Guided Endodontics Modified for Treating Molars by Using an Intracoronal Guide Technique

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Abstract

The aim of this case report was to show the concept of guided endodontics in a maxillary first molar with limited interocclusal space. Guided endodontics involves merging cone-beam computed tomographic imaging and a surface scan of the tooth in order to create a guide to perform a drill path into the seemingly obliterated root canal. In the molar region, the interocclusal space is often too small to accommodate the guide, bur, and handpiece at once, and, therefore, a modified approach is presented. A 52-year-old man was referred because the dentist had failed to localize the distobuccal root canal of a maxillary molar (#3) associated with apical pathosis. After reopening and rubber dam placement, a glide path was established for both the palatal first mesiobuccal root canal and the second mesiobuccal using a size 10 hand file and coronal flaring. Further instrumentation to the working length was achieved by reciprocating file size 25. All 3 canals were temporarily filled with calcium hydroxide. For the distobuccal root canal, guided endodontics was chosen in order to avoid further impairment of the tooth because negotiation of the canal failed even with the use of the operating microscope. Following the merged data obtained from the cone-beam computed tomographic and surface scans, a translucent SICAT Optiguide (SICAT, Bonn, Germany) was constructed containing a sleeve representing the proper direction of a drill path in order to reach the distobuccal root canal. The access cavity was temporarily filled with a composite material made for light-curing. Before light curing, the Optiguide was replaced on the teeth, and a steel pin was pressed through the sleeve and the composite whereby the proper drill path direction was transferred into the composite. After polymerization and removal of the Optiguide and pin from the composite base sleeve, the guided drilling could be performed. This case report is the first on guided access preparation in a molar with pulp canal obliteration and limited interocclusal space. The demand for more interocclusal space was solved by transforming the virtual drill path into a composite-based intracoronal guide. The use of digital technology was essential. *(J Endod 2019;■:1–6)*

Key Words

Access cavity, cone-beam computed tomography, endodontics, guided endodontics, pulp canal obliteration

> **Significance**
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> Molars are the most frequent tooth in need of RCT. In cases of canal obliteration, they can be treated using a guided endodontic concept. If the interocclusal distance is reduced, the concept can be changed by using an intracoronal guide.

Guided endodontics is a new approach to localizing and negotiating seemingly obliterated root canals. By planning the root canal treatment beforehand 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. The construction of guides was recently introduced for scouting obliterated root canals (1, 2). Buchgreitz et al (1) were the first to show that guided access principles, later known as "guided endodontics," were accurate enough to be used *in vivo*. Tertiary dentin formation resulting from caries activity (3) or after restorative procedures (4) as well as during traumatic injuries (5–7) may lead to the narrowing of the pulp chamber. Despite the introduction of an operating microscope, the localization and negotiation of obliterated root canals can be a prolonged and complex procedure (8). It may also lead to operator errors during preparation of the access cavity, including the risk of root perforation as well as separation of files during the shaping of the root canals. This includes obvious medicolegal considerations (9). Based on several case reports, guided endodontics seems to be a safe and predictable method (10–15). Most recently, we have consistently shown, based on 50 cases of referred single-rooted teeth, precision of the guided drill path leading to successful negotiation of partly or seemingly complete pulp canal obliteration (16). These positive results were observed regardless of possible influences from demographic variables including treatment status and extent of actual root canal obliteration (16). Guided endodontics has mostly been applied on incisors and premolars but can be used on molars as well if the interocclusal space is large enough for the guide, bur, and handpiece (17). The aim of this case report was to show a modification of guided endodontics with the purpose of reducing the need for interocclusal space using an intracoronal guide technique whereby it can be applied more often in the posterior region.

Materials and Methods

A 52-year-old white man was referred to the dental office (endodontic referral clinic in Allerød, Denmark) in 2016 for endodontic treatment of the maxillary right first molar (#3). The patient's dental history revealed that treatment had been initiated by the referring dentist but given up and then referred because it was only

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possible to localize the palatal root canal and the first mesiobuccal (MB1) root canal.

Medical History

From the patient's medical history, no contradicting data were apparent for the performance of a root canal treatment.

Dental History

The dental examination revealed that the maxillary right first molar (#3) showed no signs of marginal periodontal disease. Tooth #3 was restored with an indirect restoration (porcelain fused to metal crown). No presence of intraoral pain or swelling from surrounding soft tissue was observed. Pain upon percussion was noted, but there were no symptoms on biting, palpation, or mobility testing. The radiograph showed that it was not previously root filled but that treatment had been initiated. The tooth had radiographic evidence of pulp canal obliteration (Fig. 1*A*). The diagnosis was as follows: treatment of tooth #3 initiated and symptomatic apical periodontitis. The attempted initial treatment was root canal treatment. The patient was informed about the risks before all procedures, in particular, that if the initial attempt to localize the distobuccal root canal did not succeed, a guided endodontic approach would be needed. Consent was obtained from the patient.

Clinical Procedures

Orthograde root canal treatment was initiated. For local anesthesia, 1.8 mL Xion (Inibsa Dental SLU, Barcelona, Spain) was

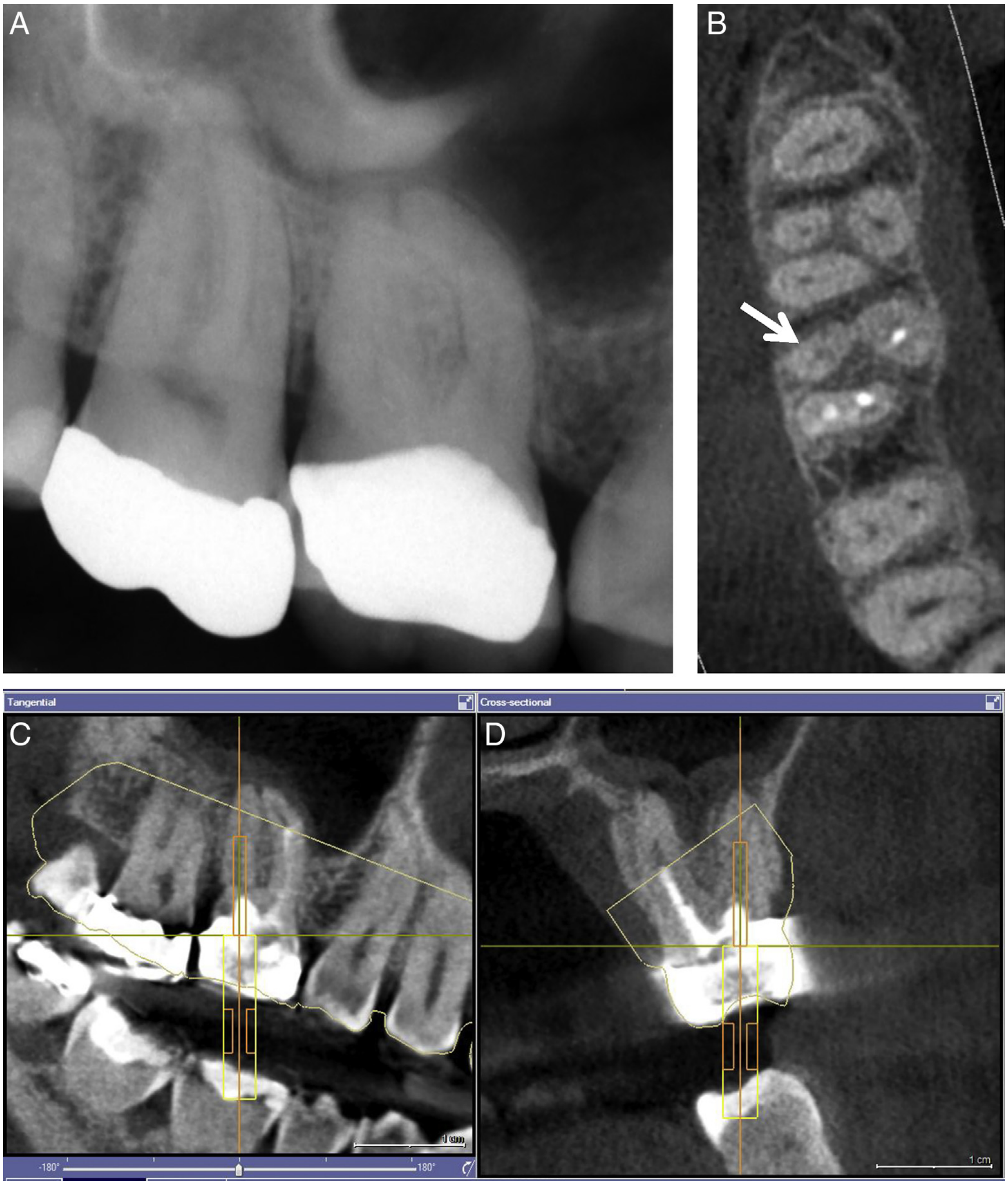

Figure 1. (*A*) Radiographic presentation of tooth #3 in need of root canal treatment because of a broadened periodontal ligament and soreness to percussion. The distal root canal is seemingly obliterated. (*B*) The axial view of the CBCT image exposes the region. The distobuccal canal is marked beyond the curvature, making further instrumentation possible (*arrow* in *B*); the 3 other root canals show radiopacity reflecting the in-between calcium hydroxide. (*C*) Tangential and (*D*) cross-sectioned CBCT images show that the virtual drill path (*orange outlines* in *C* and *D*) is placed on the images as well as the CEREC surface scan (*yellow outlines* in *C* and *D*) and merged with the CBCT image by the help of special software.

administered comprising adrenalin and lidocaine 20 mg + 0.0125 mg/mL. After reopening the occlusal access, a rubber dam was positioned including disinfection of the working field (0.5% chlorhexidine ethanol; Medic, Allerød, Denmark). Both the palatal and MB1 root canals were scouted with size 10 C+ files (Dentsply Maillefer, Ballaigues, Switzerland) using an operating microscope (Zeiss OPMI PICO; Carl Zeiss Meditec AG, Jena, Germany). Shaping of the root canals was completed using reciprocating file sizes 25–50 (Reciproc; VDW, Munich, Germany) with an endodontic handpiece (Silver 6:1, VDW) and a reciprocating motor (VDW Silver motor). The apical dimensions of the root canal determined the final file size. Additionally, the second mesiobuccal canal was scouted and instrumented in the same fashion as the MB1 canal with size 10 C+ files (Dentsply Maillefer) and a size 25 reciprocating file (Reciproc). Because it was not possible to localize the entrance of the distobuccal canal even with the help of the microscope, it was decided to use guided endodontics in order to avoid further destruction of the access cavity and, subsequently, impairment of the remaining tooth structure. Thus, root filling was postponed, and the instrumented root canals were rinsed with 5% sodium hypochlorite (20 mL) and citric acid 10% for 2 minutes followed by a calcium hydroxide dressing and temporary glass-ionomer restoration (GC Fuji Triage, Tokyo, Japan). CBCT imaging (Orthophos XG 3D unit; Dentsply Sirona, Bensheim, Germany) was recorded of tooth #3 and the neighboring teeth (Fig. 1*B*).

Preparing Molar-guided Endodontics

The virtual drill path had a diameter of 1.2 mm. It was applied using specific software made for the guiding of implant placement (Galaxis/Galileos Implant; Sirona Dental Systems, Bensheim, Germany). The virtual drill path was planned from the access preparation on the occlusal surface to the visible part of the root canal as seen on the CBCT scan (Fig. 1*C* and *D*). The drill path was aligned to involve the first visible part of the root canal in order to obtain optimal precision (16) and smooth preparation of the path. At the first clinical visit, when guided endodontics was decided, the right half of the maxillary tooth arch including tooth #3 was surface scanned (CEREC, Sirona Dental Systems). With aid of the special implant software (Galaxis/Galileos Implant), the surface scan was merged with the CBCT volume containing the virtual drill path. Afterward, a specific guide could be cut out of a translucent acrylic block made by computerized numerically controlled technology (SICAT, Bonn, Germany) as a SICAT Optiguide (SICAT). A sleeve was glued into the guide to secure the angulation and cutting depth of the drill path. For details, see Buchgreitz et al (1).

Clinical Procedure before Guided Molar Endodontics

At the second clinical visit, the fit of the Optiguide (Fig. 2*A–F*) was checked on the teeth. A part of the temporary filling was removed to the extent that a steel pin with a diameter of 1.2 mm could pass through the

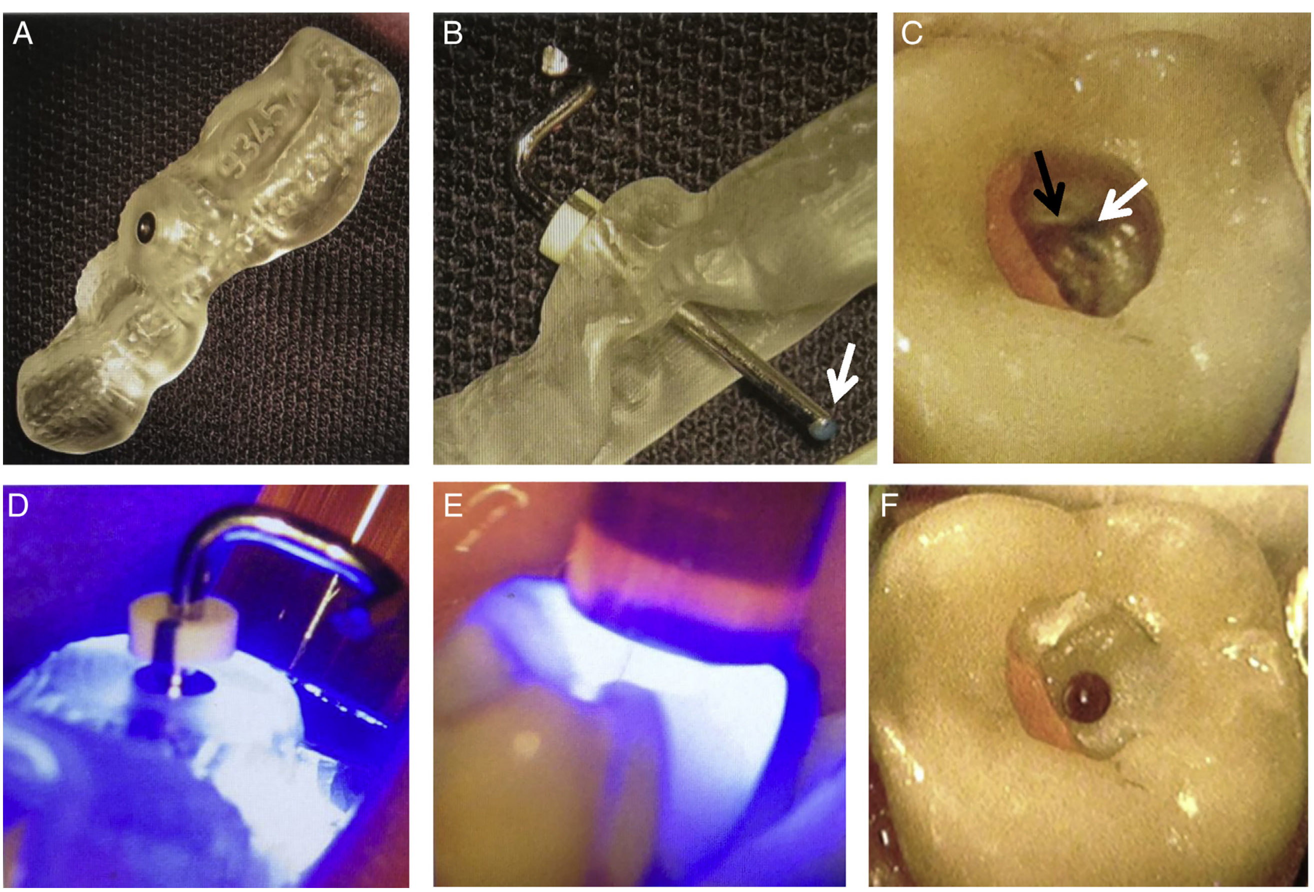

Figure 2. (*A*) A view of the Optiguide with the metal sleeve. (*B*) The guide with the guide pin in the sleeve and with blue stain at the tip (*arrow*). (*C*) Tooth #3 with the blue mark visible (*white arrow*) showing that the pin could reach the floor of the access cavity but also defining the entrance of the distobuccal root canal. The original attempt to scout the canal is visible (*black arrow*). (*D* and *E*) Because of the Optiguide, the illumination was performed without a rubber dam. (*F*) A view of the access preparation filled with cured composite (the intracoronal guide). The canal made by the guide pin is seen in the composite.

guide sleeve and reach the furcal floor without touching the other walls. To secure the clearance, the pin was covered with blue stain at the tip, and the guide with the pin was replaced to check if the pin could go to the bottom of the cavity without making blue marks by touching the walls and thereby being pushed aside. The guide with the pin was removed, and the access cavity of tooth #3 was filled with a composite (Tetric Evo Ceram Bulk Fill; Ivoclar Vivadent, Schaan, Lichtenstein). This composite has a little shrinkage during polymerization and a relatively high hardness level after polymerization. The walls of the access cavity were slightly moistened to avoid actual dentin bonding. The guide was then replaced on the teeth and the steel pin pressed through the sleeve and through the composite material to the furcal floor of the access cavity (Fig. 2*D*). A guiding length of at least 4 mm corresponding to the guiding sleeve of the Optiguide was measured in the access cavity in advance using the CBCT scan. Light polymerization was initiated using a polymerization lamp (Lysta XO unit; XO Care, Hørsholm, Denmark) through a translucent guide for 1 minute and an additional 40 seconds after the guide and pin were removed (Fig. 2*E* and *F*). Afterward, a 1.2-mm spiral bur (SICAT) could replace the steel pin and reach the bottom of the access cavity but without the Optiguide in place. Consequently, the drilling could now be performed without a previously established mandatory interocclusal distance.

Results

The Guided Drill Path

The guided drill path was performed using a 1.2-mm spiral bur in an endodontic handpiece (6:1) (VDW Silver, VDW). To reduce the heat from the sliding friction, low speed (250 rpm) was applied, and a lubricant was used (Glyde, Dentsply Maillefer). After preparation of an aseptic working field involving a rubber dam and disinfection (0.5% chlorhexidine wash), the result of the guided drill path showed that the distobuccal root canal could be localized by scouting with a size 10 K-Flex (Kerr Nordics & Baltics, Väsby, Sweden). The file was taken to the working length, and the canal was instrumented using a reciprocating file size 25 (Reciproc). The remains of the temporary composite guide were removed. The distobuccal orifice (*white arrow* in Fig. 3) was located more distally than during the first attempt (*black arrow* in Fig. 3). All 4 canals were finally irrigated using the protocol described previously. The root canals were dried and filled with BC Sealer (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) and corresponding gutta-percha cones (Reciproc Blue, VDW). The completed root canal treatment is shown in Figure 4*A*. A summary of the procedure is shown in Table 1.

Follow-up Examination

At the 2-year clinical follow-up visit, the patient expressed no subjective symptoms. The radiographic 2-year control revealed a sustained lamina dura indicative of healing (Fig. 4*B*) without any objective symptoms of apical inflammation.

Discussion

Guided endodontics is used with a high success rate, mostly in the front region because of the need of space for the guide, bur, and handpiece. This is the first case report on guided endodontics in the posterior region with limited interocclusal space involving a maxillary molar, aiming to scout and complete shaping and cleaning of the distobuccal root canal of tooth #3. A modified concept is presented wherein the customized fabricated guide is transformed into an individually composite-based access cavity guide or intracoronal guide (Table 1). On this basis, the requirement of a relatively large interocclusal space has been reduced. The case report shows successful completion of

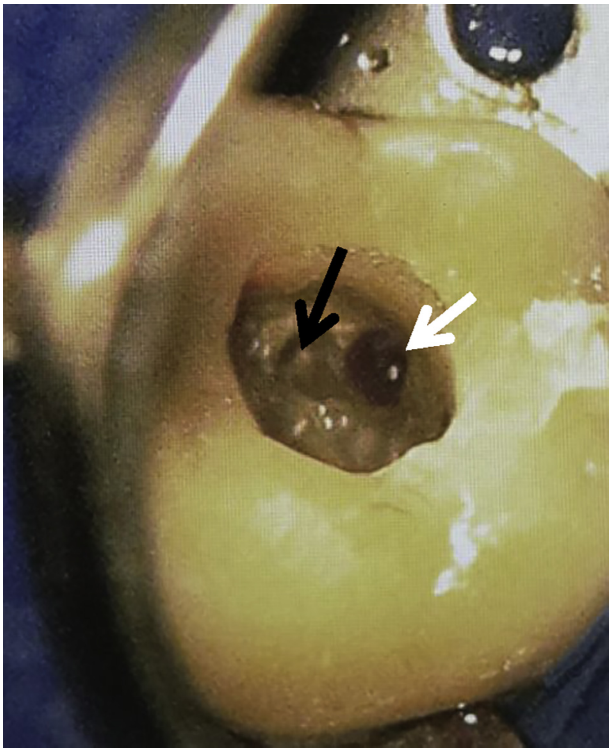

Figure 3. The drill path after the intracoronal guide has been removed marking the distobuccal orifice (*white arrow*) and still the first attempt to scout the canal is visible (*black arrow*).

the root canal treatment and a 2-year follow-up showing the absence of subjective and objective symptoms of apical inflammation. By introducing the intracoronal guide, we have eliminated the sleeve made of metal. In fact, it is not needed because the length that needs to be reached is rather short in the case report, extending from the bottom of the access cavity to the first curvature of the root. Furthermore, the present spiral bur is mainly working at the tip of the bur and not along the sides, leaving the drill path stable. One concern could be that the friction heat from the spiral bur softens the resin-based guide, but because we have generally chosen a low rotation speed, this particular risk is considered to be minimal. A guide concept for the front region has recently been reported, also without the use of a metal sleeve (15). One limitation of guided endodontics in general is that only straight canals can be negotiated. Meanwhile, on the basis of the CBCT scan, it is possible to avoid perforations or canal transportation and stop when there is a reasonable chance to complete the instrumentation beyond the curvature (Fig. 1*B*). Our recent observational study including 50 single-rooted teeth (16) consistently showed that guided root canal preparation is a very successful procedure. The hypothesis in that study was confirmed, indicating that guided endodontics shows sufficient precision irrespective of sex, age and/or tooth site, degree of obliteration, and previous attempts to find and negotiate the root canal in single-rooted teeth (16). However, when following the proposed concept of a guide, based on the merging of a CBCT scan and an optical surface scan for the construction of a guide (1, 2, 17), a relatively large interocclusal space is needed. This present report provides evidence for the fact that guided endodontics may include multirooted teeth in posterior regions, without having the interocclusal distance as a limiting factor. In order to optimize the precision of the guided drilling, the length of the drilling in relation to the degree of the pulp canal obliteration could have an influence on the ability to obtain

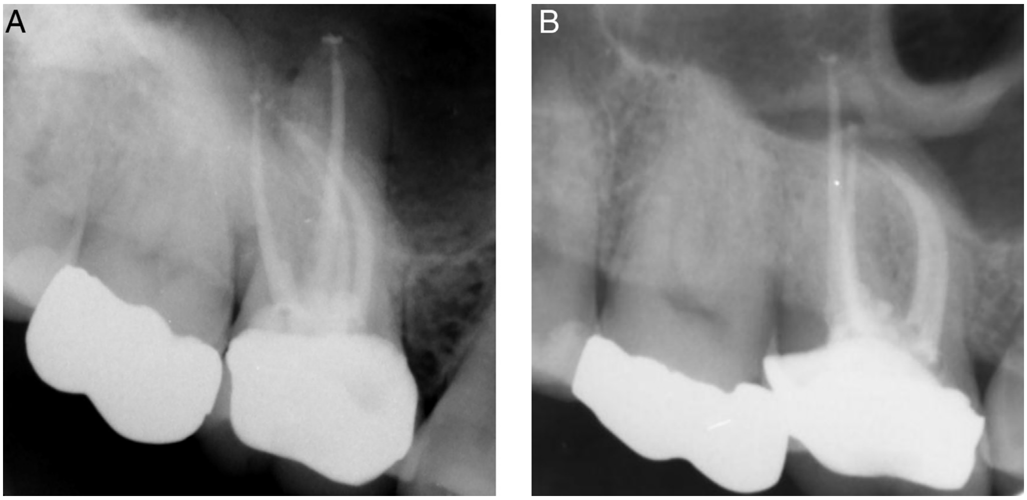

Figure 4. Postoperative radiographs are shown of the (*A*) final root canal treatment and (*B*) after 2 years.

optimal precision, defined as reaching the very center of the root canal region. Our previous results have indicated that the first visible part of the root canal as seen on the CBCT scan should be included for optimal precision, as visualized on a radiograph, but this tendency was not significant (16). It may be caused by the fact that the diameter of the spiral bur is relatively large, leading to a maintained high degree of stability and rigidity. Previously, we have shown a mean distance of 0.46 mm between a well-defined apical target point and the center of the drill path using this spiral bur (1). Although difficult to compare directly, case reports on mandibular incisors have shown a lower deviation distance at the tip of the bur, ranging between 0.12 and 0.34 mm, and with the use of a bur with a diameter of 0.85 mm (17). However, a smaller bur may not be needed in a molar approach when the metal sleeve is eliminated from the guide. In the present case report, it was also noted that the necessary depth was relatively short, making the aspect of precision less challenging. For the original clinical routines on guided endodontics, it was decided that the guided drill path was controlled and monitored by 1 or even several working radiographs. However, based on the obtained level of precision that is available today (10–17), it is suggested that the number of radiographs during the drilling phase should be reduced, even to a single one, which was the case for this report. The treatment of partial root canal obliterations could in many cases be accomplished by a specialist with the use of present technologies such as the operating microscope. Therefore, guided endodontics cannot replace the conventional approach of scouting partly or seemingly total root canal obliterations. The extra time that is used is not spent chairside at the dental office but takes place within the digital laboratory, and the actual time used for making the guided drill per se is estimated to be less than 5 minutes.

A major concern for the long-term retention of endodontically treated teeth is the preservation of tooth structure. In this context, guided endodontics provides an example of reducing iatrogenic injures and complications during a procedure of localizing partial or complete pulp canal obliteration. Within the Danish adult population, it is apparent that the most frequent tooth type in need of endodontic treatment is the molar within the aged population (18–21). Also, a recent Swedish study based on a large group covering 248,299 teeth (from the Social Insurance Agency) showed that the most frequently root-filled teeth were the maxillary and mandibular first molars (22). The present modified guided endodontics technique provides a current and relevant future alternative for negotiating root canals in multirooted teeth in posterior regions.

TABLE 1. Guided Endodontics on Molars with Limited Interocclusal Space: A Summary of Producing an Intracoronal Guide

Block the accessible canals with calcium hydroxide or with the final root filling material
Cone-beam computed tomographic scan and surface scan of the quadrant
Design the guide path on the cone-beam computed tomographic scan
Merge the scans and produce the guide by 3-dimensional printing or 3-dimensional milling
Control the fit of the guide and the possibility of the pin to go unimpeded through the sleeve and reach the floor of the access cavity
Moisten the surface of the access cavity and fill the access cavity with light-curing composite material
Place the guide on the teeth and press the pin through the sleeve in the guide as well as through the composite to the floor of the access cavity
Light cure through the guide
Remove the guide and the pin
Scout the canal through the guide path in the composite
Remove the light-cured composite
Complete the root canal treatment

Conclusions

This case report is the first on guided access preparation in a molar with limited interocclusal space and treatment of the distobuccal root with partial pulp canal obliteration. The demand for more interocclusal space was solved by transforming the virtual drill path into a composite-based intracoronal guide. The use of digital technology was essential. The presented modification may become current and relevant as populations data reveal more and more molars in need of endodontics among aged adults.

Acknowledgments

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

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