

Endodontic and restorative management of a lower molar with a calcified pulp chamber

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INTRODUCTION

Pulpal obliteration can be defined as the partial or complete calcification of the pulp chamber. Even though radiographic assessment may give an impression of complete obliteration, there is often evidence, on close examination, of an extremely fine root canal with remnants of pulp material.^{1,2} Teeth presenting with any degree of pulpal obliteration can become difficult and challenging to treat endodontically.

There is a continuous deposition of secondary dentine throughout the life of the pulp which generally reduces the volume of the pulp and the root canals. Secondary dentine is deposited at a rate of approximately 1-16 microns per day.³ Structural changes with age include a decrease in the number of blood vessels,⁴ nerves⁵ and pulpal cells with an increase in fibrous components.⁶ In posterior teeth, there is an asymmetric deposition of secondary dentine with the greatest increase on the floor of the pulp chamber, leaving the horns of the pulp behind.³ In anterior teeth most of the dentine deposition occurs on the lingual wall of the pulp chambers as a direct result of masticatory forces, followed by deposition on the incisal floor of the pulp chamber.⁷

The impact of environmental change and direct abuse can elicit a reaction from the dental pulp, resulting in dimensional and structural changes in the pulp and in the chamber. Many aspects of modern restorative procedures can have an effect on the pulp. According to Messer (2002) the net effect on the pulp is the sum of all the steps involved in preparation and restoration, modulated by the permeability of the underlying dentine and the health of the pulp before the procedure.⁸

As a response to a gradual, progressive injury (caries and abrasion) not directly involving the odontoblast processes, dentinal tubules become progressively occluded by mineral deposits. Additional dentine, called tertiary dentine, can

be deposited on the pulpal surface underlying the injury. There is also a strong relationship between trauma and the formation of tertiary dentine.⁹ According to Berkovitz, Holland and Moxham (2009) the pulp often mineralises in the form of pulp stones.¹⁰ Some teeth may present with a degree of mineralisation, occurring as discrete pulp stones, or as many tiny spicules of mineralised tissue throughout the pulp ("Snow-storm" calcifications). The latter, also called diffuse¹¹ or dystrophic calcifications,¹² can occur in any area of the pulp, but are more prevalent in the radicular regions. The spicules are usually aligned close to blood vessels and nerves or to collagen bundles, but are not visible radiographically.¹³

According to Formann (1984), pulp stones may appear to be found predominantly in the coronal pulp.¹⁴ These discrete calcific masses demonstrate an increased incidence with age.¹⁵ It has also been demonstrated that their occurrence and size often increase with external irritation.¹⁶ They consist mainly of concentric or diffuse layers of calcified tissue on a matrix which seems primarily to be collagen.¹⁷ Pulp stones can be classified as "free" stones, "attached" stones and "embedded" stones. Attached stones are those that become fused with the continuously growing dentine and embedded stones are formerly attached stones which have become surrounded by dentine. Pulp stones may alter the internal anatomy and confuse the operator by obscuring, but not totally blocking, the orifices of root canals. According to Langeland (1967), attached denticles may deflect or engage the tip of exploring instruments in the canals, thus preventing easy passage down the root canal.¹³

The presence of secondary dentine, reactionary dentine, reparative dentine, pulp calcifications and pulp stones can complicate clinical endodontic procedures and will often lead to failure of canal location, or to an inability to achieve complete root canal negotiation. Obstructions in pulp chambers and root canals can prevent access and as a result, limit complete disinfection of the most apical part of the root canal system, jeopardising the clinical outcome, particularly in infected cases.¹⁸

The purpose of this article is to demonstrate the endodontic and restorative management of a non-vital lower first molar that presented with a large pulp stone and partial canal obliteration.

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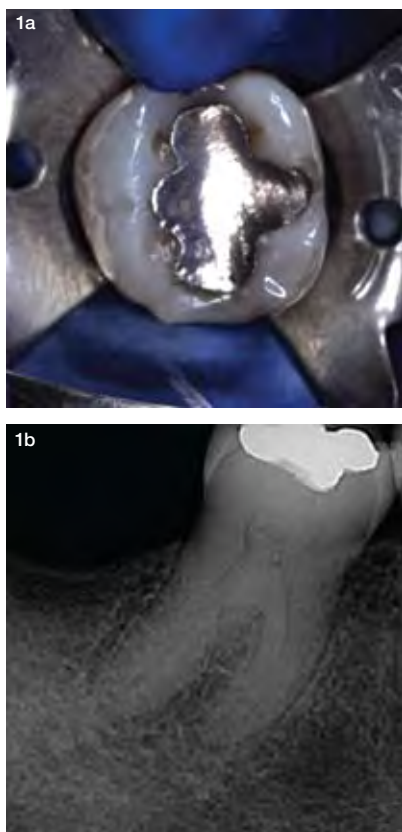


Figure 1: (a) Mandibular right first molar, restored with a large class I amalgam restoration; (b) Pre-operative radiograph of the non-vital lower right first molar. Note the nearly complete obliteration of the pulp chamber and partial calcification of the root canals.

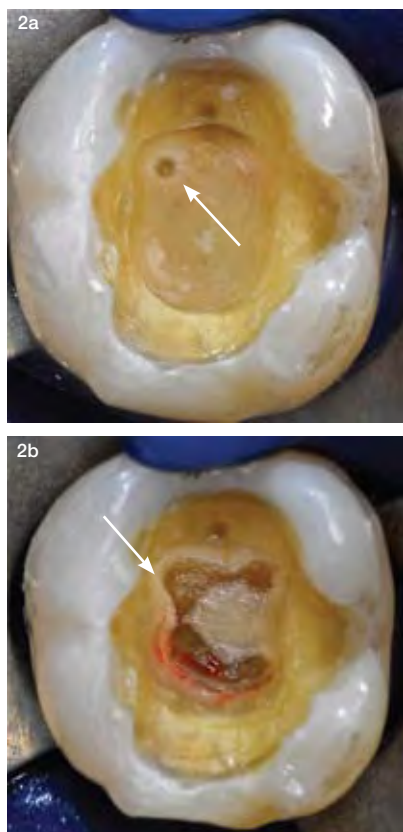


Figure 2: (a) Magnified view of the pulp chamber after removal of the amalgam and secondary caries. Note the evidence of a previous pulp exposure (arrow); (b) The roof of the pulp chamber was removed with a diamond bur, revealing a pulp stone (arrow).



Figure 4: a) The pulp stone which was removed from the pulp chamber; (b) Magnified view of pulp chamber floor after removal of the pulp stone showing evidence of small pulp stones (arrows) obscuring the canal orifices.

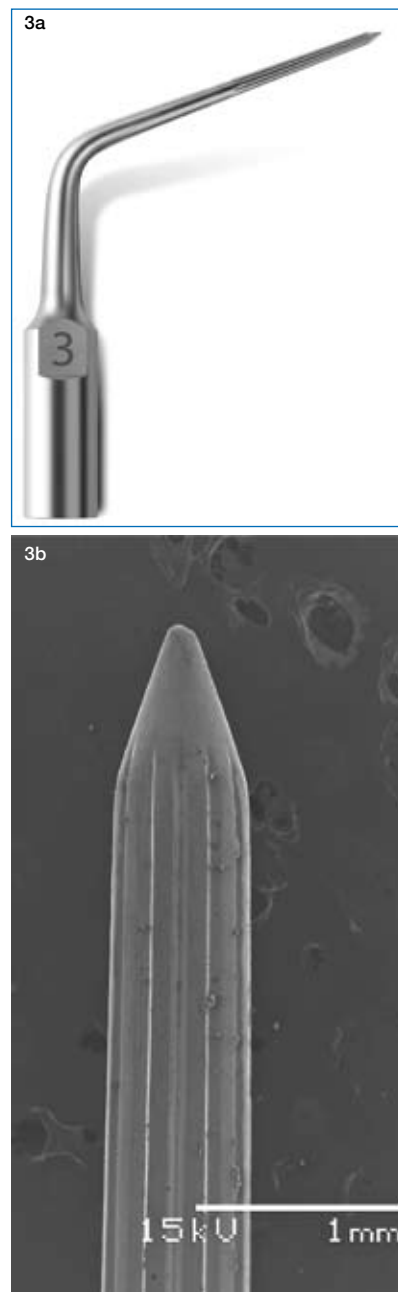


Figure 3: (a) Start-X ultrasonic tip no.3; (b) Scanning Electron Micrograph (SEM) of the tip of Start-X no.3. Note the narrow shank with the micro-blades, producing a sharp polished tip which facilitates more precision in cutting.

CASE REPORT

The patient, a 45-year-old female, presented with a main complaint of sensitivity to pressure on her mandibular first molar. A large Class I amalgam restoration had been placed, (Figure 1a) and sensibility tests revealed the tooth was non-vital. A pre-operative periapical radiograph revealed evidence of a large pulp calcification (Figure 1b). The amalgam restoration and all secondary caries were removed. Examination under magnification revealed evidence of a previous pulp exposure (Figure 2a). The roof of the pulp chamber was removed with a diamond bur, exposing the pulp stone (Figure 2b). A Start-X tip no.3 (Dentsply/Maillefer) (Figure 3a and b) was used to dislodge the pulp stone before it was removed (Figure 4a). Figure 4b shows a magnified view of the pulp chamber, illustrating evidence of numerous small pulp stones obscuring the canal orifices.



Figure 5: Size 10, taper 4%, Micro-Debrider (Dentsply/Maillefer).

Micro-Debrider (Dentsply/Maillefer) (Figure 5) was used to carefully remove them from the entrances of the canals. Finally, a Start-X tip no. 5 (Figure 6a and b) was used to smooth the pulp floor and walls of the access cavity (Figure 6c). The pulp chamber was filled Glyde (Dentsply/Maillefer), an Ethylene-Diamine Tetra-Acetic Acid (EDTA) paste, to act as a lubricant and improve hard-tissue debridement during canal preparation (Figure 7). All canals were negotiated to working length, using a combination of size 08 C+ and K-Files (Dentsply/Maillefer) (Figure 8). A reproducible glide path was established in all the root canals up to a size 10 K-File

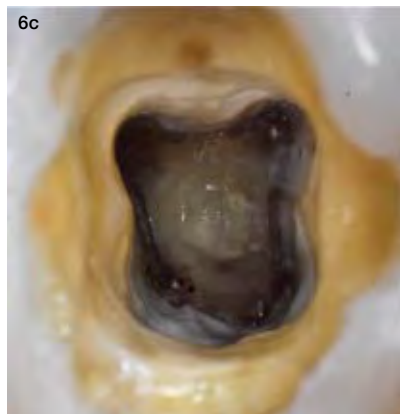
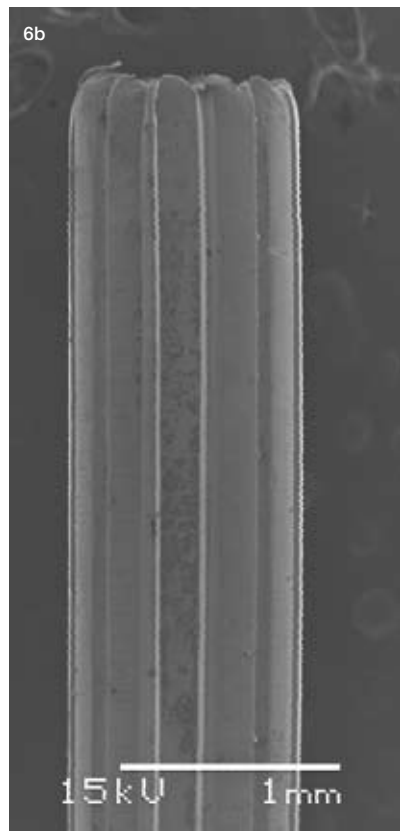


Figure 6: (a) Start-X tip no.5 (Dentsply/Maillefer); (b) Scanning Electron Micrograph (SEM) of the tip of Start-X no.5. Note the parallel sides with microblades that reach the end of the tip to increase cutting efficiency; (c) Magnified view of the access cavity after the pulp floor and walls was smoothed with the ultrasonic tip.



Figure 7: Glyde root canal conditioner (Dentsply/Maillefer).



Figure 8: Size 08 K-File (Left) and size 08 C+ File (right) (Dentsply/Maillefer).



Figure 12: Radiographic confirmation of the fit of the X2 GuttaCore verifiers.



Figure 9: (a) PathFile no 1. (purple ring); (b) PathFile no 2. (white ring); (c) PathFile no 3. (yellow ring) (Dentsply/Maillefer).



Figure 10: (a) ProTaper Next X1 (yellow ring); (b) ProTaper Next X2 (red ring) (Dentsply/Maillefer).



Figure 11: EndoActivator (Dentsply/Maillefer).



Figure 13: GuttaCore X2 obturators (Dentsply/Maillefer).



Figure 14: ThermoPrep Plus oven (Dentsply/Maillefer).

before the glide path was enlarged with PathFiles no. 1 (Figure 9a), no. 2 (Figure 9b) and no.3 (Figure 9c). Root canal preparation was done with ProTaper Next X1 (Figure 10a) and ProTaper Next X2 (Figure 10b). All four root canals were thoroughly irrigated with a 3.5% sodium hypochlorite solution (Jik, ReKitt Benckister) for 5 minutes, followed by a final rinse with TopClear (Dental Discounts), a mixture of 0.2% cetremide and 17% EDTA for 1 minute. Both solutions were activated with the EndoActivator (Dentsply/Maillefer) (Figure 11). Four X2 GuttaCore verifiers (Dentsply/Maillefer) were fitted in the prepared root canals and checked radiographically (Figure 12). The canals were obturated with AH Plus Cement (Dentsply/Maillefer) and four X2 GuttaCore obturators (Dentsply/Maillefer) (Figure 13) heated in the ThermaPrep Plus oven (Dentsply/Maillefer) (Figure 14). Figure 15 illustrates the post-operative result after obturation.



Figure 15: Post-operative result after obturation.



Figure 16: Pulp chamber and the cavity walls were sandblasted to remove any remnants of root canal cement. Enamel and dentine was etched with phosphoric acid for 15 seconds, washed with water and the etched surfaces lightly air-dried.

After root canal obturation, the pulp chamber and the cavity walls were sandblasted to remove any remnants of root canal cement. The Class I cavity preparation was etched with phosphoric acid for 15 seconds, washed with water and the etched surfaces lightly air-dried (Figure 16). XP Bond (Dentsply) (Figure 17) was applied with a micro-brush, air thinned and light-cured for 20 seconds. A 4-5mm layer of SDR (Smart Dentin Replacement) flowable composite resin (Dentsply) (Figure 18) was applied in bulk and light-cured for 40 seconds (Figure 19). The SDR was covered by two oblique layers of Ceram-X Duo Enamel (Dentsply) (Figure 20) and each layer light-cured for 40 seconds. Figure 21 shows the final result of the class I composite resin restoration.

DISCUSSION

A Start-X tip no 3, (Dentsply/Maillefer), was used to dislodge the pulp stone. This instrument is characterised by 8mm of micro-blades on a shaft with a maximum diameter of 0.9mm, tapering down to 0.64mm, ending in a sharp polished tip (Figure 3b). It is an ideal tip to cut around pulp stones, because the thin tip and shank facilitate cutting precision and unobscured vision during operation. Start-X tip no 5, (Dentsply/Maillefer), was used to smooth the pulp floor and walls off the access cavity. The tip of this ultrasonic instrument is concave to match the convexity of the pulp chamber floor of upper and lower molar teeth. Calcifications can be removed safely without altering the original anatomy of the pulp floor. The tip has parallel sides and a mean diameter of 1mm. The

micro-blades reach the end of the tip, to increase cutting efficiency (Figure 6b).

A Micro-Debrider (Dentsply/Maillefer) was used to further remove some of the calcified pulp tissue from the root canal orifices. Micro-Openers (Dentsply/Maillefer) are stainless steel instruments with 7mm of cutting flutes combining the canal finding capabilities of an explorer with the instrument capabilities of a K-File. They are available in sizes 10 and 15 with 0.4 and 0.6 tapers. The exaggerated tapers enhance the tensile strength of the instruments, making it the ideal tool to remove small pulp stones from the canal entrances.

To negotiate the constricted canals, first C+ Files (size 08) (Dentsply/Maillefer) followed by K-Files (size 08) (Dentsply/Maillefer) were used, until the canals were negotiated to patency. C+ Files are instruments used for negotiation of constricted canals, because they exhibit small dimensions and demonstrate mechanical resistance to torsion and buckling to withstand loads imposed during apical progression.^{19,20}

Berutti *et al.* (2004) recommended manual pre-flaring of the root canal to create a glide path before using nickel titanium rotary instrumentation.²¹

According to West (2010), a glide path is defined as a smooth radicular tunnel from the canal orifice to the physiologic terminus of the root canal and confirms that there is a pathway for rotary instruments to passively follow the canal.²² A size 10 K-File and rotary Pathfiles were used to secure a



Figure 17: XP-Bond (Dentsply)



Figure 19: After application of XP-Bond (Dentsply), a 4-5mm layer of SDR (Dentsply) flowable composite resin was applied in bulk and light-cured for 40 seconds.



Figure 18: SDR (Smart Dentin Replacement) (Dentsply)



Figure 21: Final result after the SDR flowable material was covered with Ceram-X Duo (Dentsply).



Figure 20: Ceram-X Duo Enamel (Dentsply).

reproducible glide path in all the canals in the present case. The recommended glide path protocol for ProTaper Next is to prepare the canals up to and including PathFile no 2. However, in the case of calcified canals with restrictive dentine, use of PathFile no 3 is suggested to prepare the glide path, prior to the use of ProTaper Next.²³ The advantages of using rotary Pathfiles include: (1) reduced operating time²⁴ with less operator and hand fatigue; (2) better maintenance of the original root canal anatomy²⁵ with a reduced incidence of canal aberrations^{24,25} and reduced extrusion of debris through the apical foramen,²⁶ resulting in a lower incidence of post-operative pain.²⁷

ProTaper Next (Dentsply/Maillefer) was selected for root canal instrumentation. These instruments are manufactured from M-Wire that ensures more flexibility of the instruments and increased safety and protection against instrument fracture.²⁸ The instruments present with a bilateral symmetrical rectangular cross section, with an offset from the central axis of rotation, (except in the last 3mm of the instrument, D0 –D3, allowing it to experience a rotational phenomenon, known as precession or swagger.²⁹ The exception is ProTaper X1, which has a square cross section in the last 3mm to give the instruments a little more core strength in the narrow apical part. These unique design characteristics present an instrument with the following advantages: (1) reduction in taper lock, screw-in effect and stress on the file, and minimal risk of instrument fracture because of the reduced amount of contact between the instrument blades and the dentine walls;^{23, 30} (2) the swaggering motion moves cut debris in a coronal direction ensuring a high level of cutting efficiency; (3) the swaggering motion activates the irrigation solution in the canal, moving the solution into canal irregularities and thereby cleaning areas not touched by the instrument; (4) each instrument is capable of cutting a larger envelope of motion (larger canal preparation size compared with a similarly sized instrument with a symmetrical mass and axis of rotation).^{23, 30} This allows the clinician to use fewer instruments to prepare a root canal to adequate shape and taper to allow for optimal irrigation and obturation.

The GuttaCore crosslinked gutta-percha core obturator (Dentsply/Maillefer) was selected for root canal obturation. Carrier-based obturation saves the operator a significant amount of time during the obturation process and excellent results have been supported by numerous studies over the years.³¹ GuttaCore consists of a carrier/core manufactured from a cross-linked, thermoset elastomer of gutta-percha, coated in regular gutta-percha. The core is a polyisoprene polymer cross-linked with peroxide for strength, designed to facilitate removal during retreatment and/or post space preparation by simply trephining through the material.^{32,33}

SDR was used as a dentine replacement for restoration of the Class I access cavity. According to an article in Clinicians Report (2011) this new category of bulk-fill, flowable composites can be effectively used in 4mm increments while decreasing shrinkage stresses generated during polymerisation.³⁴ In a study by Ilie and Hickel (2011), it was found that the contraction stress generated by SDR was only 1.1mPa, compared with 5.3mPa and 6.5mPa by Esthet-X (Dentsply Caulk) and Filtek Supreme Plus (3M ESPE), respectively.³⁵ According to the manufacturer's website, the reduction in polymerisation stress is due to the use of a "polymerisation modulator" forming a more relaxed resin network.³⁶ It has also recently been shown that bond strength is not compromised secondary to shrinkage stress, when SDR is used in 4mm increments in high C-factor cavity preparations (eg.

Class I and Class II cavity preparations).³⁷ The authors also concluded that clinicians should consider using slow-stress bulk fill materials like SDR in high C-factor cavity preparations to avoid adhesive debonding and microleakage.

Conflict of interests: None declared.

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SADA

Annual General Meeting (AGM)



Notice is hereby given that the Annual General Meeting (AGM) of The South African Dental Association (SADA) NPC will be held on

Friday, 14 March 2014 at 14:00

Assembly Room I & II, Emperors Palace, 64 Jones Road, Kempton Park, Johannesburg (SADA 2014 Congress)

for the purposes of considering ordinary and special resolutions. The Agenda for the meeting and supporting documents will be circulated to members with the SADA Annual Report and posted on the SADA website.

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