Clinical application of a new rotary file system – Part 2

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Introduction

During the past decade endodontic materials and techniques have advanced substantially. Most clinicians are searching for the perfect set of instruments to simplify endodontic therapy. The ideal file system for root canal treatment in both general and specialist practices must be able to manage simple, intermediate and advanced clinical cases. Many dentists resort to using a combination of different file systems (hybridisation) for some cases. In Part 1 of this series the authors discussed the use of the ProTaper Ultimate system for minimally invasive, conventional and large root canal system endodontics (Van der Vyver and Vorster (2022). This article reviews the use of the ProTaper Ultimate system (Dentsply Sirona, Ballaigues, Switzerland) in conventional root canal treatment and illustrates the use of the instruments in complex and challenging endodontic cases, eliminating the need for hybridisation.

Case Report 1: Minimally Invasive Endodontic Preparations

Many practitioners believe that increased apical instrumentation with minimal taper leads to weakening of root structure and loss of control during the obturation phase, specifically in the apical third of the root canal system. Contemporary endodontic techniques advocate smaller apical preparations and continuous taper. This promotes apical resistance form and a continuous shape and taper for adequate disinfection (Gluskin et al, 2014).

In small, narrow root canal systems it is possible to obtain an apical taper of 7% and an ISO size of 20 by using only two preparation files, the Shaper and the Finishing file F1. The maximum flute diameter of 1.0mm of the majority of the instruments of ProTaper Ultimate system promotes conservative coronal shapes, preserving the maximum amount of pericervical dentine.

The patient, a 45-year-old female, presented with leaking crowns on her non-vital maxillary left central and lateral incisor (Figure 1a). Conservative access cavities were prepared and working length confirmed using an electronic apex locator and verified radiographically (Figure 1b). Calcium hydroxide was then placed as an intracanal medicament (Figure 1c). At a second visit, a rubber dam was placed and glide path preparation was completed with the ProTaper Ultimate Slider (Dentsply Sirona) (Figure 1d). Canal preparation was done using the ProTaper Ultimate Shaper (Figure 1e) and F1 instruments (Figure 1f). The fit of the gutta percha cones was confirmed radiographically (Figure 1g) before the canals were irrigated with 3.5% heated sodium hypochlorite using

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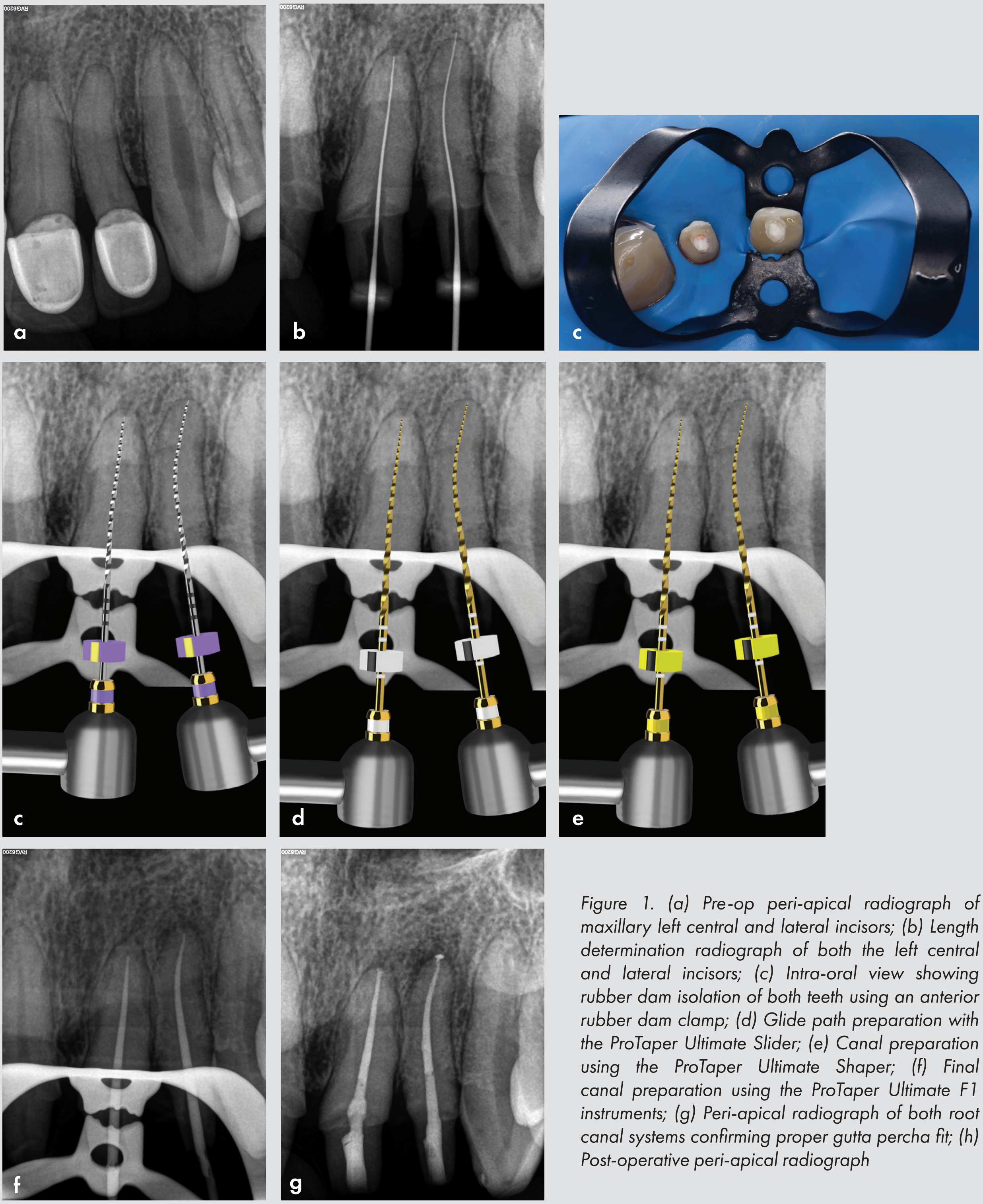

Figure 1. (a) Pre-op peri-apical radiograph of maxillary left central and lateral incisors; (b) Length determination radiograph of both the left central and lateral incisors; (c) Intra-oral view showing rubber dam isolation of both teeth using an anterior rubber dam clamp; (d) Glide path preparation with the ProTaper Ultimate Slider; (e) Canal preparation using the ProTaper Ultimate Shaper; (f) Final canal preparation using the ProTaper Ultimate F1 instruments; (g) Peri-apical radiograph of both root canal systems confirming proper gutta percha fit; (h) Post-operative peri-apical radiograph

the EndoVac system (Sybron Endo). Figure 1(h) shows the final result after obturation with AH Plus Bioceramic cement (Dentsply Sirona) and ProTaper Ultimate F1 gutta percha cones using the Gutta Smart System (Dentsply Sirona). Note the conservative canal preparations with maximum preservation of pericervical dentine.

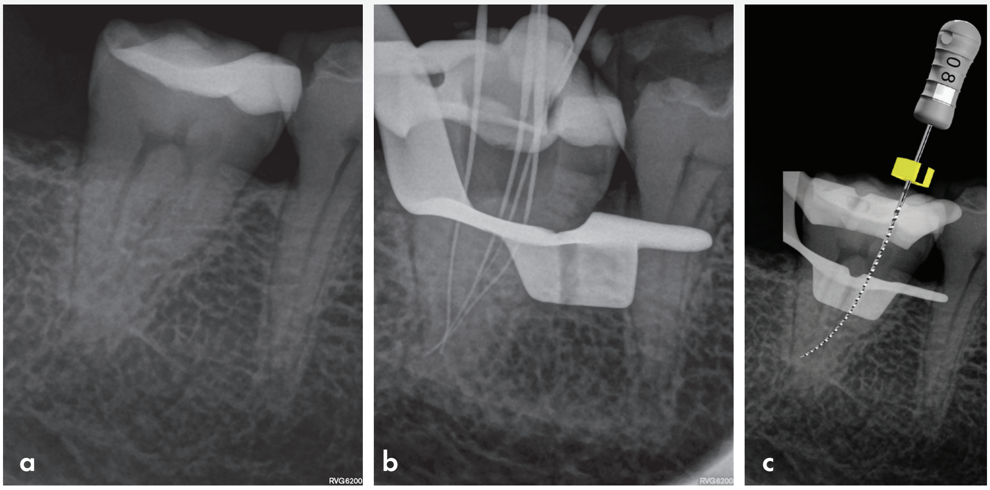

Figure 2. (a) Pre-op peri-apical radiograph of mandibular second molar; (b) Length determination radiograph; (c) A size 08 K-file used for initial canal negotiation

Case Report 2: C-shaped canal configurations in mandibular molars

C-shaped root canal configuration is an anatomical variation of root fusion and a type of taurodontism commonly seen in mandibular second molars, with a prevalence ranging from 2.7% to 45.5% in different population groups (Neelakantan et al, 2010). These complex root canals systems are connected by a slit or web with varying anatomy along the root length, which often makes adequate debridement significantly difficult.

Fan et al (2004) suggest a modified five-type categorisation of C-shaped canals with an evident distinction between types: Type I (C1; continuous C shape); Type II (C2; semi-colon morphology); Type III (C3; two or three discrete canals); Type IV (C4; only one round or oval canal in related cross-section); and Type V (C5; absence of visible canal lumen) (Figure 1).

The patient, a 42-year-old male, presented with irreversible pulpitis on his mandibular second molar, previously restored with a Class II composite restoration (Figure 2a). Figure 2b depicts the length determination radiograph showing the

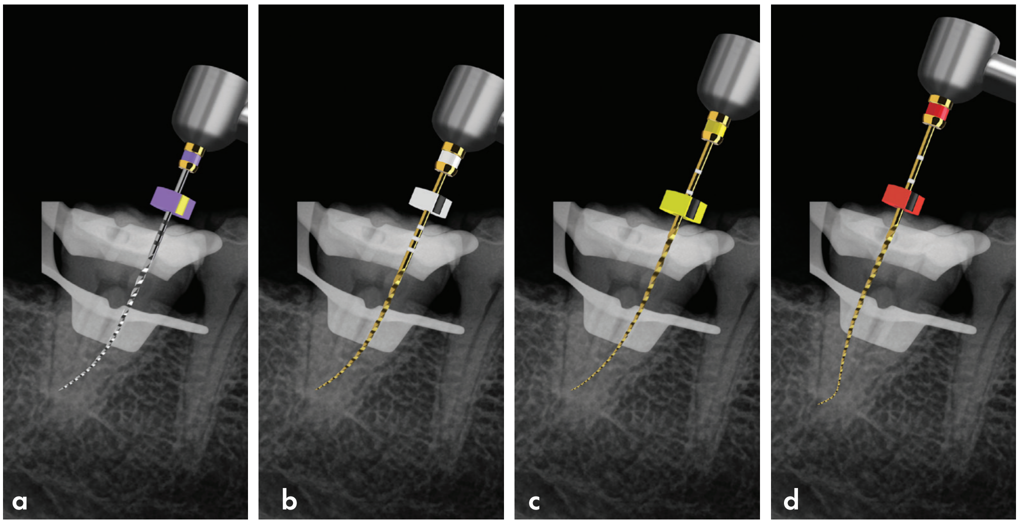

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Figure 3. (a) Glide path expansion using the ProTaper Slider instrument; (b) Canal preparation in the mesial and distal root canal systems with the ProTaper Shaper; (c) Canal preparation in the mesial and distal root canal systems with the ProTaper F1; (d) Canal preparation with the ProTaper F2 in distal canal only

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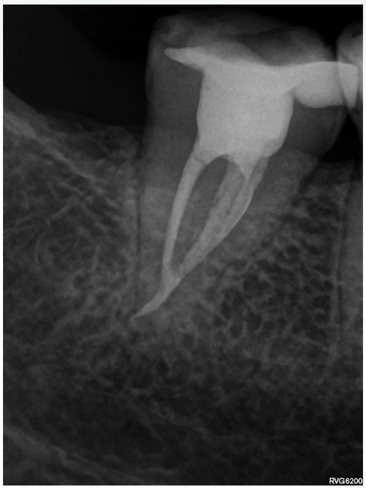

Figure 4. Final post-operative result

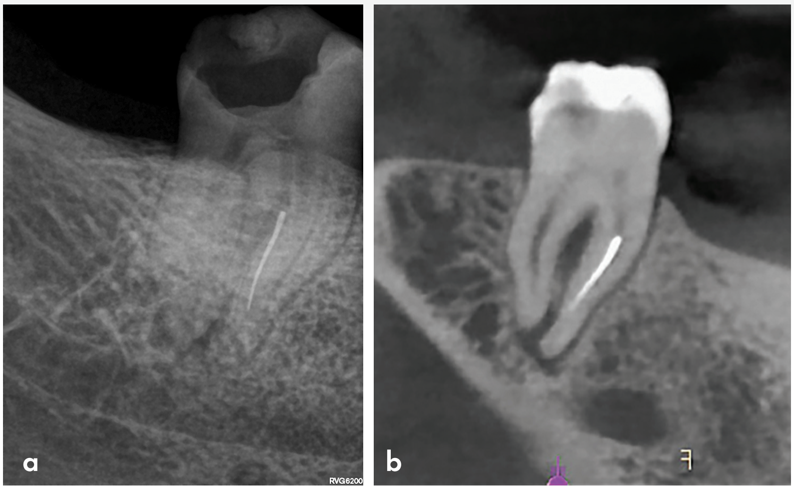

Figure 5. (a) Peri-apical radiograph confirming file fracture in the midroot region on mandibular second molar; (b) Sagittal view of a CBCT demonstrated that the fragment was located just below the maximum curvature of the root canal system

location of three mesial root canal systems and a distal root canal system with an apical curvature, joining in the apical third of the root. A size 08 K-file (Figure 2c) was used in all the canals before the glide path was expanded using the ProTaper Slider instrument (Figure 3a). Canal preparation was completed in the mesial root canal systems with the ProTaper Shaper (Figure 3b) and F1 instruments (Figure 3c). In the larger distal root canal system this was followed by the ProTaper Ultimate F2 instrument (Figure 3d). Figure 4 illustrates the final result after canal obturation.

Case Report 3: Removal of a fractured instrument

Instrument fracture is a serious complication during endodontic treatment, having an adverse effect on the outcome of the nickel titanium (NiTi) treatment, especially if the fracture prevents apical access to the infected root canal (Pillay, Vorster & Van der Vyver, 2020).

New studies indicate that instrument fracture has many variables, the most crucial being the clinician's skill (Parachos, Gordon & Messer, 2004). A study by Arens et al (2003) reports that 0.9% of brand-new NiTi instruments fractured during their first use, conceivably due to a manufacturing defect or misuse.

Clinicians should know that the treatment can be challenging and that there are complicating factors, which may include: 1. the complexity of the root canal system; 2. the treating clinician's access to the materials, instruments and devices needed to attempt removal; 3. whether the clinician is experienced enough to predict the outcome of the attempted removal; 4. the location, size, position and diameter of the fractured fragment; 5. the wishes of the patient, who might decide on extraction due to financial and/or time constraints or anxiety (Suter, Lussi & Sequeira, 2005; McGuigan, Louca & Duncan, 2013; Van der Vyver, Vorster & Jonker, 2020).

A 55-year-old male presented with a history of a debonded restoration and a fractured instrument in the mesiobuccal root canal of his mandibular right second molar. A peri-apical radiograph confirmed a fractured file located in the midroot region (Figure 5a). A sagittal view of a CBCT confirmed the location, but demonstrated that the fragment was located just below the maximum curvature of the root canal system (Figure 5b).

After delivering local anaesthesia the cavity walls were cleaned and the cavity restored using a Palodent 360 band (Dentsply Sirona) and Surefil One (Dentsply Sirona). The tooth was isolated with a rubber dam and an access cavity prepared. The orifices of mesiolingual and mesio- and distobuccal root canal systems were closed with Teflon tape as a safety measure during the attempt to retrieve the fractured instrument fragment.

Number 2 and 3 GG burs were used carefully at 600rpm in the mesiobuccal canal to create a staging platform on top of the fractured instrument (Figure 6a). The coronal aspect of the instrument was exposed by creating a small circular space at least 1mm deep with a size 15 Endosonare file (Dentsply Sirona) mounted on a U-File holder (Endo Kit E12,

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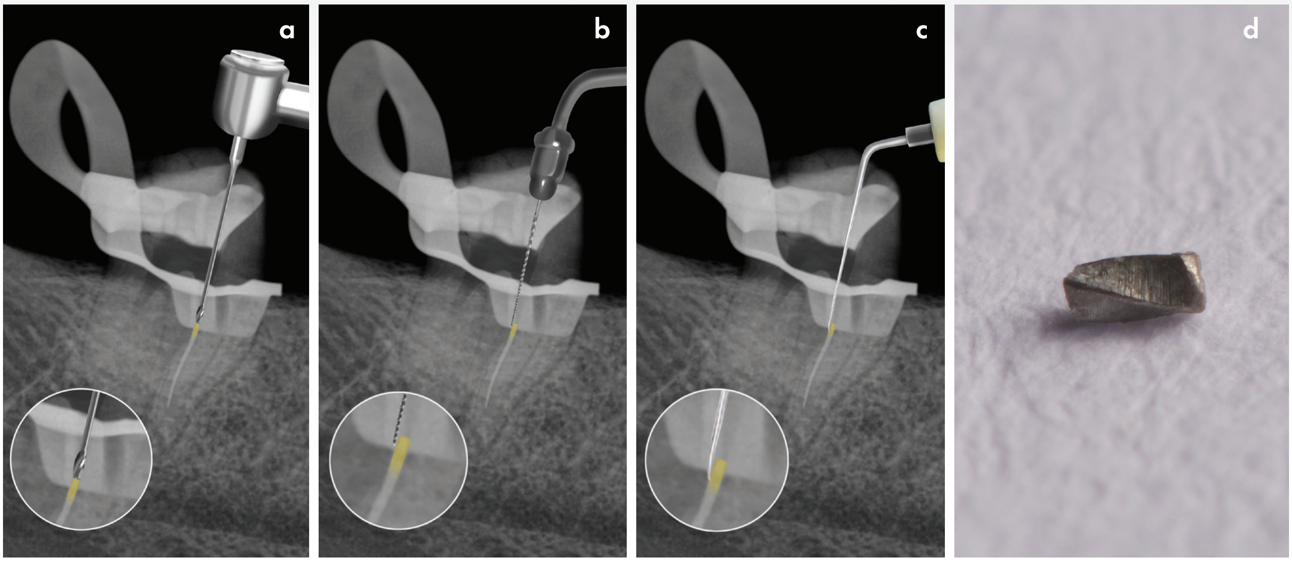

Figure 6. (a) Illustrations showing the platform created on top of the fractured instrument using a modified GG bur; (b) Size 15 Endosonare file (Dentsply Sirona) used to expose the coronal aspect of the instrument; (c) TFRK spear tip activated on the dentine walls to create more space around the instrument; (d) Secondary fractured fragment

NSK) driven by a Satelec P-5 ultrasonic scaler (Satelec). An ultrasonically driven TFRK spear tip was brought into the canal and then activated on the dentine walls on the mesial and distal aspects of the fragment to create more space around the instrument (Figure 6b), but this led to a secondary fracture of the fragment (Figure 6c).

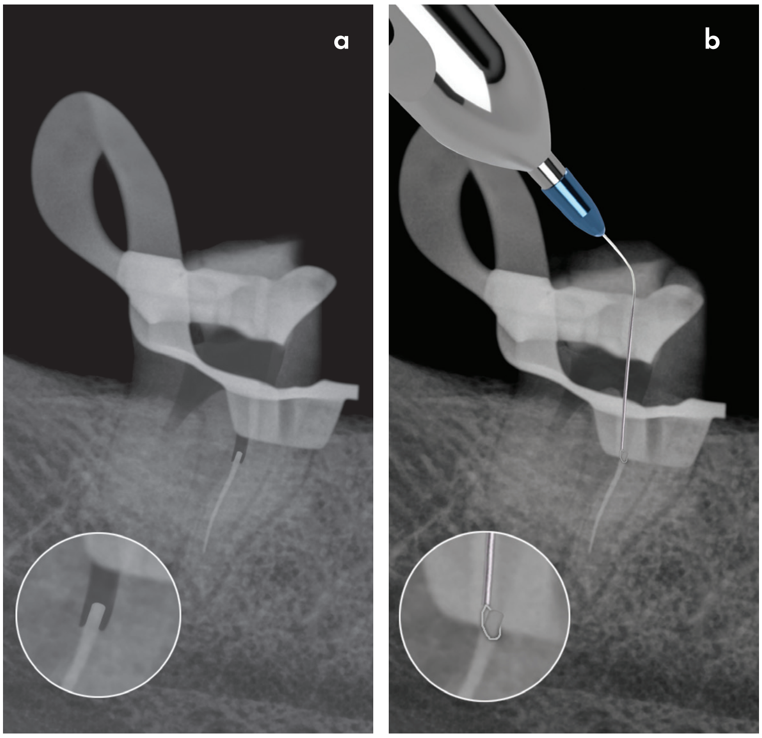

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Figure 7. (a) Illustrations showing space created around the remaining part of the fractured instrument using the same protocol as before; (b) EndoCowboy lasso wire placed over the exposed head of the fractured fragment; (c) Fractured file extracted from the root canal

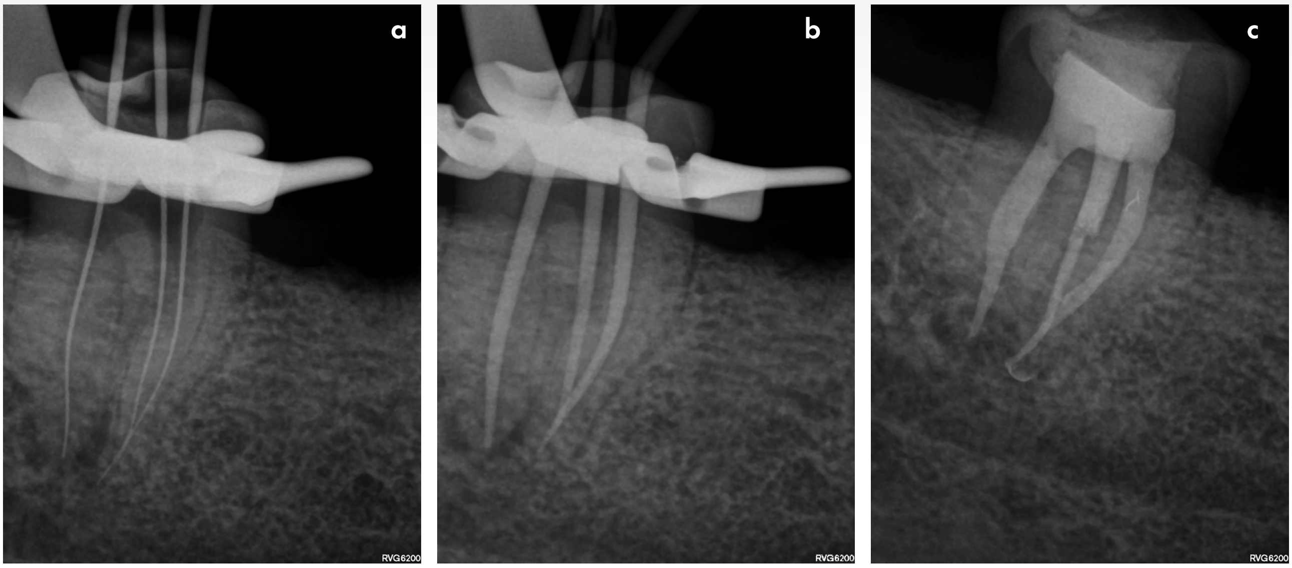

Figure 8. (a) All canals were negotiated to patency with a size 10 K-file, working length determined and a reproducible microglide path prepared; (b) Peri-apical radiograph confirming the fit of the ProTaper Ultimate Conform Fit Gutta Percha Points; (c) Final post-operative result after obturation

The above protocol was followed again to expose the coronal aspect of the remaining fragment (Figure 7a) before the EndoCowboy (Köhrer Medical Engineering) loaded with 0.12mm in a 0.5mm cannula was used to attempt removal of the fractured instrument. The preformed lasso wire loop was placed over the exposed head of the fractured fragment (Figure 7b) in the root canal. The wire loop was tightened using the special built-in ball bearing on the device that allows precise tightening and maximum tactile feedback of the wire loop tension. Once the required amount of tension was achieved, the fractured file was extracted from the root canal using a pulling movement as in extracting a tooth (Figure 7c).

A size 10 K-file was used to negotiate all the root canal systems to patency and the full working length was determined with an electronic apex locator and confirmed radiographically (Figure 8a). The glide path was expanded using the ProTaper Ultimate Slider and canal preparation was completed using the ProTaper Ultimate Shaper, F1 and F2 instruments in all the root canal systems except the distal, which was finished with the F3 instrument. Root canal systems were irrigated with heated sodium hypochlorite and activated with the EndoVac system. Canal obturation was achieved using AH Plus Bioceramic Sealer, matching ProTaper Ultimate Gutta Percha Points (Figure 8b) and the Gutta Smart system using the continuous wave of condensation technique (Figure 8c).

Case Report 4: Dens evaginatus

Dens evaginatus is an uncommon dental anomaly in which an accessory cusp is formed, presenting on both the anterior and posterior teeth (Levitan & Himel, 2006). In posterior teeth, the anomaly is found on the occlusal surface, commonly involving the mandibular premolars (Oehlers, 1967; Hill & Bellis, 1984). The distribution is commonly bilateral and symmetrical, with a slight female predilection (Merrill, 1964).

Dens evaginatus has previously been described in several population groups, but predominantly affects individuals of Asian descent (Koksci et al, 2002). In these populations the

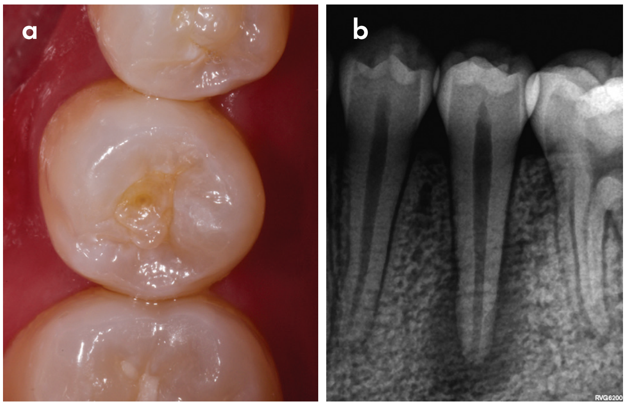

Figure 9. (a) Pre-op intra-oral photograph of mandibular left second premolar showing a small tubercle on the occlusal surface; (b) Peri-apical radiograph showing large peri-apical radiolucent lesion around the apex of the mandibular second premolar

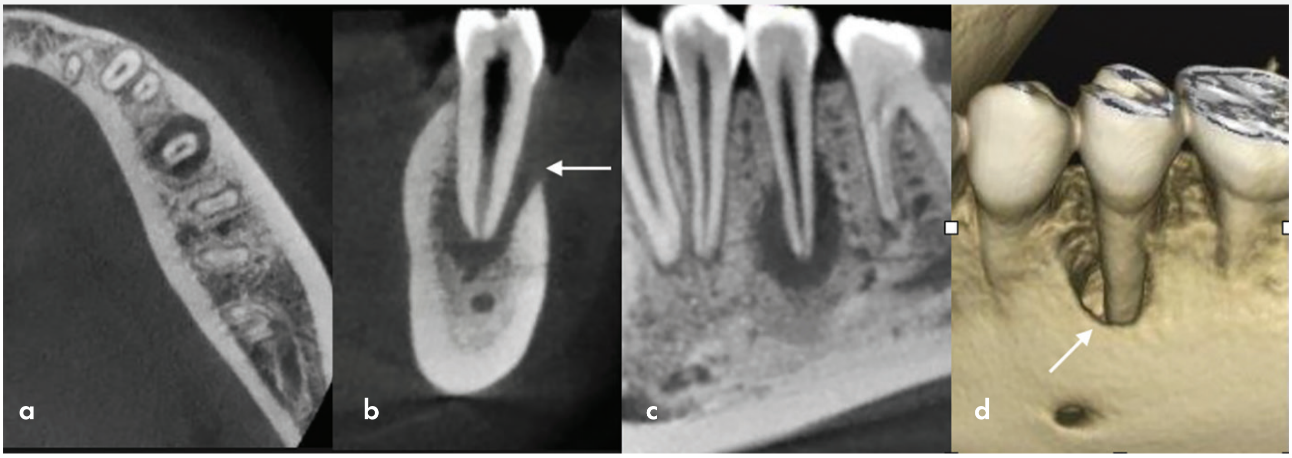

Figure 10. (a) Axial view; (b) Coronal view; (c) Sagittal view; (d) 3D reconstructed view of the CBCT scan clearly showing the extent of the peri-apical infection with associated destruction of the buccal bone plate up to the apical third level of the root (arrows)

overall prevalence has been estimated to range from 0.5% to 4.3% (Koksci et al, 2002).

The cusp-like projections found in teeth affected by dens evaginatus carry great clinical significance, especially in endodontics. Fracture or wear of the tubercles due to malocclusion or trauma may lead to pulpal exposure shortly after tooth eruption and require endodontic intervention (Levitan & Himel, 2006).

The patient, a 22-year-old female, presented with discomfort on her mandibular left second premolar. Clinical examination showed a small tubercle on the occlusal surface of the tooth (Figure 9a). Radiographic examination revealed an open root apex with a large peri-apical lesion (Figure 9b). A high-resolution CBCT scan (8200 Carestream) confirmed the peri-apical infection and revealed destruction of the buccal cortical bone plate up to the apical third of the root (Figures 10a–d). The condition was classified as dens evaginatus Type VI according to the classification of Levitan and Himel. It required the creation of a root-end barrier followed by conventional endodontic therapy.

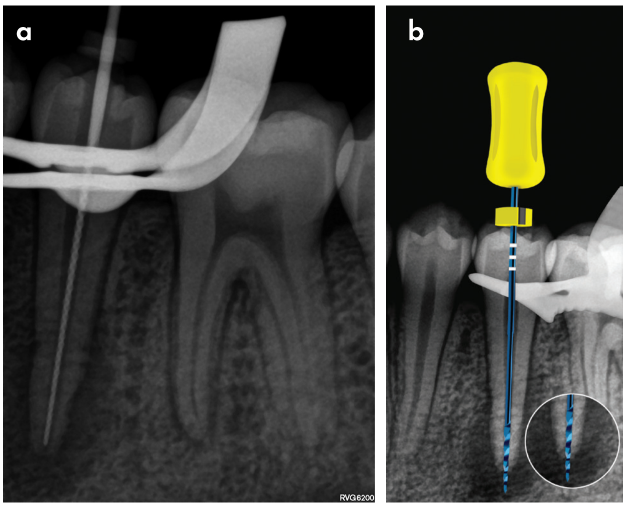

Figure 11. (a) Working length determination confirmed radiographically using a size 40 K-File; (b) Final canal preparation using a ProTaper Ultimate FXL manual instrument 2–3mm past the radiographic apex that equates to approximately an ISO 80 file size

Following administration of local anaesthesia and placement of a rubber dam, a conservative access cavity was prepared extending from the tubercle into the pulp chamber. The necrotic tissue was removed using the Shaper SX from the ProTaper Ultimate system. Length was determined using an electronic apex locator and size 40 K-File and verified radiographically (Figure 11a). The canal with the open apex was instrumented 2–3mm past the radiographic apex using a ProTaper Ultimate FXL manual instrument until resistance was experienced (Figure 11b). Heated 3.5% sodium hypochlorite was activated during and after canal instrumentation using the Eddy Irrigating Tip attached to a NSK Air scaler. Calcium hydroxide was placed as an intracanal medicament for one week.

At the second visit, sodium hypochlorite was used to remove the calcium hydroxide paste. A stainless steel endodontic plugger attached to an electronic apex locator was used to confirm the position where the apex was open (Figure 12a) and to determine the final position for placement of the MTA material. This position was confirmed radiographically. ProRoot MTA (Dentsply Sirona) was mixed according to the manufacturer's instructions and a no. 1 NiTi memory shape needle from the Micro-Apical Placement (MAP) system

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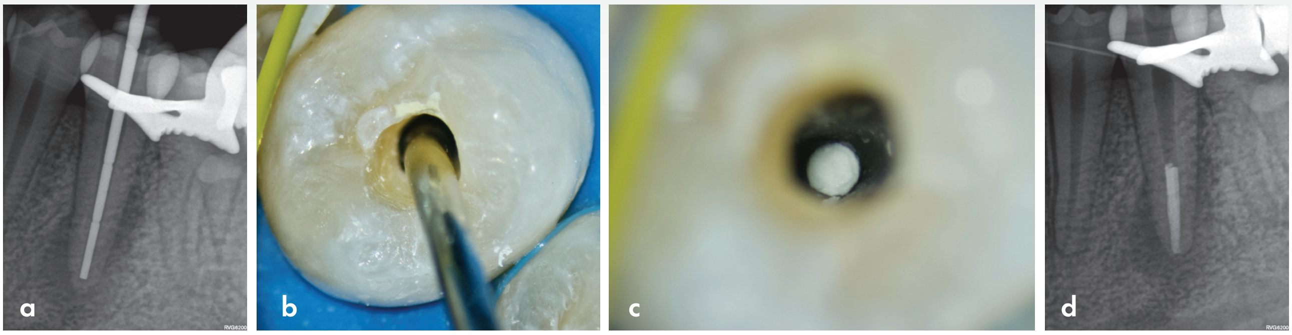

Figure 12. (a) Stainless steel endodontic plugger used to confirm the position of the open apex; (b and c) No. 1 NiTi memory shape needle from the Micro-Apical Placement (MAP) system used as a carrier to dispense a cylindrical plug of MTA into the root canal system (d) A 5mm MTA plug packed incrementally and condensed

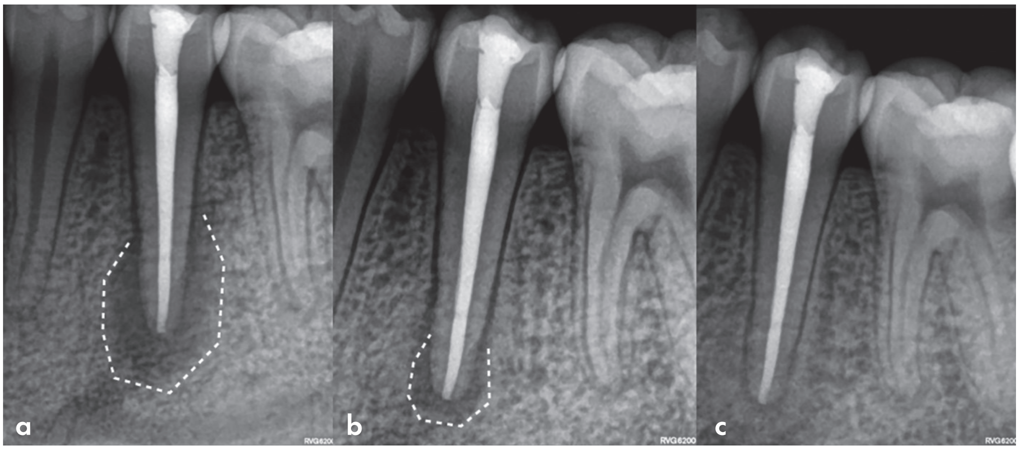

Figure 13. (a) Final obturation result; (b) Three-month follow-up peri-apical radiograph showing a reduction in the peri-apical pathology; (c) Eight-month follow-up peri-apical radiograph showing excellent healing of the peri-apical lesion

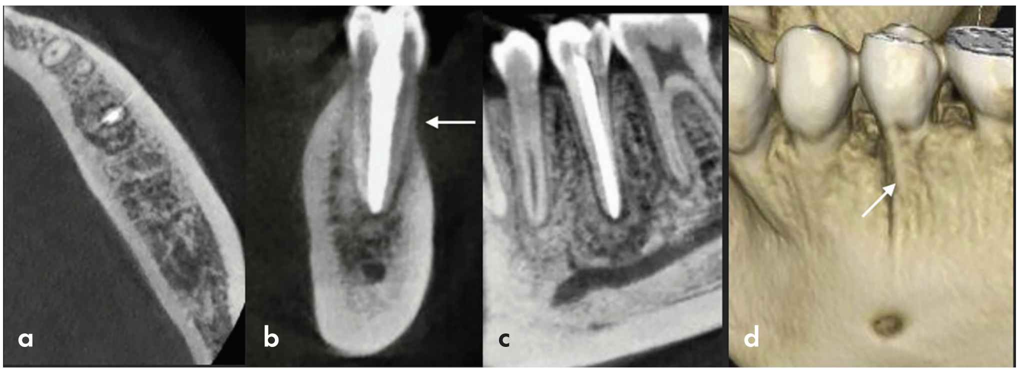

Figure 14. (a) Axial view; (b) Coronal view; (c) Sagittal view; (d) 3D reconstructed view of the CBCT scan clearly showing complete healing of the peri-apical lesion and some return of the buccal bone plate up to the coronal-midroot area of the root (arrows)

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(Produits Dentaires SA) (Figure 12b) was used as a carrier to dispense a cylindrical plug of MTA into the root canal system (Figure 12c). The small MTA plug was carried to the predetermined position using a stainless steel plugger. This procedure was repeated several times until a 5mm apical plug of MTA was packed incrementally (Figure 12d). The rest of the canal was obturated with gutta percha using the GuttaSmart system backfill device in conjunction with AH

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Plus Bioceramic sealer. Figure 13 depicts the immediate post-operative obturation result, a three-month follow up peri-apical radiograph showing a reduction in the peri-apical pathology and an eight-month follow peri-apical radiograph showing excellent healing of the peri-apical lesion. The healing was confirmed with a high-resolution CBCT scan taken at the one-year follow up visit (Figures 14a–d).

Conclusion

The ProTaper Ultimate system is a new rotary endodontic file solution which allows clinicians to perform both simple and complex root canal treatments in a wide variety of clinical cases. This report highlighted the use of these instruments in the management of both routine and challenging endodontic anatomy. The benefits of these instruments to clinicians are the maximum preservation of pericervical dentine while maintaining good apical taper and a high level of versatility, avoiding the need for instrument hybridisation as has commonly been practised in the past. Both specialists and general practitioners who provide endodontic treatment may benefit from the advantages of this new file system.

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