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Original Article

Efficacy of Microneedling Combined with Platelet-Rich Plasma for Atrophic Acne Scars

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ABSTRACT

Background: Atrophic acne scars may produce persistent cosmetic and psychosocial morbidity. Microneedling stimulates dermal remodeling, while platelet-rich plasma may augment the regenerative response through platelet-associated mediators. Objective: To compare the short-term efficacy and safety of microneedling alone with microneedling combined with autologous platelet-rich plasma in adults with moderate-to-severe atrophic facial acne scars. Methods: In this parallel-group randomized controlled trial, 80 participants were allocated equally to microneedling alone or microneedling plus platelet-rich plasma. Three treatment sessions were administered at baseline, week 4, and week 8, with final assessment at week 12. The primary outcome was change in Goodman and Baron scar grade. Secondary outcomes included scar-depth score, patient satisfaction, and adverse effects. Results: Mean scar-grade reduction was 0.90 ± 0.44 with microneedling alone and 1.60 ± 0.51 with combination treatment, yielding a between-group difference of 0.70 grade units (95% CI, 0.49–0.91; $p < 0.001$). At week 12, the scar-depth score was 5.10 ± 1.12 and 3.60 ± 1.25, respectively (difference, −1.50; 95% CI, −2.03 to −0.97; $p < 0.001$). Good or excellent satisfaction was reported by 55.0% and 80.0% of participants, respectively. Adverse effects were predominantly mild and temporary. Conclusion: Microneedling combined with platelet-rich plasma produced greater short-term improvement than microneedling alone, although confirmation using standardized protocols and longer follow-up is required. Keywords: Atrophic Acne Scars; Microneedling; Platelet-Rich Plasma; Scar Grade; Patient Satisfaction; Randomized Controlled Trial.

INTRODUCTION

Acne vulgaris is a common inflammatory disorder of the pilosebaceous unit that predominantly affects adolescents and young adults. Although active lesions may resolve, permanent scarring can persist and contribute substantially to the long-term burden of the disease (1–3). Atrophic scars are the most frequent post-acne scar subtype and develop because of collagen destruction and inadequate dermal remodeling during the healing of inflammatory lesions. They are commonly classified morphologically as ice-pick, boxcar, or rolling scars, with each subtype differing in depth, architecture, and response to treatment (4,5). The Goodman and Baron qualitative and quantitative grading systems provide structured approaches for documenting the clinical severity of post-acne scarring and evaluating treatment response (6,7).

Atrophic acne scars may adversely affect psychological well-being, body image, social functioning, and health-related quality of life. Their development is particularly associated with severe, persistent, or

inadequately treated inflammatory acne (8). Individuals with visible facial scarring may experience reduced self-confidence, social avoidance, depressive symptoms, and dissatisfaction with their appearance (9,10). Consequently, management of acne scarring should address not only visible structural changes in the skin but also outcomes that are meaningful to patients, including satisfaction with treatment and perceived improvement in appearance.

Available treatments for atrophic acne scars include chemical reconstruction, subcision, punch techniques, dermabrasion, fractional laser therapy, injectable fillers, microneedling, platelet-rich plasma, and combinations of these interventions (11,12). Treatment selection depends on scar morphology and severity, skin phototype, procedural availability, expected downtime, cost, and the risk of adverse effects such as post-inflammatory hyperpigmentation. No single intervention is uniformly effective for all scar types, and multimodal approaches are frequently required to obtain clinically appreciable improvement.

Microneedling, also termed percutaneous collagen induction therapy, produces controlled microscopic injury to the epidermis and dermis while largely preserving the surrounding tissue. The resulting wound-healing response promotes fibroblast activity, collagen deposition, elastin remodeling, and gradual improvement in scar depth and skin texture (13–15). Microneedling has been used for atrophic facial scars and may offer a favorable safety profile in individuals with darker skin phototypes when performed using an appropriate technique and followed by adequate photoprotection (16,17). However, improvement may be incomplete, particularly in patients with deeper or more severe atrophic scars.

Platelet-rich plasma is an autologous blood-derived preparation containing concentrated platelets and platelet-associated mediators involved in tissue repair, angiogenesis, extracellular-matrix remodeling, and collagen synthesis (18,19). Application of platelet-rich plasma after microneedling has been proposed to augment the regenerative response initiated by controlled dermal injury. The microchannels produced during microneedling may facilitate the delivery of platelet-derived mediators into the treated dermis, while intradermal administration may provide additional exposure in selected scarred areas. This complementary biological rationale has supported investigation of microneedling combined with platelet-rich plasma as a treatment for atrophic acne scars.

Comparative studies have generally reported greater improvement when platelet-rich plasma is added to microneedling than when microneedling is performed alone (20–25). Systematic reviews and meta-analyses have similarly suggested that the combined intervention may improve clinical scar scores and patient satisfaction without a substantial increase in serious adverse events (26–29). Nevertheless, interpretation of the available evidence is limited by variability in study design, microneedling devices, treatment intervals, platelet-rich plasma preparation techniques, routes of administration, scar-assessment instruments, and duration of follow-up. Standardized, assessor-masked comparative trials remain necessary to establish the magnitude and clinical relevance of the additional benefit associated with platelet-rich plasma.

Evidence from Pakistan has also indicated potentially favorable outcomes with microneedling combined with platelet-rich plasma, although treatment protocols and comparator interventions have differed across studies (30–36). Further locally generated evidence may therefore help determine whether the combination provides clinically meaningful short-term improvement in patients receiving treatment in routine dermatology settings.

The present randomized controlled trial compared microneedling alone with microneedling combined with autologous platelet-rich plasma in adults with moderate-to-severe atrophic facial acne scars. The primary objective was to compare the change in Goodman and Baron acne-scar severity from baseline to 12 weeks between the two treatment groups. Secondary objectives were to compare changes in scar depth, clinical skin texture, patient satisfaction, and treatment-related adverse effects. It was hypothesized that microneedling combined with platelet-rich plasma would produce greater improvement in acne-scar severity at 12 weeks than microneedling alone.

MATERIALS AND METHODS

This parallel-group randomized controlled trial was conducted in the Dermatology Department of a tertiary care hospital in Multan, Pakistan. Each participant underwent a 12-week treatment and follow-up period. The study compared three sessions of microneedling alone with three sessions of microneedling followed by autologous platelet-rich plasma administration in patients with moderate-to-severe atrophic facial acne scars.

Male and female patients aged 18–40 years who attended the outpatient dermatology clinic and had clinically diagnosed moderate-to-severe atrophic facial acne scars were assessed for eligibility. Scar severity was evaluated using the Goodman and Baron acne-scar grading system. Patients were excluded if they had active severe inflammatory acne, an active infection involving the proposed treatment area, a history of keloid formation, a bleeding or platelet disorder, uncontrolled diabetes mellitus, pregnancy or lactation, current anticoagulant use, isotretinoin exposure during the preceding six months, or laser treatment, chemical peeling, dermabrasion, or microneedling during the preceding three months. Eligible patients were enrolled after receiving information about the study procedures, expected benefits, procedural discomfort, anticipated recovery, possible adverse effects, and the need for repeated treatment sessions.

A total of 80 participants were enrolled and allocated in a 1:1 ratio to two treatment groups. Group A comprised 40 participants assigned to microneedling alone, and Group B comprised 40 participants assigned to microneedling combined with platelet-rich plasma. Allocation was performed using a lottery procedure in which identical folded slips indicating the treatment groups were placed in a closed container and selected after enrollment. Treatment allocation could not be concealed from the clinician performing the procedures because of the visible differences between the interventions. The final clinical assessment was undertaken by a dermatologist who was not involved in delivering the treatment sessions and was not informed of group allocation.

Before the first treatment session, demographic and clinical data were recorded, including age, sex, duration of acne scarring, predominant scar morphology, previous treatment history, and baseline scar severity. Atrophic scars were categorized clinically as rolling, boxcar, or ice-pick scars according to their predominant morphology. Standardized facial photographs were obtained at baseline using frontal and bilateral oblique or lateral views. The same room, lighting conditions, camera distance, participant positioning, and camera settings were maintained for subsequent photographic assessments as far as practicable.

Before each procedure, the face was cleansed and topical anesthetic cream was applied to the treatment area for approximately 45 minutes. The anesthetic was then removed, and the skin was prepared using an antiseptic solution. Microneedling was performed under aseptic conditions using a sterile dermaroller or automated microneedling device. Needle penetration was selected according to the anatomical region, scar depth, and skin thickness and ranged from 1.5 to 2.5 mm. The device was passed over the treatment area in vertical, horizontal, and diagonal directions until uniform pinpoint bleeding was achieved. Excessive pressure was avoided, particularly in areas of relatively thin skin.

Participants assigned to Group A received microneedling without platelet-rich plasma. Participants assigned to Group B underwent autologous platelet-rich plasma preparation immediately before microneedling. Approximately 15–20 mL of peripheral venous blood was collected under aseptic conditions into anticoagulant-containing tubes and centrifuged to separate red blood cells, platelet-poor plasma, and the platelet-rich plasma fraction. The platelet-rich plasma layer was collected in a sterile syringe. After completion of microneedling, the preparation was applied evenly over the treated surface. Small intradermal injections were additionally administered to selected deeper scars. Participants in Group A did not receive topical or intradermal platelet-rich plasma.

Both groups received three treatment sessions: at baseline, week 4, and week 8. The final outcome assessment was conducted at week 12. Following each session, participants were instructed not to wash the treated area for 6–8 hours and to avoid direct sun exposure, facial scrubbing, makeup, harsh topical products, and unnecessary manipulation of the treated skin for 24–48 hours. Broad-spectrum sunscreen was recommended throughout the follow-up period, and a mild moisturizer was permitted for dryness or tightness. Participants were instructed not to undergo any additional acne-scar procedure during the study.

The primary outcome was the change in acne-scar severity between baseline and week 12, assessed using the Goodman and Baron grading system. The assessment incorporated direct clinical examination and comparison of standardized facial photographs. Secondary outcomes included change in scar-depth score, clinical skin-texture assessment, patient-reported satisfaction, procedural discomfort, and treatment-related adverse effects. Patient satisfaction at week 12 was categorized as poor, fair, good, or excellent. Adverse effects assessed after each treatment session included erythema, swelling, bruising, post-inflammatory hyperpigmentation, acne flare, infection, keloid formation, and other unexpected reactions. Participants were questioned about adverse effects at each visit, and observable reactions were documented during clinical examination.

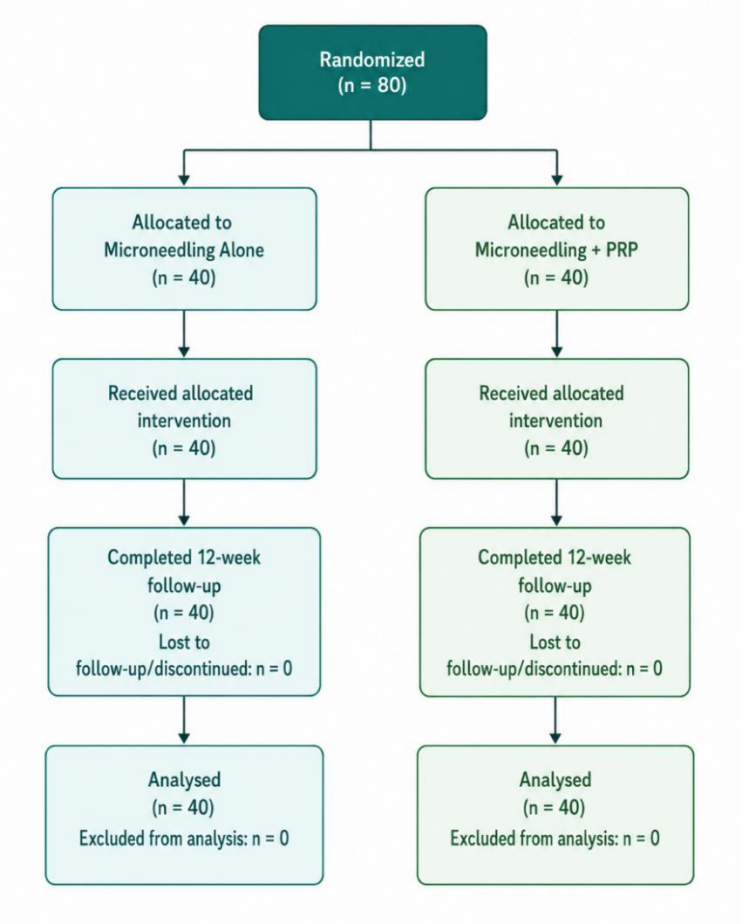

Figure 1 CONSORT Flowchart

Data were analyzed using SPSS. Continuous variables, including age, duration of acne scars, scar-grade scores, and scar-depth scores, were summarized using mean and standard deviation. Categorical variables, including sex, predominant scar type, satisfaction category, and adverse effects, were summarized using frequencies and percentages. Baseline characteristics were examined descriptively to assess comparability between the randomized groups. Between-group comparisons of continuous outcomes were performed using independent-samples tests when distributional assumptions were considered appropriate, whereas categorical outcomes were compared using chi-square tests or an

appropriate exact test. Changes in clinical outcome scores were evaluated from baseline to week 12, and a two-sided p-value below 0.05 was considered statistically significant. Participants were analyzed according to their assigned treatment groups.

Written informed consent was obtained from all participants before enrollment. The study was reviewed and approved by the institutional ethical review committee. Participant confidentiality was maintained through de-identification of study records, restricted access to research data, and exclusion of personally identifying information from the analysis and final report. Participation was voluntary, and patients were permitted to withdraw at any stage without affecting their routine medical care.

RESULTS

A total of 80 participants with moderate-to-severe atrophic facial acne scars were randomized in a 1:1 ratio. Forty participants were allocated to microneedling alone and 40 to microneedling combined with platelet-rich plasma. All randomized participants reportedly received the allocated intervention, completed the 12-week follow-up, and were included in the final analysis. No losses to follow-up or treatment discontinuations were reported.

Table 1. Baseline Demographic and Clinical Characteristics of the Participants

Characteristic	Microneedling Alone (n = 40)	Microneedling + PRP (n = 40)
Age, years, mean ± SD	25.85 ± 5.12	26.30 ± 5.44
Male, n (%)	18 (45.0)	17 (42.5)
Female, n (%)	22 (55.0)	23 (57.5)
Duration of acne scars, years, mean ± SD	3.45 ± 1.28	3.60 ± 1.36
Rolling scars, n (%)	18 (45.0)	19 (47.5)
Boxcar scars, n (%)	14 (35.0)	13 (32.5)
Ice-pick scars, n (%)	8 (20.0)	8 (20.0)
Goodman and Baron scar grade, mean ± SD	3.35 ± 0.48	3.38 ± 0.49
Scar-depth score, mean ± SD	7.20 ± 1.05	7.30 ± 1.10

Abbreviations: PRP, platelet-rich plasma; SD, standard deviation.

The two treatment groups had similar baseline demographic and clinical profiles. The mean age was 25.85 ± 5.12 years in the microneedling-alone group and 26.30 ± 5.44 years in the microneedling-plus-PRP group. Women represented 55.0% and 57.5% of the respective groups. Rolling scars were the most frequently recorded predominant morphology, accounting for 45.0% of participants receiving microneedling alone and 47.5% receiving combination treatment. Baseline Goodman and Baron scar grades and scar-depth scores were also comparable between groups.

Table 2. Change in Goodman and Baron Acne-Scar Grade From Baseline to Week 12

Outcome	Microneedling Alone (n = 40), Mean ± SD	Microneedling + PRP (n = 40), Mean ± SD	Between-Group Difference, Mean	95% CI	Cohen's d	p-value
Baseline scar grade	3.35 ± 0.48	3.38 ± 0.49	0.03	−0.19 to 0.25	0.06	0.782
Scar grade at week 12	2.45 ± 0.55	1.78 ± 0.62	−0.67	−0.93 to −0.41	−1.14	<0.001
Reduction from baseline	0.90 ± 0.44	1.60 ± 0.51	0.70	0.49 to 0.91	1.47	<0.001

Between-group differences were calculated as microneedling plus PRP minus microneedling alone. For the reduction score, positive values favor microneedling plus PRP. Confidence intervals and Cohen's d values were derived from the reported means, standard deviations, and group sample sizes. PRP, platelet-rich plasma; CI, confidence interval; SD, standard deviation.

At week 12, the mean Goodman and Baron scar grade was 1.78 ± 0.62 in the microneedling-plus-PRP group compared with 2.45 ± 0.55 in the microneedling-alone group. The unadjusted between-group difference was −0.67 grade units (95% CI, −0.93 to −0.41; $p < 0.001$), corresponding to a large standardized difference of Cohen's d = −1.14. The mean reduction from baseline was 1.60 ± 0.51 grades

with combination therapy and 0.90 ± 0.44 grades with microneedling alone. The difference in improvement was 0.70 grade units (95% CI, 0.49–0.91; $p < 0.001$), with a large standardized effect of Cohen's d = 1.47.

Table 3. Scar-Depth Scores at Baseline and Week 12

Outcome	Microneedling Alone (n = 40), Mean ± SD	Microneedling + PRP (n = 40), Mean ± SD	Between-Group Difference, Mean	95% CI	Cohen's d	p-value
Baseline scar-depth score	7.20 ± 1.05	7.30 ± 1.10	0.10	−0.38 to 0.58	0.09	0.678
Scar-depth score at week 12	5.10 ± 1.12	3.60 ± 1.25	−1.50	−2.03 to −0.97	−1.26	<0.001
Reduction from baseline	2.10	3.70	1.60	—	—	—

Between-group differences were calculated as microneedling plus PRP minus microneedling alone. Confidence intervals and Cohen's d values for baseline and week-12 comparisons were derived from the reported means, standard deviations, and group sample sizes. Confidence intervals and effect sizes for the change scores could not be calculated because standard deviations of the scar-depth change scores were not reported. PRP, platelet-rich plasma; CI, confidence interval; SD, standard deviation.

The mean scar-depth score decreased from 7.20 ± 1.05 to 5.10 ± 1.12 in the microneedling-alone group and from 7.30 ± 1.10 to 3.60 ± 1.25 in the microneedling-plus-PRP group. At week 12, the combination group had a mean score 1.50 points lower than the microneedling-alone group (95% CI, −2.03 to −0.97; $p < 0.001$). The corresponding standardized difference was large (Cohen's d = −1.26). The observed reductions from baseline were 2.10 points with microneedling alone and 3.70 points with combination treatment; however, the precision of the difference in change could not be estimated because variability measures for these change scores were unavailable.

Clinical assessments and standardized photographs were reported to show smoother skin texture and reduced visibility of scar depressions in both groups, with greater apparent improvement following microneedling plus PRP. These observations could not be quantified further because no numerical texture-assessment score or blinded photographic rating was provided.

Table 4. Patient-Reported Satisfaction at Week 12

Satisfaction Category	Microneedling Alone (n = 40), n (%)	Microneedling + PRP (n = 40), n (%)
Poor	6 (15.0)	2 (5.0)
Fair	12 (30.0)	6 (15.0)
Good	16 (40.0)	18 (45.0)
Excellent	6 (15.0)	14 (35.0)
Good or excellent	22 (55.0)	32 (80.0)

PRP, platelet-rich plasma.

Table 5. Comparative Estimate for Good-to-Excellent Satisfaction at Week 12

Outcome	Microneedling Alone	Microneedling + PRP	Risk Difference	95% CI	Risk Ratio	95% CI	Odds Ratio	95% CI	p-value
Good or excellent satisfaction, n/N	22/40	32/40	0.25	0.05 to 0.45	1.45	1.06 to 2.00	3.27	1.21 to 8.84	0.017

Effect estimates compare microneedling plus PRP with microneedling alone. PRP, platelet-rich plasma; CI, confidence interval.

At week 12, 32 of 40 participants receiving microneedling plus PRP reported good or excellent satisfaction, compared with 22 of 40 participants receiving microneedling alone. The absolute difference was 25 percentage points (95% CI, 5–45 percentage points). Participants receiving combination therapy were 1.45 times as likely to report good or excellent satisfaction (95% CI, 1.06–2.00), with corresponding odds of 3.27 (95% CI, 1.21–8.84; $p = 0.017$). Excellent satisfaction was reported by 35.0% of participants in the combination group and 15.0% in the microneedling-alone group.

Table 6. Adverse Effects Reported During the 12-Week Study Period

Adverse Effect	Microneedling Alone (n = 40), n (%)	Microneedling + PRP (n = 40), n (%)	Risk Difference	95% CI	p-value
Mild erythema	30 (75.0)	33 (82.5)	0.08	−0.10 to 0.25	0.412
Temporary swelling	9 (22.5)	13 (32.5)	0.10	−0.09 to 0.29	0.317
Post-inflammatory hyperpigmentation	3 (7.5)	2 (5.0)	−0.03	−0.13 to 0.08	0.644
Severe infection	0 (0.0)	0 (0.0)	0.00	—	—
Permanent pigmentation	0 (0.0)	0 (0.0)	0.00	—	—
Keloid formation	0 (0.0)	0 (0.0)	0.00	—	—
Major adverse reaction	0 (0.0)	0 (0.0)	0.00	—	—

Risk differences were calculated as microneedling plus PRP minus microneedling alone. PRP, platelet-rich plasma; CI, confidence interval.

Mild erythema was the most frequently reported adverse effect, occurring in 75.0% of participants receiving microneedling alone and 82.5% receiving microneedling plus PRP. Temporary swelling occurred in 22.5% and 32.5% of participants, respectively. The risk differences for erythema and swelling were imprecise and included no difference. Post-inflammatory hyperpigmentation was reported in three participants in the microneedling-alone group and two in the combination group. No severe infection, permanent pigmentation, keloid formation, or major adverse reaction was reported.

Although procedural discomfort was identified as an outcome in the Methods, numerical pain or discomfort data were not available and therefore could not be included in the Results. Similarly, bruising, acne flare, and other prespecified adverse events should be reported explicitly if these data were collected, including zero-event counts where applicable.

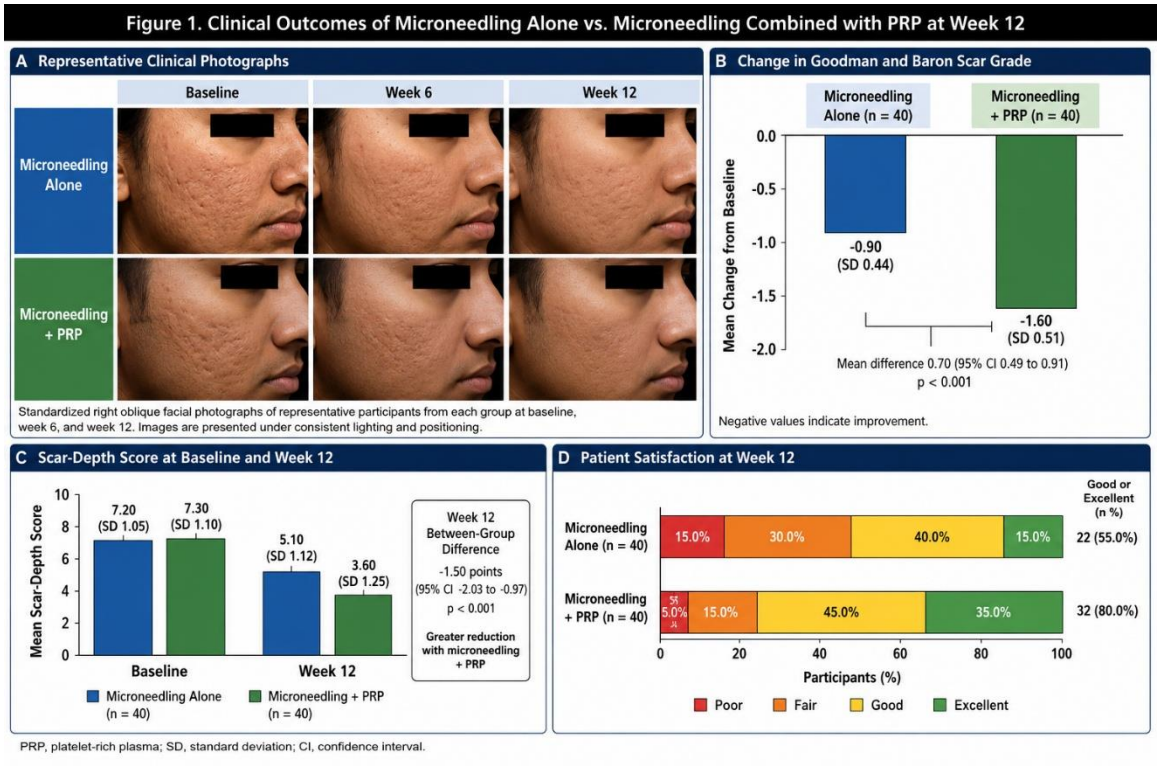

Figure 1 presents the comparative clinical outcomes of microneedling alone and microneedling combined with platelet-rich plasma at 12 weeks. Panel A shows representative standardized facial photographs at baseline, week 6, and week 12, illustrating visible improvement in atrophic acne scars in both groups, with greater apparent reduction in scar depth and surface irregularity in the combination group. Panel B demonstrates the change in Goodman and Baron scar grade, which decreased by 0.90 ± 0.44 in the microneedling-alone group and by 1.60 ± 0.51 in the microneedling-plus-PRP group. The between-group difference in improvement was 0.70 grade units (95% CI, 0.49–0.91; p < 0.001). Panel C shows that mean scar-depth scores declined from 7.20 ± 1.05 to 5.10 ± 1.12 with microneedling alone and from 7.30 ± 1.10 to 3.60 ± 1.25 with combination treatment. At week 12, the mean

between-group difference was −1.50 points (95% CI, −2.03 to −0.97; p < 0.001). Panel D displays patient satisfaction, with good or excellent satisfaction reported by 55.0% of participants receiving microneedling alone and 80.0% receiving microneedling plus PRP. Overall, the figure indicates greater short-term clinical improvement and higher patient satisfaction with the combined intervention.

DISCUSSION

This randomized controlled trial found that both microneedling alone and microneedling combined with platelet-rich plasma improved moderate-to-severe atrophic acne scars over 12 weeks. However, the combination intervention produced greater improvement in the Goodman and Baron scar grade, scar-depth score, and patient-reported satisfaction. At week 12, the mean scar grade was 1.78 ± 0.62 in the combination group and 2.45 ± 0.55 in the microneedling-alone group, corresponding to an unadjusted between-group difference of −0.67 grade units and a large standardized effect. The mean reduction from baseline was also greater with microneedling plus platelet-rich plasma, with a between-group difference in improvement of 0.70 grade units. These findings suggest that platelet-rich plasma may provide additional short-term benefit when administered with microneedling, although the magnitude of benefit should be interpreted in the context of the study's methodological and reporting limitations.

The observed superiority of the combination intervention is consistent with previous comparative studies. Gupta et al. reported greater clinical improvement with microneedling combined with platelet-rich plasma than with microneedling alone, while Nandini et al. similarly demonstrated a more favorable response on the platelet-rich plasma-treated side in a split-face comparison (20,21). Comparable findings were reported by Ibrahim et al. and Asif et al., who observed enhanced improvement in atrophic post-acne scars when platelet-rich plasma was added to microneedling (22,23). A randomized study by Ibrahim et al. also supported the therapeutic value of combining autologous platelet-rich plasma with microneedling for atrophic scars (24). Although these studies differed in treatment technique, scar-assessment method, and follow-up duration, their overall direction is consistent with the present results.

The greater reduction in scar-depth score observed with combination therapy may reflect complementary effects of controlled dermal injury and platelet-derived mediators. Microneedling initiates a wound-healing response involving fibroblast activation, extracellular-matrix remodeling, and collagen deposition, whereas platelet-rich plasma contains mediators associated with tissue repair and angiogenesis (13–15,18,19). The channels created during microneedling may facilitate the delivery of platelet-rich plasma into the superficial dermis, and intradermal administration may increase local exposure in deeper scars. Nevertheless, these mechanisms were not directly evaluated in the present trial because platelet concentration, growth-factor levels, collagen deposition, dermal thickness, and histological changes were not measured. The biological explanation should therefore be regarded as plausible rather than demonstrated.

The week-12 scar-depth score was 1.50 points lower in the combination group than in the microneedling-alone group, with a large standardized between-group difference. Similar improvement in scar morphology and texture has been reported in earlier studies evaluating combined dermaroller and platelet-rich plasma treatment (25). Chawla also found platelet-rich plasma to be a useful adjunct to microneedling when compared with topical vitamin C in patients with atrophic acne scars (37). However, interpretation of the scar-depth findings in the present study is restricted by the absence of a clearly described scale range, measurement procedure, validity evidence, and variability estimates for the change scores. These limitations prevent determination of whether the observed numerical difference exceeded a clinically established threshold.

Higher-level evidence generally supports an additional benefit from platelet-rich plasma. A meta-analysis by Kang and Lu concluded that microneedling combined with platelet-rich plasma produced better acne-scar outcomes than microneedling alone (26). Systematic reviews by Cruciani et al., Long et al., and Hesseler and Shyam similarly identified potentially favorable effects of platelet-rich plasma in atrophic acne-scar treatment (27–29). These reviews also highlighted substantial heterogeneity in

platelet-rich plasma preparation, platelet concentration, centrifugation protocols, activation methods, administration routes, microneedling techniques, outcome instruments, and follow-up periods. The present study adds to this evidence but does not resolve these standardization concerns because the platelet-rich plasma preparation and delivery procedures were not reported in sufficient detail for full replication.

The present findings are also broadly consistent with evidence generated in Pakistan. Khan et al. reported greater improvement with microneedling plus platelet-rich plasma than with microneedling alone (30). Other local studies have evaluated platelet-rich plasma following microneedling against topical insulin, glycolic acid, topical vitamin C, and fractional carbon dioxide laser-based combinations (31–36). Although these studies support the clinical use of platelet-rich plasma as an adjunctive intervention, differences in comparator treatments and outcome definitions limit direct comparison. The current results should therefore be interpreted as evidence from a specific single-center clinical population rather than as confirmation of effectiveness across all Pakistani settings.

Patient-reported satisfaction was higher in the combination group. Good or excellent satisfaction was reported by 80.0% of participants receiving microneedling plus platelet-rich plasma and 55.0% receiving microneedling alone. The absolute difference was 25 percentage points, and participants receiving the combination were approximately 1.45 times as likely to report good or excellent satisfaction. This finding is clinically relevant because the burden of acne scarring includes dissatisfaction with appearance, impaired body image, social avoidance, and reduced quality of life (9,10). Nevertheless, the satisfaction measure used in this trial was a nonvalidated four-category scale, and the dichotomization of responses into good-or-excellent versus poor-or-fair was not reported as prespecified. Future studies should incorporate validated patient-reported outcome instruments and analyze the complete ordinal response distribution.

The safety profile was generally similar between the treatment groups. Mild erythema was the most frequent adverse effect, followed by temporary swelling. Post-inflammatory hyperpigmentation occurred in three participants receiving microneedling alone and two receiving the combination intervention. No severe infection, permanent pigmentation, keloid formation, or major adverse reaction was reported. These findings are consistent with previous evidence indicating that microneedling has an acceptable safety profile when performed using appropriate aseptic technique and post-procedure care (16,17). Temporary swelling was numerically more frequent in the platelet-rich plasma group, potentially reflecting the additional topical or intradermal administration, but the confidence interval for the risk difference included no difference. Adverse-event interpretation remains limited because severity grades, duration, causality, and event occurrence by treatment session were not documented.

Several limitations should be considered. First, the study included a relatively small sample from a single clinical center and followed participants for only 12 weeks. The findings therefore describe short-term response and cannot establish the persistence of improvement or the frequency of delayed adverse effects. Second, although random allocation was reported, the lottery procedure was not described in sufficient detail to confirm robust allocation concealment. Third, the intervention was not fully standardized because either a dermaroller or an automated microneedling device could be used, needle depth varied between 1.5 and 2.5 mm, and the criteria for device selection and depth adjustment were not specified.

Fourth, platelet-rich plasma preparation was insufficiently characterized. Centrifugation force and duration, final platelet concentration, leukocyte content, activation method, and administered volume were not reported. In addition, platelet-rich plasma was applied topically and injected into selected deeper scars, potentially producing variation in treatment exposure within the combination group. Fifth, the exact version of the Goodman and Baron system was not identified, while the scar-depth and clinical texture assessments were not operationally defined or supported by validity and reliability information. Sixth, the statistical analysis did not account fully for baseline outcome values, repeated observations, or

the ordinal nature of some measures. Baseline-adjusted models, mixed-effects analyses, and ordinal regression would provide more robust estimates.

Additional limitations include the absence of a reported sample-size calculation, prospective trial-registration information, a prespecified missing-data strategy, and detailed protocol-adherence data. Although all participants were reported to have completed follow-up, screening numbers, exclusions, attendance at individual treatment sessions, and protocol deviations were not presented in a CONSORT flow diagram. The absence of Fitzpatrick skin phototype data also limits conclusions regarding applicability to specific skin-color groups. Finally, the study did not assess cost, quality of life using a validated instrument, histological remodeling, or scar-type-specific treatment effects.

Future trials should use computer-generated randomization with concealed allocation, a standardized microneedling device and protocol, and a reproducible platelet-rich plasma preparation classified by platelet and leukocyte content. Outcomes should be evaluated by blinded assessors using validated scar scales, standardized photographic ratings, objective imaging or profilometric measures, and validated patient-reported instruments. Analyses should estimate baseline-adjusted between-group effects with 95% confidence intervals and evaluate treatment-by-time interactions over longer follow-up periods. Adequately powered subgroup analyses may also clarify whether rolling, boxcar, and ice-pick scars respond differently to the combined intervention.

CONCLUSION

Microneedling combined with autologous platelet-rich plasma produced greater short-term improvement in Goodman and Baron acne-scar grade, scar-depth score, and patient satisfaction than microneedling alone in adults with moderate-to-severe atrophic facial acne scars. Both interventions were generally well tolerated, and no major adverse reactions were reported during the 12-week follow-up. However, the findings should be interpreted cautiously because of the single-center design, limited follow-up, insufficient standardization of platelet-rich plasma preparation and microneedling delivery, incompletely defined outcome measures, and absence of baseline-adjusted longitudinal analysis. Larger, prospectively registered trials using standardized intervention protocols, validated outcomes, blinded assessment, and longer follow-up are required before definitive treatment recommendations can be made.

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