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Regenerative Endodontic Microsurgery: A Case-Based Evaluation Using PRF and Nanocrystalline Hydroxyapatite

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Abstract:
Periapical surgery is often indicated in cases where conventional endodontic therapy fails to resolve persistent periapical pathology. This case report presents two clinical scenarios where endodontic microsurgery, complemented by regenerative materials—platelet-rich fibrin (PRF), nanocrystalline hydroxyapatite (NcHA), and a collagen membrane—was employed to treat large periradicular lesions. PRF, a second-generation autologous platelet concentrate, serves as a fibrin scaffold that releases growth factors to promote healing, while NcHA offers osteoconductivity for new bone formation. A resorbable collagen membrane was used to prevent soft tissue ingrowth, aligning with the principles of guided tissue regeneration (GTR). Cone-beam computed tomography (CBCT) imaging was used for preoperative assessment and postoperative healing evaluation. Both cases demonstrated significant bone regeneration and complete resolution of lesions after 12 months, with no clinical symptoms. These outcomes support the synergistic role of combining PRF with bone grafts and GTR membranes in enhancing periapical healing. Endodontic microsurgery, when paired with regenerative biomaterials, offers a reliable solution for managing complex periapical pathologies, particularly when traditional approaches fall short.
Keywords: *Periapical surgery, endodontic microsurgery, platelet-rich fibrin (PRF), nanocrystalline hydroxyapatite (NcHA), guided tissue regeneration (GTR), bone graft, CBCT, periradicular lesion, apicoectomy, regenerative endodontics.*

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I. INTRODUCTION:

Endodontic treatment aims for complete periapical healing and regeneration, with most cases responding well to non-surgical methods. However, 24.5% of cases may necessitate surgical intervention, as noted by Abramovitz et al.[1] The healing of tissues involves complex intra- and extracellular processes regulated by signaling proteins. Platelets, produced in the bone marrow from megakaryocytes, play a crucial role in both hemostasis and wound healing. These anuclear structures, with an 8–10 day lifespan, contain granules that release essential components upon activation. α-Granules store proteins such as growth factors and coagulation elements, while dense granules house calcium and serotonin.

Platelet activation is vital for initiating and sustaining hemostasis, aggregating at injury sites, and interacting with coagulation mechanisms. This process also releases cytokines, which promote cell migration and proliferation within the fibrin matrix, launching the initial stages of tissue repair and regeneration.[2]

Bone replacement materials should exhibit biocompatibility, non-carcinogenic properties, and dimensional stability. They are designed to act as a scaffold for bone formation and gradually degrade to support the growth of new bone.[3] Nanocrystalline hydroxyapatite (NcHA) has emerged as a promising biomaterial for bone healing and regeneration, with numerous case studies documenting successful mature bone formation using this graft.

Platelet-rich fibrin (PRF), a second-generation platelet concentrate, is a rich source of growth factors and is highly effective in promoting tissue repair and regeneration. The preparation of PRF produces a fibrin network that mimics natural processes, enhancing cell migration and proliferation.[4]

PRF demonstrates osteoinductive properties, while hydroxyapatite (HA) combined with collagen is osteoconductive. Their combination creates a synergistic effect, enhancing bone regeneration. Clinical evidence suggests this blend offers excellent healing without excessive inflammation, and studies have shown both materials are individually successful. This report of two cases focuses on evaluating healing post-periapical surgery using PRF and NcHA with collagen in combination. CBCT imaging was used for pre-operative evaluation, diagnosis and treatment planning and post-operative evaluation of healing in both the cases.

II. CASE 1:

A 27 years old, female patient reported to the out-patient department of Department of Conservative dentistry and Endodontics, with a chief complaint of pain in upper anterior teeth with a history of past dental treatment, following previous dental trauma. Endodontic therapy was done and PFM crown was cemented w.r.t. #11, #21; 7 years back. On radiographic examination, #11, #21 was found to be endodontically treated, with no periapical changes w.r.t. #21. Apexification with MTA along with a poorly cemented fibre post was noted w.r.t. #11. A large periapical radiolucency was noted w.r.t. #11, #12. Crown removal was done w.r.t. #11, and endodontic treatment was initiated w.r.t. #11, #12. Fibre post and MTA was removed using ultrasonics. Intra-canal pus discharge was noted, and endodontic microsurgery (apicoectomy and root end preparation and filling) was planned w.r.t. #11, #12, followed by graft (NcHA and PRF) and barrier membrane placement. Periapical radiographs and CBCT evaluation after 12 months revealed considerable reduction in size of periapical radiolucency, and increase in bone density.

III. CASE: 2

A 29 years old, female patient reported to the out-patient department of Department of Conservative dentistry and Endodontics, with a chief complaint of pain in upper anterior teeth with a history of dental trauma. There was no history of spontaneous pus discharge or no sign of sinus tract. IOPAr and CBCT revealed presence of periapical radiolucency involving #11, #21 and #22 with destruction of labial and palatal cortical plate to some extent. Root canal therapy was initiated w.r.t. #11, #21 and #22. Intra-canal pus discharge was noted, and endodontic microsurgery (apicoectomy and root end preparation and filling) was planned w.r.t. #11, #12, #22 followed by graft (NcHA and PRF) and barrier membrane placement. After 12 months, reduction in size of periapical radiolucency and increased bone density was noted, on periapical radiographs and CBCT.

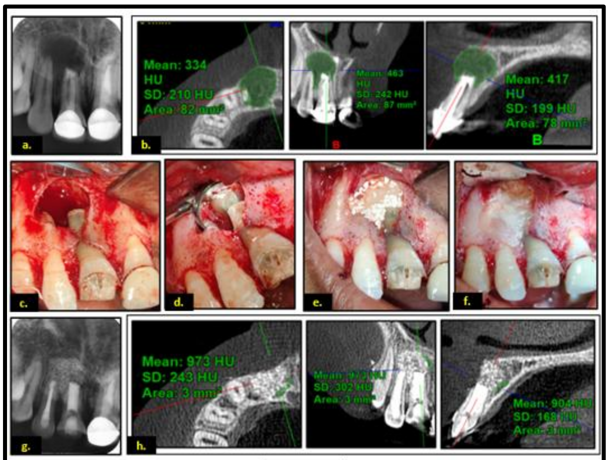

Fig. 1

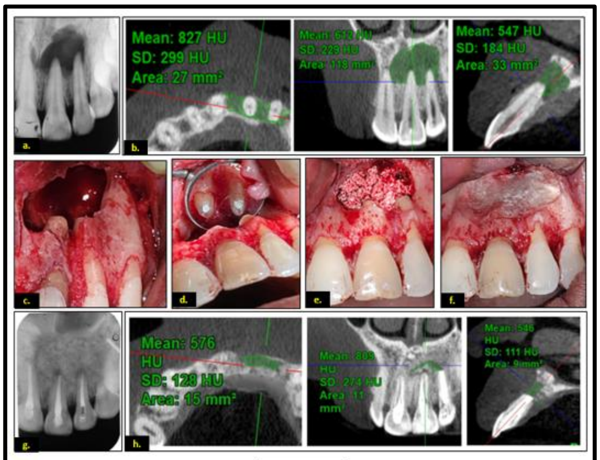

Fig. 2

Fig 1 & 2:

a. Pre-op IOPAR
b. Pre-op CBCT (in axial, coronal and sagittal sections)
c. Cyst enucleation done, bony cavity
d. Retrograde filling done
e. Bone graft + PRF mixture placement
f. GTR membrane placement
g. 12 month follow up – IOPAR
h. 12 month follow up – CBCT (in axial, coronal and sagittal sections)

IV. DISCUSSION:

When performed judiciously and supported by diagnostic imaging, apical microsurgery serves as an effective treatment approach. It becomes particularly valuable when infections persist despite previous non-surgical interventions. Now, orthodontic repositioning of the treated tooth might be necessary at a later stage. In such cases, bone quality plays a vital role, as the infiltration of connective tissue into the bone cavity hinders new bone formation, leading to suboptimal healing. Large bony deficiencies can be filled with bone grafts with a suitable membrane to stop this soft-tissue ingrowth. Since, it is easy to carry out later orthodontic and prosthodontic (as an abutment tooth) treatments when there is evidence of early osseous healing.[5] In order to preserve the biological function of the wounded tissue, optimal wound healing would result in maximum regeneration and minimal repair.

Persistent periapical lesions that do not resolve after conventional root canal therapy or nonsurgical retreatment may necessitate endodontic surgery. Recent advancements in microsurgical techniques and regenerative biomaterials have markedly improved prognosis in such cases. The two cases presented in this report demonstrate the successful management of large periradicular lesions using endodontic microsurgery combined with a mixture of bone graft and platelet-rich fibrin (PRF), followed by the placement of a collagen membrane.

Endodontic microsurgery incorporates high magnification, precise microsurgical instruments, and biocompatible retrograde filling materials, leading to higher success rates and improved patient outcomes. Setzer et al.[6] reported a success rate of over 90% when modern microsurgical protocols were followed. Both cases in this report benefited from these advancements, especially in minimizing trauma and enhancing visibility during root-end resection and filling.

The incorporation of PRF into periapical defect management has gained popularity due to its autologous origin, ease of preparation, and regenerative potential. PRF acts as a fibrin scaffold that releases growth factors such as PDGF, TGF-β1, and VEGF over an extended period, enhancing angiogenesis and osteoblastic activity.[7] Kulkarni et al.[8] and Thompson et al.[9] have shown PRF to reduce postoperative inflammation and promote faster soft and hard tissue healing.

In these cases, PRF was mixed with xenograft bone material to provide both osteoinductive and osteoconductive benefits. The bone graft helps maintain the space within the defect and provides a scaffold for new bone formation. Yelamali and Saikrishna[10] observed significantly enhanced bone regeneration when PRF was combined with graft materials, especially in large lesions.

Additionally, a resorbable collagen membrane was placed over the grafted site to prevent soft tissue ingrowth, aligning with the principles of guided tissue regeneration (GTR). According to Dahlin et al.[11], the membrane acts as a barrier, allowing osteogenic and periodontal cells to repopulate the defect without interference from epithelial cells. Taschieri et al.[12] emphasized the efficacy of this approach in achieving complete periapical healing, particularly in through-and-through defects.

The clinical and radiographic healing observed in these cases was consistent with existing literature. Both patients were asymptomatic at follow-up visits, with radiographs showing progressive bone fill and resolution of radiolucencies. The combination of endodontic microsurgery with regenerative techniques appears to be a predictable and effective strategy for treating extensive periapical pathologies.

V. CONCLUSION:

These cases highlight the synergistic benefits of combining PRF, bone graft, and collagen membrane in endodontic microsurgery. The use of regenerative materials not only facilitates healing in challenging periapical lesions but also enhances the overall success rate of surgical endodontic procedures. Future controlled studies are warranted to further validate these techniques and standardize protocols for clinical use.

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