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"Enhanced Periapical Bone Regeneration Using Recombinant Human Platelet-Derived Growth Factor And Beta-Tricalcium Phosphate: A Case Series"

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ABSTRACT:
The objective of this study was to evaluate the efficacy of recombinant human platelet-derived growth factor (rhPDGF) combined with beta tricalcium phosphate (β-TCP) in promoting the regeneration of periapical bone following periapical surgery. A case series was conducted involving patients who underwent periapical surgery, where the bone defect was treated with a graft composed of rhPDGF-BB and β-TCP. The patients were monitored over a 6-month follow-up period, during which clinical and radiographic evaluations were performed to assess the extent of bone regeneration. Results indicated significant bone regeneration in the treated sites, with almost complete restoration of the periapical bone observed at the 6-month mark. These findings suggest that the combination of rhPDGF and β-TCP is a promising biomaterial for enhancing periapical bone regeneration following endodontic surgery. Further studies with larger sample sizes and longer follow-up periods are recommended to confirm these results.

INTRODUCTION:
The regeneration of periapical bone, a crucial component in the restoration of dental health following periapical lesions, has been a significant focus of modern endodontic and periodontal research. Periapical lesions often result from chronic infections or trauma, leading to the destruction of bone tissue around the apex of the tooth[1]. Conventional treatment methods, though effective in controlling infection, frequently fall short in promoting adequate bone regeneration[2]. In recent years, regenerative therapies have gained prominence as viable solutions to this challenge.One of the most promising advancements in this area involves the use of recombinant human platelet-derived growth factor (rhPDGF) combined with β-tricalcium phosphate (β-TCP). Platelet-derived growth factor is a critical mediator in wound healing and tissue regeneration, as it stimulates cell proliferation and differentiation, particularly in osteoblasts[3]. When used in combination with β-TCP, a bioresorbable scaffold that mimics the mineral component of bone, rhPDGF can significantly enhance bone regeneration by providing both a biological stimulus and a structural framework for new bone formation[4].Recent studies have demonstrated the efficacy of this combination in accelerating periapical bone regeneration. These innovative materials have been shown to promote faster healing, increase bone density, and improve long-term clinical outcomes in patients with periapical bone defects[5-6]. As the demand for minimally invasive and biologically driven therapies continues to grow, the use of rhPDGF and β-TCP is emerging as a cornerstone of advanced regenerative endodontics and periodontology.This article aims to explore the latest research on the combined application of rhPDGF and β-TCP in the regeneration of periapical bone, highlighting their biological mechanisms, clinical outcomes, and potential implications for future dental treatments.

CASE: 1
A 29 years female patient visited with chief complaint of pain in upper anterior region, on oral examination tooth no 22 was tender on percussion. On radiographic examination open apex with big periapical pathology was observed irt tooth no 22 decided to go for surgical management before surgery root canal treatment is completed.After obtaining informed

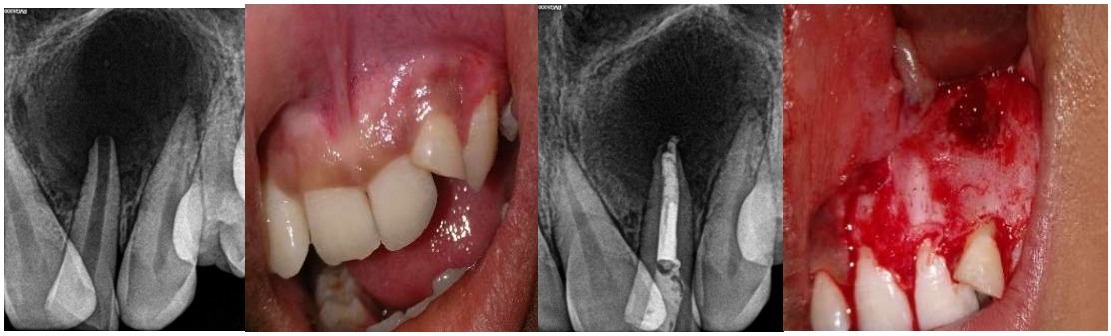
consent, the patient was prepared for periapical surgery under local anesthesia using 2% lidocaine with epinephrine. A full-thickness mucoperiosteal flap was reflected to expose the underlying bone and the periapical lesion. The incision was carefully made along the gingival margin, extending from the right maxillary central incisor to the canine to ensure adequate access. Once the flap was elevated, the periapical lesion was clearly visualized. Using a round bur and copious saline irrigation, a small window was made in the buccal bone to access the infected periapical tissue. The necrotic tissue and granuloma were thoroughly debrided from the surgical site. Special care was taken to remove all remnants of the infected granulation tissue to prevent recurrence of the infection.

An apicoectomy was performed by resecting approximately 3 mm of the apex of the involved root of the lateral incisor. The root end was examined under magnification to ensure complete removal of any residual infection or pathology. The resected root was prepared for retrograde filling using ultrasonic tips to create a clean and well-defined cavity. Following preparation, recombinant human platelet-derived growth factor (rhPDGF-BB) 12 microleter (2 pipets)was mixed with 2 grams beta-tricalcium phosphate (β-TCP) to create the graft material. The rhPDGF-BB serves as a potent growth factor that stimulates cell proliferation and differentiation, particularly osteoblasts, while β-TCP functions as a bioresorbable scaffold that supports new bone formation. The combination of these two materials was prepared to ensure optimal consistency for easy placement in the defect. The graft mixture was carefully packed into the periapical defect, ensuring thorough coverage of the exposed bone and surrounding tissue. This provided both a biological stimulus for regeneration and structural support to guide bone growth. Adequate condensation of the graft was performed to ensure there were no gaps or spaces between the graft material and the native bone, which could impede healing.

Once the graft was in place, the root-end cavity was filled with a biocompatible material, **Mineral Trioxide Aggregate (MTA)** , to create a hermetic seal and prevent any microleakage from the root canal. This step was crucial for preventing re-infection and ensuring the long-term success of the procedure.

The mucoperiosteal flap was repositioned over the surgical area. Interrupted sutures were placed to achieve primary closure and ensure the graft remained stable during the initial stages of healing. The flap was carefully adapted to minimize tension, promoting better healing.

Postoperative care included prescribing a course of antibiotics and analgesics to prevent infection and manage pain. The patient was advised to follow standard postoperative instructions, including maintaining good oral hygiene and avoiding trauma to the surgical area.

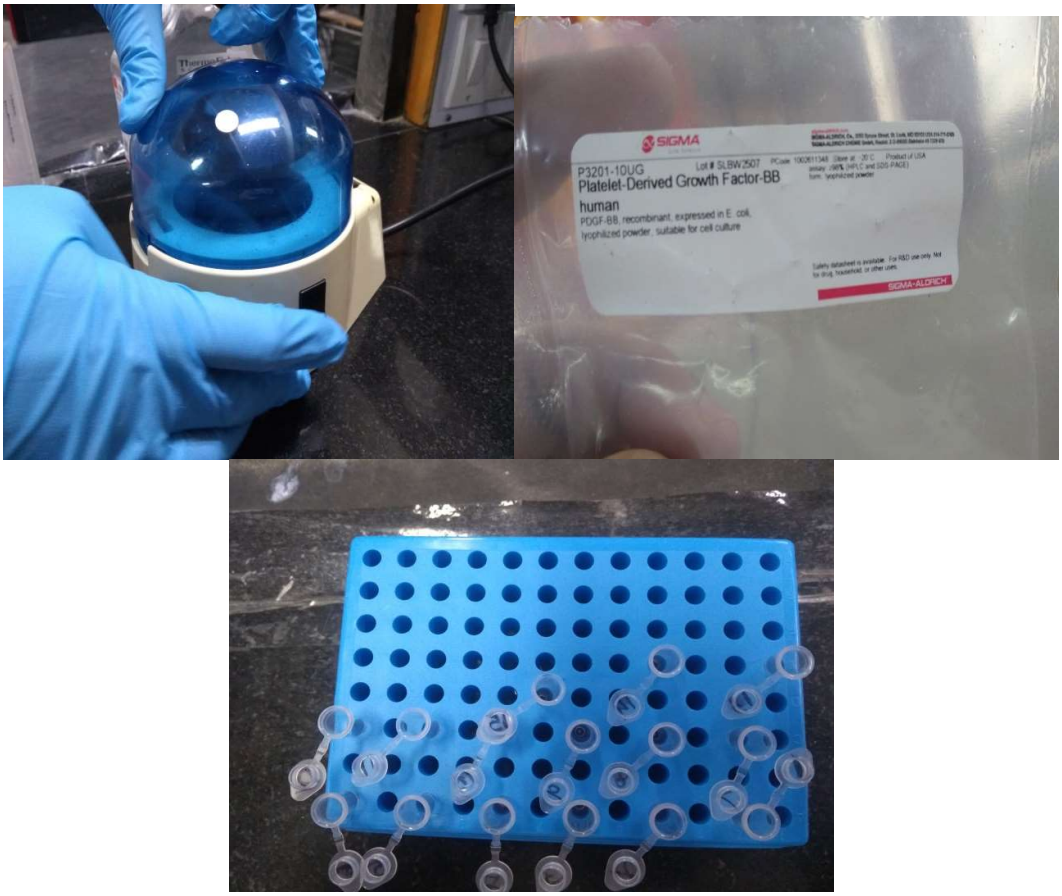


1)pre operative radiograph 2) pre operative clinical 3)After obturation 4)After granulation tissue removal

5)rhPDGF –BB and beta tricalcium phosphate as graft 6)After suturing 7) Retrogarde MTA filled 8) After 6 months follow up

RECONSTITUTION OF GROWTH FACTOR

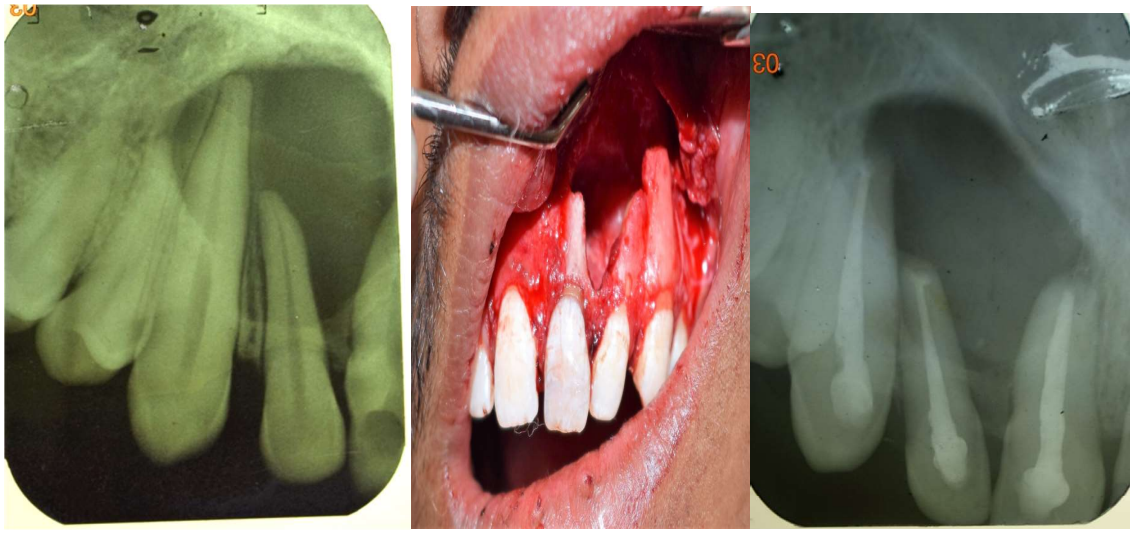
Reconstitution of 10 microgram of powder growth factor with 100 Micro-leter of distilled water to make concentration of 0.1 microgram per ml by Centrifuge with 1000 rpm per minute. solution was Stored in 17 diffrent micro pipets at -20 ° with 6 ml each andremaining 2 pipet with 5 ml (FIG-2).



1)centrifugation of growth factor 2) 10 microgram of rhPDGF-BB 3) Storage in pipets

CASE :2

A 32 years male patient visited with complaint of pain in upper anterior region on oral examination teeth no 21, 22 and 23 not responded for vitality test and tender on percussion with soft diffuse swelling at vestibular region of these teeth. On radiographic examination periapical pathology involve 21, 22 and 23, decided manage surgically before periapical surgery root canal treatment was completed. The clinical procedure began with administering local anesthesia, followed by a sulcular incision extending from tooth 21 to 23, and full-thickness mucoperiosteal flap reflection to expose the periapical areas. A small osteotomy was performed to create access to the lesions. Granulomatous tissue and infected periapical areas were carefully curetted, and the root apices of teeth 21, 22, and 23 were resected. Retrograde cavity preparations were made using ultrasonic tips, and the apical thirds of the root canals were sealed with mineral trioxide aggregate (MTA) to ensure a hermetic seal and prevent microbial leakage. Once the root fillings were complete, attention was turned to the bone defect. The site was thoroughly debrided and rinsed with saline, followed by the application of a graft material combining recombinant human platelet-derived growth factor (rhPDGF) and beta tricalcium phosphate (β-TCP). This graft was packed into the bony defect to promote osteogenesis and serve as a scaffold for new bone formation. After ensuring hemostasis, the flap was repositioned and sutured securely. Postoperative instructions were provided, and the patient was monitored for healing at follow-up visits. Radiographs at 6 months showed almost complete regeneration of the periapical bone.



1)pre operative radiograph 2)After removal of granulation tissue 3)after obturation and retrograde filling

4) rh PDGF-BB and beta tricalcium phosphate placement 5) After 6 months followup

DISCUSSION

The use of recombinant human platelet-derived growth factor (rhPDGF-BB) in conjunction with beta-tricalcium phosphate (β-TCP) represents a significant advancement in regenerative endodontics, particularly in periapical bone regeneration. In this case, the combination of these materials successfully promoted healing and bone regeneration after periapical surgery. This aligns with existing research that emphasizes the osteogenic potential of growth factors when combined with suitable scaffold materials (Nevins et al., 2019).

RhPDGF-BB plays a pivotal role in enhancing the proliferation and differentiation of mesenchymal cells, including osteoblasts, which are critical for bone regeneration (Giannobile et al., 2023). When delivered to the surgical site, rhPDGF-BB accelerates cellular activity, contributing to the rapid formation of new bone tissue. Several studies have demonstrated that rhPDGF-BB enhances angiogenesis, which further supports the bone healing process by ensuring an adequate blood supply to the regenerating tissue (Jung et al., 2020).

The choice of β-TCP as a scaffold material is also critical to the success of the regenerative procedure. β-TCP is a biocompatible and bioresorbable material that serves as a temporary matrix for new bone formation while gradually being resorbed by the body (Rodríguez-Lozano et al., 2021). In this case, β-TCP provided structural support for the newly formed bone, preventing collapse of the surgical site during the initial healing phase. The material's porosity facilitates the infiltration of osteogenic cells and vascularization, which are essential for successful bone regeneration (Kim et al., 2022).The combination of rhPDGF and β-TCP has been shown to significantly enhance bone regeneration compared to conventional grafting materials alone. This case demonstrated complete resolution of the periapical lesion within six months, with radiographic evidence of dense, trabeculated bone. These results mirror those of previous studies, where the combination of rhPDGF and β-TCP has consistently resulted in faster and more effective bone

healing in both periodontal and endodontic procedures (Nevins et al., 2019; Giannobile et al., 2023).One key advantage of using rhPDGF-BB is its ability to reduce healing time. The patient in this case showed early radiographic signs of bone formation within just six month of surgery. This is consistent with studies showing that rhPDGF-BB can expedite the initial healing process and stimulate robust bone regeneration within shorter periods compared to treatments without growth factors (Jung et al., 2020).Despite the favorable outcomes in this case, it is important to consider that the success of regenerative therapies depends on various factors, including the patient's overall health, the size of the defect, and the surgical technique employed. Proper case selection and meticulous surgical technique are essential to maximizing the benefits of rhPDGF-BB and β-TCP in clinical practice (Kim et al., 2022). In this case, thorough debridement and careful placement of the graft materials were crucial in preventing infection and ensuring stable healing.

Conclusion: The use of rhPDGF and β-TCP in these cases resulted in successful periapical bone regeneration, underscoring the potential of these materials in enhancing healing outcomes. This case supports the growing body of evidence that regenerative approaches using growth factors and scaffolds offer significant clinical advantages in managing periapical bone defects.

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