

Microneedling system alone versus microneedling system with trichloroacetic acid in the management of abdominal striae rubra: a clinical and histopathological study

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Background

Striae distensae or stretch marks, although not a health risk, are of significant cosmetic concern as it affects the patient's psychological condition. Although many treatment modalities have been attempted with variable results, there is no standard treatment modality for it.

Objective

To compare the efficacy of a microneedling system (dermaroller) when used alone or combined with 15–30% trichloroacetic acid (TCA) in the management of striae rubra.

Patients and methods

This clinical trial included 30 female patients with abdominal striae rubra treated with a dermaroller alone on the left side of the abdomen (G1) and with a dermaroller + 15–30% TCA on the right side of the abdomen (GII). Patients were treated for six sessions at 3-week intervals. We assessed the clinical features (length, width, color, and texture) of striae in each group at every session and 3 weeks after the end of the sessions (follow-up). The response to treatment was assessed objectively by the treating physicians and skin biopsies stained with hematoxylin and eosin and picosirius red stains. Subjective assessment of the clinical photographs and patient satisfaction scores was carried out by two uninvolved blind dermatologists at every session.

Results

A comparison between G1 and GII at the follow-up session revealed statistically significant differences in length ($P=0.002$), width ($P<0.001$), color, and texture ($P=0.049$ and 0.041 , respectively). More improvement in the striae was noted in GII, as 19 (63.3%) patients showed good to excellent improvement compared with 10 (33.3%) patients in G1. Skin biopsies in GII showed increased epidermal thickness after treatment ($P<0.005$). Collagen content was increased after treatment in both groups. Side effects including transient erythema, edema, burning pain, and hyperpigmentation were observed more in GII with increasing concentration of TCA peeling.

Conclusion

Both dermaroller and dermaroller + 15–30% TCA are effective treatment modalities for striae rubra. However, dermaroller + 15–30% TCA gives better results and dermaroller alone has fewer side effects.

Keywords:

dermaroller, microneedling, striae rubra, trichloroacetic acid

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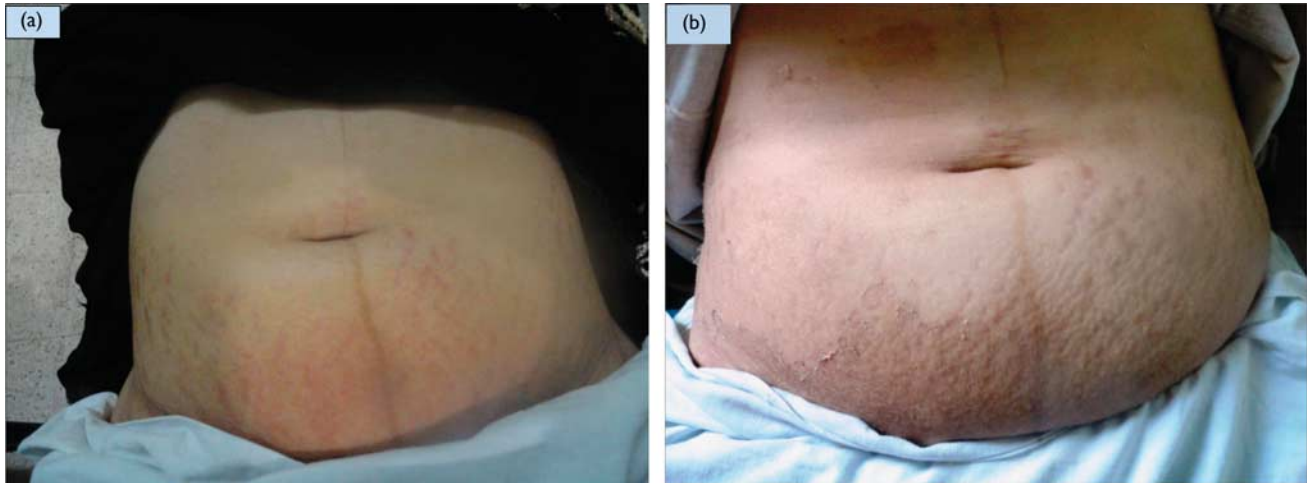
Introduction

Striae distensae are dermal atrophic scars with overlying epidermal flattening and atrophy [1]. They are a common dermatologic condition that causes cosmetic and psychologic problems and continue to remain a therapeutic challenge to dermatologists [2]. They tend to occur in areas of maximum stretch, and develop initially opposite the skin tension lines on the abdomen [3]. Striae often spread to involve the breasts, lower portion of the back, buttocks, thighs, upper arms, axillae, and inguinal areas and are sometimes accompanied by pruritus [4]. They can be seen to a lesser degree in 35% of adolescents,

appearing in girls 2.5 times more frequently than in boys [5].

A variety of treatment modalities have been used for the treatment of striae distensae, such as tretinoin cream [6], a combination of tretinoin and glycolic acid or ascorbic acid and glycolic acid [7], which have shown some effect in the early stages. Microdermabrasion can be a useful therapeutic option with a possible stimulatory effect on type I procollagen formation [8]. Several light and laser modalities such as intense pulsed light [9], pulsed dye laser [10], copper bromide laser [11], radiofrequency device [12], excimer laser [13], and fractional CO₂

Figure 1.



(a) A female patient with abdominal striae rubra before treatment. (b) The same patient at the follow-up session with more improvement on the right side (dermaroller + 15–30% trichloroacetic acid).

laser [14] have been demonstrated to achieve some effect in treating striae distensae; however, postinflammatory hyperpigmentation is of major concern in darker skin types.

Although the needling technique was developed for transdermal drug delivery [15,16], it also improves scar condition [17]. Treatment with skin needling might be able to promote the removal of old damaged collagen and induce more collagen growth beneath the epidermis. Microneedling leads to the release of several growth factors, including platelet-derived growth factors, fibroblast growth factors, and transforming growth factors α and β , which stimulate the migration and proliferation of fibroblasts, producing new collagen (natural collagen) and elastin in the papillary dermis. In addition, new capillaries are formed. This neovascularization and neocollagenesis following treatment leads to reduction of scars. The procedure is therefore called 'percutaneous collagen induction therapy' [18]. Chemical peeling using 15% trichloroacetic acid (TCA) has been tried in the treatment of striae with promising results [19]. The goal of the TCA-based peeling solution is to stimulate the fibroblasts of the healthy zones between striae. Breaking of the barrier function of the epidermis creates an immediate stimulation of lipids, DNA, and TNF- α into keratinocytes that will stimulate their differentiation [20]. The aim of this work was to compare between the microneedling system (dermaroller) alone or combined with 15–30% TCA in the management of abdominal striae rubra.

Patients and methods

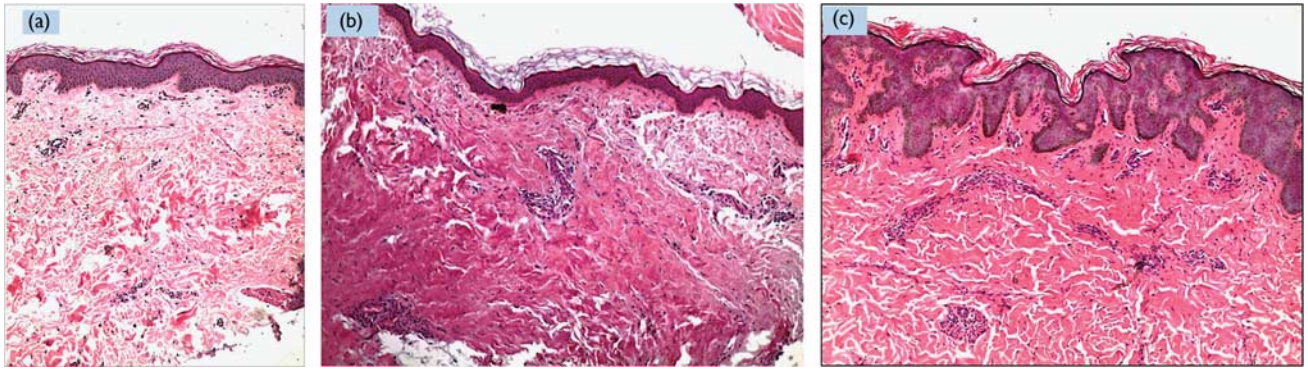
In this comparative split body study, 30 female patients with abdominal striae rubra and skin type III and IV were selected from the outpatient clinic of Dermatology of Benha University Hospital during the period from January 2012 to January 2013. Informed consent was obtained from each patient and the study was approved by the Research Ethics Committee of the faculty of medicine in Benha University. Inclusion criteria were patients with abdominal

striae rubra. The exclusion criteria were history of systemic or topical steroid use, oral contraceptive pills, pregnancy, and breast feeding. Patients with systemic diseases (e.g. hypertension, diabetes mellitus, cardiac, renal, or hepatic diseases), connective tissue disease (e.g. Cushing and Ehlers–Danlos syndromes), coagulation defects, and blood diseases were also excluded.

Each participant underwent a complete medical history taking, including personal history, onset, course, and duration of striae rubra, and a local examination of striae to determine the length, width, color, and texture.

The striae were managed by collagen induction therapy using a dermaroller for the right and left side of the abdomen, which was immediately followed by 15–30% TCA on the right side of the abdomen only. The right side of the abdomen that received dermaroller + 15–30% TCA was considered as group II (GII), whereas the left side of the abdomen that received only dermaroller was considered as group I (GI). Treatment was continued for six sessions at 3-week intervals. The skin of the abdomen was sterilized with Betadine solution, followed by alcohol, and degreased with acetone. A local anesthetic gel (Ultracaine gel; Memphis Pharma, Cairo, Egypt) was applied on the skin of both sides of the abdomen under occlusion for about 30–45 min before the procedure. The dermaroller used possesses 24 circular arrays of eight needles each (total 192 needles of 2 mm length) in a cylindrical assembly (Clinicares Inc., Torrance, Los Angeles, USA). Each patient was treated with a single dermaroller that was cleaned with water and sterilized with alcohol after each session to be used for the same patient in the next session. Rolling with the dermaroller was done in vertical, horizontal, and oblique directions with four times pass at each direction, without pressing too hard. The skin was stretched in a perpendicular direction to the dermaroller movement to reach the base of the striae.

Figure 2.



(a) Skin biopsies of untreated striae: (b) GI after treatment and (c) GII after treatment. All specimens were stained with H&E, $\times 200$. There was an increase in epidermal thickness and collagen content in GII, whereas in GI there was an increase only in collagen content.

Immediately after the dermaroller use, 15–30% TCA (prepared by weight-to-volume solution method) [21] was applied to the right side of the abdomen using a fan-shaped brush starting with 15% concentration and increased gradually at each session up to 30% concentration according to the patient's tolerance. Repeated coating with TCA was done to achieve an even white frosting denoting peeling to the level of the superficial papillary dermis.

Photographs of the striae were obtained before each session and 3 weeks after the last session (follow-up session) using a Sony Cyber-shot digital camera 8 Mega pixels (Sony Corp., Tokyo, Japan). After each session, the participants were instructed to apply a topical moisturizer and antibiotic cream to the whole abdomen until complete exfoliation of the developed crust. Five-millimeter punch biopsies were taken from 15 patients before treatment from one side of the abdomen and at the follow-up session from the right side (GII) and left side (GI) of the abdomen. The biopsies were preserved in 10% formalin and then processed and paraffin embedded. Five-micrometer-thick sections of skin were taken from each block at the Laboratory of Pathology of Benha University and stained with hematoxylin and eosin for routine histopathological study and with picrosirius red stain [22] for collagen fibers.

Objective assessments

Clinical

The clinical response to treatment was assessed by the treating physicians comparing the length, width, color (pink, skin colored, in between), and texture (atrophic, normal, in between) of the striae rubra in each group before every session and the follow-up session.

Histopathological

On light microscopic examination, collagen was seen to be red on a pale yellow background (nuclei if stained are ideally black but may often be gray or brown). The sections were analyzed using an Olympus BX51 microscope (Olympus America Inc., Melville, New York, USA)

equipped with filters to provide circularly polarized illumination. Morphometry was carried out to measure the epidermal thickness.

Subjective assessments

- (1) Quartile grading scale: photographs were assessed by two uninvolved dermatologists who were not aware of the used treatment modalities in this study, and the percentage of improvement was determined on the basis of the quartile grading scale as weak (<25%), moderate (25–50%), good (>50–75%), or excellent (>75%).
- (2) Patient satisfaction score: this was assessed as highly satisfied, somewhat satisfied, or unsatisfied [3] at the follow-up session.

Statistical analysis

The data collected were tabulated and analyzed by statistical package for the social science, version 20 (SPSS Inc., Chicago, IL, USA), on an IBM compatible computer. Tests used in this study included the Student *t*-test, the χ^2 -test, and the Mann–Whitney *U*-test. The accepted level of significance in this work was set at 0.05 ($P < 0.05$ was considered significant, whereas $P < 0.001$ was considered highly significant).

Results

This clinical trial was conducted on 30 female patients (14 patients with skin type III and 16 patients with skin type IV) with abdominal striae rubra. Their ages ranged from 15 to 50 years, with mean \pm SD of 24.73 ± 3.74 years.

On the left side of the abdomen (GI) treated with dermaroller alone, there were statistically significant differences between the first and follow-up sessions with respect to length (6.86 ± 1.78 and 3.05 ± 0.97 , respectively, $P < 0.001$), width (0.55 ± 0.11 and 0.29 ± 0.08 , respectively, $P < 0.001$), color ($\chi^2 = 30$, $P < 0.001$), and texture of the striae rubra ($\chi^2 = 21.8$ and $P < 0.001$).

On the right side of the abdomen (GII) treated with dermaroller + 15–30% TCA, statistically significant differences were seen between the first and follow-up sessions with respect to length (7.43 ± 1.82 and 2.08 ± 0.79 , respectively, $P < 0.001$), width (0.52 ± 0.14 and 0.18 ± 0.06 , respectively, $P < 0.001$), color ($\chi^2 = 32.3$, $P < 0.001$), and texture of striae ($\chi^2 = 34.7$, $P = 0.001$).

Significant differences were seen between GI and GII with regard to the length and width of the striae starting from the third session, in color from the fourth session, and in texture from the sixth session (Table 1).

Table 1. Comparison between G1 and G2 regarding length, width, color, and texture of striae at different sessions

Variables	GI (n=30)	GII (n=30)	t-Test	P value
At the third session (mean \pm SD)				
Length (cm)	5.46 ± 1.49	4.10 ± 1.95	3.04	0.004*
Width (mm)	0.43 ± 0.12	0.35 ± 0.14	2.37	0.02*
At the fourth session [n (%)]				
Color				
Pink	19 (63.3)	11 (36.7)	$\chi^2 = 6.75$	0.034*
In between	11 (36.7)	15 (50.0)		
Skin colored	0 (0.0)	4 (13.3)		
At the sixth session [n (%)]				
Texture				
Atrophic	15 (50.0)	9 (30.0)	$\chi^2 = 5.99$	0.049*
In between	13 (43.3)	12 (40.0)		
Normal	2 (6.7)	9 (30.0)		

*P value < 0.05 was considered significant.

Table 2. The degree of improvement of striae in GI and GII at the follow-up session

Improvement	GI [n (%)]	GII [n (%)]	Z-test	P
Mild (<25%)	10 (33.3)	5 (16.7)	1.49	0.13
Moderate (25–50%)	10 (33.3)	6 (20)	1.17	0.24
Good (>50–75%)	8 (26.7)	10 (33.3)	0.56	0.57
Excellent (>75%)	2 (6.7)	9 (30)	2.33	0.019*

*P value < 0.05 was considered significant.

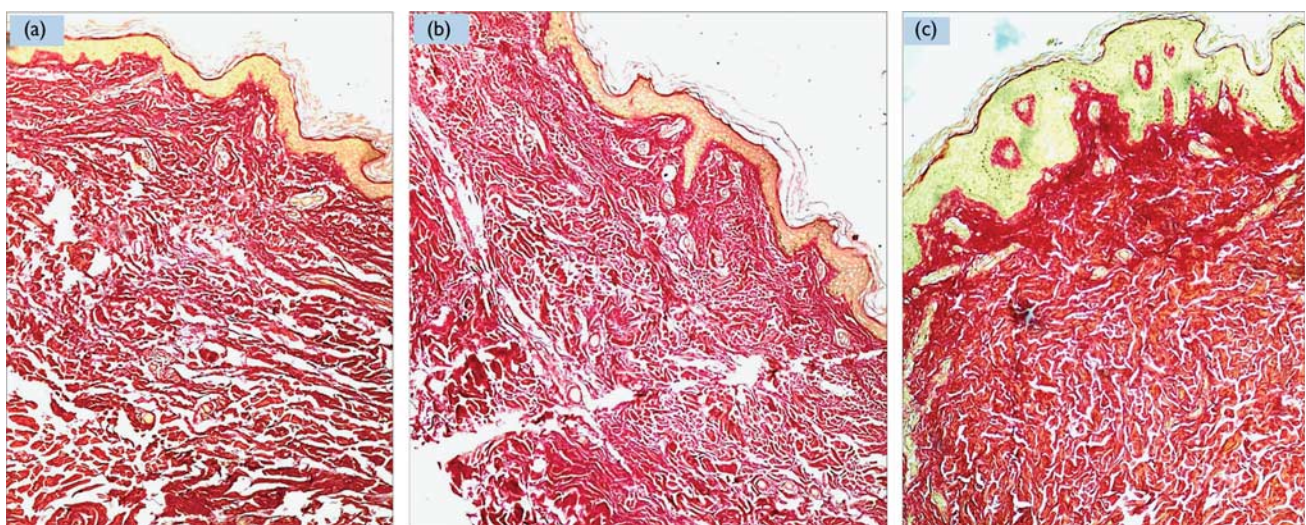
A comparison between GI and GII at the follow-up session revealed statistically significant differences regarding length (3.05 ± 0.97 , 2.08 ± 0.79 , respectively, $P = 0.006$), width (0.29 ± 0.08 and 0.18 ± 0.06 , respectively, $P = 0.001$), color ($\chi^2 = 6.01$, $P = 0.049$), and texture ($\chi^2 = 6.37$, $P = 0.041$). Greater improvement was noted in GII, as 19 (63.3%) patients showed good to excellent improvement compared with 10 (33.3%) patients in GI (Table 2 and Fig. 1a and b).

Although all patients in GI and GII received a topical anesthetic cream for 30–45 min under occlusion before the session, they complained of variable degrees of pain during the use of the dermaroller, which was generally tolerable and resolved by the end of the session. Transient erythema and edema occurred immediately during the procedure and lasted for 1 day in GI and for 3 days in GII. All patients of GII complained of more side effects in the form of burning sensation and cosmetic discomfort from the formation of brownish crusts within 2 days, which lasted for 7–10 days. Postinflammatory hyperpigmentation was observed especially after application of higher concentration of TCA (30%) in 10 (33, 3%) patients in GII, which faded within 2–4 months according to the degree of severity. The results of patient satisfaction were as follows: 11 patients were unsatisfied, 15 patients were somewhat satisfied, and four patients were highly satisfied in GI compared with seven, 10, and 13 patients in GII, respectively ($P = 0.036$).

The general histopathologic features of the skin biopsies collected before treatment showed epidermal thinning with fine collagen bundles arranged in straight lines (Figs 2a and 3a).

Histopathological examination of skin biopsies taken from GI at the follow-up session revealed increase in collagen fiber content (Figs 2b and 3b), whereas GII showed

Figure 3.



(a) Skin biopsies of untreated striae; (b) GI after treatment and (c) GII after treatment. All specimens were stained with picosirius red stain, $\times 200$. There was an increase in epidermal thickness and collagen content in GII, whereas in GI there was an increase only in collagen content.

significant increase in epidermal thickness (before = 47.34 ± 17.07 , after = 58.89 ± 13.25 ; $P = 0.005$) and collagen fiber content (Figs 2c and 3c).

Discussion

Needling therapy produces hundreds of tiny dermal injuries that stimulate dermal collagen and elastin formation [3]. When a needle penetrates the skin, the injury causes localized damage and minor bleeding by rupturing of fine blood vessels. A day after needling therapy, keratinocytes begin to proliferate and release growth factors to promote collagen deposition by the fibroblasts. It also modulates the expression of several genes in the skin (vascular endothelial growth factor, fibroblast growth factor, epidermal growth factor, collagen type I and III) that promote extracellular matrix remodeling [23].

In GI, which was treated with dermaroller alone, there were statistically significant differences between the first and follow-up sessions with respect to length, width, color, and texture of the striae in all patients. These results agreed with those of Park *et al.* [3] who reported improved skin texture, tightness, and color in all of the studied patients treated with a dermaroller three times at 4-week intervals at the follow-up visits (3 months after the last treatment).

Collagen represents the most abundant component of dermal connective tissue. Scar improvement involves collagen remodeling, including breaking old collagen strands and inducing collagen growth. Chemical peeling with TCA increases collagen fiber density and elastic fiber fragmentation [24].

TCA (10–35%) has been used for many years and is safe to use at low concentrations. At higher concentrations (e.g. 50%), TCA has a tendency to scar and is less manageable than other agents used for superficial peels. Anecdotal reports have indicated the use of TCA in stretch marks, although there is a lack of clarity and absence of data for assessment of this subject [25].

In GII, which was treated with dermaroller + TCA, statistically significant differences were seen between the first and follow-up sessions with regard to length, width, color, and texture of the striae in all patients.

Improvement of striae on treatment with 15–30% TCA is due to coagulative necrosis of the epidermis, necrosis of the dermal collagen, and increased fragmentation of elastin fibers in the papillary dermis [26].

Two studies reported improvement in the texture and color of the striae following the use of TCA 15% combined with sand abrasion [20] and topical tretinoin cream [25]; however, to our knowledge, no published studies combined TCA with dermaroller.

In this study, a comparison between GI and GII revealed statistically significant differences in length and width starting from the third session, color from the fourth session, and texture in the sixth session. These results

support that collagen induction therapy using a 2 mm dermaroller needs a minimum of three to four sessions for new natural collagen to form, which is commensurate with the results of Fernandes and Signorini [27].

In the current study, although all patients of GI and GII received a topical anesthetic gel before the session, all patients (100%) complained of variable degrees of pain during the use of the dermaroller, which was generally tolerable and resolved by the end of the session. Transient erythema and edema occurred immediately during the procedure and lasted for 1 day in the GI and for 3 days in the GII. Postinflammatory hyperpigmentation occurred especially after the application of higher concentrations of TCA (30%) and faded within 2–4 months according to the degree of severity. These results agreed with those of Adatto and Deprez [20] and Park *et al.* [3], in which there was transient hyperpigmentation in all patients.

Conclusion

Dermaroller and dermaroller + 15–30% TCA are effective treatment modalities for striae rubra. However, dermaroller + 15–30% TCA gives better results and dermaroller alone has fewer side effects. Further studies are recommended with other types of chemical peels to minimize side effects.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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