Reciprocating nickel-titanium during root canal treatment

John Rhodes examines the use of reciprocating nickel-titanium instruments in challenging root canal anatomy

CPD Aims and objectives

This clinical article aims to discuss the use of reciprocating nickel-titanium instruments in curved and sclerosed canals.

Expected outcomes

Correctly answering the questions on page xx, worth one hour of verifiable CPD, will demonstrate that the reader understands the successful negotiation of challenging root canal anatomy using a methodical approach and reciprocating nickel-titanium files.

Curved and sclerosed canals can raise difficulties for the operator during root canal treatment resulting in iatrogenic errors. In this case, challenging root canal anatomy in a maxillary molar (UR6) was successfully negotiated using a methodical approach and reciprocating nickel-titanium instruments.

Clinical examination

A 56-year-old man was referred for root canal treatment of his UR6 after his general dentist had been unable to locate or negotiate sclerosed canals in the painful tooth.

Straight-line access is advisable when using rotary or reciprocating instruments

Intraorally, there was no swelling, sinus tracts, visible cracks or increased periodontal pocketing. The tooth was restorable, but the existing amalgam restoration was defective. The tooth was non-vital to sensitivity testing with Endo-ice (Coltene).

Radiographic assessment using a paralleling periapical radiograph (Rinn, Dentsply) showed a large amalgam restoration distally, with poor marginal integrity. There was evidence of access cavity preparation and removal of dentine overlying the distobuccal (DB) canal. The DB and palatal canals appeared patent but the mesiobuccal (MB) canals had not been located or negotiated and the MB root was significantly curved. There was evidence of periapical radiolucency. There were no discernible signs of periodontal disease or gross caries. Diagnosis was a necrotic UR6 associated with periapical periodontitis.

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Treatment options

Sensible treatment options in this case include:

- Non-surgical root canal treatment, followed by placement of a cusp-coverage restoration
- Extraction only or replacement with an implant or bridge.

Extraction and replacement with an implant should be feasible, but may require bone augmentation. The natural tooth was eminently restorable and a good root filling complemented by a well-fitting crown could be expected to function as well as an implant supported crown, for significantly less cost and surgery time (Torabinejad et al, 2007; Hannahan and Eleazer, 2008; Pennington et al, 2009).

After discussing all the available options the patient decided to have UR6 root filled. Non-surgical root canal treatment was planned for a single visit.

Following profound local anaesthesia with Articaine (Septodont), single tooth isolation was achieved with rubber dam and a number 14 clamp. The existing restoration and caries were completely removed and the pulp floor refined with a Tungsten Carbide LN bur (Dentsply). A size two bur was used under the operating microscope to trough along the isthmus from MB1, which revealed a further two orifices (MB2 and MB3).

Straight-line access

Straight-line access is advisable when using rotary or reciprocating instruments; removing calcified material from the coronal aspect makes transition deeper into the canal system easier, reduces stress on instruments and allows rapid penetration of irrigant into the canal earlier during preparation (Berruti et al, 2004).

The orifice of each canal was explored to a depth of a few millimeters with a size six and 10 Flexofile (Dentsply) and then flared with a Protaper SX (Dentsply) instrument, brushing against the bulkiest wall of the canal and working to a depth approximately half the canal length as estimated from the preoperative radiograph. Thorough irrigation with 3% sodium hypochlorite was used throughout to remove debris.

It was apparent that the MB2 communicated with the MB1 and therefore it would not be necessary to enlarge this further.

Working length estimation

All root lengths were estimated with a multi-frequency apex locator (Elements Diagnostics Unit, Sybronendo) and a size six Flexofile with a small amount of Glyde (Dentsply) on the instrument. As consistent and steady zero readings were obtained a diagnostic radiograph was not deemed necessary.

Figure 1: Preoperative radiograph

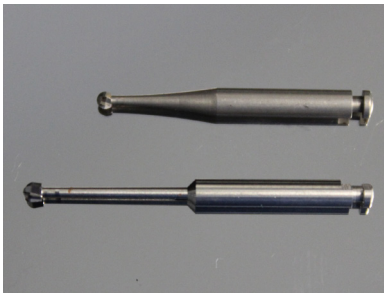

Figure 2: A large LN bur compared to a standard round bur. The narrow neck allows visualisation of the cutting tip

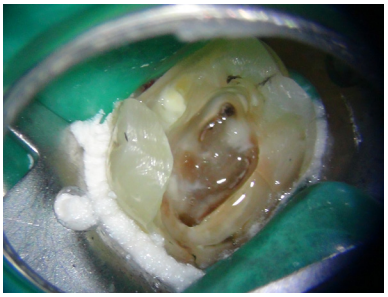

Figure 3: Microscope examination of the pulp floor after caries removal and orifice location. There is an isthmus running from the MB1 and the DB canals. A superficial crack can be seen on the distal aspect

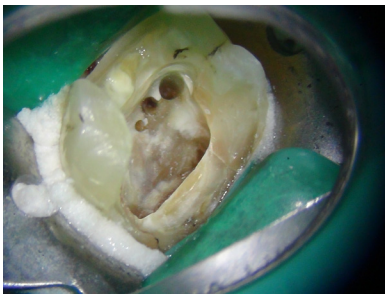

Figure 4: Flaring of the orifices of the MB canals revealed that the MB1 and MB2 interconnected

Figure 5: The X-Smart iQ cordless motor

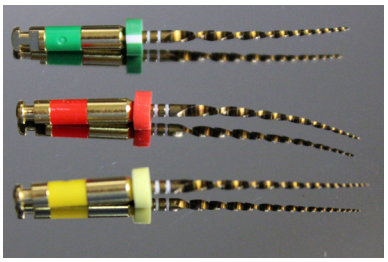

Figure 6: Waveone Gold instruments small, primary and medium. The primary instrument can be used to prepare 80% of root canals. It is possible to pre-bend the instruments, which can be very helpful

Figure 7: The pulp floor following obturation

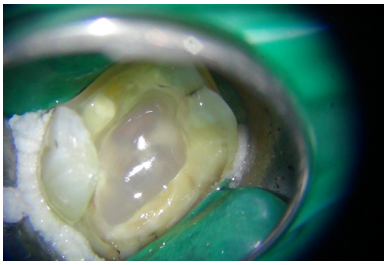

Figure 8: Smart Dentine Replacement (SDR) was used to seal the coronal aspect of the root canals and pulp floor

Figure 9: Paralleling radiograph showing homogenous completed obturation

Establishing a glide path

The buccal canals were fine and initially only a size six Flexofile could be passed to the working length after coronal flaring. With a watch-winding action this was enlarged to a size 10 Flexofile using copious irrigation with 3% sodium hypochlorite. Once at the working length the instrument was manipulated with small amplitude (2-3mm) vertical movements until it would reproducibly pass to the working length. This was particularly relevant in the DB canal, which had an acute curve in the apical tip.

The working length was re-confirmed with the apex locator. A small Waveone Gold (Dentsply) reciprocating instrument was then used to enlarge the preliminary glide path to the full working length. This instrument has an average taper of 7% and a tip size 20.

Waveone Gold instruments have a reciprocating action and have to be used in a dedicated electric motor. In this case the X-Smart IQ cordless motor was used, which is controlled from a dedicated app on an iPad. The app records and displays real-time torque monitoring, so if excess stress is incurred the instrument auto-reverses with visual and audible warnings.

Preparation and tapering

Rapid tapering of the primary root canals was completed with Waveone Gold (Dentsply) instruments, always working through a puddle of sodium hypochlorite on the pulp floor and patency confirmed with a size 10 Flexofile.

A single Primary Waveone Gold instrument (average taper 7% and tip size 25) was used in all canals apart from the palatal, which was finished using a medium Waveone Gold (average taper 6% and tip size 35).

Disinfection

A heated 3% solution of sodium hypochlorite was used to

disinfect the prepared root canals. This was agitated using a freely vibrating irrisafe tip (Satelec) inserted 2mm from the working length and an Endo Activator (Dentsply) with a red tip using a pumping action.

Obturation

The case was obturated using a vertically compacted gutta percha technique with heated pluggers, AH Plus sealer (Dentsply) and Obtura (Obtura Spartan) thermoplasticised gutta percha to backfill.

Coronal seal

The pulp floor and coronal aspect of the root canals was sealed with Smart Dentine Replacement (SDR, Dentsply) – a bulk fill, flowable composite. (This material will cure to a depth of 4mm in bulk sections.) The tooth was then temporised with resin modified glass ionomer (Fuji IX). The general dental practitioner would complete restoration with a core and full coverage crown.

Postoperative paralleling radiographs were exposed at two angles to confirm a homogenous seal. Review was scheduled for six months.

Discussion

The risk of blocking the canal during preparation is probably greater when the canal is fine or sclerosed because rotary or reciprocating instruments machine a comparatively greater surface area of the root canal wall and therefore create more dentine chips. The chips and smear can block the canal or pack into the flutes of the instrument and increase the risk of tip fracture. The volume of available irrigant is also reduced resulting in smear 'clumping'. Copious irrigation during preparation and recapitulation with a fine file can be used to avoid this happening.

It is possible to achieve acoustic microstreaming when an ultrasonic file oscillates freely in the root canal

Waveone Gold instruments are manufactured with heat-treated nickel-titanium. In-house testing by Dentsply has shown that cyclic fatigue resistance has been improved by 50% compared with Waveone. Despite superior metallurgy, it is essential to create a reproducible glide path for nickel-titanium instruments to follow (Nahmias et al, 2013; Kubde et al, 2012). The glide path reduces the chance of instrument fracture as a result of cyclic or torsional fatigue or when the tip becomes locked in the canal (Sattapan et al, 2000; Patiño et al, 2005; Plotino et al, 2009).

Flexible stainless steel instruments such as Flexofiles can be used to scout the canals and establish patency followed by a narrow taper rotary or reciprocating instrument to create the glide path. In this case, Flexofiles and a small Waveone Gold instrument were used. The Proglider (Dentsply) is a rotary instrument that has been designed specifically for this purpose, and has been shown to be one of the most efficient means of preparing a glide path (Van der Vyver, 2015).

There is evidence that microcracking of the root dentine can be induced during mechanical preparation (Yoldas et al, 2012). This appears to be more prevalent with rotary techniques and when larger sizes or tapers are used. Generally the canals should be tapered sufficiently to allow adequate irrigant penetration but avoid excessive dentine removal (Liu et al, 2011). Waveone Gold instruments are operated in a reciprocating motion, which reduces stress. They have progressive tapers but the average apical taper has been reduced from equivalent Waveone instruments and the manufacturer has introduced an intermediate size medium file with tip size 35.

Figure 10: The mesial canals all merge through a single isthmus

Mechanical preparation alone can reduce the bacterial load in an infected root canal (Byström and Sundqvist, 1981) but sodium hypochlorite in a concentration of at least 1% is required to kill any remaining bacteria (Byström and Sundqvist, 1983). Bacteria in a necrotic root canal system such as this case are present in planktonic form and as a complex biofilm in which bacteria are surrounded by matrix on the walls of the canals and can be difficult to remove.

Irrigants must therefore be agitated to break up these bacterial aggregations. It is possible to achieve acoustic microstreaming when an ultrasonic file oscillates freely in the root canal (Ahmad, Pitt Ford and Crum, 1987) and the forces created by the turbulence may disrupt biofilm. Passive ultrasonic irrigation (PUI) utilises a small file oscillating freely in the root canal to induce acoustic microstreaming and in this case PUI and agitation with the Endo activator were used. Compared with traditional syringe irrigation, PUI removes more organic tissue, planktonic bacteria and dentine debris from the root canal (Burleson et al, 2007; Van der Sluis et al, 2007).

It can be difficult to ensure adequate irrigant exchange at the apex of fine, long or highly curved canals. The primary canals must be sufficiently tapered to allow sufficient volume of irrigant to be introduced into the root canal system. Conservative tapering of the canal is generally not a problem with modern nickel-titanium systems.

The chelating agent 17% EDTA is sometimes used as a final rinse during irrigation (Byström and Sundqvist, 1985). It is used to remove smear and has a positive benefit on outcome in retreatment cases however this does not seem to be the case with primary treatment (Ng, Mann and Gulabivala, 2011).

In a two-visit approach the canals are medicated after preparation and disinfection with calcium hydroxide for seven days. This has been shown to be an effective means of

producing bacteria-free canals (Byström, Claesson and Sundqvist, 1985; Sjögren et al, 1991).

However, more recently, Peters and colleagues showed that calcium hydroxide and sterile saline slurry limits but does not totally prevent regrowth of endodontic bacteria (2002). Hargreaves, in a systematic review of the literature, reported that multiple visits with calcium hydroxide treatment did not improve upon clinical outcome and there was a minimal level of evidence for considering one versus two appointments in non-surgical endodontics (2006).

Indeed, meta-analysis has shown that a single visit approach (as used by many endodontists) has no bearing on prognosis, outcome or postoperative pain (Ng, Mann and Gulabivala, 2011). This case was, therefore, completed in a single visit.

Conclusion

In this case, curved and sclerosed canals in a maxillary molar were managed using Waveone Gold instruments. The development of a reproducible glide path was essential. The operator should not be put off by the preoperative radiographic appearance or lack of canal definition on a CBCT image however, often the canals are not as fine as they seem and using a methodical approach to preparation these anatomical challenges can be overcome. ■

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