THREE DIMENSIONAL FRACTIONAL LASER SKIN REJUVENATION

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Abstract
A novel self-induced, 3D fractional (FRAC3) method for skin rejuvenation is proposed. The method utilizes the short pulse-duration/high peak-power density of Fotona Nd:YAG Accelera mode laser pulses. The Fotona Accelera pulses produce a three-dimensional, fractional pattern in the epidermis and dermis, with damage islands located predominantly at the sites of skin imperfections. In-vivo thermal measurements of the skin surface and in-vitro of skin cross-section following illumination with Nd:YAG Accelera pulses are presented. The measurements demonstrate the creation of isolated "fractional" hot islands within the skin. The technique promises to offer another dimension in safety and self-regulation of the effects for non-ablative laser skin rejuvenation.

Introduction

Fractional laser skin rejuvenation has recently gained a lot of interest due to the fact that the remaining healthy tissue around the fractional damage spots can act as healing centers (see Fig.1 b). A disadvantage of the current approach is that the fractional illumination is only in the form of a two-dimensional matrix, resulting in the illuminated columns below the spots being damaged uniformly. In addition, the technique is non-selective with regard to local skin imperfections. Finally, the technique requires a special fractional delivery device. In this paper we describe a novel FRAC3 laser method, based on Fotona Nd: YAG Accelera pulse mode characteristics. The method produces a three-dimensional, fractional pattern within the epidermis and dermis, with damage islands located predominantly at the sites of minute skin imperfections and/or inhomogeneities (See Fig.1c). Measurements of the results of this self-induced, three-dimensional distribution of skin damage following Fotona Accelera mode Nd:YAG laser treatments are presented.

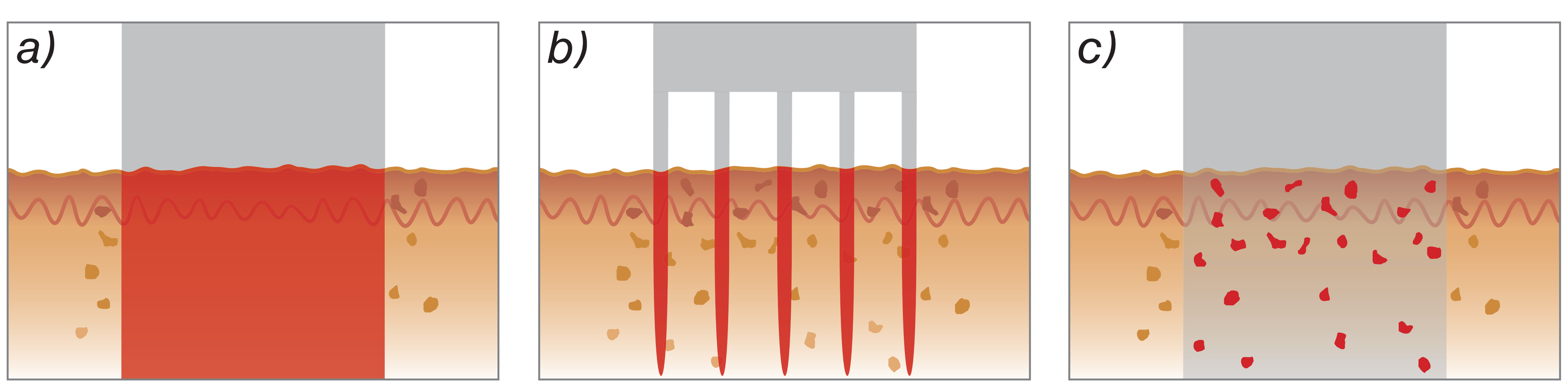

Fig.1: Laser induced damaged spots as healing centres

Measurements

Treatments were performed using Fotona XP MAX and XP PLUS Nd:YAG laser systems (see Fig.2), and measurements were made using an FLIR ThermaCAM P45 thermal IR camera with a thermal sesnsistivity of 0.08C and using a 320x240 uncooled microbolometer detector in the spectral range of 7.5 -13 µm. The applied laser fluence was 20J/cm^2 while the Accelera pulse durations ranged between 0.3 and 2 msec. Note, that in a clinical setting, higher fluences (around 40-70 J/cm^2) would be applied.

Fig. 2: Fotona XP MAX

Skin surface measurements of the temperature distribution following an Nd:YAG laser pulse with a 4 mm spot size were performed in-vivo on patients' hands. Figure 3a shows a typical skin temperature profile following a standard 20 msec long Nd: YAG pulse, and Fig.3 b shows the temperature profile following a short-duration Accelera pulse. Self-induced temperature fractionality can only be observed following illumination with the Accelera pulses, while with standard pulse durations heat conduction from the skin inhomogeneities to the surrounding tissue prevents temperature build-up, and thus no hot islands are observed within the skin. Note, that measurements on younger patients did not show any significantly higher temperature islands on the skin surface. The Accelera mode can thus be applied to target skin imperfections due to aging.

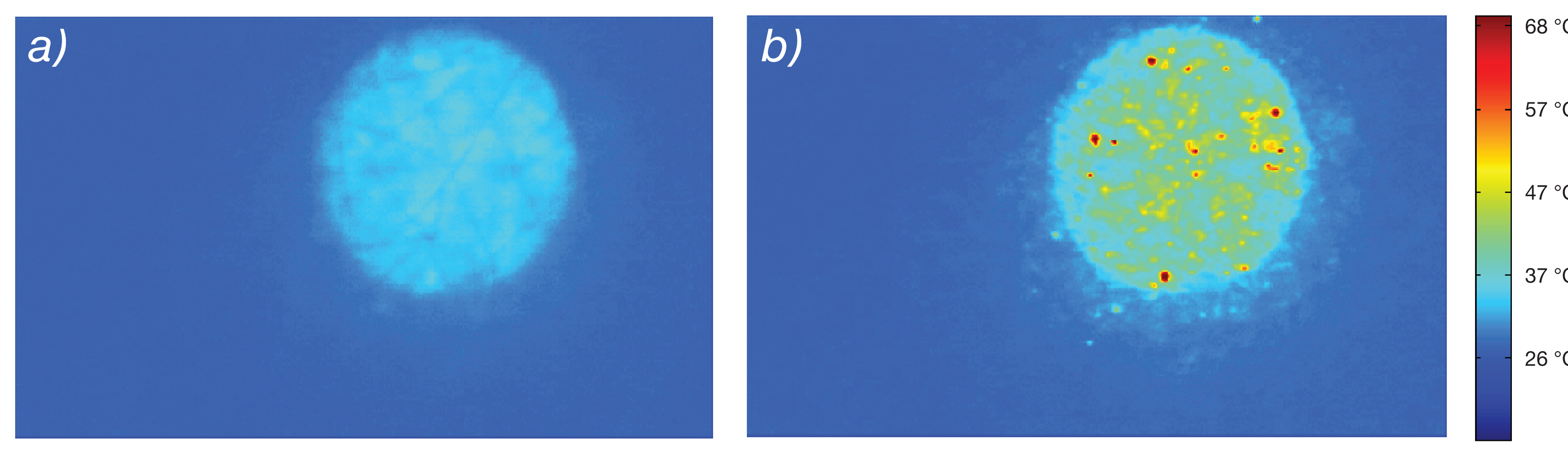

Fig. 3: Skin surface temperature profile

Self-induced temperature fractionality was also observed deeper within the skin. Figures 4a & b show the temperature distribution following Nd:YAG pulses as seen in-vitro on a skin cross-section from skin excised from a female human belly. Figure 4a shows the typical skin temperature profile following a standard 20 msec long Nd:YAG pulse, and Fig.4 b shows the temperature profile following a short-duration Accelera pulse. Again, self-induced temperature fractionality can only be observed following illumination with the Accelera pulses.

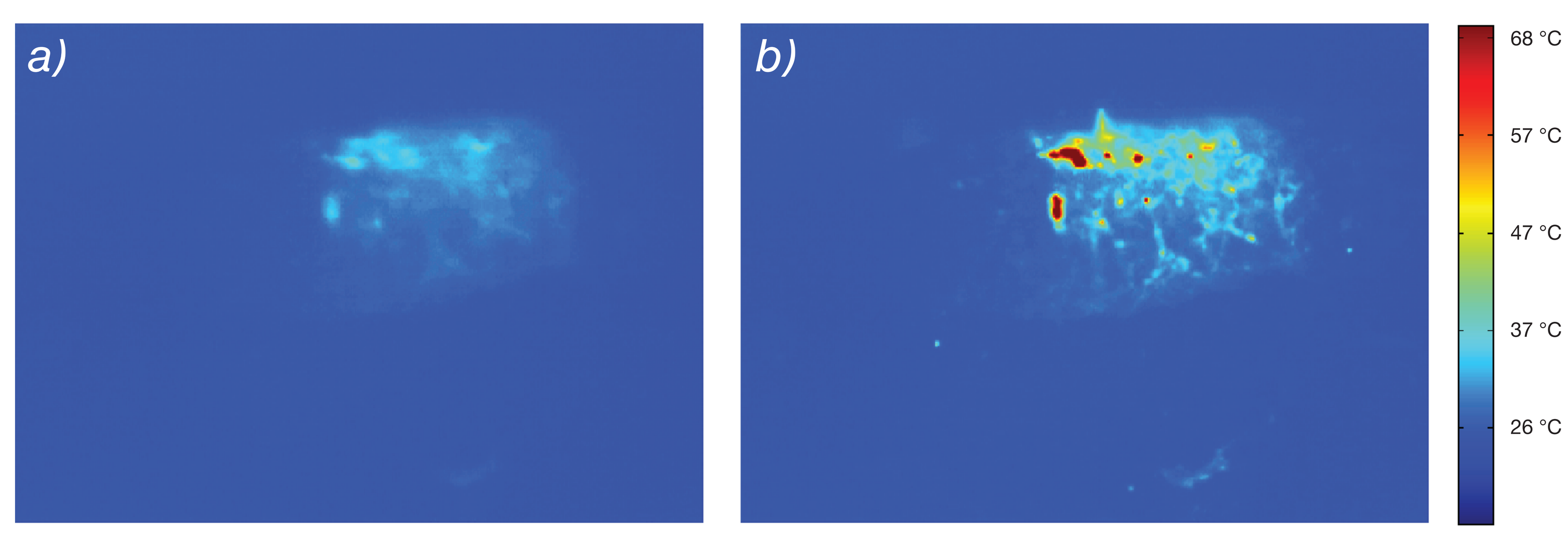

Fig. 4: Skin cross-section temperature profile

Preliminary clinical results show the procedure to be more effective with substantially reduced healing times. Furthermore, no special optical device is needed, thus leading to better cost-effectivness for the skin rejuvenation procedure as well.

Conclusions

Thermal measurements of the self-induced, three-dimensional distribution of skin damage from Fotona FRAC3 treatment, shows that laser pulses with typical durations below 2 ms, and preferably below 0.5 msec, are needed to observe this effect. Self-induced fractionality is especially pronounced in skin with a higher number of aging imperfections. To reach the damage threshold of the imperfections, fluences should typically be above 40 J/cm^2.

The new Fotona FRAC3 laser method is promising to be the next step in improved laser skin rejuvenation procedures, with its efficacy, selectiveness, short healing time and cost effectiveness.

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