XP-Endo Shaper System for the Cleaning and Shaping of Mandibular Molars with C-Shaped Canal Configuration: Case Series

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Abstract

Endodontic treatment for mandibular molars with "C-shaped" canal configurations has always been challenging for clinicians, due to the large untouched surfaces, in addition to the accumulated debris in the complex root canal system.

The present case series demonstrates the clinical and radiographic outcomes of nonsurgical root canal treatment accomplished by the use of the XP-endo Shaper system. Three mandibular 2nd molars received nonsurgical root canal treatments under rubber dam isolation and local anesthesia. Access cavities were prepared, canals were negotiated, and C-shaped canal configuration was confirmed and classified. Working length was determined, and all canals were instrumented with the XP-endo Shaper system (FKG Dentaire, La Chaux-deFonds, Switzerland). 5 ml of 5.25% sodium hypochlorite solution was used to irrigate the canals. 1 ml of EDTA irrigant was used as the final flush. Obturation was performed with a combination of cold lateral and continuous-wave techniques. All patients were followed up for 24 months. Two patients demonstrated complete clinical and radiographic periapical healing after final restoration. The third patient, who had fallen restoration, showed complete radiographic healing, but a clinical examination revealed apical periodontitis.

The present case series demonstrate favorable outcomes for molars with a C-shaped canal configurations cleaned and shaped with an XP-endo Shaper system.

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Introduction

The C-shaped canal is an anatomical variant of the root canal system that was first documented by Cooke and Cox in 1979. The term "C-shaped canal" describes its cross-sectional morphology[1]. This anatomical variation is formed due to the failure of Hertwig's epithelial root sheath to fuse[2]. Mandibular second molars are the most commonly reported teeth with C-shaped canals in the Asian population, with a prevalence of up to 52% [3–8] Female patients had a higher prevalence of C-shaped configuration than males[9]. Furthermore, C-shaped canal configuration was found to be bilateral in over 70% of the cases[10].

Morphology: The main morphological feature of C-shaped canals is the presence of a fin or web connecting the root canals. The pulp chamber may have a long occluso-apical dimension and low bifurcation. C-shaped configurations can be detected radiographically on a periapical radiograph. To confirm C-shaped canal configurations, proper clinical examinations of the access cavity should be carried out. C-shaped roots could be a single-fused root or two separate roots with communication [1, 11].

Classification: Haddad et al. (1999) reported four typical images: 1) roots fused apically, 2) roots with close proximity, 3) a large distal canal, or 4) a blurred image of a third canal in the middle of two roots [4]. Melton et al. published the first classification of C-shaped canals in 1991[12].

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This classification was modified by Fan et al. in 2004 as follows: Category I (C1): uninterrupted C without separation or division; Category II (C2): The canal shape represents a semicolon resulting from a discontinuation of the C outline, but either angle α or β should be no less than 60°; Category III (C3): Two or three separate canals and both angles α and β are less than 60°; Category IV (C4): Only one round or oval-shaped canal in the cross section; and Category V (C5): No canal lumen could be observed (usually, it is only seen near the apex)[13].

Management: Passing an instrument from the mesial to the distal aspect may aid in the diagnosis of a true C-shaped canal [12]. However, clinically, we can examine only the cervical third of the root canal. The most accurate diagnostic tool to detect root canal configuration is by cone-beam computed tomography (CBCT)[14] . The challenges encountered during root canal treatment of C-shaped canals can be attributed to excessive hemorrhage and the difficulty involved in accessing the entire root canal system. An ideal debridement and obturation could not be achieved easily in those cases [15]. The large untouched area and the accumulated debris in the root canal system are always areas of concern whenever root canal treatments are performed for the C-shaped canal [8].

To enhance the cleaning and shaping of C-shaped canals, several techniques and instruments have been suggested. Traditional hand instrumentation was found to be better at cleaning C-shaped canals than rotary instrumentation. However, rotary systems such as ProTaper are able to maintain canal curvature. It was suggested that using an advanced irrigation technique such as sonic and ultra-sonic irrigation provides better debridement efficacy.[16,17]

The XP-endo Shaper system (XPES; FKG Dentaire, La Chaux-deFonds, Switzerland) is made up of a predetermined curl-shaped MaxWire alloy (Martensite-Austenite Electropolishing-Flex) with enhanced shaping efficiency [1819]. This file appears straight in its martensitic state at room temperature. Nevertheless, it will regain its curvatures in an austenitic state whenever it is subjected to body temperature. According to the manufacturer, XPES has a small, free-floating adaptive core, enabling it to perform ideal shaping in complex anatomy and reduce debris packing in irregular areas of the canal system (FKG Dentaire 2018). XPES was found to be capable of shaping severely curved canals with minimum transportation [20].

When comparing XPES to the Mtwo system, the former was found to be more effective in instrumenting oval-shaped canals, resulting in greater volume increases and a lower percentage of unprepared canal walls in the apical region [21]. The preparation and touching of canal walls in oval-shaped canals was superior in XPES compared to Vortex Blue WaveOve Gold and TRUShape[21, 22].

For instrumenting C-shaped canals, previous micro-CT investigations indicated superior results with XPES regarding untouched canal wall areas and the amount of accumulated debris packed in the apical and middle regions compared to Reciproc Blue. The amount of untouched canal walls was approximately 50% (17, 18, 23). This could be a result of the high complexity of such canals. In the current report, XPES was used successfully to clean and shape three cases of C-shaped canal configuration in mandibular second molars.

Case Presentations:

Case No. 1

A 45-year-old female patient was unaware of any medical problems was referred to an endodontics clinic to continue the root canal treatment (RCT) of the mandibular left second molar due to difficult morphology (Fig 1-a).

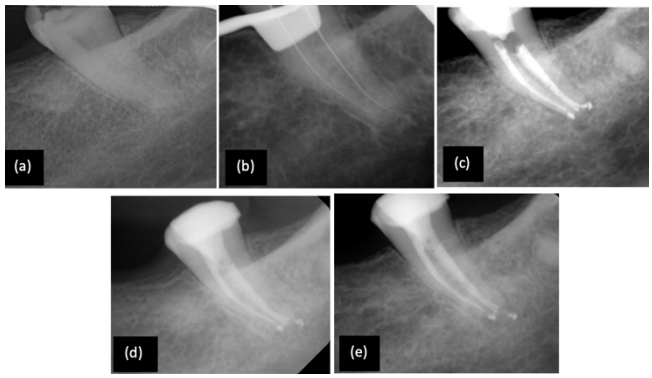

Figure 1. A 45-year-old female patient was referred to an endodontics clinic to continue the root canal treatment (RCT) of tooth 37 due to difficult morphology. Tooth 37 was diagnosed as previously initiated RCT with asymptomatic apical periodontitis. (a) pre-operative radiograph. (b) Working length determination radiograph. (c)Post-operative radiograph. (d) 1year follow-up. (e) 2 years follow-up, RCT was successful.

The tooth was diagnosed as previously initiated RCT with asymptomatic apical periodontitis. Lidocaine HCL 2% with epinephrine 1:100,000 local anesthesia (House Brand®) was administered. Access cavity was reopened and adjusted under rubber dam isolation. Two canals, mesial and distal canals, were negotiated in C-shaped canal configuration category III. Working length was determined with an electronic apex locator (Root ZX II, J Morita®) (Fig 1-b). The canals were instrumented at size 10 and 15 K files to the working length followed by XPES to complete the instrumentation (FKG Dentaire, La Chaux-deFonds, Switzerland) at 800 rpm and 1 Ncm torque. The same file was used for 45 seconds in each canal. 5 ml of 5.25% sodium hypochlorite solution was used to irrigate the canals. A final flush of EDTA solution was used. Bleeding did not stop from the distal canal; therefore, obturation was postponed. In the second visit, canals were re-instrumented, irrigated, and dried. The distal canal was then obturated with cold lateral compaction, and the mesial canal was obturated with a continuous wave technique using 4% ProTaper® universal gutta percha points (Dentsply) and AH Plus® sealer (Dentsply). Cavit™, a temporary filling material (3M, ESPE), was used as a coronal seal, and the patient was referred for final restoration (Fig 1-c). The patient was recalled twice after one and two years (Figs 1-d and 1-e). The subsequent clinical and radiographic examinations did not reveal any signs or symptoms of endodontic pathosis. The periapical tissue was found to be normal. The RCT was successful.

Case No. 2

A 55-year-old female asthmatic patient who attended the endodontics clinic complained of severe pain in the lower right molars beginning two weeks prior to her visit. According to a clinical and radiographic examination, the mandibular right second molar was diagnosed as symptomatic irreversible pulpitis with symptomatic apical periodontitis (Fig 2-a). Lidocaine HCL 2% with epinephrine 1:100,000 local anesthesia (House Brand®) was administered. Caries were excavated and an access cavity was prepared under rubber dam isolation (Fig 2-b). Three canals were negotiated in C-shaped canal configuration category III. Working length was determined with an electronic apex locator (Root ZX II, J Morita®) (Fig 2-c). The canals were instrumented with size 10 and 15 K files to the working length, and then the instrumentation was completed with XPES (FKG Dentaire, La Chaux-deFonds, Switzerland) at 800 rpm and 1 Ncm torque. The same file was used for 45 seconds in each canal. 5 ml of 5.25% sodium hypochlorite solution was used to irrigate the canals. A final flush of EDTA solution was used. For obturation, a continuous wave technique was performed in all canals using 4% ProTaper® universal gutta percha points (Dentsply) and AH Plus® sealer (Dentsply). Cavit™ temporary filling material (3M, ESPE) was used as a coronal seal, and the patient was referred for final restoration (Fig 2-d). The patient received the final restoration in prosthodontic clinic, she were able to attend the recall appointment only two years after RCT completion (Fig 2-e). The following clinical and radiographic examinations did not reveal any signs or symptoms of endodontic pathosis. Periapical tissue was normal, and RCT was successful.

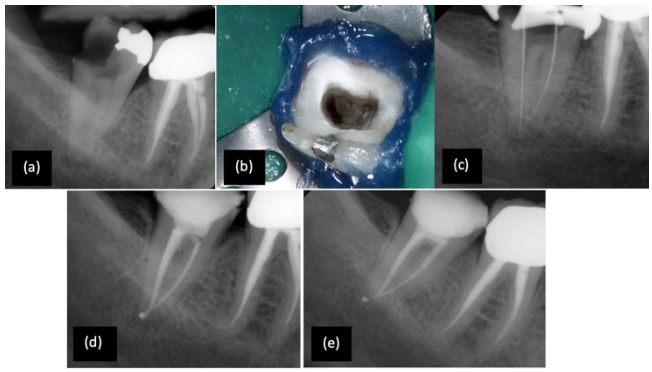

Figure 2. A 55-year-old female who attended the endodontics clinic complained of severe pain in the lower right area. Tooth #47 was diagnosed as symptomatic irreversible pulpitis with symptomatic apical periodontitis. RCT was performed using XP-endo system (a)Pre-operative radiograph. (b) Access cavity showing C-shaped canal configuration. (c) Working length determination. (d) Post-operative radiograph. (e) 2 years follow up, RCT was successful.

Case No. 3

A 23-year-old female unaware of any medical problems patient were referred to an endodontics clinic to continue the root canal treatment (RCT) of the mandibular left second molar due to its difficult morphology. According to a clinical and radiographic examination, the tooth was diagnosed as previously initiated RCT with

symptomatic apical periodontitis (Fig 3-a). Lidocaine HCL 2% with epinephrine 1:100,000 local Anesthesia (House Brand®) was administered. An access cavity was prepared under rubber dam isolation (Fig 3-b). Three canals were negotiated in C-shaped canal configuration category III. Working length was determined with an electronic apex locator (Root ZX II, J Morita®) (Fig 3-c). The canals were instrumented with size 10 and 15 K files to the working length, and then the instrumentation was completed XPES (FKG Dentaire, La Chaux-deFonds, Switzerland) at 800 rpm and 1 Ncm torque. The same file was used for 45 seconds in each canal. 5 ml of 5.25% sodium hypochlorite solution was used to irrigate the canals. A final flush of EDTA solution was used. For obturating the distal canal, a combination of cold lateral and warm vertical compaction was performed. On the other hand, the continuous wave technique was used in mesial canals. 4% ProTaper® universal gutta percha points (Dentsply) and AH Plus® sealer (Dentsply) were used in all canals. Cavit™ temporary filling material (3M, ESPE) was used for coronal seal, and the patient was referred for final restoration (Fig 3-d). The patient never showed up for final restoration or even for follow-up appointments because she said she did not feel any pain. After two years, the patient came back with fallen restoration, and reported that the restoration broke two months prior to her recent visit. (Fig 3-e). Periapical radiograph showed complete healing of the previous lesion. Clinically, it was found that she had pain on percussion with normal response to palpation. The RCT was unsuccessful and non-surgical retreatment was performed(Fig 3-f).

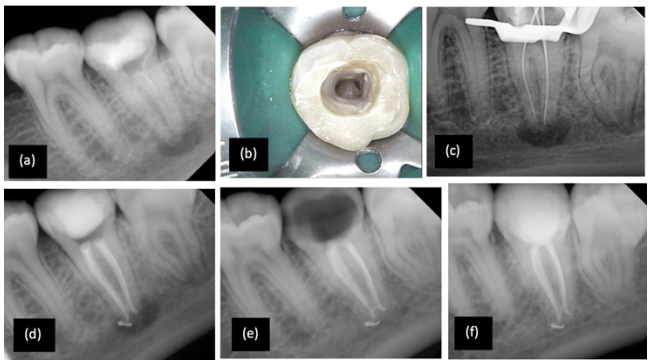

Figure 3. A 23-year-old female were referred to an endodontics clinic to continue the root canal treatment (RCT) of tooth #37 due to its difficult morphology. (a)Pre-operative radiograph. (b) Access cavity showing C-shaped canal configuration. (c) Working length determination. (d) Post-operative radiograph. (e) 2 years follow up, tooth 37 with fallen restoration and complete bone healing can be seen on the radiograph. However, patient was symptomatic and retreatment was indicated (f) After non-surgical retreatment.

Discussion

Most previously published studies in the field relate C-shaped canal configurations to the Asian population.[3,6] However, it is not uncommon to see this anatomical variation in other populations, such as the Saudi Arabian community. All patients in the current report were Saudi females, and the prevalence of C-shaped canals in the Saudi population was measured to be in 9.1–10.6% of mandibular second molars (24, 25). Therefore, clinicians in all societies should always be aware of the recommended management of C-shaped canals.

The main causes of endodontic failure in C-shaped canals were poor apical seal and complex morphology with untreated isthmuses [27]. All available endodontic files, including XPES, cannot access all the isthmuses and canal connections in C-shaped canals. Therefore, clinicians mainly depend on chemical irrigation to clean as much of the canal as possible [15,18].

After evaluating cleaning and shaping abilities of various files, the unique movement of XPES was found to surpass the efficiency of other files [23]. However, there were always areas untouched by the instruments used. Previous investigations reported that XPES instrumentation significantly reduces microorganisms and debris from the root canals of round or oval canals [27, 28].

During treatment of our patients, XPES files were activated for 45 seconds based on previous suggestions to prolong the activation time to improve performance [30]. Furthermore, our patients were treated successfully and had no postoperative complications. A previous study revealed that XPES was associated with lower postoperative pain—in terms of frequency and severity—compared to conventional rotary files [28].

The cases were followed up for almost two years. All lesions healed completely, and the endodontic treatments were successful in the two cases in which both patients received final

restoration. Post-treatment disease developed only in one case, as the patient opted to not show up at the clinic for final restoration.

Two patients received final coronal restoration after the completion of endodontic treatment, and one patient maintained her temporary restoration for two years, as she could not attend her appointments during the COVID-19 pandemic.

In the third case, the patient's history revealed that the patient was asymptomatic after completing the initial RCT. The pain developed after the loss of the coronal seal. It seems that root canals were cleaned properly and that bacterial load was reduced to the point that facilitates bone healing, as observed in the follow-up periapical radiographs. This indicates that the reason for treatment failure was due to poor coronal seal rather than root canal treatment quality.

The main goal of proper final coronal restoration is to prevent root canal recontamination through bacterial microleakage. Exposure of the root canal filling to the oral cavity will allow bacteria and their endotoxins to enter through the filling material to the apical area, resulting in an inflammatory reaction and apical periodontitis[31,32]. This emphasizes that the quality of the coronal seal is as important as the quality of root canal treatment [33,34].

According to previous publications, bacterial microleakage can occur through obturated canals within one to three months of exposure to oral environments (34, 35). In our case, the exposure time was two months, and the patient was symptomatic; therefore, retreatment was performed.

Conclusion

The XPES system performed very well in the reported C-shaped canal cases. However, this conclusion cannot be generalized because it is based on only three clinical cases. A comprehensive study should be performed to assess the potential of the XPES system to clean and shape C-shaped canals.

Declaration of Interest

The authors report no conflict of interest.

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