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Clinical evaluation of injectable platelet-rich fibrin and microneedling for gingival phenotype enhancement: A comparative clinical study

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Abstract:
Thin gingival phenotype increases susceptibility to gingival recession and aesthetic compromise, while predictable minimally invasive approaches for phenotype enhancement remain limited. Sixty adults with thin gingival phenotype (GT <1.5 mm) were randomized to i-PRF alone or i-PRF+ microneedling (MN), with gingival thickness, keratinized tissue width, plaque index and BOP% measured at baseline, 3 and 6 months. Data were analyzed using appropriate parametric/non-parametric tests, repeated-measures ANOVA and Bonferroni correction (α=0.05). Both treatments significantly improved GT, KTW, PI and BOP%. i-PRF+MN produced a greater GT gain (Δ0.58 mm vs Δ0.42 mm; p<0.001); keratinized tissue width gains were similar. Thus, adjunctive microneedling with i-PRF offers superior gingival thickness augmentation as a minimally invasive option.

Keywords: Injectable platelet-rich fibrin (i-PRF), microneedling, gingival thickness (GT), keratinized tissue width (KTW), thin gingival phenotype

Background:
Periodontal disease is a chronic, multifactorial inflammatory disease caused by dysbiosis of subgingival microbiota, resulting in progressive destruction of the tooth-supporting tissues, including the periodontal ligament, cementum and alveolar bone and, if untreated, eventual tooth loss. Gingiva, as a physical barrier, forms an integral component of the oral mucosa, covering the alveolar processes of the jaws and surrounding the cervical portion of teeth. Gingival tissues, which include marginal, attached and interdental components that withstand mechanical stress and microbial stress, provide an essential protective barrier around teeth **[1]**. According to the 2017 World Workshop classification of periodontal diseases, thin gingival phenotypes—defined by gingival thickness (GT) less than 1.5 mm and a narrow width of keratinised tissue (KTW)—increase the risk of gingival recession, attachment loss and aesthetic compromise **[2, 3]**. Although autogenous grafts, such as connective tissue or free gingival grafts are still gold standard for soft tissue augmentation, they have disadvantages such as patient discomfort, surgical chair time and donor site morbidity **[4]**. By utilizing autologous growth factors, platelet concentrates have transformed regenerative periodontology; Choukroun's invention, platelet-rich fibrin (PRF), provides a second-generation matrix rich with leukocytes, PDGF, VEGF, IGF-1 and TGF-β, without anticoagulants, supporting sustained release for angiogenesis and matrix remodelling **[5, 6]**. Compared to PRP, injectable PRF (i-PRF) exhibits superior early growth factor release (*e.g.,* PDGF at day 3) and upregulated collagen I/TGF-β expression, prepared with low-speed centrifugation (700 rpm, 3 minutes) in uncoated tubes. By generating microchannels that initiate wound healing cascades, microneedling enhances fibroblast proliferation and neocollagenesis through PDGF, TGF-α/β and FGF **[7]**. Emerging clinical evidence underscores their synergy: i-PRF alone or with microneedling yields GT gains of 0.6–1.0 mm and KTW increases at 6 months in thin biotypes, exceeding hygiene controls or standalone PRF, with minimal adverse events. However, randomized data on microneedling-i-PRF combinations versus isolated modalities in periodontally healthy thin phenotype sites are minimal which restricts usage **[8]**. Therefore, it is of interest to evaluate the effects of injectable platelet-rich fibrin (i-PRF) alone and in combination with microneedling (MN) on gingival thickness (GT) and keratinized tissue width (KTW) in patients having thin gingival phenotypes.

Materials and Methods:
A proposed study was conducted on 60 patients, aged ≥18 years, with thin gingival phenotypes, who were selected from outpatient section, Department of Periodontology. Study sample size (n) calculation was done using alpha = 0.05, 80% power, standard deviation (σ) = 0.05 mm and minimal detectable difference (d)=0.13 mm, per group was 30 samples (total n=60). Minimum sample size obtained was 30 per group. The study population was divided into Group I (i-PRF alone) and Group II (MN + i-PRF). Clinical evaluation was done using transparency method, in which it was classified as thin (≤ 1.0 mm, probe visible) or thick (≥ 1.0 mm, probe not visible). Ethical clearance was obtained from the Institutional Ethical Committee and participants were informed about the study in their regional language, with written informed consent collected before procedure. The inclusion criteria consisted of participants with age ≥18 years having no systemic diseases, thin gingival phenotype (GT <1.5 mm) in mandibular anteriors, PI and bleeding on probing ≤15% and Intact dentition without malocclusion or restorations in target sites. The exclusion criteria

included a history of anticoagulant or medication-induced gingival hyperplasia, any systemic conditions, prior orthodontic treatment, Smoking, alcohol consumption, or any medical compromise. Eligible participants were adults (≥18 years) with a thin gingival phenotype, defined as gingival thickness (GT) < 1.5 mm, at mandibular anterior sites. Bleeding on probing (BOP) and Full-mouth plaque index (PI) were required to be ≤15% at screening. Selected sites exhibited no crowding, no prosthetic restorations and no tooth-size or alignment discrepancies. Written informed consent was obtained from all participants and study protocol received institutional ethics committee approval. Supragingival scaling was performed before baseline measurements. Topical lidocaine spray was applied for local anaesthesia. All clinical measurements and interventions were performed by a single calibrated operator. Autologous injectable platelet-rich fibrin (i-PRF) was prepared from 10 mL of venous blood drawn per site into plain tubes. Tubes were centrifuged (Remi, India) at 700 rpm (approximately 60 x g) for 3 minutes. The i-PRF layer was aspirated into 2.5 mL syringes fitted with 27-gauge needles and injected apically toward the mucogingival junction at each treatment site (0.5–1.0 mL per site). Hemostasis was maintained with saline-soaked gauze for 15 minutes following injection. Microneedling was performed using a Dermapen fitted with a 12-pin cartridge. Approximately 250 microchannels per cm² were created by performing vertical passes across the keratinized gingiva from mesial aspect of central incisor to distal aspect of canine. Micro-needling was continued until bone contact was achieved. Clinical assessments were performed at baseline, 3 and 6 months. The primary outcomes were GT and keratinized tissue width (KTW) changes at 3 and 6 months. Secondary outcome measures were PI maintenance. Statistical analysis Data analysis was conducted using Statistical Package for the Social Sciences (SPSS) software, version 20.0 for Windows (IBM Corp., Armonk, NY, USA). Results were expressed as mean ± standard deviation (SD). Two-sided tests with α = 0.05 were used; Bonferroni correction was applied for multiple within-group pairwise comparisons. Continuous data are reported as mean ± SD or median (IQR); normality by Shapiro–Wilk. Within-group changes (baseline, 3, 6 months) used ANOVA or Friedman test; post hoc pairwise tests with Bonferroni. Between-group comparisons used independent t-test or Mann–Whitney U; categorical tests used chi-square or Fisher's exact test. Change scores were compared and effect sizes (Cohen's d) were reported. Correlations by Pearson or Spearman. To achieve 85% power and detect significant differences with an effect size of 0.47 (P ≤ 0.05).

Results:

Sixty sites (mean age 31.1±8.2 years; 41.7% male) with thin gingival phenotypes were analysed. Baseline demographics and clinical parameters (PI, BOP%, GT, KTW) showed no difference within the group (all p>0.05; **(Table 1).** Both groups exhibited significant within-group improvements over 6 months (repeated-measures ANOVA, p<0.001; Bonferroni-adjusted). GT increased from 1.08±0.19 mm to 1.50±0.20 mm (i-PRF) and 1.11±0.17 mm to 1.68±0.19 mm (MN+i-PRF); KTW from 4.08±0.49 mm to 4.42±0.46 mm and 4.04±0.64 mm to 4.40±0.62 mm, respectively **(Table 2)**. At baseline, groups were comparable in age, gender, PI, BOP%, GT and KTW (all p>0.05). Both protocols significantly improved GT and KTW compared to baseline. Greater GT gain was observed in the MN+i-PRF group (p<0.001). Between-group analysis at 3 months showed superior GT in MN+i-PRF (1.46±0.19 vs 1.33±0.19 mm; p=0.016). At 6 months, MN+i-PRF yielded greater GT gains (p<0.001; large effect) with lower BOP% in i-PRF (p=0.039); KTW changes were equivalent (p=0.959). GT and KTW changes showed no significant correlation overall (Spearman ρ=0.01, p=0.937), indicating independent responses. No adverse events occurred.

Table 1: Baseline data

Parameter	i-PRF (n=30)	MN+i-PRF (n=30)	p-value
PI	1.10±0.29	1.02±0.32	0.351
BOP%	10.84±2.47	11.68±2.02	0.153
GT (mm)	1.08±0.19	1.11±0.17	0.559
KTW (mm)	4.08±0.49	4.04±0.64	0.894

Table 2: Changes at 6 months

Parameter	Δ i-PRF (mean±SD)	Δ MN+i-PRF (mean±SD)	p-value	Effect size (Cohen's d)
PI	-0.30±0.09	-0.31±0.08	0.874	0.04
BOP%	-5.48±1.35	-4.89±0.98	0.058	-0.50
GT (mm)	**0.42±0.09**	**0.58±0.08**	**<0.001**	**-1.80**
KTW (mm)	0.34±0.08	0.36±0.09	0.256	-0.30

Discussion:

Modern dental practice increasingly emphasizes both aesthetics and function, tissue response to different therapies essential for successful outcomes in periodontal, implant and restorative procedures **[9].** Periodontal phenotypes significantly influence treatment outcomes and the broader construct of "phenotype" now encompasses clinical protocols, environmental factors and iatrogenic effects more comprehensively than the earlier "biotype" terminology proposed by Kan *et al.* **[10].** Injectable platelet-rich fibrin and microneedling are emerging as minimally invasive, regenerative modalities in dentistry with promising effects on wound healing, tissue regeneration and soft-tissue aesthetics **[11]**. In the present study, i-PRF alone and in combination with MN produced clinical improvements in gingival health and morphology in thin-phenotype sites. Both groups showed statistically significant reductions in plaque index and bleeding on probing, consistent with findings by Żurek *et al.* **[12]** who reported comparable PI reductions in i-PRF-treated thin gingiva, stating the importance of patient-centered oral-hygiene reinforcement. Gingival thickness (GT) increased markedly in both groups, but the greater gingival thickness gains observed with microneedling (MN) combined with i-PRF are consistent with Ozsagir *et al.* and Yadav *et al.* **[13, 14]** who reported superior gingival thickening when i-PRF was

used with MN. A plausible mechanism is that microneedling creates microchannels in the keratinized gingiva, enhancing penetration and tissue distribution of the growth factors and cytokines within i-PRF; this likely increases angiogenesis and matrix deposition compared with i-PRF alone. The magnitude of change in our study frequently crossed the clinically relevant 1.5 mm threshold, suggesting a phenotypic shift from a thin to a thicker gingival biotype—an outcome associated with improved resistance to recession and better restorative and surgical prognosis. Keratinized tissue width also increased significantly in both groups, though intergroup difference was not statistically significant by 6 months. The modest KTW gains are consistent with Patra *et al.* **[15]** and Kavi *et al.* **[16]**, who reported fibrin-mediated fibroblast recruitment and epithelial down-growth following i-PRF with MN potentially adding a marginal advantage via neo-angiogenesis-related pathways. The absence of gingival recession progression and stability of the epithelial-connective interface support phenotype modification rather than transient edema, as suggested by Mather and Cimasoni **[17]**. Compared with conventional connective tissue grafting (CTG), i-PRF avoids donor-site morbidity while providing a rich, autologous growth-factor matrix that supports early-phase tissue regeneration and vascularization **[11]**. The MN + i-PRF combination may serve as a minimally invasive, cost-effective approach that fills the gap between conventional surgical grafting and injectable fillers, showing high patient acceptability and favourable short- to mid-term results. These findings are, however, constrained by a small sample size, rely on clinical assessments alone and limited follow-up, which limit conclusions regarding long-term durability and histologic changes. More recent clinical evidence supports this interpretation: Dhanai *et al.* **[18]** reported greater short-term GT and KTW improvement with MN+i-PRF than i-PRF alone, while Muntean *et al.* **[19]** observed a modest additional regenerative benefit when microneedling was combined with i-PRF. A 2026 systematic review and meta-analysis by Nedungadi *et al.* **[20]** similarly found an adjunctive benefit for gingival thickness, particularly during the first three months, although the certainty of evidence remained low and KTW benefit was inconclusive.

Conclusion:

We show that injectable platelet-rich fibrin (i-PRF), alone and particularly with microneedling, effectively enhance gingival thickness as well as contribute to periodontal phenotype modification in patients with thin gingival morphology. Both modalities improved gingival health, with greater gains in gingival thickness and keratinized tissue width observed with the microneedling-assisted i-PRF approach, mentioning its synergistic regenerative potential.

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