

Managing Burn Scar with a Combination Therapy of Long Pulsed 1064 Nm Nd: YAG (LPND) Laser, Topical Tretinoin and Hydroquinone

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ABSTRACT

Background: Burn scars are associated with significant morbidity ranging from pigmentation, pruritus, pain, contractures and disfigurement to psychosocial impairment. Newer and advanced therapies for the treatment of burn scars have been developed, including lasers, and other topical treatments

Case Illustration: An asian woman with history of having hypertrophic scar arising from the edges of previous skin graft for her second degree of burns. We performed contact-mode long pulsed 1064 nm Nd:YAG laser treatment in combination with topical tretinoin and hydroquinone. Ten months after initial combination treatment, the scar showed improvement in term of colour, contour, and consistency.

Discussion. Burn scars have tendency to enlarge, hypertrophic and become keloids. Long pulsed 1064 nm Nd:YAG laser helps to reduce hypervascularization that usually found in hypertrophic scars or even keloid. Tretinoin is a derivate of vitamin A which has many different mechanisms in wound healing enhancement. Hydroquinone inhibits melanogenesis and plays role in maintaining pH level in wound healing process.

Conclusions: Burn scar responded well to long pulsed 1064 nm neodymium-yttrium-aluminum-garnet (Nd:YAG) laser treatment. A combination therapy with topical tretinoin and hydroquinone improved the burn scar in term of better color, contour and consistency.

KEYWORDS: burn scar, hydroquinone, long pulsed Nd:YAG, tretinoin.

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BACKGROUND

Scars are the common sequel found in burn victims. Burn scars are associated with significant morbidity ranging from pigmentation, pruritus, pain, contracture and disfigurement to psychosocial impairment. The impacts of burn scars not only entail the appearance of the scar but also involve of its accompanying symptoms. Rashaan et al identifies up to 47% of patients feel pain that is associated with their burn scars. In addition, pruritus was reported to still be present in 67% of the burn patients at two years after burn.¹ Such sequel surely lowers the quality of life of burn victims. A multi-specialty medical team that can treat the multiple aspects of rehabilitation is mandatory for the proper re-assimilation of patients into their familiar professional and social environments.²

Many modalities have been proposed to help reduce and improve the scar appearance, like lasers and topical treatments. In this case, we reported a case of burn scar that was managed with combination therapy of long pulsed Nd:YAG laser and topical tretinoin and hydroquinone.

CASE REPORT

A 50-years old Asian woman who was first referred to our plastic surgery clinic with a large granulation wound on flexor side of her left forearms after second degree burn injury a month earlier. Having no plastic surgeons in her previous healthcare, her wound had undergone only secondary healing process before we performed non-meshed split-thickness skin grafting to cover her granulation wound. During one month

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of post-operative care and routine evaluations, skin grafts successfully covered the wound, and no scarring presented along the graft edges. Maintenance therapy included mobility adjustment of forearm, topical silicone gel and pressure garment application, and she was scheduled to have

bimonthly evaluation. After six months of no shows, she visited our plastic surgery clinic with scarring arising from the graft edges (see figure 1). She admitted difficult to follow the surgeon's directions diligently, and requested to have non-surgical management for her scar.



Figure 1. Pre-treatment burn scar condition

She was later received evaluation and treatment from our dermatology clinic, underwent several series of laser therapy using long pulsed 1064 nm Nd: YAG (LPND) (Cutera-Xeo) in Genesis mode with 5-mm spot size diameter, an energy density 15 J/cm², a 300- μ s exposure time per pulse and frequency 10-Hz. This protocol was conducted with 4 weeks intervals for each session.

Due to her financial limitation, she discontinued her LPND laser therapy after the 3rd session, then continued her scar

management with only a combination of topical tretinoin 0,1% and hydroquinone 5% every night.

Ten months after initial combination treatment, the scar showed improvement. Scar colour was pinkish and lighter than the initial appearance. Flattened surface started to appear in some border area, overall scar depression is notable (see figure 2). Patient said, her scar was softer and less rigid than the initial condition. No signs of hypopigmentation and hyperpigmentation nor signs of “hydroquinone halo”, irritation, erythema, and ochronosis detected.



Figure 2. Burn scar condition after 10 months of three series of LPND laser therapy, combined with topical tretinoin and hydroquinone

DISCUSSION

A multi-specialty medical team is essential to treat burn scars because surgery alone or non-surgical therapy alone may not result in optimal post-therapeutic results. Plastic surgeons

routinely perform skin grafting for large burn wounds which is considered difficult to heal in 28 days. Smaller burn wounds may be treated with daily wound care to undergo secondary healing, with proper attention and anticipation to

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risk of post-burn scarring. Large burn wounds without surgical interventions need longer time to heal and produce burn scarring because after the 28 days period, re-epithelization process ends and fibrosis from remodelling phase of wound healing process takes over the healing process.³

Post-burn scars induce abnormalities in skin structure within epidermis or even dermis. In the dermis, changes in the extracellular matrix (ECM) include increased collagen fibers densities, which can be arranged in whorls or nodules, and decreased levels of elastic fibers.^{2,4} A proteoglycan with hydrophilic properties called Versican is usually present in large amounts in recent hypertrophic scar tissue. As the scar matures and becomes less rigid, the amount of Versican decreases.² After tissue repair, alterations in ECM composition and organization lead to changes in the mechanical properties of the skin that result in decreased elasticity, especially in hypertrophic scars.² The severity of these changes varies, depending on the depth of the original injury and other factors. When spontaneously restored, burns that involved deep dermal injury can take from three to five weeks to re-epithelize completely. Injuries that take longer to re-epithelize are more likely to evolve with hypertrophy.⁴

Some traditional therapies have been used for burn scarring include compression garment, silicone gel, corticosteroid injections, massage therapy, and surgical procedures but the newer and advanced therapies for the treatment of burn scars have been developed. Due to the limitations of surgical techniques for post-burn skin refinement, many burn patients require additional treatment to improve the texture and appearance of their new skin.⁵

Another modality to prevent scars, is silicone products and pressure garments. The goal of both interventions, alone and in combination, remains the same. The goal of interventions is to reduce keratinocyte, fibroblast, mast cell, and histamine production, thus increasing collagenase activity and subsequent collagen breakdown.⁶ Wiseman et al suggest that both silicone gel and pressure garment application may be equally effective at achieving this goal on their own as well as in combination, but state that good results may show only in the thinner skin of the paediatric population.⁷ On that basis, every skin graft border with thicker skin of mobile extremities will always be at risk of scarring despite getting silicone products and pressure garments as scar prevention treatments. Recently, laser therapy has been highlighted for scar treatment because it is relatively effective, less painful, and has a shorter recovery time compared to other methods.⁸ Laser therapy is classified into ablative laser and non-ablative laser. Generally, ablative lasers are considered more effective than non-ablative ones in treating scar, but they have a prolonged recovery time and more chance of complications, such as post-inflammatory hyperpigmentation (PIH) due to excessive thermal energy transferred to adjacent tissue.⁹⁻¹¹ As people of Asian background are prone to post-inflammatory

hyperpigmentation (PIH), non-ablative lasers are preferred more.^{8,10}

Long pulsed 1064 nm Nd: YAG (LPND) laser is a non-ablative laser method commonly used for wrinkle reduction and skin laxity. Due to its wavelength, LPND can penetrate and deliver energy to deep dermis where heat-induced damage reduces hypervascularity, restores normal local microcirculation, inhibits fibroblast hyperproliferation and supports collagen and elastin regeneration. Patients with Fitzpatrick skin type III through VI can be treated using LPND with less risk because the wavelengths of the infrared area are weakly attracted to melanin. Many studies evaluating the applicability of LPND have been done recently.^{11,12} However, to our knowledge, studies using LPND for burn scar in Asian people of Fitzpatrick skin type III or more are still lacking.¹²

Light-based technologies such as intense pulsed light laser, carbon dioxide laser and 1064-nm Q-switched Nd: YAG laser have recently been used for the treatment of hyperpigmentation or scars. These therapies are based on selective photo-thermolysis targeting melanin or water in the epidermis, but the success rate is variable and operator dependent.¹³ The success rate of the laser therapies is depended on the operator. The most side effect of laser therapies is post-inflammatory hyperpigmentation or even hypopigmentation. The treatment of hyperpigmentation in superficial post-burn scars is a routine challenge for dermatologists and plastic surgeons, especially in patients with darker skin.^{13,14}

Laser therapy effectively breaks up the excessive and disorganized collagen fibrils that are responsible for scar contraction, so the scarring site later turns to be more organized, softened, and flattened. A significant decrease in type I collagen and an increase in type III collagen is reported during a CO₂ laser therapy for scar. Laser therapy improves architectural layer of skin with finer and more fibrillar collagen.¹⁵

Scar is a resultant of interactions between mechanical force loading and inflammation, collagen production, and angiogenesis. This means that long pulsed 1064 nm Nd:YAG laser treatment may be useful for treating burn scars because it can reduce the hypervascularity factor of these scars.^{13,14} This reduction in vascularity may decrease cytokine or growth factor levels in the tissue, which, in turn, controls collagen deposition. We used 300- μ s of LPND which resulted a better response and appearance on the patient's burn scar. In a study conducted by Rossi et al (2013), they proved the use of LPND with 300- μ s was effective to improve the clinical appearance of the keloid.¹⁶

Another problem arising from burn wound healing process is post-inflammatory hyperpigmentation (PIH); an acquired hypermelanosis occurring after cutaneous inflammation or injury that can arise in all skin types, but more frequently affects skin-of-colour patients. PIH can have a significant

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psychosocial impact on skin-of-color patients (Fitzpatrick skin types IV through VI), as these pigmentary changes can occur with greater frequency and severity in these populations and likely to be more obvious in darker skin.^{17, 18} Hydroquinone is the gold standard of depigmenting agent. It works by inhibiting tyrosinase activity. This enzyme controls melanogenesis on the skin. Other depigmenting agents like may interfere the pigmentation process at different level.¹⁹ However, bleaching creams are not effective for the treatment of remnant burn scar tissue and are associated with adverse effects such as “hydroquinone halo”, irritation, erythema, post-inflammatory hyperpigmentation, and exogenous ochronosis.²⁰

Topical treatments with tretinoin have been shown to increase skin distensibility and elasticity in post-burn scarring with high levels of patient satisfaction.^{4,21,22} However, the mechanisms underlying these clinical effects are not completely understood. Tretinoin affects cell growth and differentiation and alters cell-cell cohesion. In the dermis, tretinoin modulates extracellular matrix (ECM) synthesis by fibroblasts and increases angiogenesis.^{4,23}

Both laser therapy and topical tretinoin treatment have risk of hyperpigmentation, as much as the scar itself. Topical tretinoin treatment should always include sunscreen preparations to prevent hyperpigmentation, and patients

should be encouraged to avoid sun exposure.^{13,14} The gold standard treatment of hyperpigmentation is hydroquinone, whose mechanisms of action by reversibly inhibiting tyrosinase and selectively damaging to melanosomes and melanocytes.²⁴ Melanin deposition in the scar tissue lowered the pH level in optimal wound healing process, which increased the risk of collagen density and keloid formation. The use of hydroquinone is to inhibit tyrosinase enzyme in melanogenesis which leads to maintain pH level in the wound healing process.²⁵ However, hydroquinone is relatively ineffective against dermal hyperpigmentation because it cannot penetrate the dermal–epidermal junction, but in combination with tretinoin, it will give a better result.²⁶

CONCLUSION

Burn scar responded well to contact-mode long pulsed 1064 nm neodymium-yttrium-aluminum-garnet (Nd:YAG) laser treatment. A combination therapy with topical tretinoin and hydroquinone improved the burn scar in term of better color (lighter), contour (flatter) and consistency (softer).

CONFLICT OF INTEREST

Disclosure: The authors have no financial interest to declare in relation to the content of this article. We already had patient’s permission to publish her case to public.

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