Available online at http://www.journalcra.com

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

International Journal of Current Research
Vol. 18, Issue, 06, pp.37524-37526, June, 2026
DOI: https://doi.org/10.24941/ijcr.50695.06.2026

ISSN: 0975-833X

RESEARCH ARTICLE

Q-SWITCHED ND: YAG LASER AS A STRATEGY FOR SKIN REMODELING: AN EXPERIMENTAL COMPARISON WITH THE THULIUM LASER

Taís Amadio Menegat[1], Fabiele Chieregato[2]; Thaís Rodrigues[2]; Rayssa de Carvalho Machado[2]; Diogo Francisco da Silva de Oliveira[3]; Fábio Alexandre Pinto[3]; José Ricardo de Souza[1,2]; Patricia Brassolatti[2]

[1]Postgraduate Program of the Department of Plastic Surgery, University of São Paulo, Santos/SP, Brazil
Programa de Pós-graduação em Engenharia Biomédica, Universidade Brasil, São Paulo, Brasil
[2]Department of Research, Development, and Innovation at Brazilian medical equipment industry - IBRAMED, Amparo/SP, Brazil; [3]Department of Engineering at Brazilian medical equipment company – IBRAMED, Amparo/SP, Brazil

ARTICLE INFO

Article History:
Received 27th March, 2026
Received in revised form
24th April, 2026
Accepted 25th May, 2026
Published online 30th June, 2026

Keywords:
Q-Switched Nd:YAG Laser; Thulium Laser; Porcine Skin; Melasma; Skin Rejuvenation.

****Corresponding author:***
Taís Amadio Menegat

ABSTRACT

The use of lasers in aesthetic medicine has expanded considerably, particularly for the treatment of hyperpigmentation and skin rejuvenation. High-power laser systems have gained prominence due to their ability to induce selective photothermolysis, enabling the inhibition or destruction of specific cellular targets. Among the most commonly used wavelengths, ablative and semi-ablative modalities, such as 755 nm, 1064 nm, and 1927 nm, have demonstrated effective outcomes in skin rejuvenation and the treatment of pigmentary disorders. The literature reports significant clinical effects associated with the 755 nm, 1064 nm, and 1927 nm wavelengths; however, there is still no consensus regarding the optimal energy parameters and emission modalities. Furthermore, fractional handpieces represent an innovative approach, as they fractionate light delivery and induce distinct tissue injury patterns. The Alexandrite laser (755 nm) has been extensively described in the literature for various dermatological applications; however, scientific evidence regarding the effects of a Nd:YAG laser equipped with a 755 nm filter remains limited and requires further investigation. Therefore, this experimental study compared the effects of Q-Switched Nd:YAG laser (1064 nm) and Thulium laser (1927 nm) on porcine skin, an experimental model widely used due to its structural similarity to human skin, aiming to investigate the type of tissue injury induced by each technology. The findings demonstrated that the Nd:YAG laser produced deeper and more localized lesions, whereas the Thulium laser induced more superficial and homogeneous tissue alterations. The analysis suggests a complementary relationship between the two Nd:YAG laser wavelengths, highlighting their potential clinical application in protocols designed to improve skin quality and promote cutaneous rejuvenation.

Citation: Taís Amadio Menegat, Fabiele Chieregato; Thaís Rodrigues et al. 2026. "Q-switched nd:yag laser as a strategy for skin remodeling: an experimental comparison with the thulium laser". ***International Journal of Current Research, 18, (06), 37524-37526.***

INTRODUCTION

Photoaging and its associated cutaneous alterations represent significant clinical challenges in aesthetic dermatology, being primarily characterized by acquired hyperpigmentation and structural skin changes resulting from chronic sun exposure. Despite the availability of numerous therapeutic approaches, including topical agents and physicochemical procedures, the management of these conditions often yields unsatisfactory outcomes and high recurrence rates, particularly in individuals with darker skin phototypes (Chen *et al*., 2022). Laser technology has become an essential tool in regenerative aesthetics, enabling selective treatment of hyperpigmentation, skin texture irregularities, and cutaneous aging. Among the available modalities, the Q-Switched Nd:YAG laser (1064 nm) stands out for its ability to target deep pigments and vascular lesions, whereas the Thulium laser (1927 nm) acts more superficially, favoring skin resurfacing and transdermal drug delivery (Trelles *et al*., 2019). The 755 nm wavelength is traditionally associated with the Alexandrite laser; however, recent technological advances have enabled the delivery of this wavelength in a fractional mode through the use of a specific cutoff filter integrated into a Nd:YAG laser platform, a technology developed by a leading Brazilian manufacturer (Zawodny *et al*., 2025). Among the available experimental models, porcine skin has been widely employed due to its structural and histological similarity to human skin, including comparable epidermal thickness, dermal architecture, and collagen composition. Consequently, it constitutes a suitable platform for translational investigations of the biological effects induced by laser-based technologies (Baroni *et al*., 2012; Montes, 2020). In this context, comparing different laser systems using a porcine skin model allows a practical assessment of the histological and macroscopic effects generated by each technology. Furthermore, the comparison between fractional Q-Switched Nd:YAG laser at 755 nm, Q-Switched Nd:YAG laser at 1064 nm, and Thulium laser at 1927 nm enables a controlled evaluation of tissue interaction patterns, mechanisms of action, depth of penetration, and structural tissue responses, providing scientific evidence for a comparative understanding of these technologies and their potential applications in the treatment of melasma and skin rejuvenation. Therefore, the aim of this study was to compare the effects of Q-Switched Nd:YAG and Thulium lasers on porcine skin as a model for skin rejuvenation and hyperpigmentation treatment and, based on the experimental findings and available evidence, propose a clinically relevant treatment protocol.

METHODS

For the comparative evaluation of the different laser technologies, fresh porcine skin samples obtained from a slaughterhouse were used. The laser device employed was the Syrius-YAG (Ibramed, Brazil), a Q-Switched laser system equipped with a 755 nm handpiece (Figure 1A) operated at energy settings of 200 mJ and 1400 mJ, respectively, and a 1064 nm handpiece (Figure 1B) operated at the same energy levels (200 mJ and 1400 mJ). Applications were performed using a 9-mm spot size and an asterisk-shaped scanning pattern consisting of horizontal, vertical, and diagonal passes, as illustrated in Figure 2.For comparison, a Thulium laser system (Lavieen®, Medsystems, South Korea) operating at 1927 nm (Figure 1C) was used with energy settings of 210 mJ and 1402 mJ. The same asterisk-shaped application pattern described above was employed (Figure 2).The procedure was initially performed on intact porcine skin samples. Subsequently, a red dye was applied to the tissue before laser irradiation in order to facilitate visualization of the depth and extent of tissue penetration induced by each wavelength.

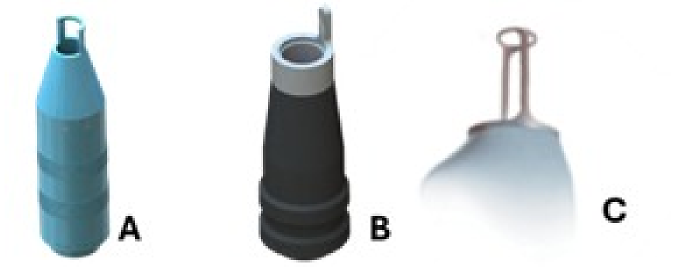

Figure 1. (A) 1064 nm handpiece of the Syrius-YAG laser system; (B) 755 nm handpiece of the Syrius-YAG laser system; (C) 10-mm handpiece of the Lavieen Thulium laser system

Figure 2 illustrates the application protocol used in the experimental model, consisting of a demarcated 5 × 5 cm treatment area. Laser irradiation was performed using vertical, horizontal, and diagonal passes (right and left), totaling three passes per treatment area. Each quadrant was assigned a specific wavelength and energy setting to enable subsequent comparison of the tissue injury patterns induced by the different laser parameters.

Macroscopic Analysis : Immediate macroscopic assessment was performed by comparing photographs of the treated areas. The evaluated parameters included lesion depth, presence of carbonization, homogeneity of tissue response, and thermal dispersion.

RESULTS

The results demonstrated distinct tissue responses according to the wavelengths and energy settings employed. The 1064 nm Q-Switched Nd:YAG laser, at an energy level of 200 mJ, produced deep, focal microlesions with slight carbonization and preservation of the surrounding epidermis (Figure 3). In contrast, for the 755 nm wavelength, the desired tissue effects were achieved only at the highest energy setting (1400 mJ), resulting in a more superficial effect when compared with the 1064 nm wavelength. The 1927 nm Thulium laser induced superficial and homogeneous lesions without evidence of carbonization, exhibiting a diffuse pattern of epidermal coagulation that may be associated with pore contraction (Figure 5).

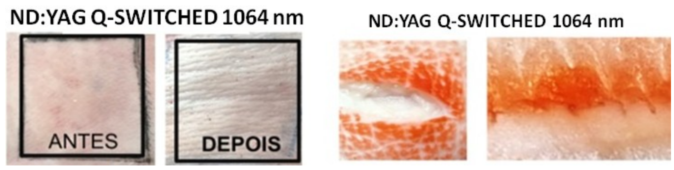

Figure 2. Cross-sectional view of porcine skin treated with the 1064 nm handpiece, demonstrating the depth of dermal penetration induced by laser irradiation

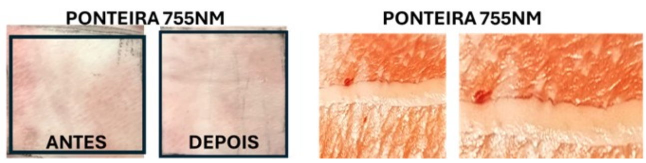

Figure 3. Cross-sectional view of porcine skin treated with the 755 nm handpiece, demonstrating the depth of dermal penetration induced by laser irradiation

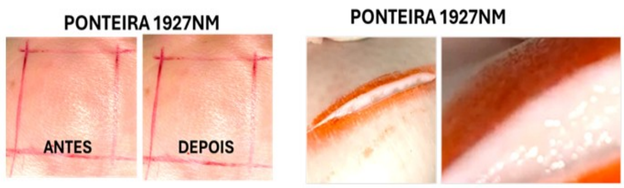

Figure 4. Cross-sectional view of porcine skin treated with the 1927 nm handpiece, demonstrating the depth of epidermal penetration induced by laser irradiation

DISCUSSION

The present study evaluated the tissue injury patterns induced by different high-power laser wavelengths using an experimental porcine skin model. The macroscopic findings demonstrated markedly distinct laser–tissue interaction profiles between the 1064 nm e o 755 nm do Q-Switched Nd:YAG laser and the 1927 nm Thulium laser, reflecting the physical and biological mechanisms inherent to their respective wavelengths and pulse dynamics. Analysis of the Q-Switched Nd:YAG laser revealed deep and focal microlesions accompanied by mild carbonization and preservation of the surrounding epidermis. These findings are consistent with previous studies identifying the 1064 nm Nd:YAG wavelength as particularly effective for targeting deep chromophores and resistant pigmentation (Anderson & Parrish, 1983).

Tabela 1. Descrição dos principais achados para cada um dos comprimentos de onda utilizados e sugestões para uso clinic

EVALUATED CRITERION	ND:YAG Q-SWITCHED		THULIUM 1927 NM
Depth	Depht	Superficial	Superficial
Homogeneity	Localized (Focal)	Extensive (Diffuse)	Extensive (Diffuse)
MAIN CLINICAL INDICATIONS	Deep pigment removal; treatment of refractory melasma; induction of the flushing effect; skin resurfacing; and enhancement of dermal drug delivery	Improvement of skin tone uniformity, enhancement of skin texture, and epidermal drug delivery	Skin rejuvenation, reduction of fine lines, and enhancement of epidermal drug delivery

Furthermore, evidence suggests that Nd:YAG laser irradiation may stimulate dermal remodeling through increased expression of markers associated with collagen synthesis, reduced matrix metalloproteinase-1 (MMP-1) activity, and enhanced production of type I collagen and elastin in cellular and animal models. These findings support a potential rejuvenating effect mediated by molecular modulation and neocollagenesis following exposure to the 1064 nm Q-Switched Nd:YAG laser (Chen *et al*., 2022).

Although the 755 nm wavelength also preferentially targets melanin (Zawodny *et al*., 2025), distinct tissue responses were observed. Higher energy levels were required to achieve therapeutic effects comparable to those produced by the 1064 nm wavelength. It is important to note that the Syrius-YAG 755 nm handpiece delivers energy in a fractional pattern, which may have influenced the amount of energy required to induce the observed tissue response. The biological effects associated with this wavelength include skin tone homogenization through melanin fragmentation, improvement in skin texture through indirect stimulation of dermal remodeling, and the promotion of immediate skin radiance resulting from transient increases in blood flow and more uniform optical light dispersion within the epidermis, a phenomenon commonly referred to as the immediate *glow effect* (Tanghetti, 2016). In contrast, the 1927 nm Thulium laser exhibits a high affinity for water, resulting in controlled epidermal ablation and increased skin permeability, potentially contributing to pore contraction and enhanced transdermal delivery of topical agents (Kawamura *et al*., 2017).

The 1064 nm wavelength, on the other hand, penetrates deeply into the dermis and demonstrates affinity for both water and hemoglobin. Consequently, it generates controlled thermal effects capable of stimulating neocollagenesis, leading to improvements in skin texture, firmness, and pore appearance without significant destruction of superficial tissues. In addition, its effects on local microcirculation may contribute to clinical improvements in conditions such as facial flushing and mild rosacea. The 755 nm wavelength provides additional benefits through melanin fragmentation, indirect stimulation of dermal reorganization, and enhancement of skin luminosity via transient vascular responses and more homogeneous epidermal light scattering. These mechanisms further support its role in skin rejuvenation and pigmentation management (Tanghetti, 2016). Taken together, these findings suggest a complementary relationship between the two Nd:YAG wavelengths. Sequential application of the 1064 nm and 755 nm wavelengths may enhance clinical outcomes in challenging conditions such as mixed melasma, which involves both epidermal and dermal pigmentation. In this context, the 1064 nm wavelength may contribute to the fragmentation of deeper pigment deposits and facilitate dermal drug delivery, whereas the 755 nm wavelength may promote superficial skin renewal and epidermal pigmentation improvement.

CONCLUSION

The 1064 nm Q-Switched Nd:YAG laser produced deeper and more focal tissue injuries, whereas the 755 nm wavelength promoted superficial skin renewal and an immediate skin-brightening effect. In contrast, the 1927 nm Thulium laser generated superficial and homogeneous tissue alterations.
The combined use of the 1064 nm and 755 nm Nd:YAG wavelengths may provide a more effective therapeutic approach for the management of resistant melasma and skin rejuvenation when compared with the isolated use of the 1927 nm Thulium wavelength. Further clinical studies are warranted to validate these findings and establish optimized treatment protocols.

REFERENCES

ANDERSON, R. R.; PARRISH, J. A. Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. Science, v. 220, n. 4596, p. 524-527, 1983.

KAWAMURA, T. *et al*. Fractional thulium laser treatment for melasma: clinical and histological evaluation. Lasers in Surgery and Medicine, v. 49, n. 2, p. 124–131, 2017.

MONTES, A. O modelo de pele de porco em pesquisas dermatológicas: revisão e perspectivas. Anais Brasileiros de Dermatologia, v. 95, n. 4, p. 517–523, 2020.

TANGHETTI, E. A. The histology of skintreatedwith a picosecondalexandrite laser and a fractionallensarray. Lasers in Surgery and Medicine, v. 48, n. 7, p. 646–652, 2016.

TRELLES, M. A. *et al*. Advances in Q-switched Nd:YAG laser technology for pigmented lesions and tattoos. Journal of Cosmetic and Laser Therapy, v. 21, n. 6, p. 341–347, 2019.

ZAWODNY, P. *et al*. The Efficacy of 532/755 nm Laser Therapy for Facial Pigmented and Vascular Lesions: A Systematic Review and Meta-Analysis. Journal of Clinical Medicine, v. 14, n. 8, p. 2546, 2025.

CHEN J, Yu N, Peng L, Li H, Tang Y, Ou S, Zhu H. Efficacy of low-fluence 1064 nm Q-switched Nd: YAG laser for the treatment of melasma: A meta-analysis and systematic review. J Cosmet Dermatol. 2022 Jul;21(7). doi: 10.1111/jocd.15126. Epub 2022 Jun 4. PMID: 35621242.

BARONI A, Buommino E, De Gregorio V, *et al*. Structure and function of the skin in relation to wound healing.J Dermatol Sci. 2012. PubMed ID: 22771208.

****