SCARS CAN BE DEFINED AS fibrotic tissue formed to replace the skin following a lesion, and occurs during wound repair and the healing process. Depending on the depth within the skin layers, scars can endure subtle changes during repair depending on the involvement of the epidermis or superficial dermis. However, a wound can be deeper, reaching the reticular dermis and occasionally, muscles or even the bone. In these cases, inflammation together with formation of reactive granulation, is of significance in the healing process as the lesion can cause destruction of the surrounding tissue, including hair follicles and sweat and sebaceous glands. Wounds in these cases re-epithelize from the edges, incurring a remodulation phenomena which can lead to hypertrophic scars or keloids1.

Wound healing goes through three phases. The inflammatory phase, in which blood vessels break as a result of injury leading to collagen formation and platelet degranulation, with involvement of neutrophils and monocytes which cleanse the wound. At the same time, proinflammatory cytokines stimulate fibroblast activity.

In the proliferative phase, fibroblasts, increased in number, build an extracellular matrix of fibrin, fibronectin and glycosaminoglycans that, together with new cytokines, activate keratinocytes and fibroblasts to initiate collagen formation, contracting the wound. An angiogenesis process maintains the temporary matrix for the re-epithelization of the wound9.

The remodelling phase, is the most important phase in the treatment of scars. Here, collagen production and the matrix are equalised with the involvement of fibroblasts, mastocytes, endothelial cells and macrophages, as well as matrix metalloproteinases and interferons. This phase can last 6-12 months depending on the wound.

A normal lesion of the dermis will scar in the first 7-10 days; however there are lesions that, irrespective of their depth, heal abnormally, transforming into a hypertrophic scar or keloid. In both cases fibroblasts produce large amounts of collagen owing to a loss of equilibrium of cytokine regulators3.

Hypertrophic scars grow respecting the edges of the wound area and can decrease to a normal size with practically no symptoms. Keloids share many characteristics of a hypertrophic scar and some authors believe them to be part of the same proliferative process4. Keloids grow outside the wound invading surrounding tissue, and can be itchy, sensitive to touch and sometimes painful. Their presence is associated with high levels of melanocyte-stimulating hormone (MSH) and an increase in mastocytes and their chemical transmitters.

Atrophic scars show a sunken and wrinkled aspect. They are usually associated with acne or chickenpox and their importance depends on the level of inflammation that occurs in the skin when formed. The damage to the connective tissue causes atrophy and dermal fibrosis.

**Treatment**

A number of approaches can be adopted such as occlusion with silicon or polyurethane gel, with or without pressure dressings, as well as steroid or other injections. The most commonly recommended are triamcinolone and bleomycin. Both substances can be mixed and diluted and, administered regularly and directly to the fibrotic tissue, have proved effective.

Currently, a range of lasers are used to treat scars5,6. However, depending on the interaction of their wavelengths, dosage and treatment techniques, related to the type of scar involved, a different epidermal or dermal response will be observed.

**Figure 1** (A) Before treatment and (B) 6 months after three sessions, spaced 2 weeks apart, for treatment of scar tissue.

A normal lesion of the dermis will scar in the first 7-10 days; however, there are lesions that, irrespective of their depth, heal abnormally, transforming into a hypertrophic scar or keloid.

**MA Trelles and J Alcolea** discuss the effectiveness of a range of treatment options available for the removal of scar tissue.
The most common and accepted laser treatment options are:
585–595 nm pulsed dye laser, 1064 nm Nd:YAG laser, 532 nm KTP laser, and IPL devices emitting between 500 and 1200 nm. All are largely used to treat hypertrophic scars and keloids. For atrophic scars the Er:YAG and CO2 ablative lasers are recommended. Non-ablative lasers such as the 1320 nm Nd:YAG, 1450 nm diode and 1540 nm erbium glass lasers are also an option.

In the case of non-ablative devices, the aim is to collapse the feeder vessels of the scar tissue and soften its fibrotic condition by means of micro wounds produced during treatment, which will help tissue to remodel. Results are inconsistent and in general, recurrences are often seen.

The 2930 nm wavelength Er:YAG laser is probably the most adaptable for the treatment of elevated and depressed scar tissue. Thanks to its excellent absorption by water, this laser can carry out layer by layer elimination, debulking and/or reshaping fibrotic tissue. When used in fractional mode, and in cases of atrophic lesions, it offers the advantage of eliminating fine shallow layers of the epidermis to activate rapid dermal and epidermal reorganisation.

In the authors’ experience, the SMA (Space Modulated Ablation) nozzle attached to the Er:YAG laser (Lininline™, Belarus), makes it possible to carry out treatments without anaesthesia (Figure 2). Passes over the scar, using this technology, produce a dermal jellification, separating fibres to remodel fibrotic tissue through, theoretically, re-initialising a modulated wound healing process. In fact, the SMA nozzle incorporates a sophisticated system of lenses that enables piercing holes in the skin, by over 10 000 laser beams, in tiny micro spots of 50 μm.

The same approach of inducing a reactive controlled wound healing phase, guided by a well confined thermal effect is used by the CO2 Pixel™ Rolling technology (Alma™ Lasers, Israel). Fractional Pixel™ laser treatment is followed by the action of an ultrasound device to facilitate transepidermal passage of creams/cosmeceuticals, the ingredients of which help fibrotic tissue re-establish a more normal condition (Figure 2). Treatment in any case and with the various systems will require a number of sessions to achieve notable results. But, in the event of seeking prevention of a pathological wound healing, the so-called LASH (Laser Assisted Surgical Healing) can be used. In this approach, a 1540 Er-Glass laser is used at the time of closure of the wound with stitches (Figure 3). The moderate thermal effect produced, will increase expression of Hsp70 and a predominance of TGF-ß3, comparatively to TGF-ß1 and TGF-ß2. This prophylactic treatment can be carried out, without violation of the efficacy–safety ratio, for an accurate surgical closure and restoration of skin condition.

Reference