White Paper

PicoToning: A Novel Laser Skin Toning Approach for the Treatment of Asian Skin Types

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INTRODUCTION

Laser skin toning has been performed in the aesthetic market for almost two decades and has continued to increase in popularity worldwide and in Asia specifically. Toning targets unwanted epidermal and dermal pigmentation as well as the superficial textural improvements associated with solar damage, age, and enlarged pores. These treatments are typically administered over a number of sessions. With advances in technology and techniques, toning has reached a wider population of patients throughout the world with an acceptable side effect profile and minimal downtime. The goal with the introduction of picosecond technology is to further improve this treatment.

Q-Switched (QS) technology used in toning involves heating melanin in the epidermis and dermis. Increasing the fluence or the number of passes increases the heat load in the targeted tissue resulting in enhanced efficacy but also a higher rate of complications such as hypopigmentation and small areas of textural changes. Although current treatments are used with a high degree of success, there are still concerns with these side effects especially in the darker skin types; patients with Fitzpatrick skin types III-VI should be treated with caution. It has been anticipated that picosecond technology with shorter pulse durations could be used in a toning procedure with less unwanted thermal side effects due to its photomechanical effects on melanin, increasing the safety when dealing with darker skin types.

DISCUSSION

Ideally laser toning treats both epidermal and dermal dyspigmentation as well as stimulates dermal elastin and collagen production. The end result is to decrease unwanted pigment and enhance the clarity of the patient’s complexion with improvements in skin texture and decreased pore size. This treatment originated in the mid 1990’s using Q-Switched YAG technology. This technique involved several passes of a nanosecond 1064 nm laser targeting the unwanted pigment associated with melasma and photo damage. The most frequently used Q-Switched devices were made by ConBio and now are being manufactured by Cynosure. The older as well as the improved newer devices continue to be a popular choice for toning procedures and tattoo removal treatments throughout the world.

Q-SWITCHED TECHNOLOGY EXPLAINED; COMPLICATIONS AND RESTRICTIONS

Q-Switched technology permitted energy to be delivered in very short pulse durations. Q-switching of lasers is a mechanism used to control the light output by concentrating all of the energy into a single intense pulse with the duration on the order of nanoseconds with relatively high energy. The mechanism is based on electro-optically changing polarity of a shutter in order to create nanosecond pulses of light. This was used to target tattoo ink and melanin as selective destruction of ink and melanosomes had been well documented by exposing the skin to submicrosecond pulses of light. These nanosecond pulses resulted in rapid thermal heating and at higher energies sometimes produced a partially photomechanical effect on the tattoo ink and melanin.

The low energy pulses used in laser toning with the QS 1064 Nd:YAG primarily heat dermal and epidermal melanin. This procedure is very technique dependent. If the energy is too high or if too many passes are performed over an area, these regions can become overheated resulting in hyper and hypo pigmentation. This presents challenges when treating skin types V and VI in a toning procedure with QS technology. While this problem is infrequent, it would be ideal to have a treatment or technology which would eliminate these problems. Many have believed picosecond technology would permit the treatment of unwanted pigmentation in darker skin types with shorter pulse duration resulting in primarily a photomechanical rather than a thermal effect. It is hoped that this type of injury would diminish the infrequent side effect of hypopigmentation.

PICO CONCEPT

Part of the allure of QS nanosecond technology was the possibility of being able to move from purely thermal heating of melanin and tattoo ink to a photomechanical process with the creation of pressure waves in targeted tissue with nanosecond pulses when used at high energies. This was done using an electro-optical technique that enables a normal mode, pulsed laser to produce ultra-short pulses in the nanosecond range (1 nanosecond = 1 billionth of a second = 1 X 10^-9 seconds). Ink particles were fractured in tattoo removal treatments, and melanosomes were heated at rapid rate when treating unwanted pigment. This allowed for the system to treat previously resistant lesions as the photothermal effect was aided by the mechanical component of the pulse leaving less dependence on
FOCUS™ LENS ARRAY

The Focus Lens Array was developed to treat unwanted pigmentation and other skin irregularities. It was felt that a diffractive device would be more efficacious with the delivery of high energy in small spots while at the same time increasing patient safety. Focus is a hexagonal, close packed diffractive lens array which is 500µm center-to-center with a 6mm irradiated diameter and an average fluence 0.7 J/cm². The Focus Lens Array redistributes the light into a multitude of high fluence tightly focused spots embedded in a low fluence background. Up to 20X of the available energy is delivered through the Focus Lens Array microbeams compared to the low fluence background (Fig 4). Up to 10% of the tissue is exposed to high fluence on each pass, making multiple passes possible when delivering energy in a unique manner. This type of energy delivery is important when dealing with darker skin type as traditional high fluence treatments can result in overtreatment and PIH. The Focus Lens Array is available on 6 mm, 8 mm and 10 mm fixed spot hand pieces. The number of micro-beams increases with increased spot size but the fluence per micro-beam decreases as the energy is now distributed over a larger area. The 6mm spot size has approximately 130mB, the 8mm has approximately 230mB, and the 10mm spot size has approximately 360mB. The fluence in each micro beam decreases as the number of micro beams in each spot increases. (Fig 5)

heating the targeted tissue. Unfortunately, when the high energies are used with these devices there are unwanted side effects in tattoos and dermal lesions with textural changes. Transient hypopigmentation was also common but true depigmentation was rare. It was felt that further shortening the laser pulse to a picosecond domain would increase the likelihood of the laser pulse producing a largely photomechanical effect on tattoo ink and melanin.

When moving into picosecond pulse durations with an alexandrite laser, the photothermal effect becomes less prevalent as there is a significant photomechanical effect. This has permitted better and more efficacious tattoo treatments with fewer sessions necessary for better clearance in comparison to QS technology. The 755 nm PicoSure® from Cynosure (Westford, MA) was the first picosecond device to become commercially available. It utilizes a sophisticated electronic shuttering mechanism (Fig 2) to create a 750 picosecond pulse duration device which now also has the capability of adjustment to 550 picoseconds. This allows for the treatment of smaller targets in the tissue by more closely matching the pulse durations to their thermal relaxation time. Upon examination under electron microscope, the tissue treated by nanosecond technology had different characteristics than that of the picosecond treated tissue. (Fig 3) As observed with picosecond pulses, ink was fractured into smaller particles than that of nanosecond technology, which was attributed to the significant photomechanical effect produced by shortening the pulse duration. The conclusion was that the picosecond alexandrite laser, with its very short pulse duration, causes both photomechanical and photothermal effects on tissue (as seen with its use in tattoo removal) and produces greater tensile strength than when using nanosecond lasers.5
PICOTONING™

The toning effect of the Focus Lens Array in combination with the picosecond pulse duration is unique and it provides dual benefits. For epidermal pigmentation, this device with the Focus optic both heats and fractures melanosomes in order to diminish unwanted pigmentation. Part of the effects of the Focus optic with the 755 nm picosecond alexandrite is the production of laser induced optical breakdown (LIOB) in the epidermis. Our histologic studies reveal localized areas of intraepidermal injury in which the surrounding epidermal cells about the basal layer and the cornified layer of the skin remain intact (Fig 6). The surrounding epidermal cells and melanocytes show no obvious areas of histological injury. It appears that these high energy pulses target melanin where a “lucky” electron is ejected from an absorber causing the number of free electrons to grow in an avalanche process. The target increasingly absorbs energy from the beam while shielding the underlying region. The laser beam terminates leaving a vacuole in the epidermis containing cellular debris. After a series of treatments there is decreased epidermal pigmentation as well as an increase in dermal collagen, elastin and mucin. It is not known whether this localized epidermal injury with the elaboration of growth factors or perhaps an electromagnetic shock wave from this treatment produces this effect.

Dr. David McDaniel has demonstrated a direct effect on fibroblasts in cell cultures when exposed to the 755 nm picosecond alexandrite laser. He demonstrated up regulation of a number of genes which could be at least in part responsible for a dermal effect. The 6 mm optic appears to create the greatest LIOB’s in the epidermis while the 8 mm and 10 mm optics appear to produce smaller LIOB’s. Every exposure does not necessarily produce an LIOB. Those pulses which do not create this type of injury result in a different type of injury to both the epidermis and dermis. These treatments have been successful in improving dyspigmentation and textural changes in all skin types.

The histological changes observed in the production of new collagen and elastin translates to improvement in both acne scarring and wrinkles. Dr David McDaniel and Dr Robert Weiss performed the clinical studies that led to the FDA clearance for wrinkle treatment while Dr Roy Geronemus performed the study that led to the FDA clearance for acne scar treatment. All of this work was done using the Focus optic.

DR SHIN

The Clear Dermatology & Laser Clinic (Shamshik Shin MD) in Gwangju South Korea was one of the earliest PicoSure locations in Asia. Dr Shin has developed a protocol that has been used to treat hundreds of patients for PicoToning with both consistent results and minimal complications. When treating Asian skin types, a variety of problems
have to be considered as the increased melanin content and sometimes unpredictable reactions of the Asian skin increase the risk of complications when using higher energies. The larger, more melanized melanosomes in darker skin types absorb and scatter more energy, providing higher photo protection. Conversely, the melanocytes and mesenchyme in darker skin seem to be more vulnerable to trauma and inflammatory conditions. Dr. Shin’s concept of toning involves diminishing unwanted pigmentation and pore size as well as improving the texture, and shallow acne scars, a major issue in the Asian market. He was originally using the standard optic, but since the introduction of the Focus optic, he uses this delivery of light as his primary device for PicoToning. He uses the 8 mm with the Focus array and has consistent results and high patient satisfaction.

MATERIALS AND METHODS

20 patients were selected from Dr Shin and his colleagues’ clinics who had received the toning treatment using the protocol listed below. Patients were photographed pretreatment and 6 months post their final treatment and the photos were then graded for improvements.

TREATMENT PROTOCOL

8 mm Focus Optic for full face. Some patients received initial treatments with standard optic.

- 5000-6000 pulses (3-4 passes)
- Treatment interval 2-4 weeks
- 3-5 treatments
- Thicker skinned patients are treated at a shorter interval than thinner skinned patients
- Maintenance treatment every 2-3 months.
- Patients with more severe textural inconsistencies (larger pores or deeper acne scarring) may receive some treatments with the 6 mm optic

RESULTS

Overall the results of these treatments have been positive, with little to no downtime and very little risk of complication. With over 100 patients treated at Dr Shin’s clinic, both patient and physician satisfaction ratings have been very high. Pigmentation, superficial skin texture, and pore size all improved over the series of 3-5 treatments. In addition, Dr. Shin is seeing up to 40% lightening in a single treatment. Patients experienced mild erythema and edema for up to 5 hours post treatment. Based on blinded grading of 20 toning patients, there was an average improvement of 90-95% in unwanted pigmentation, 70-75% for texture, and 50-60% in pore size. This was accomplished with minimal discomfort to the patient and roughly 3 hours of erythema post treatment. In the treatments where pore size is a major issue, the 6 mm spot size with the Focus optic is applied for more aggressive treatment. In cases where melasma is a prevalent factor in the pigmentation, only the 8 mm is used.

Two cases of transient hypopigmentation occurred in initial treatments when shorter treatment intervals were used along with the standard optic. Dr Shin felt that the shorter treatment interval of one treatment every week was not allowing enough time for healing, and as a result, there was a loss of pigmentation. Lengthening treatment intervals and employing the Focus optic have eliminated these issues.

CONCLUSION

755 nm picosecond toning with the Focus optic has opened a new way to treat pigmentation, pore size, and texture inconsistencies. The fractional delivery of energy appears to be well suited to all skin types without the problem of hyperpigmentation and rare scar formation from the 1064 Q-Switched toning procedures. By confining the high fluence in the microspots, the Focus optic allows for the treatment of challenging conditions while keeping the safety profile very high due to the low background fluence. This delivery method coupled with the picosecond pulse duration has allowed for the use of 755 nm on darker skin types where past technologies have caused complications. The Focus Lens Array can be used with either the 6 mm, 8 mm or 10 mm optic which permits different types of treatments based upon the patient’s indication, skin type, and physician preference. Future studies and application refinements will expand the scope and use of this device and optic.
Baseline and Post Tx photos
Courtesy of Shamshik Shin, MD
REFERENCES


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