WaveOne® Gold reciprocating instruments: clinical application in the private practice: Part 3

Peet van der Vyver[1] and Martin Vorster[2]

Introduction

The clinical use of the WaveOne® Gold system (Dentsply Sirona) was discussed in Part 1 and 2 of this series. In this article, the authors want to share another unique application of the WaveOne® Gold instruments.

According to Lambrianidis (2009) procedural accidents can interupt the sequence of the steps during root canal treatment. In most cases these accidents are the result of the dentists erroneous manipulation and inattention to detail. One of the most frequent problems during root canal treatment is that intruments cannot be advanced to working length in a previously patent canal. This might be due to ledge formation that occurred during root canal preparation or a blockage of the canal with foreign objects.

A ledge is a deviation from the original canal curvature without communication with the periodontal ligament, resulting in a procedural error termed ledge formation or ledging (Jafarzadeh, Abbott, 2007). After ledge formation, the operator works the files short of the full canal length, the canal becomes blocked and excludes the possibility of achieving an adequately shaped canal preparation up to the ideal working length. This can result in incomplete instrumentation, irrigation and obturation of the root canal system. When this happens in an infected tooth, there is always a potential for failure (Siqueira, 2001) and is frequently associated with ongoing periapical pathosis after the endodontic treatment (Jafarzadeh, Abbott, 2007).

The aim of this article is to illustrate the management of a mandibular premolar with a curved apical root, that failed endodontically, due to ledge formation during canal preparation.

[1] Department of Odontology, School of Dentistry, University of Pretoria, Pretoria, South Africa and Private Practice, Sandton, South Africa.

[2] Department of Odontology, School of Dentistry, University of Pretoria, Pretoria, South Africa

Corresponding author
PJ van der Vyver: PO Box 2609, Cresta, 2118. Tel: 011 781 1020. Cell: 082 4104 293. Email: peetv@iafrica.com

Figure 1: Preoperative periapical radiograph of a mandibular, second premolar with poorly done root canal treatment. Note the periapical pathology around the apical part of the root.

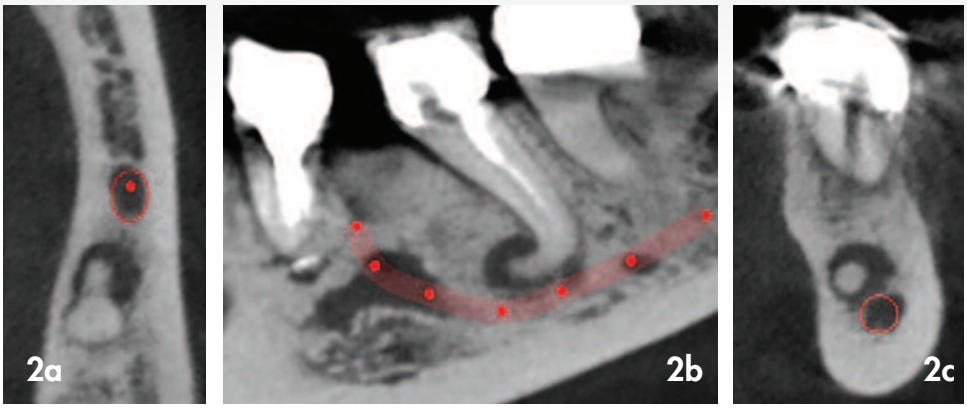

Figure 2: (a) Axial view, (b) sagittal view and (c) coronal view of a preoperative CBCT scan that confirmed a large periapical area around the root tip of the tooth, extending up to the inferior alveolar canal (red circle).

Case Report

The patient, a 45 year old female presented with percussion sensitivity on her mandibular, left second premolar. There was also paresthesia on the mucosa of her lower left lip. She gave a history of a root canal treatment being done four months ago, a few days after a porcelain veneered crown was placed on the tooth. She also recall that the dentist struggled to get around a curve at the tip of the root. A periapical radiograph revealed that the root canal treatment tooth was very short of working length, and showed evidence of periapical pathology (Figure 1). A CBCT scan showed that there was a large periapical area around the root tip of the tooth, extending up to the inferior alveolar canal (Figure 2).

After carefull examination of the CBCT scan, it was evident that there was a possibility of a ledge formation at the start of the apical curvature of the root canal and canal obstruction approximately 5 mm from the root tip (Figure 3). The tooth was anaethetised and isolated before the previous obturation material was removed from the root canal using Endosolv E (Septodont) and a size 15 Hedstrom file (Figure 4). A size 10 K-File was introduced into the canal but it was impossible to negotiate the canal further. The tip of the instrument was hitting against a solid wall of dentin (Figure 5). A ledge formation in the canal was confirmed at the start of the root curvature.

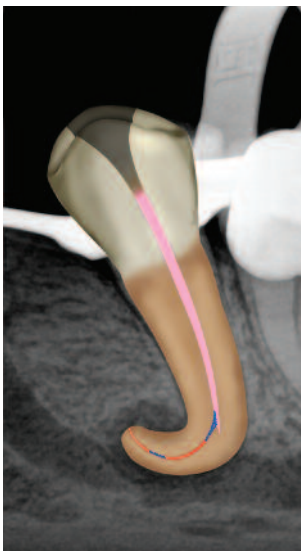

Figure 3: After carefull examination of the CBCT scan, it was suspected that there was a possibility of a ledge formation at the start of the apical curvature of the root canal and canal obstruction approximately 5 mm from the root tip, as illustrated on this drawing (blue dots).

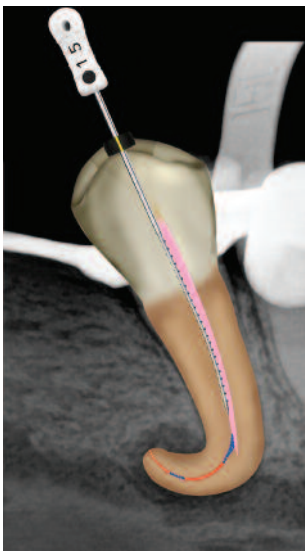

Figure 4. Previous obturation material was removed using Endosolv E (Septodont) and a size 15 Hedstrom file.

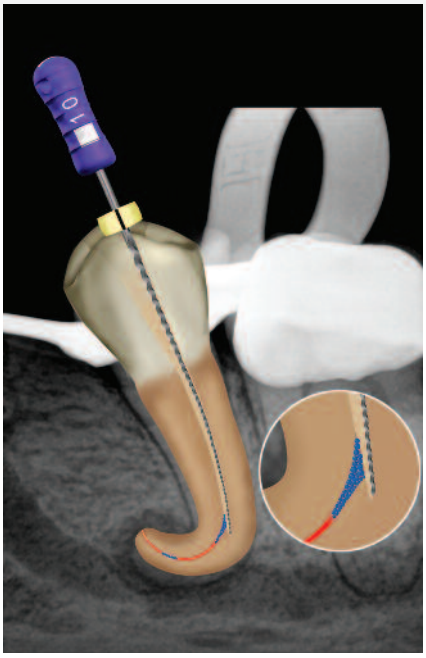

Figure 5: A size 10 K-File was introduced into the canal but it was impossible to negotiate the canal further as the tip of the instrument was hitting against a solid wall of dentin. A ledge formation in the canal was confirmed at the start of the root curvature.

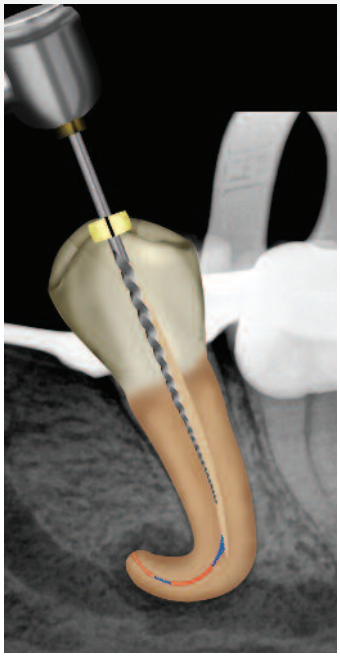

Figure 6: ProTaper® SX file (Dentsply Sirona) was used to preflare the coronal two thirds of the canal to create more coronal space to allow the canal to accept precurved files.

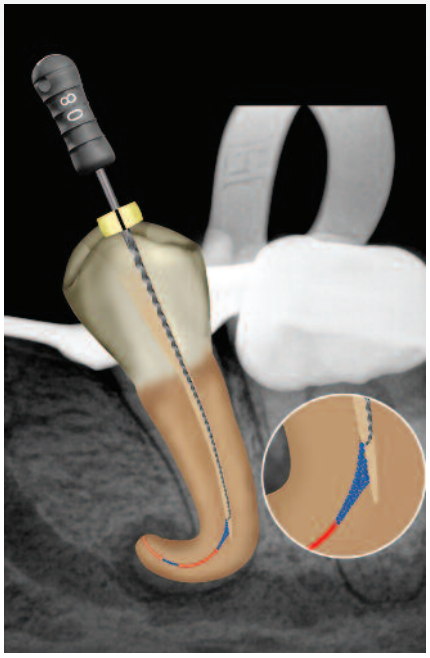

Figure 7: A size 08 C+ File (18 mm) with a distinct curve in the apical 2-3 mm of the file was selected to try and bypass the ledge.

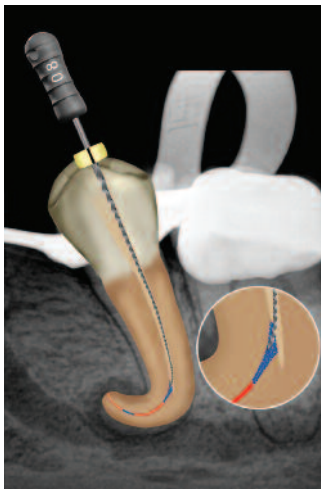

Figure 8: A size 08 C+ File was used in a slight rotation motion combined with a light "picking motion" to discover the original canal entrance.

Figure 9: The above motion was repeated untill the 08 C+ File advanced another 2.5 mm further down the root canal. With the tip of the file placed apically to the ledge, the file was used with short, push-pull motions to try and reduce the internal canal irregularity (arrows).

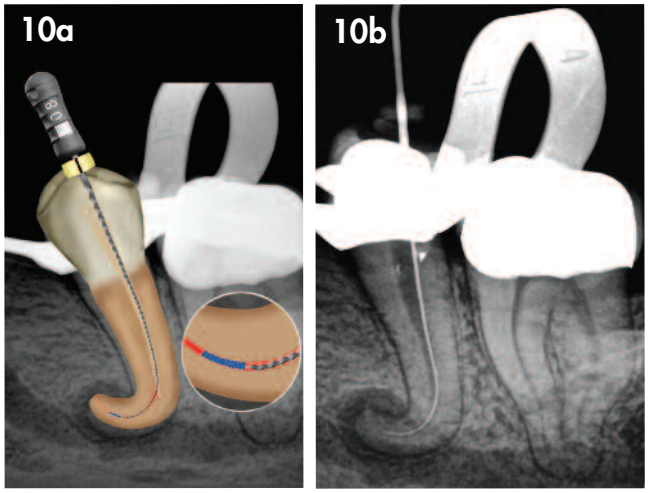

Figure 10: (a) A pre-curved size 08 K-File was introduced and it progressed another 3 mm deeper down the canal before another "dead-end" was met; (b) Periapical radiograph showing the progress of the size 08 K-File into the curvature of the root canal.

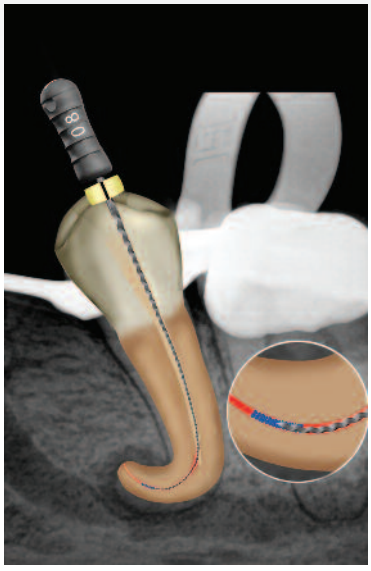

Figure 11: After a prebend C+ File (21 mm) was introduced and lightly tapped against the obstruction until a 'sticky point' was located, it was used for negotiation into the calcification. This was followed by inserting a pre-curved 08 K-File, using a watch-wind motion to extend the negotiation to another 2 mm deeper down the canal.

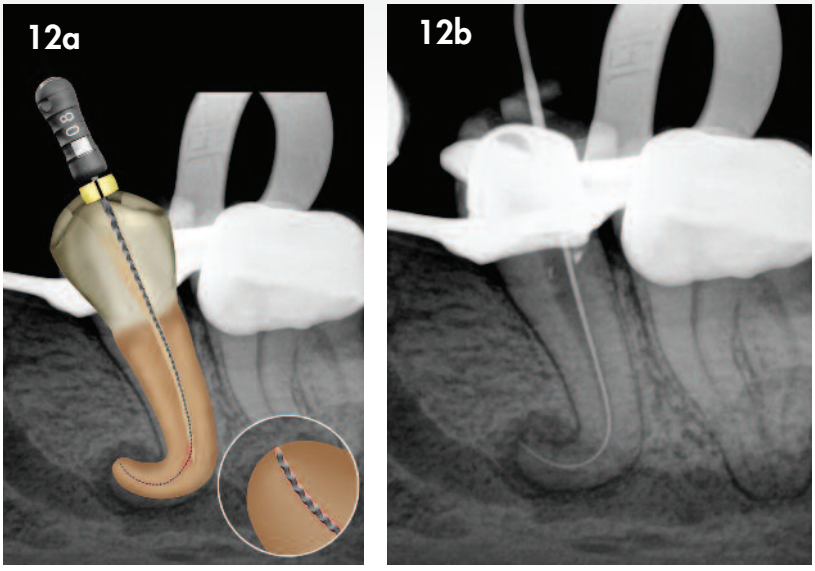

Figure 12: (a) After another negotiation sequence of 1.5mm with the 08 C+ File, it was possible to take a size 08 K-File to patency; (b) Radiographic confirmation of complete patency of the root canal.

A ProTaper® SX file (Dentsply Sirona) was used to preflare the coronal two thirds of the canal (Figure 6). This created more coronal space to allow the canal to accept precurved files and also to create more straight line access to facilitate relocation and renegotiation of the original canal. A size 08 C+ File, 18 mm long, with a distinct curve in the apical 2-3 mm of the file was selected to try and bypass the ledge. The directional marker on the stop was positioned to correspond with the same direction of the curve placed on the tip of the file (Figure 7). The file was introduced into the canal filled with 6% sodium hypochlorite (Chlor-Xtra, Vista Dental), ensuring that the curved tip was directed towards the wall opposite the ledge. A slight rotation motion combined with a light "picking motion" was used to try and discover the original canal entrance. After several attempts by reorientating the file in different positions, the pre-curved file tip advanced for about 0.5 mm (Figure 8). The file was slightly retracted, and advanced again. This procedure was repeated and the file progressively advanced further down the canal for another 2.5 mm (Figure 9). The 08 C+ File, with the tip placed apically to the ledge, was used with a filling motion combined with push-pull motions by pushing the file against the canal wall to try and reduce the internal canal irregularity. The C+ File was removed, the canal was irrigated before a pre-curved size 08 K-File was introduced and immediately progressed another 3 mm deeper down the canal before another "dead-end" was met (Figure 10).

Figure 13: A precurved size 10 K-File, with the tip placed apically to the ledge, was manipulated with a vertical in and out motion untill it was "super loose" in the canal.

Another prebend C+ File, 21mm long, was introduced with fresh 6% sodium hypochlorite solution. The C+ File was very lightly tapped against the obstruction until a 'sticky point' was located. The pre-curved C+ File was used to negotiate into part of the calcification. The motion in which this file is used is to engage the dentin by turning the file clockwise (maximum 90 degrees) with apical pressure, followed by

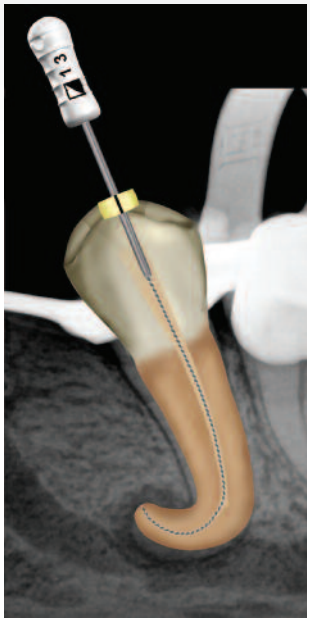

Figure 14: A size 13 Senseus ProFinder® instrument was also manipulated with a vertical in and out motion untill it was "super loose" in the canal.

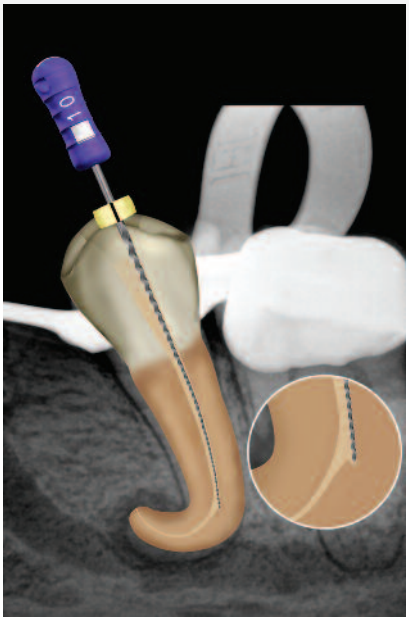

Figure 15: An attempt was made to confirm a reproducible glide path with a size 10 K-File but it was impossible as there was still an irregularity in the canal wall.

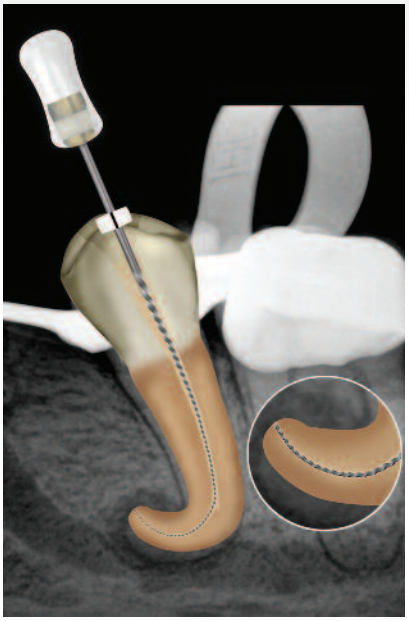

Figure 16: A ProGlider® instrument (21 mm) with a pre-curved tip and converted into a hand file was manipulated manually, using clockwise rotations untill the ProGlider® reached full working length.

anticlockwise disengagement. This motion was continued until the file progressed 1.5 mm. This was followed by inserting a pre-curved 08 K-File, using a watch-winding motion, to try and extend the negotiation down the root canal. The 08 K-File usually progress easier to deeper lengths or even to full working length in the root canal because the taper in the apical 4 mm of the file is only 2% compared to the larger taper (4.5%) of the 08 C+ File in the apical 4 mm of the instrument. In this case, the 08 K-File progressed to full working length and patency was achieved. Figure 12 shows a periapical radiograph with a size 08 K-File in the canal, confirming an electronic apex locator (Pixie, Dentsply Sirona) reading that was obtained for working length.

A precurved size 10 K- File, with the tip placed at working length, apically to the ledge, was manipulated with a vertical in and out motion, with an amplitude of 1 mm from working length. The amplitude was gradually increased to approximately 4 mm from working length (Figure 13). When the size 10 K-File was "super loose" in the canal the same protocol was followed with a size 13 Senseus ProFinder instrument (Dentsply Sirona) (Figure 14).

An attempt was made to confirm a reproducible glide path by taking the size 10 K-File to full working length, withdrawn to a point above the ledge and trying to slide back to working length. This was impossible as there was still an irregularity in the canal wall (Figure 15).

It was decided to make use of a technique suggested by Jafarzadeh and Abbott (2007). They used Greater Taper (GT) hand files (Dentsply/Tulsa Dental) that have tapers of 3-6 times the conventional 2% tapered hand files. The tips of the Greater Taper (GT) hand files were precurved with an Endo Bender Pliers (Analytic Endodontics, Orange, CA) to allow the file to bypass the ledge and the tapered flutes to reduce the ledge.

A ProGlider® instrument (21 mm) was converted into a hand file by placing a handfile adapter on the file. The tip of the ProGlider® instrument was pre-curved with an Endo Bender Pliers (Analytic Endodontics, Orange, CA), and the glide path instrument introduced into the root canal. The instrument was manipulated manually, using clockwise rotations untill the ProGlider® reached full working length (Figure 16). The canal was irrigated, recapitulated, and re-irrigated.

A WaveOne® GOLD Small file (Dentsply Sirona) was selected to attempt root canal preparation. However, the file still hanged up against the wall at the point where the ledge

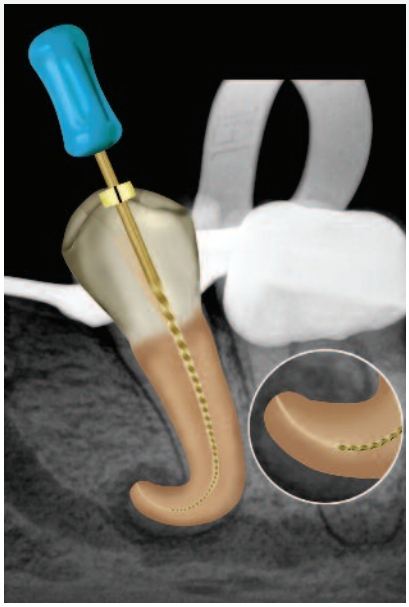

Figure 17: A prebend WaveOne® GOLD Small file, converted to manual mode by fixing a hand file adapter to the file allow the file to progress pass the remaining ledge formation.

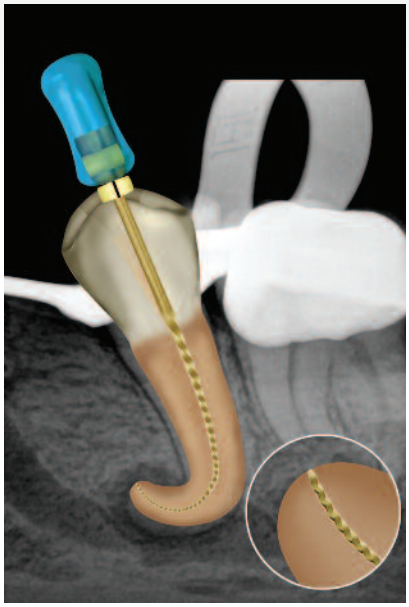

Figure 18: The pre-curved WaveOne® GOLD Small file was manipulated by hand using a reciprocation motion until the file reached full working length.

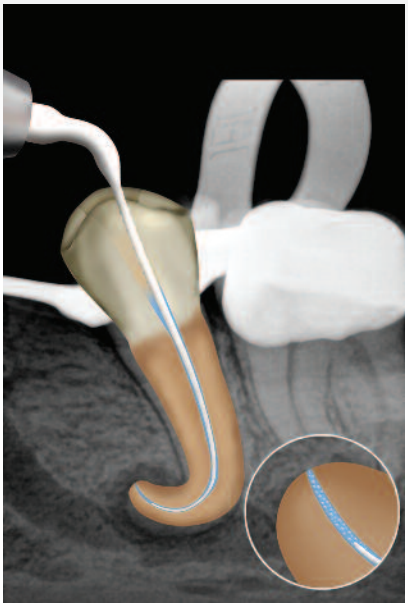

Figure 19: The prepared canal was filled with 17% EDTA and the solution activated for 1 minute with EDDY Endo Irrigation Tip (VDW) driven by an airscaler (Soniflex LUX 2000L, KAVO). Final disinfection was achieved by activating 3.5%, heated sodium hypochlorite for 3 minutes, again activated with the EDDY Endo Irrigation Tip.

was formed. Furtunately, it was noted that when the tip of the file was pre-curved by hand, the tip of the file was able to pass the ledge. The gold metal of the WaveOne® GOLD files allow that the files can be pre-curved as the metal demonstrate less memory compared to conventional nickel titanium or M-wire. Taking the severe apical curvature into account, it was decided to also convert the WaveOne® GOLD Small file into manual mode by fixing a hand file adapter to the file (Figure 17). The precurved WaveOne® GOLD Small file was manipulated by hand using a reciprocation motion (approximately 150 degrees counter clockwise and 30 degrees clockwise). When the file stopped progressing, it was removed, the flutes cleaned and the canal irrigated, recapitulated and re-irrigated. This protocol was repeated until the file reached full working length (Figure 18). The tapered instrument removed the ledge completely as it was possible to place a WaveOne® GOLD Small Gutta Percha Point to working length without any obstruction.

The prepared canal was filled with 17% EDTA and the solution activated for 1 minute with EDDY Endo Irrigation Tip (VDW) driven by an airscaler (Soniflex LUX 2000L, KAVO)(Figure 19). Final disinfection was achieved by activating 3.5%, heated sodium hypochlorite for 3 minutes, again activated with the EDDY Endo Irrigation Tip.

The canal was dried with paper points and obturated using the gutta-percha point, Pulp Canal Sealer (Kerr) and the Calamus Dual Obturation Unit (Dentsply Sirona). Figure 20 shows the final result after obturation. At a one year recall visit, a periapical radiograph (Figure 21) and CBCT scan (Figure 22) confirmed healing of the periapical pathology.

Discussion

The creation of a ledge in a canal during endodontic treatment will immediately complicate the treatment and might influence the long-term prognosis of the tooth (Kapalas, Lambrianidis, 2000; Cohen, Burns, 2002). Unfavorable outcomes of endodontic treatment associated with ledges

Figure 20: Postoperative periapical radiograph immediately after obturation.

Figure 21: Postoperative periapical radiograph at the one year follow-up visit. Note the healing of the periapical pathology.

depends on the amount of debris and bacteria left in the apical portion of the root canal (Jafarzadeh, Abbott, 2007). Ledge formation generally exclude the possibility that the canal could be adequately shaped up to working length that often results in incomplete disinfection and obturation. It could be speculated that the ledge in this case report was created early in the procedure, leaving debris and bacteria in the apical curvature of the root canal, resulting in the large periapical area.

Using microscope magnification it was possible in this case to visualize the position of the ledge and to direct the precurved files in the correct direction to facilltate relocation and renegotiation of the original canal. According to Ling, Wei and Gao (2003), the use an operating microscope and ultrasonic instruments to bypass or remove a ledge, can increase the number of favourable outcomes to 79 percent.

Sodium hypochlorite was used as the main lubricant and irrigant during canal relocation ans canal negotiation. Several studies indicated that chelating agents such as ethylenediaminetetraacetic acid (EDTA) should be used with caution when you negotiate curved canals. Because these EDTA preparations can soften dentin walls, it is possible to initiate another ledge along the root canal wall if excessive instrumentation pressure is used. Canal negotiation with C+ Files often requires pressure to break calcifications and therefore the use of sodium hypochlorite instead of EDTA preparations in this situation.

Size 08 C+ Files have stronger buckling resistance compared to conventional size 08 K-Files because they are tapered 4.5% in the apical 4 mm compared to the 2% taper of the file. This allows the operator to exert 143% more pressure during insertion into a canal than would deform a K-File of corresponding size (Castellucci, 2005).

The increased buckling resistance allows for easier location of canal orifices. C+ Files also demonstrate a pyramid-shaped tip that allows for the file to break into a blockage or calcification and facilitates canal negotiation. The aslo have a square cross-section that proved improved resistance to distortion. C+ Files are very helpful when attempting to bypass a ledge or to negotiate calcifications in root canals. Their metallic surface has also been subjected to an electro-polishing process, which makes them particularly smooth, thereby reducing the friction against the canal walls and the accumulation of debris in the spaces between the blades (Castellucci, 2005).

Another great benefit of C+Files are that they are available in 18 mm, 21 mm and 25 mm lenghts (Allen et al, 2007). Jafarzadeh and Abbott (2007) recommends that the shortest file that reaches the working length should be selected when attempting to bypass a ledge. Shorter instruments provide more stiffness and allow the clinicians fingers to be placed closer to the tip of instrument, which result in greater tactile sensation and thereby more controll over the instrument. In this case we selected the the 18 mm 08 C+ File to negotiate

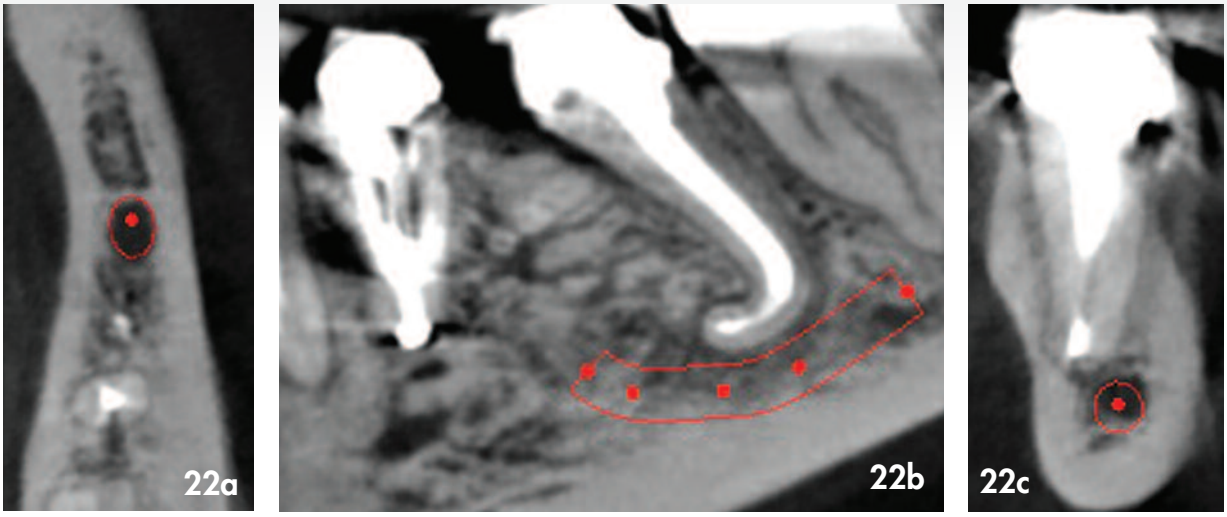

Figure 22: (a) Axial view, (b) sagittal view and (c) coronal view of a post-operative CBCT scan that confirmed healing of the periapical pathology at the one year recall visit.

past the ledge and thereafter a 21 mm 08 C+ File to negotiate the rest of the canal curvature in apical part of the root.

It is advocated that severe apical curvatures require the proper sequential use of root canal instruments to maintain a pathway to full working length of the root canal during canal preparation (Cohen and Burns, 2002; Walton and Torabinejad, 2002). In this case report we started off by using pre-curved 08 C+ and K-Files for canal negotiation, followed by a precurved size 10 K-File. After the size 10 K-File it was elected to use a size 13 Senseus ProFinder file instead of moving to a size 15 K-File.

It is important to note that a size 15 K-File is 50% larger in diameter at D0 than a size 10 K-File, and the stiffness of the size 15 K-File may render its use challenging when attempting to treat constricted, curved canals or ledged canals. Because of this large D0 discrepancy, many partially or fully negotiated canals become iatrogenically blocked, ledged, perforated, or apically transported when using a size 15 K-File (Ruddle et al, 2014). According to West (2011), the size 15 K-File is one of the most dangerous instruments that can be used for glide path enlargement, because it often results in ledges, blocks and even canal transportation.

In this case the use of the size 13 Senseus ProFinder® allowed us to increase the canal size a bit more before we introduced the ProGlider®, a dedicated rotary glide path instrument (Gutmann et al, 1997). The Senseus ProFinder® instruments are characterized by a large and ergonomic silicone handle that gives the operator an increased tactile feedback and increased working comfort.

The files are obtained by torsion of a steel wire with quadrangular cross-section and are available in three ISO diameters (0.10 mm, 0.13 mm and 0.17 mm). They are ideal for initial canal negotiation because they have a decreasing taper of the blade from the tip (2%) to the shank (1%).

The decreasing taper of the Senseus ProFinder® and its beveled tip of 65 degrees favours the negotiation of narrow and calcified canals (Castellucci, 2005).

In this challenging case, the use of a size 15 K-File could be eliminated completely. It has been demonstrated that certain rotary glide path instruments more predictably follow a previously secured canal compared to utilizing a manual size 15 K-File (Berutti et al, 2009).

The ProGlider® instrument was firstly used to increase the glide path diameter. This instrument has a semi active tip, size ISO 016 with a 2% taper and demonstrate a progressive taper from 2% (D0) to 8.5% over the 18 mm active cutting zone. The second reason for using the ProGlider® was to make use of the instrument's progressive tapered cutting flutes to further reduce the ledge formation in the canal. Conventionally, the ProGlider® is used in continuous rotation of 300 rpm and a torque of 2-4 Ncm.

Because of the irregularity in the canal wall it was not possible to introduce the file in rotary motion because it kept hanging up on the ledge formation. Therefore, the instrument was also converted to manual mode and the tip of the instrument slightly pre-curved with the Endo bender. This allowed that the tip of the ProGlider® could slip past the ledge into the main canal and that the instrument could be used with more safety in the severely curved apical part of the root canal. The file was used with a clockwise motion by gently rotating the handle until the flutes of the file are lightly engaged dentin. The dentin was then cut by rotating the handle further clockwise, while simultaneously withdrawing the file in an attempt to smooth the ledge irregularity on the canal wall.

The ProGlider®, with it progressive tapered flutes reduced the ledge drastically but it was still not possible to place for example a ProTaper® S1 or ProTaper® Next X1 file down the canal without hanging up on the ledge. It could be expected that that the ledge in this clinical case report was created with a large size hand file. According to Jafarzadeh and Abbott (2007) a ledge created by a size 25 or 30 file is much more difficult to bypass than one created by a smaller file because the shelf created by a larger instrument. It can also be assumed that that it is more difficult to remove a ledge that was created with a larger size hand file.

The recently launched WaveOne® GOLD instruments provided the solution to completely eliminate the ledge and to complete canal preparation. WaveOne® GOLD instruments are manufactured using a post-manufacturing thermal process wherby a new phase-transition point between martensite and austenite is identified to produce a file with super-elastic NiTi metal properties. This process gives the file a gold finish with improved mechanical characteristics. The WaveOne® GOLD Primary file is 50% more resitant to cyclic fatique, 80% more flexible and 23% more effiecient than the conventional WaveOne® Primary instrument (Dentsply, 2014; Ruddle, 2016; Webber, 2015). Due to the super-elastic properties of the new gold metal, the file may appear sligtly curved when it is removed from a curved root canal because the metal demonstrates less memory compared to conventional nickel titanium or M-wire. The file can either be straightened out or if it is placed back into a root canal it will follow the natural shape of that canal (Webber, 2015). Another advantages of this reduced memory of the file is that in cases with difficult straight-line access it is possible to slightly precurve the file, to allow easy placement into canal orifices. In this case report the tip of the WaveOne® GOLD Small File (20/07) could be precurved, that allowed the instrument to be placed past the remaining shelf of the ledge, before it was manually used in a reciprocating motion. After he first cutting cycle it was noted that the shelf of the ledge was completely removed. The tip of the WaveOne® GOLD Small File is size ISO 20 and the first 3mm of the file (D1-D3) has a continuous taper of 7%. From D4-D16 each file demonstrates a progressively decreasing percentage tapered design to ensure more flexibility and to preserve more dentin in the body of the prepared root canal to ensure more conservative root canal preparations. (Ruddle, 2016; Webber, 2015).

The EDDY irrigation tip was used to activate the irrigation solutions. The irrigation tip is sonically driven with an air scaler at maximum of 6000 Hz. Sonic irrigation operates at low frequencies (1-6 kHz), produces small shear stresses (Ahmad et al, 1987; Gu et al, 2009) and generates significantly high amplitudes (back-and-forth tip movement). Sonic irrigation has been shown to be efficient for root canal debridement (Walmsley, Williams, 1989). The flexible polyamide tip is softer than dentin and allows a simple and forgiving technique. In this case it was very useful as the flexible tip allowed for easy and precise placement in the severe apical curvature of the root canal, ensuring adequate disinfection in this part of the root canal system.

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