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Graft preparation and placement quality control: what physicians should know

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Introduction

Graft preparation and placement are essential to successful hair restoration, and these tasks are most often delegated to surgical assistants with minimal involvement from a physician. However, if the quality of the assistant's work is suboptimal, the quality of the physician's work would be compromised and the final result greatly affected. For that reason, addressing quality control (QC) in hair restoration is necessary. In the past, QC has not been addressed in a systematic way. This article will demonstrate quality standards related to graft preparation and placement and outline steps for physicians to follow to implement QC in their practices.

QC: Who, Why, When, and How

QC consists of setting specific quality standards relevant to obtaining desirable results, monitoring their implementation, and identifying as well as providing guidelines for correcting one's mistakes. QC is a continual process of comparing one's work against set standards, and in hair restoration it can be performed during and after the surgery. This article will focus only on the surgical portion of quality control. In addition, hair restoration is a team effort and, therefore, QC should be the responsibility of the entire team; each member of the surgical team should keep quality standards in mind and continually check his or her work against those standards, but ultimately QC is a physician's responsibility. A physician may trust his or her staff to deliver quality work but should be capable to perform and provide oversight on QC.

The objective for observing one's work is to determine whether the quality standards are obtained or could be attained. The purpose for seeking quality work is to ensure the following: maximum yield from harvested hair, maximum graft/hair survival, maximum re-growth from transplanted hair, and a natural and seamless result (re-growth).

Furthermore, QC is also a process of constant monitoring one's work for possible mistakes. Accordingly, mistakes that may occur during graft preparation and placement are grouped around those that can compromise hair yield and/or naturalness. All possible mistakes made by the surgical assistant are "human factors" considering that they cannot be blamed on faulty equipment. Common mistakes committed by surgical assistants encompass trauma done to the hair-bearing tissue and improper technique. The trauma relates to desiccation and physical damage, while improper technique includes lack of dexterity, lack of attention, lack of knowledge, and lack of magnification/sight. Trauma can be inflicted during slivering, dissecting, and placing grafts.

Drying out of slivers or grafts could result in poor growth (fewer than the transplanted hairs growing back with insufficient "coverage") or in an absence of growth (visible empty spaces where grafts were placed during the procedure but with no subsequent hair growth). Desiccation is caused by the assistant's ignorance or neglect. Oftentimes, assistants become too focused on a task so as to forget to hydrate the tissue; become involved in a conversation and neglect to hydrate the tissue; or overestimate their speed of dissection and/or placement and thereby unnecessarily expose grafts to the air and drying out. To preserve its moisture, harvested tissue should be completely immersed in the storage

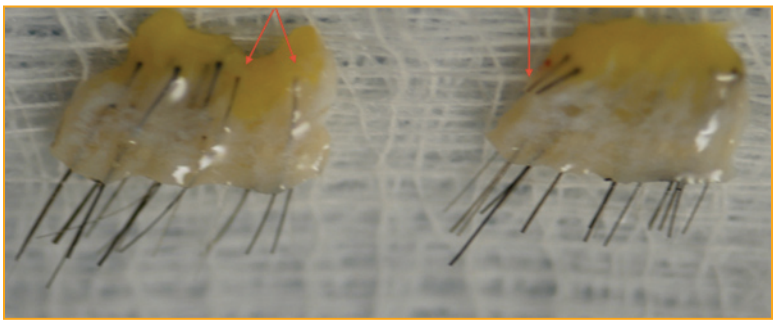

Figure 1. The sliver on the left demonstrates transection at its end, which is caused either by the physician during donor harvesting or by the assistant because of a forceful dissection. The sliver on the right demonstrates transection on its side, which is caused by the assistant during the slivering process.

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President's Message

Jerry E. Cooley, MD *Charlotte, North Carolina, USA* jcooley@haircenter.com

There are many issues facing our field at the present time. I would like to highlight one of these. At some point in the near future, it is likely that this issue will affect us at both the level of our individual practices and as members in the ISHRS; it will impact our patients as well.

This issue relates to new technologies in powered follicular unit extraction (FUE). Some companies hope to succeed by selling equipment and services to physicians with minimal background in hair restoration. The message seems to be, "Hair restoration is an easy concept, and now we've made the procedure easy too." It is understandable in today's economic climate why some physicians are attracted to this message. Why not add another service to the menu and potentially increase revenue? But what about assistants to help perform these labor-intensive procedures? "No problem," comes the reply. "We'll send in a team of experienced assistants to run the whole transplant, start to finish. You just 'supervise.'"

Hair restoration is an easy concept, right? You take hair follicles from one area where there's lots of hair and transplant them to thinning or bald areas. What could go wrong? Those of us experienced in the field are well aware of the complexities involved with this so called simple procedure: pre-op evaluation and counseling, medical treatments, assessment of candidacy for hair restoration, donor evaluation, patient goals, recipient area planning, hairline design, planning for future hair loss, female hair loss and non-androgenetic alopecia, medical clearance for surgery, preventing shock loss and poor growth, handling possible complications…. Simple procedure? The more experienced I get in hair restoration, the more complicated hair restoration gets!

There are also legal issues to consider. What constitutes the practice of medicine? What constitutes adequate training and certification to perform hair restoration surgery? The first step in FUE involves cutting the skin and removing follicles. The ISHRS has stated that this constitutes the practice of medicine. Many states, provinces, and countries will agree. An experienced hair assistant (who lacks a medical degree or physician assistant license) may be surprised to learn that what seemed like a lucrative niche is in fact putting them in great legal jeopardy. Neither the company that hired them nor the physician who "supervised" them will protect them from charges of practicing medicine without a license in certain locales.

And what about these "supervising physicians"? Many jurisdictions will be similar to the state of Maryland in this regard (www.mbp.state.md.us/). In the regulations from the Board of Physicians, it states:

1. A physician who performs, assigns, supervises, or delegates the performance of cosmetic medical procedures by a non-physician first shall obtain training in the indications for and performance of the cosmetic medical procedures and operation of any cosmetic medical device to be used.
2. Training programs provided by a manufacturer or vendor of cosmetic medical devices or supplies may not be a physician's only education in the cosmetic medical procedures or the operation of the cosmetic medical devices to be used.

The physicians who place their trust in a cosmetic company that sold them a machine and a team of assistants they've never met, is not only putting their patients at risk but also their medical license.

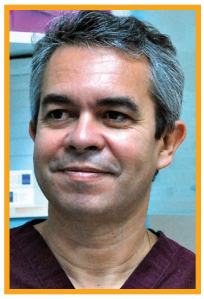
Here's the bottom line: Patients will be harmed by this situation. It is possible that a medical complication during the hair restoration procedure could occur that the inexperienced "supervising physician" is ill equipped to handle. Far more likely, however, is the scenario in which patients waste money and get poor results. That will hurt all of us as the image of hair restoration surgery in general is tarnished.

We've come too far to stand by and watch our field be harmed by those who minimize its complexities in search of a quick buck. If you become aware that such unsafe practices are occurring in your community, please contact the ISHRS and your local medical authority.

Jerry E. Cooley, MD

Co-editors' Messages

Paco Jimenez, MD *Las Palmas, Spain* jimenezeditor@clinicadelpelo.com



This, my last contribution as *Forum* editor, is basically a message of gratitude to all the people who have helped me carry out my duties as editor over these past three years.

I vividly remember one day in my office during the summer of 2007 when I received an unexpected long-distance phone call from Drs. Jerry Cooley and Bob Haber. The purpose of the call was to propose me as a candidate for the next *Forum* editor. I thought it was a great responsibility, even more so as I would be a non-native English speaking editor of a journal written in English, but, at the same time, I felt very privileged to be chosen as a candidate from among so many colleagues. I accepted the offer without hesitation, especially when I knew that Bernie Nusbaum was the candidate for the other co-editor. I would like to express my heartfelt thanks to Bob and Jerry for the trust placed in me since I would not be writing this letter today if it hadn't been for them. During these 3 years, Jerry and Bob, as well as the other past editors, have been unstinting in their support and I have only ever heard words of approval from them with respect to our work as editors.

It has been my great fortune to have worked with Bernie Nusbaum as co-editor. I honestly think that we have made a fine team, and I hope we have become lifelong friends. On the fundamental issues there has never been a disagreement between us. While deep-down Bernie is a straight-talking person, he is at the same time very diplomatic in his manners, something that is very important when on occasions you have to reject papers, deal with unfair criticism, or publish articles on controversial topics to which you know for sure there will be some strong reactions.

I want to acknowledge the hard work put in by all the *Forum* columnists. Nilofer's Hair Science column, incorporating interviews with prominent researchers, has been one of the many highlights. A great asset has been the recruitment of young and talented physicians like Bertram Ng and Sara Wasserbauer with the creation of new columns (How I Do It; Hair's the Question), which have been very well received by the readers. Sharon Keene with the Cyberchat has done a splendid job, and I would also like to thank Russell Knudsen, Marc Avram, Nicole Rogers, Sheldon Kabaker, Maurice Collins, Sam Lam, Vance Elliot, Ed Epstein, Alfonso Barrera, Tommy Hwang, Jennifer Martinick, Fabio Rinaldi, Marcelo Pitchon, as well as the past editors, for all their contributions.

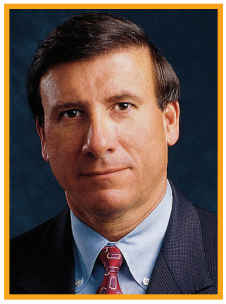
Besides Bernie and myself, there are two people who have formed the hard core of the *Forum* and who I would like to acknowledge: Cheryl Duckler and Victoria Ceh. The layout editor of the *Forum* for many years, Cheryl has worked with different teams of editors, and she is the person that ensures the *Forum* comes out in a readable and attractive form. Victoria is always there when we need her help or wise advice. Both are fine examples of superb efficacy.

Now Nilofer Farjo and Bill Reed will take over the reins of the *Forum*. I sincerely hope they enjoy each minute of this task as much as I did.

Today, December 25th, Christmas Day, a sunny day in my hometown of Las Palmas in the Canary Islands, I would like to express a sincere and heartfelt: *"Gracias a todos."*

Paco Jimenez, MD

Bernard Nusbaum, MD *Coral Gables, Florida, USA* drnusbaum@yahoo.com



It's hard to believe that three years have gone by and Paco Jimenez and I will now "hand the torch" of the *Forum* co-editorship to the extremely brilliant team of Drs. Nilofer Farjo and William Reed. I can frankly tell them that these past three years have been at times laborious but always interesting and full of enlightenment. As was described to me when I started this mission, I can also tell Nilofer and Bill that they have become part of a very privileged group of individuals who have been chosen for this honor, as even the ranks of ISHRS past presidents greatly outnumber the select, short list of former *Forum* editors. My job was made much easier by having the pleasure of working with Paco Jimenez, who always had innovative ideas, and who brought a scientific focus as well as an international flavor to the publication. I had the opportunity to read Paco's message and I agree that he has become my lifelong friend whom I greatly respect as a human being, as a physician, and as a scientist. While, as Paco mentions, during certain "sticky" situations, I may have contributed with diplomacy, he was definitely the "brains" of the operation. From the bottom of my heart, without repeating your names, I want to thank all of you who contributed with columns and submissions these past three years, and I particularly want to thank Victoria Ceh, Cheryl Duckler, the ISHRS presidents, and past *Forum* editors for their wisdom and advice.

Sincerely,

Bernard Nusbaum, MD

Thank You

On behalf of the Board of Governors, I want to personally thank Bernie Nusbaum, MD, and Paco Jimenez, MD, for an outstanding three-year stint at the *Forum*. Having served as editor for the term before, I know how challenging and time-consuming this position is. Judging by the quality of the *Forum* during their time, it is obvious that they put a lot of work into being editors. It is important to remember that this time is uncompensated, and comes at the expense of their practices and family. Please join me in expressing a heartfelt thanks for a job well done. Consider emailing them individually to express your gratitude, too. After putting so much of themselves into the *Forum*, this is the least we can do.

And so the baton is passed to Nilofer Farjo, MBChB, and William Reed, MD. I am looking forward to seeing how they bring their own unique style to the Forum. With Nilofer's interest in basic hair science and Bill's out of the box thinking, I know that we are in good hands!

Jerry Cooley, MD ISHRS President

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1. 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.
2. If results are presented, the medical regimen or surgical techniques that were used to obtain the results should be disclosed in detail.
3. Articles submitted with the sole purpose of promotion or marketing will not be accepted.
4. Authors should acknowledge all funding sources that supported their work as well as any relevant corporate affiliation.
5. Trademarked names should not be used to refer to devices or techniques, when possible.
6. 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.
7. Once the manuscript is accepted, it will be published as soon as possible, depending on space availability.
8. All manuscripts should be submitted to editors@ISHRS.org.
9. 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.
10. 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).
11. We CANNOT accept photos taken on cell phones.
12. Please include a contact email address to be published with your article.

Submission deadlines:
February 5 for March/April 2011 issue
April 5 for May/June 2011 issue

Notes from the Editor Emeritus

William M. Parsley, MD *Louisville, Kentucky, USA* parsleyw@me.com

With so many new devices and products coming out, it can become confusing to evaluate their value. What will be their place in the field, and what should be their place in your practice? Currently, you have ACell, platelet rich plasma (PRP) therapy, biotin supplements, tretinoin mixed with minoxidil, low level laser therapy (LLLT), robotics, Neograft, ReGenica, Viviscal, etc. How do you truly evaluate their worth? Here is one red flag for a product that may not stand the test of time—"rush to market." If you never heard of it and suddenly it is available for purchase, be wary. If doctors are touting it on the Internet and drawing wildly enthusiastic patients while you are still wondering if it even works, be wary. If you can't understand how or why it works even after the company's explanation, be wary. If the good results are all anecdotal or accompanied by photographic tricks (different lighting, different angles, wet hair, etc.), be very wary. If the results shown are product usage combined with minoxidil or finasteride, be very wary. If the studies are poorly constructed or performed by someone with a financial interest, be very, very wary. If they are being marketed primarily to novices, be extremely wary. If their main marketing pitch is how much money you can make or how fast you can pay off the equipment, be very extremely wary. But a common denominator is that they are already on the market and you don't know why. Good products and devices come more slowly and ethical companies prove their product's worth before marketing. For most products and devices, but not all, you should have heard about them and have been waiting for them. Some of the above products may be mainstream in a few years, but which ones? Time and experience will sort them out.

A finished LED cross polarization (CP) unit is getting closer to market. The way CP works is that you use a powerful light with a linear polarizing filter that creates a polarized plane of light, which hits the subject (in our case, the scalp). Being a flat surface that is often wet, the scalp skin reflects the light back to your eyes as a polarized light on the same plane as the light reaching the skin. This polarized light reaches a second linear polarizing filter between the subject and your magnifiers (or eyes). This second filter is rotated at 90° to the first filter, blocking nearly all of your created polarized light. So what's going on? The important factor is that not all of the light is reflected off of the skin's surface. Some of the light penetrates up to1mm into the skin and is reflected back to your eyes as nonpolarized backscatter. This allows a light that has no glare and a light that allows seeing a short distance into the skin. The advantages are that you have far less eye fatigue and better visibility. For those who have used it, it can be quite addictive.

For cross polarization/magnification, the following are desirable:

1. An LED light source. As opposed to incandescent light sources (like halogen lights), LED lights put out minimal infrared rays, and the diodes are very small and durable. LED lights can last over 50,000 hours as opposed to 500-1,000 for halogen. LED lights are more efficient than halogen; and most surgical LED lights release heat through a light heat sink or the light case, so they don't require a noisy fan. The light also can be made to daylight Kelvin instead of the yellowish hue commonly seen with halogen.
2. The closer the light to the subject, the more in line with your eyes, and the ability to focus are desirable factors.
3. The light should be adaptable and allow you to use the magnification system you desire, whether a magnifying bar or your own high-quality loupe optics.
4. The light should come with small, long-lasting batteries to free you from being hooked to the electrical outlet.
5. The polarizing filters should be linear polarizing filters. Filters that transmit 35-40% of the light are ideal. A PVA filter over the light is acceptable; but if using loupes, try to place thin 0.5mm glass polarizing filters over the optical system.
6. The light should be "powerful," as less than 5% of the light returns to your eyes when using CP. As a rough guideline, a light without filters should be able to put at least 70 kLux on the subject.

Several companies have an interest in producing a ready-made product. In addition, Dr. T.K. Shiao, using his engineering background, has been developing a workable, inexpensive model that promises to be very good for assistants and for most physicians. At any rate, a ready-made model or a simple assembly model should be available in the near future for you to check out.

I'd also like to share a helpful learning tool. Recently, I stumbled onto a website—Lynda.com—that offers video tutorials on just about every imaginable program for Windows and Macintosh. On this site, you'll find video tutorials for basic computer skills, the different Windows and Mac operating systems, PowerPoint, Word, Excel, Photoshop, Illustrator, Keynotes, iPhoto, and Aperture, to name a few, along with tutorials for website-creating programs. For video (movies), there are multiple programs: Windows Movie Maker, Adobe Premiere, iMovie, Final Cut Express, Final Cut Pro, and Avid. These don't just include the latest version, but also many of the older versions. I have watched numerous tutorials over the past month and can assure you that the quality of teaching is first class. The cost is $250US for a one-year subscription, which includes all of the hundreds of programs in their library available to you 24 hours a day. If desired, they also offer unlimited use of their exercise programs for another $125US/year. Lynda.com offers a wonderful way to learn how to use the programs that you would love to know. (It must be disclosed that I have no financial interest other than passing along what I think is a very valuable tip.) Unfortunately, these tutorials are only in English, but perhaps there are other websites that offer similar instruction in other languages that are just as good.

It is hard to believe that it has been 3 years since Drs. Paco Jimenez and Bernie Nusbaum became the *Forum* editors. Both are modest and soft-spoken, but are two of the best minds in our field. The *Forum* articles have been well presented and educational. It is sad to see them leave, but we are grateful for all their hard work in making the *Forum* such an educational tool. Thanks, Paco and Bernie! And also thanks to our extremely valuable Managing Editor, Cheryl Duckler, who so competently orchestrates the *Forum* and makes it work so well. But it is time for the "changing of the guard." We are happy to report that our new editors, Drs. Bill Reed and Nilofer Farjo, are wonderful blends of basic science, research, and clinical practice. They will undoubtedly make us think and expand our minds. Welcome, Bill and Nilofer!✧

Quality control
from front page

solution at all times and tissue being dissected and transplanted sprayed every 2-3 minutes. During placement, assistants should take only as many grafts as can be placed in 3 minutes.

Physical damage to the hair encompasses forceful manipulation (i.e., squeezing the hair bulge or hair bulb with forceps or scraping it with a blade) or transection (i.e., cutting and destroying the integrity of the hair shaft). Forceful manipulation may result in kinky-looking hair while transection may result in sparse or lack of growth.

The QC process should not be strenuous and time consuming. A physician who knows the quality standards can develop "an eagle eye" to easily recognize characteristics of the tissue and/or of the assistant's technique that indicate desired quality and high standard. Besides monitoring oneself, an assistant can place grafts made by another assistant and that way indirectly control the quality of grafts. In addition, noting which assistant placed grafts in what part of the recipient area provides a future reference for QC. When a patient returns for follow-up with a poor result, the physician can refer to the chart and address corrective actions directly with the individual(s) who worked on the affected area of that patient.

There are four areas in which QC should be performed regarding graft preparation and placement: during slivering, graft dissection, graft placement, and at the end of the procedure.

QC During Slivering

During slivering one should be attentive to the following: transection, consistent width of the slivers, and desiccation. Transection may be caused by an assistant's lack of dexterity: sawing or pushing the blade through tissue instead of sliding it in small progressive movements. Alternatively, transection may arise when an assistant does not recognize when the blade is dull and ineffective for fine dissection. Further, the assistant may not be able to see the hair structure clearly to cut between the hairs or may have poor hand and eye coordination thus misaligning a blade vis-à-vis the hair angles. Slivers are made in a rectangular shape giving them two narrow ends and two wide sides. If transection is observed on the end of the sliver, it is often an indication that it occurred by the physician during the donor harvest; while if observed on its side, it reveals an assistant's mishandling. However, an assistant may cause transection at the end of a sliver if the last movement of the blade before the sliver detaches from the donor strip is a push instead of a sliding motion. To determine more clearly who is at fault, the donor strip should be examined for transection immediately after the harvest and before it gets further dissected (Figure 1).

Donor tissue is slivered before being dissected in order to expose follicular units (FUs) so that they can be dissected more easily. Therefore, the ideal width of a sliver is one row of FUs. An inconsistent width results in more tissue manipulation and prolonged time of graft preparation (Figure 2).

The difference between hydrated and desiccated tissue is in its appearance. Hydrated tissue looks plump and shiny while desiccated tissue looks shriveled and matte. Whether it is slivers or grafts, transplanted tissue loses its shiny look after being exposed to the air for about 5 minutes. Figure 3 illustrates the difference between moist and dried-out slivers, and it applies to graft dissection equally. Considering that monitoring for proper hydration should take place throughout the entire procedure, its implementation will be assumed and to avoid repetition, there will be no further mention of tissue/graft hydration in this article (Table 1).

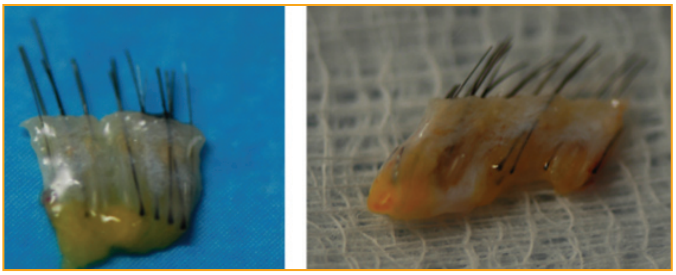


Figure 2. The sliver on the left is thin and even rectangular shape, exposing only one row of follicular units. The sliver on the right is thick and uneven shape, displaying two rows of follicular units.

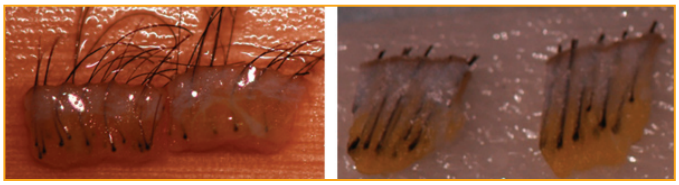
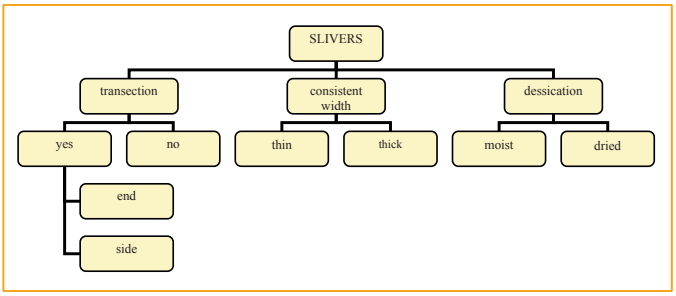


Figure 3. The slivers on the left are well hydrated, looking plump and shiny. The slivers on the right are dehydrated, looking shriveled and matte.

Table 1. Step-by-Step Quality Control During Slivering



QC During Graft Dissection

During graft dissection one should be watching for transection, correct graft size and shape, and desiccation. Transection may be obvious or buried into the tissue that is trimmed away and wasted. Obvious transection displays a hair shaft with a missing bulb or a hair bulb with a very short hair shaft (cut below the hair bulge) (Figure 4). It is a common understanding that the highest yield from transplanted hair is obtained from non-transected hair follicles. In the situation when the same amount of tissue or approximately the same number of slivers are dissected by a different assistant but one assistant obtains significantly fewer grafts, there could be two culprits to blame: 1) that the hair density of the donor tissue in one section was inferior to another section, and 2) that the assistant transected follicles then trimmed them away in order to make desirable grafts. If the donor tissue did not show significant difference in hair density, then the tissue waste should be examined to confirm possible improper dissecting. On average, the tissue waste contains hair fragments that consist mostly of hair shafts and occasional hair bulbs.

Seamless healing of transplanted grafts ensures naturalness of the result. Recipient sites are made to fit specific-sized grafts, and considering that they are made using the same-sized instruments, grafts allocated for specific sites should also be of a consistent size and shape (Figure 5). The ideal recipient site-to-graft fit is

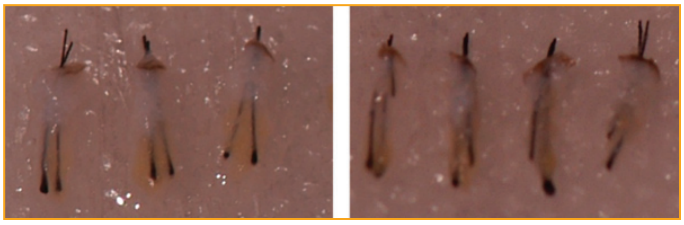


Figure 4. The grafts shown in the image on the left have their hair shafts intact, while the grafts in the image on the right are transected.

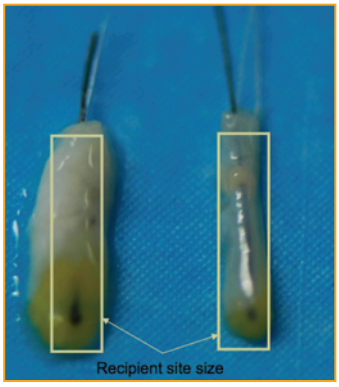


Figure 5. The image shows graft size to recipient site size fit: The graft on the left is a misfit (too big and "fluffy"), while the graft on the right is a perfect fit (appropriate size and rectangular shape).

snug; grafts should not be squeezed or loosely fitting. A graft that is too big for a recipient site could get traumatized from forceful insertion as well as cause a "pluggy" result from hairs being compressed instead of freely spread out within a site. If a graft is too small, it may slide inside the site, leaving the site looking empty, which in turn may falsely encourage the surgical assistant to put another graft into the same site. This is called piggybacking and it often results in ingrown hairs. Another factor in achieving a natural result is correct hair count distribution. It is common for a physician to create sites for 1-hair grafts in the very front of the hairline, but the assistant may not be aware of the importance of placing 1-hair grafts only. A graft that has one visible dark hair but another transected or telogen hair is no longer considered as a single-hair graft and thereby is not suitable for placement along the very front of the hairline (Figure 6). Therefore, each graft should be cut cleanly into a rectangular shape and examined for its hair count so that it can be grouped with grafts that contain the same number of hairs. Additionally, selecting finer (not coarser) hair for the hairline is preferable. It is important to note that if there is a significant difference in hair color observed within the donor strip (e.g., hair in temples is mostly white while hair in the mid-occiput is mostly dark), the assistant should pay attention either to separate white from dark hair and allocate white hairs for the temple region or alternatively to mix grafts of the same size but different color in order to prevent patchy results (Table 2).

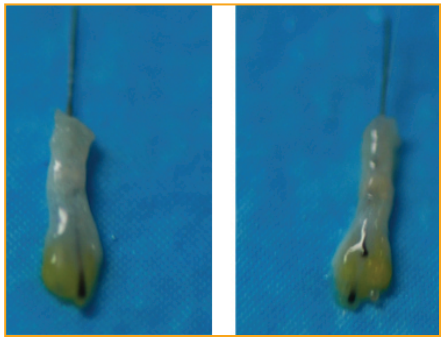
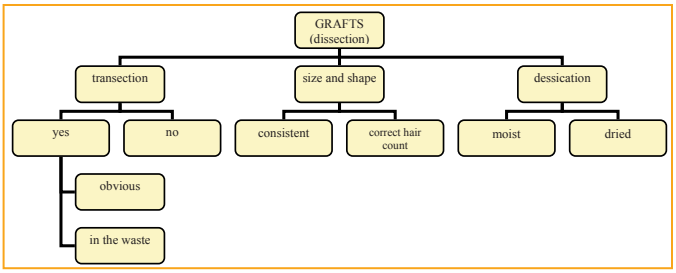


Figure 6. Closer examination of the same graft reveals that viewed from one side the graft looks as if it is a 1-hair FU, but, when examined from the other side, it is revealed to be a 3-hair FUG.

Table 2. Step-by-Step Quality Control During Graft Dissection



QC During Graft Placement

Correct graft placement is equally essential to achieving natural results. During graft insertion, look for the following: handling, location, and dessication. Graft handling refers to proper grasping and minimal manipulation during insertion. The safest way to grasp a graft is by the fat tissue below or beside the hair follicle. If the tip of the forceps grasps the graft directly on the bulb or along the mid-shaft, the instrument may damage the follicle (Figures 7 and 8).

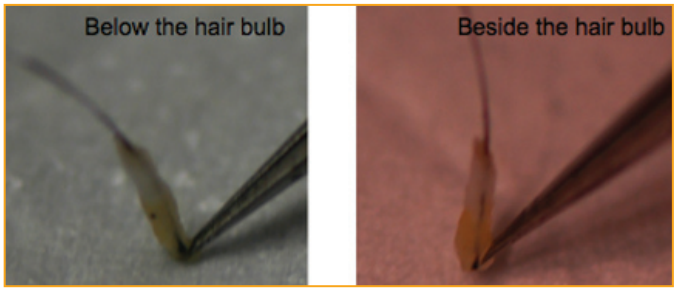


Figure 7. This image shows correct graft grasping.

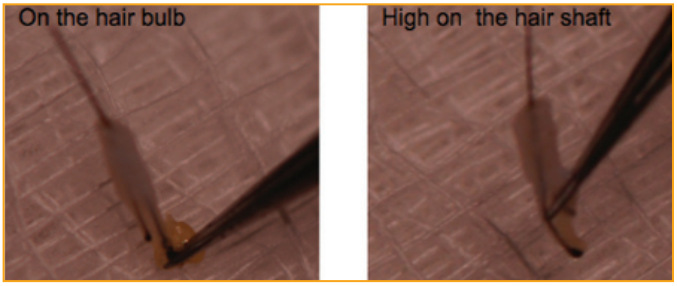


Figure 8. This image shows incorrect graft grasping.

Elegant graft insertion means that the graft is deposited inside of a recipient site with 1-2 movements, possibly with an additional 2 adjustments as needed but no more than 4 movements in total. Excessive graft adjustment during placement indicates incorrect forceps-to-site alignment (the tip of the forceps is not aligned with the midline of the recipient-site cavity). Grafts should be placed with their epithelium protruding 1-2mm above the surrounding scalp. If a graft is placed too deep (epithelium even with or below the scalp surface), it may cause pitting, an intradermal cyst; and if buried very deep into a site, it may cause an ingrown hair. Pitting appears as a small scalp indentation around the hair exiting point, making the scalp look rough and unnatural. Conversely, if a graft is placed too shallow (exposing half the length or more of the hair follicle), it is prone to drying out. It is important that 1-hair grafts are placed into recipient sites allocated for them; therefore, any grafts that are larger and placed instead into a site intended for a 1-hair graft would be considered as placed in an incorrect location, which

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Quality control

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can cause "pluggy" result. Alternatively, the central forelock is intended for stronger grafts in order to provide superior covering; puny grafts (containing 1 instead of 3 and 4 hairs) placed into this location are considered as placed incorrectly. Another technique error relates to hair curl and whether it curls toward or away from the scalp (Figure 9). Each hair follicle possesses a natural curl, which the assistant should identify and properly orient in the site during graft placement. Following a natural pattern, hair curl always faces toward the scalp, and in the male hairline faces forward, in the temples down and back, and in the vertex it follows the whorl. If the hair curl points sideways or upwards in the hairline and the temples (instead of forward and downward), the hair will not cover but expose the scalp causing a see-through effect as well as an unnatural cowlick. The result would lack visual density, and the patient would have difficulty styling his hair or have a result that would look unsightly. (Table 3)

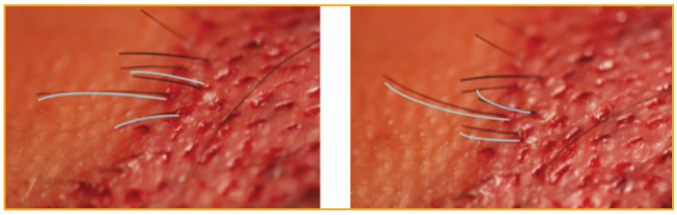


Figure 9. The image on the left demonstrates hair curl facing scalp (correct), while the image on the right shows hair curling away from the scalp (incorrect).

Performing Final Check

At the end of each procedure, it is important to perform one final inspection of the recipient and donor areas to ensure that the procedure has met the intended quality standards. The recipient area is examined in a progressive and systematic way making sure that the following parameters are verified:

- All sites are filled with grafts. During placement it happens that some sites are left empty accidentally; working on a small field often changing focus makes it easy to skip sites. When there are extra grafts at the end of the case (a higher number of grafts vs. the number of sites), before making extra sites an assistant should first examine whether there are any skipped, empty sites. Conversely, if there is a discrepancy in the number of grafts obtained vs. the number of sites created (i.e., a shortage of grafts), an assistant should be certain that strategic areas are filled with the appropriate grafts, such as the frontal hairline area and central forelock.
- All grafts are situated 1-2mm above the epithelium. If grafts are not showing sufficient epithelium, they should be pulled up, and if grafts are severely protruding, they should be adjusted to their appropriate depth/height.
- All hair curls face toward the scalp and point in an appropriate direction. Hair curl should face the scalp and point in the direction of natural hair growth.
- Only 1-hair grafts are placed in the hairline. There should be no 2- or 3-hair grafts placed in the first two frontal rows of recipient sites, but there should also be no 1- or 2-hair grafts placed in the central forelock.
- No hair is entrapped underneath grafts (when transplanting between hairs). Hair trapped underneath a graft is often noticed as a tiny loop. After combing the hair, an assistant should pull on any existing hair gently in order to loosen the hairs that may be trapped. Additionally, each graft should be examined individually for hair loops and the trapped hair freed gently (Figure 10).
- Finally, the donor and recipient areas are examined for no visible bleeding and that they are cleaned of any blood clots. In addition, the donor area should not have any hairs trapped under sutures or staples. (Table 4)

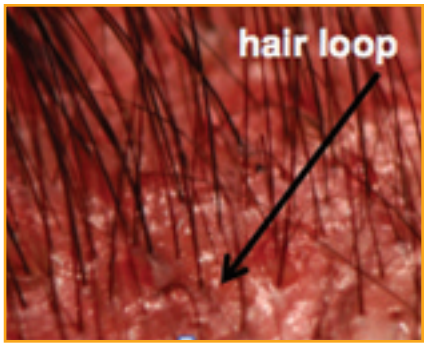


Figure 10. The image shows a hair loop that reveals hair entrapped underneath a graft.

Table 3. Step-by-Step Quality Control During Graft Placement

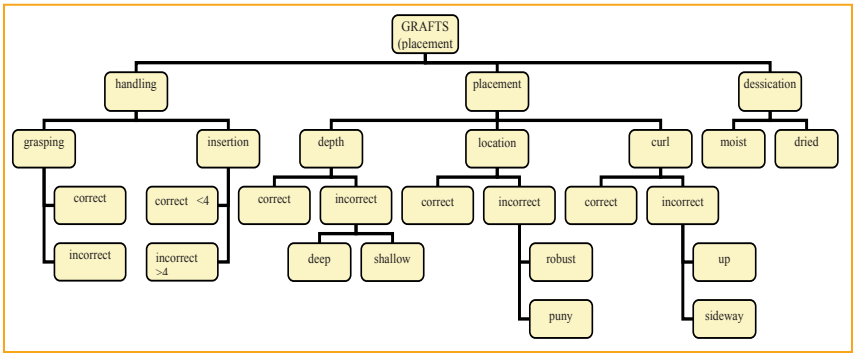
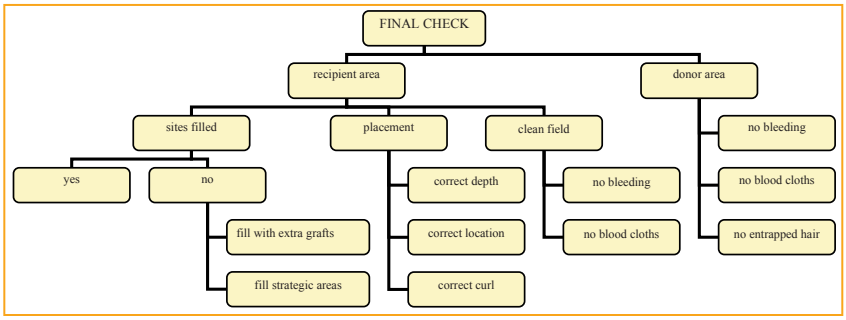


Table 4. Step-by-Step Quality Control at End of Procedure



Conclusion

In general, QC is a process used to ensure products or services are designed to meet customers' expectations and requirements. This article provides basic guidelines for producing consistency in quality and thereby achieving excellence with every hair transplant procedure.✧