Fractional versus ablative erbium:yttrium-aluminum-garnet laser resurfacing for facial rejuvenation: An objective evaluation

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Background: Laser is one of the main tools for skin resurfacing. Erbium:yttrium-aluminum-garnet (Er:YAG) was the second ablative laser, after carbon dioxide, emitting wavelength of 2940 nm. Fractional laser resurfacing has been developed to overcome the drawbacks of ablative lasers.

Objective: We aimed to objectively evaluate the histopathological and immunohistochemical effects of Er:YAG 2940-nm laser for facial rejuvenation (multiple sessions of fractional vs single session of ablative Er:YAG laser).

Methods: Facial resurfacing with single-session ablative Er:YAG laser was performed on 6 volunteers. Another 6 were resurfaced using fractional Er:YAG laser (4 sessions). Histopathological (hematoxylin-eosin, orcein, Masson trichrome, and picrosirius red stains) and immunohistochemical assessment for skin biopsy specimens were done before laser resurfacing and after 1 and 6 months. Histometry for epidermal thickness and quantitative assessment for neocollagen formation; collagen I, III, and VII; elastin; and tropoelastin were done for all skin biopsy specimens.

Results: Both lasers resulted in increased epidermal thickness. Dermal collagen showed increased neocollagen formation with increased concentration of collagen types I, III, and VII. Dermal elastic tissue studies revealed decreased elastin whereas tropoelastin concentration increased after laser resurfacing. Neither laser showed significant difference between their effects clinically and on dermal collagen. Changes in epidermal thickness, elastin, and tropoelastin were significantly more marked after ablative laser.

Limitations: The small number of patients is a limitation, yet the results show significant improvement.

Conclusion: Multiple sessions of fractional laser have comparable effects to a single session of ablative Er:YAG laser on dermal collagen but ablative laser has more effect on elastic tissue and epidermis. (J Am Acad Dermatol 2013;68:103-12.)

Key words: collagen; elastin; epidermal thickness; erbium:yttrium-aluminum-garnet; fractional; skin aging.

Ablative laser resurfacing remains the gold standard for rejuvenating severely photodamaged facial skin, but it is associated with long-term sequel-related patient downtime (delayed re-epithelialization and postlaser erythema which may lead to hyperpigmentation). Recently, fractional resurfacing has been introduced in the dermatologist's armamentarium as an alternative to ablative laser resurfacing, designed to decrease the photothermal side effects while still achieving good results, with faster healing and significant reduction in downtime.[1]

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Erbium:yttrium-aluminum-garnet (Er:YAG) laser emits a wavelength of 2940 nm that closely approximates absorption peak of water, therefore nearly all its energy is absorbed in the epidermis and papillary dermis, yielding superficial ablation.[2] Each pass of Er:YAG 2940-nm laser (250-350 microseconds) ablates approximately 20 to 25 μm at 5 J/cm^2 (4 μm of tissues per J/cm^2). Depth of thermal damage has been shown to be 30 to 50 μm beyond the ablation area.[3,4]

Fractional resurfacing creates microscopic treatment zones (MTZs) of controlled width, depth, and densities; these controlled zones of thermal heating and tissue damage are surrounded by spared areas of viable epidermis and dermis that allow for rapid repair of the MTZs.[5]

Although not equaling the results seen after conventional ablative resurfacing treatment, clinically notable improvements in facial rhytides, photodamage, and even in skin laxity have been reported with the new ablative fractional laser devices even after a single treatment.[6] However, fractional resurfacing with Er:YAG laser will usually require multiple sessions to enhance the condition of moderate to severely photoaged skin.[1]

The aim of this study was to objectively evaluate and compare the effects of multiple sessions of fractional laser versus a single session of ablative Er:YAG laser resurfacing both histopathologically and immunohistochemically after 1 month and 6 months of laser facial rejuvenation.

CAPSULE SUMMARY

- Ablative laser resurfacing remains the gold standard for rejuvenating severely photodamaged facial skin, but it is associated with long-term sequel-related patient downtime (delayed re-epithelialization and postlaser erythema which may lead to hyperpigmentation).
- Both multiple sessions of fractional erbium:yttrium-aluminum-garnet (Er:YAG) laser and a single session, with multiple passes, of ablative Er:YAG laser have comparable efficacy clinically and on dermal collagen.
- Multiple sessions of fractional Er:YAG laser resurfacing are effective with higher safety and shorter downtime.

METHODS

This study was conducted on 12 volunteers who desired facial rejuvenation to improve laxity and wrinkles. The subjects, ranging in age from 35 to 66 years, were recruited from the dermatology outpatient clinic of Al-Minya University Hospital, Egypt. The volunteers had Fitzpatrick skin types III to V, with class II to IV wrinkles based on Glogau scale.[7] The patients were not using any antiaging topical medications and did not perform any other cosmetic procedure. Treatment and study details were fully explained to subjects, and all gave informed consent for laser facial rejuvenation, study participation, and skin biopsy specimens. The volunteers were randomly selected and divided into 2 groups: 6 individuals (2 male and 4 female) were treated by a single session of short pulsed ablative Er:YAG laser, whereas the other 6 volunteers (3 male and 3 female) were treated by 4 sessions of fractional Er:YAG laser.

The clinical changes and improvement were rated and evaluated by the dermatologic surgeon and 2 independent observers before treatment and at 1 and 6 months after the start of treatment, based on a 5-point scale (none = 0%, poor = 1%-25%, fair = 26%-50%, good = 51%-75%, and very good = 76%-100%).

Devices and techniques

Ablative Er:YAG laser resurfacing. The device used for complete or full ablative (traditional) laser resurfacing was SkinPlus Er:YAG device, (Fotona medical laser, Ljabljana, Slovania) (code 51082; model M 220A).

Acyclovir tablets (400 mg/8 hours) were taken 1 day before laser resurfacing and for 5 days after the procedure. The face was covered with a thin layer of topical anesthesia (lidocaine 2.5% and prilocaine 2.5% cream) for 1 hour before the procedure in all patients. Eye protection goggles were applied for the patients. Two to 3 passes of short pulsed ablative Er:YAG laser were applied to ablate the epidermis (points of bleeding) at the forehead and the crow's feet areas with pulse width of 350 microseconds and spot size of 5 mm at a fluence of 3 to 5 J/cm^2 per pass.[4,8,9] Meanwhile, an additional 1 to 2 passes were only performed over the rhytides until they were effaced.

All patients received an oral broad-spectrum antibiotic for 1 week after the procedure. The treated area was covered with Fucidin Intertulle (fusidic acid—impregnated sterile gauze) as a postoperative dressing and covered by facial mask, which was changed every day for 1 week.

Fractional Er:YAG laser resurfacing. The fractional laser device was Fotona ablative fractional laser system Er:YAG 2940-nm model Dualis XS, "Ljabljana Slovania." The laser system has 5 levels, with MTZ (pixel) number ranging from 4 to 256 and MTZ size of 20 to 300 μm according to the selected level.

Acyclovir tablets (400 mg/8 hours) were given 1 day before the fractional laser sessions and for 3 days after resurfacing. No anesthesia was needed;