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# 3D Comparative Evaluation of Healing Following Successful Management of Large Periapical Lesions of Endodontic Origin with Palatal Perforations – A Case Series with Three Years Follow-Up

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## Abstract

Though periapical lesions with labial perforations have been adequately addressed in the endodontic surgical literature, the management of palatal perforations is rarely referred to. The evaluation of post-surgical healing for long has been quite subjective with 2D imaging, however with the availability of newer 3D software, volumetric analysis with numerical values has brought greater scientific accuracy in the evaluation of post-surgical healing. This case series has been written according to Preferred Reporting Items for Case Reports in Endodontics (PRICE) 2020 guidelines.

**Case Description:** After an appropriate diagnosis, root canal treatment was carried out as per protocol and on the day of surgery, lesion contents were completely removed palatal perforation was repaired with bone putty material acting as a scaffold and the enucleated cavity was filled with platelet-rich fibrin. Primary closure was done after repositioning the mucoperiosteal flap. Patients were kept under three years of follow-ups and were evaluated yearly using 3D software for CBCT analysis for a reduction in the size of the bone cavity post-surgically.

**Practical implications:** The 3D evaluation of CBCT shows a significant volumetric reduction in the size of the bone cavity corroborating that, the exact placement and retention of bone putty material in the nasal/palatal perforations followed by filling the lesion with PRF aids in faster and efficient healing of the large periapical lesion.

**Keywords: Periapical cyst; Periapical surgery; Apicoectomy; Bone putty; Platelet-rich fibrin; Palatal perforation; Volumetric Analysis; ITK-SNAP**

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## Introduction

The success of the surgical intervention in cases with large periapical lesions associated with labial and palatal perforations of endodontic origin depends not only on proper case selection but also on the surgical skills of the operator and the materials used to fill in the enucleated periapical defect [1]. Various bone grafts and regenerative materials have been used to fill the enucleated large periapical lesions in endodontic surgeries [2]. Ideally, the bone replacement materials should be non-carcinogenic, bio-compatible, and dimensionally stable and should act as a scaffold for bone formation [3].

Autologous platelet-rich concentrates (platelet-rich plasma and platelet-rich fibrin) act as efficient bone regeneration agents in regenerative endodontics [4]. Though platelet-rich concentrates have been widely used with successful outcomes, their application in large periapical lesions with labial and palatal perforations of endodontic origin is still a dilemma in endodontic surgeries. The platelet-rich concentrates are difficult to retain in the exact position in large periapical lesions with palatal perforations, as they tend to push through the perforations if they are not suitably supported by scaffolds.

In addition to the platelet-rich concentrates, bone graft/putty materials also aid in the successful healing of bony defects. The hyaluronic acid a natural polymer with excellent biological properties when mixed with tricalcium phosphate granules in bone grafts generates bone putty-like material,

which has better handling properties than bone grafts [5]. In addition, bone grafts when used alone or along with platelet-rich concentrates have a faster rate of new bone formation when compared to the platelet-rich concentrates used alone in the bone defects [6]. Thus, it could be hypothesized that the placement of bone grafts in putty form, effectively aids in filling the palatal perforations and further acts as a scaffold for platelet-rich concentrates in managing large periapical lesions of endodontic origin.

Three-Dimensional (3D) volumetric analysis giving a numerical value is the only clinical authentication for the above-proposed hypothesis. Thus, the use of ITK-SNAP Software version 4.0.1 (www.itksnap.org) for Cone-Beam Computed Tomography (CBCT) analysis was preferred over any other Two-Dimensional (2D) radiographic evaluation. ITK SNAP is an open-access popular library image analysis algorithm funded by the US National Library of Medicine [7].

The present case series presents the surgical management with a year's follow-up of palatal perforations associated with large peri-apical lesions of endodontic origin using Platelet-Rich Fibrin (PRF) and bone putty material. The healing was evaluated by ITK-SNAP Software for CBCT Analysis. This case series has been written according to Preferred Reporting Items for Case Reports in Endodontics (PRICE) 2020 guidelines [8].

## Case Series

### Case 1

A 31-year-old female patient reported to the Department of Dentistry, with a chief complaint of pain in the upper front teeth region for 5 months and swelling under the upper lip and on the palate for 7 days. The patient gave a history of trauma to the upper front teeth fifteen years back, followed by swelling in the upper lip for 1 month. The swelling gradually increased in size in the last 1 week, not accompanied by fever and weight loss. No significant medical history was elicited. A history of root canal treatment in two teeth 2 years back was reported by the patient. Extra-oral clinical examination revealed diffuse swelling in the maxillary anterior region with the raised upper lip. Intra-oral examination revealed a discharging sinus in relation to the maxillary right central incisor with mild palatal swelling. Intra-oral Periapical Radiograph (IOPAR) was advised to evaluate the periapical changes in relation to #11 and #12. IOPAR revealed a well-defined periapical lesion in relation to the root canal treated #11 and #12 (Figure 1a). Considering the history and clinical findings provisional diagnosis of periapical abscess in relation to the maxillary right central and lateral incisor was made. Considering the extent of the periapical lesion, after obtaining the patient's informed consent CBCT (limited FOV CBCT, Field of View is 5 cm × 5 cm, voltage – 8 mA, and voltage – 110 kV, slice thickness of 2 mm) was advised to evaluate the extent of the lesion to the surrounding areas (Figure 1b, 1c). CBCT reveals periapical lesion in relation to #11 and #12 with a breach in the continuity of the palatal aspect right maxillary anterior region. Volumetric analysis using ITK-SNAP software showed a lesion volume of 2,145 cubic millimeters (Figure 2a).

The patient's informed consent was obtained, and after treatment, procedural steps were explained to the patient. RCT was initiated and carried out as per standard protocol. After the rubber dam application, access opening with large round (314 G) and endo access preparation was done, working length was estimated using the 20 number K file. Chemo-mechanical preparation was done with hand K files (Dentsply, India) and draining through the canals was established. Canals were irrigated with 5.25% Sodium Hypochlorite (Prime Dental, India), and 2% chlorhexidine (Prevest DenPro, India). Normal saline (Sodium chloride 0.9% W/V, Otsuka, India) was used in between alternate irrigation solutions. Then calcium hydroxide closed dressing was given for one week. One day before surgery, root canal obturation was done using Gutta-percha (Dentsply, India) and Bioceramic Sealer (BioRoot RCS, Septodont, Saint-Maur-des Fosses, France) with lateral/vertical condensation method.

**Surgical procedure:** The patient was painted with 5% povidone-iodine and draped under sterile conditions. Local anesthesia was achieved with 2% lignocaine (1:80000 adrenaline). A crevicular

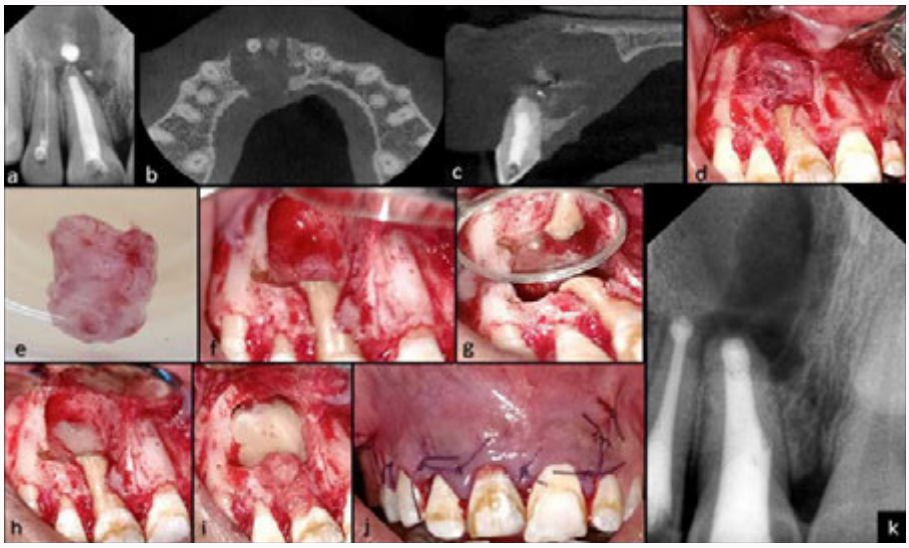


**Figure 1:** Surgical Procedure:
a) Preoperative intra-oral periapical radiograph, b) Axial view of preoperative CBCT of periapical lesion, c) Sagittal view of preoperative CBCT of periapical lesion, d) Exposed surgical site after raising rectangular mucoperiosteal flap, e) Removed peri-radicular lesion, f) Surgical site after enucleation and Apicoectomy, g) Retrograde MTA filling, h) Bone putty applied over the palatal defect, i) PRF placed in the enucleated bony defect, j) Silk 4-0 sutures placed, k) Postoperative intra-oral periapical radiograph

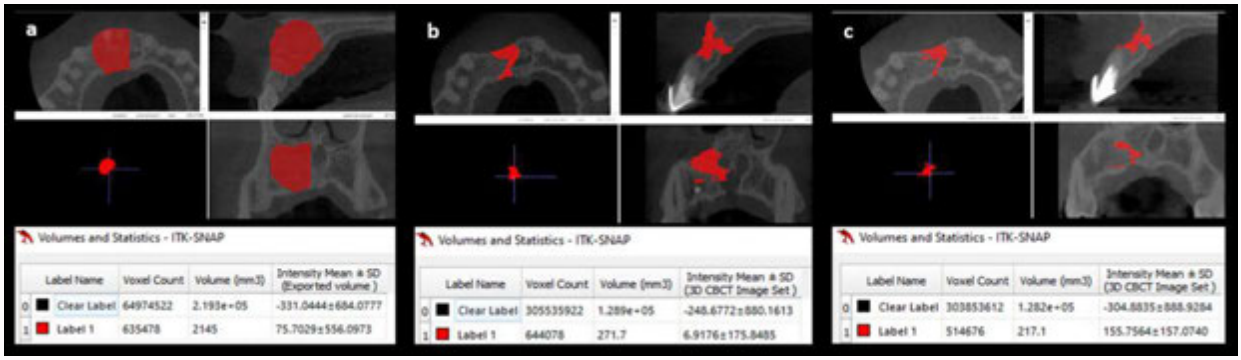


**Figure 2:** Case 1. a) Pre-operative CBCT Volumetric analysis using ITK-SNAP Software, b) First follow-up CBCT Volumetric analysis using ITK-SNAP Software, c) Second follow-up CBCT Volumetric analysis using ITK-SNAP Software.

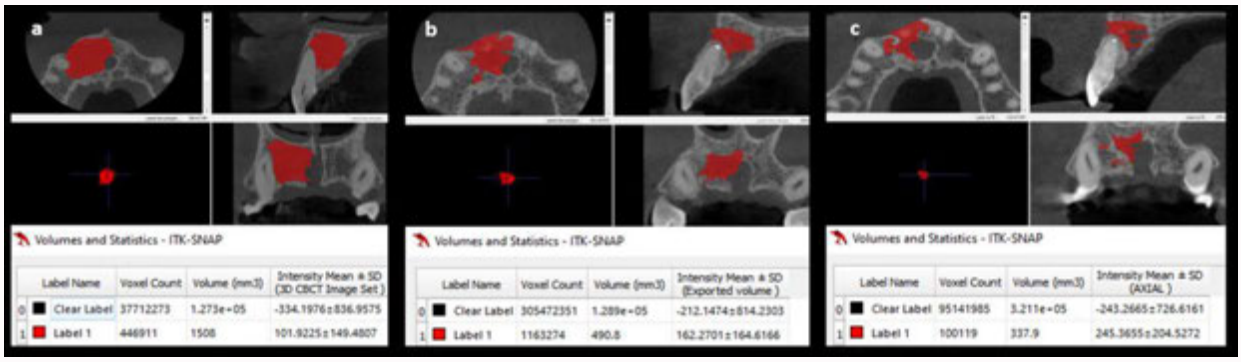


**Figure 3:** Case 2. a) Pre-operative CBCT Volumetric analysis using ITK-SNAP Software, b) First follow-up CBCT Volumetric analysis using ITK-SNAP Software, c) Second follow-up CBCT Volumetric analysis using ITK-SNAP Software.

incision was given from canine to canine with releasing incisions bilaterally, thus raising a rectangular mucoperiosteal flap (Figure 1d). Complete curettage of the periapical lesion contents was done and root apex manipulation was completed (Figure 1e, 1f). Burs no 701 (thin straight fissure carbide - surgical length bur) was used to cut the 3 mm of root tip in a straight handpiece of the physio-dispenser (Implantmed, W &H, Austria) at a slow speed of 40,000 rpm with adequate water jet. A retrograde cavity was prepared to accommodate the MTA retrograde restoration (Figure 1g). Straight ultrasonic tip (No F00106/F00079, SATELAC, Acteon ultrasonic tips) was used to remove gutta-percha and prepare the retro cavity. Micro-mirror (GDC, India) was used to inspect the final cavity preparation. After mixing the ProRoot MTA (Dentsply, India) (as per manufacturer's instruction), MTA was carried to the retro-cavity and condensed using a micro-surgical plugger (Apical micro-retrofilling instrument & Retrofilling DE plugger, Hu-Friedy) in 2 to 3 increments. Sharp margins were rounded off and thorough lavage of the cavity with normal saline was done. Clinically, the nasal floor was intact palatal perforation was sealed with bone putty material (NovaBone, NovaBone products, Bangalore, India), and the bony cavity was filled with PRF completely (Figure 1h, 1i). The lesion was sent for histopathological examination and the mucoperiosteal flap was then repositioned. Primary closure was done using 4-0 silk sutures, supported by periodontal dressing (COE-PAK AUTOMIX, GC, India) (Figure 1j, 1k).

**PRF placement:** On the day of surgery, 25 mL of blood was withdrawn from the blood bank section of our institute, and then it was collected in a 5 mL vial for the centrifuge process. Five vials of PRF were received before initiating surgery. Once the osteotomy site was ready after bone putty placement, a straight-toothed tissue holder was used to lift the PRF from the vial and then the red corpuscles base was removed. The Fibrin clot segment was placed into the bony cavity till it was filled. A thin film layer of fibrin clot segment was placed at the cervical margins. Then the surgical site was sealed with multiple interrupted sutures and periodontal dressing.

A custom-made prefabricated acrylic palatal splint was fitted in the patient's mouth and was advised antibiotics and analgesics for five days. The patient was recalled after 5 days for evaluation suture removal was done and postoperative instructions were given. The patient was further advised to use the palatal splint for one week. The patient was kept under regular follow-up and the periapical healing (in terms of reduction in the lesion volume) was assessed using ITK-SNAP Software for CBCT volumetric analysis. Postoperative follow-up evaluation after three years revealed near complete healing of periapical lesion with a reduction in lesion volume from 2,145 cubic millimeters to 217 cubic millimeters (Figure 2a-2c and Table 1).

## Case 2

A 32-year-old male patient reported to the Department of Dentistry, with a chief complaint of pain and swelling in the upper front teeth region. The patient gave a history of trauma to the upper front teeth twenty years back and gave a history of severe pain and swelling for one week. The patient further gave a history of surgical intervention in the area 5 years back. Extra-oral clinical examination showed swelling in the right maxillary anterior region and intra-oral examination revealed palatal swelling in the right maxillary anterior teeth region. Considering the clinical findings radiographic investigations were advised and a well-defined cystic lesion in relation

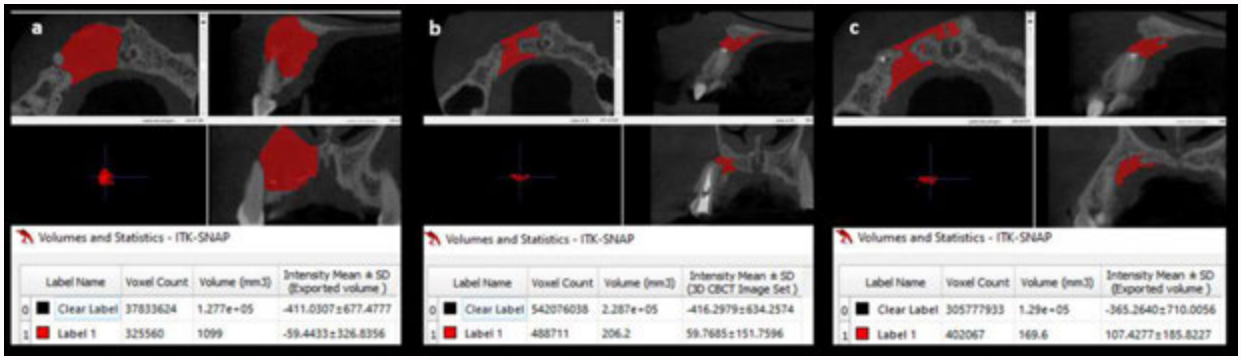


**Figure 4:** Case 3. a) Pre-operative CBCT Volumetric analysis using ITK-SNAP Software, b) First follow-up CBCT Volumetric analysis using ITK-SNAP Software, c) Second follow-up CBCT Volumetric analysis using ITK-SNAP Software.

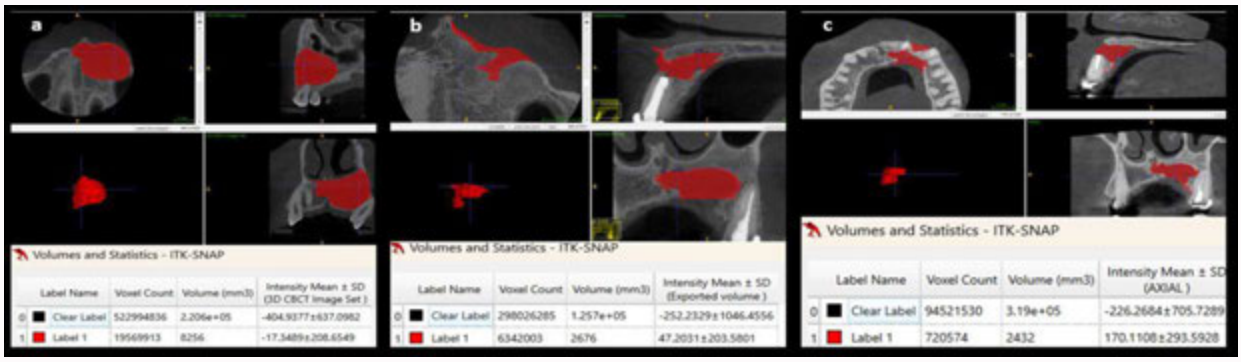


**Figure 5:** Case 4. a) Pre-operative CBCT Volumetric analysis using ITK-SNAP Software, b) First follow-up CBCT Volumetric analysis using ITK-SNAP Software, c) Second follow-up CBCT Volumetric analysis using ITK-SNAP Software.

to #11, and #12 was observed. Tooth #12 was root canal treated and restored with fiber post & core & and crown. After obtaining the informed consent, the patient was further advised to get a CBCT done for the maxillary anterior region (limited FOV CBCT, Field of View is 5 cm × 5 cm, voltage – 8 mA, and voltage – 110 kV, slice thickness of 2 mm). The pre-operative volumetric analysis of the periapical lesion showed a lesion measuring 1,508 cubic millimeters (Figure 3a).

After obtaining the patient's informed consent, RCT and surgical procedures were carried out as detailed for the first case with no additional modifications. The patient was followed up for three years, and six months and near complete healing of the periapical lesion was observed in CBCT examination with a reduction in lesion volume from 1,508 cubic millimeters to 338 cubic millimeters (Figure 3a-3c, Table 1).

## Case 3

A 28-year-old female patient reported to the Department of Dentistry, with a chief complaint of pain and pus discharge from the upper front teeth region. The patient gave a history of trauma to the upper front teeth twelve years ago and gave a history of intermittent pus discharge for 6 months. Medical history was noncontributory. Extra-oral clinical examination showed swelling in the right maxillary anterior region and intra-oral examination revealed draining sinus and palatal swelling in the right maxillary anterior teeth region. Considering the clinical findings radiographic investigations were advised and a well-defined cystic lesion in relation to Root canals treated #11, and #12 was observed. After obtaining the informed consent, the patient was further advised to get the CBCT done (limited FOV CBCT, Field of View is 5 cm × 5 cm, voltage – 8 mA, and voltage – 110 kV, slice thickness of 2 mm) for the maxillary anterior region and the preoperative volumetric analysis of the periapical lesion was done (Figure 4). A value of 1,099 cubic millimeters was inferred (Figure 4a).

After obtaining the patient's informed consent, RCT and surgical procedures were carried out as detailed for the first case with no additional modifications. The patient was followed up for three years and near complete healing of the periapical lesion was observed in CBCT examination with a reduction in lesion volume from 1099 cubic millimeters to 169 cubic millimeters (Figure 4a-4c and Table 1).

## Case 4

A 27-year-old male patient reported to the Department of Dentistry, with a chief complaint of pain and pus discharge from the maxillary incisor region. The patient gave a history of trauma to the upper anterior teeth ten years back and gave a history of swelling for 3 years and pus discharge for two weeks. No significant medical or dental history was reported by the patient. Extra-oral clinical examination showed swelling in the left maxillary anterior region. Intra-oral examination revealed draining sinus and palatal swelling in the left maxillary anterior teeth region. Considering the clinical findings radiographic investigations were advised and a well-defined cystic lesion in relation to teeth #11, #21, #22, #23, #24, #25 was observed. After obtaining the informed consent, the patient was further advised to get the CBCT done for maxilla (limited FOV CBCT, Field of View is 5 cm × 8 cm, voltage – 8 mA, and voltage – 110 kV, slice thickness of 2 mm) (Figure 5). The preoperative volumetric analysis of the periapical lesion gave a value of 8,256 cubic millimeters (Figure 5a).

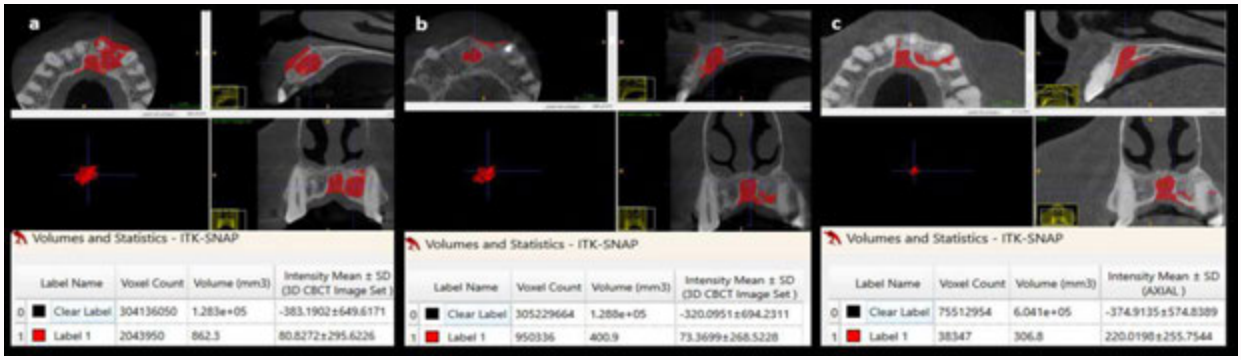


**Figure 6:** Case 5. a) Preoperative CBCT Volumetric analysis using ITK-SNAP Software, b) First follow-up CBCT Volumetric analysis using ITK-SNAP Software, c) Second follow-up CBCT Volumetric analysis using ITK-SNAP Software.

**Table 1:** CBCT Volumetric analysis data of five cases.

| S. No. | Name | Age/ Sex | Teeth involved | Pre-op CBCT Volumetric Analysis | Follow-up CBCT at 1-year Volumetric Analysis | Follow-up CBCT at 3-year Volumetric Analysis |
|---|---|---|---|---|---|---|
| 1. | Case 1 | 31/F | 11,12 | 2145 $mm^3$ | 271.7 $mm^3$ | 217.1 $mm^3$ |
| 2. | Case 2 | 32/M | 11,12 | 1508 $mm^3$ | 490.8 $mm^3$ | 337.9 $mm^3$ |
| 3. | Case 3 | 28/F | 11,12,13 | 1099 $mm^3$ | 206.2 $mm^3$ | 169.6 $mm^3$ |
| 4. | Case 4 | 27/M | 11,21,22,23,24,25 | 8256 $mm^3$ | 2676 $mm^3$ | 2432 $mm^3$ |
| 5. | Case 5 | 47/F | 21,22,23 | 862.3 $mm^3$ | 400.9 $mm^3$ | 306.8 $mm^3$ |

After obtaining the patient's informed consent, RCT and surgical procedures were carried out as detailed earlier with no additional modifications. The patient was followed up for three years and significant healing of the periapical lesion was observed in CBCT examination with a reduction in lesion volume from 8,256 cubic millimeters to 2,432 cubic millimeters (Figure 5a-5c and Table 1).

### Case 5

A 47-year-old female patient reported to the Department of Dentistry, with a chief complaint of pain and swelling in the maxillary anterior region. The patient gave a history of trauma twelve years ago. A history of multiple episodes of pus discharge in the last two years was given. No significant medical history was elicited and no history of any previous dental treatments was reported by the patient. Extra-oral clinical examination revealed swelling in the left maxillary anterior region. Intra-oral examination revealed decreased labial vestibular depth with draining sinus and palatal swelling in the left maxillary anterior teeth region. Radiographic investigations were advised and a well-defined cystic lesion in relation to #21, #22, and #23 was observed. After obtaining the informed consent, the patient was further advised to get the CBCT done in relation to the maxillary anterior region (limited FOV CBCT, Field of View is 5 cm × 5 cm, voltage – 8 mA, and voltage – 110 kV, slice thickness of 2 mm). A pre-operative volumetric analysis of the periapical lesion gave a value of 862 cubic millimeters (Figure 6).

After obtaining the patient's informed consent, RCT and surgical procedures were carried out with no additional modifications. The patient was followed up for three years and a near complete healing of the periapical lesion was observed in CBCT examination with a reduction in lesion volume from 862 cubic millimeters to 306 cubic millimeters (Figure 6a-6c and Table 1). (Patients are still under follow-up).

## Discussion

Though biofilms are invariably present in the apical segment of the root canal wall (77%), the overall prevalence of biofilm is higher (95%) in cases of cystic lesions. It was concluded that they are more likely to be associated with longstanding pathologic processes including large lesions and cysts [9]. Surgical intervention is indicated when there is persistent endodontic disease and where it is not possible to treat from within the pulp cavity [10]. A formal communication session (including the available treatment options, treatment steps, duration/ number of visits required and prognosis) was conducted with each patient and informed consent was obtained before commencing the treatment.

Though multiple treatment modalities have been suggested for the management of buccal perforations caused by large periapical lesions like the use of collagen membranes and platelet-rich concentrates, none of them have been evaluated in the management of palatal perforations of endodontic origin. Though collagen membranes used along with bone grafts were indicated in managing buccal perforations with periapical lesions, these recommendations have mixed opinions for their use in surgical endodontics [11]. Platelet-rich concentrates aid in enhanced bone regeneration when used along with bone grafts. The presence of large quantities of growth factors like platelet-derived growth factor, transforming growth factor-beta, epidermal growth factor, vascular endothelial growth factor, insulin-like growth factor-1, and basic fibroblast growth factor aid in the new bone formation efficiently [12].

Bone graft/putty materials have been used to maintain space for the repopulation of cells and further act as osteoinductive/ osteoconductive agents to form the host bone [11]. Bone graft/putty materials interact with the host's body fluids and initiate a series of reactions like leaching, dissolution, and precipitation to form silica and calcium-rich surface gel. The silica and calcium-rich surface gel traps cellular and non-cellular materials within the gel matrix and further the hydroxyl carbonate/apatite nucleates crystallize and interact with mucopolysaccharides, glycoproteins, collagen, and osteo-cellular materials. Over some time, the matrix gets transformed,

remodeled, and replaced by the osseous tissue [13].

NovaBone putty material used in the management of the present five cases is composed of Calcium Phosphosilicate (CPS) particles that exist in bimodal size distribution and are combined with binders like polyethene glycol and glycerin. The binders improve the handling properties and aid in maintaining the space between the particles, which further facilitates revascularization. After placement in the lesion site, binders get soluble and absorbed within 24 h to 72 h, generating a three-dimensional porous scaffold that aids in the diffusion of tissue fluids and blood throughout the matrix [14]. In addition to osteoconductive properties, the NovaBone putty material also has osteostimulative properties. After placement, different reactions like absorption of graft material and controlled release of silicon, calcium, and phosphorous ions aid in the stimulation of new bone formation by elevating the osteocalcin and alkaline phosphatase levels [15].

Platelet-rich fibrins release polypeptide growth factors like platelet-derived growth factors, transforming growth factors-β, vascular endothelial growth factors, and matrix glycoproteins into the surgical lesion in a sustained manner [16]. The increased beneficial effects were observed in the previous literature specifically in treating the intra-bony and other periodontal defects [17]. It was also reported that PRF serves as a biological connector between the bone graft materials and the release of cytokines from PRF plays a vital role in the self-regulation of the inflammatory phenomenon with the graft material [18]. Thus considering the unique osteostimulative and osteoconductive properties of the NovaBone putty material and properties of autologous PRF, synergistic outcomes were hypothesized in managing the large periapical lesions with palatal perforations in the present five cases. The mentioned technique needs to be evaluated with well-designed clinical trials with long follow-ups and clinicians managing the large periapical lesion with palatal perforations need to carefully select the patients and materials for successful treatment outcome.

To evaluate treatment outcome and healing of the periapical area, Huumonen and Ørstavik previously investigated the changes in the 2D Periapical Index (PAI) score and thus healing for endodontically involved teeth [19]. With the growing use of CBCT imaging in endodontics, many recent studies have used changes in lesion volume to gauge periapical healing [20-22]. Estrela et al., had given CBCT PAI score to each lesion based on the maximum diameter of the lesion. According to Estrela et al., a lesion with a score of 0 represents an intact periapical structure [23]. Scores 1, 2, 3, 4, and 5 have an increasing maximum diameter starting with .0.5 mm to 1 mm, 1 mm to 2 mm, 2 mm to 4 mm, 4 mm to 8 mm, and 8 mm. In a subsequent development, a volume-based CBCT Periapical Index (Score 1-6) was given [24]. According to CBCTPAI, all the cases mentioned in this case series fall under score 6, necessitating a detailed volumetric analysis to arrive at some effective conclusion. ITK-SNAP Software was used to calculate the effective reduction in the volume of the lesion at different time intervals. Of the two possible methodologies, Bubble Cluster and Polygonal shape fill, the latter was preferred for its greater accuracy and unbiased repeatability.

## Conclusion

The combined effect of bone putty in palatal perforation and PRF in peri-apical lesions successfully aided in the healing of large peri-apical lesions. After a follow-up of three years, all five subjects were clinically asymptomatic and showed a favorable reduction in the size of the periapical lesion as well as repair of the palatal perforation defect. Good quality clinical trials are recommended to reinforce the results observed from combining the bone putty and PRF placement in the large peri-apical lesions.

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