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ORIGINAL ARTICLE

Treatment of hypertrophic scars and keloids with a fractional CO_2 laser: A personal experience

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Abstract

Keloids and hypertrophic scars are both abnormal wound responses in predisposed individuals but they differ in that keloids extend beyond the original wound and almost never regress, while hypertrophic scars remain within the original wound and tend to regress. How keloids grow is not totally clear because there is no animal model; in fact, keloids affect only humans. Different injuries can result in keloids, including burns, surgery, ear piercing, lacerations, abrasions, tattooing, vaccinations, injections, insect bites and any process causing skin inflammation (chicken pox, acne, folliculitis, zoster). Skin or wound tension is considered a critical factor in the formation of keloids and hypertrophic scars. This study is based on eight consecutive patients (four females and four males, F:M = 1:1) with a total of 12 keloids. All of whom were treated monthly with a MiXto SX CO_2 laser, using 13 W of power, 8 SX of index and 40% coverage (density) in combination with Same Plast Gel® twice a day. Each scar required 12 treatments, and all the patients, followed up for 1 year after the last treatment, had optimum results and no recurrence.

Key Words: *Fractional CO_2, keloids and scars, lasers and light sources*

Introduction

Keloids and hypertrophic scars are both abnormal wound responses in predisposed individuals but they differ in that keloids extend beyond the original wound and almost never regress, while hypertrophic scars remain within the original wound and tend to regress. An important obstacle for researchers in the study of keloids and hypertrophic scars is the lack of animal models; in fact, they affect only humans.

Keloids result from overgrowing connective tissue due to different types of injury, including burns, trauma, surgery, ear piercing, lacerations, abrasions, tattooing, vaccinations, injections, insect bites and inflammation (chicken pox, acne, folliculitis, zoster) (1,2). Skin or wound tension is considered a critical factor in the formation of keloids and hypertrophic scars (3,4).

All races can be affected by keloids and hypertrophic scars but they occur more frequently in black individuals, Hispanics and Asians. In these populations, the incidence of keloids seems to be 4.5–16%, with an equal male-to-female ratio, most of them occurring between 10 and 30 years.

Materials and methods

This study is based on eight consecutive patients (four females and four males, F:M = 1:1), aged from 20 to 55 years, with a total of 12 keloids. The patients had Fitzpatrick skin types II–IV and the scars, classified according to the Vancouver Scar Scale (VSS), ranged in duration from 1 to 4 years.

All patients were treated monthly with a MiXto SX CO_2 laser (Lasering Srl, Modena, Italy), with 13 W of power, 8 SX of index and 40% coverage (density), in combination with Same Plast Gel® twice a day (Savoma Medicinali SpA, Parma, Italy).

Slim Evolution is a CO_2 laser with a wavelength of 10.6 nm provided by the MiXto SX fractional system. This system is crossed by the laser beam, which is delivered to the scanner handpiece with an articulated arm. It is possible to choose between different spot sizes: 180 and 300 μm. Thanks to this flexibility it is possible to work with advanced fractional methods or conventional ablation methods at the same time.

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A computerized pattern generator was used to distribute the microspots in a precise square matrix, which can have different dimensions: from 6 × 6 mm to 20 × 20 mm for the 300 μm spot and from 5 × 5 mm to 12 × 12 mm for the 180 μm one. Other parameters can be modified, such as the density of each spot (i.e. the percentage of ablated epidermis that ranges from 5% to 40%), the time of exposure (that varies from 2.5 ms to 16 ms), and the index parameter. A thermal water-based soothing cream was applied (NoAll Pasta all'ossido di zinco; Rottapharm-Madaus, Monza, Italy) after each treatment to soften and remove the microcrusting caused by the laser.

Patients applied sunscreen on the treated area to avoid sun exposure and were evaluated at 4 weeks after each treatment.

Clinical digital photography was performed under standard and cross-polarized illumination with a Canon EOS digital Kiss X camera. Scars were evaluated, before the treatment, under parallel- and cross-polarized light magnification and were identified as keloids according to their dimensions compared to the ones of the original wound. Clinical photographs were taken by a blinded observer, who calculated the VSS and evaluated the scars at each visit.

Results

A total of 12 treatments per scar were required and all patients, followed up for 1 year after the last treatment, had optimum results and no recurrence. In some cases blistering occurred, while microcrusting occurred all the time but always resolved within 12 days. No patients experienced any purpura, or hypo- or hyperpigmentation.

A different number of treatments were required by different scars according to their age: the later a scar is treated, the more sessions are necessary to normalize it (and generally scars are first treated with corticosteroid injection or surgical excision before undergoing laser treatment). Clinical photographs of some results are shown in Figures 1 and 2.

Discussion

Keloids are unpredictable, generally occurring after trauma, but some of them develop spontaneously (especially in the mid-chest area) (5). Certain body regions, such as the deltoid, presternal, upper back region and earlobes, are more frequently affected by keloids (6–8), while eyelids, genitalia, palms or soles are quite rarely involved (9).

Keloids can be either pedunculated, especially on the ears, neck and abdomen, or with a flat surface and wide base like those on the central chest, upper back and the extremities (10). They range in size from a papule of a few millimetres in diameter to football size or even larger. Keloids and hypertrophic scars are usually the result of a wound in certain areas where tension is constantly present, such as joints and where skin creases at right angles (11).

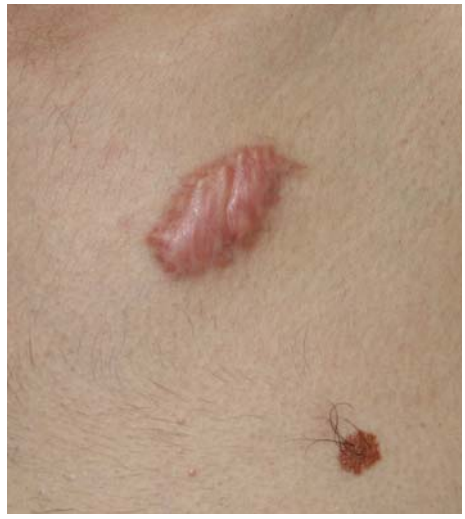

Figure 1. Upper chest keloid due to surgical excision (naevus).

The lesions are lacking in adnexal glands and hair follicles. The colour varies, depending on the age of the scar, from erythematous young lesions to brownish-red and then pale old scars. Their consistency can range from soft and doughy to rubbery hard. Usually they grow above the surrounding surface; hypertrophic scars are rarely elevated more then 4 mm (12) and they seldom project into the underlying tissue (10).

The patient's main concern is the cosmetic one, but hypertrophic scars and keloids can also give problems such as pain, itching, and a burning sensation or tenderness.

Magnetic resonance imaging (MRI) allows us to distinguish biochemically hypertrophic scars from keloids. Babu et al. (13), using MRI, reported differentiation of the two types of lesion by correlation of the water proton relaxation times with the duration of the scar.

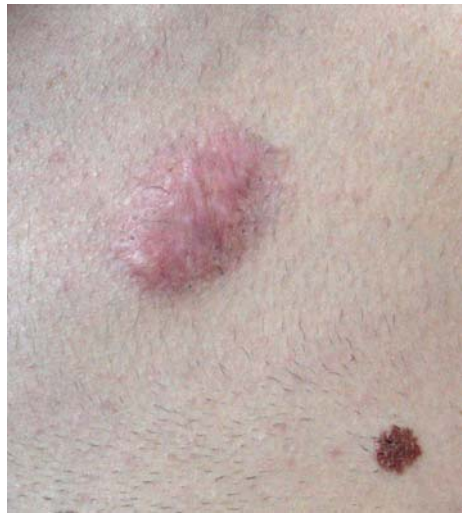

Figure 2. One year after monthly laser treatment (CO_2 MiXto SX, 13 W, 8 Sx, 40% coverage) and Same Plast massage.

While the light microscope shows several difficulties, an important method for histologically differentiating between the lesions is the scanning electron microscope. Normal skin contains distinct collagen bundles running mainly parallel to the epithelial surface. Fine fibrillar strands of collagen randomly connect the bundles with each other. In hypertrophic scars, the majority of bundles are still parallel to the epithelial surface but they are flatter, not well demarcated, and the fibers are arranged in a wavy pattern. Keloids show fibers haphazardly; loose sheets randomly oriented to the epithelial surface and collagen bundles virtually non-existent (6,14).

Normal dermal healing is constituted by three phases: inflammatory, fibroblastic and maturation. During the first phase, the inflammatory cells, move into the wound area, secrete many biochemical substances that cause vasodilatation, with a consequent augmentation of fluid into the wound and pain. Fibrin clots and seals the wound. Meanwhile, the epithelium rapidly grows across the sealed wound (15). In the fibroblastic phase, fibroblasts migrate into the fibrin clot and produce a large amount of collagen, forming a framework and increasing the strength of the wound (15). During the last phase, there is the maturation of the scar, with a gradual softening and flattening. Biochemically there is ongoing collagen synthesis and degradation. This maturation phase lasts about 12 months (11).

In normal wound healing, fibroblast and connective tissue elements regress after the third week; contrariwise in keloids, they proliferate and form dense masses of collagen around the new blood vessels. The fibroblast proliferation is significantly higher in keloids then in hypertrophic scars or normal skin (16). The size of keloids depends on the time during which this process occurs, ranging from months to years (16).

Fibronectin has an important role in wound healing: it promotes clot formation, the growth of granulation tissue, and reepithelization. Oliver et al. (17) and Babu et al. (18) observed that a keloid's fibroblasts produce an amount of fibronectin four times greater than normal fibroblasts. Similarly, collagen is synthesized 20 times more than in normal scars and three times more than in hyperthrophic scars.

Scar contraction is regulated by several growing factors, such as transforming growth factor-β (TGF-β) and platelet-derived growth factor (PDGF). TGF-β promotes the chemotaxis of fibroblasts to the site of inflammation, to produce the extracellular matrix proteins. TGF-β is able to regulate its own expression with an autocrine mechanism (20), and this activity normally turns off when repair is completed; abnormal fibrosis can occur if this mechanism does not work and production or activity of TGF-β is dysregulated (19). Younai et al. (21) showed that fibroblasts in hypertrophic scars produce a heightened amount of TGF-β.

Kenneth et al. (22) described the effect of superpulsed CO_2 laser energy on normal dermal and keloid fibroblasts' proliferation and release of growth factors (including basic fibroblast growth factor (bFGF) and TGF-β1). bFGF is mitogenic, inhibits collagen production and stabilizes cellular phenotypes. TGF-β1 stimulates growth and collagen production and has an important role in keloid formation. Dermal fibroblasts cell lines, both normal and keloid, were taken from facial skin samples using standard explant techniques. Three different keloids and three different normal dermal fibroblast cell lines were used as samples. Compared with controls, the superpulsed CO_2 laser allowed shortening of the population doubling time; statistically significant differences were obtained when fluences of 2.4 and 4.7 J/cm^2 were used. bFGF was more abundant in normal dermal fibroblasts than in keloid dermal fibroblasts. Application of the superpulsed CO_2 laser induced and increased bFGF secretion in both fibroblast types; this increase was significant in the keloid group at the fluence of 4.7 J/cm^2.

The superpulsed CO_2 laser enhances fibroblast replication and stimulates bFGF production while inhibiting TGF-β1 secretion. Therefore, it may support normalized wound healing. According to these findings, the use of the superpulsed CO_2 laser in the management of keloid scar tissue may have beneficial effects (22).

Conclusions

This study demonstrates that the use of the superpulsed CO_2 laser, with a spot diameter of 300 μm, reduces the risk of recurrence of scarring after treatment. This kind of treatment can be compared with the intralesional excision of the scar, without the risk of postoperative radiotherapy. According to our results, this can be considered the safest way to treat pathological scars and hopefully we will confirm it with more cases in our activity.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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