly, insufficient for survival) and the third hair contains only the middle two-thirds of the hair follicle length (missing a piece from the top and bottom). I would not keep this graft, but if someone chooses to keep it hoping that the longest hair would regenerate, I would recommend not trimming it. Trimming this graft would eliminate the epidermis, the hair curl, and possibly a portion of the sebaceous glands. In addition, I would recommend keeping this graft on a separate pile and placing it at the very end of the procedure using a stick-and-place technique. Contrary, if this graft is trimmed and the transected hair placed in a full-depth site, it could easily slip inside the site and cause various problems, such as an additional graft being placed on top of it, a foreign-body reaction, or an ingrown hair. Most importantly, any graft that has questionable survival should never be placed in any prominent position of the recipient area.

Critical thinking is also needed in identifying the number of hairs in each graft or in identifying telogen hairs and knowing how to trim them. Figure 10.1 shows two grafts, both having two hairs exiting the epidermis; the graft on the left side has one intact and one transected hair, while the graft on the right has one intact and one telogen hair. The transected hair in the graft on the left may be trimmed but it is not crucial, and the graft should be counted as a 1-hair graft and could be placed in the back of the hairline. The graft on the right should be counted as a 2-hair graft. When hairs are moving into the telogen phase of their cycle, the hair bulb and the dermal papilla move upward, making the telogen hair shorter than the anagen hair. It is my belief that the tissue below telogen hairs should not be trimmed away for two reasons: first, so as to keep the graft its full length and to minimize its chances of slipping inside the site, and second, so as not to inadvertently discard vital hair structures. Figure 10.2 shows two sets of two follicular units that need to be separated. The follicular units outlined in yellow each contain telogen hairs and should be trimmed as shown in the figure.

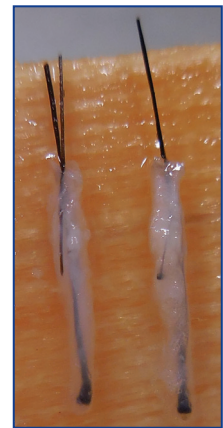


Figure 10.1. These two grafts look seemingly the same; the graft on the left has one transected and one intact anagen hair, while the graft on the right has one telogen and one anagen hair. The differentiation is made by observing the roundness at the end of the telogen hair while the transected hair exhibits a sharp edge.

Graft Dissection in Scar Tissue

Dissecting hairs out of scar tissue may prove challenging due to the toughness of the scar and distortion in the hair fol-

licles, as demonstrated in Figure 11. Isolating follicular units from the scar requires skillfulness and it can be time consuming. In addition, hairs obtained from scar are often coarser and should never be placed in exposed areas such as the hairline or temporal points. If a significant number of grafts are obtained from a scar, they should be mixed with grafts obtained from the virgin scalp in order to achieve a softer and more natural result. I found that scars caused by old-fashioned, large-punch harvesting are easier to dissect and cause less hair distortion than scars from strip donor harvesting.

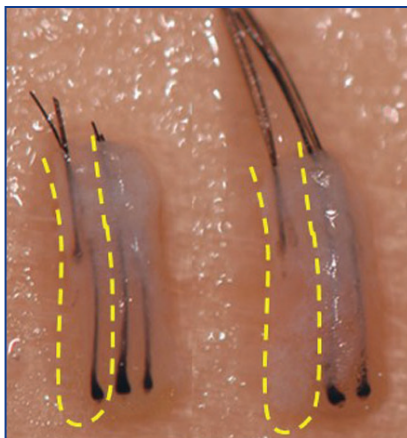


Figure 10.2. These two sets of two follicular units that need to be separated show telogen hair occurring in different groupings, one on the left containing one telogen and one anagen, while the graft on the right contains two telogen hairs. When separating follicular units, the grafts should look uniform in size and shape and extra tissue below the telogen hair(s) should not be trimmed away.



Figure 11. The donor strip contains scar tissue in the middle, pushing hair follicles to change direction.

Graft Dissection with White Hair

While dissecting scars may be challenging, dissecting white hair is always demanding. The lack of pigment and color contrast between the hair shaft and surrounding tissue make identifying and isolating follicular units very difficult. Although using backlighting can facilitate dissection as a general principle, it is very helpful and almost necessary in dissecting white hairs as shown in Figures 12.1 and 12.2. A helpful tip during graft dissection and trimming is to make grafts chunkier. In order to prevent transection during trimming, I recommend finding a graft that has a visible bulb and keeping it as a measuring stick so that other grafts can be compared to it and not over trimmed/transected (Figure 12.3). Some physicians recommend using methylene blue to facilitate visualizing white hair, but the latest study presented at the 2015 ISHRS World Congress in Chicago, Illinois, USA, showed some alarming findings that methylene blue may actually diminish graft survival. A team of physicians and nurses from the Institute of Dermatology and DHT clinic in Bangkok, Thailand, led by Dr. Chinmanat Tangjaturonrusamee, demonstrated decreased graft survival when diluted methylene blue in normal saline solution was used as a storage solution. Although this pilot study consisted of only 3 patients, the difference in growth compared to normal saline solution was sufficiently significant to raise questions of the safety in using methylene blue during hair transplantation. (Please see page 194 for Dr. Tangjaturonrusamee's article, "Methylene Blue: Its Efficacy and Safety as a Storage Solution in Hair Transplantation.")

Slivering and dissection of white hairs in patients who color their hair is a somewhat easier task since the dyed hair allows the assistant to identify the follicular units above the skin and

thereby use the colored hair as a guide to separate them below the skin (Figure 12.4). Similarly, in some patients who do not color their white hair, a donor strip can be quickly colored immediately prior to the procedure using a color product such as Just for Men for Beard and Moustache. Caution needs to be given, first not to color beyond the area outlined to be harvested, and second to thoroughly wash out the color before harvesting so that the dye's toxins do not contaminate the storage solution and the tissue.



Figure 12.1. It is difficult to see well the white-hair follicular units contained in the sliver resting on this tongue blade.



Figure 12.2. The white-hair follicular units in this sliver are easier to see when the sliver is placed on a clear board illuminated with a top and a backlight.



Figure 12.3. Avoiding transection when dissecting white hairs can be challenging. The graft on the left is transected, which is easy to see when placed beside a graft with an intact follicular unit.



Figure 12.4. Coloring hair can facilitate slivering and graft dissection. Following follicular units from the top and visualizing them below the skin surface is easier when hair is colored (as seen on this donor strip and a sliver).

On a side note, dissecting "salt-and-pepper" hair is easier than dissecting purely white hair, but doing so requires unique critical thinking. Patients with salt-and-pepper hair rarely have uniformly distributed white and dark hairs, so special attention should be given to graft placement so as not to group white or dark hairs and thereby create a patchy look. In addition, the assistant should try to match graft hair color with the recipient area. For example, the patient in Figure 12.5 has his temporal points restored but the transplanted grafts are darker than his existing temples, making them look somewhat unnatural. The patient's donor area was predominantly dark, and isolating white-hair follicular units was

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difficult. However, adding a few dark single-hair grafts among his existing white temple hairs could have made this result look more natural.

Besides an unpredictable survival, the second damaging effect of transection is wasted hairs and effort. Transection can occur during follicular unit extraction, strip harvesting, slivering, and dissection. The survival of the hairs that are transected during harvesting, whether those that are extracted or left behind, is questionable since the transection is often done blindly and can happen at any level (as opposed to the deliberate transection done during a trichophytic closure). In Figure 13, observe the donor strip being transected during donor harvesting. Examining a sliver obtained from this donor strip and counting the follicular units, this sliver originally had 7 follicular units but 4 were transected, leaving only 3 follicular units that were good enough to be transplanted, which resulted in a yield of less than 50%. As also shown in Figure 9, out of a total of 5 grafts and 11 hairs, probably only 2 hairs would grow, which would result in a graft survival rate of less than 20%. It is important to understand that besides wasted hair follicles, there is also a wasted effort in graft dissection. When working with transected tissue, the assistants spend more time trimming away the unusable tissue while yielding fewer grafts, consequently making their effort less efficient.



Figure 12.5. This 62-year-old patient received a hair transplant to restore his hairline and temporal points. His hair color, grafts-to-recipient area, was not matched correctly, making his transplanted hairs stand out.



Figure 13. This transected donor strip and sliver show damage done by wasting transected hair follicles. The sliver originally had 7 follicular units but 4 were transected leaving only 3 follicular units to be transplanted and resulting in less than a 50% yield.

Slivering

To minimize transection during graft preparation, it is important to make slivers thin (a single row of intact follicular units) in order to facilitate visualization and separation of each follicular unit (Figure 14.1). Slivering is a difficult skill to acquire. To prevent transection during slivering, you need to know what “wrong” movement of the blade has caused transection and how to rectify mistakes. In Figure 14.2, observe a sliver that has two types of transection, caused by accidentally tilting the blade in

two different directions during slivering. In Figure 14.3, the photo on the left shows a blade tilted away from the viewer causing transection of the follicular units on the left side of the sliver leaving only the top portion of the follicular unit. The photo on the right shows a blade tilted toward the viewer causing transection of the two units on the right side of the sliver and leaving only the bottom portion. Both figures show a blade parallel to the follicular units as the ideal orientation to pass through the tissue and to avoid transection. In summary, tissue should be kept hydrated at all times and handled gently. Follicular units should be kept intact, slivers thin, and grafts uniform in size and shape.



Figure 14.1. When slivering, it is paramount to make thin slivers, comprised of a single row of intact follicular units.

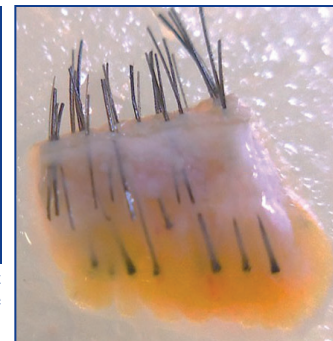


Figure 14.2. This sliver shows two types of transection: on the left side, the upper half of four follicular units and, on the right side, the bottom one-third of two follicular units.

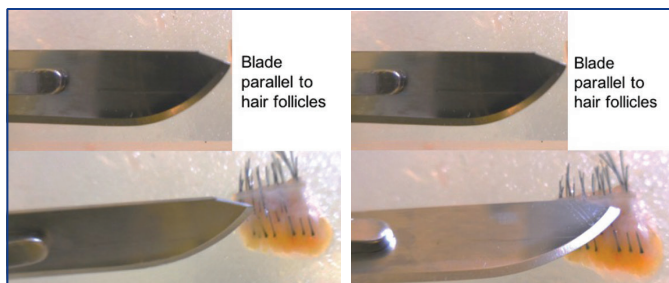


Figure 14.3. The blade is tilted toward the sliver (away from the observer) causing transection on the left side of the sliver (left); blade is tilted away from the sliver (toward the observer) causing transection of the two follicular units on the right side of the sliver (right).

3. Physical Injury

Besides transection, physical injury also has the potential to reduce graft survival. Beehner conducted a study intentionally damaging hair follicles at the hair bulb and bulge with both a hard- and soft-crush injury.⁴ His study demonstrated a 42% survival following hard-crush injuries at the bulb and merely a 17% rate following hard-crush injuries at the bulge. Accordingly, it is critical that the assistants handle the bulge area during graft preparation and placement with utmost care. More encouraging was the survival rate of 82% after soft-crush injury at the bulb. In conclusion, whether during graft extraction, slivering, graft dissection, or graft placement, it is important to gently grasp the tissue around the hair follicles and at all cost avoid firmly grasping (squeezing with the forceps) around the hair bulge or bulb. Scraping hair fragments off the surface of the grafts during dissection can also cause injury to the hair follicles and thereby compromise their survival (Figures 15.1 and 15.2).

Graft Size and Survival

The size of grafts can also affect their survival. Grafts can be divided into the categories “skinny” and “chubby” depending on the amount of tissue left around the follicular unit during graft preparation or follicular unit extraction. Skinny or denuded grafts



Figure 15.1. The follicular units received a crush injury above the bulb, caused by forceful squeezing of the forceps during graft placement.



Figure 15.2. The follicular units received a crush injury of the bulb, caused by scraping of the blade during graft dissection.

are more fragile and more prone to suffer desiccation or trauma during handling. The finding of a study conducted by Seager in 1997 and one by Beehner in 1999 comparing chubby vs. skinny grafts demonstrated a higher regrowth rate in favor of chubby grafts after six months.⁵⁻⁶ The latest study done by Beehner and presented at the 2015 ISHRS World Congress in Chicago, Illinois, compared the growth of strip and FUE grafts. Dr. Beehner treated 4 patients with a total of 1,780 grafts (FUE and FUT grafts, with 1-, 2-, and 3-hair follicular units represented). The sagittal slit sites were made with 0.8, 1.0, and 1.1mm blades for the three corresponding sizes of grafts. One patient, who had 84% growth with FUT and 33% with FUE, was described as an “outlier” by Dr. Beehner. When all four patients were put together, the overall survival (those found at 11-14 months) was 62% for FUE and 86.5% for FUT. If the one outlier patient is removed and only the other three are looked at, the survival becomes 87.5% for FUT grafts and 71% for FUE, a 16.5% difference. Obviously, this is only one study, so it should not be concluded that FUE grafts always have such a disparity in survival compared with FUT grafts.

It is worth mentioning that it is a common practice to make white-hair grafts chunkier (as white hairs are usually coarser and extra tissue is intentionally left around the hair shaft to minimize transection due to over trimming, as explained above). Consequently, fewer 1-hair grafts are made and used when transplanting a white-hair patient and placing some 2-hair grafts close to the hairline seems acceptable. Although this practice may seem more “forgiving” visually, you should be cautious not to be cavalier about placing large grafts in the hairline because the patient may get excited with the newly transplanted hair and decide to color his or her white hair, thus exposing the large grafts placed in the hairline.

Recipient Sites and Graft Size

When talking about the size of the graft, it needs to be noted that the recipient site size should match the graft size. If placed grafts are too large for their recipient sites, hairs would grow squeezed causing compression, which is another reason a hair transplant may look unnatural. Instead of several hairs growing out of the scalp freely and the tissue between hairs occupying their natural space, hairs and tissue are compressed and appear as a clump of hairs. Figure 16.1 shows how compressed grafts look when hair is grown back; Figure 16.2 shows what they look like immediately after being placed. Ideally, grafts should be trimmed of extra tissue so that their hair count defines their size (as shown in Figures 16.3 and 16.4), and the assistants should make graft sizes as consistent as possible. Physicians should measure the



Figure 16.1. This shows compression caused by large grafts being placed into small sites (very tight fit).

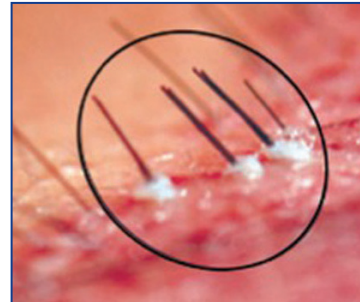


Figure 16.2. Grafts in the circle are much larger than the surrounding grafts indicating an improper fit. On close examination, these are 3-hair grafts placed into 1-hair sites, which is also an indication of improper graft placement that would make a hairline look pluggy.

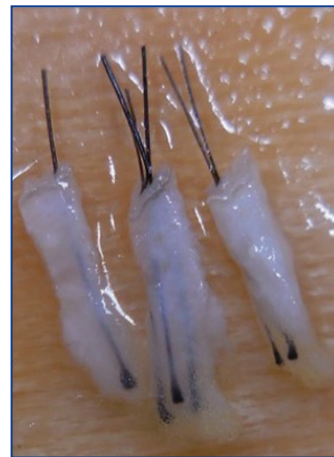


Figure 16.3. The three grafts shown in the image are not trimmed correctly. They contain different hair counts but are of the same size due to the untrimmed tissue.

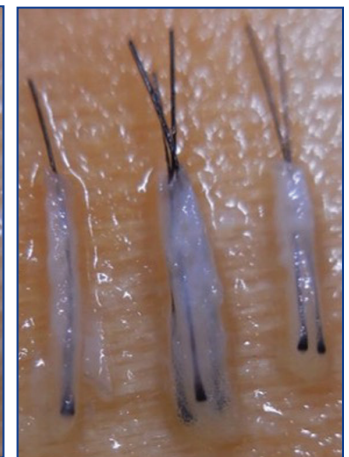


Figure 16.4. The three grafts shown in Figure 16.3 are properly trimmed now demonstrating the difference in their size.

size and length of the instrument used to create recipient sites and match it to the grafts, and their fit should be tested at the beginning of the recipient site creation.

Another reason for an unnatural result is graft pitting seen as a skin depression around transplanted hair follicles (Figures 17.1 and 17.2). As the grafts are stored in a storage solution during the procedure, they are somewhat swollen, and

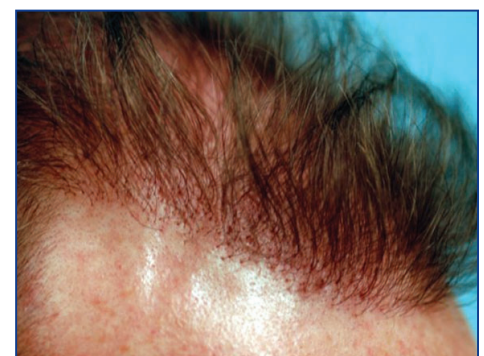


Figure 17.1. This 41-year-old patient shows scalp pitting around transplanted follicular units. This patient demonstrates how pitting can make single follicular units look unnatural.

once placed into the scalp, they deflate and recede. If grafts are placed slightly above the skin surface, they recede and become flush with the skin surface allowing for seamless healing. For that reason, when placed, grafts should have their epidermis protruding about 1mm above the surrounding scalp. Sometimes grafts have

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a tendency to slide inside the sites and they have to be repeatedly pulled up. Assistants placing the grafts and the person performing a final check should look carefully at the placed grafts, making sure that the epidermis on each graft is visible. Leaving hair 5mm long, for example, allows for easier spotting of which grafts are placed more deeply than desired (Figure 17.3).

Hair curl is important and when grafts are placed with disregard to the natural hair growth patterns, transplanted hairs can appear unnatural. Hair curls should always point toward the scalp and their direction should follow natural hair growth patterns. Hair-curl orientation contributes to natural results and it also facilitates hairstyling (Figures 18.1 and 18.2). It is very important to respect the hair-curl orientation in the temples and the eyebrows because the hairs in those areas are exposed and other hairs cannot be combed over (as it is possible to hide an unnaturally looking hairline) (Figure 18.3). Some people suggest that respecting the hair curl in African Americans is not im-



Figure 17.2. When multi-unit grafts are pitted, oftentimes they also show compression as seen in the image. Photo courtesy of Dr. V. Elliott.

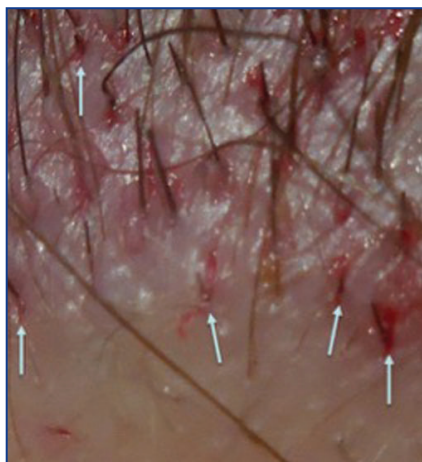


Figure 17.3. The arrows in this photograph point to the grafts that are sinking in and placed too deep. Looking at the length of the hairs protruding out of all sites helps identify those that sank down and should be pulled up so that their epidermis rests about 1mm above the skin level.



Figure 18.1. This patient shows several mistakes made during hair transplant: large grafts are placed in the hairline, grafts are sparse, and hair curls are misplaced pointing in whichever direction. Photo courtesy of Dr. V. Gambino.



Figure 18.2. The hair curl is placed incorrectly (pointing upward) in the three highlighted 1-hair grafts; and in the two above the highlighted hairs, the hair curl is placed correctly, pointing toward the scalp.

portant, but I would argue that it is as important as in the Caucasian. When extracting a donor strip, the hair curl and the curvature of the hair follicle can be observed as always oriented in the same direction; and when closely observing the hairstyling of African hair, it can be noted that the hair curls point in the same direction (matching that of the Caucasian hair pattern) (Figure 18.4). In summary, to ensure seamless results grafts should be handled gently, inserted in a properly sized site and site location, and left about 1mm elevated above the surrounding epidermis.



Figure 18.3. This patient demonstrates transplanted eyebrows with somewhat "wild" hair curls.



Figure 18.4. This sliver was obtained from an African American patient demonstrating J- and C-shaped follicular units all curling in the same direction.

Conclusion

Physicians and surgical assistants should keep quality goals in mind during and after a surgical procedure and constantly monitor the quality of their work. Quality control should be performed throughout the entire procedure as well as during a patient's follow-up visits. Physicians need to avoid transection during donor harvesting and assistants during graft preparation. Furthermore, the assistants should be mindful of graft handling during graft extraction and graft placement. During follow-up visits, consistent photography is essential. Patient hair is examined for naturalness and density, and detailed documentation during the procedure is invaluable.

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