Research Article

Comparative Radiographic Evaluation of Bone Regeneration At Mandibular Symphysis and Parasymphysis Fracture Site With or Without Application of Platelet Rich Plasma (Prp)

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Abstract:

Introduction: In order to treat maxillofacial traumatic injuries (MFT), platelet-rich plasma (PRP) has become the most preferred option due to a recent paradigm shift towards a regenerative strategy. However, it could be challenging to quickly assess bone regeneration using standard radiography tools like OPG and RVG. Furthermore, conflicting findings have been documented regarding the same.

Aim: To compare radiographic evaluation of bone regeneration at different time intervals in mandibular symphysis and parasymphysis fracture site with or without application of PRP.

Materials & Method: A total of twenty patients (n=20) participated in a prospective clinical trial conducted at Department of Oral and Maxillofacial Surgery, School of Dental Sciences, Krishna Vishwa Vidyapeeth (KVV), Karad, Maharashtra, India during the period of June 2023 to December 2024. The total samples were split into two groups at random using the odd-even sequence randomization approach wherein the odd-numbered serials were allocated as “Group A” designated as the study group & even numbered serials were allocated as “Group B” designated as the control group. Group A (study group) underwent ORIF with PRP and Group B (control group) underwent ORIF without PRP. Bone regeneration over time in both the groups were quantitatively assessed by observing bone density variations radiographically using Orthopantomagram (OPG) & Radiovisiography (RVG) at different time intervals (preoperative, immediate post operative, one-month post-operative & six-month post-operative follow up). Pixel values and resolution values were visualized using Microsoft Paint (Version 11.2210.4.0) software at each time interval by precisely observing gray scale changes in width and height of bone formation. SPSS software version 26 was used to compute the data. Inter-group comparisons were measured using the Shapiro-Wilk test, Bonferroni post hoc testing, unpaired t test, and ANOVA.

Results: During the pre-operative phase, there was no statistically significant difference in pixel values in OPG and RVG between Group A & Group B (p-value=0.2) whereas the resolution values for RVG indicated no statistically significant difference between groups with p-values of 0.16 and 0.15 respectively. Immediate post-operative OPG pixel values & resolution values showed a statistically significant difference between the two groups with a p-value of 0.0106. Immediate post-operative RVG pixel & resolution values showed no discernible difference between the two groups with a p-value of 0.726. In case of OPG values for pixel and resolution values at 1 month and 6 months demonstrated a statistically significant difference for resolution at 6 months, with the Group A exhibiting greater post-operative resolution values than Group B, as indicated by the Chi-square value of 49.39 (p =0.025). RVG values between the study and control groups for pixel and resolution values at one and six months demonstrated significant differences between both groups with p = 0.023 and p = 0.015 respectively.

Conclusion: This study demonstrated that PRP treated group demonstrated superior healing and improve bone regeneration in cases of mandibular parasymphysis and symphysis fractures in ORIF treated cases that were assessed radiographically using RVG and OPG at different time intervals.

Keywords: Bone regeneration, Platelet rich plasma, Mandibular fractures, radiographic pixel, radiographic resolution.

Introduction:

Maxillofacial traumatic injuries (MFT) are the most frequent injuries encountered in Indian population, especially in younger adults. According to epidemiological data, males (37.5%) aged of 21-30 yrs are most commonly affected due to the fact that this age group is more susceptible/vulnerable to falls, sports-related mishaps, road accidents, and/or interpersonal aggression. Regarding, anatomical distribution, mandible is most commonly involved i.e symphyseal and parasymphyseal areas (34%), followed by mandibular body (22.3%) and condylar process (0.66%) [1-2].

Early therapies relied mostly on conservative measures such as closed reduction, maxillomandibular fixation (MMF) & open reduction and internal fixation (ORIF). Although effective, these methods cognated with prolonged immobility, malnutrition, delayed normal function, postoperative infections, potential damage to adjacent neurovascular systems, and occasionally, the need for frequent follow-ups. Furthermore, in order to overcome these enduring constraints, more focus shifted towards improving the biological component of bone healing & hence Platelet-Rich Plasma (PRP) became the most popular regeneration therapy during this period. An era of golden transition in treatment of MFT from "simply achieving mechanical stability to biologically active augmentation" came into existence [3-5]. Since osteogenesis, angiogenesis, and soft tissue healing are stimulated by PRP, it acts as a prospective adjunct to overcome the drawbacks of traditional treatments and accelerate the healing process, particularly in situations of complicated or damaged fractures. Moreover, prompt radiographic evaluation of bone healing applying existing radiographic diagnostic tools such as Orthopantomogram (OPG) and Radiovisiography (RVG) can aid clinicians with indirect evidence of the physiological mechanisms underlying regeneration. Various studies have correlated and examined the relationship between pixel value, bone density and fracture healing with PRP treated cases by applying different radiographic tools. Premsak Sakarinpanichakul (2026) [6], Ahmed A. Elhamshary (2023) [7], Xu Z et al. (2022) [8], Heba Mohammad Fayed (2019) [9] & Daif, E.T. et al (2013) [5] investigated and found that larger pixel value enhanced the identification of high-density bone areas and fracture sites, especially when regeneration therapies like PRP and Bone Morphogenetic Proteins (BMPs) were applied. According to these studies, greater pixel value improves grayscale differences across tissue types, making it easier to identify regions of mineralized bone. Furthermore, these studies speculated that when bone heals and becomes thicker, it changes from radiolucent to radiopaque on radiography. They documented that the best way to capture the densification process is through measuring the bone density variations and monitoring the bone changes overtime. Hence, they concluded that pixel size dimensions and mapping of the gray scale changes within a specific region of interest (ROI) directly correlates with the bone density changes and help the clinicians to accurately track bone regeneration with PRP. Thereafter, various comparative studies [11-19] involving different diagnostic modalities like Cone Beam Computed Tomography (CBCT), Computed Tomography (CT), Micro-Computed Tomography (Micro-CT), Dual-Energy X-ray Absorptiometry (DEXA), Magnetic Resonance Imaging (MRI), Ultrashort Echo Time (UTE), and Zero Echo Time (ZTE) were further conducted to quantitatively measure bone density variations. However, these were highly expensive, inaccessible in underdeveloped nations, and carried a significant risk of radioactive tracer exposure. Additionally, few clinical trials reported conflicting findings indicating that PRP had no statistically significant advantages over traditional therapeutic approaches (MMF, Closed reduction, ORIF) [14-20].

Based on the identification of this research gap, the present study aimed to compare radiographic evaluation of bone regeneration at mandibular symphysis and parasymphysis fracture site, treated with ORIF, with or without application of PRP at different time intervals (preoperative, immediate post operative, one month and six month follow up). Null hypothesis was set as "There is no difference in radiographic evaluation of bone regeneration at mandibular symphysis and parasymphysis fracture site, treated with ORIF, with or without application of PRP at different time intervals".

Materials & Methods: A randomized clinical trial was conducted in the Department of Oral and Maxillofacial Surgery, School of Dental Sciences, Krishna Vishwa Vidyapeeth (KVV), Karad, Maharashtra, India during the period of June 2023 to December 2024. The study was initiated after due approval of an institutional ethical committee, bearing the Protocol No. 687/2022-2023. CTRI Reg. No. CTRI/2025/02/081201 was duly obtained (https://ctri.nic.in/Clinicaltrials/pdf_generate.php). The study was conducted as per the "World Medical Association Declaration of Helsinki (Carlson, Boyd, and Webb, 2004) & PRIRATE guidelines [21].

Sample size calculation: A longitudinal study conducted by Daif E. T. et al. "on mandibular fractures treated with PRP that examined the radiographic parameters for optimal healing assessment" was considered as a reference/parent article for choosing the appropriate sample size. The sample size formula applied was:

$$[(Z_{1-\alpha/2}+Z_{1-\beta})^2 * (SD_1^2 + SD_2^2)] / (M_1-M_2)^2$$

The predicted sample size was 12 (six for each group). After accounting for 15% attrition rate, the final sample size used was 20 (ten for each group). G*Power version 3.0.1 (Franz Faul universitat, Kiel, Germany) was used to create a power analysis.

Eligibility criteria: The study included patients in the age group 25 – 60 yrs, patients with mandibular symphysis or parasymphysis fracture, unilateral or bilateral, displacement of the jaw and /or associated facial injuries requiring ORIF having serum platelet count > 1.5 lakhs, individuals belonging to ASA I and ASA II and patients willing to take part in the research. Fracture sites with signs of infection, patients with bone pathologies such as osteoporosis, medically compromised individuals, history of previous surgeries and non-ambulatory patients were excluded from the study.

Randomization & allocation concealment: Simple randomization based on CONSORT guidelines was duly followed by applying odd-even sequence method to ensure unbiased allocation and preserve group homogeneity. At the time of enrollment, patients were assigned serial numbers. Group A (study group) was assigned with odd-numbered serial, whereas Group B (control group) was assigned to even-numbered serial numbers. The head nurse enrolled and allocated the mandibular fracture cases (study participants) through computer generated "randomizer.org" method (www.randomizer.org). Each patient's details and the designated instrumentation technique were recorded and sealed in an envelope after the examinations. The head nurse created the participant enrollment and allocation sequence. To guarantee uniformity, every surgery was carried out by a skilled oral surgeon. The investigator conducting the intervention was blinded in order to reduce the possibility of bias; the oral surgeon applied PRP to the fracture site only after receiving notification from head nurse following the conclusion of the PRP group participants' initial treatment sessions. The entire procedure was done applying CONSORT guidelines. To reduce bias, the statistician and the outcome assessor, the individual assessing the radiographic images and clinical data were blind to the equipment groups. Following the completion of a full and comprehensive case history, an initial trauma assessment was performed using the standard ABCDE methodology. This was subsequently followed by a comprehensive head-to-toe secondary survey that included a physical examination to identify all injuries. A neurological state assessment was also done, along with examination, palpation, percussion, and auscultation of the main systems (cranium, neck, chest, belly, pelvis, and extremities). CT, or computed tomography, scans were performed on patients to assess head injuries. The trauma sheets were filled up and recorded as part of the medical records, carefully documenting every finding. Vital signs, descriptions of injuries, preliminary treatments, imaging data (if any), and clinical impressions were all included. As per the inclusion criteria, patients with maxillofacial trauma (MFT), particularly those with mandibular symphysis or parasymphysis fractures were clinically evaluated and the first line of intervention was meticulously followed as per the Advanced Trauma Life Support (ATLS) guidelines. In order to balance effectiveness and safety, particularly in patients with multisystem trauma or renal impairment, antibiotic & analgesic coverage were customized to each patient's pain threshold and clinical condition. As part of the pre-operative evaluation for general anesthesia fitness/pre-anaesthetic checkup (OAC), a comprehensive series of pre-anesthetic investigations were requested concurrently.

Autologous PRP Preparation: PRP was made by hand using the double-spin method using Platelet Rich Plasma Centrifuge & Kit (Platelet Rich Plasma (REMI-PRP) Ultra; Rajendra Electric Motor Industries, Mumbai, India). To avoid premature platelet activation and degranulation, a total of 20 mL of blood was extracted from the antecubital vein using a sterile syringe and transferred into an anticoagulant tube containing sodium citrate. At roughly 1500 revolutions per minute (rpm), the initial centrifugation (soft spin) was carried out for five minutes. This resulted in three layers: platelet-poor plasma (PPP), a layer of red blood cells at the bottom and a layer of buffy coat with PRP in the center. A second sterile tube was used to delicately aspirate the PPP, buffy coat, and a little amount of red blood cells, this time without the use of an anticoagulant. The second centrifugation (hard spin) was carried out at 2500 rpm for around 15 minutes. After then, an automatic cell counter was used to confirm the produced PRP's platelet count. The final PRP solution was collected into an insulin syringe that had been preloaded with calcium gluconate in a 1:9 ratio (calcium gluconate: PRP), which neutralized the anticoagulant effect of sodium citrate to act as a platelet activator. During surgery, Group A fracture site was covered with activated PRP [22].

ORIF Surgical procedure: In order to produce vasoconstriction, local anesthesia (lignocaine with 2% adrenaline 1:2,00,000) was administered along the mucosa above the fracture line following the pre-anesthetic check-up (PAC). Erich arch bars and Stainless-Steel wire number 26 (AK Surgicals, Delhi, India) were used to position the mandibular and maxillary arch bars. A standardized surgical approach ORIF was performed on all patients in order to treat mandibular fractures. To reduce procedural variability, the surgical technique was the same for both groups and was performed by a single, skilled maxillofacial surgeon to reduce bias. Autologous PRP was administered directly to the fracture site in Group A after the ORIF treatment was finished. The intraoral closure was finished with Vicryl 3-0, a resorbable suture material. A dynaplast bandage was used as a pressure dressing. After being extubated, the patient was sent to the recovery area.

Radiographic assessment using OPG & RVG with ROI: The region of interest (ROI) in the present study was mandibular symphysis and para symphysis areas especially the fracture site treated for Group A and Group B. The present study maintained uniform consistency in assessing the ROI by applying the ruler tool available in Microsoft paint to avoid any selection bias. The ROI was selected by the authors by setting specific inclusion/exclusion criteria. The radiographic images obtained from OPG and RVG demonstrating patients with maxillofacial trauma (MFT), particularly those with mandibular symphysis or parasymphysis fractures were only included, thereby excluding other cases. Double blinding was applied through metadata stripping wherein all DICOM tags containing patient names, dates of birth, hospital IDs, and original acquisition site were masked/removed or replaced with neutral, randomized identifiers and the ROI parametric dimensions included height and width of bone measured for each case using the Microsoft ruler tool. In multi-time point assessment, radiographic images were frequently presented in a randomized temporal order rather than chronological order to prevent bias in measuring bone formation after PRP. To avoid inter examiner and intra examiner variability, the authors selected external experts in the field of oral radiology for precise interpretation of radiographic images. "Double Reading with Adjudication" method was applied in which two radiologists reviewed images independently and if any discrepancy was observed, a blinded third reader evaluates the images to reach to a consensus.
In the present study, the radiographic standardization for OPG & RVG was achieved by following the ALARA (As Low as Reasonably Achievable) principles & guidelines. The patient preparation and use of protective lead collar or apron was strictly adhered as per the radiation safety protocols. Selective collimation and precise automated kVp and mA Optimization of OPG can modulate the exposure time based on the patients jaw size and shape. In case of RVG, rectangular collimation and parallel technique ensures perfect geometric alignment and avoid image distortion. The machines were calibrated to minimize radiation exposure to the lowest possible dose while maintaining image clarity. Radiographic images with clear visibility of anatomical jaw structures with adequate density and contrast providing clear demarcation were achieved by following standard protocols.

Digital method of assessment: The main purpose of using Microsoft paint in the present study was to precisely observe the region of interest (ROI) areas of bone formation after PRP application in mandibular parasymphysis and symphysis fractures treated with ORIF procedure so as to automatically calculate pixel values and image resolution values through "segmental preprocessing" phenomena. It aided in importing the radiographic images obtained from OPG & RVG into a dedicated software and further provided micro-detailing of specific anatomical landmarks needed to assess the large-scale bone regeneration and healing process. However, Microsoft paint only modifies and displays the exported images and acts as an image editing tool and not a quantifiable densitometry tool in research for data annotations before analysis. Moreover, Microsoft paint features rapid screenshot processing, zero learning curve and built in annotation for highlighting specific data images, and hence the present study applied this tool. Furthermore, it is user friendly and freely available with smart art integration technology making quick assess to various functional elements for making data consistent and professional. The color coding and ruler tool element available in Microsoft paint helped to mark the height and width of bone formed after PRP treatment. No previous literature studies have applied this tool for captured radiographic images and hence the present study implemented this tool for bridging the research gap in clinical translational studies. However, this tool was applied in previous scientific evidence-based studies for captured histological images, manual color coding of histological structures (hard /soft tissue counterparts) and histomorphometric assessment [23].

Post-operative management protocol: Standardized postoperative care and oral hygiene practices as per standard protocol was given to every patient in order to reduce the impact of confounding variables and guarantee uniformity in recovery.

Postoperative Follow Up and Evaluation Protocol: Evaluations for postoperative follow-up were conducted immediately after surgery, one month later, and six months later (Figure 1-4). Microsoft Paint (Version 11.2210.4.0) was utilized for image analysis in order to assess bone density variations. Pixel value & resolution values at each postoperative time point served as the basis for measurements. The PORT-X II portable X-ray machine and RVG sensor setup were used for radiovisiography (RVG) imaging during follow-up. After being examined with CSISuiteSetup software, the acquired RVG images were transferred to an HP Pavilion 14 (12th Gen Intel Core i7, 16GB SDRAM, 1TB SSD, 14-inch hard drive).

Statistical analysis: The data obtained was subjected to SPSS software version 26. The significance level was set at 5%. The Shapiro-Wilk test was used to assess the normality of the data. The unpaired t-test was used to compare groups. Intergroup comparisons over time, repeated measures ANOVA or Bonferroni post hoc tests were employed as needed. Equivalent non-parametric tests were employed if the data did not satisfy the normality assumptions.

Results:

In the present study, a total of twenty patients were included that were randomly divided into two groups, Group A (study group) involving ORIF with PRP and Group B (control group) involving ORIF without PRP. The mean age range of participants in Group A was 33.2±5 years and for Group B was 29.7±4 years. The gender distribution of this study revealed 90% (n=18) of the study group and 80%(n=16) of the control group were male and 10% (n=2) of study group and 20% (n=4) of control group were female.

Preoperative pixel size: Preoperative radiographic pixel size in Group A (PRP-treated) were greater than those in Group B (non-PRP), as determined by OPG and RVG. Table 1 indicates preoperative pixel size and resolution values between Group A & Group B with p values. This observation implies that the baseline bone density of both groups was similar, suggesting that any variations in future healing and regeneration are more likely to be due to the impact of PRP than to the quality of the starting bone.

Pre-operative resolution values: The Group A resolution values were higher compared to Group B both for OPG & RVG with a significant p-value as shown in table 1 indicating that the Group A (study group) had higher OPG Resolution values.

Immediate post-operative OPG pixel size & resolution values: A statistically significant difference between the two groups was indicated as shown in table 2. This implied that, in comparison to the Group B, the post-operative OPG values for Group A, both pixel size and resolution values were noticeably higher.

Immediate post-operative RVG pixel size & resolution values: RVG values for both pixel size and resolution values was higher for group A with no statistically significant difference between inter-groups (Table 2).

Pixel size and resolution values at 1-Month between both groups: The 1-month post-operative pixel size and resolution values between Group A & Group B is depicted in Table 3. The OPG & RVG values were higher for Group A with statistically significant p values. However, there was no much discernible difference in resolution values at one month follow up.

Pixel size and resolution values at 6-Month between both groups: The 6-month post-operative pixel size and resolution values between Group A & Group B is depicted in Table 4. The OPG & RVG values were higher for Group A with statistically significant p values. However, there was no much discernible difference in resolution values at one month follow up.

Discussion:

In the present study, the mean age range of participants in both the groups was 31.5±5years (Group A- 33.2 years & Group B - 29.7 years), indicating highest incidence of occurrence in third decade of life. With respect to the gender distribution, the present study revealed highest prevalence in male participants accounting for a cumulative count of 70 % in both the groups. The study results were in accordance to Barde et al (2014) [24] & Saravanan et al (2020) [25] who also documented a male-to-female distribution ratio of 3.7:1, with 79% of cases occurring in males, especially in third decade of life (21–30 years), suggestive of increased vulnerability in this age group. This could be attributed to high-risk behaviour and greater experience to trauma in this age group. Hence, the present study further demonstrated the importance of demographic variables in the epidemiology of fractures of the mandible. The same sample sizes in both groups reduced demographic bias despite the gender difference, enabling a targeted assessment of PRP's effect on bone regeneration. [1-2]

In the present study, the immediate post-operative radiographic evaluation using OPG and RVG showed that group A displayed greater pixel size in both radiographic modalities, suggesting improved early bone repair and accelerated healing at the fracture site. The fact that this difference was statistically significant indicates that PRP had a beneficial effect on the early stages of bone repair. The results were in alignment to study conducted by Marx RE (2004 & 2005) [3-4]. Anitua et al (2021) [26] supported the use of PRP as a successful adjuvant in the treatment of maxillofacial fractures, whereas Marx (2004) [3] showed that PRP speeds up bone regeneration in both clinical and experimental contexts. Moreover, Daif ET et al (2013) [10] lend credence to the notion that using PRP can enhance bone healing and density in mandibular fractures. The author concluded that PRP promotes early bone repair by releasing growth factors including PDGF and TGF-β. The present study findings were further supported by systematic review conducted by Gowri et al (2026) [27] & Jamal MS eta la (2022) [28] who reported evidence-based literature studies demonstrating the therapeutic benefit of PRP in fracture care. Van Lieshout EM et al (2021) reported faster fracture healing using PRP that was in consistent with the current study [29].

The present study reported that Group A patients demonstrated better image quality and bone detail in both OPG and RVG modalities than Group B. However, intergroup comparisons demonstrated that the early bone alterations at the symphyseal and parasymphyseal fracture sites could be seen with greater sensitivity and detailing with intraoral radiovisiography (RVG). A greater degree of early mineral deposition and more consistent bone repair with improved clarity seen in pixel size dimensions and resolution values were seen in the PRP group using RVG imaging. This study results were in support with Patil et al (2026) [30] & Supreet Jain et al (2025) [31] who inferred potential efficiency of RVG in diagnosis. The present study also highlighted the physiologic advantage of PRP and the diagnostic usefulness of RVG in catching these early alterations with improved resolution values. The results thus support the therapeutic use of RVG in postoperative monitoring of bone density variations and concluded that it can be a potent instrument for tracking bone regeneration in the treatment of mandibular fractures when combined with PRP. With respect to Group A, OPG also demonstrated improved resolution and these findings were in agreement with Shamnad et al [32] & Ansari et al [33] who concluded OPG as a reliable diagnostic tool. However, in the present study, RVG provided more consistency and made it possible to detect minor changes in bone density in the early postoperative period with greater accuracy. These results lend credence to the idea that RVG is a more accurate and dependable way to measure early bone regeneration, particularly when gauging localized fracture repair after PRP treatment.

Additionally, the current study closes the research gap by assessing the resolution values and consistency of imaging over the course of the follow-up period in patients undergoing treatment for mandibular symphysis and parasymphysis fractures, in addition to the initial quality of radiographic images. By showing how high-resolution and steady imaging directly leads to more accurate assessment of bone regeneration, especially when improved by biological adjuncts like platelet-rich plasma (PRP), this study offers a fresh viewpoint and rejects the null hypothesis. Group A reported persistent radiographic resolution quality that serves as a useful indicator of improved bone mending as well as the clinical significance of upholding good imaging standards along the course of treatment and recuperation. By highlighting the fact that resolution quality is not just a technical criterion at the moment of exposure but also a crucial part of follow-up evaluation and treatment planning, this adds a new dimension to conventional radiography protocols. Furthermore, a significant difference in consistency and quality observed between Group A & Group B resolution values were compared and evaluated. Throughout the observation period, the Group A picture clarity was completely consistent, which further supports the efficacy of PRP in fostering stable and consistent healing responses by indicating a consistently high level of bone density and structural regeneration. Group B, on the other hand, showed a great deal of variation in imaging resolution, suggesting uneven bone repair and less predictable results. This study also presents a simplified yet clinically significant radiographic technique that can be readily used in routine practice, especially in settings with limited resources, by adopting digital OPG. Furthermore, by proposing and confirming pixel size and resolution measurements using application of Microsoft paint software, the present study aims to feature measurable elements quantitatively using “Pixel Measurement Tool”. The current study additionally supports the use of digital radiography technologies, especially RVG and OPG along with Microsoft Paint (Version 11.2210.4.0) software as dependable, useful ways to monitor these results and highlights the potential of PRP as a physiologically active enhancer of bone healing in mandibular fractures.

Limitations & future scope: Notwithstanding these positive findings, the current study also identifies a number of crucial areas that require more research. Although this study sample size was enough for the scope and timeframe of this investigation, expanding the cohort in future researches would permit for greater statistical power and enhanced representation of diverse patient populations. This would improve the generalizability of the results along with the detection of subtler effects of PRP application, particularly across different demographic groups and fracture types. Large-scale, multicentric trials could generate more definitive evidences and help establish standardized clinical guidelines. One of the most important aspects of this study was keeping an eye on any confounding variables. Standardization of PRP preparation techniques, surgical techniques, and postoperative care protocols reduced the amount of variation in results that may be attributed to outside factors. However, innate patient characteristics including drug use, smoking status, diet, and systemic health might affect how the bone heals and appears on radiographs.

Future research should use timely imaging methodologies and calibration procedures to reduce these sources of variability. It may also include automated or AI-assisted analysis tools to further standardize evaluations.

Conclusion: This study demonstrates how PRP can improve bone regeneration in cases of mandibular parasymphysis and symphysis fractures. According to radiographic assessments including RVG and OPG, the PRP-treated group demonstrated superior healing, with better bone quality, higher pixel intensity, and better resolution at different time intervals. According to these results, PRP may be a useful supplement to hasten bone repair in mandibular fractures, providing a viable choice for therapeutic use. To confirm these findings and evaluate the long-term advantages of PRP in bone repair, more research with bigger sample sizes and longer follow-ups is required.

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Annexure: Consort flow chart

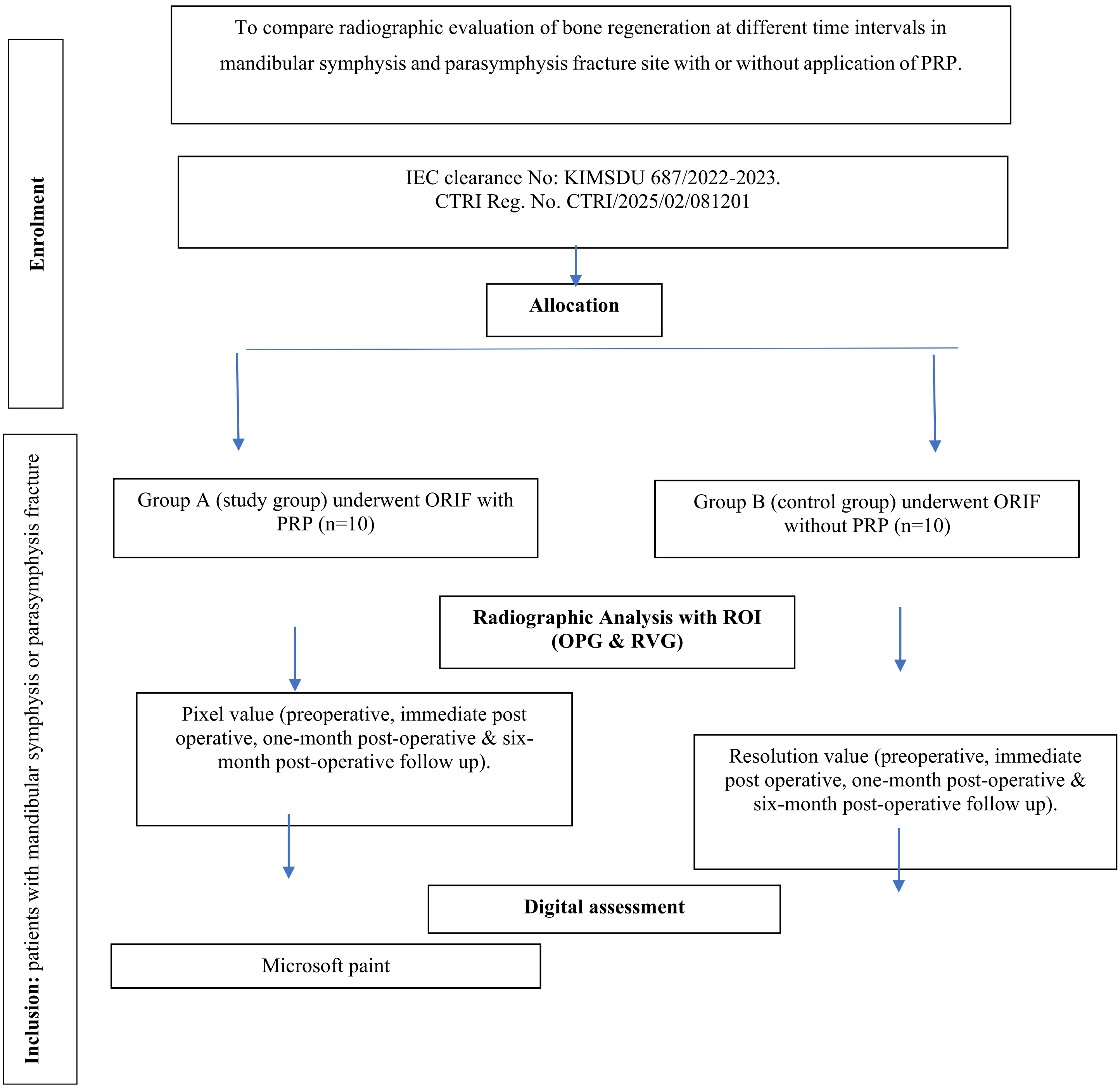
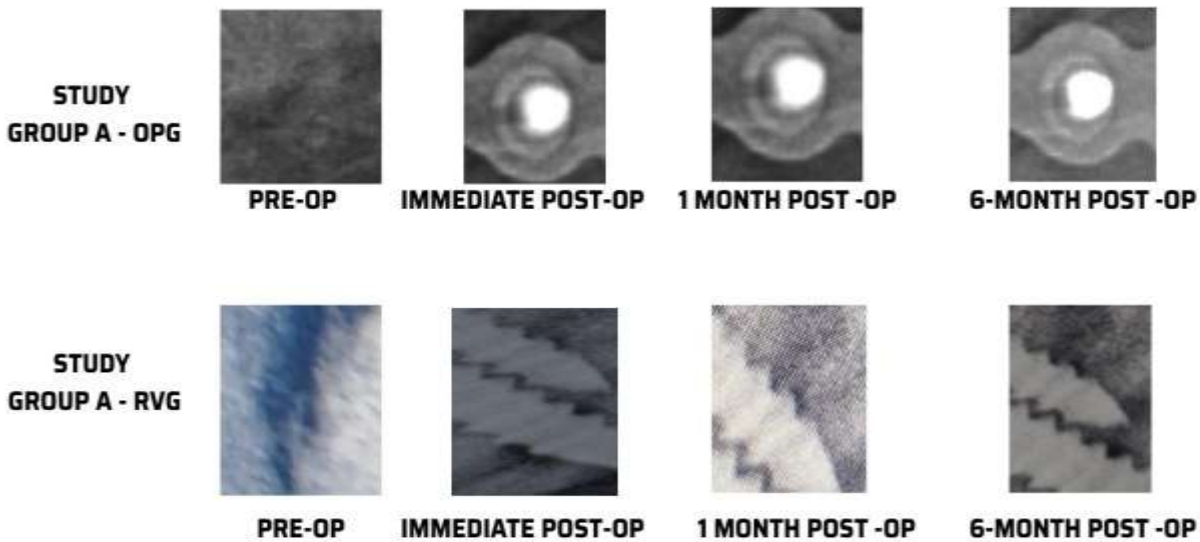
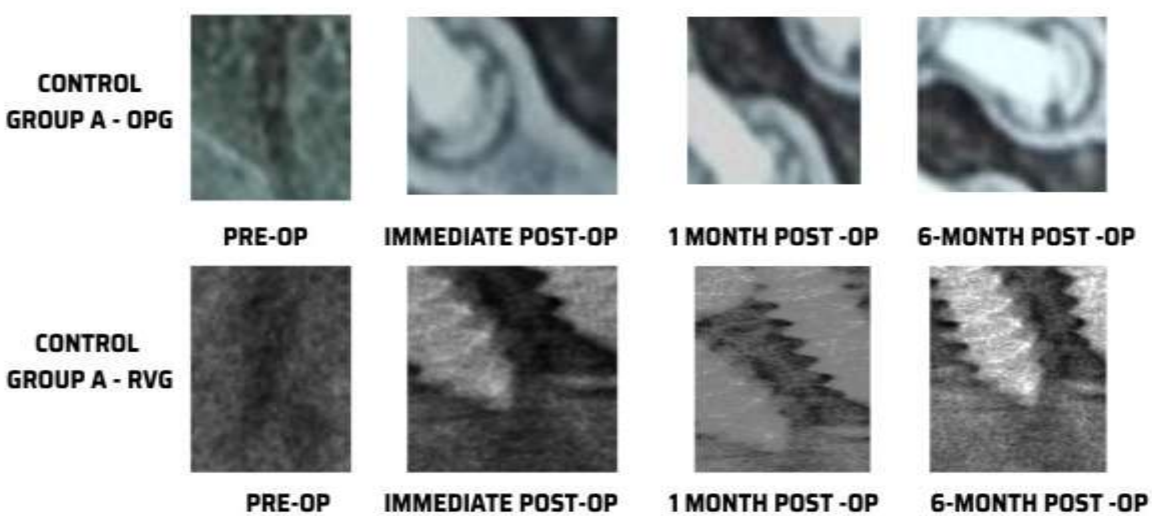


Figure 1]: Depicts the postoperative follow-up radiographic images of Group A (Study Group) at different intervals (preoperative, immediately after surgery, one month later, and six months)

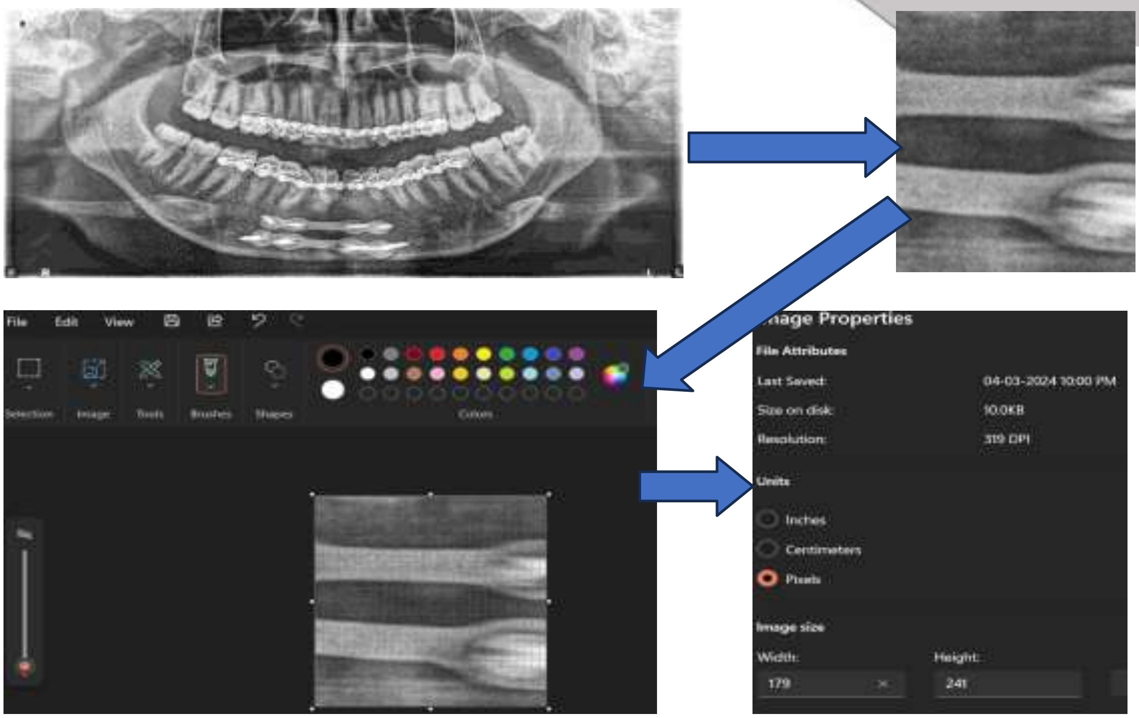


[Figure 2]: Depicts the postoperative follow-up radiographic images of Group B (Control Group) at different intervals (preoperative, immediately after surgery, one month later, and six months)

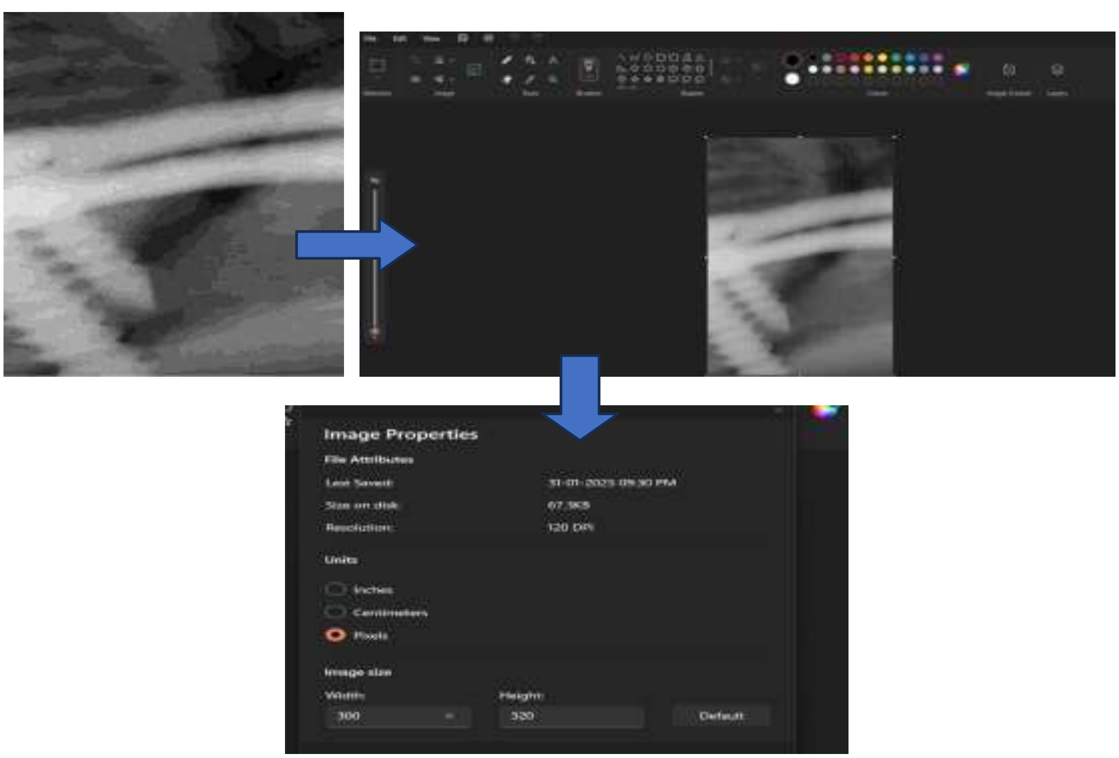


[Figure 3]: Illustrates the methodological framework of assessing pixel size and resolution values from

Microsoft Paint (Version 11.2210.4.0) software by precisely observing gray scale changes in width and height of bone formation using OPG



[Figure 4]: Illustrates the methodological framework of assessing pixel size and resolution values from Microsoft Paint (Version 11.2210.4.0) software by precisely observing gray scale changes in width and height of bone formation using OPG



[Table 1]: Comparison of preoperative pixel size and resolution values between Group A & Group B

Pre-operative pixel value			
	Group A Mean ± SD	Group B Mean ± SD	P value
OPG	22478.9 ±9557.5	12308.3±10868.1	0.001
RVG	82103.1±90643.5	25289.2±6513.8	0.06
Pre-operative resolution values			
	Group A Mean ± SD	**Group B Mean ± SD**	**P value**
OPG	298.70±70.52	111.10±74.78	0.001
RVG	721±664.14	358.40±515.46	0.19

[Table 2]: Comparison of immediate post-operative pixel size and resolution values between Group A & Group B

Immediate post- operative pixel value			
	Group A Mean ± SD	Group B Mean ± SD	P value
OPG	17556±10161.6	10033.8±13922.2	0.19
RVG	76845.4±75920.3	24454.8±7167.4	0.04
Immediate post- operative resolution values			
	Group A Mean ± SD	**Group B Mean ± SD**	**P value**
OPG	319	140±95.37	NA
RVG	363.4±532.2	120	NA

[Table 3]: Comparison of 1-month post-operative pixel size and resolution values between Group A & Group B

1-month post-operative pixel value			
	Group A Mean ± SD	Group B Mean ± SD	P value
OPG	27640±25470	10245.10±10404	0.001
RVG	99265.1±66968	26180.4±7254.3	0.002
1-month post-operative resolution values			
	Group A Mean ± SD	**Group B Mean ± SD**	**P value**
OPG	319	138.2±96.25	NA
RVG	358.6±534.75	120	NA

[Table 4]: Comparison of 6-month post-operative pixel size and resolution values between Group A & Group B

6-month post-operative pixel value			
	Group A Mean ± SD	Group B Mean ± SD	P value
OPG	47880±68262	15427.1±17595	0.008
RVG	159674±90558	28309.5±7542.1	0.001
6-month post-operative resolution values			
	Group A Mean ± SD	**Group B Mean ± SD**	**P value**
OPG	319	138.2±96.25	NA
RVG	346.6±541.05	120	NA