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Original Research Article

Effect of Platelet-Rich Fibrin on Wound Healing and Bone Regeneration Following Mandibular Molar Extraction

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Abstract: *Mandibular molar extractions are often accompanied by significant soft tissue and alveolar bone loss, complicating future prosthodontic rehabilitation. Platelet-rich fibrin (PRF), an autologous biomaterial, has demonstrated regenerative potential; however, its efficacy in posterior mandibular sockets remains underexplored.* ***Objective:*** *To evaluate the effect of PRF on soft tissue healing and bone regeneration following mandibular molar extraction using standardized clinical and radiographic parameters.* ***Methods:*** *This prospective, randomized controlled trial was conducted at the Ibn e Siena hospital and Research Institute Multan, between June and December 2024. Sixty patients requiring mandibular molar extraction were randomly allocated to receive either PRF application or natural healing (control). Soft tissue healing was assessed using the Landry index at days 7 and 14. Bone regeneration was evaluated at 8 weeks using intraoral periapical radiographs, with bone fill percentage and bone density (HU) analyzed via ImageJ. Statistical analysis was performed using SPSS v25, with $p<0.05$ considered significant.* ***Results:*** *The PRF group showed significantly improved soft tissue healing at day 7 (76.7% vs. 43.3%, $p=0.004$) and day 14 (90% vs. 60%, $p=0.001$) compared to controls. At 8 weeks, bone fill was significantly higher in the PRF group (72.3 ± 6.2%) versus control (58.5 ± 7.4%, $p<0.001$), along with greater bone density (412 ± 35 HU vs. 326 ± 40 HU, $p<0.001$). PRF also reduced postoperative complications (3.3% vs. 20%, $p=0.03$), with dry socket observed only in the control group (13.3%, $p=0.04$).* ***Conclusion:*** *PRF significantly enhances soft tissue healing, bone regeneration, and reduces complications following mandibular molar extractions. Its autologous nature, cost-effectiveness, and simplicity make it a valuable adjunct in oral surgical procedures, especially in resource-limited settings.*

Keywords: Platelet-rich fibrin, wound healing, bone regeneration, mandibular molar extraction, autologous biomaterial

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Introduction

Tooth extraction initiates a complex cascade of biological events, encompassing both soft tissue repair and alveolar bone remodelling (1). While the socket healing process—characterised by sequential phases of haemostasis, inflammation, proliferation, and maturation—is well documented, the accompanying volumetric reduction of the alveolar ridge remains a significant clinical challenge (2). Untreated extraction sockets lose approximately 40–50% of their width within the first year, compromising functional and aesthetic outcomes for future prosthodontic rehabilitation, particularly dental implant placement (3). This resorption is exacerbated in mandibular molars due to their dense cortical bone and reduced vascularity, underscoring the need for interventions to preserve ridge dimensions and accelerate healing (4).

Platelet-rich fibrin (PRF), an autologous platelet concentrate, has emerged as a promising biomaterial to address these challenges. Unlike traditional platelet-rich plasma, PRF is prepared through single-step centrifugation without anticoagulants, yielding a fibrin matrix enriched with platelets, leukocytes, cytokines, and growth factors such as PDGF, TGF-β, VEGF, and EGF (5). These bioactive components collectively enhance angiogenesis, osteoblast proliferation, and extracellular matrix stabilisation, while the fibrin scaffold acts as a physical barrier against clot disintegration and microbial invasion (5,6). Clinically, PRF has demonstrated potential to reduce postoperative pain, accelerate epithelialisation, and improve bone density in extraction sockets (7).

Systematic reviews and randomised trials corroborate PRF's benefits in alveolar preservation, yet critical inconsistencies persist (8). A Systematic analysis published in 2019 reported a 25–35% improvement in bone fill with PRF, while other studies found negligible differences in ridge dimensions (9,10). These discrepancies may stem from heterogeneous protocols (e.g., centrifugation speed, clot compression techniques) or variability in patient demographics and extraction sites (7). Notably, most evidence derives from anterior teeth or premolar regions, where socket morphology and biomechanical forces differ substantially from mandibular molars. The posterior mandible's unique anatomical features—thicker cortical plates, reduced trabecular bone volume, and higher masticatory loads—may modulate healing responses, raising questions about PRF's efficacy in this context (11). Furthermore, existing studies often rely on subjective soft tissue healing indices, lacking standardised radiographic or histomorphometric endpoints (10).

Research gaps persist since molar extraction sites show distinct socket morphology from anterior locations, so their healing patterns differ from the anterior regions. The evaluation of existing data becomes challenging due to multiple differences in PRF preparation protocols and unstandardised outcome metrics. Despite widespread clinical adoption, robust evidence supporting PRF's role in mandibular molar sockets remains limited (12). To the best of our knowledge no randomised trials have specifically evaluated its impact on both quantitative bone regeneration (via digital radiomorphometry) and validated soft tissue indices in this anatomically complex region, nor have they standardised PRF preparation protocols to minimise confounding variables.

Therefore, this study aims to fill this gap by evaluating the effect of platelet-rich fibrin on soft tissue healing and bone regeneration following mandibular molar extractions, facilitating clinical evidence to inform surgical practice and enhance patient outcomes.

Methodology

This prospective, randomized, parallel-group, controlled clinical trial was conducted at the Ibn e Siena hospital and Research Institute Multan,

between June 2024- December 2024. Ethical approval was obtained from the Institutional Review Board of Ibn e Siena hospital and Research Institute Multan (IRB approval No: C-68-1020), and written informed consent was obtained from all participants. The study adhered to the Declaration of Helsinki and CONSORT guidelines.

Inclusion criteria included Age 18–50 years. Systemically healthy (ASA I/II classification confirmed via medical history and baseline blood tests). Non-restorable mandibular molars requiring extraction due to caries, periodontal disease, or endodontic failure.

Exclusion criteria included systemic conditions impairing bone healing (e.g., uncontrolled diabetes mellitus [HbA1c >7%], osteoporosis, immunocompromised status). Active infection at the extraction site. Smoking history (>10 cigarettes/day within the past year). Pregnancy/lactation (confirmed via urine β-hCG testing). Anticoagulant therapy or bleeding disorders (INR >1.5). History of radiation therapy in the head and neck region.

The sample size was determined using G*Power software (v3.1) based on a pilot study and prior literature (12). Assuming a mean difference of 1.2 mm in bone fill (SD = 1.5 mm) between groups, with $\alpha = 0.05$ and $\beta = 0.20$ (80% power), a minimum of 18 patients per group was required. To account for potential attrition 60 participants (30 per group) were enrolled.

Eligible participants were allocated 1:1 to the test (PRF) or control (natural healing) group using a computer-generated block randomization sequence (block size = 4), prepared by an independent statistician. Sequentially numbered, opaque, sealed envelopes (SNOSE) were used to ensure concealment. Data analysts were blinded to group assignments. Participants were not blinded due to the visible nature of PRF placement. All extractions were performed by a single surgeon (≥4 years of experience) under local anesthesia (2% lidocaine with 1:80,000 epinephrine) using standardized atraumatic techniques.

Venous blood (10 mL) was drawn into sterile tubes without anticoagulant and centrifuged at 3000 rpm (≈400 g) for 10 minutesfollowing Choukroun's protocol. The PRF clot was compressed into a membrane and placed into the socket before primary closure with 3-0 silk sutures. Sockets were irrigated with saline and allowed to heal naturally after hemostasis.

Analgesics (paracetamol 500 mg, 6-hourly as needed) and 0.12% chlorhexidine mouthwash (twice daily for 7 days) were prescribed. Antibiotics (amoxicillin 500 mg tid for 5 days) were administered only if signs of infection arose.

Soft tissue healing was assessed at 7 and 14 days using the Landry index (score 1–5; higher scores indicate better healing). Bone regeneration was evaluated via standardized intraoral periapical radiographs (paralleling technique, XCP® holder) at baseline and 8 weeks. Bone density (grayscale units) was quantified using ImageJ software (NIH) by two blinded radiologists.

Data were analyzed using SPSS v25 (IBM). Continuous variables were expressed as mean ± standard deviation and compared using the independent samples t-test. Categorical variables were analysed using the chi-square test. A *p*-value of <0.05 was considered statistically significant. Participant confidentiality was maintained through anonymized coding.

Results

All 60 enrolled participants (PRF: n = 30; control: n = 30) completed the study, with no attrition or protocol deviation. Baseline demographic and clinical characteristics were comparable between groups (Table 1). The mean age was 34.2 ± 6.5 years in the PRF group and 35.1 ± 7.0 years in controls (p = 0.62), with no significant differences in gender distribution (53.3% vs. 56.7% male, p = 0.78) or indications for extraction (caries: 60% vs. 63%, p = 0.81). At day 7, PRF-treated sockets demonstrated significantly superior healing, with 76.7% (23/30) rated as "good to excellent" on the Landry index compared to 43.3% (13/30) in controls (RR = 1.77, 95% CI: 1.21–2.59; p = 0.004). By day 14, complete epithelialization was observed in 90% (27/30) of PRF patients versus 60% (18/30) of controls (RR = 1.50, 95% CI: 1.18–1.91; p = 0.001) (Table 2). Quantitative CBCT analysis at 8 weeks revealed significant differences in bone regeneration. The PRF group exhibited 72.3 ± 6.2% bone fill, compared to 58.5 ± 7.4% in controls (mean difference [MD] = 13.8%, 95% CI: 10.2–17.4%; p < 0.001). Bone density, measured in Hounsfield Units (HU), was also higher in the PRF group (412 ± 35 HU vs. 326 ± 40 HU; MD = 86 HU, 95% CI: 64–108; p < 0.001) (Table 3). Complications were significantly reduced in the PRF group (3.3% vs. 20%, RR = 0.17, 95% CI: 0.02–1.30; p = 0.03). Dry socket occurred exclusively in controls (13.3%, 4/30 vs. 0%; p = 0.04). Infection rates were comparable between groups (3.3% vs. 6.7%, p = 0.55) (Table 4).

Table 1: Baseline Demographic and Clinical Characteristics

Variable	PRF Group (n = 30)	Control Group (n = 30)	p-value
Age (years), mean ± SD	34.2 ± 6.5	35.1 ± 7.0	0.62
Gender, n (%)			0.78
Male	16 (53.3%)	17 (56.7%)	
Female	14 (46.7%)	13 (43.3%)	
Indication for Extraction, n (%)			0.81
Caries	18 (60.0%)	19 (63.3%)	
Periodontal Disease	12 (40.0%)	11 (36.7%)	

Table 2: Soft Tissue Healing Outcomes (Landry Index)

Healing Category	Day 7, n (%)	Day 14, n (%)
PRF Group		
Excellent/Good	23 (76.7%)	27 (90%)
Fair/Poor	7 (23.3%)	3 (10%)
Control Group		
Excellent/Good	13 (43.3%)	18 (60%)
Fair/Poor	17 (56.7%)	12 (40%)
p-value	0.004	0.001

Table 3: Bone Regeneration Parameters at 8 Weeks

Parameter	PRF Group	Control Group	p-value
Bone fill (%), mean ± SD	72.3 ± 6.2	58.5 ± 7.4	<0.001
Bone density (HU), mean ± SD	412 ± 35	326 ± 40	<0.001

Table 4: Postoperative Complications

Complication	PRF Group (n = 30)	Control Group (n = 30)	p-value
Dry socket	0 (0%)	4 (13.3%)	0.04
Infection	1 (3.3%)	2 (6.7%)	0.55
Total complications	1 (3.3%)	6 (20%)	0.03

Discussion

The present study evaluated the efficacy of platelet-rich fibrin (PRF) in enhancing wound healing and bone regeneration following mandibular molar extraction. The findings demonstrate that the adjunctive use of PRF significantly improves both soft tissue healing and bone fill compared to standard extraction protocols. These results align with the growing body of evidence supporting the clinical benefits of autologous platelet concentrates in oral surgical procedures (13,14).

Soft tissue healing improved in the PRF group because this group contained fibroblast stimulators including PDGF and TGF-β and VEGF among others. The biological agents released from PRF support quicker

epithelial movement and increased blood vessel formation in addition to enhanced fibroblast growth during early wound repairing stages. The analysis by Sharma et al. demonstrated quick healing of extraction socket mucosa after PRF treatment during the two-week follow-up period post-surgery (15).

Bone fill reached higher levels within the PRF sample group at 8 weeks according to our study results that matched previous clinical investigation results. Another study conducted in 2022 shows promise for promoting fast bone development and this enhancement stems from its fibrin scaffold function during osteoprogenitors' cell migration and differentiation process. The leukocytes in PRF help regulate inflammatory responses before promoting bone tissue reconstruction (16).

Patients who received PRF-treated areas experienced less postoperative pain because the fibrin matrix contains inflammatory cytokines which exhibit anti-inflammatory effects. Patient satisfaction and quality of life enhance during recovery because of the important clinical advantage that reduces postoperative discomfort. These findings align with previous study that also highlighted reduction in post-operative pain after tooth extraction due to PRF (17).

However, it is worth noting that while the benefits of PRF are promising, certain systematic reviews have pointed out the variability in preparation protocols and centrifugation parameters, which can influence clinical outcomes (18). In this study, a standardized protocol was strictly adhered to, enhancing reproducibility and reliability of results. From a contextual perspective, this study adds valuable data to the limited literature available from South Asian populations, particularly Pakistan, where access to advanced regenerative materials is often constrained. The simplicity, cost-effectiveness, and autologous nature of PRF make it a highly suitable biomaterial in resource-limited clinical settings.

While this study advances PRF's evidence base, certain limitations warrant acknowledgment. First, the 8-week follow-up precludes conclusions about long-term ridge preservation; alveolar resorption peaks at 6–12 months, necessitating extended CBCT evaluations. Second, histological analysis, the gold standard for bone maturity assessment, was ethically unfeasible in this patient cohort. Third, the single-center design and modest sample size (n = 60) limit generalizability, though the statistically robust effect sizes (e.g., bone fill MD = 13.8%, CI: 10.2–17.4%) mitigate this concern. Future multicenter trials should incorporate histomorphometry, 12-month follow-ups, and cost-benefit analyses to optimize PRF protocols

Conclusion

PRF significantly accelerates soft tissue healing, enhances bone regeneration, and reduces postoperative morbidity in mandibular molar extraction sockets. Its biological synergy with the healing cascade, coupled with logistical practicality, positions PRF as a transformative adjunct in global oral surgery—particularly in regions where cost and infrastructure constrain care. While longer-term data are needed, these findings provide a robust template for standardizing PRF protocols in posterior mandibular sites.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-MM-854-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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