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Research Article

A Comparative Study of Platelet-Rich Fibrin Alone and Platelet-Rich Fibrin Combined with Hydroxyapatite for Healing of Impacted Mandibular Third Molar Extraction Sockets

Dr. Janapareddi Sreedevi[1], Dr. Duddu Yesuratnam[2], Dr. Korrapati Kishore[3*], Dr. Krishna Chaitanya S[4], Dr. Gorantla Chandra Sekhar[5], Dr. Satya Sai S[6]

[1]Associate Professor, Department of Oral and Maxillofacial Surgery, Government Dental College, Kadapa, Andhra Pradesh, India.

[2]Professor and Head of Department, Department of Oral and Maxillofacial Surgery, Government Dental College, Kadapa, Andhra Pradesh, India.

[3*]Dental Assistant Surgeon, CHC Y. Ramavaram, Andhra Pradesh, India.

[4]Assistant Professor, Department of Prosthodontics, Anil Neerukonda Institute of Dental Sciences, Visakhapatnam, Andhra Pradesh, India.

[5]Tutor, Department of Oral and Maxillofacial Surgery, Government Dental College and Hospital, Kadapa, Andhra Pradesh, India.

[6]Tutor, Department of Oral and Maxillofacial Surgery, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India.

Corresponding Author: Dr. Korrapati Kishore
Dental Assistant Surgeon, CHC Y. Ramavaram, Andhra Pradesh, India.
Email: drkorrapatikishore@gmail.com

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ABSTRACT

Background: Surgical removal of impacted mandibular third molars is frequently associated with postoperative pain, swelling, trismus and delayed socket healing. Platelet-rich fibrin (PRF) promotes tissue regeneration through the sustained release of growth factors, while hydroxyapatite (HA) provides an osteoconductive scaffold that supports bone formation. Their combined application may improve postoperative healing.

Aim: To compare the efficacy of PRF alone and PRF combined with hydroxyapatite in promoting soft and hard tissue healing following surgical removal of impacted mandibular third molars.

Materials and Methods: This randomized controlled clinical study included 60 patients requiring surgical removal of impacted mandibular third molars at the Department of Oral and Maxillofacial Surgery. Participants were allocated into two groups: PRF alone and PRF combined with HA. Postoperative pain, facial swelling, trismus and soft tissue healing were evaluated on postoperative days 1, 3 and 7. Bone density was assessed using digital orthopantomograms four months postoperatively. Between-group comparisons were performed using independent-samples *t*-tests and the Mann–Whitney U test, as appropriate.

Results: The PRF with HA group demonstrated significantly lower postoperative swelling along the mouth-to-tragus and tragus-to-pogonion measurements on days 1, 3 and 7 ($p<0.001$). No statistically significant differences were observed in swelling measured along the outer canthus-to-mandibular angle, postoperative pain or trismus between the groups ($p>0.05$). Soft tissue healing scores were comparatively higher in the PRF with HA group on day 7, although the difference was not statistically significant ($p=0.077$). Four-month radiographic assessment demonstrated significantly greater bone density in the PRF with HA group ($p=0.001$).

Conclusion: The combination of PRF and hydroxyapatite demonstrated advantages over PRF alone, particularly in reducing postoperative facial swelling and improving radiographic bone density. However, no significant additional benefit was observed for postoperative pain, trismus or soft tissue healing. The combination may therefore be a useful adjunct for improving healing outcomes following impacted mandibular third molar surgery.

Keywords: Platelet-Rich Fibrin, Hydroxyapatite, Impacted Mandibular Third Molar, Extraction Socket, Postoperative Healing, Bone Regeneration.

INTRODUCTION

Impacted mandibular third molars are among

the most frequently encountered conditions requiring surgical intervention in oral and maxillofacial practice. Their extraction is commonly indicated in the presence of recurrent pericoronitis, dental caries, periodontal pathology, root resorption and associated odontogenic lesions. Despite being a routine surgical procedure, removal of impacted mandibular third molars may result in postoperative complications, including pain, facial swelling, trismus, delayed soft tissue healing and inadequate bone regeneration.[1,2]

Healing of an extraction socket is a complex biological process involving haemostasis, inflammation, proliferation and remodelling. Following tooth removal, the blood clot serves as an initial scaffold for cellular migration and tissue regeneration. Subsequent angiogenesis, fibroblast proliferation and collagen deposition contribute to soft tissue repair, followed by progressive replacement of granulation tissue with mineralized bone. Disruption of these processes may delay socket healing and compromise the quality of regenerated bone.[3]

Platelet-rich fibrin (PRF) is an autologous platelet concentrate prepared through centrifugation of venous blood without the addition of anticoagulants. It consists of a fibrin matrix enriched with platelets, leukocytes and various growth factors, including platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β) and vascular endothelial growth factor (VEGF). These biological mediators facilitate angiogenesis, cellular migration, fibroblast proliferation and tissue regeneration. PRF has consequently gained importance as a regenerative biomaterial in oral and maxillofacial surgery, particularly for promoting postoperative healing and socket preservation.[4,5]

Hydroxyapatite (HA) is a calcium phosphate-based biomaterial that closely resembles the inorganic mineral component of natural bone. Its excellent biocompatibility and osteoconductive properties make it a valuable bone graft substitute. It provides a structural framework for osteoblast attachment and proliferation, supports mineral deposition and helps maintain the volume of the extraction socket during bone regeneration.[6]

The combination of PRF and hydroxyapatite offers a potential approach to improving both biological and structural aspects of socket healing. While PRF provides a growth factor-rich fibrin scaffold that supports tissue repair, HA contributes an osteoconductive framework for bone formation. Their complementary properties may facilitate improved wound healing, reduce postoperative complications and enhance radiographic bone regeneration compared with the use of PRF alone.[7]

However, the additional clinical benefit of combining PRF with hydroxyapatite in impacted mandibular third molar extraction sockets requires evaluation across different healing parameters. Therefore, the present study was undertaken to compare PRF alone with PRF combined with hydroxyapatite in promoting postoperative healing, with particular emphasis on pain, facial swelling, trismus, soft tissue healing and radiographic bone density.

Aim and Objectives

Aim

To compare the efficacy of platelet-rich fibrin (PRF) alone and platelet-rich fibrin combined with hydroxyapatite (PRF + HA) in promoting healing of impacted mandibular third molar extraction sockets.

Objectives

1. To evaluate and compare postoperative pain between the PRF and PRF + HA groups using the Visual Analogue Scale (VAS).
2. To assess and compare postoperative facial swelling between the two groups using standardized facial measurements.
3. To evaluate and compare postoperative trismus by measuring mouth opening.
4. To assess and compare soft tissue healing using a standardized healing index.
5. To evaluate and compare radiographic bone density at four months postoperatively using digital orthopantomograms (OPG).
6. To determine whether the addition of hydroxyapatite to PRF provides additional benefits in soft tissue and hard tissue healing following surgical removal of impacted mandibular third molars.

MATERIALS AND METHODS

Study Design and Setting

This randomized controlled clinical study was conducted in the Department of Oral and Maxillofacial Surgery, Government Dental College and Hospital, RIMS, Kadapa. The study included 60 consecutive patients of either gender who required surgical removal of impacted mandibular third molars. Written informed consent was obtained from all participants after explaining the planned surgical procedure.

Study Groups

The participants were divided into two groups according to the biomaterial placed in the extraction socket:

Group I – PRF group: The extraction socket was treated with platelet-rich fibrin alone.

Group II – PRF + HA group: The extraction socket was treated with platelet-rich fibrin combined with hydroxyapatite.

The thesis does not clearly describe the randomization sequence or allocation concealment procedure; these details should be added if documented.

Inclusion Criteria

Patients willing to participate voluntarily and provide written informed consent.

Patients presenting with an impacted mandibular third molar requiring surgical removal.

Patients with complete blood picture and platelet counts within the physiological range (1.5–4.5 lakhs/cmm).

Exclusion Criteria

Patients who smoke.

Patients unwilling to participate in the study.

Patients with systemic diseases.

Patients with a potentially compromised immune system.

Patients with documented allergy to any component of the bone substitute or local anaesthetic drugs.

Patients with pathology associated with the impacted mandibular third molar.

Preparation of Platelet-Rich Fibrin

Approximately 10 mL of venous blood was collected from each patient into an anticoagulant-free blood collection tube. The sample was centrifuged at 3000 rpm for 10 minutes. Following centrifugation, three layers were obtained: an upper straw-coloured acellular plasma layer, a middle PRF layer, and a lower red blood cell fraction. The PRF clot was collected approximately 2 mm below the interface with the red blood cell layer to incorporate the remaining platelets.

Surgical Procedure

Before surgery, patients were instructed to rinse their mouths with 5% povidone-iodine solution for two minutes. The face was prepared with povidone-iodine and draped under aseptic precautions. Local anaesthesia was administered using 2% lignocaine with adrenaline.

A standard Ward's incision was given, followed by elevation of a full-thickness mucoperiosteal flap to expose the underlying bone. Bone guttering was performed on the lateral and distal aspects of the impacted molar using No. 701, 702 and 703 burs under continuous saline irrigation to minimise thermal injury. Tooth sectioning was performed when indicated, followed by controlled elevation and extraction.

The surrounding bone was smoothened using a bone file. Granulation tissue and the dental follicle were removed, and the socket was irrigated with povidone-iodine and sterile saline. After ensuring the absence of residual bone or tooth fragments, the socket was managed according to the assigned study group. Freshly prepared PRF was placed in the extraction socket in Group I, whereas PRF combined with hydroxyapatite was placed in Group II. The surgical site was then sutured, and a pressure pack was applied. Postoperative instructions were provided to all patients.

Postoperative Medication

The postoperative medication regimen documented in the study was:

Amoxicillin-clavulanate 625 mg twice daily for five days.

Metronidazole 400 mg three times daily for five days.

Aceclofenac 100 mg with paracetamol 325 mg twice daily for five days.

Ranitidine 150 mg twice daily for five days.

Assessment of Clinical and Radiographic Parameters

The following parameters were assessed postoperatively:

1. Postoperative pain

Pain intensity was evaluated using a Visual Analogue Scale (VAS), ranging from 0 (no pain) to 10 (severe pain). Patients were blinded to the treatment material used. Pain scores were recorded on postoperative days 1, 3 and 7.

2. Facial swelling

Postoperative facial swelling was assessed using a graded measuring tape along three reference lines:

Horizontal measurement: buccal commissure to tragus.

Vertical measurement: lateral canthus to gonion.

Oblique measurement: tragus to pogonion.

Measurements were recorded on postoperative days 1, 3 and 7.

3. Trismus
Trismus was evaluated by measuring the maximum interincisal mouth opening using a measuring scale. Measurements were recorded on postoperative days 1, 3 and 7.
4. Soft tissue healing
Soft tissue healing was assessed on postoperative days 1, 3 and 7 using the healing index described by Landry et al. The index categorised healing into five grades: very poor, poor, good, very good and excellent, based on tissue colour, bleeding on palpation, granulation tissue, epithelialisation and suppuration.
5. Radiographic bone density
Bone density at the extraction site was assessed using digital orthopantomograms (OPGs) obtained at the four-month follow-up. The radiographic assessment was used to compare bone regeneration between the two study groups.

Statistical Analysis
Data were analysed using IBM SPSS Statistics, version 26. Descriptive statistics were expressed as mean and standard deviation. Normality of the data was assessed using the Shapiro–Wilk test. Analysis of variance (ANOVA) was performed to evaluate overall differences between groups, followed by Tukey's post hoc test for pairwise comparisons. A p-value of less than 0.05 was considered statistically significant.

RESULTS
A total of 60 patients undergoing surgical removal of impacted mandibular third molars were included and evaluated in two groups: PRF alone and PRF combined with hydroxyapatite (PRF + HA). Postoperative outcomes were assessed on days 1, 3 and 7, while radiographic bone density was evaluated at four months.
The addition of hydroxyapatite to PRF was associated with significantly reduced postoperative swelling in two facial measurements and improved radiographic bone density at four months. However, no statistically significant differences were observed in postoperative pain, trismus or soft tissue healing between the groups.
Important statistical note: The thesis reports different tests for different outcomes: independent-samples t-tests for swelling and trismus, and Mann–Whitney U tests for pain, soft tissue healing and bone density. The manuscript's Statistical Analysis section should reflect these tests rather than stating ANOVA and Tukey post hoc testing unless those analyses are independently confirmed.

Table 1. Comparison of Postoperative Facial Swelling Between the Two Groups

Measurement	Postoperative day	PRF (Mean ± SD)	PRF + HA (Mean ± SD)	t value	P value
Mouth corner to tragus (cm)	1	11.52 ± 1.50	9.80 ± 1.79	4.007	**0.05

statistically significant differences were observed (p>0.05).

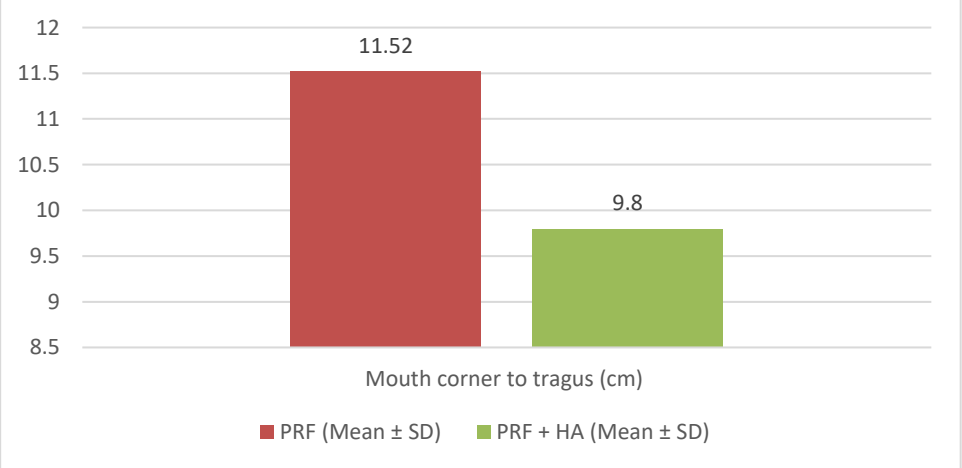


Table 2. Comparison of Postoperative Pain Scores Between the Two Groups

Postoperative day	PRF (Mean ± SD)	PRF + HA (Mean ± SD)	Z-value	p-value
Day 1	3.36 ± 0.92	3.13 ± 1.38	−1.118	0.263
Day 3	2.66 ± 0.99	2.26 ± 0.98	−1.570	0.116
Day 7	1.36 ± 0.61	1.50 ± 0.73	−0.658	0.510

Mann–Whitney U test. No, statistically significant differences were observed (p>0.05).

Pain scores decreased progressively in both groups. However, the differences between the groups were not statistically significant at any postoperative interval

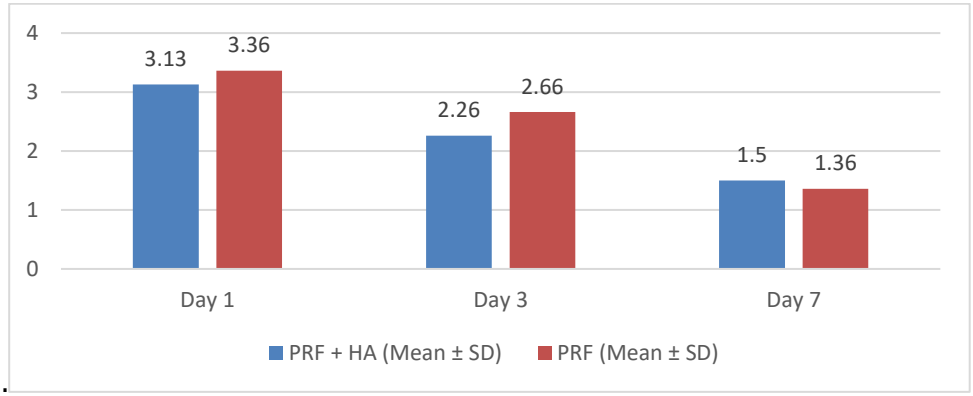


Table 3. Comparison of Postoperative Trismus

Postoperative day	PRF (Mean ± SD)	PRF + HA (Mean ± SD)	t value	p-value
Day 1	2.90 ± 0.66	3.00 ± 0.36	0.747	0.458
Day 3	3.28 ± 0.60	3.30 ± 0.36	0.156	0.877
Day 7	3.58 ± 0.58	3.69 ± 0.29	1.002	0.321

Footnotes: Values are expressed as mean ± SD. Trismus was assessed by measuring maximum interincisal distance in centimetres. Between-group comparisons were performed using the independent-samples t-test. No statistically significant differences were observed (p>0.05).

Interpretation: Mouth opening improved progressively in both groups. No statistically significant difference in postoperative trismus was observed between the groups at any assessment interval.

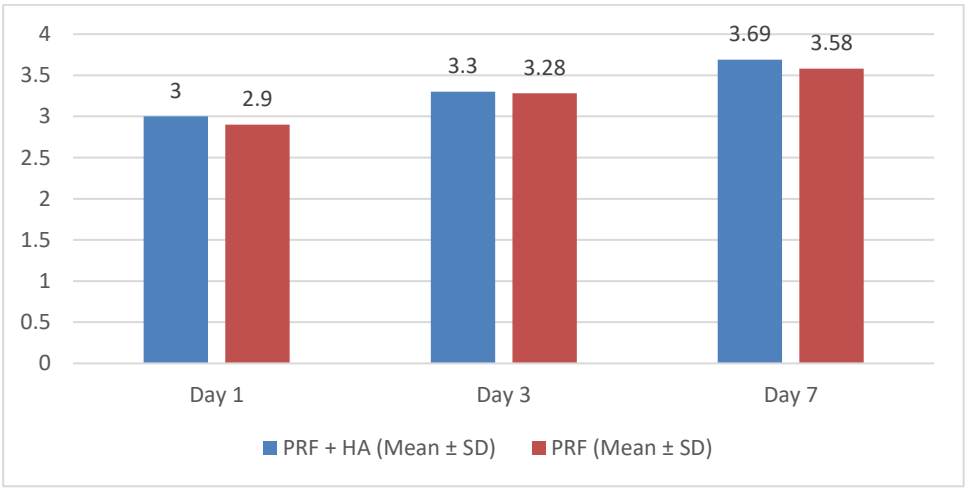


Table 4. Comparison of Postoperative Soft Tissue Healing Scores Between the PRF and PRF + HA Groups

Postoperative day	PRF (Mean ± SD)	PRF + HA (Mean ± SD)	Z value	p-value
Day 1	2.66 ± 0.54	2.56 ± 0.56	−0.737	0.461
Day 3	3.83 ± 0.91	3.63 ± 0.80	−0.816	0.415
Day 7	4.23 ± 0.72	4.56 ± 0.50	−1.771	0.077

Footnotes: Values are expressed as mean ± SD and median. Soft tissue healing was assessed using the healing index described in the thesis. Between-group comparisons were performed using the Mann–Whitney U test. No statistically significant differences were observed (p>0.05).

Interpretation: Soft tissue healing scores improved in both groups. The PRF + HA group demonstrated a higher mean healing score on Day 7; however, the difference was not statistically significant (p=0.077).

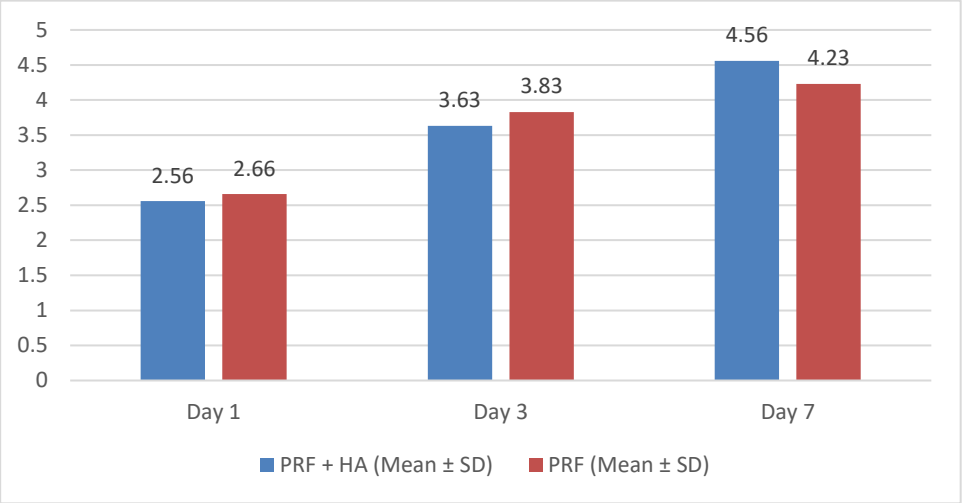
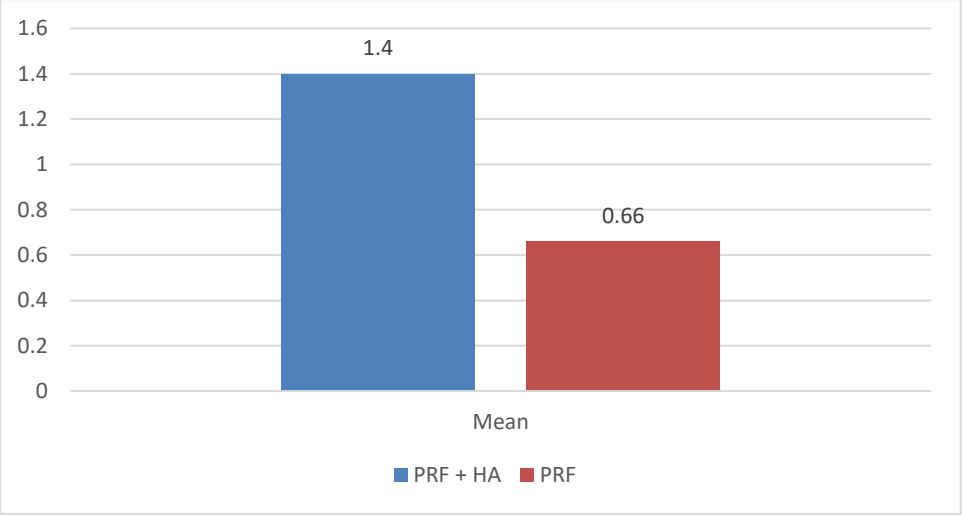


Table 5. Comparison of Radiographic Bone Density Between the PRF and PRF + HA Groups at Four Months

Parameter	PRF	PRF + HA	Z value	p-value
Mean ± SD	0.66 ± 0.88	1.40 ± 0.72	-3211	0.001
Median	1.00	2.00		

Footnotes: Values are expressed as mean ± SD and median. Bone density was assessed using digital orthopantomograms at four months. Between-group comparison was performed using the Mann–Whitney U test. *Statistically significant at p



DISCUSSION

The present randomized controlled clinical study compared the effectiveness of platelet-rich fibrin (PRF) alone with PRF combined with hydroxyapatite (HA) in promoting healing following surgical removal of impacted mandibular third molars. A total of 60 patients were evaluated for postoperative pain, facial swelling, trismus, soft tissue healing and radiographic bone density. The findings demonstrated that the addition of HA to PRF was associated with significantly reduced postoperative swelling along selected facial measurements and significantly higher

radiographic bone density at four months. However, no statistically significant differences were observed between the groups in postoperative pain, trismus or soft tissue healing.

PRF is an autologous platelet concentrate containing a fibrin matrix, platelets, leukocytes and growth factors involved in tissue repair and regeneration. Its biological activity supports angiogenesis, fibroblast proliferation and collagen synthesis. HA, on the other hand, is a biocompatible calcium phosphate-based bone substitute with osteoconductive properties. It provides a structural scaffold for cellular attachment and new bone deposition. The combination of PRF and HA may therefore offer complementary biological and structural advantages during socket healing.[15,16]

Postoperative Facial Swelling

Postoperative facial swelling is a common consequence of surgical removal of impacted mandibular third molars and is primarily associated with tissue manipulation, surgical trauma and the subsequent inflammatory response. In the present study, swelling was assessed using three standard facial measurements on postoperative days 1, 3 and 7.

The results demonstrated significantly lower swelling in the PRF + HA group for the mouth corner–tragus and tragus–pogonion measurements at all three postoperative intervals ($p < 0.001$). In contrast, the outer canthus–angle of the mandible measurement did not show a statistically significant difference between the groups on days 1, 3 or 7. These findings suggest that the addition of HA to PRF may provide an advantage in controlling postoperative edema, although this effect was not uniform across all facial measurements.

The reduced swelling observed in the combination group may be related to improved socket stabilization and the complementary effects of the two materials. PRF provides a fibrin matrix containing biologically active mediators that participate in tissue repair, while HA provides a supporting scaffold within the extraction socket. Sharma et al. reported improved postoperative outcomes with the use of PRF and bone graft materials in third molar extraction sockets. Similarly, studies evaluating PRF and HA in mandibular third molar sockets have reported favourable postoperative healing outcomes with the combined approach.[8,9]

However, the absence of a significant difference in the outer canthus–angle of the mandible measurement indicates that the effect of the combination may vary according to the anatomical region assessed. Differences in the distribution of postoperative edema and the sensitivity of individual facial measurements may contribute to this variation. Therefore, the present findings support a reduction in swelling with PRF + HA for two of the three measurements rather than a uniform reduction across all facial dimensions.

Postoperative Pain

Pain following mandibular third molar surgery is influenced by the extent of tissue injury, inflammatory mediator release and individual pain perception. In the present study, postoperative pain was assessed using the Visual Analogue Scale (VAS) on days 1, 3 and 7.

The mean pain scores were slightly lower in the PRF + HA group on days 1 and 3, whereas the PRF group showed a marginally lower mean score on day 7. However, the differences between the groups were not statistically significant at any of the assessed intervals (day 1: $p = 0.263$; day 3: $p = 0.116$; day 7: $p = 0.510$). These findings indicate that the addition of HA to PRF did not produce a statistically demonstrable improvement in postoperative pain reduction.

PRF may contribute to postoperative comfort through its fibrin architecture and sustained release of growth factors involved in tissue repair. Previous studies evaluating PRF in mandibular third molar extraction sockets have reported reductions in postoperative pain compared with untreated extraction sites.[13,14] Nevertheless, the present study did not demonstrate a significant additional analgesic benefit from incorporating HA into PRF.

The findings suggest that PRF alone may be sufficient to support postoperative pain management, while the addition of HA may have a more noticeable influence on other healing parameters, particularly swelling and radiographic bone density. The absence of statistical significance should not be interpreted as proof of equivalence between the two interventions; larger studies may be required to identify smaller differences in postoperative pain outcomes.

Postoperative Trismus

Trismus is another important postoperative

complication following surgical removal of impacted mandibular third molars. It commonly results from inflammation, edema and trauma involving the muscles of mastication and surrounding tissues. In the present study, trismus was assessed by measuring the interincisal distance on postoperative days 1, 3 and 7.

The mean interincisal measurements were comparable between the PRF and PRF + HA groups at all three intervals. Although the PRF + HA group showed slightly higher mean measurements on days 1, 3 and 7, the differences were not statistically significant (day 1: $p = 0.458$; day 3: $p = 0.877$; day 7: $p = 0.321$). Both groups demonstrated progressive improvement in mouth opening during the postoperative period.

These findings indicate that the addition of HA to PRF did not provide a statistically significant advantage in reducing postoperative trismus. The limitation of mouth opening following third molar surgery is influenced by several factors, including surgical duration, degree of bone removal, tissue manipulation and postoperative inflammation. The effect of regenerative materials placed within the extraction socket may therefore be limited in relation to the functional recovery of the muscles of mastication.

Previous studies have demonstrated the potential of PRF to improve postoperative recovery following mandibular third molar surgery. However, the extent of its influence on trismus has varied across studies.[13,14] The findings of the present study indicate that both PRF and PRF + HA were associated with improvement in mouth opening, without a significant difference between the treatment groups.

Soft Tissue Healing

Soft tissue healing is an important indicator of postoperative recovery following surgical extraction. In the present study, healing was evaluated using the Landry healing index on postoperative days 1, 3 and 7.

Both groups demonstrated progressive improvement in soft tissue healing scores over the observation period. The PRF group showed a mean score of 2.66 ± 0.54 on day 1, 3.83 ± 0.91 on day 3 and 4.23 ± 0.72 on day 7. Corresponding values in the PRF + HA group were 2.56 ± 0.56, 3.63 ± 0.80 and 4.56 ± 0.50, respectively.

Although the PRF group had slightly higher mean scores on days 1 and 3, the PRF + HA group demonstrated a higher mean score on day 7. However, the differences were not statistically significant at any interval (day 1: $p = 0.461$; day 3: $p = 0.415$; day 7: $p = 0.077$). The results indicate a favourable trend towards improved soft tissue healing with PRF + HA at the seventh postoperative day, although this difference did not reach statistical significance.

The biological properties of PRF may contribute to soft tissue repair through the release of growth factors involved in angiogenesis, fibroblast proliferation and collagen formation. Dohan Ehrenfest et al. described the biological characteristics of platelet concentrates and their potential role in tissue regeneration.[15] HA may provide additional structural support within the extraction socket; however, its contribution to early mucosal healing may be less pronounced than its role in supporting bone regeneration.

Previous studies have reported favourable soft tissue healing following the use of PRF and bone substitute materials in extraction sockets.[9,10] The findings of the present study are consistent with the possibility of a beneficial effect of combining PRF with HA, particularly during the later stages of early postoperative healing. Nevertheless, because the observed differences were not statistically significant, the combination cannot be considered conclusively superior for soft tissue healing based on the present results.

Radiographic Bone Density

Bone regeneration is a major consideration following surgical extraction of impacted mandibular third molars, particularly when preservation of the alveolar socket is desired. In the present study, radiographic bone density was evaluated using digital orthopantomograms at four months postoperatively.

The PRF + HA group demonstrated a significantly higher mean bone density value than the PRF group. The mean value was 0.66 ± 0.88 in the PRF group compared with 1.40 ± 0.72 in the PRF + HA group. The difference was statistically significant ($p = 0.001$), indicating better radiographic bone density in the combination group at the four-month assessment.

This finding represents an important outcome of the present study and suggests that the addition of HA to PRF may improve radiographic bone regeneration within the extraction socket. The potential explanation

lies in the complementary properties of the two materials. PRF provides a biologically active fibrin matrix containing platelets, leukocytes and growth factors that participate in the healing process. HA acts as an osteoconductive scaffold, supporting cellular attachment and mineral deposition.[15,16]

Previous studies have also demonstrated the potential of HA-containing graft materials to improve radiographic bone healing following mandibular third molar extraction. Sharma et al. reported differences in bone healing among PRF, platelet-rich plasma and HA-treated extraction sockets, with HA demonstrating favourable radiographic bone density outcomes.[8] A comparative study evaluating PRF and PRF combined with HA also reported more favourable osseous regeneration in the combination group.[9] These findings provide support for the improved radiographic bone density observed in the present study.

The results should, however, be interpreted in the context of the radiographic assessment method. The present study used digital OPG-based measurements at a single four-month follow-up interval. Radiographic density provides an indirect indication of mineralization and does not independently establish the histological quality or maturity of newly formed bone. Furthermore, the measurement scale and unit should be clearly specified when reporting these values. Histological assessment or standardized quantitative imaging would provide additional evidence regarding the quality of bone regeneration.

Overall Interpretation of Findings

The findings of the present study demonstrate that the combination of PRF and HA produced significantly better outcomes in selected parameters of postoperative healing compared with PRF alone. The most notable differences were observed in facial swelling and radiographic bone density. The PRF + HA group demonstrated significantly lower swelling in two of the three facial measurements and significantly higher radiographic bone density at four months.

In contrast, postoperative pain and trismus did not differ significantly between the groups. Although the PRF + HA group showed a higher mean soft tissue healing score on day 7, the difference was not statistically significant. These findings indicate that the potential advantages of combining PRF with HA may be more evident in socket stabilization and bone regeneration than in immediate postoperative pain relief or functional recovery.

The results also highlight the importance of evaluating multiple dimensions of postoperative healing rather than relying on a single clinical parameter. While both treatment approaches were associated with favourable postoperative recovery, the addition of HA appeared to provide an advantage in selected inflammatory and radiographic outcomes.

Clinical Implications

The use of PRF combined with HA may be considered a useful adjunct in the management of impacted mandibular third molar extraction sockets, particularly when improved socket healing and bone regeneration are desired. PRF provides an autologous biological matrix, whereas HA contributes osteoconductive structural support. Their combination may therefore offer complementary benefits during the healing process.

However, the present findings do not establish superiority of PRF + HA across all postoperative outcomes. The lack of significant differences in pain, trismus and soft tissue healing should be considered when interpreting its clinical advantages. The selection of regenerative materials should therefore be based on the clinical requirements of the extraction site, the intended healing outcome and the availability of suitable materials.

Strengths of the Study

The study evaluated two regenerative approaches using multiple clinical and radiographic outcome measures. The assessment of postoperative pain, facial swelling, trismus and soft tissue healing provided a comprehensive evaluation of early postoperative recovery. The additional assessment of radiographic bone density at four months enabled comparison of a longer-term healing outcome. The inclusion of both clinical and radiographic parameters strengthens the overall evaluation of PRF and PRF combined with HA.

Limitations of the Study

The study included 60 patients, which may limit the statistical power to detect smaller differences between the groups, particularly for pain, trismus and soft tissue healing. Bone density was evaluated using digital OPG at a

single four-month interval, and the findings were not supported by histological analysis or three-dimensional imaging. The assessment of radiographic density should therefore be interpreted as an indirect measure of bone regeneration. In addition, longer follow-up would be useful to evaluate the stability and maturation of regenerated bone.

Future Scope

Further randomized controlled studies involving larger sample sizes and longer follow-up periods are recommended to validate the findings. Standardized radiographic assessment, preferably using quantitative three-dimensional imaging where clinically justified, may provide more reliable information regarding bone volume and mineralization. Future studies may also evaluate the cost-effectiveness, handling characteristics and long-term clinical outcomes of combining PRF with different bone graft materials.

Discussion Conclusion

The present study demonstrated that PRF combined with HA was associated with significantly reduced postoperative swelling in selected facial measurements and significantly higher radiographic bone density at four months compared with PRF alone. However, no statistically significant differences were observed in postoperative pain, trismus or soft tissue healing. These findings suggest that the combination of PRF and HA may offer an advantage in selected aspects of socket healing, particularly radiographic bone regeneration, while both approaches provide comparable outcomes for several early postoperative clinical parameters.

CONCLUSION

The present study demonstrated that the combination of platelet-rich fibrin (PRF) and hydroxyapatite (HA) provided better outcomes than PRF alone in selected parameters of healing following surgical removal of impacted mandibular third molars. The PRF + HA group showed significantly reduced postoperative swelling in two facial measurements and significantly higher radiographic bone density at four months ($p = 0.001$). However, no statistically significant differences were observed between the groups in postoperative pain, trismus or soft tissue healing. Although both treatment groups demonstrated progressive improvement during the postoperative period, the addition of HA appeared to offer an advantage in controlling swelling and promoting radiographic bone regeneration. Thus, PRF combined with HA may be considered a useful adjunct for improving selected aspects of extraction socket healing, particularly bone regeneration, following impacted mandibular third molar surgery.

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