

How to Cite:

Shokeir, H. A., Sami, N. A., Esmat, S., Mahmoud, S. B., Hilal, R. F., Sayed, S. S. E. D., & Taha, I. S. (2022). Clinical and histochemical response to automated microneedling therapy in treatment of traumatic scars. *International Journal of Health Sciences*, 6(S3), 643–650. <https://doi.org/10.53730/ijhs.v6nS3.5277>

Clinical and Histochemical Response to Automated Microneedling Therapy in Treatment of Traumatic Scars

Hisham Ali Shokeir

National Institute of Laser Enhanced Sciences, Cairo University, Cairo, Egypt

Nevien Ahmed Sami

National Institute of Laser Enhanced Sciences, Cairo University, Cairo, Egypt

Samia Esmat

Department of dermatology, Kasr Al Ainy Faculty of Medicine, Cairo University, Cairo, Egypt

Sara Bahaa Mahmoud

Department of dermatology, Kasr Al Ainy Faculty of Medicine, Cairo University, Cairo, Egypt

Rana Fathy Hilal

Department of dermatology, Kasr Al Ainy Faculty of Medicine, Cairo University, Cairo, Egypt

Safinaz Salah EL Din Sayed

Department of Histology, Kasr Al Ainy faculty of Medicine, Cairo University, Cairo, Egypt

Inas Shaker Taha

National Institute of Laser Enhanced Sciences, Cairo University, Cairo, Egypt

Abstract---Post traumatic skin injuries are challenging to manage. Patients may have erythematous, hypertrophic, or atrophic scars. Microneedling therapy is minimally invasive non-surgical and non-ablative procedure used for skin rejuvenation that relies on the principle of neocollagenesis. We aimed to assess the clinical and histochemical response to automated microneedling therapy in treatment of traumatic scars. This prospective study included twenty patients with traumatic scars. All patients received 4 monthly sessions of automated microneedling therapy. Outcome assessment included modified Vancouver Scar Scale, digital photographic documentation

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2022.

Corresponding author: *authorname*

Manuscript submitted: 18 Nov 2021, Manuscript revised: 09 Feb 2022, Accepted for publication: 27 March 2022

and patient's satisfaction. Histochemical evaluation by quantitative morphometric assessment for collagen and elastic fibers using image analyzer performed before and 3 months after treatment for Masson's trichrome and Orcein stained sections respectively. There was statistically significant improvement in scar vascularity ($p=0.018$), scar pigmentation ($p=0.008$), and scar pliability ($p=0.002$) and sum of mVSS ($P=0.000002$). Histochemically, there was significant increase in collagen content, ($p=0.023$), and elastin content ($p=0.003$) as quantified by image analyzer. There was no significant correlations (r : 0.158 and -0.259; p -values: 0.55 and 0.34) between micro-needling therapy and scar type (atrophic versus hypertrophic). Treatment was associated with satisfactory outcome and except for a temporary erythema, no adverse effects were noted in any patient. Microneedling therapy for post traumatic scars showed clinical improvement associated with significant increase in collagen and elastin content. Microneedling seems to be promising treatment modality being safe, efficacious and affordable treatment option for this patient.

Keywords---automated microneedling, histochemical, traumatic scars.

Introduction

Post traumatic skin injuries are challenging to manage. Patients may seek care either immediately after injury or even months later. Patients who seek expert care long after the acute phases of wound healing may have erythematous, hypertrophic, or atrophic scars (1). Microneedling therapy is minimally invasive non-surgical and non-ablative procedure used for skin rejuvenation. This procedure involves the use of a microneedling device to create controlled skin injury. There are various skin needling devices including Dermaroller and automated microneedling devices (Dermapen). Microneedling relies on the principle of neocollagenesis and neovascularization that occurs as a result of the release of growth factors following needle piercing of the stratum corneum. These growth factors are believed to be responsible for the beneficial effects of the procedure in the treatment of scars. (2) In this prospective study we aimed at evaluating the clinical and histochemical response to automated microneedling therapy in treatment of traumatic scars.

Patients and Methods

Twenty patients with post traumatic scars were prospectively recruited in this study. Patients with Fitzpatrick skin types V and VI, unrealistic expectations, isotretinoin therapy or cosmetic interventions in treatment area within the past 12 months were excluded from the study. All patients provided an informed signed consent and the study was approved by the Dermatology Research Ethics Committee.

Treatment strategy

All patients received 4 automated microneedling sessions (4 weeks apart), using electric Derma stamp pen, Ostar Beauty -OB-DG 01-12 pins-0.25: 2.00 mm depth of penetration. It was adjusted at 1.5 mm depth and speed level 4. It contains, 12 stainless steel needles, each needle has a 33-gauge diameter, with a 250 μ m diameter at entry point. Lidocaine 25% cream was applied under occlusion 60 minutes before and wiped off just before the session. Sterile saline was used to help gliding of the tip of the pen over the skin. All patients were advised for topical antibiotic cream and a broad-spectrum sunscreen after microneedling sessions. All patients were followed up for 3 months after last treatment session.

Assessment of outcome

Assessment of outcome was done at baseline and three months after the last treatment session by two blinded investigators: Functional outcomes for scar vascularity, pigmentation and pliability according the modified Vancouver Scar Scale (3). Digital photographic documentation using Sony Cyber shot digital still camera (DSC-W300, Japan); improvements in scars were assessed independently by comparison of clinical photographs obtained before and at follow up visit (3 months) after treatment under identical conditions of lighting and positioning. Patient's satisfaction after 3 months of microneedling therapy was graded into slightly better, fair, good, and excellent corresponding numerically to less than 25%, 25% to 50%, 51% to 75%, 76% to 100% improvement respectively.

Histochemical evaluation

Two skin biopsies were taken from each patient; one was taken from the scar before the treatment and the 2nd at 3 months after treatment. Sections were prepared for histochemical staining of collagen fibers using Masson's trichrome stain and elastic fibers using Orcein stain. (4)

Image analysis (quantitative morphometric study)

This was performed at the histology department, faculty of medicine, using the Leica Qwin 500 Image Analyzer (Leica Imaging Systems Ltd, Cambridge, UK). It consists of Leica DM-LB microscope with JVC color video camera attached to a computer system (Leica Q 500IW). Morphometric analysis was carried out on both Masson-stained and orcein-stained slides. Adjustment of illumination was checked for on the video monitor. Morphometric measurements were performed on real-time image from the microscope that was visualized on the video monitor. Then the area stained with Masson/ orcein was measured in five fields using magnification $\times 400$. Results automatically appeared on the monitor in the form of mean $\pm$ SD. (5)

Statistical analysis

All analyses were done using IBM, SPSS version 24.

Results

The age of study group patients ranged between 17 and 43 years (mean $\pm$ SD 27.27 $\pm$ 9.65). Males represented 65% (13 patients) and females represented 35% (7

patients). Fourteen patients (70%) had Fitzpatrick skin type III and the remaining 6 patients (30%) had Fitzpatrick skin type IV. Scar duration ranged between 1 and 5 years (mean $\pm$ SD: 3.13 ± 1.4 years). Thirteen patients (65%) had atrophic scars and 7 patients (35%) had hypertrophic scars. Scar length ranged between 15 and 154 mm (mean $\pm$ SD: 54.13 ± 42.7 mm) and scar width ranged between 1 and 5 mm (mean $\pm$ SD: 2.73 ± 1.1 mm). As shown in table 1, there was statistically significant improvement in scar vascularity ($p = 0.018$), scar pigmentation ($p = 0.008$), and scar pliability ($p = 0.002$) after treatment. This was reflected as significant improvement in the sum of mVSS after treatment with automated microneedling (mean $\pm$ SD: 1.2 ± 1.5 compared to 5 ± 1.5 before treatment, $P = 0.000002$).

Table 1
Modified VSS (before) and (3 months) after microneedling therapy

Modified VSS (before) and (3 months) after microneedling therapy									
	Vascularity			Pigmentation			Pliability		
Scale	Pre	Post	P value	Pre	Post	P value	Pre	Post	P value
0	6	14	0.018	7	14	0.008	0	7	0.002
1	11	5		3	2		0	12	
2	3	1		10	4		7	1	
3	0	0		0	0		9	0	
4	0	0		0	0		4	0	

There was statistically significant increase in collagen content as assessed by Masson stain, (figure 1) and quantified as area percentage by image analyzer after treatment with automated microneedling (13.6 ± 8 versus 15 ± 7.3 , $p = 0.024$, figure 2).

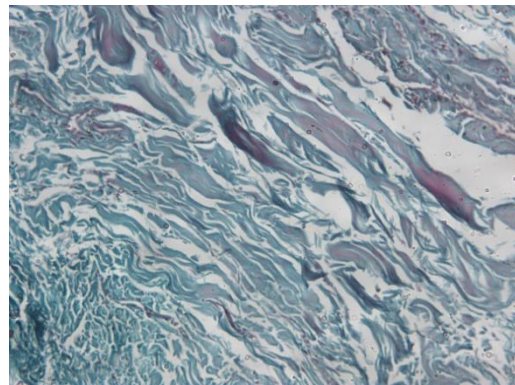
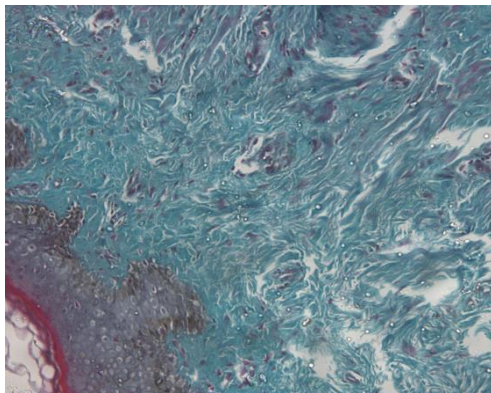


Figure 1: Collagen content before and after 4 monthly microneedling therapy, Masson stain, x 400

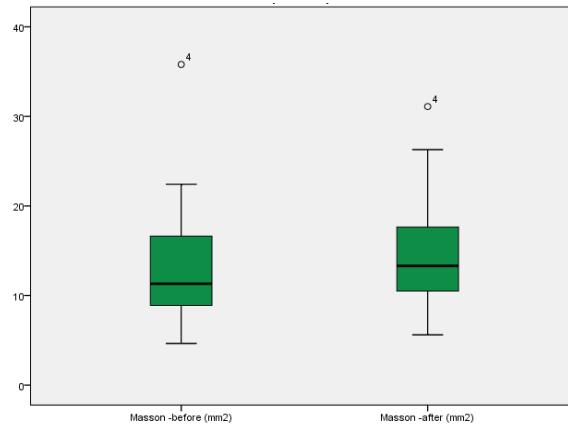


Figure 2: Collagen content (Masson stain area) before and after 4 monthly microneedling therapies

There was also statistically significant increase in elastin content as assessed by Orcein stain, (figure 3) and quantified as area percentage by image analyzer after treatment with automated microneedling (3.8 ± 2.7 versus 5 ± 3.1 , $p: 0.0003$, figure 4).

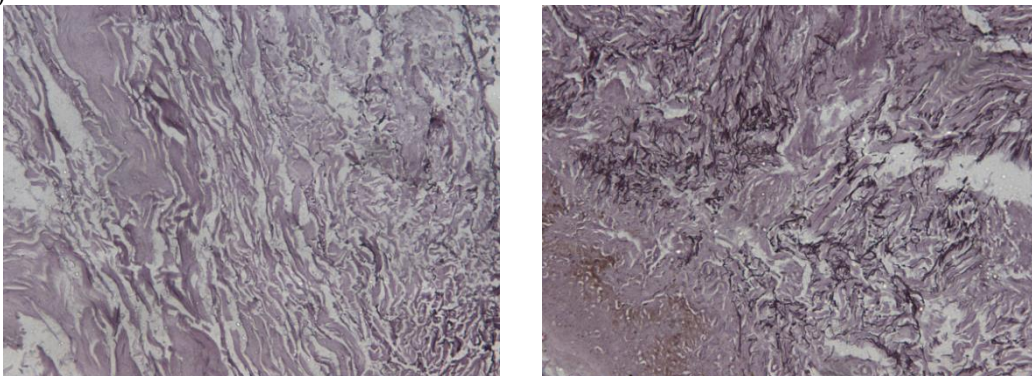


Figure 3: Elastin content before and after 4 monthly microneedling therapy, Orcein stain, x 400

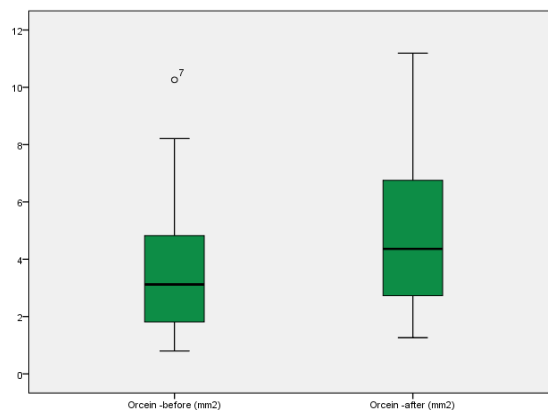


Figure 4: Elastin content (Orcein stain area) before and after 4 monthly microneedling therapy

As the study population included atrophic and hypertrophic scars with different histopathological features and to study the effect of automated microneedling on histopathological changes we collected correlation between scar type (atrophic/hypertrophic) and stain areas. There was no statistically significant correlations (r : 0.158 and -0.259; p -values: 0.55 and 0.34) between atrophic versus hypertrophic scars treated with microneedling therapy regarding change in Masson or Orcein stain area respectively. There was improvement in clinical appearance of scars as shown in table 2, figures 5 and 6.



Figure 5: Atrophic scar, before and 3 months after treatment with microneedling



Figure 6: Atrophic scar, before and 3 months after treatment with microneedling

Automated micro-needling therapy was associated with satisfactory outcome as assessed after 3 months of treatment, (table 2). All patients tolerated the procedure well, and except for a temporary erythema, no adverse effects were noted in any patient.

Table 2
Photographic outcome and patient satisfaction after microneedling therapy

	Photographic outcome				Total
	SB	Fair	Good	Excellent	
Count (%)	3 (15%)	2 (10%)	9 (45%)	6 (30%)	20 (100%)
	Patient satisfaction				Total
	SB	Fair	Good	Excellent	
Count (%)	2 (10%)	2 (10%)	8 (40%)	8 (40%)	20 (100%)

SB: Slightly better

Discussion

In the current prospective study, twenty patients with traumatic scars were subjected to automated microneedling therapy using dermapen device. There was a statistically significant improvement in scar vascularity, pigmentation, pliability and the sum of modified VSS after treatment. This was associated with significant improvement in photographic outcome and patient satisfaction.

Compared with ablative procedures, microneedling keeps the epidermis partially intact, and the retained skin barrier hastens recovery and limits the risks of infection and scarring. (6) Also, microneedling does not target specific chromophores in the skin or use thermal energy, and therefore has minimal effect on pigmentation. (7)

Few previous studies evaluated the role of microneedling therapy in treatment of traumatic scars. Vijaya Y et al., evaluated microneedling therapy using dermaroller for 14 patients with facial scars mostly of traumatic and postoperative origin and reported satisfactory clinical improvement in scar level and color with an added advantage of minimal downtime. (8) Bandral et al., evaluated the role of microneedling using dermaroller in treatment of 50 patients with facial scars of different etiologies including 27 patients with traumatic scars and reported 64% clinical success rate.(9)

In a large prospective study, Alster et a., evaluated 120 patients with facial and nonfacial scars from a variety of etiologic sources (acne, trauma, surgery) treated using mechanical microneedling device, clinical improvement was achieved in the majority of patients. Moreover, no significant clinical differences were observed in treatment responses of facial versus nonfacial scars nor between responses of atrophic acne scars and traumatic or surgical scars. (10) In a recently published systematic review involving 1845 patients from 58 studies, microneedling therapy was well-tolerated, minimally invasive procedure with a high level of patient satisfaction in treatment of different types of scars. (11)

Histochemically, this study revealed a statistically significant increase in collagen and elastin contents, as quantified by image analyzer. In a pilot study, El-Domyati et al., reported a 51%–60% improvement in scar appearance, 40%–50% improvement in skin texture, 80%–85% overall satisfaction, and significant increase in the production of collagen types I, III, and VII following six treatment sessions using microneedling in 10 patients with atrophic post acne facial scars. (12) In post burn scars, Zayed et al., reported significant increase in elastin deposition but insignificant increase in collagen deposition after microneedling

therapy. (13) On the other hand, Aust et al., reported considerable increase in collagen deposition in atrophic burn scars 6 months following microneedling treatment sessions. (14)

Few studies in the literature compared the efficacy of microneedling versus other modalities like laser resurfacing in different clinical subsets. Soliman et al., reported 55% moderate-excellent improvement of striae in the dermaroller-treated side versus 76% with fractional CO₂ laser-treated side concluding that, fractional CO₂ laser is more effective in treating striae with acceptable side effects but still microneedling can be afforded as an effective, safe and cheap method (15). In a split-face study, Osman et al., reported significantly higher efficacy of ablative fractional Er:YAG laser than microneedling in the treatment of atrophic acne scars, with significantly shorter total downtime in the microneedling-treated sides. (16) On the other hand, Cachafeiro et al., reported no statistically significant difference between the efficacy of 1,340 nm non-ablative fractional erbium laser and microneedling in the treatment of post acne scars. (17)

Previous articles suggest that microneedling improves the appearance of scars. However, a noticeable difference in treatment regimen was observed in a recently published systematic review. Microneedling was performed between 3 and 8 times with intervals ranging from 2 to 4 weeks, highlighting the lack of standard treatment protocol (18). During the 3-month follow-up in our study, there were no reported cases of hypopigmentation or permanent hyperpigmentation. Moreover, treatment sessions were well tolerated by patients. Treatment with microneedling may reduce the risk of hyperpigmentation through downregulation of melanocyte-stimulating hormone during the postinflammatory response. (19)

To the best of our knowledge, this is the first prospective study assessing automatic microneedling therapy for post traumatic scars with clinical and histopathological analysis of all the study population. Current study clearly demonstrated that microneedling therapy is a safe, efficacious more affordable alternative treatment option for these patients. Microneedling seem to be promising treatment modality for post traumatic scars. Multiple adjunctive therapies are available and scar treatment should be individualized based on patient and scar characteristics. The best results will likely to be achieved through multi-specialty collaboration, innovative technology, and a combination of therapeutic modalities. Finally, further studies need to be carried out on a larger sample size and also considering scar subtypes and skin types of individuals for more conclusive results.

Conclusion

Microneedling therapy for post traumatic scars showed clinical improvement associated with significant increase in collagen and elastin content. Microneedling seems to be promising treatment modality being safe, efficacious and affordable treatment option for these patients.

References

1. Tripathi BP, Nelson JS and Wong BJ. Posttraumatic Laser Treatment of Soft Tissue Injury. *Facial Plast Surg Clin N Am.* 2017; 25(4):617-628. doi: 10.1016/j.fsc.2017.06.012.
2. Majid I. Microneedling and its applications in dermatology. *International journal of aesthetic and anti-Ageing medicine* sep.2014.
3. Bowes L.E., Nouri K. and Berman B.: Treatment of pigmented hypertrophic scars with the 585 nm pulsed dye laser and the 532 nm frequency-doubled Nd:YAG laser in the Q- switched and variable pulse modes: a comparative study. *Dermatol. Surg.* 2002; 28:714– 719.
4. Jones ML, Bancroft JD, Gamble M. *Connective Tissues and Stains.* In Bancroft JD, Gamble M (eds). *Theory and practice of histological techniques.* 6th ed. Philadelphia, Elsevier Health Sciences, Churchill 411 Livingstone, 2008; 135-60.
5. Mahfouz S. M., El-Sharkawy S. L., Sharaf W. M. Hussein H. E., and EL Nemr R.S. Image Cytometry of Fine Needle Aspiration of Thyroid Epithelial Lesions. *Image Cytometry of Fine Needle Aspiration of Thyroid Epithelial Lesions. Applied Immunohistochemistry & Molecular Morphology:* 2012; 20(1):25–30. DOI: 10.1097/PAI.0b013e31821ffa6a
6. Cohen BE, Elbuluk N: Microneedling in skin of color: A review of uses and efficacy. *J Am Acad Dermatol.* 2016; 74(2):348-55. doi:10.1016/j.jaad.2015.09.024.
7. Seo KY, Kim DH, Lee SE, Yoon MS, Lee HJ. Skin rejuvenation by microneedle fractional radiofrequency and a human stem cell conditioned medium in Asian skin: a randomized controlled investigator blinded split-face study. *J Cosmet Laser Ther.* 2013; 15(1):25-33.
8. Vijaya Lakshmi Y, Swetha Reddy L, Naga Neelima Devi K, Phani Kumar K, Guru Karthik G, Srinivas Chakravarthy P, Nageswar Rao K Evaluation of Microneedling Therapy in Management of Facial Scars *Journal of craniofacial surgery*, 2020, 31(2), e214-e217.
9. Bandal MR, Padgavankar PH, Japatti SR, Gir PJ, Siddegowda CY, Gir RJ. Clinical Evaluation of Microneedling Therapy in the Management of Facial Scar: . Clinical Evaluation of Microneedling Therapy in the Management of Facial Scar: A Prospective Randomized Study. *J. Maxillofac. Oral Surg.*2019;18: 572–578.
10. Alster TS, Li MKY. Microneedling of Scars: A Large Prospective Study with Long-Term Follow-Up. *Plast Reconstr Surg.* 2020; 145(2):358–64.
11. Juhasz MLW, Cohen JL. Microneedling for the Treatment of Scars: An Update for Clinicians. *Clin Cosmet Investig Dermatol.* 2020; 22 (13):997-1003. doi: 10.2147/CCID.S267192.
12. El-Domyati M, Barakat M, Awad S, Medhat W, El-Fakahany H, Farag H. Microneedling therapy for atrophic acne scars: an objective evaluation. *J Clin Aesthet Dermatol.* 2015; 8(7):36–42.
13. Zayed AA, Mashaly HM, Abdel Raheem HM, El-Nabarawy E, El-Hawary MS, Shaker OG, Elnemer RS, Aldhahebi WE. Microneedling versus fractional CO2 laser in the treatment of atrophic postburn scars. *J Egypt Womens Dermatol Soc* 2019; 16:37-42.
14. Aust MC, Reimers K, Vogt PM. Medical needling improving the appearance of hypertrophic burns scar. *Aesthet J* 2011; 1:42–49.
15. Soliman M, Mohsen Soliman M, El-Tawdy A and Shorbagy HS. Efficacy of fractional carbon dioxide laser versus microneedling in the treatment of striae

- distensae. J Cosmet Laser Ther. 2018; 15:1-8. doi: 10.1080/14764172.2018.1525749.
16. Osman MA, Shokeir HA, Fawzy MM. Fractional Erbium-Doped Yttrium Aluminum Garnet Laser Versus Microneedling in Treatment of Atrophic Acne Scars: A Randomized Split-Face Clinical Study. *Dermatol Surg* 2017;43:S47–S56 •DOI: 10.1097/DSS.0000000000000951
 17. Cachafeiro T, Escobar G, Maldonado G, Cestari T, Corleta O. Comparison of nonablative fractional erbium laser 1,340 nm and microneedling for the treatment of atrophic acne scars: a randomized clinical trial. *Dermatol Surg*. 2016; 42(2):232–241.
 18. Sitohang IBS, Sirait SAP, Suryanegara J. Microneedling in the treatment of atrophic scars: A systematic review of randomized controlled trials. *Int Wound J*. 2021;18:577–585.
 19. Cohen B, Elbuluk N. Microneedling in skin of color:a review of uses and efficacy. *J Am Acad Dermatol*. 2015; 74:348-355.