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Letter to the Editor

Laser Hair Transplantation: Is it Really State of the Art?

There has been a recent surge of interest in "laser hair transplantation" that has paralleled the increased use of lasers for a wide variety of cosmetic surgical procedures. Lasers generate great enthusiasm on the part of both physician and patient, but this has sometimes exceeded the actual value of the laser as a surgical tool. An obvious example has been the use of the CO_2 laser as a nonselective, destructive modality to remove tattoos which left scarring and a cosmetic deformity worse than the tattoo itself. This has been subsequently replaced by pulsed lasers with specific pigment absorption (such as the Nd:YAG, Ruby, and Alexandrite lasers) operating on the principle of selective photothermolysis that truly offers benefit in the treatment of these lesions. Super- and ultra-pulsed CO_2 lasers are now being used to replace "cold steel" in generating hair transplant sites. However, before we rush to use lasers in hair restoration surgery, we should first apply logic and reason to this aplication, and then proceed cautiously with carefully controlled studies so our patients will only benefit from its use. The following discussion will address various aspects of current laser technology in the specific context of the most recent advances in hair transplantation techniques. The intent will be to challenge the theoretical basis for the use of existing lasers, to question some dubious claims regarding their benefits, and to suggest future areas of laser research.

WHAT IS A LASER HAIR TRANSPLANT?

First, it is important to clarify what is meant by "laser hair transplantation." The present role of lasers is to solely create the holes or slits (recipient sites) for the grafts to be inserted into. To consider this a "laser transplant" is to ignore the myriad of other factors that contribute to making the procedure successful. Until lasers are involved in other major components of the transplant, such as harvesting, graft dissection, or placing, "laser hair transplantation" should be replaced with a term such as "laser site creation" to more accurately reflect its current role in the procedure.

A PAINLESS PROCEDURE?

The claim that laser transplantation is a painless process is misleading. The lasers currently being used are "ultra- or super-pulsed" CO_2 lasers. Unlike lasers that operate by selective photothermolysis, these lasers create a hole by simply vaporizing tissue. Because the pulse (span of time the beam is on at any given moment) of these new lasers is extremely short, there is not much heat transfer or injury to "surrounding tissues." Nevertheless, the tissue which the laser acts upon is nonselectively destroyed. Because of this, the laser is extremely painful unless local anesthesia is administered to completely numb the area prior to its use. Thus, it is not the laser that is painless. The pain-free environment is set up by the preoperative anesthesia used in all transplant procedures.

BLOODLESS SURGERY?

The next claim, that the laser procedure is relatively bloodless, minimizes the most important physiological consideration determining the success of the transplant, namely oxygenation. The hair transplantation process should be aimed at maximizing blood flow to the implanted hair follicles, rather than reducing it, and any manipulation that compromises proper oxygenation will potentially compromise graft survival. Preliminary results suggest that when the laser sites are compared to sites made with conventional surgery, "a few patients have shown less hair yield in some of the laser grafts [1]. Dr. Unger points out that when making conventional slit sizes with the laser, "we are close to an unacceptable width of thermal damage." The experience of Khan is similar, and he expresses special concerns of decreased growth when the distance between laser sites is 1 mm or less [2]. When using extensive micrografting techniques, the spaces between grafts are often in this range, and the cumulative thermal damage produced in large sessions may prove disastrous. It is, therefore, extremely important to objectively measure the impact of the coagulating effects of the laser on blood supply and graft survival in the setting of extensive micrografting, since this does appear to be the trend of the future [3]. As with electrosurgery, the laser specifications can be modified so that there is relatively more cutting than coagulation. It seems reasonable that work be focused in this direction, as this will decrease thermal injury while, at the same time, taking advantage of the laser's ability to make rapid, uniform sites.

PROBLEMS WITH HEMOSTASIS

The coagulating effect of the CO_2 laser may enhance visibility during the procedure, but the application of bi-manual traction on the skin and the judicious use of epinephrine can also provide hemostasis and allow for adequate visibility during both site creation and the placing of grafts without compromising the blood supply. Cold steel techniques that produced defects in the recipient area in the form of slits, 2–6 mm in length, or punches, 1.5–5 mm in diameter, significantly compromise blood flow to the recipient site and reduce graft survival when the transplants are made too close. The laser has the added detrimental effect of sealing off the microvasculature. The poor growth with older techniques taught us the vital importance of preserving the vascularity in the recipient area, and this lesson should not be wasted when trying to increase operative visibility with the laser, especially when this can be accomplished by simpler means.

INTEGRITY OF THE CONNECTIVE TISSUE

Another problem created by the laser is the destruction of dermal collagen and elastic fibers. This effect on recipient tissues causes a decrease in normal skin elasticity and, as a result, grafts have an increased tendency to fall out from laser-made sites. Certainly, one would have to question if the grafts that remain are secure enough to ensure optimal growth. Work by Beeson has shown laser sites to have more necrosis and scarring 3 days after surgery and more fibrosis at 2 months than with the sites made with steel [3]. The elasticity of normal skin allows the recipient site to grasp the small follicular implants and secure them in place. This assures for the close proximity of the sides of the implant to the dermis in the recipient site, which serves to minimize microscopic dead space and hematoma formation, and facilitate healing. In a new method of hair restoration surgery recently described in the *International Journal of Hair Restoration Surgery* [4], where the actual follicular units are used as the implant, recipient wounds as small as 1.0 to 1.3 mm in length can accommodate as many as four hairs. This is accomplished by taking advantage of the anatomic proximity of hair within each naturally occurring group and discarding the intervening skin in the dissection. In this situation, the preservation of recipient dermal elasticity is evidenced by the fact that patients undergoing follicular transplant procedures are able to shower and gently rinse the transplanted area the day after surgery without the risk of losing their grafts. In addition, the rapid healing allows oozing and crust formation to subside over this same 24-hour period. When healing is complete, there is no clinical evidence of scarring, even when the scalp is shaved.

LASERS: NEW TECHNOLOGY FOR AN OUTDATED TECHNIQUE

The major advantage that lasers are claimed to have over traditional slit and punch grafting is that they can create a slit (which purportedly looks more natural than a hole created by a punch), while, at the same time, removing tissue like a punch to make more room for the implant, in effect, having the best of both worlds. In the older techniques, where the grafts were not "anatomic" and contained hair that reached across multiple follicular units, the recipient site needed to accommodate it was unduly large, causing poor healing, as well as graft compression. In follicular transplantation, neither large slits nor punches are required to accept the donor grafts. By identifying the patient's natural hair groupings, the implants can be pretrimmed of the excess tissue between the groups, resulting in tiny follicular units that can be placed in very small sites, solving the problems of both recipient bulkiness and compression. Therefore, the claim that lasers have the advantage of removing recipient tissue while creating a slit has no relevance in follicular transplantation.

THE DIRECTION FOR LASER RESEARCH

Future laser research should be directed toward a technology that could "read" the follicular groups "in situ." In the donor area, the laser would dissect away the tissue between follicular units having the effect of decreasing the transplanted volume of skin, while maximizing the transplanted quantity of hair; producing an implant containing hair groups matching those found in nature.

In the recipient area, current laser use is limited to areas relatively devoid of hair, as the beam would obviously damage any adjacent follicles. It is also limited in its ability to re-treat an area already transplanted, unless significant spacing were left between the previous grafts. In contrast, hand-made sites using a very small steel instrument can easily avoid existing hair or grafts, and if a hair was "hit," it would most likely survive the trauma or regenerate from its growth center. Much of current laser research has been directed to the production of a laser scanner that has the ability to rapidly produce uniform sites in either a grid-like pattern or random distribution without regard to the location of existing hair [5]. In order to be of general value, the laser must be able to identify the existing hair and make sites only in the intervening spaces, requiring a level of technology not presently available.

Another challenge of the laser scanner would be to compensate for variability in laser effects brought on by the inherent curvature of the skull. Not only will the changing contour serve to amplify or defocus the beam by altering the effective operating distance, it will also change the incident angle of the light source and, ultimately, the direction of the hair. These adjustments are now performed manually, but are, nevertheless, critical to a successful cosmetic outcome. There is also significant variability in the thickness of the scalp from one patient to another and in different regions of the scalp. The laser must be able to at least match the sensitivity of the human transplanter who can "feel" these differences and can limit the depth, sparing injury to the larger blood vessels and nerves. In order to have a more natural appearance, modern lasers should generate sites only in a random pattern rather than according to an organized template. Finally, artistic nuances used in creating a delicate hairline, a widow's peak, the swirl of the crown, or in rebuilding the temples (with its abrupt directional changes) would be difficult to program into the laser and might still have to be accomplished manually.

A look at current research in hair transplantation worldwide suggests that in the near future, significant advances in hair restoration surgery may lie in automating the manual process, rather than in laser surgery per se. Mechanical instrumentation currently being developed will streamline the entire procedure, from the harvesting of the donor strip to the creation of sites with the simultaneous insertion of the implants. The role lasers will play in this overall process is still unclear.

CONCLUSIONS

As laser technology improves, laser sites become smaller, and the problem of thermal damage is adequately addressed, the advantage of rapidly producing large numbers of uniform sites will make the laser a more valuable tool. When the laser, directed at the donor area, can cut skin by "reading" the spaces between the natural hair units with minimal thermal injury, it will significantly alter the transplant process and create a more compelling argument for its use. And until the laser scanner can be designed to avoid existing hair, this instrument will not be truly versatile. Hopefully, this level of sophistication is not "light years" away. Until then, let us be cautious and allow time for science to catch up with our enthusiasm. Only when the power of the laser has been applied successfully to all of the critical elements of the procedure may we rightfully use the term "laser hair transplantation."

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