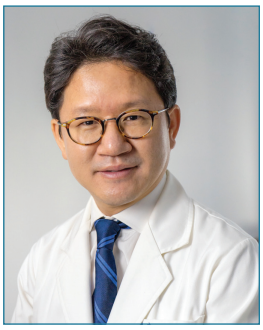

President's Message

Sungjoo (Tommy) Hwang, MD, PhD, FISHRS | *Seoul, South Korea* | president@ishrs.org

Greetings everyone! Wishing you all a happy New Year.

The ISHRS was founded in 1993 and has been around for 25 years. I would like to express my gratitude and thanks to our society's founders, Drs. Dow Stough and O'Tar Norwood. Also, I would like to extend my sincerest thanks to the former presidents, Board of Governors, committee members, and all staff who have contributed to the ISHRS's growth for the past 25 years.

Over the past 25 years, there have been many changes in the field of hair restoration surgery. There have been many developments in surgical skills such as FLAP, REDUCTION, PUNCH GRAFT, MINIGRAFT, FUT, and FUE. Furthermore, there has been advancement in medical treatment and research including finasteride, dutasteride, minoxidil, LLLT, PRP, and so on. I am looking forward to seeing how the field of hair restoration surgery will develop in the next 10 years.

Many ISHRS-sponsored academic conferences are scheduled for 2018. The main conferences include the ISHRS World Live Surgery Workshop scheduled for March 8-10 in Dubai, UAE, and the 26th World Congress of the ISHRS, which will take place October 10-14 in Hollywood, California. Again this year, the ISHRS World Live Surgery Workshop is taking place outside of the United States, offering a good opportunity to visit Dubai. I anticipate that the 26th World Congress in Hollywood will be the largest meeting in the history of the ISHRS. I ask for your active participation in these main events. The ISHRS also has a Pre-Congress on Hair Transplantation in conjunction with the 4th International Congress of the Aesthetic Academy of Egypt planned for September 12 in Cairo, Egypt. As far as I know, this would be the first ISHRS-related meeting in the African continent. I hope it is successful. Another ISHRS regional workshop on Scalp Micropigmentation will be held in Walnut Creek, California, after the Hollywood World Congress.

In addition, there are many academic conferences being held by Global Council members. HAIRCON 2018 will be in Mahabalipuram, off Chennai, India, February 16-18. The Present & Future of Hair Restoration Surgery and Medicine will be held by the British Association of Hair Restoration Surgery in London, UK, March 17. The 2nd SILATC Annual Meeting & Live Surgery Workshop, organized by the Ibero Latin American Society of Hair Transplantation (Sociedad Iberolatinoamericana de Trasplante de Cabello – SILATC), will take place May 2-3 in Cancun, Mexico. The 6th Asian Hair Restoration Surgery Meeting & Live Surgery Workshop, organized by the Asian Association of Hair Restoration Surgery in collaboration with the Chinese Association of Hair Restoration Surgery, will take place in Beijing, China, May 11-13. The 4th Latin American Workshop of FUE, organized by the Paraguayan Society of Hair Restoration Surgery, will take place in Guatemala City, Guatemala, May 25-27. The 8th International Congress of the Korean Society of Hair Restoration Surgery will be held in Seoul, Korea, June 9-10. Lastly, the 7th Congress of the ABCRC (Brazilian Society of Hair Restoration Surgery) will take place in Foz do Iguassu, Brazil, August 22-25. I hope that many of you will take the opportunity to experience, learn, and widen your collegiality through the various ISHRS meetings and other meetings held by Global Council member societies.

As announced at the Prague World Congress last year, volunteers are being recruited for various committees, and we have had a good response. Currently, we are in the process of arranging volunteers onto committees. I would like to thank all those who have actively taken part in and supported various committees.

Recently, there was a discussion to change the term FUE from FU Extraction to FU Excision. I am glad that Sharon's article and Ricardo's paper on FUE were published on the cover page, which gives the background on this change. I also believe that excision is a more appropriate word—medically and scientifically—than extraction.

Lastly, I would like to welcome the new 95 members who were approved for membership at our General Membership Business Meeting in Prague. Congratulations on your membership! Our society holds the highest standards of medical practice, medical ethics, and research in the field of hair restoration surgery. I have no doubt that our members will continue to strongly support the ISHRS's unlicensed practice policy and the work of our society.

I am looking forward to having a great year with you. Thank you! ■

Pardon the error…

In the November/December 2017 issue of the *Forum* (Vol. 27, No. 6; p. 232), Figure 1 of Dr. Parsa Mohebi's article, "Dynamics of FUE," was inadvertently cropped. I sincerely apologize to Dr. Mohebi for not catching the error before going to press.

Shown on the right is the figure as it should have appeared.

An updated version of the November/December 2017 *Forum* has been posted to the Members Only section of the ISHRS website.

—Cheryl Duckler, Managing Editor

FIGURE 1. Scalp hair histology: anchor system in relation to hair follicles

Co-editors' Message

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Dear Colleagues:

BREAKING NEWS!
FUE = Follicular Unit EXCISION

Breaking news! The name of the most popular harvesting technique in the world is changing. As the front cover of this issue notes, FUE is now Follicular Unit Excision. Congratulations to Ricardo Mejia for authoring the article outlining this change. The support is widespread as evidenced by the accompanying comments. We also support this change and have edited the articles in this issue to reflect it. Up to this point, "extraction" summarized the entire technique, however, to be more accurate, this harvesting procedure now has been divided into two steps: the incision and the extraction. In the future, when discussing FUE, we encourage all authors to use the word "excision" to describe the removal of follicular units, and we encourage you to be very specific when using the terms incision and extraction. In addition to being more accurate, the updated term reflects something that surgeons do—excise tissue—and in doing so, also helps combat the burgeoning problem of unlicensed FUE surgery by subtlety reminding everyone that only licensed professionals are legally able to excise tissue.

Unlicensed FUE surgery is a common theme in this issue. Sharon Keene touches on the topic in her expansive and comprehensive review of the FUE donor area. She highlights the importance of maintaining an aesthetic donor area appearance and the many factors that contribute to potential overharvesting using FUE. She also points out that only licensed professionals should be making the myriad of decisions necessary to preserve precious follicles. FUE is not a simple harvesting technique but requires special knowledge and medical expertise. In his letter to the editors, Cagatay Sezgin comments on illegal surgeries and suggests steps to be taken to address this practice. The ISHRS has been the leading voice in exposing unlicensed surgery with our "Stand Proud, Be Loud" campaign. The ISHRS's position statement of qualifications for scalp surgery can be found at ishrs.org. A warning concerning societies not affiliated with the ISHRS that permit the unlicensed practice of medicine by their members is published on page 29 of this issue. This topic is very important and if not curtailed, unlicensed surgery will negatively affect our specialty for years to come.

Another recurring topic in this issue is immune-mediated alopecia. Anastasios Vekris presents a case study of twins with Alopecia Areata (AA) successfully treated with platelet rich plasma (PRP) therapy, his second article for this journal discussing the treatment of AA with PRP.[1] In Cyberspace Chat, Robin Unger and colleagues chat about their preferred treatment regimens for AA including PRP. She surmises that practical experience is very important in treating this disease. In Literature Review, Nicole Rogers comments on the use of low dose naltrexone (LDN) to treat lichen planopilaris by reducing inflammation and Nutrafol®, a nutraceutical, to treat hair loss. In Clinical Rheumatology, they "review the evidence that LDN may operate as a novel anti-inflammatory agent in the central nervous system, via action on microglial cells."[2] In the lay press, there is much information on LDN, including The Low Dose Naltrexone Homepage (www.lowdosenaltrexone.org), that you may find interesting. Some tout it as a new wonder drug. Research into the mechanism of naltrexone and its effects on inflammation and immune-mediated alopecia will be interesting.

We are delighted to introduce a new column, Medical and Professional Ethics, written by Gregory Williams, Chairman of the ISHRS Ethics Committee. In each issue, he will discuss cases from the Ethics Committee. This will certainly be a great contribution for the members as we learn about this important committee.

This year, there are 13 meetings listed on the calendar of events (page 41), so there will be many options for us to learn about, present on, and discuss all aspects of hair restoration surgery. There is sure to be a meeting near you. If you'd like to report on a meeting you attend, please contact our Meeting Reviews editor, Nina Otberg. If you are presenting a lecture at one of these meetings, consider converting it into an article for submission to the *Forum*. Letters to the editors are also always welcome. We look forward to keeping you updated in 2018.

—Andreas & Bradley

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1. Vekris, A., et al. Total regrowth in chronic severe alopecia areata treated with platelet rich plasma: a case report and literature review. *Hair Transplant Forum Int'l.* 2015; 25(5):190-191.
2. Younger, J., et al. The use of low-dose naltrexone (LDN) as a novel anti-inflammatory treatment for chronic pain. *Clin Rheumatol.* 2014; 33(4):451-459. ■

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it did not imply surgery and was advertised in 1995 as it is today as "no scalpel, no stitches, no scar." However, as Dr. Mohebi and the Research Committee concluded, "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."

So why do doctors continue to use the word extraction? The answer is simple. It's routine and accepted as the standard. It is very clear with simple mathematics what FUE surgeons do. We perform surgery to excise full-thickness skin grafts containing hair follicles. It all adds up, ½ + ½ = 1, or: Incision + Extraction = Excision.

Hence, a more appropriate and accurate term is **Follicular Unit Excision**. (The good news is that we can continue to refer to this procedure as "FUE," and it will always remain.)

Over the past 20+ years, there has been less focus on true extraction techniques and more focus on the incision aspect of the equation to minimize damage and transection rates and to obtain a better-quality graft. We have seen an explosion in the variety of "incision techniques" using handmade punches from 18- and 19-gauge needles, and sharp, serrated, non-serrated, dull, hybrid, Upunch, Trumpet punches, and more. A variety of automated devices also has evolved to assist with the speed of incisions, such as the S.A.F.E. System™, ARTAS®, NeoGraft®, SmartGraft®, Vortex, PCID, WAW system, Atera, 3 Step FUE, RotoCore, Mamba, and other international devices. These devices, as well as many manual punch handles, have the ability to limit the depth of incisions.

As we continue to evolve and develop better-quality incision techniques, why do we continue to use inappropriate or misleading language? Simply put, it's a bad habit. The ATOE (Cole Instruments)—or Aide to Extraction—is one instrument that is appropriately named. To be precise and accurate in our communication, we should use the term "extraction" only when we are using techniques to physically manipulate and handle the graft to remove it from the body AFTER the incision is made. This can be done by suction, ATOE, the one-handed or two-handed technique, wiping grafts out using gauze, or other techniques that safely avoid damage to the graft. I see conferences and workshops advertising "extraction techniques" when all they are discussing is the way to properly cut the skin with the above incision techniques.

We are in the habit of using this term—extraction—and it will not be easily forgotten or changed. However, to use language in a precise, technically accurate way, we are advocating the change to Follicular Unit Excision. Excision embodies the true aspect of what we do as surgeons in both the academic and clinical aspect as it focuses on the two aspects of the equation: incision and extraction.

In addition, we have a responsibility for truth in advertising. Over the past 15 years, the term extraction has been minimized by many across the world to imply a non-surgical procedure that only involves "extracting" hairs as if they were being plucked out of the scalp without surgery. We continue to see advertisements that promise "no scar" or that use phrases such as "harvesting grafts," which minimize the procedure as if we are non-surgically gathering crops from a field. Given the worldwide expansion of this technique by non-medical and unlicensed personnel, the term extraction often is used to falsely mislead individuals so the procedure can be performed by non-medical personnel and to justify these actions to the public and legislators.

This is why I have proposed that hair transplant surgeons adopt Follicular Unit Excision as the new medical term. In a recent personal communication regarding the name change, both Drs. Rassman and Bernstein agree. Dr. Bernstein noted, "Times have changed and it will give more clarity to the term FUE and hopefully it will be more respected for the surgical procedure that it is." Many international FUE surgeons with whom I have discussed this also agree.

So how should we define FUE? We should define it to reflect the accuracy of the surgical implications:

Follicular Unit Excision is the surgical technique that refers to circumferential incision of the skin around the follicular unit bundle or group of hair follicles for the purpose of extracting a full-thickness skin graft containing hair follicle(s), intradermal fat, dermis, and epidermis.

The ISHRS Board of Governors has reviewed this new terminology and agreed that the above definition more accurately reflects the true nature of the procedure. It also prevents any type of misleading or fraudulent information that may be conveyed to the public. We have heard from leading physicians and textbook authors across the world that this updated terminology "makes sense," and that they are already making plans to incorporate the new culture and terminology into future textbooks. The ISHRS is also on board with making this part of our communication dialogue. Consequently, we are suggesting that the membership adopt this new terminology. Follicular unit incision and extraction techniques will never go away, but at least we can be more academically and clinically precise with our language and communication. I hope that each of you will join us in this transition as we bring in the New Year with Follicular Unit Excision for 2018 and beyond.

On page 6, please see what your colleagues are saying about this change from Extraction to Excision.

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Robert M. Bernstein and **William R. Rassman** began a chain of responses to this change of nomenclature:

This article on FUE name change adds significant clarity to the nomenclature of hair transplantation. Renaming Follicular Unit Extraction to Follicular Unit Excision acknowledges two distinct steps—incision and extraction—that will make communicating with our patients easier and more concise. It will also allow clinicians and researchers to think more clearly about the two steps of FUE, both separately and together, when addressing such issues as transection, suction injury, punch design, automation, and robotics. Although Shakespeare aptly pointed out that at times a name can be quite irrelevant: "What's in a name? That which we call a rose by any other name would smell as sweet" [Romeo and Juliet, II, ii, 1-2], in this case the important change in wording should have lasting significance.

Our current president:

Sungjoo (Tommy) Hwang, MD, PhD, FISHRS: I think it is a great idea. FU Excision is a more scientific and medical term.

Our past presidents:

Jerry E. Cooley, MD, FISHRS: I think it's excellent

Paul C. Cotterill, MD: I definitely agree with the name change to Follicular Unit Excision. This important step will help to control the ambiguity that has been perpetuated and exploited inappropriately by some physicians and companies in our field. This new terminology—FUE: excision = incision + extraction—more accurately reflects the technique.

Edwin S. Epstein, MD: Well written and timely.

Bessam K. Farjo, MBChB: Congratulations on the excellent document you put together, and certainly the term "excision" is far more logical and correctly describes the process. It would have been almost impossible to change the acronym FUE, and so it is great that the suggested new terminology slots in perfectly!

Vincenzo Gambino, MD, FISHRS: Your draft is an excellent piece of scientific writing and truly clarifies a very important distinction that FUE is a surgical procedure.

Marcelo Gandelman, MD: Definitely Follicular Unit Excision! The repeating pattern in relation to the term FUE is in fact damaging our communication with patients. Your idea is innovative with a practical solution surely necessary for our colleagues both in an academic or professional environment. With this article, you are bonding your experience with innovation and have found the solution to the problem. As Dr. Bernstein would say: "Why didn't I think of that?"

Robert S. Haber, MD: While it is almost impossible to change a term once it has entered the public lexicon, it is still a sensible plan; I applaud the idea. By the way, I've been using the term FU Excision in my verbal discussions with patients since the concept was presented, and it was very easy to make the switch.

Sheldon S. Kabaker, MD: "Excision" seems to be a more accurate term than "extraction." All this is appropriate academically, and I support this subtle but more proper definition.

Sharon A. Keene, MD, FISHRS: I like the latest version, and agree it encompasses the important aspects of the technique—including the fact that the extraction does not preclude excision—so when people read this it seems quite clear incising and excising of tissue is occurring… Agree with the need for a definition that describes the important surgical aspects of the technique and is sufficiently broad to cover many different devices—and indicates that more than one hair follicle is often being removed.

Robert T. Leonard, Jr., DO: I wholeheartedly support the Board's decision to change the definition of the "E" in FUE to Excision from Extraction. Hindsight is 20:20, isn't it? If this had been the initial definition from many years ago, our field would not be in the mess we find ourselves in today with unethical, inappropriate, and misleading advertising of this surgical harvesting technique coupled with the fact that non-surgeons are still excising tissue, i.e., performing surgery!

Jennifer H. Martinick, MBBS: The change to "excision" makes perfect sense as it encapsulates the total procedure; incise (a surgical procedure) plus extraction. Well done improving the nomenclature.

Mario Marzola, MBBS: I also agree that the name change better reflects the technique of FUE. It will be difficult to change an established name, but if we all band together, it will gain momentum. We are starting today!

James E. Vogel, MD: Of course this new terminology makes 100% logical sense. Certainly I support it!!

Kuniyoshi Yagyu, MD, FISHRS: I agree with the idea of FU Excision. It is an accurate term of the procedure.

Other comments

Konstantinos K. Anastassakis, MD, PhD: Good idea.

Marco N. Barusco, MD, FISHRS: I think that the nomenclature change is very appropriate and scientifically correct.

Michael L. Beehner, MD, FISHRS: I welcome this change in terminology, since for too long some of the proponents of Follicular Unit Extraction have tried to portray to the public the idea that the procedure is done without any surgery or cutting of tissue. I also agree the change helps label the procedure for what it is, namely, surgery, and that non-physicians should not be performing this.

Kanokwan Chantauppalee, MD: I agree about the new terminology.

Ekrem Civas, MD, FISHRS: I completely agree with this change to excision. Extraction only describes the act of pulling out something, as if a punch incision was not made beforehand. The use of the word extraction simplifies the perception of the procedure, that it can easily be done by anyone and not a hair surgeon; extraction is not a scientifically sufficient academic term.

Ivan S. Cohen, MD, FISHRS: Redefining the "E" in FUE to mean Excision rather than Extraction is a brilliant idea. It defines what we do more accurately, which will help the public understand that this is in fact a surgical procedure.

James A. Harris, MD, FISHRS: FUE as commonly performed is in fact an excision. Excision covers it all…whether rotary, oscillation, sharp or blunt, ultrasound or laser…partial or full depth.

Chiara Insalaco, MD, PhD: The new term synthesizes perfectly what technically happens during the FUE hair restoration. I hope it can be a start towards a big change in this, unfortunately, wild field.

Paul J. McAndrews, MD, FISHRS: For the public to be deceived that FUE is an extraction (not excision) with the implication that it is not really a surgery and only gives you "white dots" is wrong. I absolutely agree. The only difference between the punch excision done in the 1960s and FUE of today is the size of the punch. The total surface area of scar tissue created per follicular unit removed is actually greater for a 1mm FUE punch versus a 4mm punch. Unfortunately, that is not great for marketing.

Osman T. Oguzoglu, MD: I think it's very good idea. I will change all FUE extraction to FUE excision in my website, because patients will think it's a more complicated process and should be done by a doctor.

David Perez-Meza, MD, FISHRS: I agree and I support the proposal about FU Excision. I and others discussed the terminology "excision" with Dr. Crassas 18-19 years ago at the 1999-2000 Orlando Live Surgery Workshop.

Marcelo Pitchon, MD: I consider the change is pertinent and welcome. It is one of the elements necessary to make patients and the general public correctly informed that FUE is real surgery. And that it is not excision-free, nor sequelae-free, nor riskless, nor scarless.

Nicole E. Rogers, MD, FISHRS: Wow! What a great concept! I think this is very helpful and will definitely clarify the concept that FUE is still surgery, not just "extraction" (sounds simple, non-surgical?) of hair follicles.

Antonio Ruston, MD: My opinion is that you are absolutely right—excision is the correct terminology and defines better and more accurately the procedure (incision + extraction), and besides that, I agree that would prevent misleading or fraudulent information.

Arthur Tycosinski, MD, FISHRS: The name change is a master idea: Bingo! I totally support it.

Robin Unger, MD: I agree wholeheartedly. It is FU excision when the skin is cut. Extraction is removing them after the surgical aspect has been completed. And it does also clarify the need for the procedure to be done by trained medical personnel.

Michael W. Vories, MD: I agree that excision is a more precise term. If this at least has the possibility of defining the procedure as a surgical procedure, then I am all for it.

Sara M. Wasserbauer, MD, FISHRS: I am on board.

Ken L. Williams, DO, FISHRS: The nomenclature suggested by you I think is very good. It makes sense. As long as Bernstein, Rassman, and Rose are on board, I don't think there should be any problem in adopting this new language in our future FUE textbook. I like it.

Jerry Wong, MD: I agree that it is better defined as follicular unit excision.

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While the above indices are cumbersome to measure manually, they do include the important factors of hair follicle density and hair shaft diameter. Consider, however, that hair shaft diameter is not uniform among hairs on the same head with neighboring hairs sometimes varying by a factor of 2, and variability occurs even within the same hair. Because of this variability, a sample size of at least 25 hairs must be measured for a reasonably meaningful average.[4-6] To further complicate these calculations, variable hair density between occipital and parietal areas necessitates several index measurements be obtained for a given patient during their first procedure.[7] This becomes even more complex for subsequent FUE surgeries as donor density becomes increasingly variable. More importantly, these parameters (Hair Diameter Index and the Hair Coverage Value) exclude a variety of other contributing factors and circumstances that at times may be more important to the cosmetic appearance of the donor area. A simpler approach described in this paper focuses on easily measured baseline follicular unit (FU) density, safe excision density, and residual donor FU density after FUE. Surgical judgment based on experience as well as knowledge and understanding of contributing cosmetic factors can be used to fine-tune maximum FU excision and residual FU donor density.

Respecting the safe donor area

Experienced hair restoration surgeons know that the same factors that allow us to successfully restore density to the recipient area are relevant to the appearance of cosmetic coverage and fullness in the donor area. Furthermore, various circumstances can increase the importance of one factor over another. To maintain safe donor area (SDA) excision densities (FU/cm²) after FUE, we must first consider basic tenets imposed by donor area limitations. Permanent donor follicles are finite for all patients. Those patients destined for advanced patterns of hair loss are caught in a hair restoration conundrum: the larger the area of projected need, the smaller the donor area is to provide for it. To determine the safe excision density, we must first consider donor area limitations and avoid excising from areas likely to be affected by androgenetic alopecia (AGA). This usually means excluding the nape of the neck, superior lateral fringes, and the superior aspects of the occiput near the regions of the balding crown.

IMPORTANT VALUES

1. **Preoperative density (65-85)—measured prior to surgery**

Values below depend on the hair characteristics described in this article:

2. **Safe single pass excision density—FU/cm² that can be safely excised in one surgery (10-25)**
3. **Maximum excision density—FU/cm² that can be safely excised in multiple surgeries**
4. **Residual donor density—FU/cm² projected for minimum density necessary for satisfactory donor area coverage after one or more surgeries (40-50)**

Predicting the SDA is influenced by the following: a patient's age at the time of assessment, the projected pattern of hair loss based on family history, whether the patient has or is likely to maintain a stable pattern, and whether a patient will progress to more advanced patterns of hair loss. Successful hair transplantation should be considered using a "master plan" that considers hair loss from natural causes as well as the potential loss of hair caused by the surgery. Patients presenting with advanced patterns of hair loss must be educated as to the limitations of donor supply prior to surgery or risk falling prey to those who promise to deliver more hair to the recipient area than the donor area can safely provide. These promises can be made by inexperienced or unscrupulous doctors, and in some cases by unlicensed technicians. When this occurs, what was previously a recipient site focus for the patient can become a donor area nightmare. Experienced surgeons respect the donor area and its follicles in the way they are harvested and managed. If not, both the recipient and donor areas can be adversely affected.

How follicular distribution affects cosmetic donor density

In addition to density and hair shaft diameter, other factors influence cosmetic coverage in the donor area. While each patient's donor density in their occipital or temporal areas is generally consistent, the follicular unit *distribution* within each square centimeter can be irregular. After excising FUs, it is important to attempt to leave the remaining density consistent in each square centimeter excised. Other factors impacting cosmetic density include hair/scalp color contrast and the three-dimensional properties impacting the appearance of volume, which include straight versus wavy or curly hair, the exit angle of the hair, and the patient's planned hair length. This article focuses on the importance of these additional factors in greater detail, and on the clinical situations in which one factor becomes more important than the others. We will introduce simple predictive methods including **safe single pass excision** density based on the preoperative FU density and **maximum excision density** based on the projected **minimum residual donor FU density** necessary for satisfactory donor area coverage. Minimum residual donor FU density depends on the hair characteristics described in this article.

The inability to predict cosmetic improvement on the basis of hair counts and hair shaft diameter alone is shown by the cosmetic limits of 4mm-diameter punch grafts in common use until the mid-1990s. Each graft contained 15-20 FUs placed in punch holes in the recipient area surrounded by bare scalp. This technique created 4mm-diameter punch scars in the donor area. Although a canopy of hair was created to cover the recipient area, short hair styles exposed a pluggy distribution of hair. The same unnatural pattern of hair distribution was seen in the donor area.[8] The pattern of distribution for hair numbers and hair shaft diameter must be considered when follicles are redistributed to the recipient area as well as in the donor area after the excision process.

Visible FUE donor area defects can occur if too many FUs are removed too close to each other. While small punches (<1mm) leave tiny donor scars, increases in excision density create larger spaces between follicular groupings. Jimenez et al. established that normal follicular spacing varies between

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1-1.4mm[9] and excising follicular units doubles that distance. Large spaces between residual FUs can create a mottled appearance. Excision distribution must be irregularly uniform across the donor area—with all square centimeters roughly equal in excision density. If both hair and FU density in one area of scalp is not balanced with other harvested areas, a visible low-density cosmetic defect can be created that may be detectable upon casual observation. Figure 2 illustrates this problem in a young Asian man, whose preferred hairstyle and hair characteristics contribute to a visible and disturbing defect in density.

FIGURE 2. Young Asian male disturbed by pattern of donor scarring following a single session of FUE.

Other factors affecting donor coverage

In addition to the natural distribution of FUs, hair and scalp color contrast is an important cosmetic factor when considering donor coverage. Minimizing contrast between hair and scalp to effectively mask thinning underlies the premise and focus of scalp camouflage agents and techniques that color the scalp and reduce or eliminate the contrast.[10] A similar goal is achieved with scalp micropigmentation.[11] Patients with lighter hair color and fair scalp, or dark hair and dark scalp, have minimal contrast and can achieve acceptable aesthetic results with less density in the recipient area and can support a lower residual donor area density. However, the reverse is also true, referring again to Figure 2 where high contrast is a significant contributing factor to the visibility of donor area scarring. Had the patient's hair been blonde, gray, or salt and pepper, the area of visibly thinner hair would have been much less apparent or not detectable at all.

It is also known that wavy or curly hair covers the scalp better than straight hair. This advantage applies to the donor area appearance when hair is sufficiently long for the curl to manifest itself. In the case of tight curls, hairs can complete a circle, cover more scalp, and double or triple the visual impact of a single hair follicle. When this occurs, the effect of curl is more important than hair shaft diameter, making a coverage value or hair diameter index inapplicable.

Consider, for example, straight, black hair 80 microns in diameter compared to tightly curled, black hair of 60 microns, both grown to 1 inch. This length allows the curly hair to complete 360 degrees or even triple the strand on itself. The lower diameter, curly hair for the same numbers will appear more dense. Add to this scenario dark scalp with minimal contrast, and the resulting visual effect is more than a multiplier of the original hair diameter. For wavy hair, the greater the frequency of undulations, the greater the appearance of volume (fullness). Wave and curl improve the ability of the hair canopy to block light. Visual qualification of these hair characteristics is complex, with classification of curl and curvature described by De La Mettrie and others.[12] Complex mathematical equations are required to duplicate curl in computer software imaging, with no simple way to quantify the visual impact on density or donor area coverage.[13] This is particularly true given the greater or lesser impact that occurs as a function of hair length and layering. Regardless of the positive visual impact of a wave or curl, it should not be viewed as a reason to overharvest and reduce residual FU density. If a patient gets out of a swimming pool or is in a wind storm, or merely wishes to wear a short hair style, these valuable hair characteristics lose "coverage" value.

When the exit angle of the hair is more acute, it provides more effective "shingling," which improves the appearance of scalp coverage and cosmetic fullness. This acute angulation is a natural orientation of hair in the donor area for most patients, which generally layers over itself, maximizing light blocking. Harris observed that Asian patients, who have more obtuse exit angles, are at greater risk for visible donor thinning from FUE.

Postoperative hair length is a critical factor for determining cosmetic coverage in the donor area. For patients who plan to wear their hair short (3-6mm), also known as a #1-2 guard on clippers used by barbers, there will be no hair "canopy" and little or no layering benefit. The residual donor densities in these patients must be higher than for those who keep their donor area hair longer. Figure 3 illustrates donor defects that could be potentially less noticeable with longer hair styles. Very short hair in the donor area (also known as stubble) eliminates any contribution from wave or curl and strongly reduces the contribution of even coarse hair. Short or stubble hair will accentuate the "empty spaces" created by FUE, making FU distribution and their numbers per cm^2 more important than hair counts per cm^2. For example, if hair in the donor area is 3mm long at a residual donor density of 50 FUs averaging 1.5 hairs/FU vs 30 FUs averaging 2.5 hairs/FU, despite equal hair numbers, the higher FU density will reveal fewer and smaller bare spaces. In this situation, high contrast color differentials can also exacerbate any lower residual FU donor density present (e.g., black hair on light scalp).

FIGURE 3. Longer hair length could assist in donor scar coverage.

Knowledgeable surgeons can integrate these hair characteristics to successfully excise large numbers of grafts with high excision densities while maintaining cosmetically adequate donor coverage. Figure 4 illustrates a successful excision of >6,000 FUs in a patient with favorable hair characteristics including hair/scalp color contrast, medium hair shaft diameter, and wavy hair. Comparison of before and after photos of his donor area reflects a visible decrease in overall donor volume; however, the donor area coverage remains aesthetically pleasing for the patient's hair style and hair characteristics.

Patients must be counseled and cautioned about donor limitations if they have less than favorable hair characteristics in the donor area, such as lower hair shaft diameter, straight hair, high color contrast between hair and scalp, an obtuse

FIGURE 4. Serial photos document cosmetic changes after 6,000 FUE grafts *(compliments J. Harris).*

exit angle of donor hair, average or lower baseline FU or hair follicle densities, or length and style that exposes the scalp.

Donor area capacity

The donor area capacity for FUE can be calculated based on 1) the size of the donor area (in cm^2), 2) baseline FU density per cm^2, 3) the maximum excision density per cm^2, and 4) residual donor FU density. For example, a safe donor area of $189cm^2$ (27cm × 7cm) with baseline average density 65 could easily support an excision density of 10-15, yielding 1,890-2,835 grafts. This would leave a residual donor density of 50-55 in the donor area. This yield may be sufficient for patients with Class II-IV patterns of hair loss depending on the recipient area size and hair characteristics. However, the requirement for greater yields to achieve cosmetic goals in Class V-VII patients may risk overharvesting. Many of these patients will need 3,000-5,000 grafts (or possibly more), requiring excision densities of 16-26 in the above example, leaving residual densities less than 50 (39-49). Depending on other hair characteristics, the residual donor density in this range could begin to appear thin, see-through, and mottled. It is always important to be aware that meeting a patient's goal for recipient area density or coverage may not be achievable without creating visible donor area thinning including alopecia.

Maximum excision density without overharvesting

How can a surgeon determine a safe maximum excision density and avoid the complications of overharvesting? What factors contribute to focal necrosis? Currently no single algorithm integrates all the various factors to predict the minimum adequate donor area density after FUE. However, in every circumstance, FU donor density is a critical factor and this seems a reasonable variable to examine first when identifying safe levels of excision and residual donor density.

Baseline FU density, as a parameter, can be used by a surgeon to educate patients on how excising a particular number of grafts per square centimeter (excision density) will yield a particular number of grafts for transplantation. Furthermore, excision density can be used to explain the visual impact on donor area density (residual FU donor density) incorporating a surgeon's knowledge of the patient's hair characteristics and planned donor length.

Each patient's donor area should be examined and baseline FU density (FU/cm^2) measured at the outset of every preliminary evaluation. FU density in both the occipital and temporal donor regions of the safe zone can be determined using a simple tool, the densitometer, as described by Boden (Figure 5).[14] Average density in the donor area reveals ethnic variation ranging from 65-85 in the central occipital donor area in Caucasians to 61-63 in Asians.[9,15] African hair density has the lowest FU density.[11] While absolute hair counts create the fullness of the canopy, residual FU density and its distribution within that area will determine the cosmetic appearance of the donor area after FUE, therefore, FU density provides a useful barometer until lower residual densities require the incorporation of other factors.

FIGURE 5. Densitometer is an easy tool to determine baseline FU density.

Normal hairline and temporal densities have been noted to average 40-50.[16] A residual donor area density of 40-50 can be expected to maintain adequate coverage for a patient with medium diameter hair that is straight or mildly wavy and has moderate contrast between hair and skin color. A lower residual density could be risky, especially in patients with less favorable hair characteristics such as fine, straight black hair and light scalp. Man-made density charts have been used to compare density of 20-40 when hair groupings are all 1's and 2's versus all 3's and 4's.[17] These charts, shown in Figures 6 and 7 (on page 10), were created by author Dr. Sharon Keene to illustrate the cosmetic importance of hair counts for a certain graft density, but they can also be used to illustrate density issues for the donor area. For example, surgeons must be aware how selectively excising larger FUs during FUE procedures can impact residual donor density, especially after aggressive excision has occurred. As the figures illustrate, residual densities of 20-30, especially when groupings are all 1-2 hairs, are "see-through," thin, and must be avoided. Alternatively, the density chart also illustrates that patients with above average numbers of 3- to 4-hair FUs, if left *in situ*, can tolerate lower residual density and still provide aesthetically pleasing coverage at longer hair lengths.

Most FUE experts recommend 10-15 excisions/cm^2 as a safe single pass density in a person with baseline average density of 65-75. Article co-author Dr. James Harris reports a routine use of higher excision density in the range of 20-25 without problems. In the case of a patient with an average baseline density of 70, an excision density of 10-15 leaves a residual FU donor density of 55-60. A second pass FUE surgery with the same excision density would further reduce

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FIGURE 6. Man-made density charts, black hair, from 20-50 FU/cm^2. Top row illustrates "see-through" appearance at 20-30; bottom row cosmetic coverage at 40-50.

FIGURE 7. Top row illustrates "see-through" for both black and blonde hair at 20 FU, all 1- to 2-hair groupings. The bottom row compares blonde hair at 30 FU/cm^2 with all 1- to 2-hair groupings vs all 3- to 4-hair groupings.

residual density to 40-45, and a third pass to 25-30. Visible thinning may be expected in the latter case, but it could also appear at a residual density between 40-50, particularly when hair shaft diameter is low, contrast is high, hairs are straight, and the hairstyle is short.

The importance of higher-than-average baseline density becomes apparent if we measure residual density in a patient with a baseline density of 100. If this patient undergoes excision at a density of 10-15, the residual donor density will go down to 85-90, resulting in a higher residual density than the baseline density of the previous patient. It is unlikely that a reduction of FU donor density as high as 50% for a patient with 100 will leave visible thinning as this will still provide a residual donor density of 50 regardless of other hair characteristics. In comparison, a maximum excision density of 30-35% for patients with an average density of 70 will leave a residual density of 46-49; the latter is <50, and cosmetic coverage will depend on other hair characteristics previously discussed. Higher maximum excision density can be safe when baseline donor FU densities are higher than average, leaving a higher residual donor FU density. These are relatively simple parameters to obtain in a first-time patient and require simple subtraction to make the calculations.

A more complex situation arises in repeat FUE cases, where excision density from the first surgery may not be uniform and baseline density is low. In such cases, any areas of visible thinning should be documented, measured, and avoided. The "new" baseline density may require measurements in several areas, with the goal to avoid creating more areas of "visible thinning" and to determine a safe excision density that will maintain a cosmetic residual density (40-50), modified based on hair characteristics and planned hair style. Density in the thinning areas can allow the surgeon to know cosmetic density limits for that patient's hair characteristics. ***The centimeter-by-centimeter examination that occurs during surgical FU excision to avoid overharvesting underscores the need for experienced and ethical professionals to make the medical decisions necessary for safe maximum excision density.***

While an average of 10-15 excisions/cm^2 is reportedly safe for a single pass in patients with at least average baseline densities, it also appears safe in avoiding focal necrosis. Contiguous FU excisions, where the punch holes merge with each other, must be avoided, not only to prevent areas of empty skin, which produces mottling, but also to reduce the risk of local devascularization, which could lead to scalp necrosis. Higher excision densities would seem to increase the risk of necrosis, but an exact maximum to avoid this complication has not been identified.

CONCLUSION

There are many factors that contribute to visual hair "fullness" in both the recipient and the donor areas. Avoiding the complications of visual overharvesting or focal necrosis from FUE requires that the surgeon pay attention to irregularly distributed, uniform levels of safe excision densities to maintain a residual density of 40-50. This should leave a donor area that does not appear thin for the patient's hair characteristics and hairstyle the patient prefers to wear. Conservative single pass excision density of 10-15 in virtually all patients who have normal baseline densities is safe. A higher single pass donor FUE density of 20-25 may be possible when the baseline donor densities are significantly higher than average. Hair characteristics, such as the thickness of the hair shafts, the degree of curl or wave, the color contrast between hair and scalp, the exit angle of hairs on the donor scalp, and whether hair will be worn short or long, allow the surgeon to then alter the residual donor FU density using his or her best judgment. While there is no single mathematical algorithm to incorporate all of the factors that contribute to donor area density, a weighted system may be possible to further enhance our ability to predict safe excision and residual donor densities.

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