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Comparing The Efficacy of Photobiomodulation and Platelet-Rich Fibrin on Post Surgical Paraesthesia in Patients Undergoing BSSO: A Randomized Control Trial

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Abstract

Introduction: Bilateral sagittal split osteotomy (BSSO) frequently results in inferior alveolar nerve (IAN) injury, with neurosensory disturbances (NSD) like paraesthesia affecting up to 91% of patients immediately postoperatively, dropping to 44-57% at 6-12 months in controls. Photobiomodulation (PBM) and platelet-rich fibrin (PRF) have shown individual promise in accelerating recovery via anti-inflammatory effects, growth factor release, and neural regeneration, but direct comparisons are lacking.

Aims and Objectives:

Aims

- To assess and compare the effectiveness of photobiomodulation therapy, platelet-rich fibrin and their combination in improving postoperative neurosensory recovery following Bilateral Sagittal Split Osteotomy.

Objectives

- To evaluate the effectiveness of photobiomodulation therapy in improving postoperative neurosensory recovery in patients undergoing Bilateral Sagittal Split Osteotomy.
- To evaluate the effectiveness of platelet-rich fibrin in improving postoperative neurosensory recovery in patients undergoing Bilateral Sagittal Split Osteotomy.
- To compare the effectiveness of photobiomodulation therapy and platelet-rich fibrin in improving postoperative neurosensory recovery in patients undergoing Bilateral Sagittal Split Osteotomy.

Material and Method:

Study Design: The study was designed as a prospective randomized controlled clinical study.

Study Place: The study was carried out the Department of Oral and Maxillofacial Surgery, Sree Anjaneya Institute of Dental Sciences, Modakkallur

Study Period: The study was conducted over 24 a period of months.

Study Participants: A total of 18 patients with postoperative paraesthesia following Bilateral Sagittal Split Osteotomy were included in the study.

Sample Size: A total sample size were 18.

Result: All three treatments improved pain and neurosensory outcomes over time, with significant within-group reductions ($p<0.01$). PBM + PRF showed the greatest gains (VAS 5.17±1.17 and two-point discrimination 4.83±1.72 mm at 1 year; 47.3% sensory improvement) versus PRF (VAS 6.00±1.41; 43.4%) and PBM (VAS 5.83±1.47; 25.0%), though between-group differences were not significant ($p>0.05$); 50% normal sensation in PBM/PRF groups at 1 year, no adverse events.

Conclusion: Within the limitations of this study, Photobiomodulation (PBM), platelet-rich fibrin (PRF), and their combination all improved pain reduction and neurosensory recovery over time, with PBM + PRF showing the greatest gains—though intergroup differences lacked statistical significance. These results indicate that PBM and PRF effectively aid postoperative recovery, and combining them may provide added clinical benefits for neurosensory healing. Larger studies with extended follow-up are needed to validate these findings.

Keywords: BSSO, IAN Injury, Photobiomodulation, Platelet-Rich Fibrin, Paraesthesia.

Introduction

Trigeminal nerve damage is a danger associated with surgical procedures in oral and maxillofacial practice, such as the administration of local anaesthesia, the extraction of third molar [1], the insertion of dental implants, orthognathic adjustments, and the use of stiff internal systems for fracture fixation. The most commonly impacted structure is the inferior alveolar nerve (IAN) [2], which is the main cause of paraesthesia. Treatment options for nerve damage include pharmaceutical medications, electrical stimulation, acupuncture, physical rehabilitation, microsurgical procedures, and more. Neuropraxia, axonotmesis, and neurotmesis are the three severity levels identified by Seddon's classification [3]. Usually, neurotmesis requires microsurgical repair through grafting or anastomosis.

Low-intensity laser therapy, a form of photobiomodulation (PBM), offers a non-thermal method to address nerve damage by alleviating pain, fostering tissue regeneration, and curbing inflammation. It boosts beta-endorphin release, enhances neurotransmission and vascular flow for inflammation clearance, accelerates wound healing, supports osteogenesis, and restores neural integrity. Additional mechanisms include DNA repair, enzyme activation, photochemical signaling cascades, and immune system modulation [4]. Bilateral sagittal split osteotomy (BSSO) ranks among the most common mandibular procedures, prized for its adaptability across the ramus and body. This orthognathic technique involves sagittal cuts to reposition the mandible anteriorly or posteriorly.

Platelet-rich fibrin (PRF)—an autologous second-generation platelet concentrate introduced in 2001—has surged in popularity within oral and maxillofacial surgery. Derived from concentrated patient platelets, PRF harbors progenitor cells pivotal for wound closure and osteogenesis, alongside key growth factors like platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), insulin-like growth factor (IGF), platelet factor 4 (PF4), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), and platelet-derived endothelial cell growth factor [5].

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Sample Size Estimation

Sample size is determined using the following formula

$$n = \frac{z\ 1\text{-}\alpha/2\ 2\ p(1\text{-}p)}{d2}$$

Where,

p = previous expected values

d =desired Margin of error

Z1-α/22 confidence interval of 95%,

n = sample size

Analysis: A priori: Compute required sample size

Input: Tail(s) = One

Slope H1 = 0.19

α err prob = 0.05

Power (1-β err prob) = 0.95

Slope H0 = 1

Std dev σ_x = 0.1

Output:

Noncentrality parameter δ = 0.129

Critical t = 1.874

Df = 10

Total sample size = 18

Actual power = 0.793

With above mentioned calculation, sample size determined is 18 by G power analysis, the total sample size with 95% of confidence interval is calculated to be 18. Considering three groups, each will have a sample size of 6.

Inclusion Criteria

- Adult patients aged 18 years and above who underwent Bilateral Sagittal Split Osteotomy.
- Patients presenting with postoperative inferior alveolar nerve paraesthesia / neurosensory deficit following BSSO.
- Patients willing to participate in the study and provide written informed consent.

Exclusion Criteria

- Patients with pre-existing neurosensory disturbances prior to surgery.
- Patients with diabetic neuropathy or other systemic neuropathic conditions.
- Patients with hyperesthesia or dysesthesia.
- Patients unwilling to participate or unable to comply with follow-up protocol.

Statistical Analysis

The collected data were compiled and analyzed using IBM SPSS Statistics. Descriptive statistics were used to summarize the study variables. Continuous variables such as age, VAS scores, and two-point discrimination values were expressed as mean ± standard deviation (SD) along with minimum and maximum values where appropriate. Categorical variables such as gender distribution and contact detection scores were presented as frequency and percentage. For baseline comparisons, the mean age among the three study groups was compared using one-way analysis of variance (ANOVA). Gender distribution among the groups was analyzed using the Chi-square test. For paraesthesia assessment, VAS scores recorded at 2 months, 6 months, and 1 year were analyzed. Between-group comparisons at each time interval were performed using one-way ANOVA. Within-group comparisons over time were evaluated using repeated measures ANOVA to determine whether there was a significant reduction in pain scores during the follow-up period. The overall percentage change from 2 months to 1 year was also calculated to quantify improvement within each group. For sensory evaluation, two-point discrimination values measured in millimeters at different follow-up intervals were analyzed similarly. Between-group comparisons were performed using one-way ANOVA, while changes within each group over time were analyzed using repeated measures ANOVA. Contact detection was assessed using a categorical scoring system where 0 represented no sensation, 1 represented reduced sensation, 2 represented normal sensation, and 3 represented increased or unpleasant sensation. As this variable was categorical, the distribution of scores among the study groups was compared using the Chi-square test.

Result

Table 1: Between-Group Comparison of Age Among Study Groups

Group	Treatment Modality	Mean ± SD (years)	Minimum	Maximum
Group I	Photobiomodulation (PBM)	23.67 ± 9.73	18	43

Group II	Platelet Rich Fibrin (PRF)	22.00 ± 3.10	17	26
Group III	PBM + PRF	25.17 ± 3.66	22	31

The mean age of participants in Group I (Photobiomodulation) was 23.67 ± 9.73 years, with an age range of 18–43 years. In Group II (Platelet Rich Fibrin), the mean age was 22.00 ± 3.10 years, ranging from 17 to 26 years. Participants in Group III (PBM + PRF) had a mean age of 25.17 ± 3.66 years, with ages ranging from 22 to 31 years.

Graph 1:

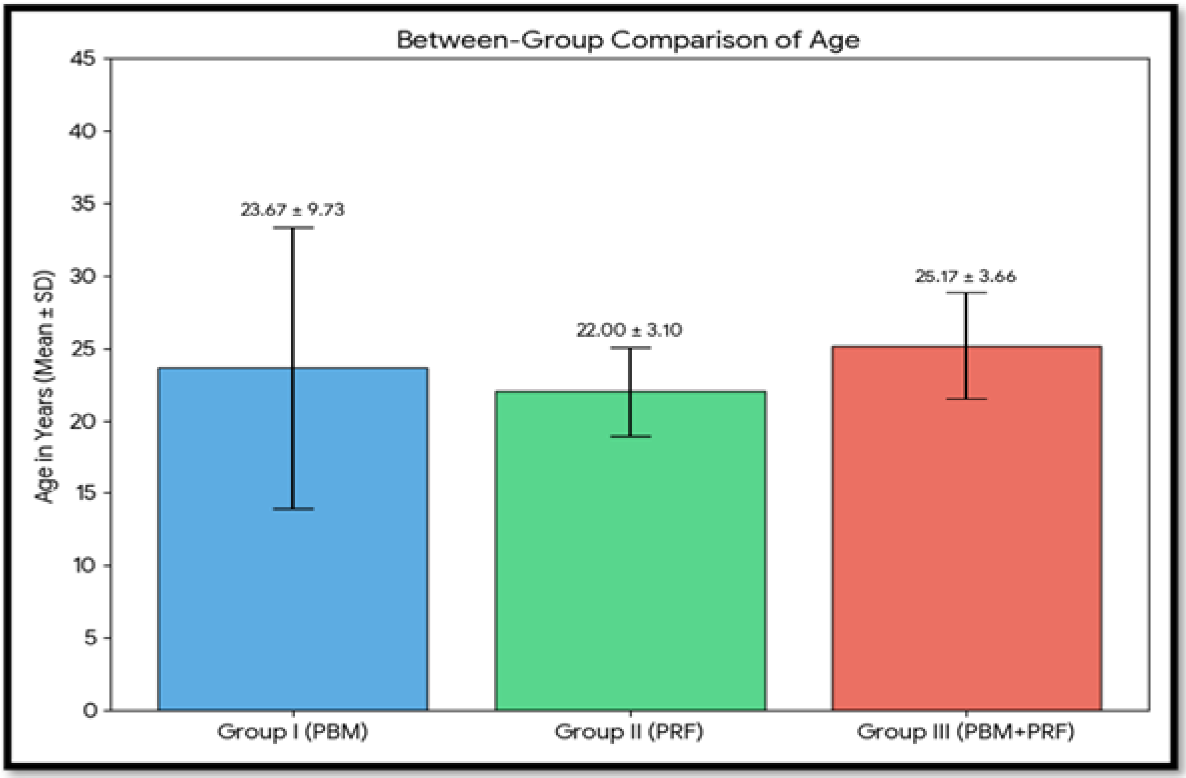

Table 2: Gender Distribution Among Study Groups

Gender	Group I – PBM n (%)	Group II – PRF n (%)	Group III – PBM + PRF n (%)	χ^2	p value
Male	0 (0%)	5 (83.3%)	5 (83.3%)	8.73	0.056
Female	6 (100%)	1 (16.7%)	1 (16.7%)		

Chi square test * P<0.05 is statistically significant

In Group I (PBM), all participants were female (100%). In Group II (PRF), the majority were male (83.3%), with one female participant (16.7%). Similarly, in Group III (PBM + PRF), 83.3% were male and 16.7% were female. The comparison of gender distribution among the study groups using the Chi-square test showed no statistically significant difference (χ^2 = 8.73, p = 0.056).

Graph 2:

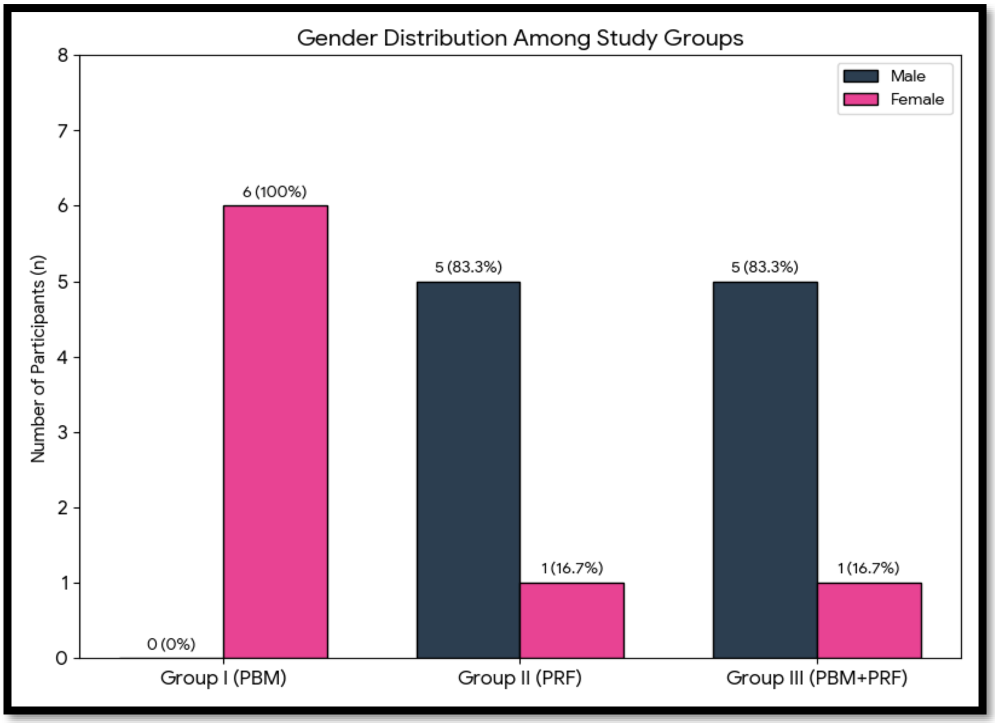

Table 3: Within-Group Comparison of VAS Scores Over Time

Time Interval	Group I – PBM (Mean ± SD)	Group II – PRF (Mean ± SD)	Group III – PBM + PRF (Mean ± SD)
2 Months	7.83 ± 1.47	8.00 ± 1.41	8.50 ± 0.55
6 Months	6.83 ± 1.47	7.00 ± 1.41	7.33 ± 0.52
1 Year	5.83 ± 1.47	6.00 ± 1.41	5.17 ± 1.17
Overall % change (2M–1Y)	25.5% ↓	25.0% ↓	39.2% ↓
F value	18.67	20.34	29.21
p value	0.001*	0.001*	<0.001*

Repeated measures of Anova test * P<0.05 is statistically significant

Within-group comparison of VAS scores demonstrated a progressive reduction in pain levels across all three treatment groups during the follow-up period. In Group I (Photobiomodulation), the mean VAS score decreased from 7.83 ± 1.47 at 2 months to 6.83 ± 1.47 at 6 months and further to 5.83 ± 1.47 at 1 year, representing an overall reduction of 25.5%. Similarly, in Group II (Platelet Rich Fibrin), the mean VAS score declined from 8.00 ± 1.41 at 2 months to 7.00 ± 1.41 at 6 months and to 6.00 ± 1.41 at 1 year, corresponding to a 25.0% reduction in pain scores. The greatest reduction was observed in Group III (PBM + PRF), where the mean VAS score decreased from 8.50 ± 0.55 at 2 months to 7.33 ± 0.52 at 6 months and to 5.17 ± 1.17 at 1 year, indicating a 39.2% improvement from baseline. Statistical analysis using repeated measures ANOVA revealed that the reduction in VAS scores over time was statistically significant in all three groups ($p \leq 0.001$), indicating that each treatment modality contributed to a significant reduction in postoperative pain perception.

Graph 3:

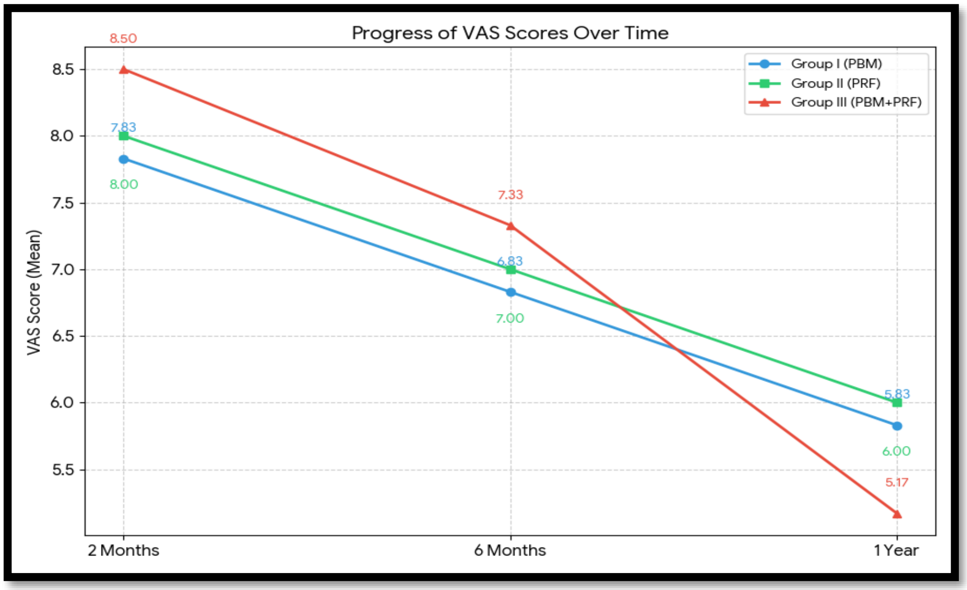

Table 4: Between-Group Comparison of Two-Point Discrimination (mm)

Time	Group I (PBM)	Group II (PRF)	Group III (PBM+PRF)	p value
2 Months	8.00 ± 2.10	8.83 ± 1.17	9.17 ± 0.98	0.41
6 Months	7.00 ± 2.10	7.17 ± 1.47	8.00 ± 1.26	0.48
1 Year	6.00 ± 2.10	5.00 ± 2.19	4.83 ± 1.72	0.32

One way Anova test * P<0.05 is statistically significant

Between-group comparison of two-point discrimination values revealed a gradual decrease in discrimination distance across all treatment groups over the follow-up period. At 2 months, the mean two-point discrimination values were 8.00 ± 2.10 mm in Group I, 8.83 ± 1.17 mm in Group II, and 9.17 ± 0.98 mm in Group III. At 6 months, these values improved to 7.00 ± 2.10 mm, 7.17 ± 1.47 mm, and 8.00 ± 1.26 mm, respectively. By 1 year, the mean values further decreased to 6.00 ± 2.10 mm in Group I, 5.00 ± 2.19 mm in Group II, and 4.83 ± 1.72 mm in Group III, indicating progressive sensory recovery. Although Group III showed comparatively lower two-point discrimination values at the final follow-up, suggesting better sensory improvement, statistical analysis showed no significant difference between the three groups at any time interval ($p > 0.05$).

Table 5: Between-Group Comparison of Contact Detection

Score	Sensory Response	Group I (PBM) n (%)	Group II (PRF) n (%)	Group III (PBM+PRF) n (%)	χ^2	p value
0	No sensation	0 (0%)	0 (0%)	2 (33.3%)	2.57	0.28
1	Reduced sensation	3 (50.0%)	3 (50.0%)	3 (50.0%)		
2	Normal sensation	3 (50.0%)	3 (50.0%)	1 (16.7%)		
3	Increased / unpleasant sensation	0 (0%)	0 (0%)	0 (0%)		

Chi square test * $P<0.05$ is statistically significant

Contact detection scores were compared among the three treatment groups using the Chi-square test. In Group I (PBM), 50% of participants exhibited reduced sensation and 50% demonstrated normal sensation at the final follow-up, while none reported absence or increased sensation. Similarly, in Group II (PRF), half of the participants showed reduced sensation and the remaining half demonstrated normal sensation. In contrast, Group III (PBM + PRF) showed a slightly different distribution, where 33.3% of participants had no sensation, 50% exhibited reduced sensation, and 16.7% demonstrated normal sensation, while none reported increased or unpleasant sensation. Statistical comparison of the frequency distribution of sensory responses revealed no statistically significant difference between the three groups ($\chi^2 = 2.57$, $p = 0.28$). This suggests that although improvements in tactile sensation were observed in all groups, the distribution of sensory recovery outcomes did not differ significantly among the treatment modalities.

Discussion

The present study evaluated the effectiveness of photobiomodulation (PBM), platelet-rich fibrin (PRF), and a combination of PBM + PRF in improving neurosensory recovery. Baseline comparison showed that the age distribution among the three groups was comparable, while a statistically significant difference was observed in gender distribution. VAS scores demonstrated a progressive reduction in paraesthesia levels over the follow-up period in all groups. Within-group analysis revealed a statistically significant decrease in VAS scores over time, indicating improvement in postoperative paraesthesia. The greatest percentage reduction in VAS scores was observed in the PBM + PRF group, suggesting enhanced paraesthesia relief with combination therapy. However, between-group comparisons at each time interval did not reveal statistically significant differences.

Neurosensory disturbances following Bilateral Sagittal Split Osteotomy, particularly those resulting from trauma to the inferior alveolar nerve, represent a common and clinically significant postoperative complication [6]. Conventional treatment modalities have demonstrated variable success and possess inherent limitations, which has led to increasing interest in newer, minimally invasive therapeutic strategies. In this context, the present study was designed to evaluate the therapeutic efficacy and safety of photobiomodulation.[7] Eighteen patients were randomly allocated into three groups of six patients each. Group I received PBM alone, Group II received PRF placement at the osteotomy site on the treatment side, and Group III received a combination of PBM and PRF.

The present study demonstrated progressive neurosensory improvement in all three groups during the follow-up period, indicating that PBM, PRF, and combination therapy each contributed positively to postoperative nerve recovery. However, comparatively greater improvement was observed in the combination group, suggesting that the adjunctive use of PRF with PBM may enhance the regenerative response. The beneficial effects of PBM may be attributed to its ability to improve mitochondrial activity, increase ATP synthesis, reduce inflammation, and promote neural tissue repair. PRF, being an autologous biomaterial rich in growth factors, may support angiogenesis, Schwann cell proliferation, extracellular matrix remodeling, and axonal regeneration [9].

Conclusion

Within the limitations of the present study, all three treatment modalities photobiomodulation (platelet-rich fibrin and the combination of PBM + PRF—demonstrated progressive improvement in postoperative neurosensory recovery over the follow-up period.

Although the combination therapy group showed comparatively greater clinical improvement in paraesthesia and sensory recovery, the intergroup differences were not statistically significant. Therefore, it may be inferred that PBM and PRF are both clinically effective adjunctive modalities in the management of postoperative neurosensory disturbances following Bilateral Sagittal Split Osteotomy and their combined use may provide additional therapeutic benefit.

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