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Research Article

Regenerative Potential of Platelet-Rich Plasma-Enriched Autograft and Xenograft in Peri-Implant Deficient Sites: A Clinical and Radiological Study

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Abstract

Background: Platelet-rich plasma (PRP) is an autologous concentrate rich in growth factors that may enhance bone regeneration and healing around dental implants. This study evaluated the efficacy of PRP combined with autograft and xenograft in peri-implant deficient sites.

Methods: Ten patients with peri-implant bone deficiencies were treated with a PRP-enriched autograft-xenograft mixture. Clinical parameters including pain, swelling, wound dehiscence, infection, and implant mobility were assessed. Radiological evaluation was performed using digital tomograms preoperatively and at 3 months postoperatively. Area-wise measurements were analyzed using SYSTAT (Sigma Scan Pro 5) software.

Results: Mild postoperative pain and swelling were observed in a few cases, no implant mobility or infection was observed after 3 months. Radiological assessment demonstrated a significant increase in bone area measurements at grafted sites compared with baseline values.

Conclusion: PRP-enriched autograft and xenograft demonstrated favorable clinical healing and enhanced bone regeneration in peri-implant deficient areas. The combination appears to be a promising adjunct for improving early peri-implant bone healing.

Keywords: *Platelet-Rich Plasma; Autograft; Xenograft; Bone Regeneration; Dental Implants; Peri-Implant Defects*

Introduction

Dental implants have become a predictable and widely accepted treatment modality for the rehabilitation of partially and completely edentulous patients. Successful implant therapy depends on adequate bone volume and quality to ensure osseointegration and long-term stability. However, alveolar bone resorption following tooth loss often necessitates bone augmentation procedures to achieve optimal implant outcomes [1,2].

Autogenous bone grafts remain the gold standard for bone reconstruction because of their osteogenic, osteoinductive, and osteoconductive properties. Xenografts and other bone substitute materials are frequently used as adjuncts to enhance bone volume in deficient sites. In recent years, the use of biologic mediators such as platelet-rich plasma (PRP) has gained considerable attention in regenerative dentistry [3,4].

PRP is an autologous concentration of platelets containing numerous growth factors, including platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), vascular endothelial growth factor (VEGF), and epidermal growth factor (EGF). These growth factors promote cell proliferation, angiogenesis, and tissue regeneration, thereby enhancing bone healing and graft maturation. Marx., *et al*. first demonstrated the positive effect of PRP on radiographic bone maturation, highlighting its potential role in regenerative procedures [5].

Digital tomographic imaging provides an effective method for evaluating bone quantity and quality before and after implant placement.

Aim of the Study

The present study aimed to assess the clinical and radiological effectiveness of PRP-enriched autograft and xenograft mixture in peri-implant deficient regions using digital tomographic analysis [6].

Materials and Methods

Study design and patient selection

The study was done on out patients who visited the Department of Periodontology, Chandra dental college and hospital Safedabad, Barabanki. Ten patients requiring implant-supported prosthetic rehabilitation and presenting with peri-implant deficient sites were included.

Inclusion criteria: Partially or completely edentulous patients aged 18 - 50 years, presence of peri-implant bone deficiency, adequate inter-arch space, and good systemic health.

Exclusion criteria: Medically compromised patients, individuals younger than 18 years or older than 50 years, and patients lost to follow-up.

All participants provided written informed consent prior to enrollment. Preoperative evaluation included clinical examination, routine hematological investigations, study model analysis, and digital tomographic assessment for implant planning.

Preparation of platelet-rich plasma

Ten milliliters of venous blood were collected from each patient into tubes containing citrate phosphate dextrose anticoagulant. PRP was prepared using a double-centrifugation technique. The first centrifugation was performed at 1300 rpm for 10 minutes, followed by a second centrifugation at 2000 rpm for 10 minutes. Approximately 4 - 5 mL of PRP was obtained and stored under sterile conditions until graft preparation.

Graft preparation

Autogenous bone was harvested from implant osteotomy sites using a FRIOS bone collector. Xenograft material (Bio-Oss®, anorganic bovine bone, particle size 0.25 - 1 mm) was mixed with autogenous bone in a ratio of 3:1 (xenograft). The graft mixture was enriched with PRP to obtain a cohesive graft material.

Surgical procedure

Implant placement was performed under local anesthesia following standard surgical protocols. After implant osteotomy and placement of tapered endosseous implants, peri-implant deficient areas were identified and grafted with the PRP-enriched autograft-xenograft mixture. Flaps were repositioned and closed using 3-0 Vicryl sutures.

Clinical evaluation

Patients were evaluated on the ^{3rd} postoperative day, 7^{th} postoperative day, and at 3 months. Clinical parameters assessed included pain, swelling, infection, wound dehiscence, implant exposure, and implant mobility.

Radiological evaluation

Digital tomograms were obtained preoperatively and 3 months postoperatively using the same imaging unit (Planmeca Promax). Area-wise measurements of grafted regions were performed using SYSTAT (Sigma Scan Pro 5) software. Stable anatomical landmarks were used to ensure reproducible measurements, and preoperative and postoperative values were compared to assess bone regeneration.

Postoperative care

Patients received antibiotics and anti-inflammatory medications for 5 days. Sutures were removed after one week, and oral hygiene instructions were provided. Radiological assessment was repeated after 3 months, followed by placement of healing abutments and definitive prosthetic rehabilitation.

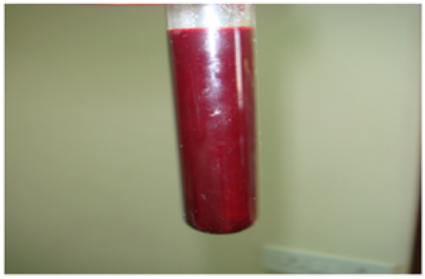
Results

All patients underwent both clinical and radiological evaluation. Digital tomograms were obtained preoperatively for assessment of bone dimensions and implant planning and were repeated three months postoperatively to evaluate implant healing and bone regeneration. Radiographic measurements were performed using SYSTAT (Sigma Scan Pro 5) software. Stable anatomical landmarks, including the cemento-enamel junctions of adjacent teeth, inferior border of the mandible, coronoid and condylar processes, piriform aperture, and tooth apices, were used to ensure reproducible measurements. Five readings were recorded for each patient, and the mean value was considered for analysis.

Radiological assessment demonstrated a substantial increase in bone dimensions at the grafted sites after three months. The mean gain in area measurements was approximately 4 cm^2 in single-implant cases and approximately 20 cm^2 in multiple-implant cases when compared with preoperative values, indicating significant bone regeneration [5,6].

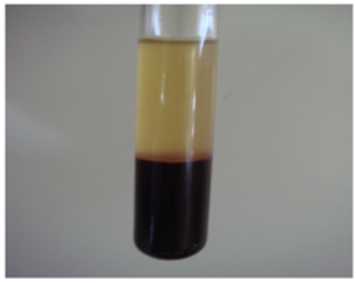
Clinical evaluation on the third postoperative day revealed mild pain and swelling in a few patients, while one patient exhibited wound dehiscence that was successfully managed by resuturing. No implant mobility was observed during the immediate postoperative period or at the three-month follow-up [7-9].

At the three-month evaluation, all implants remained stable and functional. No signs of infection, implant exposure, or complications related to the prosthetic components were noted. Soft tissue healing was satisfactory in all cases, and patients reported a high level of satisfaction regarding esthetics, comfort, function, and overall treatment outcomes [10].

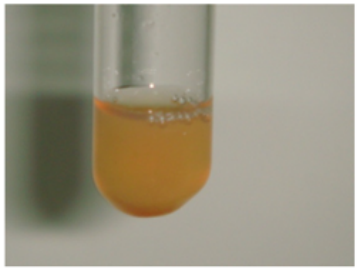


10 ml of blood withdrawn taken in test tube with anticoagulant

Blood placed in centrifuge for PRP preparation



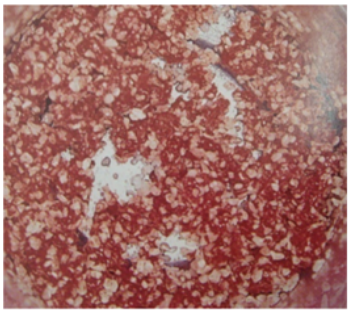
Platelet rich plasma prepared as a layer between RBCs and platelet poor plasma above.



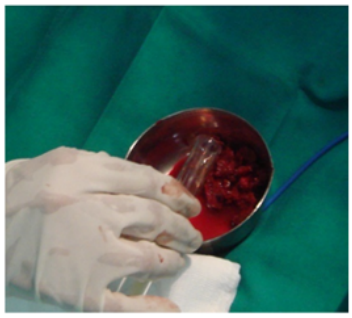
Platelet rich plasma pipetted out after double buffy centrifugation

Bone collected from the drill bits after osteotomy procedure

Bio-Oss used as Xenograft



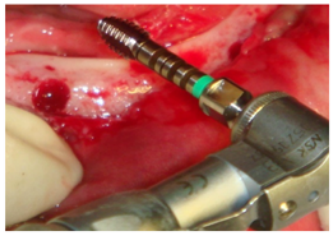
Auto graft and Xeno graft Mixture



PRP mixed with the bone grafts

Surgical procedure

Osteotomy sites identified with pilot drill



Osteotomy site prepared

Surgical procedure

Discussion

Bone regeneration remains a major challenge in oral and maxillofacial surgery. Although bone possesses a remarkable capacity for self-repair, successful reconstruction of osseous defects often requires the use of grafting materials and biologic mediators to enhance healing. In recent years, Platelet-Rich Plasma (PRP) has gained considerable attention because of its high concentration of growth factors, including platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), vascular endothelial growth factor (VEGF), and insulin-like growth factor (IGF), which are known to promote wound healing and bone regeneration [11-14].

PRP has been advocated as a biologic adjunct to improve the quantity and rate of bone formation when used in combination with autografts, allografts, xenografts, or alloplastic materials during implant site augmentation and ridge reconstruction procedures. Several studies have reported favorable outcomes with PRP-enhanced bone grafting. Fennis., *et al*. demonstrated a positive effect of PRP when combined with autogenous bone grafts, while Choukri Mannaï., *et al*. reported accelerated soft- and hard-tissue healing following reconstruction using autogenous bone, xenograft, and autologous platelet concentrate. Similarly, Gerard., *et al*. observed enhanced early bone healing in PRP-treated grafts, although the effect diminished over time [15-20].

The biological basis for these findings is supported by *in vitro* studies demonstrating that PRP stimulates osteoblastic proliferation and activity. Ogino., *et al*. reported that PDGF and TGF-β significantly contributed to osteoblast proliferation, suggesting a potential role for PRP in enhancing early bone formation. Thor., *et al*. also observed significantly greater new bone formation in PRP-treated sites after

three months of healing, although this difference was not evident after six months, indicating that PRP may primarily influence the early stages of bone regeneration [21-24].

However, the literature remains inconclusive regarding the effectiveness of PRP. Some investigators, including Slapnicka., *et al*. found no significant increase in osteoblast proliferation following PRP application, while Tae-Min You., *et al*. suggested that PRP may not enhance peri-implant bone healing when combined with xenograft materials under certain conditions. These conflicting findings highlight the need for further clinical research [25-30].

In the present study, PRP was combined with autogenous bone harvested from implant osteotomy sites and Bio-Oss® xenograft in a 1:3 ratio and used to augment peri-implant deficient regions. Clinical evaluation revealed satisfactory healing with only minor postoperative complications. Mild pain and swelling were observed in a few patients, and one patient developed wound dehiscence that was successfully managed by resuturing. No implant mobility, implant exposure, or infection was observed during the three-month follow-up period [31-34].

Radiological assessment using digital tomograms and SYSTAT (Sigma Scan Pro 5) software demonstrated a substantial increase in bone dimensions at grafted sites. The mean gain in area measurements was approximately 4 cm^2 in single-implant cases and 20 cm^2 in multiple-implant cases compared with baseline values. These findings suggest that PRP-enriched autograft and xenograft may contribute to enhanced bone regeneration and improved peri-implant healing [35-39].

The positive clinical and radiographic outcomes observed in this study are consistent with previous reports indicating that PRP may accelerate the early phase of bone healing. Nevertheless, the present study was limited by its small sample size and relatively short follow-up period. Therefore, larger randomized controlled trials with longer observation periods are required to validate these findings and establish the long-term benefits of PRP in implant-related bone regeneration [40].

Conclusion

The present study evaluated the effectiveness of Platelet-Rich Plasma (PRP) combined with autograft and xenograft in the management of peri-implant deficient sites. The findings demonstrated favorable clinical and radiological outcomes following the use of a PRP-enriched autograft-xenograft mixture.

Radiological assessment using digital tomograms and SYSTAT (Sigma Scan Pro 5) software revealed a substantial increase in bone dimensions at grafted sites three months postoperatively, indicating enhanced early bone regeneration. Clinically, all implants remained stable, and no major complications such as implant mobility, infection, or implant exposure were observed during the follow-up period. Soft tissue healing was satisfactory, and overall treatment outcomes were favorable.

These results suggest that PRP may serve as a valuable adjunct to autograft and xenograft materials by enhancing the early phase of bone healing and regeneration in peri-implant deficient regions. The study findings support the clinical use of PRP-enriched grafts for implant-related bone augmentation procedures.

However, the present study was limited by a small sample size and a relatively short follow-up period of three months. Therefore, further studies involving larger patient populations and longer follow-up durations are recommended to validate these findings and establish the long-term benefits of PRP in peri-implant bone regeneration.

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