Integrated Cooling-Vacuum-Assisted Non-Fractional 1540 nm Erbium:Glass Laser Is Effective in Treating Acne Scars

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ABSTRACT

Introduction: Acne scars are a common result of inflammatory acne, affecting many patients worldwide**.** Among which, atrophic scars are the most prevalent form, presenting as dermal depressions caused by inflammatory degeneration of dermal collagen. Mid-infrared laser skin interaction is characterized by its modest absorption in water and finite penetration to the mid-dermis. Since collagen is a desirable laser target, 1540-nm wavelength is amenable for collagen remodeling within the depressed area of atrophic scars.
Objectives: To evaluate the safety and efficacy of acne scars treatment using an integrated cooling-vacuum-assisted 1540 nm Erbium: Glass Laser.
Patients and Methods: This interventional prospective study included 25 volunteers (10 men, 15 women) with post acne atrophic scars. Patients were treated with a mid-infrared non-fractional 1540 nm Er:Glass laser (Alma Lasers Ltd. Caesarea, Israel) with integrated cooling- vacuum assisted technology. Acne scars were exposed to 3 stacked laser pulses (400-600 mJ/pulse, 4 mm spot size, frequency of 3 Hz). Patients underwent 3-6 treatment sessions with a 2-3 week interval and were followed-up 1 month and 3 months after the last treatment. Clinical photographs were taken by high resolution digital camera before and after treatment. Clinical evaluation was performed by two independent dermatologists and results were graded on a scale of 0 (exacerbation) to 4 (76%-100% improvement). Patients' and physicians' satisfaction were also recorded (on a 1-5 scale). Pain perception and adverse effects were evaluated as well.
Results: Almost all patients (24/25) demonstrated a moderate to significant improvement. Average improvement was 3.9 and 4.1 points on the quartile scale used for outcome assessment 1 and 3 months following the last session, respectively. Patient satisfaction rate was 4.2. Side effects were minimal and transient: erythema, mild transient vesicles, and mild pain or inconvenience.
Conclusion: Cooling-Vacuum-Assisted mid-infrared non-fractional Er:Glass 1540 nm laser is safe and effective in the treatment of atrophic acne scars.

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INTRODUCTION

Acne vulgaris is a very common condition affecting billions worldwide.[1-3] Post acne scars are common sequelae of acne.[4] Inflammation is a major factor in their development,[5] influenced by acne inflammation severity, extent, and immunological status. Early and proper treatment of active acne is crucial, especially in patients with the tendency of scarring. Despite many available modalities for the treatment of inflammatory acne residual scarring do occur.[6]

The actual extent and incidence of post acne scarring remains unknown, yet one study found acne scars in 1% of adult population.[7] Often presents in highly visible areas such as the face, permanent and disfiguring acne scars may significantly decrease self-esteem and well-being.[8]

Acne scars can be divided into two main categories[6]: atrophic and hypertrophic, the former, appearing much more frequently than the latter. Atrophic scars are characterized by loss of collagen deposition during the wound-healing process. The affected skin has an abnormal contour, with most scars being depressed below the adjacent normal skin. These atrophic scars could be further subdivided into 3 morphological main types[9]: ice pick like type, boxcar like type, and rolling like type scar.

The development of advanced technologies in recent years, brought on a new era in the treatment of acne scars.[10] Laser treatments are in constant growing utilization for that purpose,[11, 12] alone or in treatment combinations,[13] as well as the demand for a minimal downtime following treatment.

Non-ablative, fractional photo-thermolysis laser therapy is considered the standard-of-care in various cutaneous conditions such as wrinkles, atrophic and surgical scars, hypo-pigmentation, and others, with high safety profile across all skin types.[14-18]

Fractionation refers to manipulation of a laser beam via a defractive lens in which multiple microscopic laser beams are

delivered into microscopic treatment zones to target a fraction of the overall surface area while sparing the intervening areas of skin, thus confluent epidermal damage is avoided.[19-21] Mid-infrared fractional lasers are considered the lasers of choice for acne scars treatment due to their poor melanin absorption and which allows a predictable optical penetration to the mid-dermis,[22-23] thus inducing collagen production and stimulating dermal remodeling within the depressed scars area. In general, compared to non-fractionated lasers,[24] fractionated lasers have the benefits of fewer side effects and shorter down time. However, some difficult to treat conditions, might require the use of a non-fractionated laser, which delivers higher energy (per particular tissue area) than the fractionated one, thus also increasing the potential side effects and downtime. Despite the availability of a wide variety of medical and surgical therapeutic modalities, optimal treatment is still a challenge, when it comes to acne scars.[10,11] It often requires an individually tailored patient-specific regimen and frequently carries the risk of potential complications.[25]

In a recent study[26] we demonstrated the efficacy and safety of a novel cooling-vacuum-assisted non-fractional Erbium:Glass (Er:Glass) 1540 nm laser for the treatment of mild-to-moderate active acne vulgaris. The minimal side effects observed along with a clinical observation that in some of the patient's acne scars were improved as well, prompted us to evaluate this novel technology for the treatment of atrophic acne scars.

Objectives

The aim of this study was to determine the efficacy and safety of a cooling-vacuum-assisted, non-ablative non fractional Erb:Glass 1540 nm laser in treating atrophic acne scars.

PATIENTS AND METHODS

Patients

The inclusion criteria were patients above the age of 18 years, suffering from moderate to severe atrophic facial acne scars. The exclusion criteria were prior treatment with ablative laser, any laser therapy 3 months prior to enrollment, systemic isotretinoin therapy within 6 months prior to enrollment, topical treatment with alpha hydroxy acids, retinoids products, salicylic acid, or vitamins C derivatives 14 days prior to enrollment. Pregnancy, age below 18 years, and excessive sun exposure during the course of study were additional exclusion criteria.

Standardized high resolution digital photography of the treatment area was performed for each patient at baseline, before each treatment, and at 1 and 3 months follow-up visits.

Visual Analog Scale (VAS)[27] was used to quantify acne scars severity (Grade 0 = excellent appearance, Grade 5 = poor appearance) at the screening visit.

Treatment

Patients were treated using a mid-infrared 1540 nm Er:Glass laser (Harmony XL, Alma Lasers Ltd.) receiving 3-6 treatments with 2-3 weeks intervals. Number of treatment sessions was determined by clinical improvement.

The Er:Glass laser device operates with integrated cooling-vacuum-assisted apparatus. This unique technique enables 2 advantages compared to ordinary setting:

It permits retraction of the treated skin area closer to the surface prior to lasing, thus bringing the treated area and the laser closer to each other, allowing deeper penetration of optic energy without increasing the fluence.

At the same time a continuous contact cooling of the tip protects the outer skin layers from thermal damage.

Treatment area was disinfected prior to each treatment. Protective eyewear was utilized during treatments. Laser settings included: spot size 4 mm, fluence of 400-600 mJ/pulse, 3 stacked pulses emitted at a rate of 3 Hz. All settings were pre-adjusted and dependent on patient's tolerability and comfort.

Outcome Measures

Clinical evaluation was performed by two independent dermatologists at each office visit and at 1 and 3 months after the last treatment session. A quartile scale of improvement graded as 0 (exacerbation), 1 (1-25% improvement), 2 (26-50% improvement), 3 (51-75% improvement), or 4 (76-100% improvement) was used to assess improvement in acne scars appearance.

Patients' satisfaction was assessed as well at each treatment visit (after treatment 1) and at 1 and 3 months following the final follow-up visit (Graded on a score of 1- 5; 1 being not satisfied and 5 being very satisfied).

Pain perception and adverse effects were estimated as well by the physician, who also assessed the incidence of post-treatment reactions (erythema, edema, dyspigmentation, blistering, flaking, dryness, and/or pruritus) using a 0 to 3 grading scale (0=none, 1=mild, 2=moderate, 3=severe) at each treatment and follow-up visit, and recorded any additional side effects.

RESULTS

Twenty-five patients (10 male, 15 female) were included in this study. Age range was 21-47 years. Fitzpatrick skin types were II to IV.

All patients had moderate to severe facial acne scars at baseline. The severity of their condition was rated as grade 2-5 (mean, 3.7 +/- 1.2) using a VAS severity scale at their screening visit.

Twenty four patients completed treatment (3-6 sessions; mean, 5.1 +/- 1.7) and follow-up visits at 1 and 3 months after the last treatment session. One female patient dropped from the study and was lost to follow up, after a single treatment due to immigration to a different country.

Improvement in facial appearance (in regard to acne scars) occurred gradually over the course of the treatment; patients demonstrated moderate to significant improvement (average, 3.9 and 4.1 points of improvement on the quartile scale used for outcome assessment 1 and 3 months following the last session, respectively). Figures 1-4 portray representative cases.

Patients' self-rated satisfaction was 3-5 (mean, 4.2 +/- 1.1) at 3 months follow up.

The treatment was well tolerated by all patients, as side effects included: transient erythema, very mild transient vesicles, and mild pain or inconvenience during or immediately after treatment.

No side effects were recorded at the 1 and 3-month follow-up visits.

DISCUSSION

In recent years, non-ablative lasers are gaining popularity in the treatment of acne scars.[10-12,14-17]

Acne scars are unique in comparison to the development of traumatic scars. Inflammation starts deep, in the infrainfundibular part of the pilosebaceous area,[28] resulting in damaged structures beneath the epidermis followed by fibrosis and contraction that create the final scar.

Most publications so far[14-17, 29-31] have demonstrated the efficacy of fractional lasers, including 1540 nm Er:Glass laser[31] in treatting this condition. In a recent publication[26] we have demonstrated the advantage of using an integrated cooling–vacuum–assisted non fractional 1540 nm Er:Glass laser for the treatment of inflammatory active acne.

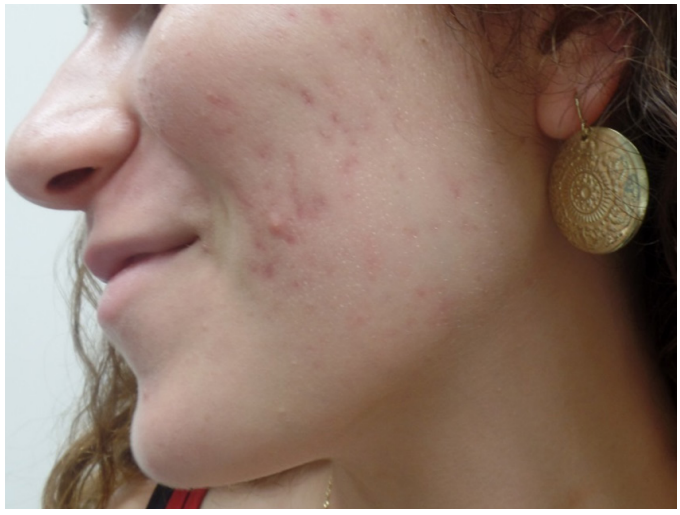
While exploring this modality we've also noticed a clinical improvement of adjacent atrophic acne scars, skin color, and texture in some of the patients. This clinical observation led us to explore the possibility of using the same device for the treatment of acne scars.

The standard Er:Glass laser emits photons in a 1540 nm wavelength, which enables penetration of theses photons to the level of the mid-dermis. The high absorption coefficiency of the 1540 nm wavelength by water, yields a bulk-heating of the dermal collagen.

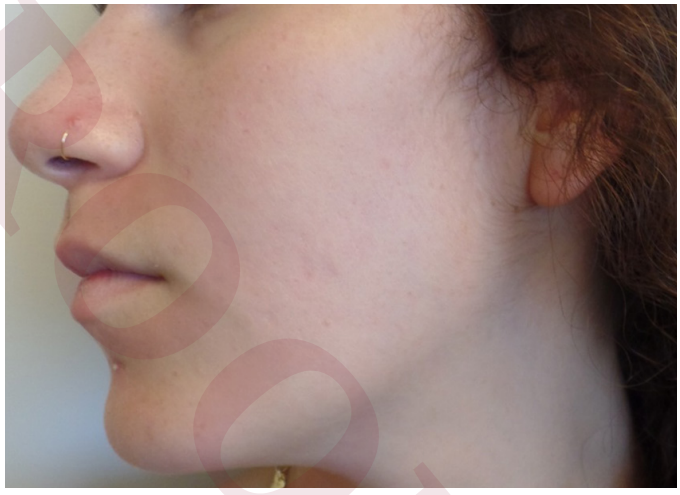
The beneficial effect of the integrated cooling–vacuum–assisted non fractional 1540 nm erbium: glass laser could be attributed to several factors:

FIGURE 1. (A) Patient 1 before treatment. (B) Patient 1 at 3 month follow-up visit (the patient completed 4 treatment sessions).

(A)



(B)



The relative aggressiveness compared to fractional laser treatment produces higher bulk dermal heating, which consequently induces a uniform neocolagenesis and thereby improves scars' appearance.

The incorporated vacuum system stretches the skin within the treatment tip, thereby reducing the concentration of competing chromophores, such as melanin and hemoglobin, so that the target selectivity of collagen increases. The suction also brings the bottom of the scar closer to the device's tip, thereby allowing treatment of deeper scars.

Since water is also present in the epidermis, epidermal protection with cooling is highly advised for mid-infrared lasers, to decrease potential adverse outcomes such as blistering and necrosis. Hence, the combined selective cooling of the epidermis (without

FIGURE 2. (A) Patient 2 before treatment. (B) Patient 2 at 3 month follow-up visit (the patient completed 3 treatment sessions).

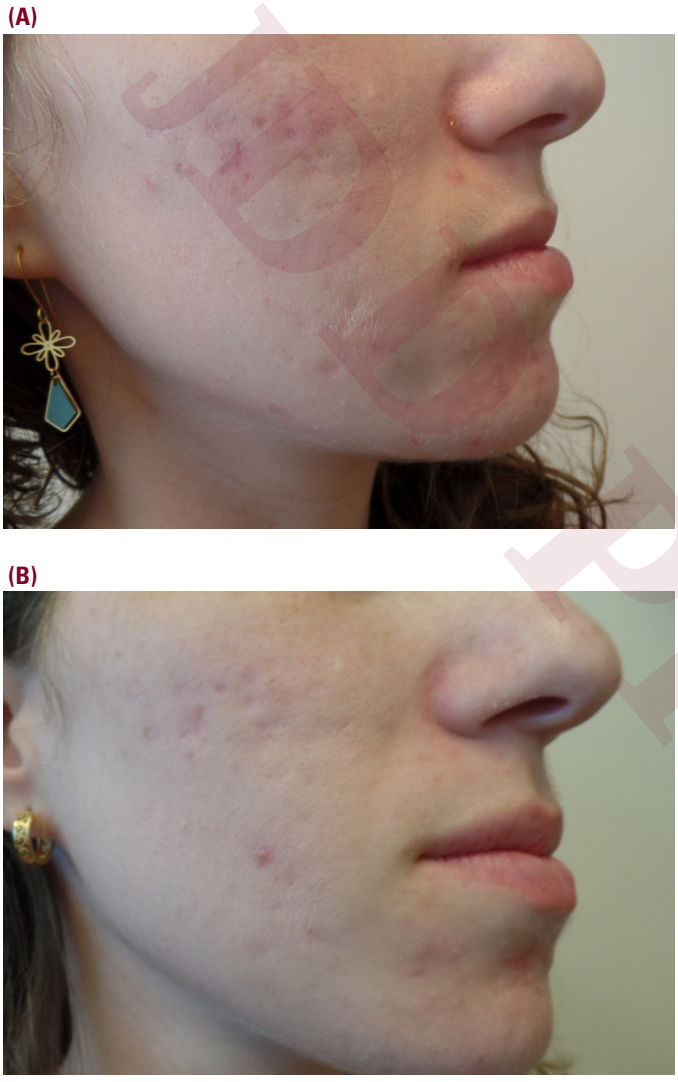
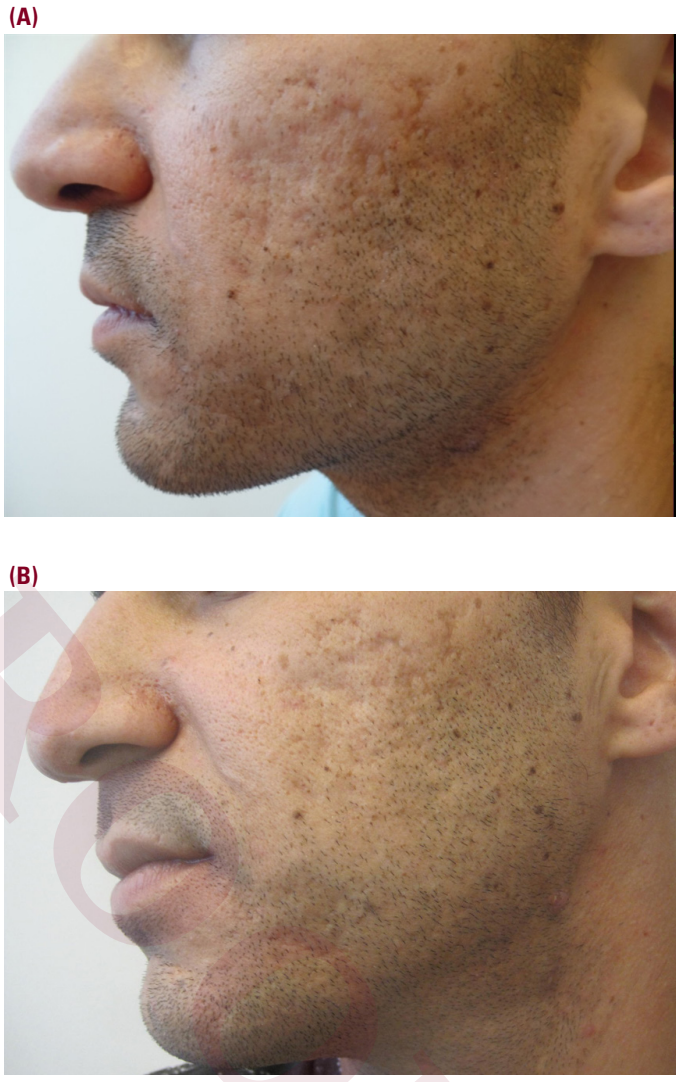


FIGURE 3. (A) Patient 3 before treatment. (B) Patient 3 at 1 month follow-up visit (the patient completed 4 treatment sessions).



cooling the end target), produced by the device, reduces side-effects without decreasing the energy settings, thus enhancing clinical efficacy. The cooling system also aids in minimizing pain.

In summary, the relative aggressiveness of this treatment (in contrast to the fractional lasers), due to the bulk heating generated, induces a uniform neocolagenesis and a subsequent improvement in the treated area, without increasing down time and side effects.

The improvement, generated in of our patients following treatment, is encouraging, as an additional monotherapy for this prevalent condition with minimal to negligible side effects and high efficacy. However, it should be noted that resistant cases might require additional combined therapies[33] (such as with adjuvant hyaluronic acid[13]).

It is also noteworthy, that our current study results potentially lead the way to combined treatment with the same device of both active inflammatory acne and concomitant residual acne scars.

CONCLUSION

Our study demonstrates, for the first time, the efficacy and safety of the integrated cooling-vacuum-assisted 1540 nm Erbium:Glass Laser for the treatment of acne scars.

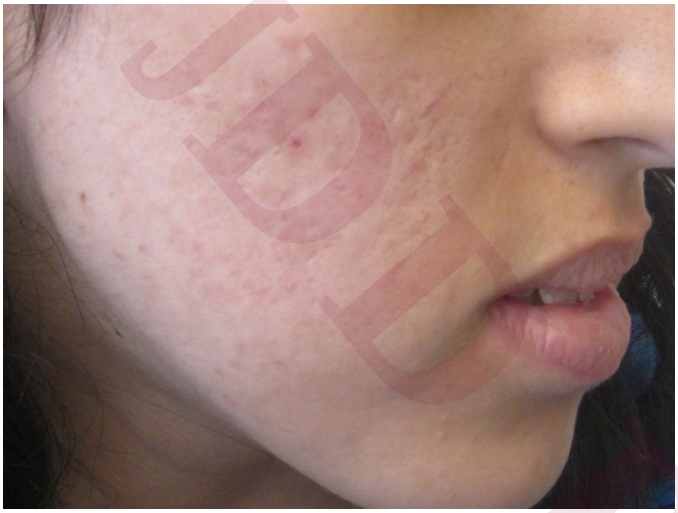
Further studies comparing this modality to fractional lasers are also indicated.

DISCLOSURES

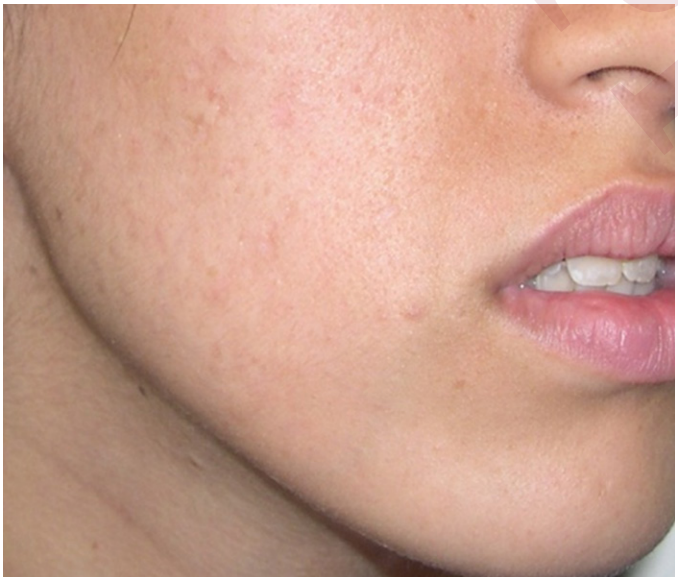
The authors have no conflicts of interest to declare.

FIGURE 4. (A) Patient 4 before treatment. (B) Patient 4 at 1 month follow-up visit (the patient completed 3 treatment sessions).

(A)



(B)



REFERENCES

1. Lynn DD, Umari T, Dunnick CA, Dellavalle RP. The epidemiology of acne vulgaris in late adolescence. *Adolesc Health Med Ther*. 2016;7:13-25.
2. Collier C, Harper J, Cantree W, et al. The prevalence of acne in adults 20 years and older. *J Am Acad Dermatol*. 2008;58:56–59.
3. Holzmann R, Shakery K. **Postadolescent acne in females.** *Skin Pharmacol Physiol*. 2014;27:3-8.
4. Fife D. Evaluation of Acne Scars: How to Assess Them and What to Tell the Patient. *Dermatol Clin*. 2016;34:207-13.
5. D. B. Holland, A. H. T. Jeremy, S. G. Roberts et al. Inflammation in acne scarring: a comparison of the responses in lesions from patients prone and not prone to scar. *Br Med J*. 2004;150:72–81.
6. Fabbrocini G1, Annunziata MC, D'Arco V et al. Acne scars: pathogenesis, classification and treatment. *Dermatol Res Pract*. 2010;2010:893080.
7. Cunliffe WJ, Gould DJ. Prevalence of facial acne vulgaris in late adolescence and in adults. *Br Med J*. 1979;1:1109-10.
8. B. Capitanio, J. L. Sinagra, V. Bordignon, P. et al. Underestimated clinical features of postadolescent acne. *J Am Acad Dermatol*. 2010;63:782–788.
9. C. I. Jacob, J. S. Dover, and M. S. Kaminer, Acne scarring: a classification system and review of treatment options. *J Am Acad Dermatol*. 2001;45:109–117.
10. Abdel Hay R, Shalaby K, Zaher H et al. Interventions for acne scars. *Cochrane Database Syst Rev*. 2016;4:CD011946.
11. Cohen BE, Brauer JA, Geronemus RG. Acne scarring: A review of available therapeutic lasers. *Lasers Surg Med*. 2016;48:95-115.
12. Hession MT, Graber EM. Atrophic acne scarring: a review of treatment options. *J Clin Aesthet Dermatol*. 2015;8:50-8.
13. Halachmi S, Ben Amitai D, Lapidoth M. Treatment of acne scars with hyaluronic acid: an improved approach. *J Drugs Dermatol*. 2013;12:e121-3.
14. Alexis AF1, Coley MK, Nijhawan RI et al. Nonablative Fractional Laser Resurfacing for Acne Scarring in Patients With Fitzpatrick Skin Phototypes IV-VI. *Dermatol Surg*. 2016;42:392-402.
15. Yang Q, Huang W, Qian H et al. Efficacy and safety of 1550nm fractional photothermolysis in the treatment of acne scars in Chinese patients: A split face comparative study. J Cosmet Laser Ther. 2016; 16:1-13.
16. Al-Dhalimi M, Jaber A. Treatment of atrophic facial acne scars with fractional Er:Yag laser. *J Cosmet Laser Ther*. 2015;17:184-8.
17. Kandhari R, Kandhari S. Non ablative fractional photothermolysis for atrophic acne scars. *J Cutan Aesthet Surg*. 2012;5:287-9.
18. de Sica RC, Rodrigues CJ, Maria DA, Cucé LC. Study of 1550nm Erbium Glass Laser Fractional non-ablative treatment of photoaging: Comparative clinical effects, histopathology, electron microscopy and immunohistochemistry. *J Cosmet Laser Ther*. 2016;25:1-36.
19. Haedersdal M, Moreau KE, Beyer DM et al. Fractional nonablative 1540 nm laser resurfacing for thermal burn scars: a randomized controlled trial. *Lasers Surg Med*. 2009;41:189-95.
20. Taub AF. Fractionated delivery systems for difficult to treat clinical applications: acne scarring, melasma, atrophic scarring, striae distensae,and deep rhytides. *J Drugs Dermatol*. 2007;6:1120-8.
21. Cohen SR,Henssler C,Horton K,et al. .Clinical experience with the Fraxel SR laser: 202 treatments in 59 consecutive patients. *Plast Reconstr Surg*. 2008;121:297e-304e.
22. Lupton JR,Williams CM, Alster TS. Nonablative laser skin resurfacing using a 1540 nm erbium glass laser: a clinical and histologic analysis. *Dermatol Surg*. 2002;28:833-5.
23. Fournier N, Mordon S. Nonablative remodeling with a 1,540 nm erbium: glass laser. *Dermatol Surg*. 2005;31:1227-35.
24. You HJ, Kim DW, Yoon ES, Park SH. Comparison of four different lasers for acne scars: Resurfacing and fractional lasers. *J Plast Reconstr Aesthet Surg*. 2016;69:e87-95.
25. Majid I, Imran S. Fractional CO2 Laser Resurfacing as Monotherapy in the Treatment of Atrophic Facial Acne Scars. *J Cutan Aesthet Surg*. 2014;7:87-92.
26. Politi Y, Levi A, Enk CD, Lapidoth M. Integrated cooling-vacuum-assisted 1540-nm erbium:glass laser is effective in treating mild-to-moderate acne vulgaris. *Lasers Med Sci*. 2015;30:2389-93.
27. Duncan JAL, Bond JS, Mason T, et al. Visual Analogue Scale scoring and ranking: a suitable and sensitive method for assessing scar quality? PRS. 2006;118:909-18.
28. Harvey A, Huynh TT. **Inflammation and acne: putting the pieces together.** *J Drugs Dermatol*. 2014;13:459-63.
29. Firooz A, Rajabi-Estarabadi A, Nassiri-Kashani MH. Treatment of atrophic facial acne scars with fractional Er:YAG laser in skin phototype III-IV: A pilot study. *J Cosmet Laser Ther*. 2016;12:1-4.
30. Cachafeiro T, Escobar G, Maldonado G et al. Comparison of Nonablative Fractional Erbium Laser 1,340 nm and Microneedling for the Treatment of Atrophic Acne Scars: A Rando mized Clinical Trial. *Dermatol Surg*. 2016;42:232-41
31. Chae WS, Seong JY, Jung HN et al. Comparative study on efficacy and safety of 1550 nm Er:Glass fractional laser and fractional radiofrequency microneedle device for facial atrophic acne scar. *J Cosmet Dermatol*. 2015;14:100-6.
32. Isarría MJ, Cornejo P, Muñoz E et al. Evaluation of clinical improvement in acne scars and active acne in patients treated with the 1540-nm non-ablative fractional laser. *J Drugs Dermatol*. 2011;10:907-12
33. Zaleski-Larsen LA, Fabi SG, McGraw T et al. Acne Scar Treatment: A Multimodality Approach Tailored to Scar Type. *Dermatol Surg*. 2016;42:S139-49.

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