Clinical Outcomes of Platelet-Rich-Plasma (PRP) Injection for Acne Scar Treatment Assessed by Antera 3D Imaging and Patient Satisfaction

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Abstract

Aberrant inflammation and dysregulated wound healing following acne vulgaris may lead to extracellular matrix remodeling and collagen degradation, resulting in the formation of atrophic acne scars. Platelet-rich plasma (PRP) promotes dermal repair through growth factors that stimulate fibroblast proliferation and collagen production; however, clinical responses remain variable. The heterogeneous depth of atrophic acne scars, as well as the injection technique and depth of delivery may, influence therapeutic outcomes. This pilot study investigated a depth-controlled platelet-rich plasma injection approach to optimize dermal targeting. Ten participants aged 18–45 years with atrophic acne scars underwent three PRP treatment sessions at 3-week intervals. Clinical assessments were performed at each visit and again 12 weeks after the final treatment. The primary outcome was evaluated using Antera 3D imaging, while secondary outcomes were assessed using a patient satisfaction score. Result from the Antera 3D analysis showed an observable reduction in acne scar size at week 6; however, this improvement was not sustained at the final follow-up visit and did not reach statistical significance, although an overall improvement from baseline was observed. Because most scores fell within a similar range, participants also reported satisfaction with the overall procedure. In this pilot study, the injection technique did not demonstrate a statistically significant effect; however, observable trends suggested a possible influence on treatment outcomes. Further investigation with a larger sample size is warranted to confirm these findings.

Keywords**:** *acne scar, atrophic scar, platelet-rich plasma, dermal stimulation, neocollagenesis*

1. Introduction

Acne scars occur through prolonged inflammation within the pilosebaceous unit, leading to dermal collagen destruction and impaired wound repair. When inflammatory activity persists, collagen degradation exceeds structural restoration, resulting predominantly in atrophic acne scar formation. Clinically, atrophic acne scars are classified according to depth and morphology into icepick, boxcar, and rolling subtypes. Icepick scars are narrow and deep, reflecting vertical loss of collagen extending into the deep dermis; boxcar scars are wider with sharply defined edges and involve the superficial to mid-dermis; and rolling scars are characterized by broad depressions caused by fibrous tethering between the dermis and subcutaneous tissue. These depth-dependent features highlight a complex disruption of normal wound healing, characterized by altered fibroblast activity, abnormal extracellular matrix remodeling, and incomplete dermal regeneration (Bolognia et al., 2024; Connolly et al., 2017; Fabbrocini et al., 2010; Jennings et al., 2024; Kang et al., 2019; Long et al., 2020).

Within this disrupted healing environment, Uchiyama et al. (2021) demonstrated that effective cutaneous repair depends on tightly regulated growth-factor signaling and coordinated immune responses. Macrophages play a critical role in this process, with classically activated M1 macrophages promoting inflammation and tissue degradation, and alternatively activated M2 macrophages supporting the resolution of inflammation, matrix remodeling, and tissue repair. Persistent inflammatory acne lesions are associated with an imbalance favoring prolonged M1 macrophage activity, contributing to defective wound healing and permanent scarring. Platelet-rich plasma (PRP) delivers a concentrated source of growth factors, including platelet-derived growth factor, transforming growth factor-β, epidermal growth factor, and insulin-like growth factor-1, and has been shown to suppress M1 polarization while promoting a shift toward the M2

phenotype. Through modulation of macrophage polarization and growth-factor–mediated signaling, PRP may help restore a pro-regenerative wound environment and support dermal remodeling in atrophic acne scars (Chilicka et al., 2022; Feng et al., 2024).

When used in conjunction with procedural treatments rather than as a stand-alone treatment, platelet-rich plasma appears to provide therapeutic benefit for the management of acne scars (Hesseler & Shyam, 2019). While PRP monotherapy may result in only modest improvement in atrophic acne scars, combination approaches often demonstrate superior clinical outcomes and higher patient satisfaction (Nanda et al., 2021) These findings suggest that the therapeutic efficacy of PRP is influenced not only by its biological properties but also by the manner in which it is delivered to the underlying pathologic tissue. Accordingly, optimizing PRP delivery to match scar depth and tissue characteristics may play a critical role in enhancing treatment outcomes. Subcision represents a well-established technique for releasing fibrotic strands and facilitating targeted delivery of regenerative agents to deeper dermal layers. Current literature indicates that needle-based and cannula-based subcision offer comparable clinical efficacy (Ahramiyanpour et al., 2023; Bhargava et al., 2019). In addition, the adjunctive use of PRP following subcision may help prevent scar recurrence by inhibiting dermal re-tethering and promoting neocollagenesis. Based on these considerations, the present study employed a needle-based subcision approach to allow precise depth control, combined with PRP administration to optimize regenerative outcomes in atrophic acne scars.

2. Objectives

To evaluate the relation between clinical outcomes and different injection techniques of platelet-rich plasma in the treatment of atrophic acne scars.

3. Materials and Methods

3.1 Study Design

This pilot, single-arm, prospective study evaluated the association between injection technique and clinical outcomes in platelet-based acne scar treatment. A total of 10 participants aged 18–45 years with atrophic acne scars on one side of cheek and Fitzpatrick skin types II–IV were enrolled. Participants with hematologic disorders, autoimmune diseases, pregnancy or lactation, active skin infection at the treatment site, or a history of acne scar treatment within the preceding 6 months were excluded from the study. Participants were withdrawn from the study in the event of severe allergic or hypersensitivity reactions, significant or persistent injection-site reactions, confirmed infection, clinically relevant bleeding or hematoma, prolonged systemic symptoms, or any other serious adverse event deemed by the investigator to compromise participant safety. Discontinuation also occurred in cases of poor compliance with study procedures or withdrawal of consent by the participant. The study was conducted in accordance with the principles of the Declaration of Helsinki, and written informed consent was obtained from all participants prior to initiation of treatment. The study was conducted between July and November 2025.

3.2 Research Device

1) 3.2% Sodium Citrate Tubes

In this study, blood was collected into 3.2% sodium citrate tubes for platelet-rich plasma (PRP) preparation. Sodium citrate acts as an anticoagulant by inhibiting the coagulation cascade and maintaining blood in a non-clotted state during PRP processing. Blood was collected at a 9:1 blood-to-citrate ratio, which effectively prevents coagulation without inducing platelet activation or aggregation.

2) Ugaiya L500 (Medical Centrifuge L500 PRP)

The Ugaiya centrifuge was used for the preparation of platelet-rich plasma (PRP) using a standardized double-spin protocol. Whole blood was first centrifuged at 1,400 rpm (approximately 400 g) for 10 minutes to separate red blood cells from plasma. The plasma layer above the buffy coat was then transferred into a sterile conical tube and subjected to a second centrifugation (hard spin) at 2,400 rpm (approximately 900 g). This step allowed platelets to sediment at the bottom of the tube, after which leukocyte-poor platelet-rich plasma (LP-PRP) was collected for clinical use.

3) Conical Polypropylene Tubes

Sterile 15-mL conical polypropylene tubes were used as intermediate containers during PRP preparation, particularly for the second centrifugation step, to facilitate accurate separation of platelet pellets and preparation of leukocyte-poor PRP. All tubes were single-use and sterile and were discarded after use according to biohazard waste regulations.

4) Scalp Vein Set (21-gauge Butterfly Needle)

A 21-gauge butterfly needle was used for venous blood collection to allow steady blood flow while minimizing hemolysis and platelet damage. All needles were sterile, single-use devices and were disposed of in approved sharps containers after use.

5) Needle No. 18 (1.5-inch)

An 18-gauge needle was used for blood transfer into sodium citrate tubes, transfer of plasma into conical tubes, and handling of PRP during preparation to reduce shear stress and prevent premature platelet activation. A new needle was used for each step and discarded after single use.

6) Needle No. 30 (½-inch)

A 30-gauge, ½-inch needle was used for intradermal PRP injection to allow precise, depth-controlled delivery with minimal tissue trauma and improved patient comfort. The needle was sterile, single-use, and was disposed of in a sharps container after the procedure.

7) Syringe (20 mL)

A sterile, single-use 20-mL syringe was used for initial venous blood collection prior to transfer into sodium citrate tubes. Syringes were discarded after use according to biohazard waste protocols.

8) Syringe (5 mL)

A sterile 5-mL syringe was used to aspirate platelet-rich plasma after the first centrifugation step and transfer it into conical tubes for the second centrifugation. Syringes were single-use and discarded after use.

9) Syringe (3 mL)

A sterile 3-mL syringe was used for PRP transfer during intermediate preparation steps. Syringes were single-use and discarded after use.

10) Syringe (1 mL)

A sterile 1-mL syringe was used for final PRP delivery during injection to ensure accurate volume control. Syringes were single-use and were disposed of in biohazard waste containers after treatment.

3.3 Study Protocol

The treatment protocol consisted of three sessions administered at 3-week intervals. Participants were required to attend a total of four hospital visits, including treatment sessions and follow-up assessments. Platelet-rich plasma (PRP) was injected into one side of the cheek in each participant. To minimize procedural discomfort, a topical anesthetic cream containing 10% lidocaine was applied to the treatment area for approximately 40 minutes using a single-use sterile applicator under aseptic conditions. During the anesthetic period, approximately 10 mL of peripheral blood was collected from each participant using a 21-gauge catheter. The blood was drawn into tubes containing 3.2% sodium citrate as an anticoagulant.

Platelet-rich plasma was prepared using a standardized double-spin centrifugation protocol with a Ugaiya centrifuge. The first centrifugation was performed at 1,400 rpm (approximately 200 g) for 10 minutes to separate red blood cells from the plasma fraction. After removal of the upper plasma layer, a second centrifugation was conducted at 2,400 rpm (approximately 800 g) to obtain leukocyte-poor platelet-rich plasma (LP-PRP). Approximately 3 mL of LP-PRP was obtained and used for treatment.

A mechanical subcision was first performed using a fanning technique without PRP delivery, consisting of at least five fan-shaped passes per entry point. Subsequently, 0.1 mL of PRP was slowly injected within the same tissue plane. Vertical linear injections were then performed in a similar manner, delivering PRP along the vertical axis from the subcutaneous layer toward the superficial dermis. A 30-gauge needle was selected for PRP delivery to minimize procedural trauma and patient discomfort while allowing precise and depth-controlled injections. Fine-gauge needles are associated with reduced tissue disruption, a lower risk of bleeding, and improved patient tolerability compared with larger-bore instruments. In the context of

acne scarring, where treatment targets the dermis and subdermal fibrotic attachments, the use of a 30-gauge needle enables controlled mechanical subcision and accurate PRP deposition across multiple tissue planes. In contrast, cannulas, while advantageous for broad volumetric delivery, offer less precision for focal scar release and depth-specific injection.

Participants were instructed to avoid touching the treated area or applying topical products for at least 6 hours after treatment, and to avoid sun exposure, heat, and strenuous activity for 24–48 hours. Gentle cold compresses were permitted. A mild skincare routine and daily use of broad-spectrum sunscreen (SPF ≥50) were allowed after the initial post-treatment period, while exfoliating agents, acne treatments, and skin-lightening products were prohibited throughout the study. Any adverse events were recorded and managed according to the study safety protocol.

3.4 Outcomes Assessment

The primary outcome was assessed using Antera 3D in depression mode, with improvement defined as a reduction in the total depression volume (mm^3). The secondary outcome was evaluated using patient satisfaction scores.

3.5 Statistical Analysis

As a pilot single-arm study with a limited sample size, this research prioritized the estimation of treatment effects rather than formal hypothesis testing. Repeated-measures ANOVA was used to evaluate temporal trends across four time points: baseline, week 3, week 6, and week 18. To account for the small cohort and to better characterize statistical uncertainty, we calculated mean changes from baseline alongside 95% confidence intervals (CIs). Secondary and patient-reported outcomes such as satisfaction scores and VAS ratings were summarized descriptively. This emphasis on effect magnitude and trend interpretation is intended to establish feasibility and inform the design of future, adequately powered trials.

4. Results and Discussion

4.1 Result

In this prospective pilot study involving 10 participants, longitudinal evaluation using Antera 3D demonstrated modest time-dependent changes in acne scar volume. The baseline mean Antera 3D value was 7.71 mm^3 (95% CI, 3.11–12.30). At week 3, mean scar volume remained comparable to baseline, with a mean change of 0.08 mm^3 (95% CI, −1.67 to 1.82), indicating no measurable early structural response.

By week 6, a reduction in mean Antera 3D values was observed, corresponding to a mean change of −1.05 mm^3 from baseline (95% CI, −2.37 to 0.27). Although the confidence interval crossed zero and statistical significance was not reached, the direction of change favored improvement, suggesting a delayed response pattern. At the follow-up visit, the mean Antera 3D value remained slightly lower than baseline, with a mean change of −0.47 mm^3 (95% CI, −2.15 to 1.21), indicating partial attenuation of the observed improvement and increased inter-individual variability over time.

Repeated-measures ANOVA did not demonstrate a statistically significant overall difference across time points, which is consistent with the exploratory nature and limited sample size of this pilot study. Despite the modest and statistically non-significant objective changes, patient-reported outcomes revealed high treatment acceptance, with a mean satisfaction score of 8.00 ± 0.47 and a mean VAS score of 7.40 ± 1.65. This discrepancy between objective imaging and subjective perception is commonly observed in aesthetic studies and suggests that even subtle structural changes may translate into perceived clinical improvement from the patient's perspective.

Table 1 Demographic data

	Number
Male	3(30%)
Female	7(70%)

Table 1 summarizes the demographic characteristics of the study participants. A total of 10 participants were included, with 7 (70%) females and 3 (30%) males.

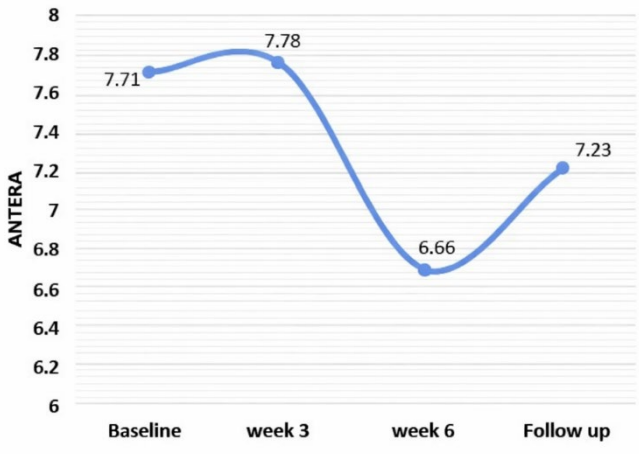


Figure 1 Antera 3D mean result

Figure 1 Time-dependent changes in mean Antera 3D measurements of acne scars. The y-axis represents the mean scar-related values calculated by Antera 3D, and the x-axis represents the treatment time points. The greatest reduction was observed at week 6, followed by partial attenuation at the follow-up visit.

Table 2 Antera 3D result

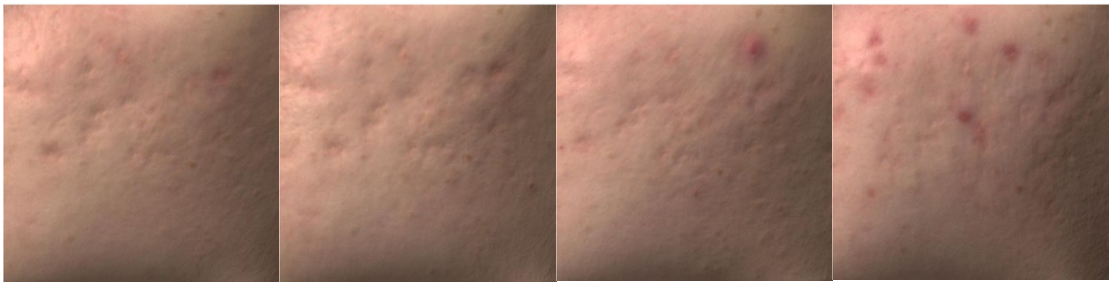
week	mean	SD	95% CI	Mean change	95% CI	P-value
Baseline	7.71	6.42	3.11-12.30	Reference	-	-
Week 3	7.78	6.06	3.45-12.11	0.08	-1.67, 1.82	0.923
Week 6	6.66	5.08	3.03-10.29	-1.05	-2.37, 0.27	0.106
Follow-up	7.23	5.98	2.96-11.51	-0.47	-2.15, 1.21	0.540

Table 2 presents longitudinal Antera 3D measurements obtained at baseline and subsequent follow-up visits. Mean values represent the average Antera 3D measurements at each time point. Mean change indicates the average difference in Antera 3D values at each follow-up visit compared with baseline, calculated as the mean value at the respective time point minus the baseline value. Negative mean change values therefore indicate a reduction in scar-related measurements relative to baseline, whereas positive values indicate an increase. The corresponding 95% confidence intervals (95% CIs) for mean change represent the range within which the true mean change is likely to lie. Confidence intervals crossing zero indicate uncertainty regarding the presence and magnitude of change, reflecting the limited precision associated with the small sample size in this pilot study. P-values were derived from repeated-measures analysis of variance to explore overall temporal trends across visits. No meaningful change was observed at week 3 compared with baseline, as reflected by a minimal mean change and a wide 95% confidence interval crossing zero, indicating the absence of an early structural response. At week 6, a reduction in mean Antera 3D values was observed, with a negative mean change suggesting improvement in acne scar parameters. Although the corresponding 95% confidence interval still crossed zero and statistical significance was not reached, the direction of change favored improvement, indicating a potential delayed treatment effect. At the follow-up visit, mean values remained lower than baseline, suggesting persistence of directional improvement; however, the magnitude of change was attenuated and accompanied by wide confidence intervals, reflecting substantial inter-individual variability and limited precision.

Table 3 Patient satisfaction score and VAS

	Mean ± SD
Patient satisfaction score	8.00 ± 0.47
VAS	7.40 ± 1.65

Table 3 summarizes patient-reported outcomes, including patient satisfaction scores and Visual Analogue Scale (VAS) ratings. The mean patient satisfaction score was high (8.00 ± 0.47), indicating that most participants reported a consistently positive level of satisfaction with the treatment. The relatively small standard deviation suggests low variability among participants, reflecting a uniform perception of benefit. The mean VAS score demonstrating favorable patient-reported experiences, although with greater inter-individual variability compared with satisfaction scores.



Baseline | 3rd Week | 6th Week | 18th Week (Follow up)

Figure 2 Acne scar improvement

Figure 2 Improvement of acne scars assessed by Antera 3D at baseline and at 3-, 6-, and 18-week follow-up.

4.2 Discussion

The study was designed as a prospective single-arm pilot study focused on the feasibility and preliminary clinical response to a platelet-rich plasma injection protocol for the treatment of atrophic acne scars, using both objective imaging and patient-reported outcomes. Over the course of the study, Antera 3D measurements demonstrated gradual improvements, with the greatest reduction observed at week 6. Although the overall repeated measures analysis did not demonstrate statistical significance, a directional decrease in scar-related measurements at week 6 suggests a delayed structural response rather than an immediate effect. This temporal pattern is consistent with the current understanding of dermal remodeling following such interventions, where collagen reorganization, neocollagenesis, and extracellular matrix remodeling typically evolve over several weeks rather than occurring during the early post-treatment phase.

The absence of meaningful change at week 3 may reflect the early inflammatory and proliferative phases of wound healing, during which transient edema and tissue reorganization may alter surface topography without producing a stable reduction in scar depression measurable by Antera 3D analysis. By week 6, the observed reduction in Antera values aligns with the expected transition toward the remodeling phase, during which collagen maturation and dermal reorganization begin to contribute to visible and measurable improvement in atrophic acne scars. At the final follow-up, mean values remained lower than baseline, indicating a sustained directional trend toward improvement despite attenuation of the effect magnitude. As illustrated in Figure 2, Antera 3D analysis reveals a progressive reduction in scar depth at each follow-up visit, culminating in the final assessment. However, the associated 95% confidence intervals were wide and crossed zero, reflecting substantial uncertainty in the estimated effect size. This imprecision is likely

attributable to inter-individual variability in healing dynamics, scar morphology, and baseline severity, as well as the limited sample size inherent to the pilot design.

The previous study by Deshmukh and Belgaumkar (2019) reported notable clinical improvement when PRP was used in combination with subcision. Although direct comparison with the present study is limited due to differences in study design, treatment protocols, and outcome assessment methods, both investigations demonstrate a consistent directional trend toward improved acne scar appearance following PRP-based therapy. Further studies are needed to determine whether needle gauge influences the extent of subcision release, tissue response, or patient-perceived outcomes.

In parallel with the objective findings, patient-reported outcomes demonstrated consistently high satisfaction and favorable VAS scores, despite the absence of statistically significant changes in Antera 3D measurements. This divergence between subjective perception and quantitative imaging may reflect the multifactorial nature of aesthetic improvement. Objective analyses primarily quantify absolute volumetric or depth changes, whereas clinical treatments may also induce subtle morphological modifications that influence visual perception. For example, softening of sharp scar margins may reduce shadow casting, making scars appear less conspicuous even without substantial volumetric filling.

Additionally, improvements in overall skin quality, including enhanced hydration, dermal remodeling, and collagen organization, may alter the light reflection and scattering properties of the skin surface. These changes can produce a smoother visual appearance that is perceptible to patients but may not be fully captured by depth-based imaging parameters alone. Furthermore, reductions in erythema or pigmentary contrast may contribute to a more uniform skin tone, further enhancing the perceived cosmetic outcome. Collectively, these factors highlight that patient satisfaction in aesthetic dermatology often reflects broader improvements in skin appearance that extend beyond isolated quantitative measurements of scar depth.

These findings indicate that the intervention was well tolerated and was associated with favorable patient-reported satisfaction. However, patient-reported outcomes should be interpreted independently of objective structural measurements. Although directional improvements from baseline were observed, the limited sample size restricts the precision of the effect estimates. Larger, adequately powered studies are necessary to more clearly define the magnitude and clinical relevance of treatment-related changes.

From a clinical applicability perspective, using a double-spin procedure for PRP preparation may result in longer preparation times and higher costs due to the requirement for additional tubes. Although the procedure does not require complex adjunctive technologies beyond standard centrifugation and injection equipment, the depth-controlled subcision and multilayer injection technique is operator-dependent and may require prior experience in acne scar care management. Strict adherence to procedural standardization is therefore essential to minimize variability and enhance reproducibility.

4.3 Limitation

This pilot study has several constraints that warrant consideration. First, the relatively small sample size may limit the statistical power and precision of the estimated treatment effects. Although measurable improvements were observed in Antera 3D parameters, the associated confidence intervals reflect a degree of statistical uncertainty, and the findings should therefore be interpreted as preliminary rather than definitive. Second, the follow-up duration was limited, potentially underrepresenting the full extent of collagen remodeling and dermal matrix reorganization, which may continue beyond the observation period. As a result, the present outcomes primarily reflect short- to intermediate-term responses. Third, the absence of a control group limits the ability to distinguish treatment-related changes from regression to the mean or measurement variability over time. This study did not include a parallel control group because it was conceptualized as an exploratory, hypothesis-generating investigation rather than a definitive efficacy trial. The primary objective was to evaluate the clinical signal and feasibility of a standardized PRP protocol under the practice conditions. Given its single-arm, exploratory design, the results should be interpreted as preliminary and hypothesis-generating rather than confirmatory. The effect estimates derived from this study may therefore serve as a

foundation for future sample size calculations and controlled investigations. Larger, controlled studies with extended follow-up are required to confirm durability and establish comparative efficacy.

5. Conclusion

This pilot study demonstrated a trend toward acne scar improvement emerging around week 6; however, statistical significance was not reached. Although outcomes at week 18 appeared improved compared with baseline, these changes remained statistically non-significant, likely reflecting the limited sample size and the exploratory nature of the study. Although statistically significant differences were not observed, the use of multilayer PRP injection with a 30-gauge needle showed an observable trend toward improvement, suggesting its potential role as an adjunctive option in acne scar treatment.

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