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# My Clinical Experience with Needle and Laser SMP Devices

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## INTRODUCTION

The ever-changing inclinations of patients for non-surgical hair loss treatments and procedures is of great importance to the hair restoration surgeon.[1] Many non-surgical hair loss treatments garner attention, such as minoxidil, DHT inhibitors, laser light therapy, and regenerative procedures. Scalp micropigmentation (SMP), which has been gaining in popularity, does not treat hair loss, but rather it is a permanent concealer for patients with hair loss. The primary factors for increasing consumer interest in SMP are that it is a less expensive alternative to other treatments, and it is a simple outpatient process that is often performed by tattooists or technicians trained in basic SMP skills.

SMP has been described in great detail in the medical literature.[2-6] The history of tattooing, government statutory requirements to perform the procedure, the inks used to impart the appearance of density, training, and various devices used are beyond the scope of this paper. The semantics and terminology of SMP varies but is best summarized as *"a procedure that is used to create the illusion of shaved hair stubble, or greater density in hair-bearing areas that have lost hair or require augmentation."*[7] Hair transplant surgeons generally define the indications of SMP to include, but not be limited to, conditions requiring donor linear scar camouflage, treatment of depleted donor areas, or augmentation of the results of hair transplantation to produce a fuller appearance. SMP is generally successful because it decreases the contrast between the lighter colored scalp and the darker melanin-containing hair shafts. Some hair transplant surgeons have been quick to add the needle-based SMP systems into their practices. As a permanent concealer, SMP works very well to obtain these outcomes.[8,9]

Traditional needle-based SMP uses a needle system with between 1-5 needles that reciprocate at various cycles between 100-150/cycles per second. The needle-based SMP hand piece contains the pigment, which is held in place by the surface tension as the needles reciprocate. Because the surface tension varies and is inconsistent during the SMP procedure, accurate control of the amount of ink that is placed into the scalp potentially can create inhomogeneous outcomes with differing sizes of pigmented dots. With needle-based SMP systems, there are many variables controlling the dot size, dot characteristics, or how it will look when introduced into the dermis. An angled hand piece, for example, will make an oval dot, but a perpendicular hand piece will create a round dot. As the reciprocating needles place the ink dots into the scalp, precise control and the timing of the needles contacting the scalp, that controls the dot size and quantity of the ink injected into the scalp is challenging and imperfect. Depth control is another challenge for the operator, as the multi-needle system depends upon the subjective "feel" of the operator, a skill that often takes a long time to achieve.

Many hair transplant physicians just starting to learn how to integrate SMP into their practice possess inadequate control of their SMP dot depth and size, and this may result in less than satisfactory results in their first few patient experiences. Dot color is dependent upon the quality of inks, and an inexperienced operator might more easily create a larger pigmented dot than the ideal smaller-appearing dot size. While not established in the medical literature, this paper advances the concept that the dot size should be less than 1.0mm diameter, or the size of the follicular orifice. In other words, SMP requires considerable experience for the physician to develop the skills and the feel to obtain consistent results. Because the learning curve associated with SMP can be long and arduous, this may discourage some physicians from advancing their clinical experience and increasing their confidence.

The use of the injector mechanism for the delivery of vaccines and drugs is commonly used today in animals and humans. Needle-free micro-jet delivery systems have been in use in medicine for more than 50 years. In my experience, a patient's anxiety about SMP is founded on its use of needles; patients often find or believe needle-based SMP will be painful when delivered without anesthesia. Today's practitioners often utilize a ring block or local injections of lidocaine to reduce the pain of the SMP process.

Rassman, however, pioneered the "laser" SMP device and introduced it to the hair restoration community. In his description of the needleless microjet injector, which uses laser pulse energy to drive it, he described the procedure for patients as having the *"advantage of an almost painless experience, eliminating the need for anesthesia."*[6] The engineering and design of the needleless injector was primarily motivated by the need to address patient anxiety and needle phobia. In addition, it eliminates the potential contamination associated with conventional needle-based systems. It was

first introduced as an investigational device for the transdermal delivery of drugs without the use of a needle.[11,12] It is important to note that the laser energy generated by the SMP device described herein never touches the skin; it is totally confined to the hand piece, which generates the kinetic energy or force to propel ink through the skin through a secondary chamber.

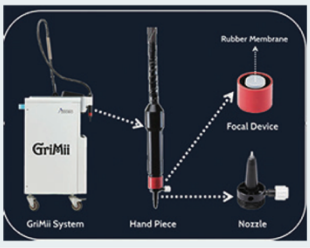
### *Laser SMP Principles and Technology for Hair Loss Surgeons*

The laser SMP device GriMii™ (Adobio, Seoul, South Korea) is a 2940nm Er:Yag pulsed laser device with a forced water cooling system. It is a proprietary needleless injector instrument with unique specifications (Figure 1). It has a small footprint, with wheels at the base of the platform for movement in a small space, although it is not considered portable as it weighs 41kg. It operates from a foot switch, touchscreen display, and the hand piece possessing 360-degree turning capability.

FIGURE 1. Specifications of the SMP laser device.

| | |
|---|---|
| **Power Supply** | **Pulse width(㎲)** |
| 1p, 220VAC, 60Hz, 2200VA | 0.5 - 1.2 |
| **Wavelength(nm)** | **Cooling System** |
| 2940(Er:YAG) | Forced water cooling |
| **Repetition Rate(Hz)** | **Dimensions** |
| 1 - 15 | 270(W) x 430(D) x 795(H) (mm) |
| **Energy(Lv)** | **Weight** |
| 0.5 - 1.2 | 41kg |

FIGURE 2. Standardized components of the GriMii System: hand piece, nozzle, and focal device. *Illustration provided by Adobio.*




The four main components of the device are the functional platform with a touch screen control panel, a hand piece, a non-disposable focal device containing a disposable elastic membrane, and disposable nozzle (Figure 2). The generated laser beam from the unit passes through the articulated arm consisting of mirrors until being focused by a lens of 100-mm focal length. The Er:Yag laser beam is only contained in the hand piece, and it does not exit the nozzle or make contact with the skin. The focal device, nozzle, and hand piece are separate pieces of the device that are connected by threading them together.

### *Practical Application*

The medical control panel (Figure 3) allows the operator to control ink injection parameters and the cycle of ink emissions by 1) controlling the speed of injection by increasing or decreasing the delay between cycling of pigment injection, 2) modifying the power or kinetic energy that injects the ink in the dermis to determine the desired depth and dot size, and 3) establishing the total number of injections or micro-jet emission from the laser beam per system cycle.

FIGURE 3. GriMii display panel.


The hand piece generates the kinetic energy. It connects to the focal device that contains a chamber filled with water or, preferably, hyaluronic acid (HA). The focal device then is covered by a light touch by the operator with a disposable elastic membrane. The nozzle piece then is threaded or connected to the focal device. The chamber of the nozzle piece is filled with approximately 1cc of the medical-grade ink (Figure 4). The medical-grade pigment solution is created using standard diluting tables of normal saline and medical-grade brown and black inks. The focal device and nozzle are then connected to the hand piece.

FIGURE 4. Filling the chamber of the nozzle with medical-grade pigment. *Illustration provided by Adobio.*


After the medical-grade ink is injected into the nozzle, it is delivered by the device through the epidermis by the operator via the hand piece. The manufacturer claims the medical-grade ink typically can be repeatedly injected into the upper dermis at a depth of 0.08mm to 0.20mm (Figure 5). If a black pigment is used, it should be diluted with water/saline or mixed with another color such as a brown pigment. The laser nozzle has various sizes (0.08mm, 0.10mm, 0.13mm, 0.16mm) to create varying sizes of the dot pigments. I find that the 0.80mm nozzle produces the optimal round-appearing pigment in the scalp (Figure 6).

FIGURE 5. Illustration demonstrating a layer of pigment introduced into the dermis. Figure courtesy Jaypee Brothers Medical Publishers, *Hair Transplant 360: FUE*, 2nd Ed, Chapter 36, Figure 9.

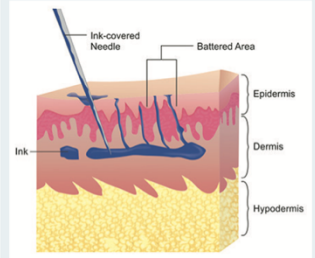
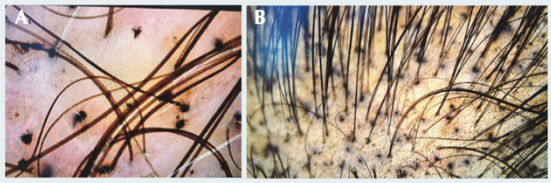



FIGURE 6. *A:* Typical Laser SMP results at lower density. *B:* Laser SMP results at higher density with observed splash.




The engineering of the device is relatively straightforward (Figure 7). The system's main electrical energy source is produced via standard electrical current (220 VAC or 220VA) or power from a wall outlet. The laser beam is created and generated from the hand piece that is connected by flexible fiber connections to the device's main platform. The laser does not ablate or make contact with the skin. The Er:Yag laser beam (2940-nm wavelength and 150µs pulse duration) first passes through the window portion of the focal device, which contains water or, as noted previously, HA.

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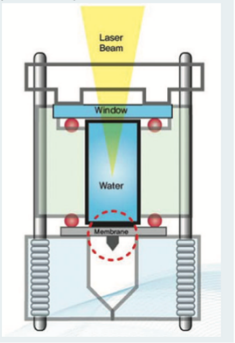
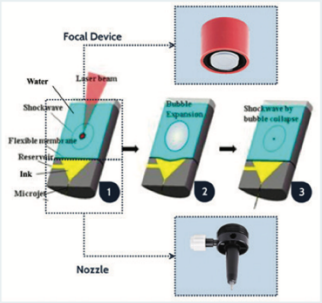
FIGURE 7. Schematics of the GriMii device. *Illustration provided by Adobio.*




### *Bubble Expansion*

When the kinetic energy of the laser beam passes through the focal device, air bubbles of HA are created in the focal device. The HA amplifies the kinetic energy produced by the Er:Yag laser energy. The laser provides the energy source to create the kinetic energy that expands the bubbles of the HA contained in the focal device. The laser kinetic energy creating bubbles in the focal device immediately results in bubble expansion and eventual bubble collapse. This collapse creates a shockwave effect in the hand piece. The air bubble collapse and resulting pressure gradient deforms the elastic membrane within the hand piece in a controlled manner, and the mechanical force generated injects the ink instantly through the nozzle at a high speed into the upper dermal layer of the scalp (Figure 8).

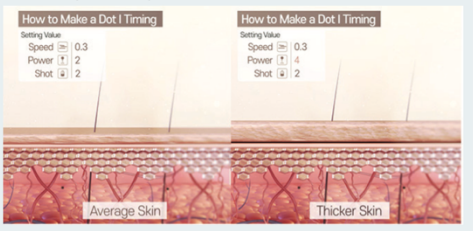
FIGURE 8. Basic principles of medical pigmentation injection in the dermis. *Illustration provided by Adobio.*




It is important to move the hand piece with each audible beep generated by the device. The injection rate is adjustable on the control panel. When injecting the ink, the tip of the nozzle needs to be in contact with the skin. The nozzle tip needs to be vertical and upright at 90 degrees to the skin and moved with a regular tempo matching the tempo of the audible beep from the device. Synchronization with the audible beep is critical as any absence of synchronization will result in an ink splash or splatter (Figure 6B). If the nozzle tip is also not 90 degrees perpendicular or vertical, the ink splash effect can be easily observed.

Skin that is thickened or scalp donor regions with a linear scar will require a higher level of laser power (Figure 9). To create optimal dot size and appearance, the proper technique required for successful dot depth placement in the upper dermis, requires an operator's gentle contact of the nozzle tip with the skin. In some cases of thick or raised donor linear scars, the laser SMP may not be successful in inserting the dot pigment into the thickened scar tissue. In these instances, a needle-based SMP device may be the more appropriate choice.

FIGURE 9. Laser power and skin thickness settings on the control panel. *Illustration provided by Adobio.*




### *Physician and Staff Training*

I began using needle-based SMP devices many years ago after I completed an ISHRS-sponsored SMP course. I originally purchased one of the many tattoo needle-based devices that were available for physician use. I have used my current needle-based device for the last several years infrequently but with successful aesthetic outcomes. Admittingly, many of my patients are fearful of needles and ring blocks and the laser SMP device has made the procedure experience better tolerated. Many tattooists performing SMP who work independently from physicians are unable to offer anesthesia, and patient reports of pain from their experience is not uncommon.

Physician training for SMP can be obtained from private non-physician organizations[13] or ISHRS-sponsored workshops. Wasserbauer details her experience and expertise in an outstanding chapter written for the novice surgeon hair surgeon considering introducing SMP into their practice.[9] In my experience, the laser SMP device requires some preparation and training, as a learning curve is a part of the new procedure experience.

To properly perform SMP, an intact functional central and peripheral neurosensory system and dexterity is required. It is believed that 30-85% of the brain in mastering hand-eye coordination requires visual and motor skills. The use of proprioception of the hands to guide the eye, intact visual and motor memory, depth perception, simple visual acuity, and fast muscle twitch rates is essential for easier transition and adoption of all SMP systems into a hair surgeon's practice. For operators with benign medical or movement disorders involving eye-hand coordination, such as Benign Essential Tremors or Parkinson-related motor disorders, the learning curve may be longer and cosmetic outcomes diminished.

When utilizing the laser SMP system, the operator's dexterity and hand movement must be purposeful and steady, as it requires the ability to delicately press the ink nozzle tip on the skin exactly timed with the audible beeping from the device. The laser SMP system requires hand-eye-audible coordination, muscle memory coordination, and the "right aesthetic touch." At the operator's prerogative, the speed of imparting ink into the skin can be changed on the control panel. The device creates a consistent rhythm and medium pitch sound during the SMP application process. In other words, the audible sound assists the operator with the timing of the nozzle and nozzle application to the scalp.

### *Ergonomics and Learning Curve*

Similar to follicular unit excision (FUE) donor hair harvesting, the prolonged static positions over time may lead to musculoskeletal conditions. Overall, unlike the learning curve for FUE donor harvesting, I found the learning curve for laser SMP was moderately easy to overcome. In addition, the use of the laser SMP device is a delegable procedure that staff may learn and implement. The cosmetic principles

of laser SMP system are no different than the traditional needle-based SMP system, therefore, an eye for aesthetics and knowledge of the basic principles of SMP are essential. The most challenging aspect to the use of the laser SMP system is the size and weight of the hand piece. It may be too big for a person with a small hand size, and it is awkward to grasp. Its long-term use may contribute to ergonomic and musculoskeletal issues for the operator such as carpel tunnel syndrome, "tennis elbow," or other upper-extremity joint and muscle problems. The manufacturer anticipates there will be a smaller, lighter hand piece in the future.

## CONCLUSION

The most common complication we observe with needle-based SMP devices is that large amounts of pigment can be deposited in the scalp, often too deep, leading to unnatural results (Figures 10 and 11). While not established in the medical literature, this paper advances the concept that the dot size should be less than 1.0mm diameter, or equal to the size of the follicular orifice. In other words, contrary to the cosmetic results we are observing today, the pigment dot size ideally should be no larger than the largest follicular unit orifice (approximately 1mm or less). In my experience, the painless element of the laser-based SMP device has made this an easier integration into my hair restoration practice. Because of the unique patient-friendly characteristics of the laser SMP system, I am more confident and successful in counseling patients who are candidates for SMP about the advantages and benefits of this technique. My clinical results (Figure 12) have produced excellent aesthetic outcomes, and my patients overall have been very satisfied with the use of the laser SMP system.

My office has been using the GriMii for several months. I ask patients to return to the office two weeks after the initial procedure. I do not claim mastery of the laser tattoo system yet, but I do believe that we can take advantage of the speed of the system and the consistent dot size as we continue to use it. My goal is to be able to complete the three SMP treatment areas of the scalp (Figure 13) in a single session. The benefits of no anesthesia, no needles, and instant cosmetic results offer my patients excellent cosmetic outcomes and they leave happy.

FIGURE 10. Unnatural SMP result performed by an unlicensed provider. The results show bleeding of SMP ink into one another or too large dot size. *Photo courtesy of Dr. Sara Wasserbauer.*

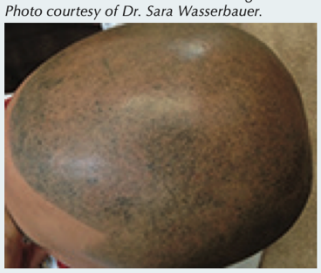


FIGURE 11. Unnatural appearing SMP results. The dot size is much larger than the diameter of the follicular unit orifice.

*The author wishes to acknowledge Dr. William Rassman and his personal impact on my clinical practice as well as his academic contributions to the SMP literature.*

FIGURE 12. Photos of my results.

FIGURE 13. Three areas of the scalp defined regions used by author. *Image courtesy of Dr. William Rassman.*

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