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A NOVEL METHOD IN INTERVENING PULPAL CANAL OBLITERATION WITH 3D - PRINTING: A REPORT OF TWO CASES

Short title : NOVEL METHOD IN INTERVENING PULPAL CANAL OBLITERATION

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Introduction

Pulp calcification is one of the factors that make endodontic treatment challenging and capable of compromising access of instruments and irrigant solutions to the entire extension of the root canal, making it impossible to disinfect it adequately. Pulp canal calcification (PCC), also known as pulp canal obliteration or calcific metamorphosis, is characterized by the deposition of calcified tissue along the canal walls. PCC cases are associated with luxation injuries of dental trauma and pulpal responses to various insults such as Invasive pulp therapy procedures, Extended carious lesions, Abfractions, and Restorations. [(1)]

The use of orthodontic forces may also induce PCC because of interference in the blood supply [(2)]. Moreover, in elderly patients, the deposition of secondary dentin may also severely reduce the root canal space and obliterate it partially or completely [(3)]. Root perforations and canal deviations have been reported as common complications after the treatment of PCC cases, which may ultimately result in tooth loss [(4)]. In these cases, even the most experienced clinicians can encounter difficulties in achieving the goals of endodontic treatment [(5)]. Guided endodontics has been proposed as a new approach to localizing and negotiating seemingly obliterated root canals and makes the endodontic treatment more predictable and safer in this complex situation [(6)].

By planning the root canal treatment in 3 dimensions on the volume of a cone-beam computed tomographic (CBCT) scan and merging this with a surface scan, it is possible to manufacture a template to guide the treatment. Buchgreitz et al. were the first to show that guided access principles, later known as "guided endodontics," was accurate enough to be used in vivo [6]. In this method, a digital impression of the patient's jaw or scan of the impression is taken and registered to the data from the CBCT. Then, a path for the bur is created up to the location of the root canal on the CBCT. For a customized bur, guide for the bur being used during treatment is designed by empolying a computer-aided design (CAD) software and printed using a 3D printer or a pilot implant drill, long shank burs, Munce discovery burs can be used [7,8,9] .

It could be speculated that using a guided access cavity preparation in the treatment of partial or complete PCO, the teeth may be successfully treated without jeopardizing the entire root. Thus, this study aims to create a miniaturized and minimally invasive method by creating a 3D- printed guide to gain access to the obliterated root canals based on CBCT data.

CASE REPORT 1

A 25 year old female patient presented with chief complaint of pain in the upper front tooth to our department, past history revealed that there was trauma 6 years back. On clinical examination tooth was tender on percussion, there was no response to thermal and electric pulp tests i.r.t # 11. Radiographic examination showed a severely calcified root canal (figure 1). However, root canal space could only be identified in the middle third with 3D imaging (CBCT CS 2100 (Carestream Dental, Atlanta, GA)) (figure 2). The final diagnosis of symptomatic apical periodontitis was formulated. After analysis and discussion with the patients. Endodontic therapy with guided endodontic access as an initial strategy was the proposed treatment plan, which leads to minimally invasive access.

Fig 1. Preoperative radiograph

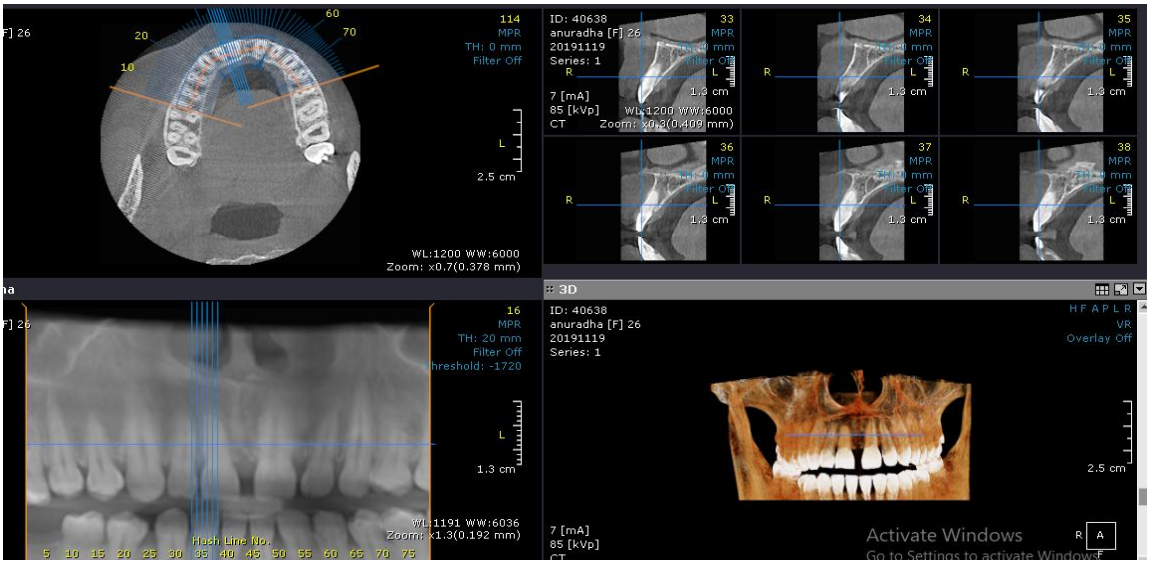


Figure 2.CBCT Image

To create a 3D Printed Template, polyvinyl siloxane impression (Aquasil Ultra; Dentsply Caulk, Milford, DE) was made, and a gypsum dental model was created and scanned using Straumann CARES 3D scanner (Straumann dental India LLP) (figure 3.a). Both CBCT imaging and model scan data were aligned in Blue Sky Plan 3 [Blue Sky Bio, LLC, Grayslake, IL] and processed with implant software (figure 3.b). A virtual copy of a drill with a diameter of 1.5 mm and a length of 18mm was superimposed onto the scans in a position that allowed its access to the identified root system within the apical one third of the tooth. The position of the drill was checked in 3 dimensions (figure 3.c). Utilizing the previously described position of the drill (figure .d), the software automatically created a virtual template by applying its designer tool(figure.e). Template made of polylactide material was printed using the 3D printer Stratasys (India pvt ltd)

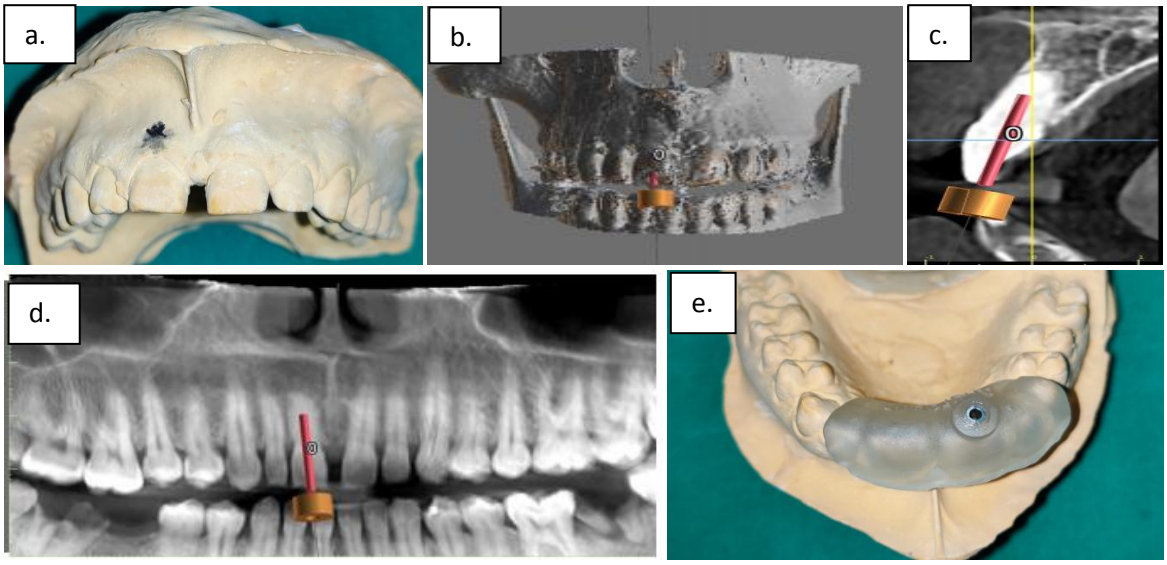
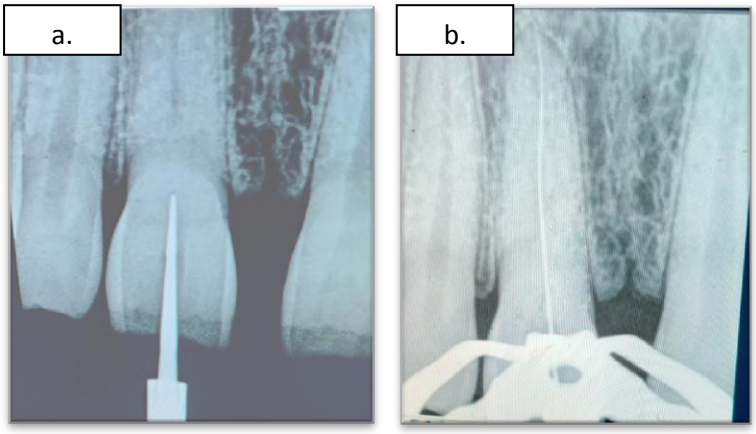


Figure.3. 3D Printing

A guiding sleeve (with a 3.0-mm external diameter, 1.5-mm internal diameter) is virtually customized and incorporated into the planning process to access. The template fit and bur position was checked in the mouth (Figure 4).

Fig.4.TEMPLATE FIT

The bur was coupled to a high speed handpiece. Drilling was performed with pumping movements to penetrate through the calcified part of the root canal under copious irrigation with saline. After 7-mm apical advance,a radiograph was taken to confirm the correct position of the bur (figure.5.a). After achieving canal patency rubber dam clamp was placed, 15 k file was introduced and root canal length electronically & radiographically confirmed (figure.5.b). The tooth was instrumented with NITI rotary system (25.06, 30.06) and irrigation was done with 2.5 % Naocl, canal was dried, calcium hydroxide intracanal medicament was given. Patient recalled after one week and the obturation (figure.5.c) was performed using 30.06 GP using AH-plus sealer and access cavity was sealed with composite resin (figure.5.d).The patient is under follow up .



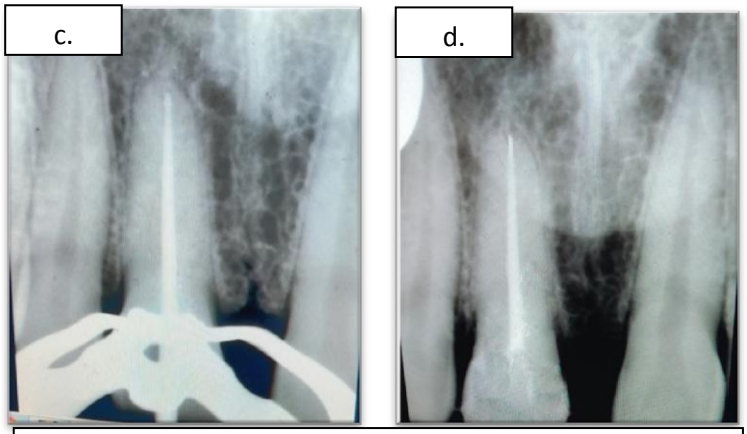


Figure.5. INTRAOPERTIVE AND POSTOPERATIVE RADIOGRAPHS

CASE REPORT 2

A 38 year old female patient presented with a chief complaint of pain in the upper front tooth to our department, history revealed there was trauma 10 years back. On clinical examination tooth was tender on percussion, there was no response to thermal and electric pulp tests i.r.t # 11. Soft tissue examination revealed periapical sinus opening with pus drainage i.r.t # 11. Radiographic examination showed a severely calcified root canal (figure 6). However, root canal space could only be identified in the middle third with 3D imaging (figure 7). The final diagnosis was formulated as a chronic periapical abscess. After analysis and discussion, a guided template was obtained, a minimal invasive access was done and endodontic treatment was completed as similar to case 1 (figure 8, 9).

Fig 6. Preoperative radiograph

Fig 7. CBCT IMAGE

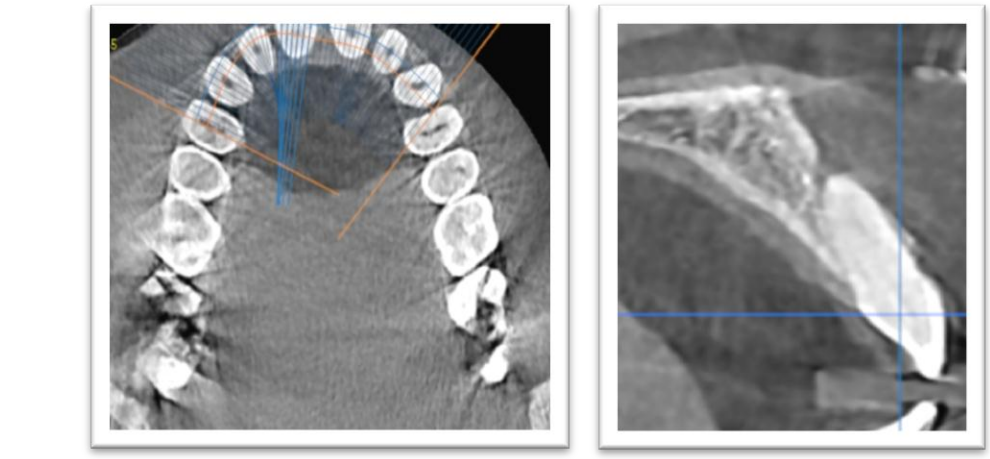


Fig.8.TEMPLATE FIT AND BUR POSITION

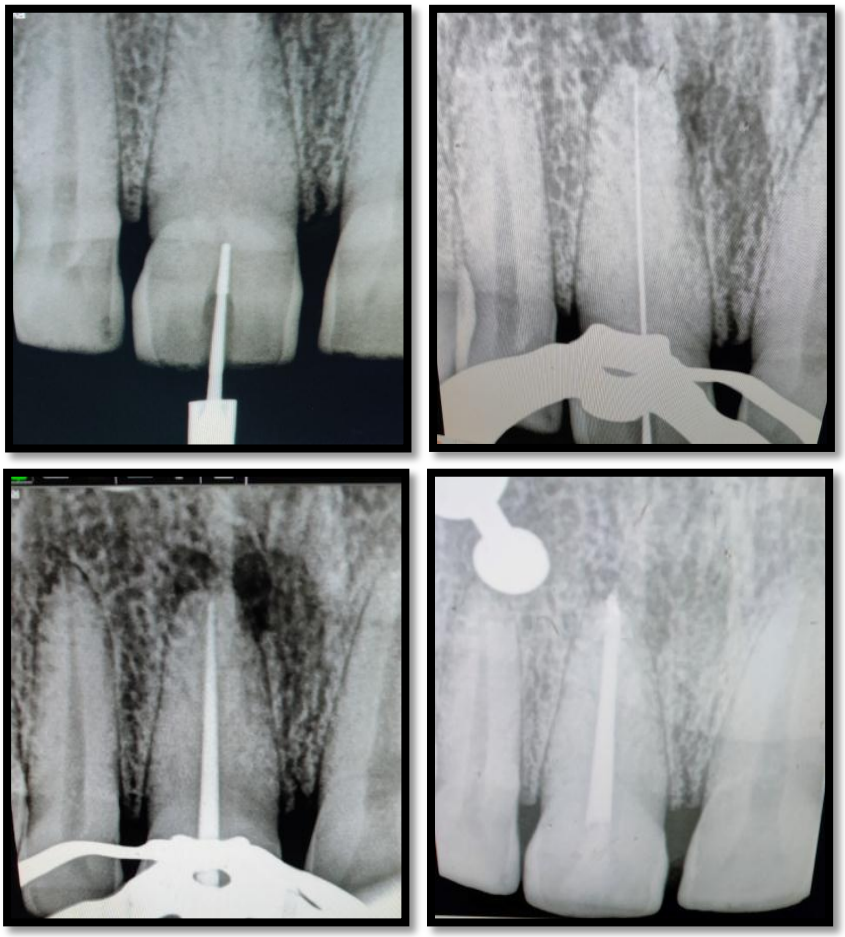


Figure 9 .INTRAOPERTIVE AND POSTOPERATIVE RADIOGRAPHS

DISCUSSION

Pulp canal obliteration most commonly reported in apical portions may also occur in coronal or middle third that appears as narrowing of the root canal , is a very challenging case for any endodontist. It requires experience and patience for successful management of these cases. All cases of PCO doesn't require to be instigated, only symptomatic teeth with pulpitis or apical periodontitis or with periapical lesions can be treated. [10]

During this process, even very skilled clinicians can create a deviation from the original path of a root canal when treating teeth with complex anatomies and severe calcifications.[11] These deviations may lead to perforations in 75% of cases during the negotiation of calcified canals.[12] All these factors hamper adequate endodontic treatment and may significantly effect long-term prognosis.

Guided Endodontics can be used by clinicians because of feasibility. It is a successful option, a very diverse technique for the treatment of PCO [13], dens evaginatus [14] and even during apicoectomy [15]. Guided Endodontics was first introduced by Krastl et al.[7] and used it on a clinical case with PCO of the maxillary central incisor.

3D-printed guide with a metal sleeve was used [16,10] as it will serve as protection for the acrylic guide [17]. Mean deviation of the access cavities are reduced to 0.7 mm by the radius of the bur and radius of the root canal [6], Connert et al. [16] found a mean angular deviation of less than 2 degrees and small deviations from the intended access was (0.12- 0.34 mm at the tip of the bur). 3D printed template guides the access as a safe means for challenging endodontic scenarios, enabling both chemomechanical debridement and conservation of tooth structure.

The accuracy rate of CBCT is higher than periapical radiographs for the detection of periapical lesions using histopathological findings as gold standard [18]. With intra-oral imaging, there is difficulty in detecting apical periodontitis due to obscure of apex by cortical bone. In a series of cases, van der Meer et al. [9] after taking digital impressions and CBCT scans, merged them in CAD software, DICOM data was sent as STL file (Stereolithography files) containing bony architecture for teeth in pulp canal obliteration-affected maxillary incisors (Figure 2 and 4) access guides were then printed and utilized, to target burs to otherwise elusive canal spaces without perforation. Printed templates having high accuracy and extended flexibility is promising.[7]

In the present study drmoogs bur was used which has a very small diameter size of 0.8mm , a minimally invasive orifice directed dentin conservative access was achieved, maintaining as much of the root's rigidity increasing the fracture resistance of root [19] and this smaller diameter bur produces low wear of dentin. To avoid unnecessary attrition and microcracks during dentin drilling care was taken by slowly penetrating the bur. After negotiation of the calcified canal with the template, it was easy to perform cleaning and shaping in very less time has operators hand fatigue will be reduced saving valuable chairside time with increased efficacy of the treatment.

However, an endodontist using an operating microscope may take time to localize obliterated root canals that can vary from 15 min to 1 h [3] whereas using a 3D-printed guide, showed that it minimizes the time from around 9 to 208 s, as reported by Connert et al. [16] in a laboratory study. The time used for the design and fabrication of the guide during the planning of the case was long as for any learning phase. However, this was compensated with a significant reduction in treatment time.

CONCLUSION

In these case reports about severely calcified maxillary central incisors in which the planning and execution of minimally invasive access were altered to mitigate the damage to the dental incisal edge. This conservative approach is likely to improve the long-term prognosis and it was made possible because the guided endodontic treatment was performed in a quick, safe, and predictable way. Efforts must be made to improve the technique and allow its use in the treatment of curved canals, guidance for retreatment of selective canals, and the removal of fiber posts.

CONFLICT OF INTEREST

No

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None

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