

Ensuring Endodontic Success: Tips for Clinical Predictability

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Innovations in materials, equipment, and technique continue to sophisticate endodontic treatment procedures enhancing the incidence of predictable clinical success. There are no biological absolutes; there are however varying degrees and definitions of success. Successful endodontic therapy is perceived to be the resolution and/or prevention of apical periodontitis or the retention of a functional tooth. The perception presents a treatment planning decision to the clinician as to whether to retain the natural tooth or extract it, and replace the space with an osseo-integrated implant. The clinical and systemic factors affecting the longevity of a natural tooth or an implant supported tooth must be factored into the decision making process in addition to the specifics of the location, bone quality and quantity, and the condition of the patient's other teeth.¹

Prospective studies under strict controlled parameters have shown

that the success rate of teeth without apical periodontitis remaining free of disease after initial treatment or those with orthograde retreatment is 92 to 98 percent. The chance of teeth with apical periodontitis to completely

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heal after initial treatment or retreatment is 74 to 84 percent according to strict criteria defining success. Survival, or functional success over time has been determined to be 91 to 97 percent. The outcome of apical surgery is more obscured in the literature than that of the non-surgical treat-

ment. The chance of teeth with apical periodontitis to completely heal some four years or longer after apical surgery is 74 to 78 percent. However, even with the lower chance of complete healing according to the strict definition of success, the functionality of these teeth over time is determined to be 86 to 92 percent. Considering the favorable outcomes, conservative endodontic therapy, both non-surgical and surgical, is justified and should be undertaken when a good restorative and periodontal prognosis is anticipated.¹⁻⁵

The purpose of this article is to review a number of techniques and technological advances that will allow for the predictable retention of endodontically treated teeth and to take their survival to unprecedented levels.

PREVENTING CORONAL LEAKAGE

In a review of 41 articles published between 1969 and 1999 (the majority from the 90s) Heling states that "the literature sug-

gests that the prognosis of root canal-treated teeth can be improved by sealing the canal and minimizing the leakage of oral fluids and bacteria into the periradicular areas as soon as possible after completion of root canal therapy".⁶ A similar review by Saunders et al. also concluded that coronal leakage of root canals is a major cause of root canal failure.⁷ Sritharan states that "it has been suggested that apical leakage may not be the most important factor leading to the failure of endodontic treatment — but that coronal leakage is far more likely to be the major determinant of clinical success or failure".⁸ Coronal microleakage of the final restoration can occur due to a deficient final restoration and resultant secondary caries,⁹ with the fatigue of post and cores with cemented metallic posts showing a statistically higher microleakage than bonded fibre posts.¹⁰ This coronal microleakage can be significant during the temporization phase. Many temporary restorative materials used after the initial endodontic therapy, and before the placement of the final restoration, have been identified as a major source of microleakage affecting the overall prognosis for success of endodontic treatment. In a study by Zaia, IRM showed dye penetration and microleakage in 25% of the specimens,¹¹ and similarly in a study by Galvan IRM leaked significantly.¹²

To increase the success of root canal therapy, by decreasing the likelihood of microleakage with bacterial and endotoxin penetration along the root canal filling, it is best to place the final restoration immediately.¹³ However this is often difficult to achieve in practice. Since many temporary materials show microleakage, it is best to place an impervious adhesive coronal seal over the canals and it is especially important to

cover the furcation areas in molars with a bonded base before the temporary materials are placed on top. PermaFlo Purple (Ultradent South Jordan, UT) is a flowable composite that has been specifically formulated for this technique. After the root canal therapy is complete, the excess sealer and gutta percha is removed down to the ideal level (Fig. 1), the tooth is acid etched for 15 seconds, a light cured bonding agent is placed, and PermaFlo Purple is placed over the gutta percha and over the furcal areas and light cured (Fig. 2). The removal of the temporary restoration and placement of the final

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restoration is simplified as the purple colour is easy to recognize, and thus it eliminates the possibility of perforation, while maintaining the seal during the final restoration phase.

RESTORATION OF THE ENDODONTICALLY TREATED TOOTH — THE CORE BUILDUP

Tay in his 2007 article discusses the potential of currently available bondable materials to achieve mechanically homogeneous units with root dentin and discusses the concept of the term monoblock in endodontics.¹⁴ "The objectives for the restoration of endodontically treated teeth is based on the use of materials with a modulus of elasticity similar to that of dentin at 18.6 GPa".¹⁵ Core buildups fabricated with glass ionomers, when tested in fatigue, show the highest rate of defects¹⁶ and in

one fatigue study all of the glass ionomer core materials covered by crowns failed.¹⁷ Their fatigue resistance suggests that they are inadequate for post and core applications.¹⁸ Resin composite core materials perform better than glass ionomer materials¹⁹ and when looking at the chemical affinity between different components of the core, the bond strength tests of composite resins is better than resin cements.¹⁵ There is no need to use a separate resin luting cement and a separate core material when placing fiber posts. "The ideal system of products for the endodontic-restorative continuum includes: an esthetic resin fibre post, and current techniques that combine the automixed resin luting cement and composite core into the same component".²⁰ Cosmecore (Cosmedent Chicago, IL) is a dual cure core material that can be used by itself as a core material only, but can easily be injected into a post space because of its high flow and slow chemical set, and therefore used as a combination luting agent and core material all at once with fibre posts. It can be mixed directly from the cartridge into a Skini Syringe (Ultradent South Jordan, UT) which is mated to a 20 or 22 gauge Endo-Eze tip (Ultradent South Jordan, UT) (Fig. 3). After etching the canal from the bottom up and after the bonding agent is placed on the walls of the entire canal according to the manufacturer's directions, the Endo-Eze tip allows for injection of the Cosmecore from the bottom of the preparation up, avoiding air entrapment (Fig. 4). The fibre post is placed into the Cosmecore, and after light curing through the post, Cosmecore can be added without the need for a bonding agent to form the core. For easier and faster extrusion of the Cosmecore a larger 18 gauge Endo-Eze tip may be used for this part of the procedure.



FIGURE 1

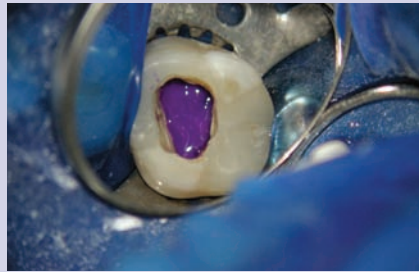


FIGURE 2

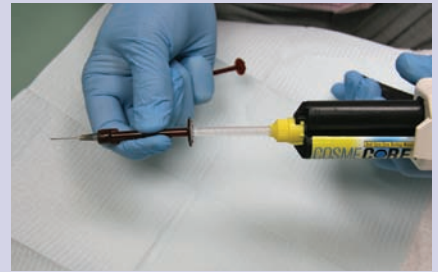


FIGURE 3



FIGURE 4



FIGURE 5



FIGURE 6

It is critical for the restorative dentist to realize that there are incompatibilities between self-cured core materials and some dual-cured adhesives.²¹ This also occurs between some dual-cure composites and light-cured bonding agents. “No predictable relationship was found between the general formulation of the dentin adhesive agents and shear bond strength to dentin. Material incompatibilities were judged to be dependent on formulation”.²² It seems that the acidity of some adhesive formulations interferes with the amine reaction that is necessary for the polymerization process to occur. This article can’t possibly cover the full scope of dentin bonding, but some generalities can be stated. As a rule, any three-step etch and rinse system is acceptable. Of the etch and rinse one-bottle systems One Step Plus (Bisco, Schaumburg, IL) and SealBond Ultima (RTD, Clinical Research Dental) are predictable due to their low acidity. MPa Direct (Clinical Research

Dental, London, ON) shows high bond strength to self-cure composite when the oxygen-inhibited layer is removed with alcohol.²³ Due to the high acidity of many self-etch systems, these are not recommended.

A SIMPLE TOOL FOR ENDODONTIC RETREATMENT

Treatment of teeth with recurrent pathology and the resulting disassembly of restorations often involves removal of metal and the newer generation fiber posts, gutta-percha, and popular obturation carriers, the removal of which can be an impediment to successful endodontic retreatment.²⁴ Composite fiber posts do offer clear advantages over cast and pre-fabricated metal posts, due to their low modulus of elasticity, high flexural strength, fatigue resistance, and their ability to be bonded within the root canal.^{25,26} However, if they need to be retrieved from the canal, the two perceived challenges have been the difficulty of locating them and then their sub-

sequent removal.²⁷ While metal posts can often be successfully removed with the use of ultrasonic vibration, this approach is not indicated for fiber posts.²⁸ Recently, a simple, specifically designed drill series has transformed this dreaded procedure of fiber post removal into a quick, safe, and predictable task.²⁹ This 3-in-1 drill is also extremely useful for removal of gutta-percha and obturation carriers. The Unicore Drill (Ultradent Products, UT) features a patented heat-generating tip which will keep the drill centered in the post or rigid carrier and will soften the matrix of fiber posts, simplifying their removal. High on the shaft of the drill is a diamond-coated collar which dissipates heat caused by drill-to-tooth contact, enhancing the safety of the procedure (Fig. 5). The drills are used in a slow-speed handpiece at 20,000 rpm (use at full speed for entering, preparing, and exiting), and may be used up to fifteen times for gutta-percha, obturation carrier, and fiber post removal. Fiber post



FIGURE 7



FIGURE 8



FIGURE 9



FIGURE 10



FIGURE 11



FIGURE 12

removal is achieved by creating a pilot hole in the post with a round bur, followed by using the smallest Unicore drill with a rubber stop at approximate post length, pushing into the post with controlled hand pressure.

Within 10 seconds, you will notice filings and dust from the fiber post until you feel the drill punch through into the softer gutta percha. Larger drill sizes are used as required. (use smallest to largest). A slight modification to this technique (working from the largest drill that will enter the filled canal without engaging dentin) can be used very effectively to remove carrier based obturation systems (i.e., Thermafil (Dentsply International)).

PRECISE AIR AND WATER DELIVERY

The Stropko Irrigator (John J. Stropko, DDS, Carefree, AZ) Irrigator is a brilliant device for precise air and water delivery to the endodontic operating field (Fig. 6). This metal adaptor fits

directly into the air/water or air-only syringe (replacing the standard syringe tip), facilitating the attachment of any tip with a luer lock fitting, such as the aforementioned Ultradent tips. (It is worth noting that more and more practitioners are seeing the wisdom of having a dedicated air only syringe on their dental delivery unit. Combination air/water syringes often leak or draw water even when the air button is depressed. This has the potential to severely compromise effective bonding). During access cavity preparation and refinement, the Stropko, fitted with an EndoEze tip, is ideal to propel air into the preparation in order to visualize all anatomy (Figs. 7 & 8). Rinsing etchant from bonded post preparations, air-thinning of adhesives and many other applications make this little tool a must have for endodontics and restorative dentistry. Cleaning and drying the field can be done with more precision, efficiency, and confidence. Inadvertent splashing or

contamination of the site is avoided, saving time and eliminating stress. The advantages of using the Stropko Irrigator are especially appreciated when using magnification loupes or a surgical operating microscope during the dental procedure.

SO YOUR RUBBER DAM LEAKS?

Bacterial control in endodontics is critical for success, and as such, every effort should be made to prevent introducing new bacteria into the root canal space.³⁰ One common clinical challenge, which can lead to the introduction of a new bacterial load, is the less than perfect seal that can occur around teeth isolated with rubber dam (Fig. 9). This may be due to the type and shape of the rubber clamp chosen, the elasticity of the rubber dam chosen (light or heavy), tooth position and/or rotation and stretching of the dam, or the amount of breakdown circumferentially of the tooth to be endodontically treated. OraSeal Caulking (Ultradent,



FIGURE 13

South Jordan, UT) is a Hectorite clay and is cellulose-based.³¹ It has the ability to stick to wet surfaces and is invaluable for sealing areas of poor rubber dam isolation to create a fluid-tight environment³² (Fig. 10).

Being cellulose based the OraSeal does not harden and is easy to remove after treatment, although it must be noted that it is better to remove the OraSeal Caulking with a hand instrument and not by suction. This material has been reported to block suction lines if a large amount is carried into the lines. OraSeal also comes as OraSeal Putty which is a simple clinical adjunct, mainly used for blocking undercuts when fabricating temporary restorations to prevent them from locking into place, blocking out precision attachments during impression procedures, or blocking interproximal undercuts created by open spaces or by periodontal recession when taking impressions. This procedure is much simpler than using wax as a block out material.

EFFECTIVE ACTION AND DELIVERY OF CALCIUM HYDROXIDE

The use of calcium hydroxide (Ca(OH)²) has become standard of care as an intra-canal medication to eliminate or significantly reduce microorganisms in the root canal system,³³ especially in

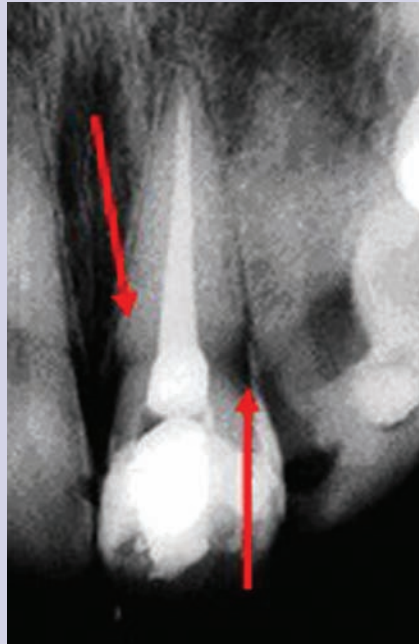


FIGURE 14A



FIGURE 15—Photograph courtesy of Dr. T. Sellner.



FIGURE 14B



FIGURE 16—Photograph courtesy of Dr. T. Sellner.

necrotic cases.³⁴ Three important keys to the success of this strategy are the ability to effectively deliver Ca(OH)² to the most apical extent of the canal, the effectiveness of the paste or material used, and the ease of removing it from the canal. UltraCal (Fig. 11) from Ultradent (South Jordan, UT), well known for their unique syringes and tips allows for effortless placement of Ca(OH)² to the apical region, even with severe curvatures. This is accomplished using a 29 gauge NaviTip (Fig. 12), a needle that is stiff close to the hub, but extremely flexible toward the tip, allowing the rounded end to negotiate complicated apical anatomy. The for-

mula is unique with a high pH of 12.5, highly important in battling bacteria such as enterococcus faecalis.³⁵ It is pre-mixed in a sealed syringe, to maintain its strength and effectiveness. Because of its aqueous base, UltraCal is easily removed using the brush-tipped NaviTip FX along with citric acid (Fig. 13). Alternatively, the Irrisafe Ultrasonic tip (Satelec, ACTEON) may be used to cavitate the irrigants, effectively removing all remnants of the Ca(OH)² from the canal.

DISCOLORATION OF ENDODONTICALLY TREATED TEETH

One of the challenges associated with endodontically treated teeth

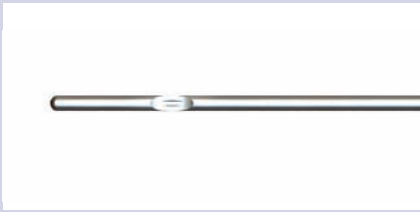


FIGURE 17



FIGURE 18



FIGURE 19

is that they have the potential to discolour leaving the tooth dark and unattractive. Traditionally, these teeth have been treated internally with a liquid 40% hydrogen peroxide solution soaked in cotton, placed in the canal and sealed in for three to five days. This technique is commonly referred to as the walking bleach technique.

The challenge with liquid peroxides is that they are more difficult to control and are more likely to leak past a glass ionomer (GI) plug placed to prevent leakage into the canal. Such leakage has been proven to be damaging, as peroxide can penetrate through root surfaces causing cervical resorption (Figs. 14A & B).

Opalescence Endo (Ultradent Products, South Jordan, UT) is a 38% hydrogen peroxide gel that provides easier handling and control due to the ability to place it directly into the canal via its syringe tip delivery system. A GI plug is placed in the canal at the CEJ, Opalescence Endo is delivered directly into the canal and sealed in with a temporary filling material such as Cavit (3M ESPE St. Paul, MN) or UltraTemp Firm (Ultradent Products South Jordan, UT) and left for three to five days then repeated if necessary. In most cases one application is all that is required and results can be seen as quickly as one day (Figs. 15 & 16).

IMPORTANT: Proper place-

ment of the GI plug is critical for any internal whitening procedure to prevent cervical tooth resorption regardless of the technique whether a walking bleach, take-home tray or a chairside whitening system is used. The cement plug must be taken high up interproximally on the anteriors to follow the CEJ and so from the anterior the plug resembles a curve and is not straight across from mesial to distal.

Although Calcium Hydroxide is an extremely effective medicament it can at times be difficult to remove from the canal

THE RIGHT TIP FOR THE JOB

The right tip for the job, endodontically speaking, is the one that enables the clinician to apically access and backfill any size shape or length of canal with irrigants, lubricants, obturation materials or sealers as well as providing for easy evacuation of unwanted chemicals or blood.

One of the challenges with the delivery of heavy viscosity materials to the apex such as etchants and medicaments like calcium hydroxide is ensuring that the apex has been reached without leaving a void. Such a void can prolong the healing process or lead to an inef-

ficient bond for posts or resin obturation materials.

One of the challenges with dispensing Calcium Hydroxide such as UltraCal XS (Ultradent Products South Jordan, UT) into the canal is ensuring the delivery of the medicament to the apex. The delivery tip ideally suited for this application is the 29 gauge NaviTip. This delivery tip can also be used to deliver EDTA such as File-Eze (Ultradent Products, South Jordan, UT).

Although Calcium Hydroxide is an extremely effective medicament it can at times be difficult to remove from the canal. A very effective way to remove this paste is to scrub the internal walls of the canal with a 20% citric acid solution with a flocked 30 gauge NaviTip FX (Ultradent Products, UT).³⁶

Chemical debridement and irrigation is just as, if not more important than, mechanical shaping and cleaning of the canal so safe and effective delivery of these chemicals such as sodium hypochlorite (ChlorCid — Ultradent Products, South Jordan, UT) and liquid EDTA is crucial. The delivery tip ideally suited for these chemicals is the safe ended, dual side port 31 gauge Navi Irrigation tip (Ultradent Products, South Jordan, UT) (Figs. 17 & 18).

The Navi tips are uniquely designed with a dead soft end to the canula and a rigid shank that al-

lows the 29, 30 or 31 gauge tips to follow the path of least resistance to the apex.

When it comes to a fast and efficient way to evacuate blood, chemicals and dry the canal, eliminate the need for multiple paper points by using a combination of a Capillary tip with a Luer Vac Adapter (Ultradent Products South Jordan, UT) (Fig. 19). In order to facilitate delivery of high viscosity materials such as etchants, luting cements or the core materials such as Cosmecore (Cosmedent Chicago, IL) that are commonly used for single step post cementation and core build up, a smaller gauge tip is required. Endo-Eze delivery tips from Ultradent are dead soft and come in 18, 19, 20 and 22 gauge which provide access to the depth of any post preparation.

Samuel Johnson once wrote that “Genius is nothing more than knowing the use of tools, but there must be tools for it to use”.

The combination of all innovative technologies has allowed patients to receive the best care available and the most predictable outcomes possible. That being said, it is the provider that must take this technology and be able use it in the most predictable and efficient way possible. **OH**

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Oral Health welcomes this original article.

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