

# Fractional ablative radiofrequency: a pilot study of twenty cases involving rejuvenation of the lower eyelid

Radiofrequência ablativa fracionada: um estudo-piloto com 20 casos para rejuvenescimento da pálpebra inferior

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## ABSTRACT

**Introduction:** The skin is a marker of chronological age and appearance, being important for self-esteem and quality of life. Fractional ablative radiofrequency is one of the treatments aimed at delaying the effects of aging.

**Objective:** To describe the operating principles, methodology, and results of rejuvenation of the lower eyelids when treated with fractional ablative radiofrequency, and the resulting thermal damage observed on histology.

**Methods:** Twenty female patients with aging skin on the lower eyelids were selected for treatment with this method. In one of the patients, who concurrently underwent upper blepharoplasty, ablative fractional radiofrequency was carried out on the skin fragment to be removed from the upper eyelid for anatomical-pathological examination and measurement of thermal damage. The evaluation of clinical results was performed using photographic comparison and analysis of satisfaction questionnaires answered by patients.

**Results:** Photographic comparison showed significant skin retraction effects on the skin of the lower eyelids, while the analysis of questionnaires revealed a significant degree of patient satisfaction. Ten percent of patients experienced reversible local hyperpigmentation as a complication. Ablative and non-ablative damage was observed up to the superficial reticular dermis, with negligible thermal effects on the sides.

**Conclusion:** Fractional ablative radiofrequency was proven safe, effective, and cost-effective in skin rejuvenation, nevertheless further studies should be conducted with the aim of determining the optimal parameters, as well as the ideal number of sessions needed to achieve the best result with the lowest percentage of side effects.

**Keywords:** pulsed radiofrequency treatment; rejuvenation; skin aging; ablation techniques; laser coagulation; lasers.

## RESUMO

**Introdução:** A pele é um marcador da idade cronológica e da aparência, de grande importância para a autoestima e a qualidade de vida. A radiofrequência ablativa fracionada é um dos tratamentos que visam retardar os efeitos do envelhecimento.

**Objetivos:** Descrever princípios de funcionamento, metodologia e resultados do rejuvenescimento em pálpebras inferiores tratadas com radiofrequência ablativa fracionada e consequente dano termal observado na histopatologia.

**Métodos:** Foram selecionadas 20 pacientes do sexo feminino com envelhecimento da pele da pálpebra inferior para tratamento com o método. Em uma delas, submetida concomitantemente à blefaroplastia superior, foi realizada a radiofrequência ablativa fracionada no fragmento de pele a ser retirado da pálpebra superior para estudo anatomopatológico e mensuração do dano termal. A avaliação dos resultados clínicos foi realizada através de comparação fotográfica e análise de questionários de satisfação respondidos pelas pacientes.

**Resultados:** A comparação fotográfica mostrou efeito de retração cutânea importante na pele das pálpebras inferiores, e a análise dos questionários revelou grau de satisfação significativo. Dez por cento dos pacientes apresentaram como complicação hiperpigmentação local reversível. Notou-se dano ablativo e não ablativo até derme reticular superficial com efeito termal desprezível nas laterais.

**Conclusão:** A radiofrequência ablativa fracionada mostrou-se segura, eficaz e de baixo custo, porém, mais estudos devem ser realizados para determinar os melhores parâmetros, assim como o número de sessões para obtenção do melhor resultado com menor percentual de efeitos colaterais.

**Palavras-chave:** tratamento por radiofrequência pulsada; rejuvenescimento; envelhecimento da pele; técnicas de ablação; coagulação por laser; lasers.

## INTRODUCTION

Personal appearance is a human preoccupation dating back to ancient times, one that has led to the creation of numerous cosmetic practices.<sup>1</sup> The skin, being the most evident organ of the human body, becomes a marker of chronological age and appearance, and is an important factor in self-esteem and a good quality of life. Patients increasingly seek treatments aimed at delaying the effects of aging, whether they are related to advancing age or caused by environmental affects.<sup>2</sup>

The palpebral region is one of the first body sites to suffer such effects, not only because the local dermis is thin (the total thickness of skin varies between 400 and 800 microns), but also because it is a small cosmetic area, where the action of the muscles promotes resorption of the deep fat and favors the breakdown of the periorbital collagen fibers.<sup>3</sup> Rejuvenation of this area involves much more than just the improvement of the skin; local volumization, correction of muscle hypertrophy, and improvement of the tarsal support are also necessary and can, in general, imply invasive techniques, such as blepharoplasty, botulinum toxin, and cutaneous filling.<sup>3</sup>

In order to be successful at rejuvenating this very important cosmetic area, an accurate examination of the eyelid and its supporting structure—which corresponds to the posterior lamella (septum, fat pads, and tarsal), and the anterior lamella (skin, subcutaneous tissue, and orbicularis muscle)—should be carried out.<sup>4</sup> One of the major concerns when using any technique for rejuvenating the skin of the lower eyelid is not to cause retraction of the anterior lamella to the extent that it causes ectropion as a complication. Thus, the skin depth reached during the technique and density are of great importance.<sup>5</sup> Other minor complications, such as hyperpigmentation, persistent erythema, and hypochromia, are also described. Chemical peels with trichloroacetic acid (TCA) and phenol (the formula described by Baker and Gordon) were the first techniques developed for the improvement of the skin of the lower eyelid.<sup>6</sup> The 50% TCA or phenol peeling produces coagulation of proteins up until the papillary or reticular dermis, and its penetration is often not predictable, as in laser technologies.<sup>7</sup> In most cases, complications are related to infection, focal hypopigmentation, postinflammatory hyperpigmentation, and persistent erythema, but not ectropion.<sup>8</sup> Over time, some ablative technologies, such as radiofrequency ablation and non-fractional CO<sub>2</sub> laser, have been widely used. These technologies have conferred greater precision to the treatment, reaching depths greater than 1mm, meaning thermal lesion of all the anterior lamella was achieved. However, they often cause ectropion.<sup>9</sup> Major drawbacks of these techniques were also the recovery time after the procedure (seven to ten days) and complications that, according to Alster, in a survey conducted in 2003 with 500 cases of non-fractional CO<sub>2</sub>, amounted to 37%.<sup>10</sup> With the onset of fractional technologies, many of the above problems were solved.<sup>11</sup> Complications of hyperpigmentation and rare cases of ectropion decreased from 40% to 9%. The recovery time decreased, however there was often a need for more than one session to achieve similar results.<sup>12</sup> This is one of the factors that encouraged the authors

to search for new therapeutic possibilities for facial rejuvenation, including ablative fractional radiofrequency (FARF).

The onset of high-frequency electrosurgery took place in 1978, when Maness et al.<sup>13</sup> defined the ideal alternating current frequency to cut and promote coagulation, i.e. an electric current that alternates its polarity in 4,000,000 cycles/second. This frequency is in the range of FM radio, what gave rise to its being called 'radiofrequency'. High frequency alternating currents generate magnetic fields, which are released at the tip of the electrode that is attached to the device, in a way that the action of the system will take place through electromagnetic waves rather than through electrical current—which explains a very similar effect to that of the CO<sub>2</sub> laser. It is, therefore, a cutting and/or coagulation process depending on the type of current selected. If the current is slowed, it will have a coagulation effect; if it is purely sinusoidal, it will have a cutting effect; if it is a slowed sinusoidal current, it will both cut and promote coagulation. The intensity of the "brakes" exerted on the current (low blend or high blend) determines the intensity of the coagulation or thermal effect. The high frequency causes the positive and negative charges within the cell to oscillate, raising the temperature rapidly to 100°C, causing its vaporization. The type of tip used determines the concentration of energy on a specific point; therefore, the smaller the area of contact (electrode's tip), the greater the ablation or evaporation power. There are three application models: Cut (20% coagulation and 80% cut), Low Blend (50% coagulation and 50% cut) and High Blend (80% coagulation and 20% cut).

Since Rox Anderson<sup>14</sup> discovered the advantages of the fractionation of some forms of light for skin rejuvenation, several other studies have been performed, and today there are different types of laser, radio frequency, and infrared devices that use this property as a way to render the treatments safer and more effective. As a result, the development of fractionating FARF began. The first successful attempts to use non-fractional ablative radiofrequency for rejuvenation were used for the resurfacing of the lower eyelid. However, such procedures are very dependent on the operator and in these first attempts lead to complications due to the excessive thermal effect.

Radiofrequency is radiation between 30KHz and 300MHz, within the electromagnetic spectrum that generates heat. This type of heat reaches the deeper tissues, creating energy and strong heat in the deeper layers of the skin, keeping the surface cool and protected, causing the contraction of existing collagen fibers and stimulating the formation of new fibers, making them more efficient in supporting the skin. The thermal effects of radiofrequency cause denaturation of collagen, promoting the immediate and effective contraction of its fibers, activating fibroblasts and leading to neocollagenesis, to the reorganization of collagen fibers and to the subsequent remodeling of the tissue.<sup>15, 16</sup> FARF is a new procedure that uses a random energy fractionation system that observes the tissue thermal relaxation time, similar to that which occurs with fractional CO<sub>2</sub> laser, however using a different energy source.<sup>17, 18</sup>

## OBJECTIVES

To demonstrate, through the treatment of the lower eyelid with FARF, the tightening effect, i.e. the contraction of the tissue with improvement in the texture and in the appearance of the skin, and the rejuvenation entailed.

To demonstrate through an anatomical pathological study, the thermal effect of FARF on the skin that underwent this procedure, attempting to describe it quantitatively.

## METHODS

A prospective study was carried out with 20 patients randomly selected from those who sought periorbital rejuvenation and presented with lower eyelid skin redundancy, at the Dermatology Ambulatory of the Faculdade de Medicina do ABC. FARF was indicated as the method to improve the lower eyelid skin. Cases of a protrusion of fat pads were treated with transconjunctival blepharoplasty in order for the skin to remain untouched. The included patients were female patients who had phototypes I - IV, with ages between 40 and 65 years. They patients were instructed to use SPF 50 sunscreen for at least 30 days before the procedure and suspend the use of topical retinoids a week before. The study was conducted according to the guidelines recommended by the Declaration of Helsinki 2000, which was updated in 2008. All patients signed a free and informed consent form for the procedure and a term authorizing that photographic records could be made. In one patient, who concomitantly underwent upper blepharoplasty, the authors took photographs of the skin to be removed with the same configuration used in the lower eyelid. The specimen was sent for histological study, carried out in vertical and horizontal sections stained with hematoxylin and eosin.

All procedures were performed under infiltrative local anesthesia with 30ml 0.9% saline solution associated with 10ml 2.0% lidocaine, 0.4 ml 1/10,000 epinephrine, and 1.0ml 8.4% sodium bicarbonate. The patients underwent a single session of fractional ablative radiofrequency with 3 passes in the lower eyelid, meaning that 80% of the region's skin was treated. The skin was humidified with sterile saline and gauze, carefully in order not to allow an excess of saline on the skin's surface (liquid film) thus avoiding possible burns in the site caused by the heating of this liquid film. The device, Wavetronic 5000 (Loktal Medical Electronics Industria e Comércio Ltda, São Paulo, SP, Brazil), was coupled with the megapulse system HF FRAXX (Loktal Medical Electronics Industria e Comércio Ltda.), which has an electronic circuit for fractioning energy. A pen with 64 microneedles 0.2mm thick and 0.8mm long, mounted on a teflon body, divided into eight columns of eight needles each, were in turn connected to the megapulse system. The laser parameters were then set as follows: 60% of power in the Wavetronic 5000's potentiometer (corresponding to 46watts) and on the 'Cut' option. The pen was always kept perpendicular and touching the damp skin. The overlap between one shot and another was 2mm, aiming at a fairly uniform application. When the applicator compresses the shooting pedal, the 64 needles are not energized at the same time, but in columns of eight needles,

according to a preset sequence (in the present study's case, the sequence number 2 was used). That selection is made through the 'P' key (program), followed by the 'E' key (enter). The delivery of energy is randomized, i.e. it alternates between columns in a predetermined way, such that two adjacent columns are not energized sequentially, allowing cooling between shots and less thermal damage (Figure 1).

Through the ACTIVE key—which controls nothing more than the duration of the active current or the time during which the skin is exposed to heat—the megapulse system allows the selection of the duration of the current in milliseconds (ms), for each column formed by 8 needles. The possible range is 0 to 320ms (60ms was used in the present study). Moreover, the system also allows the variation of the resting time or thermal relaxation time of the eight columns through the DELAY key, which ranges between 60 and 320ms (60ms was used in the present study). Based on serial applications carried out earlier in pig skin, it was found that the optimal value for the ACTIVE and DELAY keys was of 60 ms in order for the thermal injury to resemble that of the fractional CO<sub>2</sub> laser. The initial selection of those parameters was made considering an amount of energy sufficient (345mJ) for a safe treatment (Figure 2). Each of the pen's shots will cause 64 perforations in the skin (Figure 3). The post-treatment care was carried out using 5% dexpanthenol solution in the treatment site several times a day for five days, with the SPF 50 sunscreen being continued.<sup>19</sup>

The clinical results were evaluated through the comparison of the pictures taken before and 30 days after the procedure; the patients also answered a questionnaire regarding their satisfaction, which could be classified into three categories: very satisfied, satisfied, dissatisfied.

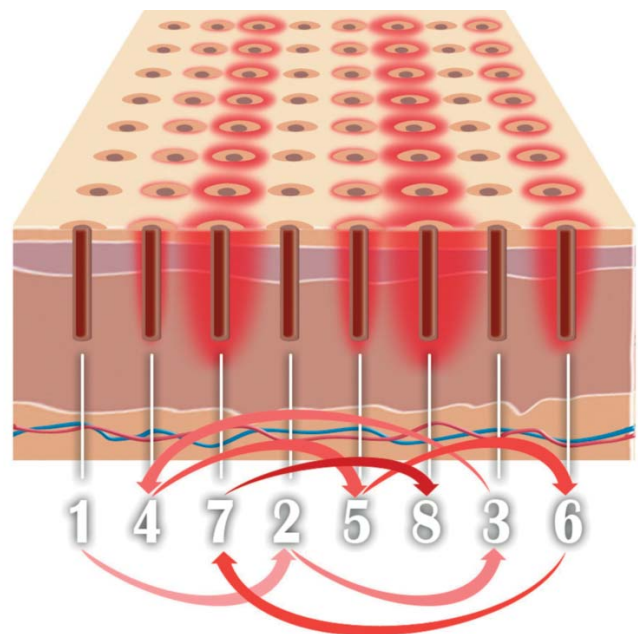


FIGURE 1: Fractionation of the shot (sequence of columns)

The histologic evaluation was carried out by measuring the thermal effect on the skin, in millimeters (mm).

**RESULTS**

Assessing the photographs taken before and after the procedure with a single session of fractional radiofrequency, it was possible to observe the contraction effect in the skin of the lower eyelid, with the consequent improvement in skin texture and reduction of local rhytids (Figures 4 and 5).

Of the 20 patients, 18 were very satisfied (90%) and only two (10%) indicated that they were only just satisfied with the results. Two (10%) had post-inflammatory hyperpigmentation in the treated area, which resolved after topical use of the combination hydroquinone/tretinoin for 15 days. In all cases, the crusts formed within two days after the procedure and took an average of 10 days to disappear. The erythema had a mean duration of 17 days, and the swelling lasted three days. Regarding the histologic study of the vertical sections, it was observed that the perforation of the needle in the epidermis, i.e. the ablative perforation, measured 0.1mm (100µm), and the thermal effect on the dermis, or the destruction of the non-ablative effect was 0.1mm (100µm) deep, with negligible lateral thermal effect (Figure 6). In the horizontal section, a thermal effect could be observed in the dermis underlying the needle's perforation and the 1mm spacing between the needles, with total preservation of tissue between the perforations (Figure 7).

**DISCUSSION**

FARF constitutes a further possibility for the treatment of aging skin. It is a procedure that emits waves that reach the deeper layers of the skin, generating energy and strong heat over them, nevertheless keeping the surface cool and protected. It was possible to observe that the procedure can achieve the depth of 100 microns, i.e. it reaches the papillary dermis, where it causes ablation and coagulation of surrounding proteins due to the residual thermal damage. This leads to both the contraction of existing collagen fibers and stimulates the formation of new fibers, making them more efficient in supporting the skin. The present study's result shows that this procedure can be consid-



FIGURE 3: Aspect of the perforations seen through stereomicroscopy

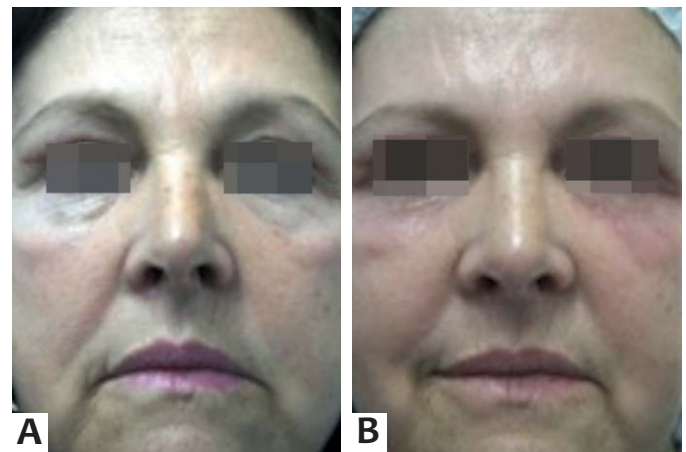


FIGURE 4: A: Pre-treatment photograph—note the sagging and rhytids in the lower eyelids. B: Photograph at 30 days after the FARF session showing improved texture and sagging of the skin and attenuation of rhytids

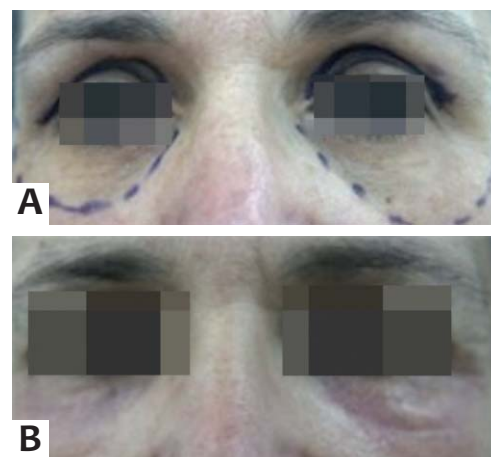
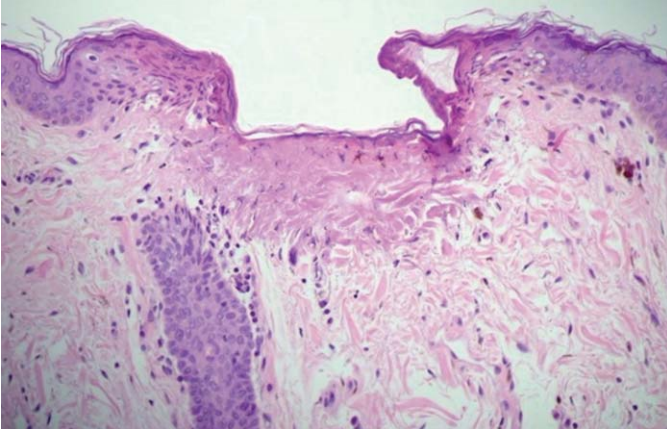


FIGURE 5: A: Pre-treatment photograph—note the sagging and rhytids in the lower eyelids. B: Photograph at 30 days after the FARF session showing improved texture and sagging of the skin and attenuation of rhytids

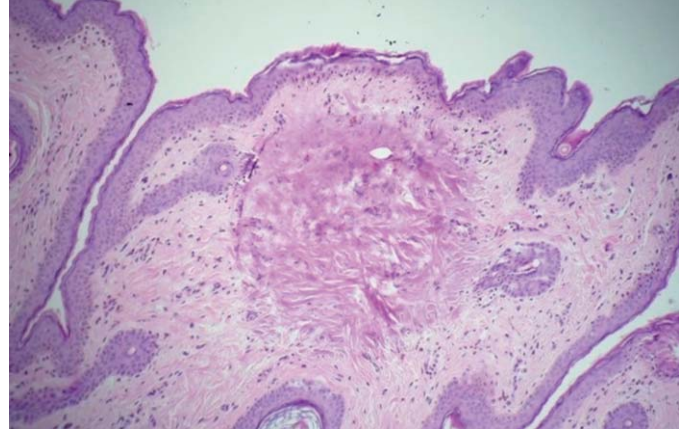


FIGURE 2: Selection of the current duration of each column (60ms), and of the relaxation time between the columns (60ms).

ered a useful treatment for periorbital rejuvenation, a fact that has motivated several ongoing studies in an attempt to demonstrate these effects not only on the eyelids, but across the face, acne scars, unaesthetic scars, and recent and old atrophic striae.



**FIGURE 6:** Histologic control stained through the HE technique showing a 0.1 mm ablative effect on the epidermis and a 0.1mm non-ablative effect on the dermis, with minimal side effects



**FIGURE 7:** Horizontal section showing non-ablative thermal effect in the needle's base measuring 200µ, corresponding to the needle's diameter, with minimal lateral thermal effect.

The side effects were easily resolved with expectant conduct, adequate hydration, sun protection, and topical post-operative whitening therapy.<sup>20</sup> This technique has allowed a considerably interesting rejuvenation effect at low cost and with low complication rates. Due to the fact that the device has no consumables and does not necessarily need coolers and even a light source, it is more affordable and easier to maintain as compared to laser devices, offering very similar results.<sup>21, 22</sup> The treatment of periorcular aging skin is challenging, and new technologies have been emerging for a long time, most of them with poor results. CO<sub>2</sub> laser has been standing out recently due to both the cosmetic results and the low incidence of post-operative side effects, as well as for the quick recovery time. However, it is an expensive treatment, which limits its use.<sup>23-27</sup>

Some of the limitations of the present study reside in the fact that only one radiofrequency session was carried out, which may affect the actual final result. There are ongoing studies showing significant clinical results with the number of sessions ranging from 3 to 5. We cannot say, therefore, that the results

obtained in the present study were the best possible. Furthermore there is no consensus yet about the ideal number of passes nor the minimum or maximum number of sessions needed for a result that could be considered excellent.

There is still much to be studied regarding this new therapeutic resource, such as the analysis of the treated area in the long run with anatomical pathology, definition of standards for the energy applied, new therapeutic possibilities, and even comparisons with the parameters used in CO<sub>2</sub> laser, for the same scope.

## CONCLUSION

As in other already published studies, FARF proved to be safe, efficacious, and cost-effective in the present study, and among the tools available in the periorbital rejuvenation armamentarium.<sup>6</sup> Further studies should be carried out in order to determine the best parameters and optimal number of sessions to achieve the best result with the lowest rate of side effects. ●

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