Case Report

Management of S-Shaped Root Canals with a Novel Instrumentation Technique – A Report of Two Cases

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Abstract

Management of root canal curvatures poses a challenge to the clinician. Pre-determination of the degree of curvature and usage of proper instrumentation techniques enable successful negotiation of the bends, favoring a successful outcome. The following report elaborates on the application of a novel instrumentation technique known as the tactile-controlled activation technique in the management of S-shaped curvatures in maxillary premolars.

Keywords: Bayonet, Curved canal, Root canal curvatures, S Shaped, Tactile-controlled activation.

Introduction

It is uncommon to observe that a straight root canal extends the entire length of the root. Either a constriction is present before the apex is reached or as is often the case, a curvature is present. The curvature may be a gradual curvature of the entire canal, a sharp curvature of the canal near the apex, or a gradual curvature of the canal with a straight apical ending. Double curvature in the form of the letter "S" may also occur.[1]

A wide variety of teeth can exhibit S-shaped root anatomies, with one of the most prominent and challenging anatomies being found in maxillary second premolars. The mesial-distal narrowness of these teeth both coronally and apically, along with the propensity for external root invaginations, makes enlarging, shaping and debridement, and disinfection on this tooth very difficult, even with the use of nickel-titanium (NiTi) hand or rotary instruments.[2] Recently, a novel technique known as the tactile controlled activation (TCA) technique by Dr. Antonis Chaniotis has been recommended to be useful in negotiating severe curvatures safely using controlled memory files.[3] This report of two cases discusses the endodontic management of an S-shaped root canal of maxillary premolars using the TCA technique.

Case No. 1

A 32-year-old female patient reported to the Outpatient Department of Conservative Dentistry and Endodontics of the Dental College and Hospital with severe pain in the upper left back tooth region. The medical history was non-contributory. All teeth in the area responded within normal limits to the thermal and electrical pulp testing except the left maxillary second premolar which showed considerable hypersensitivity. On clinical examination, tooth #25 had a large carious lesion on the distoproximal aspect. Radiographic examination of the tooth revealed radiolucency in the distoproximal aspect, very close to the pulp chamber with periodontal ligament space widening (Figure 1a). Furthermore, the root of tooth #25 was doubly curved (Bayonet or S shaped). The pulpal diagnosis was suggestive of symptomatic irreversible pulpitis, whereas the periapical diagnosis was consistent with symptomatic apical periodontitis concerning tooth #25. Hence, endodontic treatment was planned for tooth #25.

After administrating infiltration anesthesia with 1.8 ml of 2% lignocaine with 1:80,000 adrenaline (Lignox 2% A, Indoco Remedies Ltd. India),access opening was done using a No. 2 round diamond point (Mani, Japan) and refinement of the access cavity was achieved using the Endo Z bur (Dentsply Maillefer, Ballaigues, Switzerland).

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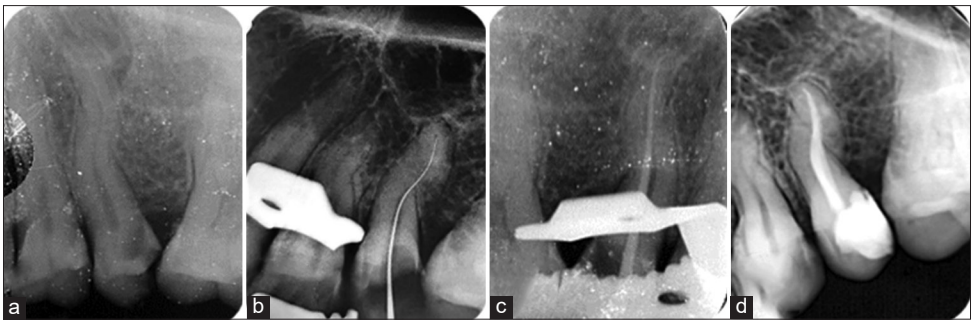

Figure 1: Endodontic management of permanent left maxillary premolar (Tooth #25). (a) Pre-operative radiograph, (b) WL radiograph, (c) master cone radiograph, and (d) post-obturation radiograph

Instrumentation protocol

For checking the patency of the root canals, #8 and #10 stainless steel K files (Mani Inc., Japan) were used. There was a single canal that was negotiated to the apex. Subsequently, the coronal flaring of the canal was performed using an orifice opener of HyFlex CM® (Coltene-Whaledent, Switzerland) rotary file system of size 25 and 8% taper along with EDTA gel (Glyde, Dentsply Maillefer, Ballaigues, Switzerland).

Once the coronal pathway was established, the working length (WL) was determined using an apex locator (ProPex Pixi Apex Locator, Dentsply Sirona) and confirmed radiographically using a #15 K-flex file (Figure 1b). Sequential filing of the curved canal was done using NiTi hand K-files #15 and #20 (Nitiflex K-file, Dentsply Maillefer, Ballaigues, Switzerland) to the WL. The apical portion of the canal was prepared using short amplitude filing. Frequent irrigation of the root canal with sodium hypochlorite (NaOCl) and recapitulation with #10 K-file was done to avoid blockage by dentinal debris.

The TCA technique

Final cleaning and shaping of the canal were carried out using HyFlex CM rotary files from 15/0.04, then 20/0.04, sequentially up to 25/0.04 using the TCA technique. The files were pre-curved and were passively inserted into the canal after obtaining a proper glide path until a frictional resistance was felt. Following this, the file was activated with an in-stroke until a feeling of further resistance, then it was pulled out of the canal (out-stroke). Subsequently, the canal was instrumented in a similar motion until the file reached the apex. Blocking of the canal was prevented using multiple recapitulations with a No. 10 K-file (Mani, Japan) between each rotary file use. About 17% EDTA gel was used as a lubricating agent while the instrumentation. A thorough irrigation protocol was maintained throughout the preparation of the canal with 5.25% NaOCl solution (Prime Dental Products Pvt. Ltd., India) and normal saline.

The canal was then dried with size #25/0.04 paper points (Diadent Group International, Burnaby, Canada) and calcium hydroxide (UltraCal, Ultradent Inc., South Jordan) was used as an intracanal medicament and the access cavity was sealed with Cavit (3M ESPE). The patient was recalled after 7 days.

On the next visit, the patient was found asymptomatic. The canal was flushed with normal saline and dried with paper points. The final irrigation was done in the following sequence: 5.25% NaOCl→Normal Saline→17% EDTA→Normal Saline. The irrigant solution was activated using a sonic irrigant activation system (Endoactivator, Dentsply Sirona, USA) with a 15/0.02 sized polymer tip, which was inserted into the canal 1 mm short of the WL and activated at 10,000 CPM for 1 min. A master cone (size 25/0.04 gutta-percha cone) radiograph was taken for confirmation of apical fit (Figure 1c). The cold lateral condensation method of obturation was performed using AH Plus sealer (Dentsply Sirona, USA). The post-obturation (Figure 1d) restoration was done with light cure composite resin (Tetric N-Ceram, Ivoclar Vivadent AG, Germany) to maintain a good coronal seal. The patient was given post-operative instructions and recalled for further follow-up. After 1 month, a PFM crown was fabricated. At 3-month, 6-month, and 12-month reexaminations, the patient was found absolutely symptom free in relation to tooth #25.

Case No. 2

A 36-year-old male patient reported to the Outpatient Department of Conservative Dentistry and Endodontics of the Dental College and Hospital with a chief complaint of decay concerning the upper right back tooth region. The tooth was sensitive to percussion relating to the right maxillary second premolar (Tooth #15). The pulp sensibility test resulted in a delayed response. Radiographic examination revealed a deep proximal carious lesion with a slight widening of the periodontal ligament and the root exhibited a double curvature (Figure 2a). From the clinical and radiographic findings, a diagnosis of asymptomatic irreversible pulpitis along with symptomatic apical periodontitis was made with respect to tooth #25. Therefore, endodontic treatment was planned.

The preliminary steps were similar to the first case. Following caries removal, access cavity preparation, coronal flaring, and WL determination (Figure 2b), the glide path was established with pre-curved #10 K hand files, and instrumentation was done subsequently with # 15, and #20 K NiTi hand files. Consequently, instrumentation was done with rotary instruments using HyFlex CM® files from 15/0.04, then

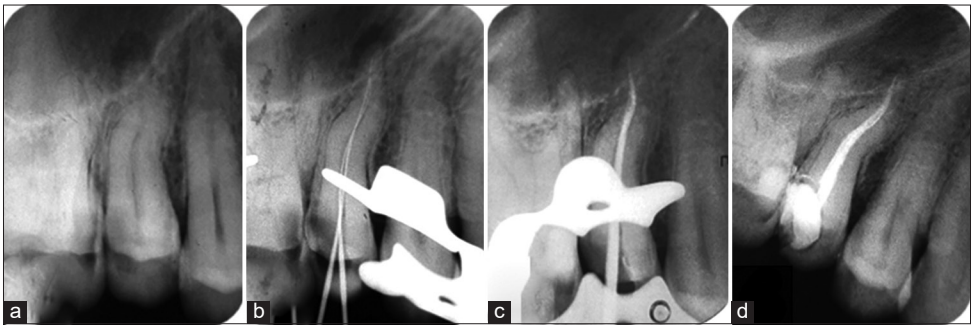

Figure 2: Endodontic management of permanent right maxillary premolar (Tooth #15). (a) Pre-operative radiograph, (b) WL radiograph, (c) master cone radiograph, and (d) post-obturation radiograph

20/0.04 sequentially up to 25/0.04 using the TCA technique. Special importance was given to irrigation following the same protocol as mentioned in Case No.1. As the pulp was vital and there was a lack of pre-operative pain, the treatment was planned to be completed in a single visit. Thorough irrigation, following the same protocol as mentioned in Case no.1 was carried out and the canal was obturated using 25/0.04 gutta-percha point with a resin-based root canal sealer and later composite resin was used to restore the access cavity (Figure 2c and d).

Discussion

Anatomical complexities and double curvatures have been reported by several studies.[4-6] Proper knowledge of root morphology is a prerequisite in preparing for highly curved root canals. Complex root canal systems that are not cleaned and filled adequately might provide a source of persistent irritation, compromising the long-term success of root canal therapy.[7,8] The diagnosis and management of double curvatures or S-shaped canals present an endodontic challenge. Careful examination of pre-operative radiographs is clinically helpful. The use of pre-curved stainless steel hand files (No.10, 15) is essential for initial negotiation and following the abrupt curve.

There is a consensus in the literature that instrumentation in curved canals considering a great degree of curvature predisposes higher risks of accidents.[9-11] Success in negotiating a narrow, curved canal depends on the degree of curvature, the size and flexibility of the endodontic instrument blade, instrumentation techniques followed during the management, and most important the skill of the operator. A curvature of about 20 degrees in a narrow root canal may be difficult or even impossible to negotiate with endodontic instruments, whereas a curvature of even 30 degrees may be negotiated if the root canal is wide.[1]

Knowledge of root curvature is an important factor in choosing the appropriate chemomechanical protocol for cleaning and shaping the root canal system. Before the introduction of NiTi instruments, several iatrogenic procedures were associated with the preparation of curved canals including zips, separated instruments, ledges, and perforations. Nowadays, these iatrogenic complications are no longer a problem, except for instrument separation. Therefore, this is one of the factors determining the difficulty of treatment and the likelihood of iatrogenic errors and shows that pre-operative recognition of canal curvature is of utmost importance.[12]

Nearly, all root canals are curved in the apical third, particularly in a faciolingual direction, which is not evident on standard radiography. Curved root canals exhibit great difficulty in cleaning, shaping, and obturation of the root canal system.[13]

Numerous methods have been proposed to determine root canal curvature,[14,15] but the Schneider's method has been the most widely used. It is easiest method of canal angle measurement and this method was used to determine the root canal curvature in this case report. Schneider[16] classified single-rooted permanent teeth according to the degree of curvature of the root, which was determined by first drawing a line parallel to the long axis of the canal, then a second line connecting the apical foramen to the point in the first line where the canal began to leave the long axis of the tooth. The angle formed by these two lines was the angle of curvature and its degree was classified as straight (≤5 degrees), moderate (10–20 degrees), or severe (25–70°).

The "S"-shaped (sometimes referred to as bayonet shaped) canal has two curves, with the apical curve being very difficult to negotiate and most vulnerable to deviations in anatomy, loss of WL, and the potential for instrument separation. The chances of strip perforation are also very high in these root canals. Guttman suggested pre-flaring the coronal 1/3rd of the canal (at the expense of the tooth structure) to reduce the angle of curvature.[17] Once this procedure is completed, it is easy to negotiate the remainder of the root canal. Endodontic file tends to straighten up in the canal, and hence, it is difficult to control the removal of dentin along the entire length of the file in a push-pull motion.

Historically, various instrumentation techniques had been proposed for curved canal preparation such as the step-back technique, crown-down technique, and anti-curvature file technique. Regardless, a crown-down approach is superior to step-back in decreasing fracture risk by preventing a large portion of an instrument from engaging root dentin.

TCA is a novel instrumentation approach that incorporates a tactile feedback mechanism with the passive engagement of the file only during activation, thus reducing the development of torsional fatigue. Activation of a file that is passively engaged inside the canal is considered to be a safer alternative than activating a file that is engaged under the tension of the dentin.[18] As the canals of the teeth presented in this report presented with a double curvature, the same technique was adopted to instrument the canals. The final apical enlargement was limited to size 25 only. Any over-enlargement can easily result in perforation or canal transportations in these canals.[19] Moreover, studies have indicated that unwarranted or excessively large apical enlargement may not be necessary in the presence of suitable coronal tapers for the efficient irrigation of the canal system.[20]

NiTi instruments are available along a large spectrum that spans austenitic (A) phase rotary files to a martensitic (M) phase instrument. These two forms represent two crystalline structures of the same NiTi metal, each with different characteristics. Traditional NiTi files are in the A phase and are referred to as shape memory files. Recently, files have been introduced that are heat treated to change their crystalline phase, and these files are referred to as controlled memory files, for example, the HyFlex CM files, that control the material's memory and possesses a raised transformation temperatures to obtain a stable martensite at room temperature making the files extremely flexible, thus allowing pre-curving and more resistant to cyclic fatigue.[18,21]

In highly curved canals, the ability of irrigant solutions to be delivered to the critical apical third depends directly on the ability of the instruments to create adequate apical preparations and on the selection of the appropriate delivery techniques.[22]

The present report provides an atypical approach for dealing with severely curved root canals. However, it may be approached using alternative methods and instruments.

Conclusion

Severe root curvature may pose substantial difficulty in cleaning and shaping as well as obturation of the root canal. A thorough knowledge of the internal anatomy of the tooth, appropriate instrumentation techniques, and customized treatment planning depending on the degree of curvature will help manage curved canals, prevent complications, and enhance the quality of the treatment. The TCA technique seems to be a promising alternative to the conventional approach to safely instrument severely curved canals.

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