Microneedling Combined with Platelet-rich Plasma for Management of Burn Scars: A Clinical and Histological Study

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Abstract

Background: Burn scars pose challenges in plastic surgery with varied treatment outcomes. Microneedling and platelet-rich plasma (PRP) aim to enhance skin regeneration, offering promising results in scar management.

Objectives: To evaluate microneedling and PRP's efficacy in managing mature burn scars clinically, and histpathologically

Patients and methods: The prospective study at Qena University Hospitals, Egypt, involved 18 outpatient clinic patients with post-burn mature scars. Inclusion criteria included scar presence; exclusions were immunocompromised status, refusal to participate, incomplete data, and concurrent injuries. Patients consented to treatment, photography, and biopsies, with detailed histories and scar assessments using the Vancouver Scar Scale (VSS). Treatment included PRP preparation via autologous blood centrifugation and microneedling with PRP injections over three sessions. Outcome measures included VSS scores, patient satisfaction, and histological analysis after three months.

Results: This clinical trial study involved 18 patients; their ages ranged from 4 to 16 years with a mean age of 7.22 ± 3.66 years, of which 72.2% were female. Scald was the prominent burn type in 94.4%. The most common burn site was the left arm (4 patients (22.2%)) followed by the right arm (3 patients (16.7%)) and right flank (2 patients (11.1%)). There was a non-significant difference pre and post-derma rolling with and without PPR, No signficant difference of the histological finding between groups.

Conclusion: Combining microneedling and PRP did not significantly improve VSS scores postoperatively. Further research with larger samples and extended follow-up is warranted to explore this treatment's efficacy in burn scar management.

Keywords: Microneedling; Platelet-rich plasma; Burn scars; Histological analysis.

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Introduction

Because of their complex nature and the difficulty of achieving good cosmetic and functional results, burn scars represent a significant challenge in plastic surgery. There is not—a widely recognized conventional treatment procedure, Despite the availability of numerous therapeutic methods such as topical medications, dermabrasion, laser resurfacing, corticosteroids, chemical peels, and fat grafting. Dermal extracellular matrix (ECM) proteins are essential for skin regeneration and healing, and these procedures aim to increase their levels. However, due to their inconsistent effectiveness and possible side effects, further research into more reliable and effective treatment approaches is needed **(van Baar, 2020).**

A promising new tool in the toolbox for treating burn scars is Collagen induction therapy by microneedling technique. To induce regulated micro-injuries in the dermal and epidermal layers and activate the body's natural wound-healing response, this technique uses fine stainless steel needles (0.25 to 3 mm). This process leads to neocollagenesis and neovascularization, which improve the appearance of scars, especially raised burn scars. Compared to more invasive therapies, microneedling has the benefit of little epidermal damage, which leads to fewer side effects and quicker recovery times **(Lin et al., 2019; Juhasz and Cohen, 2020).**

Platelet-rich plasma (PRP) therapy is the use of concentrated platelets from the patient's blood to increase growth factors such as insulin-like growth factor (IGF), transforming growth factor (TGF), vascular endothelial growth factor (VEGF), and platelet-derived growth factor (PDGF). In the field of dermatology, this treatment is growing in popularity. These components are necessary for improved tissue regeneration, collagen synthesis stimulation, and tissue remodeling. PRP's ability to encourage healing and tissue restoration makes it suitable for a range of dermatological and cosmetic applications **(Cengiz et al., 2018; Gupta et al., 2021).**

By combining PRP with microneedling, an inventive method for treating post burn hypertrophic scars has been developed, utilizing the complementary benefits of both therapies. In addition to promoting wound healing, microneedling produces microchannels that improve PRP absorption. In turn, PRP promotes collagen synthesis and vascularization, which improves the texture and look of scars and speeds up the healing process. The advantages of both PRP and microneedling are maximized in this combined therapy, while the disadvantages of each when used alone are reduced **(Badran and Nabili, 2018; Kang and Lu, 2022).**

The main aim of the study was to evaluate and compare clinically and histopathologically the use and effectiveness of some of the minimally invasive procedures, using microneedling alone or in conjunction with platelet-rich plasma for the management of mature burn scars.

Patients and methods

A prospective randamized clinical trial study was conducted at Plastic Surgery Department of Qena University Hospitals, South Valley University, Egypt. It involved 18 patients from the outpatient clinic seeking management for post-burn mature scars

Inclusion criteria : patients with mature scars more than 6 months, non hypertrophic or keloid scars.

Exclusion criteria: immature scars less than 6 months, patients with keloid scars, non compliant pateints for follow up.

Informed Consent and Patient Evaluation: All patients provided informed

consent for treatment, photography, and biopsies. Comprehensive patient histories were obtained, including age, sex, scar location, burn type, and time since injury. Scar photography was conducted before and after each treatment session. A pre-treatment biopsy was taken from the scar target area, followed by a post-treatment biopsy three months later for histopathological analysis. **Ethical approval code:** SVU-MED-SUR011-1-23-5-652.

Assessment Tools

The Vancouver Scar Scale (VSS) was used to assess scar severity at baseline and post-treatment, evaluating vascularity(0_3) , height (0_3), pliability(0_5), and pigmentation(0_2). Scores ranged from 0 to 13.

All specimens were formalin-fixed and paraffin-embedded to prepare hematoxylin and eosin stained slides

Biopsies were examined by binocular light microscope Olympus CX21. The epidermal thickness was assessed by using Leica DM 1000 image analyzer

Platelet-Rich Plasma (PRP) Preparation: Autologous whole blood (10 mL) was collected and centrifuged to separate plasma and platelets. A second centrifugation concentrated platelets, resulting in PRP with increased platelet count. PRP activation involved the addition of calcium chloride **(Gentile et al., 2020).**

Treatment Procedure: Before treatment, lidocaine cream was applied for local anesthesia. Scars were divided into halves for treatment: one side received derma-roller alone, while the other received a combination of derma-roller and PRP injections. Each scar was injected with 1 mL of PRP over three sessions, spaced three weeks apart.

Outcome Measures: Primary outcomes included VSS scores and patient satisfaction levels, while Secondary outcomes included histopathological findings.

Statistical analysis

Data were processed and analyzed using SPSS version 22. Qualitative variables were presented as numbers and percentages, while quantitative variables were reported as mean ± standard deviation. Statistical analyses included univariate logistic regression, multivariate regression, and various tests: Student's t-test for independent groups, Mann-Whitney test for non-normally distributed data, one-way ANOVA for multiple group comparisons, Fisher exact test for non-parametric data, Chi-square test for association, Pearson correlation for linear relationships, and Spearman correlation for ranked data. A significance level of 5% ($P < 0.05$) was used to interpret results, where a lower P value indicated greater significance.

Results

This clinical trial study involved 18 patients from the plastic surgery department at Qena University Hospital with hypertrophied post-burn scars; their ages ranged from 4 to 16 years with a mean age of 7.22 ± 3.66 years, of which 72.2% were female. Scald was the prominent burn type in 94.4%. The most common burn site was the left arm (4 patients (22.2%)) followed by the right arm (3 patients (16.7%)) and right flank (2 patients (11.1%)). (**Table.1).**

Table 1. Patient's demographic features (N = 18)

Parameters		Frequency	Percentage (%)
Gender	Male	5	27.80%
	Female	13	72.20%
Burn type	Scald	17	94.40%
	Flame	1	5.60%

Burn site	Abdomen	1	5.6%
	Lower back	1	5.6%
	Right arm	3	16.7%
	Left arm	4	22.2%
	Chin	1	5.6%
	Chest	1	5.6%
	Dorsum of both hands	1	5.6%
	Left shoulder	1	5.6%
	Back	1	5.6%
	Left flank	1	5.6%
	Right flank	2	11.1%
	Right thigh	1	5.6%
		Mean ± SD	**Median (range)**
Age (years)		7.22 ± 3.66	6.50 (4-16)

There were no statistically significant differences in the Vancouver scar scale post-derma rolling, compared to pre-derma rolling (P = 1.00). (**Table. 2).**

Table 2. Difference in VSS post-derma rolling compared to pre-derma rolling (N = 18)

Parameter	Pre derma rolling	Post derma rolling	P value
	Mean ± SD	Mean ± SD	
Vancouver Scar Scale (VSS)	4.00 ± 0.84017	4.00 ± 0.84017	1.00

Paired t-test

There were no statistically significant differences between the use of derma rolling alone and a combination of derma rolling and PRP on the Vancouver scar scale of studied patients (P = 1.00)). (**Table. 3).**

Table 3. Comparison between Derma rolling and a combination of Derma rolling with PRP (N = 18)

Variable	Derma rolling	Derma rolling and PRP	P value
	Mean ± SD	Mean ± SD	
Vancouver Scar Scale (VSS)	4.00 ± 0.84017	4.00 ± 0.84017	1.00

Student's t-test, PRP: platelet-rich plasma

There were no statistically significant differences in the Vancouver scar scale post-derma rolling and PRP, compared to pre-derma rolling and PRP (P = 1.00). (**Table.4).** Epithelization thicknes showed non-signififcant differences (P = 0.5632). (**Table.5**)

Table 4. Difference in VSS post-derma rolling and PRP compared to pre-derma rolling and PRP (N = 18)

Parameter	Pre-derma rolling and PRP	Post-derma rolling and PRP	P value
	Mean ± SD	Mean ± SD	
Vancouver Scar Scale (VSS)	4.00 ± 0.84017	4.00 ± 0.84017	1.00

Paired t-test, PRP: platelet-rich plasma

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Table 5. Difference in histopathologcal findigs between post-derma rolling and post-derma rolling and PRP (N = 18)

Parameter	Post derma rolling	Post derma rolling and PRP	P value
	Mean ± SD	Mean ± SD	
Epthelization thickness (µm)	215.56 ± 7.47	217.06 ± 8.02	0.5632

Case presentation

Fig (1. A)

Fig (1. B)

Fig 1. Male, 13yrs , hypertrophic scar of lt arm divided into 2 halves :- Half A was treated with dermarolling only & Half B with dermaroling with prp (fig 1.A) before begining of sessions (fig 1.B) after 3 sessions

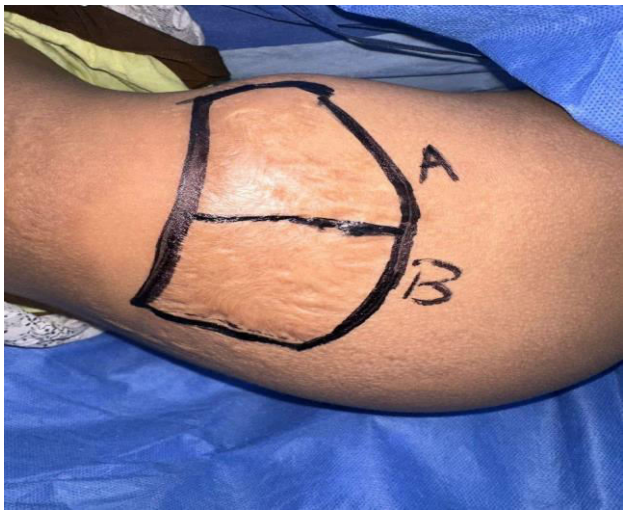

Fig (2. A)

Fig (2. B)

Fig. 2. Female , 10yrs , hypertrophic scar over rt flank divided into 2 halves A&B,, A:- treated with dermarolling only ,B :-with dermarolling & prp , (fig 2.A) :- before begining of sessions , (fig 2.B) after 3 sessions

Histopathological examination:

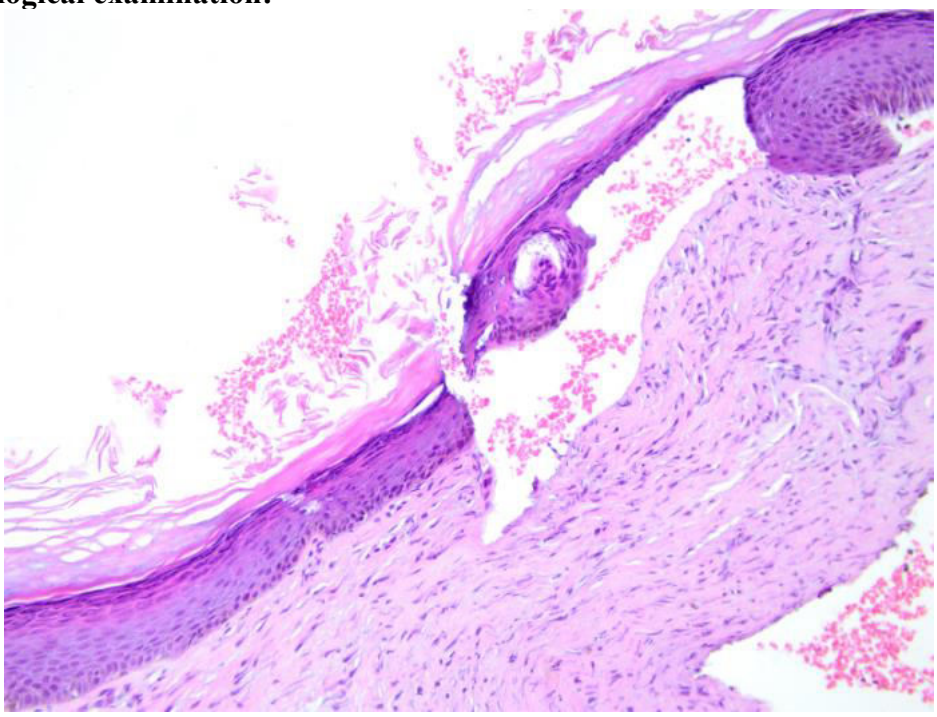

Fig. 1.A: Histopathological appearance of the skin of left arm before treatment shows immature reepithelization, low dermal fibers, numerous monocellular infiltrates and angiogenesis

A

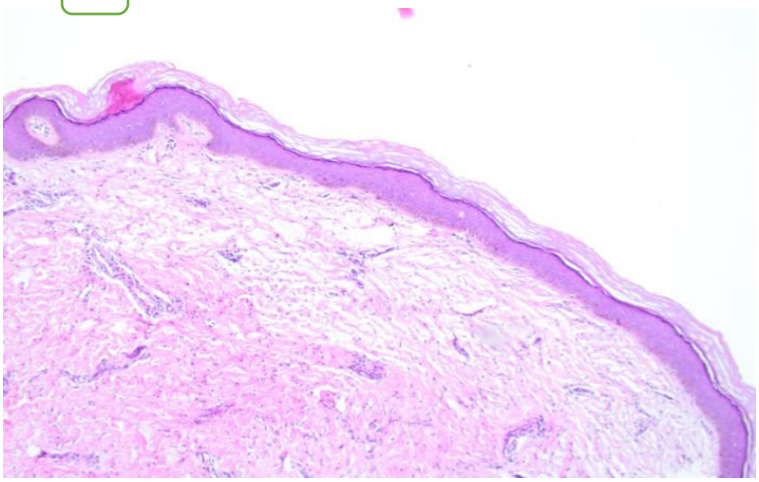

Fig.(2.A) Histopathological appearance of the skin of left arm on day 90 treated with microneedling shows immature reepithelization, dense and less organized dermal fibers, numerous monocellular infiltrates and angiogenesis.

B

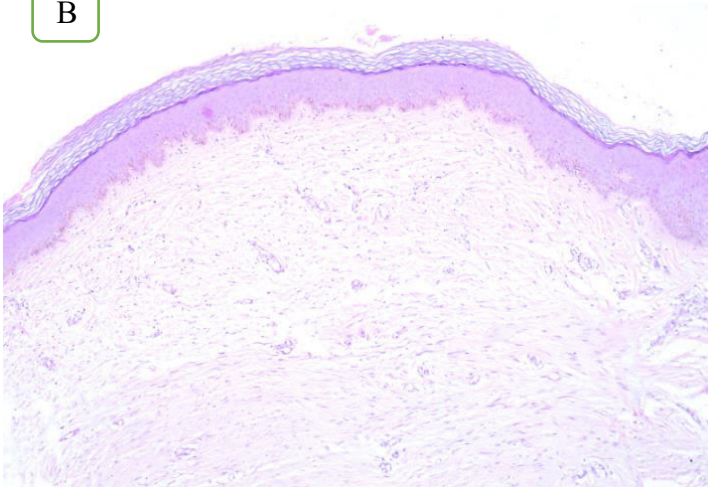

Fig.(2.B) Combined microneedling &PRP shows mature reepithelization, dense and more organized dermal fibers, few monocellular infiltrates and few angiogenesis

Discussion

Our study findings align with **Oosterwijk et al. (2017),** who emphasized significant associations between flame burns, female gender, and pediatric age groups in the development of contractures. In contrast, Mahmud et al. (2023) reported a different demographic profile with a male predominance (59%) and younger age (mean 3.18 years ±1.34 years), highlighting diverse epidemiological patterns in burn injuries.

In our study, our findings indicated no significant change in scar severity measured by Vancouver Scar Scale (VSS) scores following combined treatment, with both preoperative and postoperative mean VSS scores averaging 4.00 ± 0.84017 (p-value = 1.00). This suggests that our approach did not achieve the anticipated reduction in scar severity, highlighting the complexity and variability in treatment outcomes despite employing combined therapies.

Marck et al. (2016) similarly found no significant difference in scar quality between PRP-treated and control areas in 52 patients undergoing split skin grafts for deep burns after a 12-month follow-up. This indicates that in their study population, PRP did not provide additional benefits beyond standard treatments, illustrating variability in outcomes across patient cohorts and treatments.

In contrast, **Elsayed et al. (2017)** compared PRP injections to silicone-based products in 38 patients with post-burn scars over six months. Their findings suggested PRP's efficacy in improving scar quality, particularly in reducing itching, improving pigmentation, and enhancing scar pliability. However, silicone-based products were more effective in reducing scar thickness, highlighting PRP's potential to enhance specific aspects of scar healing while recognizing different treatments may excel in targeting diverse scar characteristics.

Recent studies, unlike ours, have demonstrated promising outcomes with PRP in scar treatment. **Darwish et al. (2019) and Mohamed et al. (2019)** highlighted PRP's effectiveness in combination therapies and across various treatment modalities, respectively, showing substantial clinical benefits and emphasizing its diverse applications in scar management.

Furthermore, **Garg et al. (2018)** observed significant improvements in scar characteristics and patient-reported outcomes with a PRP cocktail for post-burn scars, indicating PRP's potential to rejuvenate damaged skin layers and promote tissue regeneration. These studies collectively underscore PRP's evolving role in scar treatment, offering multifaceted approaches that enhance patient care and satisfaction despite our study's findings of no significant improvement.

In contrast, **Fabbrocini et al., (2011)** conducted a split face study done on 12 patients with scars, all patients were treated with combined PRP and dermaroller on one side and on the other side treated with dermaroller alone. The results were better on the side treated with combined dermaroller and PRP than the side treated with dermaroller alone.

Conclusion

In conclusion, the combination of microneedling and platelet-rich plasma (PRP) therapy did not result in statistically significant improvements in Vancouver Scar Scale (VSS) scores postoperatively also no signficant difference of the histopathological finding , Despite the theoretical advantages and positive outcomes documented in other studies, our findings underscore the necessity for further research. Future studies should incorporate larger sample sizes, extended follow-up periods, and more comprehensive assessment methodologies to

thoroughly evaluate the efficacy and potential benefits of this combined therapeutic approach in the management of burn scars.

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