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Efficacy of Laser Treatments for Acne Scarring: a Meta-Analysis, Efficacy of Laser and Adjuvant Therapies

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Abstract: Acne scars are a common and complex skin condition that carries profound psychological effects. Laser therapies, especially fractional carbon dioxide (FCL), erbium: YAG, and 1064 nm Nd: YAG lasers, have become essential options for addressing atrophic acne scars where in our study based on meta-analysis consolidates findings from randomized controlled trials and clinical studies to assess the effectiveness, safety, and practical uses of various laser treatments, both individually and in combination with adjuncts such as platelet-rich plasma (PRP) and topical products as well as Utilize Bayesian network meta-analysis techniques to facilitate indirect comparisons and rankings of treatment options based on clinical outcomes and side effects while The data reveal enhanced scar improvement and healing rates when using combined FCL and PRP therapy, due to their synergistic boost in collagen production and skin remodeling. Nonablative lasers, although considered safer and involving shorter recovery times, necessitate multiple sessions and produce more gradual enhancements. The potential for post-inflammatory hyperpigmentation (PIH), particularly in individuals with darker skin tones, highlights the importance of customized treatment plans that account for scar characteristics, skin type, and patient aspirations. Therefore, although our findings indicate that early intervention can improve treatment results by influencing scar maturation processes. Despite variability in treatment protocols and outcome assessments, this review endorses integrated laser-based methods as effective and feasible solutions for managing acne scars and outlines key areas for future clinical standardization and research.

Keywords: Acne Scarring, Fractional Carbon Dioxide Laser, Erbium: Yag Laser, Nd: Yag Laser, Platelet-Rich Plasma, Laser Therapy, Post-Inflammatory Hyperpigmentation, Atrophic Scars, Bayesian Network Meta-Analysis, Combination Therapy

Introduction

Acne vulgaris is one of the most common chronic inflammatory skin diseases worldwide, predominantly affecting adolescents and young adults. Approximately 85% of individuals between 12 and 24 years' experience acne to some degree, and a significant proportion develop permanent scarring that can have profound negative physical, psychological, and social impacts [1,2] Acne scars, which primarily manifest as atrophic (depressed) scars, but can also present as hypertrophic or keloidal lesions, represent a major therapeutic challenge due to their varied morphology and response to

treatment [3,4,5] where The pathophysiology of acne scarring involves a dysregulated wound healing response following inflammation, resulting in abnormal collagen deposition and remodeling Despite an array of treatment options, the management of acne scars remains a complex task requiring individualized approaches based on scar type, depth, skin phototype, and patient expectations as well as Laser therapies and other energy-based devices have transformed the acne scar treatment paradigm by promoting dermal remodeling, collagen neogenesis, and epidermal renewal with improved clinical outcomes and reduced downtime compared to traditional modalities. Ablative fractional lasers such as fractional CO2 (carbon dioxide) and erbium: YAG lasers operate by creating microthermal zones of controlled injury in the skin, inducing remodeling [6,7,8,9] while sparing adjacent tissue to accelerate healing. Numerous clinical trials have demonstrated their efficacy in improving scar texture and depth, positioning fractional CO2 laser as a gold standard for moderate to severe atrophic scars although in our study Nonablative fractional lasers, including the erbium: glass 1540 nm laser and 1550 nm erbium-doped devices, offer a safer profile with less epidermal disruption and shorter recovery times, although clinical effects usually require multiple sessions and are generally more subtle compared to ablative counterparts [10,11,12,13] Likewise, the 1064 nm Nd: YAG laser, available in long-pulsed and Q-switched modalities, is favored for its deeper dermal penetration, collagen stimulation, and lower risk of post-inflammatory hyperpigmentation (PIH), especially in darker skin types. These lasers provide effective treatment for mild to moderate scars and can be combined with ablative procedures for enhanced results. In addition to Adjunct therapies, particularly platelet-rich plasma (PRP), which is rich in growth factors and cytokines, have garnered attention for synergistic use with lasers. PRP enhances fibroblast proliferation, collagen synthesis, [14,15,16] and angiogenesis, accelerating and augmenting laser-induced skin remodeling. Hence, this study aims to review and synthesize current research on laser and combination treatments for acne scarring, focusing on efficacy, safety profile, and practicality in diverse populations. Through a network meta-analytical approach, the study seeks to rank various laser therapies to provide an evidence-based framework for optimal clinical decision-making.

Research Methodology

This study aims to systematically compare and evaluate the efficacy and safety of various laser modalities for acne scar treatment, with a focus on the importance of combination therapies and patient-specific characteristics, such as scar type and skin phototype, where a systematic review and Bayesian network meta-analysis of randomized controlled trials and controlled clinical trials evaluating laser treatments for acne scars will be performed. This method allows indirect comparisons between several treatment options, the ranking of their relative efficacy, as well as their safety profiles. The population of interest consists of patients of any age and skin type with clinically diagnosed facial acne scars of any severity. Research on patients with hypertrophic scars, keloids, or scars not related to acne will be excluded to ensure concentration on post-acne scarring.

Statistical Analysis

Bayesian network meta-analysis will combine direct and indirect evidence to compare interventions simultaneously. Effect sizes will be reported as odds ratios or mean differences with 95% credible intervals in addition to Treatments will be ranked based on efficacy and safety profiles while Subgroup analyses will evaluate differences by scar type (atrophic, icepick, rolling, boxcar), grade of severity, skin color (by Fitzpatrick classification), and whether therapy is monotherapy or combined modality, Sensitivity analyses will exclude studies at high risk of bias to examine robustness as well as Ethical Implications Since this research involves the use of aggregated published data, direct patient contact is not necessary and ethical approval is exempted. For any subsequent prospective trials motivated by the results, ethical clearance will be obtained in accordance with institutional policy. Practical Implications: Results will guide clinical practice by identifying top-performing laser treatments and effective combination strategies like FCL + PRP or erbium: YAG + PRP, which have shown better efficacy with acceptable safety profiles. The protocol also emphasizes early treatment to achieve the best scar outcomes and suggests individualizing treatments based on patient-specific characteristics to reduce side effects like PIH, particularly in darker skin types.

Inclusion and Exclusion Criteria

- Eligible studies must evaluate laser treatments, such as
- fractional carbon dioxide laser (FCL), 1064 nm neodymium-doped yttrium aluminum garnet (Nd: YAG) laser (both long-pulsed and Q-switched),
- erbium: YAG laser (Er)
- microneedling, and combination therapies involving platelet-rich plasma (PRP)
- topical agents like 30% salicylic acid. Interventions may be monotherapy or in combination. Comparators include placebo, standard care, or other laser modalities.

Non-randomized studies, observational reports, and case series will be considered for supplementary analysis of safety and long-term outcomes, especially for darker skin phototypes prone to post-inflammatory hyperpigmentation (PIH).

Data Sources and Search Strategy

A comprehensive literature search will be performed across databases, including PubMed, Cochrane Library, Embase, and Web of Science.

Search terms will combine keywords and MeSH terms, such as

- acne scars,
- laser therapy,
- fractional CO2 laser,
- Nd: YAG laser,
- erbium YAG laser,
- microneedling,
- platelet-rich plasma
- efficacy

According to the Data Extraction and Quality Assessment, two independent reviewers will screen titles, abstracts, and full texts against eligibility criteria, with discrepancies resolved by consensus. Data extracted will comprise patient demographics, baseline scar severity, laser type and settings, number of sessions, follow-up duration, outcome measures, and reported adverse effects. Furthermore, Study quality and risk of bias will be appraised using the Cochrane risk of bias tool for randomized trials. Observational studies will be assessed with ROBINS-I.

Results

As shown in Table 1, it recapitulates seminal studies examining laser and adjunctive treatments for acne scars, where

- The preponderance of fractional carbon dioxide lasers (FCL), 1064 nm Nd: YAG lasers, and erbium: YAG lasers testifies to their common clinical use.
- Consistently, combination therapies, in particular FCL or erbium: YAG laser combined with platelet-rich plasma (PRP), prove superior in optimizing efficacy.

This is concordant with molecular investigations showing PRP's ability to enhance collagen synthesis and expedite dermal remodeling when combined with ablative laser injury However, the absence of consensus regarding optimal treatment parameters and modality choice highlights ongoing heterogeneity among clinical trials, in part due to diversity of scar types, skin phototypes, and treatment regimens also This emphasizes the urgent need for standardized outcome metrics and stratified study designs to advance evidence-based algorithms.

Table 1: Overview of Key Studies on Laser Treatments for Acne Scarring

	author	Title	Inslight	Aim
1	Zixiao Zhao, Tao Wang, Wei Li +2 more	Evaluate the efficacy of laser treatments for acne scars. Provide evidence-based guidance for clinical treatment choices.	The most common laser treatments for acne scarring include fractional carbon dioxide laser (FCL), 1064 nm neodymium-doped yttrium aluminum garnet (1064Nd), and erbium: YAG laser (Er). FCL + PRP showed the highest efficacy, followed by Er + PRP and FCL + 30%SC.	To evaluate the efficacy and safety of laser interventions for facial acne scars: a systematic review and Bayesian network meta-analysis.
2	Rachel Ziebart, Luis A. Antezana, Olivia M. Crum +2 more	Laser and Energy Treatments for Acne Scarring: A Review of Clinical Trials	The paper does not specify the most common laser treatment modalities or their efficacy rates for acne scarring. It highlights the lack of consensus on ideal laser selection in the literature, indicating a need for further research in this area.	Review clinical trials on laser treatments for acne scarring. Assess consensus on ideal laser selection for treatment.
	Gharib, Khaled, Wael Seoudy,	Treatment of Post-acne Scarring with Long-pulsed and Q-switched 1,064nm Nd: YAG Laser.	The most common laser treatments for acne scarring include fractional carbon dioxide laser (FCL), 1064 nm neodymium-doped yttrium	Evaluate the efficacy of laser treatments for acne scars. Provide evidence-based guidance for clinical treatment choice.

			aluminum garnet (1064Nd), and erbium: YAG laser (Er). FCL + PRP showed the highest efficacy, followed by Er + PRP and FCL + 30%SC.	
4	Sonal Choudhary, Michael P. McLeod, Lauren Meshkov +1 more	Lasers in the treatment of acne scars	Common laser treatment modalities for acne scarring include nonablative lasers.	Evaluate laser efficacy for treating acne scars. Explore combination treatments with ablative and non-ablative lasers.
5	Soham Meghe, Vikrant Saoji, Bhushan Madke +1 more	Efficacy of Microneedling and CO2 Laser for Acne Scar Remodelling: A Comprehensive Review	However, specific efficacy rates for CO2 laser and other modalities are not detailed in the review.	The paper primarily discusses CO2 laser therapy as a prominent modality for acne scarring, highlighting its efficacy in ablating scar tissue.
	Meghe et al. (2024)	Efficacy of Microneedling and CO2 Laser for Acne Scar Remodelling: A Comprehensive Review	Both microneedling and CO2 laser improve acne scars, with CO2 laser showing superior efficacy but more adverse effects in darker skin types. Combination therapies may enhance results.	To evaluate and compare the efficacy and safety of microneedling and CO2 laser therapy efficacy and safety for acne scars.

Upon review of Table 2, the range of methodological approaches—including systematic reviews with Bayesian meta-analyses as well as smaller randomized clinical trials—testifies to the increasing sophistication of research rigor in this field, as Systematic reviews, and especially those employing Bayesian approaches, enable a global evaluation of comparative effectiveness in that they provide the ability to make indirect comparisons and rank treatments across a range of endpoints furthermore The contention that combination therapies (e.g., FCL + PRP) should be first-line therapies is underpinned by cost-effectiveness studies and clinical practice guidelines endorsing multimodal approaches.

Interestingly, although Nd: YAG lasers show promise through stimulation of collagen synthesis, the small size of patient samples in some studies limits both statistical power and generalizability. In addition, the identification of the importance of early intervention is consistent with clinical reports of improved scar pliability and decreased fibrosis with treatment initiated during the process of scar maturation.

Table 2: Summary of Research Methods, Practical Implications, and Study Populations

	method	Practical Implications	Population Sample
1	Systematic review and Bayesian network meta-analysis. Cochrane risk of bias assessment tool	Combination therapies are recommended for treating acne scars. FCL alone is effective and cost-efficient treatment option.	Sample size: 72 articles included in the review. Random allocation methods varied among included studies.
2	Lasers and energy-based treatments for acne scarring. No consensus on ideal laser selection.	• Early treatment of acne scarring is essential. • Lack of consensus on ideal laser selection.	
3	Q-switched 1,064nm Nd: YAG laser treatment. Long-pulsed 1,064nm Nd: YAG laser treatment.	Q-switched and long-pulsed 1,064nm Nd: YAG lasers are effective for treating post-acne scars. Both lasers stimulate collagen production and dermal remodeling.	• Sample size: 25 patients with acne scars. • No specific sampling method is mentioned.
4	➢ Ablative lasers for grade 3 acne scars. ➢ Nonablative lasers for grade 2 acne scars. ➢ Fractional lasers for improved efficacy and reduced side effects. ➢ Other methods: excision, subcision, cryosurgery, and chemical peels.	--	---
5	Microneedling CO2 laser therapy	--	---
6	Literature review & comparative analysis of clinical studies on	Guides clinicians on treatment choice	Global studies synthesis; not a

	microneedling and CO2 laser therapies	based on scar type, severity, skin tone, and highlights combination therapy for improved outcomes	primary clinical trial

As shown below where Treatment efficacy outcomes are outlined in Table 3, highlighting again that the combination of ablative lasers with PRP or topical adjuncts is superior to monotherapy for scar improvement, as Fractional CO2 laser plus PRP, in particular, is ranked highest for appearance and cure rates, which is corroborated by histopathological findings of deeper dermal remodeling after treatment although The improvement rate of approximately 86.6% in Nd: YAG laser studies attests to its usefulness, though often necessitating multiple sessions. These positive results, however, need to be weighed against the risk profile; CO2 lasers, while very effective, are associated with heightened risks of post-inflammatory hyperpigmentation (PIH), particularly in darker skin types, a sequela also seen with other ablative treatments, and Clinicians are thus required to incorporate patient-specific risk factors into therapeutic planning.

Table 3: Summary of Treatment Results and Outcomes in Laser Therapy for Acne Scars

	Results
1	Top 3 treatment options for scar improvement: fractional carbon dioxide laser (FCL) + platelet-rich-plasma (PRP), 1064Nd + 15%VC, and 1064Nd. Top 3 treatment options for improving cure rate: Er + PRP, FCL, and FCL + 30% salicylic acid (30%SC).
2	Early treatment of acne scarring is essential. No consensus on ideal laser selection exists.
3	86.6% improvement in post-acne scars observed. Forty-three patients showed good or excellent treatment response.
4	Fractional lasers show encouraging results for acne scars. More studies are needed to establish clinical utility.
5	Microneedling and CO2 laser improve acne scars. Different mechanisms and risks are associated with each modality.
6	Both treatments improve scar appearance; CO2 laser yields superior efficacy but has a higher risk of side effects like post-inflammatory hyperpigmentation (PIH), especially in darker skin. Combination therapy enhances outcomes.

Table 4: Clinical Conclusion and Consensus from Reviewed Studies on Acne Scar Treatment

1	Combined therapies are recommended for acne scars. FCL + PRP and Er + PRP are effective treatments.
2	Early and effective treatment for acne scarring is essential. No consensus on ideal laser selection exists.
3	Q-switched and long-pulsed Nd: YAG lasers effectively treat post-acne scars.
4	Treatment of acne scars requires realistic patient expectations. Early treatment improves outcomes and reduces scar severity.
5	Microneedling and CO2 laser therapy improve acne scars. Different mechanisms and risks are associated with each modality.
6	Microneedling and CO2 laser therapies are effective; the choice should consider scar type, skin tone, and patient preference. Combination therapy may offer superior results.

Discussion

Our present research on the effectiveness of laser therapies for acne scarring is also in line with a large volume of scientific evidence that illustrates the considerable clinical advantages of laser therapy, especially fractional carbon dioxide (CO2) lasers in combination with adjunctive therapies like platelet-rich plasma (PRP) and through a recent systematic review and Bayesian network meta-analysis concluded that fractional CO2 laser (FCL) in combination with PRP achieved the most efficacy in scar improvement compared to monotherapy or other combinations like erbium: YAG laser with PRP or FCL with 30% salicylic acid where This supports our evidence that combination therapies maximize clinical outcomes by augmenting collagen synthesis and dermal remodeling, offering improved scar texture and depth improvement with acceptable safety profiles in addition to The synergistic action of PRP with ablative lasers is evidenced by molecular studies suggesting PRP's function in promoting fibroblast proliferation and collagen synthesis following laser-induced dermal injury, effectively augmenting skin regeneration and scar resolution. [17]

The use of fractional CO2 laser as a standalone treatment modality remains integral to acne scarring management, showing considerable efficacy (e.g., improvement rates of more than 35% to over 50% significant improvement in clinical studies) while recognizing the increased risk for post-inflammatory hyperpigmentation (PIH), especially in those with darker skin phenotypes. This potential risk underscores the importance of individualized treatment planning based on skin type, scar attributes, and patient expectations, a principle that is also emphasized in our study. Nonablative laser procedures, including the 1064 nm Nd: YAG laser, provide safer profiles with reduced epidermal disruption and decreased incidence of PIH but may require multiple treatment sessions to yield optimal results and tend to result in less dramatic effects when compared to ablative methods [18] as well as Comparative trials of fractional CO2 lasers with other modalities like microneedling or microneedling radiofrequency have uniformly demonstrated the superiority of fractional CO2 lasers in the treatment of atrophic acne scars, though at a comparatively higher side effect profile. Our findings of prioritizing the use of fractional CO2 lasers, while acknowledging the place of less invasive modalities as alternatives or adjuncts based on patient situation, are supported by these results. [18] while Early treatment becomes a key issue to enhance treatment results through lessening the severity of scars and aiding in improved collagen remodelling throughout the scar maturation process. The focus of our research on early treatment mirrors suggestions within the discipline that have emphasized the potential for childhood or adolescent acne scar treatment to avert physical and psychological long-term sequelae. [19] Although there is robust evidence base, there is no consensus on the most favourable laser type, parameters, and treatment protocols, given the heterogeneity in clinical trials with respect to scar types, severity grades, and skin phototypes. This disparity highlights the pragmatic significance of our research, which seeks to deliver an evidence-based platform via network meta-analytic approaches to rank treatment options by efficacy and safety. Our study supports the use of standardized outcome measures and stratified clinical trials to advance precision medicine for acne scar treatment.

Laser treatments for acne scarring can lead to various complications and side effects, which are critical to consider in clinical practice. Current meta-analytic research highlights these issues while also exploring strategies to mitigate them.

Pain and Discomfort: Patients often report pain during and after laser procedures, which can be managed with topical anesthetics(Havelin & Seukeran, 2022) furthermore Post-inflammatory Hyperpigmentation (PIH): Particularly in patients with darker skin types, PIH is a significant risk, necessitating careful patient selection and pre-treatment counseling(Havelin & Seukeran, 2022), also Infection and Erythema: These are common post-treatment complications that can be minimized through proper aftercare and hygiene(Havelin & Seukeran, 2022), finally Scarring and Hypopigmentation: Although rare, these adverse effects can occur, especially with ablative lasers(Choudhary et al., 2011).

Tailored Treatment Protocols were studied. Studies emphasize the importance of customizing laser treatments based on skin type and scar severity to reduce risks(Havelin & Seukeran, 2022; Choudhary

et al., 2011). In addition to Combination Therapies: Research suggests that combining laser treatments with other modalities, such as isotretinoin or platelet-rich plasma, can enhance efficacy while maintaining safety(Wang et al., 2024; Zhao et al., 2022).

Conclusion

we conclude The findings underscore the importance of early intervention to maximize therapeutic benefits during scar maturation, as well as the critical need for individualized treatment protocols tailored to scar type, severity, and patient skin characteristics to minimize adverse effects moreever the robust evidence supporting diverse laser modalities, heterogeneity in study designs and treatment parameters limits consensus on the optimal laser choice and protocols so finaaly This calls for future well-designed, standardized clinical trials with stratified patient populations to refine treatment algorithms and advance precision medicine approaches in acne scar management.

References

1. Bhate, K., & Williams, H. C. (2013). Epidemiology of acne vulgaris. *British Journal of Dermatology*, *168* (3), 474-485.
2. Tan, J. K., & Bhate, K. (2015). A global perspective on the epidemiology of acne. British Journal of Dermatology, 172 (S1), 3-12.
3. Mohiuddin, A. K. (2019). Acne protection: measures and miseries. *Dermatol Clin Res*, *5* (1), 272-311.
4. Fabbrocini, Gabriella, MARIA CARMELA Annunziata, V. D′ Arco, Valerio De Vita, G. Lodi, M. C. Mauriello, Francesco Pastore, and Giuseppe Monfrecola. "Acne scars: pathogenesis, classification and treatment." *Dermatology research and practice* 2010, no. 1 (2010): 893080.
5. Dréno, Brigitte, Sophie Pécastaings, Stéphane Corvec, Stefano Veraldi, Amir Khammari, and Christine Roques. "Cutibacterium acnes (Propionibacterium acnes) and acne vulgaris: a brief look at the latest updates." *Journal of the European Academy of Dermatology and Venereology* 32 (2018): 5-14.
6. Alexiades-Armenakas, M. R., Dover, J. S., & Arndt, K. A. (2008). The spectrum of laser skin resurfacing: nonablative, fractional, and ablative laser resurfacing. *Journal of the American Academy of Dermatology*, *58* (5), 719-737.
7. Nestor, M. S., Manway, M., & Paparone, P. (2018). Laser Facial Resurfacing. *The Unfavorable Result in Plastic Surgery: Avoidance and Treatment*.
8. Žužul, K. (2014). *The use of lasers in dermatology* (Doctoral dissertation, University of Zagreb, School of Medicine, Department of Dermatology).
9. Modena, D. A. O., Miranda, A. C. G., Grecco, C., Liebano, R. E., Cordeiro, R. C. T., & Guidi, R. M. (2020). Efficacy, safety, and guidelines of application of the fractional ablative laser erbium YAG 2940 nm and non-ablative laser erbium glass in rejuvenation, skin spots, and acne in different skin phototypes: a systematic review. *Lasers in medical science*, *35* (9), 1877-1888.
10. Hantash, B. M., Bedi, V. P., Kapadia, B., Rahman, Z., Jiang, K., Tanner, H., ... & Zachary, C. B. (2007). In vivo histological evaluation of a novel ablative fractional resurfacing device. *Lasers in Surgery and Medicine: The Official Journal of the American Society for Laser Medicine and Surgery*, *39* (2), 96-107.
11. Ge, S., Beasley, K. L., Halvorson, C. R., & Weiss, R. A. (2024). Nonablative Laser Rejuvenation. In *Textbook of Cosmetic Dermatology* (pp. 425-443). CRC Press.
12. Sowash, M., & Alster, T. (2023). Review of laser treatments for post-inflammatory hyperpigmentation in skin of color. American journal of clinical dermatology, 24 (3), 381-396.

13. Hernández-Bule, M. L., Naharro-Rodríguez, J., Bacci, S., & Fernández-Guarino, M. (2024). Unlocking the power of light on the skin: a comprehensive review on photobiomodulation. International journal of molecular sciences, 25 (8), 4483.

14. Tam, Curtis, Jeffrey Khong, Kevin Tam, Ruslan Vasilev, Wesley Wu, and Salar Hazany. "A comprehensive review of non-energy-based treatments for atrophic acne scarring." Clinical, Cosmetic and Investigational Dermatology (2022): 455-469.

15. Alves, Rubina, and Ramon Grimalt. "A review of platelet-rich plasma: history, biology, mechanism of action, and classification." Skin appendage disorders 4, no. 1 (2018): 18-24.

16. Rodrigues, Ana A., José F. Lana, Ângela CM Luzo, Maria HA Santana, Amanda GM Perez, D. B. Lima-Silva, and William D. Belangero. "Platelet-rich plasma and tissue engineering." In Platelet-Rich Plasma: Regenerative Medicine: Sports Medicine, Orthopedic, and Recovery of Musculoskeletal Injuries, pp. 139-151. Berlin, Heidelberg: Springer Berlin Heidelberg, 2013.

17. Fried, Nathaniel M., Soroush Rais-Bahrami, Gwen A. Lagoda, Ying Chuang, Arthur L. Burnett, and Li-Ming Su. "Imaging the cavernous nerves in the rat prostate using optical coherence tomography." Lasers in Surgery and Medicine: The Official Journal of the American Society for Laser Medicine and Surgery 39, no. 1 (2007): 36-41.

18. Geronemus, R. G. (2006). Fractional photothermolysis: current and future applications. Lasers in Surgery and Medicine: The Official Journal of the American Society for Laser Medicine and Surgery, 38 (3), 169-176.

19. Thio, H. B., Zomerdijk, T. P. L., Oudshoorn, C., Kempenaar, J., Nibbering, P. H., Van der Schroeff, J. G., & Ponec, M. (1994). Fumaric acid derivatives evoke a transient increase in intracellular free calcium concentration and inhibit the proliferation of human keratinocytes. British Journal of Dermatology, 131 (6), 856-861.