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CASE REPORT

Endodontic guides and ultrasonic tips for management of calcifications

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ABSTRACT

Aim: *To describe the role of guided endodontics with ultrasonic tips in management of calcified canals.*

Summary

Case 1: A 23-year old female presented with esthetic complaint related to the maxillary left central incisor with a history of trauma. Radiographic examination revealed internal resorption and apical calcification. A silicone impression of the maxillary jaw was obtained and scanned to plan for access of the calcified canal by means of implant planning software. Guides were fabricated through rapid prototyping and allowed for the correct orientation of an ultrasonic tip to provide access through the calcifications. An access cavity was done, the calcified canal was accessed by the help of the fabricated guide, and the root canal was prepared and obturated using warm vertical technique apical to the resorptive defect. The rest of the canal was filled with mineral trioxide aggregate (MTA). One-year follow-up revealed no symptoms and evidence of radiographic healing.

Case 2: A 43-year old male was referred for endodontic treatment of the maxillary right first molar. The mesiobuccal and palatal canals were prepared by the referring dentist who failed to locate the distobuccal canal. Radiographic examination revealed a previously initiated root canal therapy, widening of the periodontal membrane space and coronal calcification of the distobuccal canal. A silicone impression of the maxillary jaw was obtained and scanned similar to the first case. The distobuccal canal was located using the ultrasonic tip through the guide, prepared, and obturated using warm vertical technique. One-year follow-up revealed no symptoms and evidence of radiographic healing.

Key-learning points

- *Endodontics guides with ultrasonic tips are reliable in management of root canal calcifications.*
- *Three-dimensional imaging using CBCT and CAD/CAM provides accurate 3D guides.*

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Key-learning points

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Introduction

Partial or complete canal calcification is a common finding in permanent teeth which may be a sequela of caries, aging, traumatic injuries and systemic conditions (1). In such cases, root canal treatment is recommended in symptomatic cases of pulpal and/or periapical pathosis (2). Localization and negotiation of calcified root canals is a challenging procedure, where iatrogenic errors may occur.

According to the classification of the American Association of Endodontists of the level of difficulty, treatment of calcified root canals is considered to have a high level of difficulty (3). Long-shank drills and ultrasonic tips coupled with dental operating microscope are used for such cases. Yet, the possibility of procedural errors and risk of failure are still high when dealing with calcified canals. Surgical approach is another treatment option, but it possesses many challenges (4).

Cone beam computed tomography (CBCT) is a very beneficial tool for diagnosis and treatment planning of complex endodontic cases and management of procedural errors (5, 6). Guided endodontics and virtual planning help to preserve the remaining tooth structure and avoid procedural errors.

According to the European Society of Endodontology statement in 2019 about the applications of CBCT in endodontics, it is recommended for the identification of the spatial location of extensively obliterated canals taking into account the possibilities of guided endodontics (7). Guided endodontics in the management of root canal calcification has been previously reported and considered safe and predictable (8). Guided endodontics in addition to dynamic navigation has shown excellent results as a training tool for dental students and might be of great value in management of calcified root canals (9).

In this report we describe the management of calcified canals in maxillary central incisor and maxillary first molar to reach the remaining apical tissues using the guided endodontic technique and ultrasonic tips.

Report

#Case 1

On October 15th, 2019, a 23-year old female patient presented with esthetic complaint related to the maxillary left central incisor. The patient gave history of a traumatic injury about 10 years ago with intrusion of the tooth. The patient was asymptomatic and two-dimensional periapical radiographic examination revealed internal resorption and apical calcification plus widening of the periodontal membrane space. No previous dental intervention was noted. Clinical examination revealed an intruded maxillary left central incisor which was sensitive to percussion and negative on palpation. Normal periodontal support was noted. Negative response was shown to thermal and electrical pulp testing. CBCT scans confirmed the periapical radiographic findings. Different treatment options were discussed with the patient taking into consideration the case difficulty. The use of 3D guide was decided, and a written consent was obtained.

An impression was done to the maxillary jaw using an addition silicone (Elite, Zhermack, Germany) then poured with dental stone material (Elite, Zhermack, Germany). The dental cast was scanned using CBCT so that it can be used along with the patient's scan for planning and guide fabrication.

Clinical procedures were done under local anesthesia. The coronal access cavity preparation was done in the usual position in the middle middle third of the palatal surface of the tooth using diamond round bur size 2 operated in high speed. The fabricated guide was adjusted in place. An ultrasonic tip ET25 (Satelec, France) attached to P5 ultrasonic scaler (Satelec, France) was used to locate the canal and access through the calcification. The ultrasonic tip operated till reaching the predetermined planned length. After reaching the length, the 3D guide was removed, and rubber dam isolation was done. K file #10 and #15 (Mani, Japan) were used to negotiate the canals and working length was determined using electronic apex locator (Dentaport, Morita, Japan). Root canal preparation was performed using rotary file system M3-Pro Gold (Udg, China)

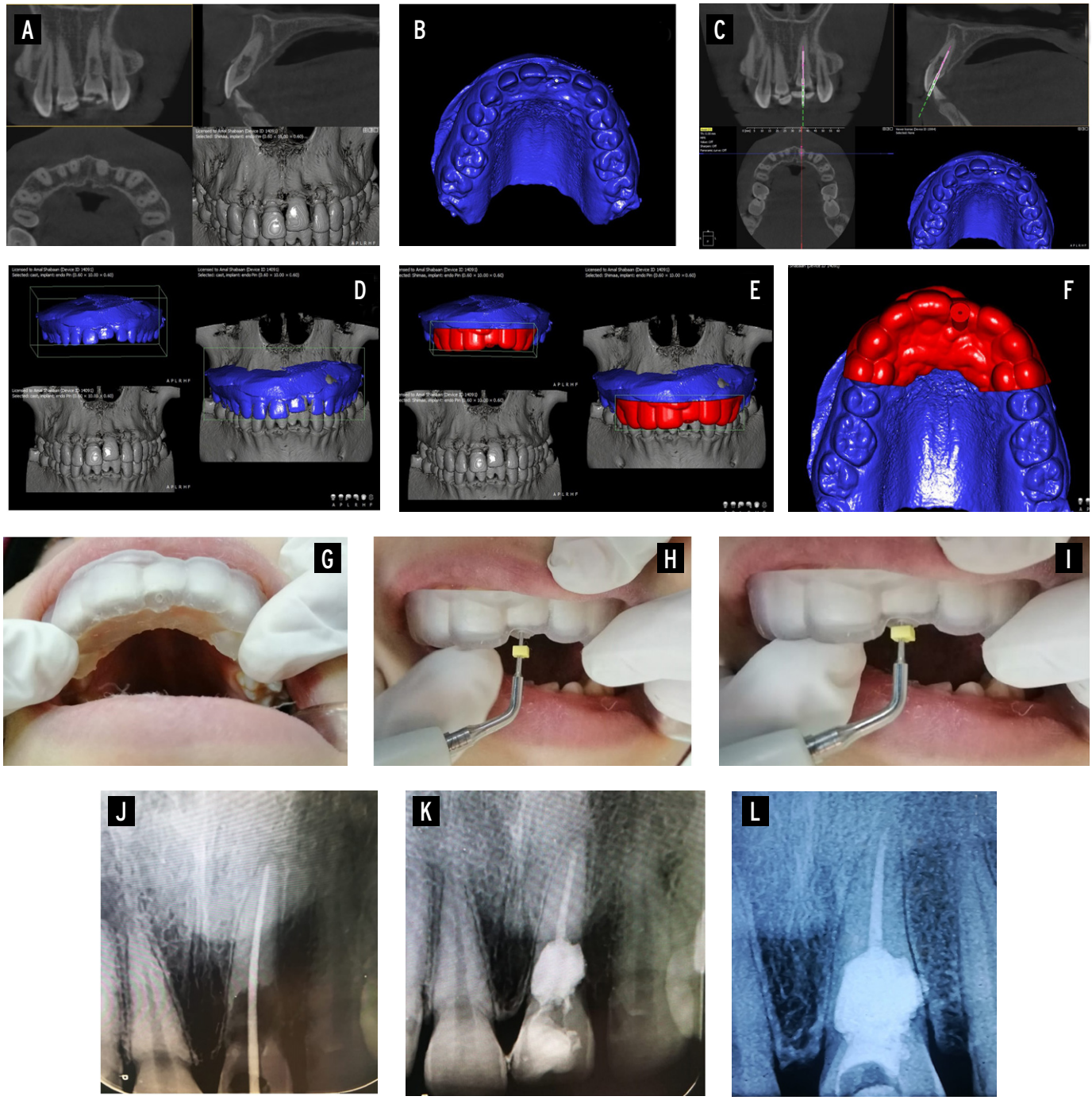

Figure 1
A) Preoperative CBCT scan showing maxillary left central incisor with internal resorption and calcified root canal apical to the resorption. **B**) CBCT scan for a stone cast for the maxillary jaw converted to STL file. **C)** CBCT scan showing the virtual planning for the ultrasonic tip in a guided path to the calcified canal. **D)** Superimposition of the cast scan and the CBCT scan **E)** and **F)** design of the guide. **G)** The 3D printed guide fitting inside the patient's mouth. **H)** Ultrasonic tip guided through the 3D acrylic guide. **I)** Ultrasonic tip after reaching the planned working length. **J)** Periapical radiograph showing the master gutta percha cone reaching the working length. **K)** Postoperative periapical radiograph showing MTA in the resorptive area and gutta percha apically. **L)** One-year follow up periapical radiograph with normal periapical bone and periodontium.

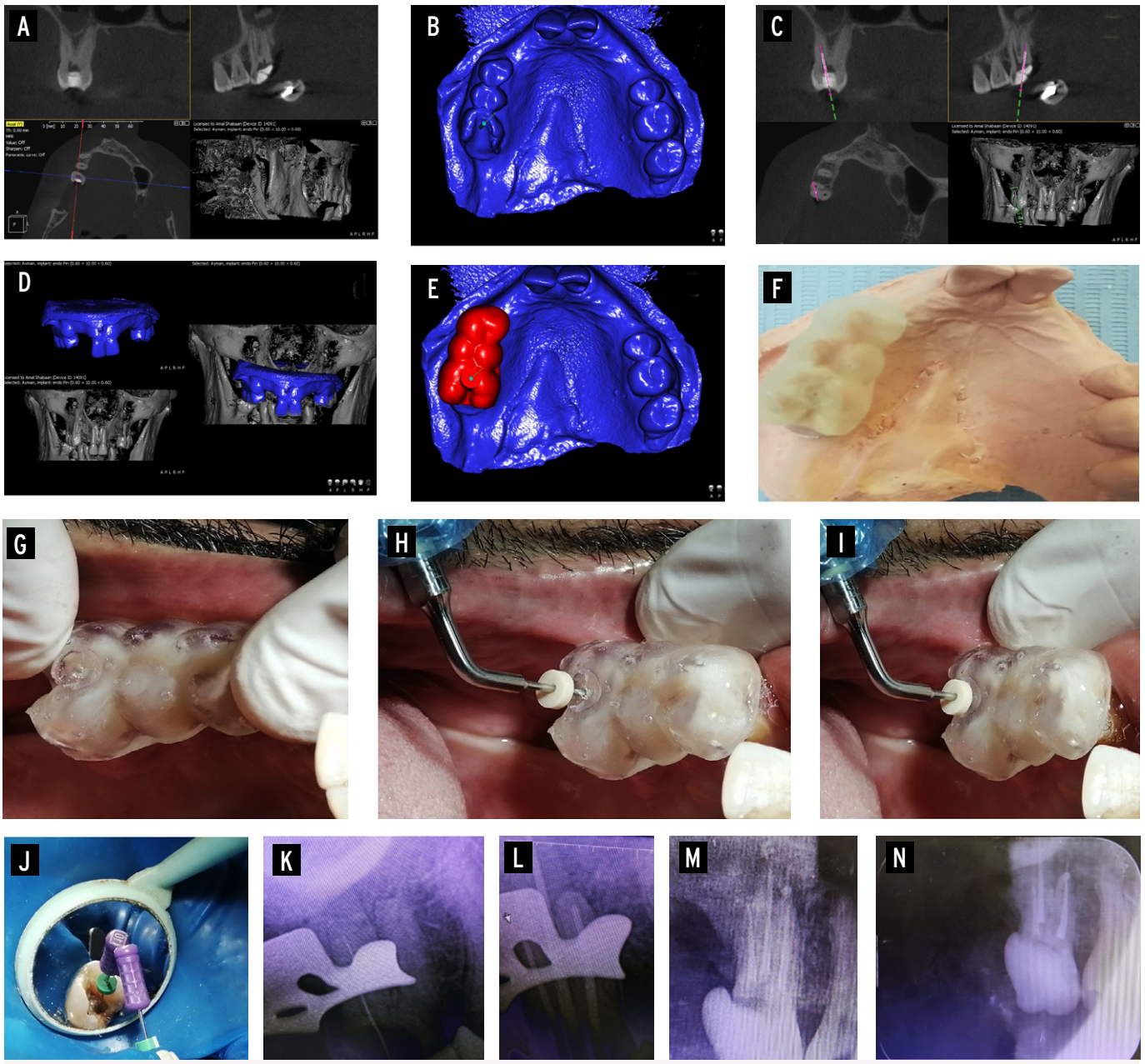

Figure 2

A) Preoperative CBCT scan showing maxillary right first molar with calcified coronal part of the DB canal. **B)** CBCT scan for a stone cast for the maxillary jaw converted to STL file. **C)** CBCT scan showing the virtual planning for the ultrasonic tip in the guided path to the calcified canal. **D)** Superimposition of the cast scan and the CBCT scan. **E)** Design of the 3D guide. **F)** Acrylic guide fitting on the cast. **G)** 3D printed guided fitting inside the patient's mouth. H) Ultrasonic tip in the planned path through the acrylic guide. I) Ultrasonic tip after reaching the planned working length. **J)** Negotiation of the DB canal using k file #10. **K)** Periapical radiograph showing k file reaching the working length in the DB canal. **L)** Periapical radiograph showing the master gutta percha cones. **M)** Postoperative periapical radiograph showing the obturated maxillary first molar. **N)** One-year follow up periapical radiograph with normal periapical bone and periodontium.

with the following sequence 20 .04, 25 .06, 30 .04, 35 .04, 40 .04 at 300 rpm rotational speed and 1.5 N/cm^2 torque.

Copious irrigation using 2.5% sodium hypochlorite (NaOCl) was performed along the procedure. Finally, active irrigation using 2.5% NaOCl was performed using ultrasonic tip ET25 for one minute to ensure proper cleaning of the resorptive defect.

Following canal dryness, warm vertical compaction technique was used to seal the apical third of the canal using master gutta percha cone 40 .04 (Meta Biomed, Chungcheongbuk-do, Republic of Korea) and AH Plus resin sealer (Dentsply Tulsa Dental, Tulsa, OK, USA). The coronal portion of the canal was filled with MTA (Angelus, Londrina, Parana, Brazil).

#Case 2

On November 2, 2019, 43-year old male patient was referred to our clinic for endodontic treatment of the maxillary right first molar. The mesiobuccal (MB) and palatal (P) canals were prepared by the referring dentist who failed to locate the distobuccal (DB) canal after troughing.

Clinical examination revealed a previously initiated root canal therapy. The tooth was sensitive to percussion, negative on palpation and no swelling was noted. Two-dimensional periapical radiographic examination revealed widening of the periodontal membrane space. CBCT confirmed calcification of the coronal 2.4 mm of the DB canal. Ultrasonic troughing was done in a wrong direction endangering the furcation.

Different treatment options were discussed with the patient taking into consideration the case difficulty. The use of 3D guide was decided, and a written consent was obtained. Maxillary impression and cast fabrication were performed as detailed in the first case. Clinical procedures were done under local anesthesia. The 3D guide was properly seated on the occlusal surfaces as designed. An ultrasonic tip ET25 (Satelec, France) attached to P5 ultrasonic scaler (Satelec, France) used to locate the canal and access through the calcification. The ultrasonic tip operated till the predetermined planned length. After reaching the length the guide was removed and rubber dam isolation was done. K file #10 and #15 (Mani, Japan) were used to negotiate the canals and working length was determined using electronic apex locator (Root ZX II, Morita, Japan). The DB canal was prepared using rotary file system M3-Pro Gold (Udg, China) with the following sequence 17 .04, 20 .04, 25 .06, 30 .04, 35 .04. Refinement of the preparation of the MB and P canals was done.

The root canals were irrigated using 2.5% sodium hypochlorite (NaOCl) along the procedure followed by manual dynamic agitation for 5 minutes (100 stroke per 30 seconds) using master gutta percha cone 35 .04 in MB and DB canals and 50 .02 in the palatal canal.

Following canal dryness, warm vertical compaction technique was applied using master gutta percha cones (Meta Biomed, Chungcheongbuk-do, Republic of Korea) and AH Plus resin sealer (Dentsply Tulsa Dental, Tulsa, OK, USA).

At two-week follow-up examination, both cases were totally asymptomatic, negative on palpation and percussion.Both cases were referred for prosthetic treatment. One-year follow-up showed good evidence of healing and normal periapical radiographic appearance.

Fabrication of the endodontic guide

Limited field of view, high resolution CBCT scan for the patient was stored in Digital Imaging and Communication (DICOM) format. Record of tooth surface and soft tissue surfaces was obtained indirectly by scanning the model obtained from the impression. One quadrant was obtained to secure a stable support for the guide. CBCT scan for the stone cast was exported from DICOM file to Surface tessellation language (STL) file using special software (Romexis). Data from DICOM format of the patient and STL file of the study cast was imported and superimposed over each other on software that was originally designed for guided implantology (DDS PRO, Poland). During superimposition, three to six points or reference landmarks are marked, then the software automatically merges both scans. Tracing of the calcified canal was performed, and if the canal is not visible, law of canal centrality was followed. The target point was placed at the first visible part of the pulp canal space. Virtual drill path, 1 mm in diameter, was planned by placing a thin drill

along the path of the canal and maintain centrality within the root. The angle of the drill was a bit tilted to avoid the incisal edge.
Virtual images of the ultrasonic tip were designed and implemented in the software to the proper position and direction at the beginning of the root canal beyond the calcification. The data was transferred to a three-dimensional printer (Formlab 3, USA), and the three-dimensional template was fabricated.

Discussion

Pulp space calcification is considered a normal aging process. Nowadays, there are lots of elderly patients retaining their normal dentition, showing pulp space calcifications, in need of root canal treatment (10).
Dental trauma is a major cause of pulp space calcifications in younger patients (11). Calcified dental pulp does not require any intervention; yet, about 1-27% of these pulps will become necrotic at a certain point (12).
Localization and negotiation of the root canal orifice past the calcification is a challenging procedure which might be associated with procedural errors such as loss of tooth structure, ledge formation, risk of fracture, and perforation (13, 8).
Three-dimensional CBCT imaging is valuable tool in endodontic diagnosis, assessing treatment outcomes, studying root canal morphology, pre-surgical planning, and guided endodontic treatment (6, 7).
Three-dimensional endodontic guides have been previously reported in management of root canals with calcifications (2, 8, 13-16). This technique is reported to be fast, safe and predictable.
The 3D guides direct the drill to the proper position, without the need for dental operating microscope, without any reported procedural errors to date reported.This technique replaced the valuable chairside time by spending time in the digital lab designing and manufacturing the guide. Yet, further research is deemed mandatory in this field in order to reach a standardize clinical protocol. In both cases reported, silicon impression was obtained that yielded great precision. Silicon impression is readily available, easy to use and less costly than optical impression which was used in all previously reported cases (2, 15, 17).
The use of drills or round burs with resin-based guide will result in damage of the guide. Metallic sleeves are used with drills in order to keep it within the planned path. In both cases reported, ultrasonic tip ET25 was used which allowed the use of resin-based guide without metallic sleeves and kept the amount of tooth structure lost to minimum.
No radiographs were needed during drilling which was terminated upon reaching the predetermined working length.
The first limitation of these 3D guides is the relatively large amount of tooth structure lost due to the drill size used. Yet, the loss of tooth structure is less than that occurring without using 3D guides, even when dental operating microscope is used (13). Connert et al (16) used this technique in mandibular incisors with very small drills that were quite precise in such narrow canals. In both cases reported, ET25 ultrasonic tip was used which is 20 mm in length, 0.3 mm in diameter at the tip with 3% taper; much smaller than any other drill or bur previously used.
The second limitation is related to the interocclusal distance available as previously reported by Connert et al (16) who suggested that it might be inapplicable in posterior teeth. In the present case report, similar to Lara Mendes et al (17), it was possible to apply the 3D guides in maxillary molars. Patients with limited mouth opening might not be good candidates for the 3D guides. Buchgreitz et al (2) reported successful use of intracoronal 3D guides in order to overcome the constrain of interocclusal distance available, especially in posterior teeth.
The third limitation is the inability to apply these guides beyond curvatures, limited to the straight portion of the canal (16)
As long as pulp space calcifications are located mostly in the straight portion of the canal, cervical and middle thirds (18), the 3D guides appear to be applicable in most of the cases.

Conclusions

Endodontics guides and ultrasonic tips were shown to be a valuable, predictable, safe, reliable and accurate technique for management of calcified root canals. Three-dimensional imaging using CBCT and CAD/CAM are needed to create accurate 3D guides. Further research is deemed mandatory in this field in order to reach a standardized clinical protocol.

Clinical Relevance

Endodontics guides and ultrasonic tips were shown to be an excellent technique in management of root canal calcifications.

Conflict of Interest

The authors deny any conflicts of interest related to this study.

Acknowledgments

None.

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