Non-invasive Monitoring of the Mechanical Properties of Keloids during Cryosurgery

Sir,

Non-invasive skin bioengineering techniques are successful in monitoring the progress and response to treatment of various skin diseases. Recently, measurements of skin thickness, elasticity, blood flow, trans-epidermal water loss and hydration were used for objective and quantitative assessment of the maturation of keloids and hypertrophic scars (1–3) and their response to treatment with intralesional triamcinolone acetonide (4). The aim of the present study was to determine the changes in mechanical properties of keloids during cryosurgery.

CASE REPORT

A 25-year-old Caucasian male outpatient first presented to our Department of Dermatology in November 1996. He complained of the spontaneous appearance of multiple papules and nodules on his trunk and upper extremities since 1989. There was no history of prior skin injury or familial occurrence. The patient suffered from acne vulgaris. Surgical excision of a lesion on his left shoulder performed 2 years earlier had been followed by regrowth of a larger lesion. Therapy with intralesional corticosteroids alone and with topical madecassol had been unsuccessful.

Clinical examination revealed an annular lesion on the left shoulder, with a diameter of 60 mm, an atrophic centre and periphery composed of multiple firm nodules the size of peas or hazelnuts (Fig. 1A). There were scattered papules and nodules on the trunk and upper extremities. All laboratory examinations were normal.

Cryosurgery was performed by the contact method, using liquid nitrogen as the refrigerant and a single freeze session of 30 s per lesion. Seven keloids were treated five times at intervals of 30 days.

The mechanical properties of the keloids were determined with a non-invasive, *in vivo* suction device (Cutometer SEM 474, Courage and Khazaka, Cologne, Germany). Two measuring probes, with diameters of 2 mm and 8 mm, were used. A suction of 400 mbar was applied for 5 s, followed by a 5 s relaxation time. The mean of two consecutive measurements was used for further calculation. Skin elasticity of the treated keloids was evaluated before each cryosurgical session and 6 months after the last session. The averaged values were compared with those of the adjacent normal skin. The mechanical parameters analysed were final distension (FD), biological elasticity (BE) and viscoelastic to elastic ratio (VER). The method has been described previously (5).

As a result of treatment, four keloids flattened to skin level with slight local atrophy and hypopigmentation of the skin. Three keloids were considerably improved (Fig. 1B). No recurrence was observed during the 18-month follow-up.

Initial measurements of skin elasticity using both probes showed significantly lower mean values of FD and BE, and higher VER in keloids than in normal skin.

After cryotherapy a significant increase in FD and a significant reduction in VER were observed. BE was not significantly increased. However, the values remained significantly different from those of the controls (Fig. 2).

DISCUSSION

In this study we applied a non-invasive suction technique in order to investigate the mechanical properties of keloids during cryosurgery. Our results showed that keloids are characterized by lower skin distensibility and elasticity, and higher VER than normal skin. The clinical improvement after cryosurgery was accompanied by an increase in skin distensibility and elasticity and a decrease in viscoelasticity. This was probably due to the thinning of the keloids.

Our results were similar to those reported by Krushe & Worret (4). Using the cutometer device they observed the same changes in keloid mechanics after three injections of triamcinolone acetonide at intervals of 3 weeks. They concluded that intralesional steroids cause a reduction in the abundance of ground substance and the lesions become smaller.

The mode of action of cryosurgery is unclear. An autoimmune reaction against the keloid tissue or an effect on the fibroblast proteinkinase activity was supposed (6). Zouboulis et al. (7) suggested that the favourable effect of cryosurgery is due to the decrease in collagen formation, rearrangement of collagen bundles and the increase in vascularization of the lesion, as histologically observed. Using biochemical and electron microscopy techniques, Sizov et al. (8) also found a normalization of the collagen structure regarding the amino acid composition and the correlation between the collagen types after cryosurgery.

In our opinion, the mechanical properties of keloids and hypertrophic scars are related to the amount of extracellular material, i.e. the lesion volume. Regardless of the treatment applied (intralesional steroids, cryosurgery, silicone gel sheets or elastic compressive bandages), the decrease in lesion volume due to the decline in ground substance and some

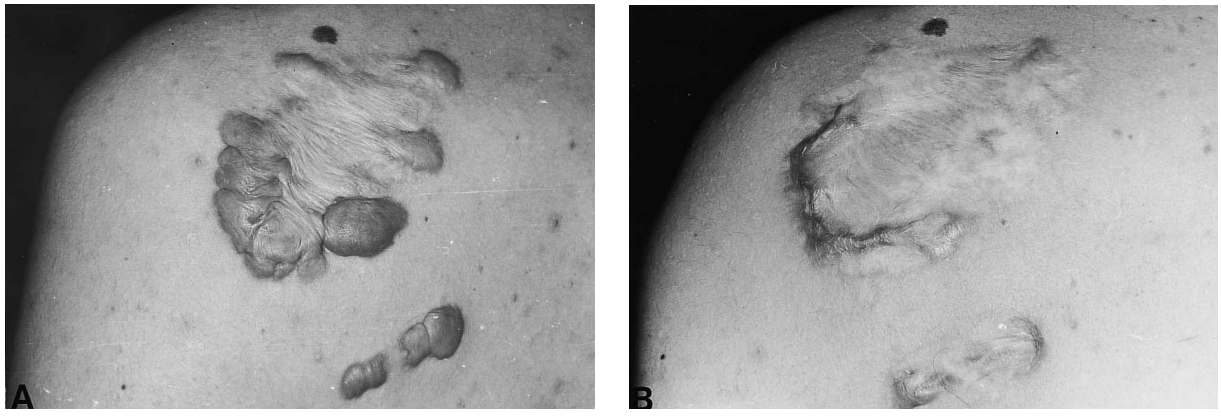

Fig. 1. Keloids on the left shoulder (*A*) before and (*B*) 6 months after the last session of cryosurgery.

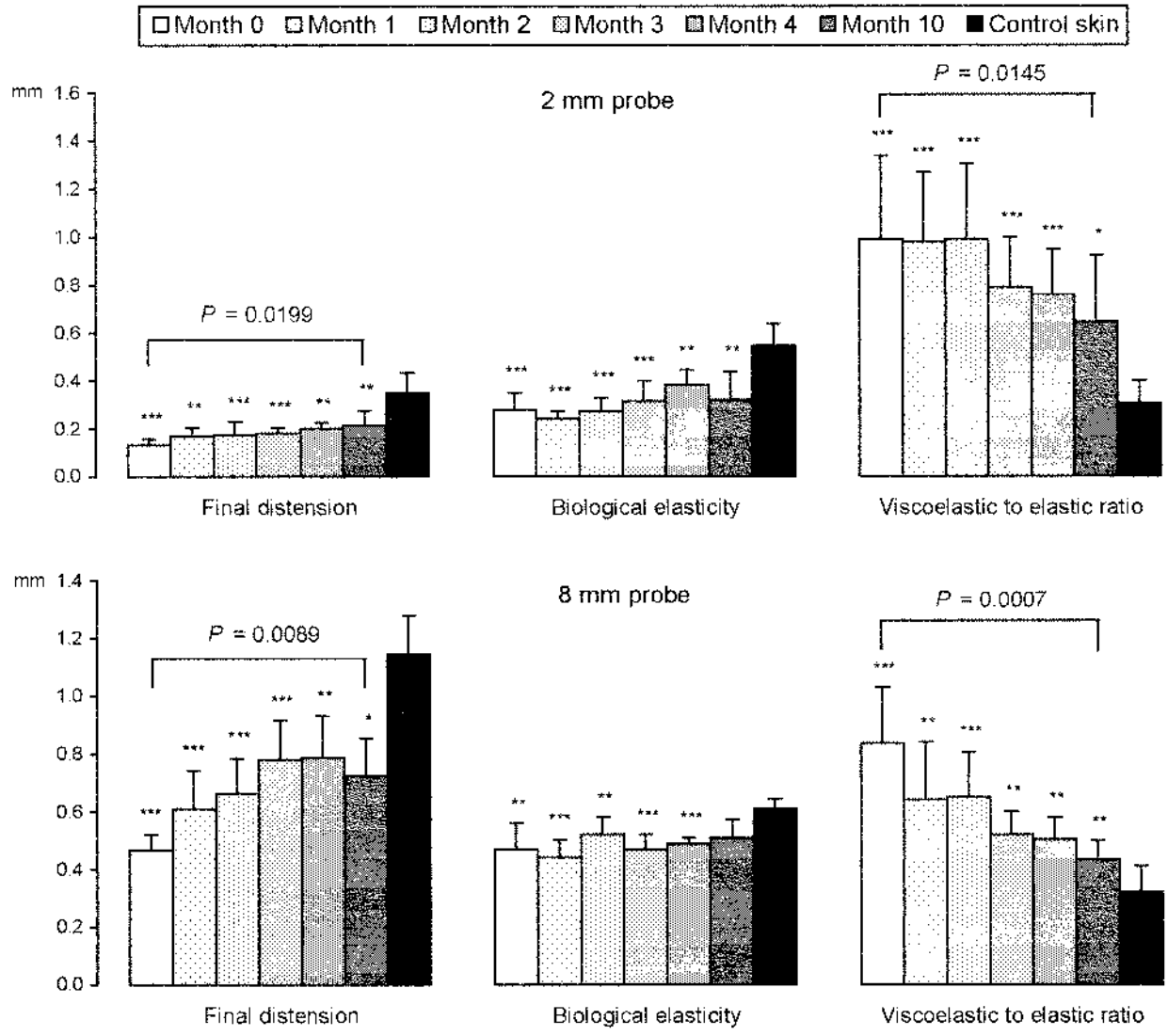

Fig. 2. Mechanical parameters of keloids and normal skin measured by 2 and 8 mm diameter probes. Mean values ± SD are shown. **t*-test between keloids and normal skin (*$p<0.05$, **$p<0.01$, ***$p<0.001$). *Pt*-test between keloid mechanical parameters measured before the treatment and 6 months after the last session of cryosurgery.

rearrangement of collagen bundles is responsible for clinical improvement and normalization of keloid mechanics. Since the main alterations are localized in the dermis, results obtained with the large 8-mm diameter probe were more pronounced.

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