

THE EFFECTS ON THE SKIN OF A NEW FRACTIONAL LASER. MACROSCOPICAL AND HISTOLOGICAL EXAMINATION

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Summary

Fractional resurfacing is an exciting new technology that fills a unique niche in any skin care rejuvenation protocol. "Fractional Photothermolysis" seeks to only damage certain zones within the selected target area, (producing tiny dot, or pixel-like treated areas on the skin), leaving the other zones within it perfectly intact; hence only causing fractional damage through the heat of the light source. This allows the skin to heal much faster than if the whole area was treated, as the 'healthy' untreated tissue surrounding the treated zones helps to fill in the damaged area with new cells.

The Authors examine the effects of this new procedure on the skin, with the aim of analyze the treatment, exploring the cutaneous reaction to various laser pulse durations and energies by means of the macroscopic reaction and histological appraisal.

Riassunto

Il resurfacing frazionale è una nuova tecnologia che colma una nicchia unica nei protocolli di ringiovanimento cutaneo. "La Fototermolisi frazionale" riesce a danneggiare solo parzialmente il tessuto bersaglio, producendo piccole colonne di coagulazione, lasciando le altre zone tra di esse perfettamente intatte. Provoca, quindi, esclusivamente un danno frazionale grazie al calore della luce laser, e le zone risparmiate dal trauma fungono da serbatoi di rigenerazione per la produzione delle nuove cellule.

Gli Autori esaminano gli effetti di questa nuova procedura sulla pelle, con lo scopo di analizzare il trattamento attraverso le reazioni cutanee da un punto di vista macroscopico ed istologico a diverse durate dell'impulso e a diverse energie.

INTRODUCTION

The Fractional Skin Resurfacing is a new laser technique that is becoming day by day more popular in the aesthetic surgery and dermatology sector.¹⁻³ It is used for the treatment and improvement of many symptoms of the skin ageing, for some traumatic lesions and acne scars²⁻⁴. The aim of this study is to analyze the treatment of Fractional Skin Laser Resurfacing, exploring the cutaneous reaction to various laser pulse durations and energies by means of the macroscopic reaction and histological appraisal.

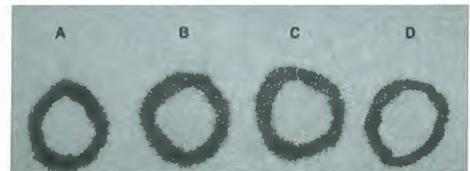
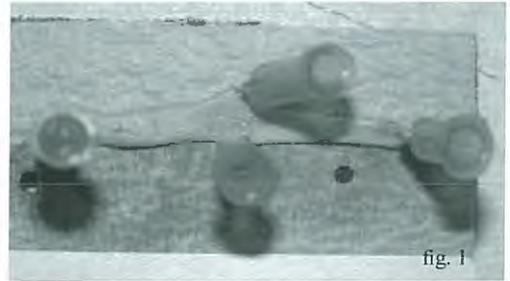
MATERIALS AND METHODS

- Skin portion of the retro-auricular region irradiated immediately after the surgical excision. Biopsy immediately after laser irradiation (fig. 1).
- Skin of the forearm region irradiated at four different pulse/energy configurations (Area A, B, C, D) and “punch biopsy” of 3mm, 24 hours after the laser exposure (fig. 2).
- Coloration with Haematoxylin-Eosin.
- Macroscopic pictures and images captured with digital polarized camera.
- Histology with Zeiss microscope and JVC camera.
- Fractional Skin Resurfacing Laser System 1540 nm (Matissetm, Quanta System S.p.a., Varese, Italy).

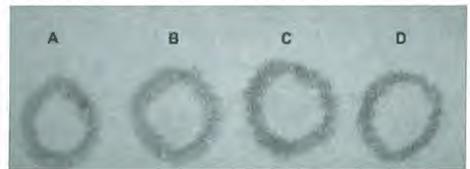
RESULTS

First series of tests (fig. 1), has been treated with laser, with energies equivalent to those of the second series (fig.2) and after the histology there are no visible alterations to the laser treatment. No signs of carbonization, vaporization or ablation of the cutaneous tissues. The second series has been treated with various energies and pulse

durations of the laser (fig. 2) and the “punch biopsy” has been done 24 hours after the laser exposure.



1 hour



24 hours

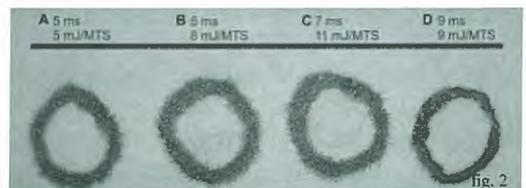


fig. 2

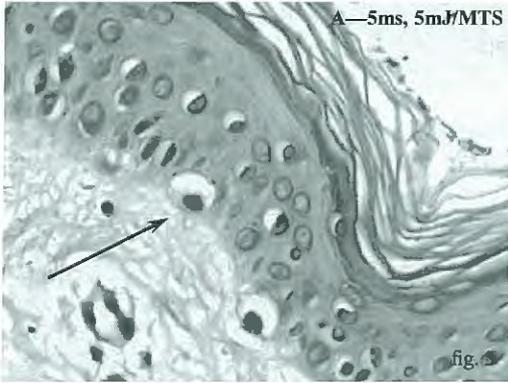


Fig. 3 Area A— 5ms, 5mJ/MTS. Small vacuolization of a group of keratinocytes, with lysis of the correspondent basal membrane.

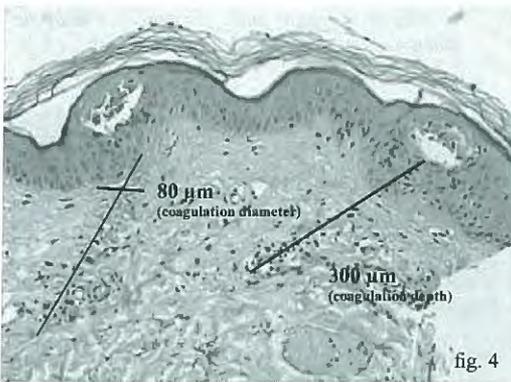


Fig. 4 Area B—5ms, 8mJ/MTS. Coagulative necrosis and of a group of keratinocytes with gaps formation in the medium assizes of the malpighian; it is accompanied with several alterations of the basal membrane: delamination or histolysis, with small enlargement of the collagen, or disintegration of the same collagen.

Conservation, like always, of the stratum corneum, inconstant conservation of the granular layer, coagulative necrosis of a group of keratinocytes generally close to a dense eosinophil mass, other times they are disintegrated in grains, with intra-epidermal gap formation: The basal membrane is no longer recognizable, the dermal collagen in a “column” is changed in small dense bands, eosinophil with a light blue tonality, the bands are separated by empty spa-

ces, other times by rough mass. In some “columns” the superficial small blood vessels show coagulative necrosis of the wall with pyknosis of the endothelial nucleus. At the lower limit of the “column” often small blood vessels are observed that seem to represent the deep limit of the dermal alteration (fig. 5).

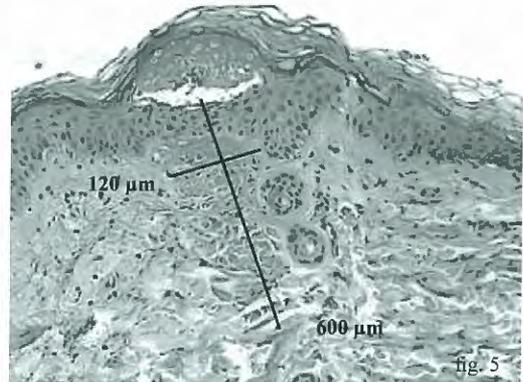


Fig. 5 Area C—7ms, 11mJ/MTS.

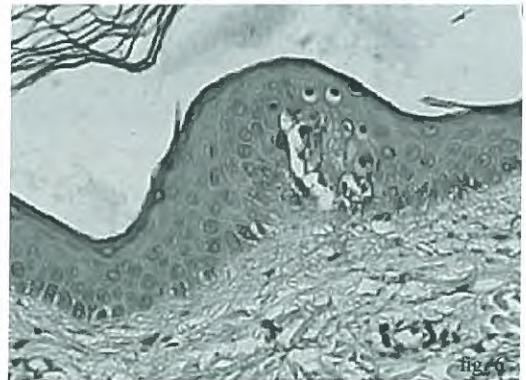


Fig. 6 Area D—9ms, 9mJ/MTS. Skin alterations similar to the case of 5ms, 8mJ/MTS.

The development of the erythema

A moderate erythema was produced by all the pulse/energy laser configurations

More detailed:

A. This configuration produces a very light erythema which disappears within an hour.

B. The erythema is more stable, 24 hours later has almost completely disappeared.

C. One hour later the erythema is still evident but moderate. Within 24 hours it is in regression but still visible.

D. Similar to the B configuration.

Images in dermatoscopy, 24 hours after the laser treatment



Fig. 7: A. No macroscopic visible alterations.

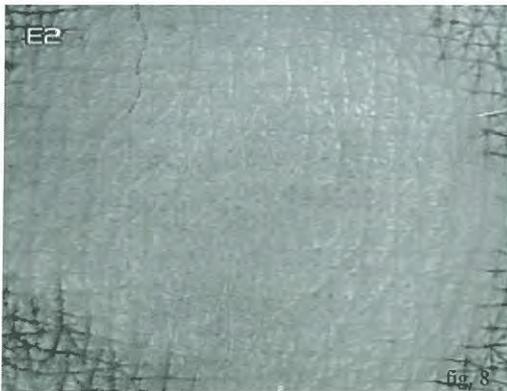


Fig. 8: B. No homogenous punctiform alterations of the cutaneous pigmentation. It is possible to identify a reticulum of "microscabs" similar to the theoretical print of the fractional lens array of the laser.

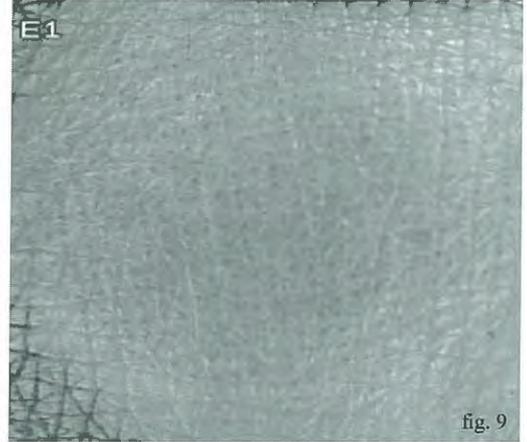


Fig. 9: C. Homogenous punctiform alterations of the cutaneous pigmentation. The reticulum of "microscabs" is completely similar to the theoretical print of the fractional lens array.



Fig. 10: D. Similar to the A configuration.

DISCUSSION

From the comparison between the first series and the second one, probably the alterations of the keratinocytes and the dermis after the laser irradiation, is a "vital" phenomenon that has developed within the 24 hours of observation and is consequent to a thermal insult concentrated inside the microspots and caused by the laser beam.

In all the cases, damage to level of the corneum layer does not exist and it is interesting to notice the presence of free melanin in the epidermis. Lower times of exposure and fluence (es. 5ms, 5mJ/MTS) determine damage to the level of the basal membrane and an overheating of the superficial dermis without coagulation.

The basal membrane carries out a fundamental role of support and regulation of the cellular proliferation (sees improvement of the texture), it is a structural support and allows for the nourishment and the refuse to diffuse. It acts as a filter for macromolecules, and also a zone of polarization of the cells, in the regeneration process as it works a "freeway" for the cellular migration. Its alteration therefore, that happens also at relatively low parameters, can already justify the positive observations on the improvement of the cutaneous texture at low laser parameters.

The maximum depth of coagulation in the test is 600 micron using 11 mJ/MTS (fig. 5). The system can reach 20 mJ/MTS and the coagulation columns can reach in the dermis at approximately 900 micron.

References

- 1) **Manstein D, Herron GS, Sink RK, et al. (2004)** Fractional photothermolysis: A new concept for cutaneous remodeling using microscopic patterns of thermal injury. *Lasers Surg Med.* **34**: 363-7.
- 2) **Tanzi EL, Alster TS, Williams CM. (2003)** Treatment of facial rhytides with a nonablative, 1450 nm diode laser: A controlled clinical and histologic study. *Dermatol Surg.* **29 (2)**: 124-8.
- 3) **Bass LS. (2005)** Rejuvenation of the aging face using Fraxel laser treatment. *Aesthet Surg Journal* **25**: 307-309.
- 4) **Rokhsar CK, Fitzpatrick RE. (2005)** The treatment of melasma with fractional photothermolysis: A pilot study. *Dermatol Surg.* **31**: 1645-1650.

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