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CONTENTS

Is Endodontic Retreatment Passé?

Dr. Rico Short

INTRODUCTION

The definition of *passé* means to be no longer current or out of date. With the fast rise of dental implants now being done by almost any dental provider, endodontic retreatment has been slowly waning. So, who's at fault for this dilemma? Is it the dentist, the endodontist, or the dental companies? I believe everyone plays a part in this issue. However, it is our duty as dental professionals to give the most current recommendation to our patients based on evidence-based research. Unfortunately, this has not been practiced lately, especially during this time of economic uncertainty.

In 2007, I attended a practice management seminar in Las Vegas. The practice management guru told me if I was not placing implants within the next 2 to 3 years, my endodontic practice would be in jeopardy. This alarmed me, so I decided to do some soul searching. I had to ask myself, "Should I learn to place implants as an endodontist to sustain my practice for several years to come?" Well, I had another thought; therefore, I asked myself another question: "If it were my tooth, who would I want to perform the implant surgery?" The answer was simple: The one who is most qualified to perform the procedure (based on successful completion of an accredited residency program) and can handle any complications, should they arise. Based on this thought process, I decided to stay in my lane and to focus on being the best endodontist I can possibly be. As a result, my practice has been sustained during these economic times because people still want to save their natural teeth!

As with anything "new," the "hotness" has to die off before we can look at the cold, hard facts. Similar to when the original root canal filling material was gutta-percha and then it changed to silver points, or a combination of both, about 46 years ago. After some time, we realized silver points leak and corrode contributing to apical periodontitis.[1] Now, years later, we are back to using gutta-percha (or some form thereof) as the root canal obturation material of choice. Perhaps we may see this cycle repeat itself again when comparing true success rates or "retained rates" of endodontic retreatment versus implants long-term.

According to the American Association of Endodontist (AAE) in 2010, there are more than 15 million root canals performed in the United States each year. In addition, according to the AAE, dentists refer an average of 46% of their root canal patients to an endodontist. This means more than one half of root canal therapies are performed by the general dentist (GP).

Studies have shown that success rates of conventional endodontic treatment can be upwards of 95%.[2] In a survey of survivability of endodontically treated teeth completed by endodontists and GPs, endodontists experienced significantly greater success (98.1%) than did general dentists (89.7%).[3] New techniques, in-depth training, microsurgical instruments, new materials, microscopes, and understanding biological principles inside and outside the root canal system have greatly enhanced the endodontist's ability to successfully treat and/or retreat endodontically involved teeth.

Although initial root canal therapy success rates are very high, patients can experience "post-treatment disease," as coined by Dr. Shimon Friedman in 2002.[4] When this happens, conventional endodontic retreatment has been suggested as preferable to surgical intervention.[5] "Endodontic retreatment has been defined as a procedure performed on a tooth that has received prior attempted definitive treatment, resulting in a condition requiring further endodontic treatment to achieve a successful result."[4] According to Bergenholtz et al,[5] overall average retreatment usually results in successful outcomes of 75%. However, successful retreatment can be as high as 98% in teeth without apical periodontitis (no lesion present), according to Sjogren et al[6] in a 10-year follow-up; and as high as 86% in teeth with apical periodontitis (lesion present), according to Farazneh et al[7] in a 4-year follow-up.[8] This article is an introduction to nonsurgical retreatment, and it will also highlight some of the issues that cause root canal failure. There will be 5 mini case examples presented and discussed. The purpose of this article is to: (1) Discuss reasons for endodontic failure; (2) Discuss when retreatment should be considered; and (3) Demonstrate that endodontic retreatment has a high rate of success and long-term predictability.

Why Does Root Canal Therapy Fail?

There are a number of common causes for endodontic failure. Among these are: leaky restorations, root fractures, untreated canals, inadequately cleaned canals, operative errors (such as errors in placing posts), separated instruments, blocks, ledges, perforations, zips, and transportations.[9] We need to keep all these considerations in mind when performing root canal therapy. There

are no 2 cases, nor 2 patients, exactly alike.

Case 1

This patient presented with spontaneous pain associated with tooth No. 30. He said his root canal was performed more than 10 years ago. The diagnosis was previous endodontic treatment with acute apical periodontitis. The tooth was restored with 2 posts and a crown. There was no probing, swelling, or significant mobility (Figures 1a to 1e).

Tooth No. 30 had to be extracted, and then the patient later received an implant in the site from an oral surgeon. This was a case that, although the final case looked acceptable in the postoperative radiographs at the time of treatment, the patient unfortunately had developed post-treatment disease 2 years later, resulting in an extraction and implant placement.

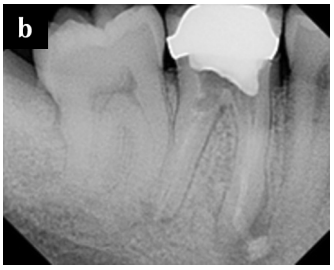


Fig 1a. Tooth No. 30; previously treated with a periapical lesion.
Fig 1b. Tooth No. 30 was disassembled utilizing ultrasonics to remove the posts. No apparent crack was noted using the surgical microscope. Calcium hydroxide was placed for 3 weeks.

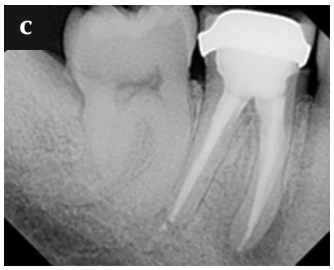


Fig 1c. Case completed with gutta-percha, and the patient was asymptomatic.
Fig 1d. Patient returned 2 years later with a buccal sinus tract associated with tooth No. 30. microscope. Calcium hydroxide was placed for 3 weeks.

Fig 1e. Exploratory surgery revealed a vertical fracture in the mesiobuccal root.

When Should Retreatment be Considered?

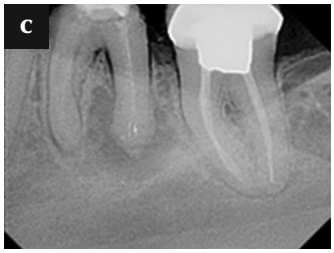
Biological, aesthetic, clinical, functional, and financial factors must be considered.

1. The periodontal status is of the utmost importance: (a) Periapical and bite-wing radiographs must be evaluated to make sure the tooth has a solid foundation; (b) The attachment apparatus must be intact; (c) Periodontal probing must be within normal limits unless a sinus tract is draining from the sulcus; (d) Good crown-to-root ratio.
2. Evaluate tooth restorability: (a) Strategic value; (b) Remaining tooth structure; (c) Periodontal support.
3. Access patient concerns: (a) Cost; (b) Expectations; (c) Motivation.
4. Communicate clearly to the patient before retreatment: (a) Diagnosis; (b) Prognosis; (c) Treatment options just in case the tooth can't be saved.

Case 2

The patient's chief complaints were as follows: tooth No. 19 hurt sometimes; his crown kept falling off; and, in addition, there was a "bump" on his gum (Figures 2a to 2h). Upon clinical evaluation, it was noted that there was a buccal sinus tract associated with tooth No. 19 that could not be traced. There was no mobility and probing was 3.0 mm circumferentially. As demonstrated in the radiographs, the tooth had been previously obturated with silver points, and there was a large periapical lesion associated with the distal root of tooth No. 19. The diagnosis was previous root canal treatment with an associated chronic apical abscess.

Fig 2a. Tooth No. 19 with crown removed and buccal sinus tract.
Fig 2b. Tooth No. 19 pre-op showing silver points and a periapical lesion on the distal.



Figs 2c. and 2d. Ultrasonics (ENAC [Osada USA]), on low power under the surgical microscope, was used to remove the silver points. It was very important not to hit the silver points with the ultrasonic tips because it could have broken the silver points more apically inside the canals, making retrieval more difficult. Calcium hydroxide paste was placed for 2 weeks.

Figs 2e. and 2f. Four corroded silver points were removed with a pair of Stieglitz forceps.

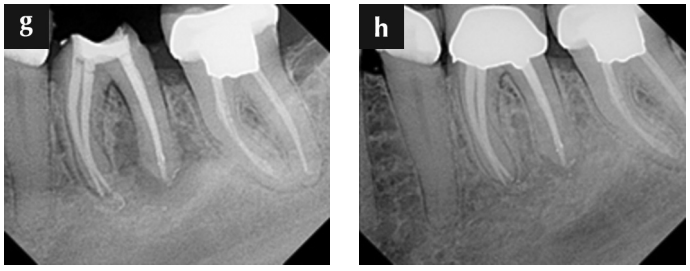


Fig 2g. Obturation was completed with gutta-percha, with Cavit (3M ESPE).
Fig 2h. Tooth was restored; this is a 4-year recall showing healing.

Case 3

This patient presented with a chief complaint of pain when biting on tooth No. 15 (Figures 3a to 3c). She reported that her root canal therapy had been completed more than 20 years ago. There was no evidence of mobility, and probing was within normal limits. Radiographically, there was a silver point in the distobuccal canal. The mesiobuccal and palatal canals appeared to be underfilled with a pastelike material. The diagnosis was previously treated with acute apical periodontitis.

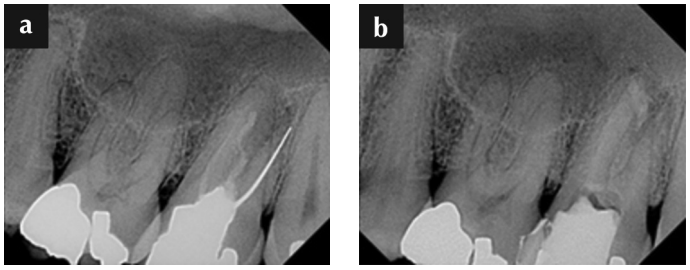


Fig 3a. Tooth No. 15 preoperative radiograph.
Fig 3b. Ultrasonics was used to remove the silver point in the distobuccal canal. Chloroform was used with a combination of Gates Glidden drills and Hedstrom (SybronEndo) files to remove the paste.

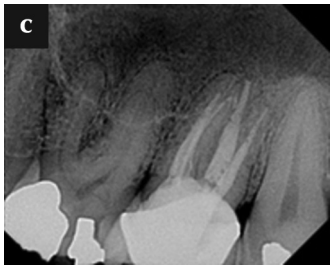


Fig 3c. Located an MB2 with the surgical microscope; all canals were then obturated with gutta-percha.

Case 4

In this case, the patient presented with pain and swelling associated with tooth No. 3 (Figures 4a to 4d). She said a GP had completed the root canal procedure about 5 years previously. The tooth had a crown, a large post, and a large periapical lesion. The diagnosis was previous endodontic treatment with an acute apical abscess.

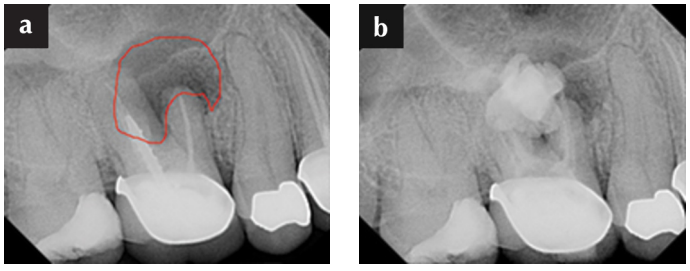


Fig 4a. Preoperative radiograph revealed a large periapical lesion.
Fig 4b. Tooth was disassembled and calcium hydroxide placed for 2 weeks.

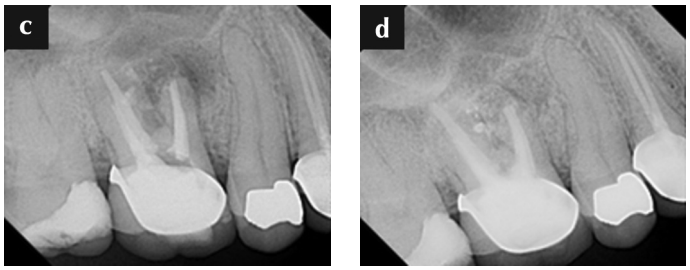


Fig 4c. MB2 was located and canals were obturated with gutta-percha.
Fig 4d. Six-month recall showing healing.

Case 5

The final case example is shown in Figures 5a to 5e. Patient "x" presented with pain upon biting. She reported her root canal procedure was completed by her GP about 6 months previously. Her chief complaint included sharp pain and that it felt like there was something in her right jaw bone.

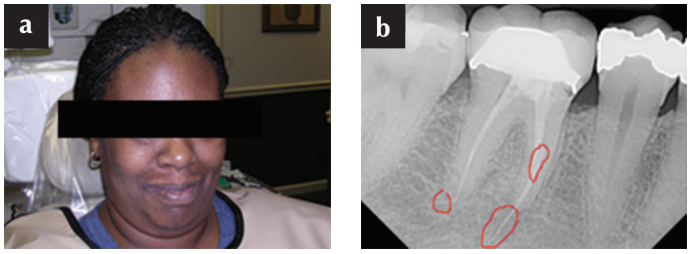


Fig 5a. Patient "x."
Fig 5b. Preoperative radiograph of tooth No. 30, showing previous endodontic treatment with overfill in the mesial and a separated instrument in the distal.

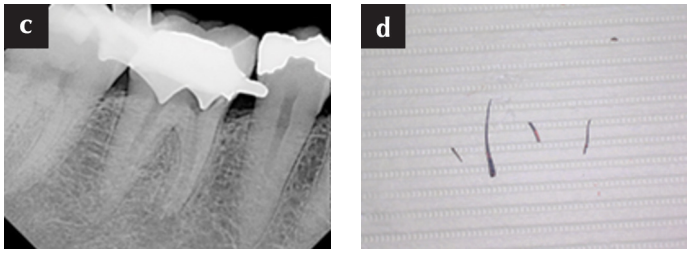


Fig 5c. Tooth No. 30 was disassembled. Thermofil was used to obturate the tooth. Thermofil was removed using a Touch'n Heat tip (Sybron Endo) and a Hedstrom file (Sybron Endo) screwed into the remaining material. The separated file was removed using ultrasonics after staging with a cut-off tip No. 4 Gates Glidden Drill.
Fig 5d. Overextended Thermofil material was removed, including a separated rotary file tip (first object).

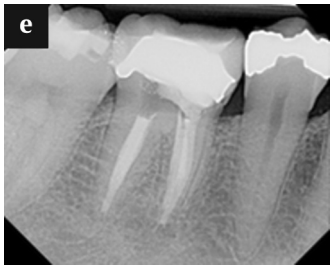


Fig 5e. Final obturation with gutta-percha (done in one visit).

DISCUSSION

Clinicians should look at the overall case before choosing to retreat a tooth themselves. Ethical questions should arise as to who is best qualified to produce the desired result. In addition, the clinician must consider balancing desire and monetary issues with what is best for the patient. Ask yourself what you would want if it were your tooth. In most instances, a referral to an endodontist is prudent.

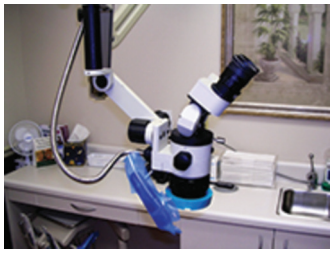


Fig 6. Global Surgical Microscope (Global Surgical Corporation).
Fig 7. Mineral trioxide aggregate (ProRoot MTA [DENTSPLY Tulsa Dental Specialties]).

Dental implants are excellent treatment options in cases when natural teeth cannot be saved. However, an implant should never be used as the "gold standard" when a previous root canal-treated tooth has failed to heal. The erroneously perceived high rate of treatment success and "ease" of procedure when inserting single-tooth implants, compared with endodontic treatment, has often biased the GP's objectivity in recent years when selecting treatment options. As a result, the endodontist usually gets isolated from the patient's overall treatment plan. This definitely needs to be reconsidered, especially since the advent and advancement of new materials and technologies in endodontics (such as mineral trioxide aggregate [a "miracle" material] and surgical microscopes) are increasing the success rates even more (Figures 6 and 7).

According to Doyle et al,[10] restored endodontically treated teeth and single-tooth implant restorations have similar failure rates. However, the implant group was reported to have more maintenance issues and postoperative complications. The postoperative complications were confirmed by the research of Goodacre et al[11] at Loma Linda University and included: hemorrhage, neurosensory disturbances, adjacent tooth devitalization, mandibular fracture, air emboli (sometimes fatal), and implant abutment screw loosening/breakage.

CLOSING COMMENTS

This article is an attempt to persuade and convince all dental professionals not to give up on an endodontically treated tooth that may be a candidate for retreatment. In most cases, nonsurgical retreatment is performed to reduce the need for surgery, or to increase the prognosis for a future surgery. In addition, it is more effective from a cost and biological perspective to maintain a person's natural tooth. With the latest advances in technology (magnification, illumination, ultrasonics, apex locators, rotary instrumentation, advances in intracanal irrigation and medicaments, and devices to remove or bypass intracanal obstructions), nonsurgical retreatment is very often possible and highly successful.

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Dr. Rico Short is a board-certified endodontist in private practice near Atlanta in Smyrna, Ga. He also serves as an expert consultant to the Georgia Board of Dentistry, and is an assistant clinical professor at the Medical College of Georgia School of Dentistry.

Update on Apexogenesis: Case Reports: Achieving Predictable Root Maturation in Young Patients

Dr. Rico Short

INTRODUCTION

Dental implants are now considered the hallmark procedure if a tooth cannot be saved. However, implants cannot be used predictably in young children, since they can only be placed after the jaw has finished growing. If a dental implant is placed before a child's jaw growth is complete, then it may impede jaw growth and stop other teeth from moving into their natural positions.

What do you do if a child has deep decay into the pulp, or trauma with a pulp exposure and with an open apex? Obviously, an extraction and an implant will not be an acceptable treatment. The answer is to keep the pulp alive! Keeping the pulp alive will allow thickening of the dentinal wall to occur, bring more strength to the root, allow the bone more time to mature, and will also allow the crown-to-root ratio to improve. If the patient were to ever lose the tooth as an adult, an implant would be a viable option due to bone maturation and jaw stabilization.

This article will discuss the apexogenesis procedure, presenting 3 clinical case examples.

Apexogenesis

Most dentists and specialists agree that vital pulp therapy is the treatment of choice for immature teeth (incompletely developed apices).[1] One of the most current techniques to be able to achieve this goal predictably is using a technique called apexogenesis. Apexogenesis is defined as a vital pulp therapy of an immature tooth that permits continued root formation and apical closure.[2] In the past, there have been 2 major agents used over the years to achieve apexogenesis. One is calcium hydroxide USP (CaOH) and the other is called mineral trioxide aggregate (MTA).

Calcium Hydroxide Powder (Sultan Dental) (Figure 1a) has been a popular pulpotomy agent for this type of vital pulp therapy and it is still widely used clinically around the world. It was introduced by Hermann[3] in 1936 as a type of biological dressing for the pulp. Because of its alkalinity (pH of 12), it is so caustic that when placed in contact with vital pulp tissue, the reaction produces a superficial necrosis of the pulp.[4] In addition, CaOH is known to wash out over time in both powder/paste or liner forms. Therefore, the search continued for procedures and materials that are more biocompatible while stimulating continued dentin formation and apical closure of immature teeth without washing out so readily.

Mineral trioxide aggregate (Pro Root MTA [DENTSPLY Tulsa Dental Specialties]) (Figure 1b), is in the author's opinion, an endodontist's "miracle material" because it can be used for various procedures such as perforation r pair, apexification, retrofill material for apicoectomy, revascularization, and apexogenesis. It is also currently being used as the vital pulp therapy material of choice, and has been shown to provide an enhanced nonresorbable seal over the pulp.[5] Mineral trioxide aggregate was used experimentally for a number of years, and was approved for human use by the FDA in 1998.[6]

Mineral trioxide aggregate is a powder consisting of tricalcium silicate, dicalcium silicate, tricalcium aluminate, calcium sulfate dehydrate, and bismuth oxide.[7] When the material is hydrated, it becomes a colloidal gel that solidifies in approximately 3 hours.[6] It is available in one-gram packets of MTA powder (both white and gray in color) and costs approximately $300 for a box containing 5 packets.

Mineral trioxide aggregate has been shown to have superior sealing ability compared to amalgam, zinc oxide eugenol, or intermediate restorative material (IRM).[8] Mineral trioxide aggregate used as a direct pulp capping material stimulates natural dentin repair at pulpal exposure sites.[9] It was also found to produce less inflammation and better dentin bridge formation, when compared with CaOH in monkeys.[8] In addition, MTA was found to be biocompatible when implanted into guinea pigs, dogs, and monkeys, and was more biocompatible than amalgam, super ethoxy benzoic acid, and immediate restorative material.[10] In animal studies, MTA was the only material that allowed cementum overgrowth and attachment of the Sharpey's fibers from the periodontal ligament.[10] Furthermore, the setting ability of MTA is uninhibited by blood or water.[11] The hydrophilic nature of MTA makes it a great material to use for pulp capping.

CASE REPORTS

Case 1

Diagnosis and Treatment Planning—A 7-year-old female patient

presented with deep and extensive decay in her right permanent first molar (tooth No. 30) (Figure 2a). The tooth was asymptomatic and there was no sign of swelling or lymphadenopathy. There was no sinus tract noted and the tooth was not mobile. Probing depths were 2 to 3 mm. In addition, the tooth exhibited no percussion sensitivity and the cold test (Hygienic Endo Ice [Coltène]) revealed that the pulp was vital. Radiographically, there was extensive decay that appeared to encroach on the pulp. The mesial and distal roots were immature with open apices; and the patient had deciduous and permanent teeth present, with succedaneous teeth forming in the mandible. The diagnosis was asymptomatic irreversible pulpitis with normal immature apicies.

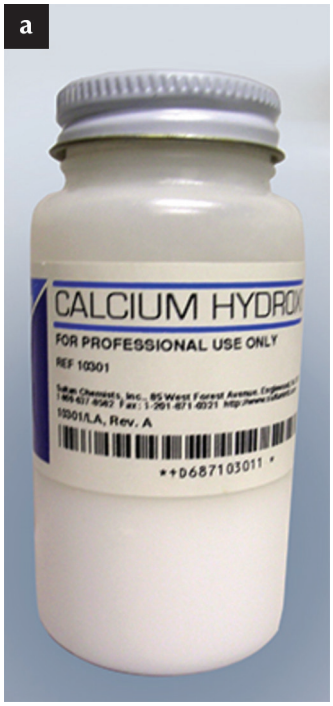


Fig 1a. Calcium Hydroxide Powder (Sultan Dental).
Fig 1b. Mineral trioxide aggregate (White) (Pro Root MTA [DENTSPLY Tulsa Dental specialties]).

Clinical Treatment (Apexogenesis Procedure)—Informed consent was obtained for treatment. Two carpules of xylocaine 2% (1:100,000 epinephrine) were administered via an inferior alveolar nerve block. A medium green latex rubber dam (Safe Touch Dental Dam [Medicom]) was applied, and the decay was excavated with a No. 8 surgical-length latch round bur (RA-8SL [SS White]) (with a slow-speed handpiece very carefully until pulp horn was reached. A spoon excavator was used to remove remaining decay. At that point, the pulp started to hemorrhage. Sterile saline rinse was applied over the pulp horn, while a high-speed diamond bur was used to remove approximately 2 to 3 mm of pulp tissue, until healthy pulp tissue was reached and the bleeding ceased. CALASEPT 2% Chlorhexidine Solution (Nordiska Dental) (Figure 2b) was used to disinfect the coronal pulp by lightly irrigating the remaining pulp tissue coronal to pulpal floor (3% sodium hypochlorite can also be used as the irrigant to disinfect the coronal aspect of the pulp). Mineral trioxide aggregate (white) was mixed with xylocaine 2% (1:100,000 epinephrine) to a moist sandlike consistancy, dried with a 2 x 2 guaze, and gently packed directly on top of the coronal pulp with an amalgam carrirer and plugger. It is advisable to get at least 2 to 3 mm of MTA on top of the pulp, if possible. A moist cotton pellet and Cavit (3M ESPE) was placed on top of the MTA (Figure 2c). Mineral trioxide aggregate usually sets up hard in about 3 hours. Our patient's mother was told to use over-the-counter ibuprofen if the area became sore after treatment. She was also told to take the child to her general dentist (GP) for a restorative evaluation and treatment within one month, and also given a postoperative appointment at our office.

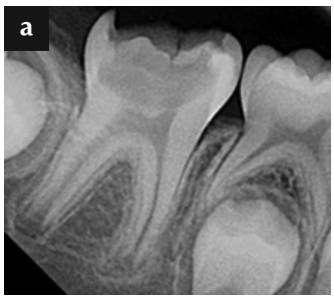
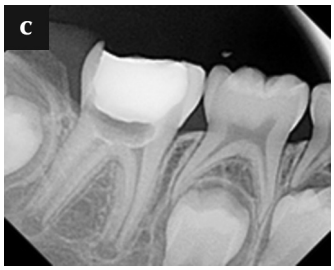


Fig 2a. Tooth 30 pre-op with gross decay and open apices.
Fig 2b. CALASEPT 2% Chlorhexidine Solution (Nordiska Dental).



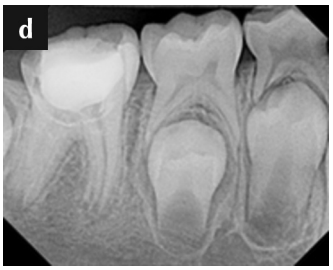


Fig 2c. Mineral trioxide aggregate pulpotomy with Cavit (3M ESPE).
Fig 2d. One month recall—patient asymptomatic and tooth is still vital.

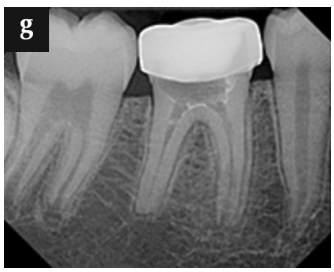


Fig 2e. One-year recall—patient is still asymptomatic and tooth is vital.
Fig 2f. Two-year recall shows continued root formation.
Fig 2g. The distal root is completely closed and tooth is still vital at 3-year recall.

The patient returned to our office for a one-month recall (Figure 2d). The patient reported the tooth to be asymptomatic. Pulp testing was performed with Endo Ice and the tooth still tested vital. There was no percussion or palpation sensitivity, no sinus tract noted, and no mobility observed. Probing was 2 to 3 mm. It was noted that the patient still had the Cavit in place, so the patient's mother was again reminded/advised to have the buildup restoration placed as soon as possible by the GP.

The patient returned for a one-year recall (Figure 2e). The patient still was reporting tooth No. 30 to be asymptomatic. A buildup

and a stainless steel crown had been completed. Radiographically, there was evidence of continued root formation, and no pathology was noted. The pulp was tested and was still vital. There was no sinus tract noted or mobility and probing results remained at 2 to 3 mm.

Our patient returned for a 2-year recall appointment (Figure 2f) and was still reporting that the tooth was asymptomatic. Radiographically, it appeared that the distal root had completely closed, and the mesial root appeared to still be slightly open. The tooth was still vital to pulp testing, and there was no palpation or percussion sensitivity. There was no sinus tract noted or mobility, and periodontal probing remained at 2 to 3 mm. The patient's mother was told that we would continue to follow her progress on a yearly basis. In addition, she was told, if signs/symptoms of pain and/or swelling would become associated with her tooth, to return for an evaluation and possible conventional endodontic treatment.

When our patient returned for her 3-year recall (Figure 2g), the distal root was completely closed. However, the mesial roots still appeared to be slightly open at the apex.

Case 2

Diagnosis and Treatment Planning—A 6-year-old female with a history of dental trauma presented to our office. A complicated crown fracture with a pulp exposure was evident, involving her right permanent central incisor (tooth No. 9) (Figure 3a). The apex was still open, and she was in pain. Her left permanent central incisor (tooth No. 8) was asymptomatic and pulp tested vital.

Synopsis of Clinical Treatment—Two carpules of 2% xylocaine 1;100,000 were adminstered to the patient via infiltation. Tooth no. 9 was isolated with a rubber dam and accessed. It was cleaned out and irrigated very carefully (with the same technique described in the previous case).

Fig 3a. Complicated crown fracture on tooth No. 9 with open apex.
Fig 3b. Mineral trioxide aggregate on glass slab.

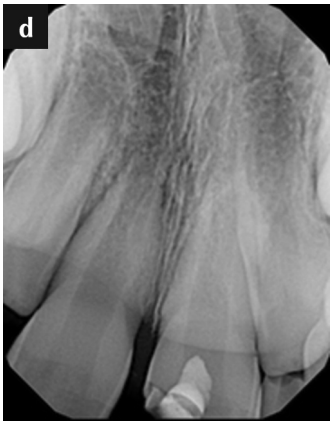


Fig 3c. Amalgam carrier and MTA.
Fig 3d. Apexogenesis procedure completed with MTA.

Mineral trioxide aggregate (white) was removed from packet and placed on a glass slab (Figure 3b). Next, the MTA was mixed with 2% xylocaine (1:100,000 epinephrine) to a wet sand consistency. It was then slightly dried using a sterile 2 x 2 guaze to allow easier packing onto the already moist pulp with an amalgam carrier (Figure 3c). The MTA was placed directly on to the pulp with the amalgam carrier, and then compressed with a moist cotton pellet.

An apexogenesis procedure was completed utilizing the same clinical protocol as described above in Case 1 (Figure 3d). A cotton pellet and Cavit was placed into the access opening, and the patient was referred back to her general dentist for a permanent restoration.

Case 3

Diagnosis and Treatment Planning—A 7-year-old male presented with spontaneous pain a sociated with his left first permanent molar (tooth No. 19). There was a broken amalgam with recurrent decay. The apices were open on the both the mesial and distal roots (Figure 4a).

Synopsis of Clinical Treatment—Apexogenesis procedure was completed utilizing the same procedure from the previous cases. Cotton and Cavit were placed in the access opening (Figure 4b).

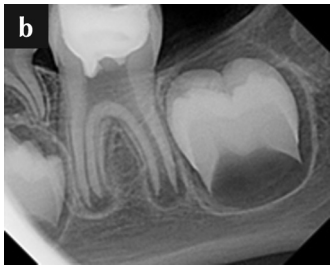
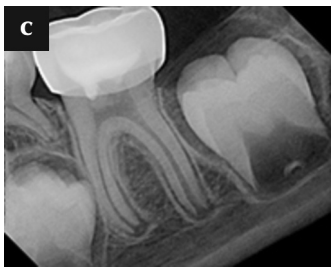
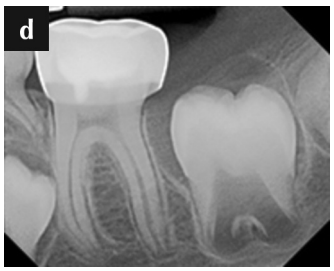


Fig 4a. Tooth 19 Pre-Op.
Fig 4b. Apexogensis using MTA on tooth 19.





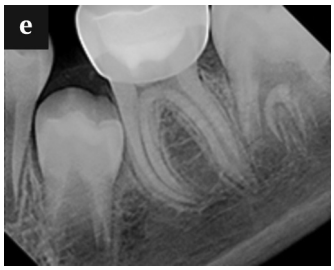


Fig 4c. Six-month recall showing root starting to close.
Fig 4d. One-year recall showing continued root formation and length
Fig 4e. A 2-year recall showing complete closure of the apex.

A 6-month recall was performed. The patient was asymptomatic, and a composite resin core and a stainless steel crown has been

placed. Tooth pulp testing demonstrated that it was vital, and evidence of root closure was apparent (Figure 4c).

At the one-year recall, the patient was still asymptomatic and tooth pulp testing showed it was vital. In addition, evidence of further root closure was apparent (Figure 4d).

At the patient's 2-year recall, the tooth was still asymptomatic and tooth pulp testing was vital. The roots appeared to be completely closed (Figure 4e).

CLOSING COMMENTS

Mineral trioxide aggregate, as a pulpotomy agent is excellent, despite the fact that is costly. One way in which the use of MTA can be made more cost effective is to carefully store unused portions of the powder from an opened packet in a sterilized empty film canister; this will prevent hydration and keep it fresh. (When the material was in the "experimental" phase in the early 1990s, it was sent out this way to the endodontists for trial use.)

As demonstrated in this case report article, the young and immature permanent tooth had an excellent capacity to respond to apexogenesis. This is true, whether dealing with caries or trauma, as long as the clinical treatment is performed quickly and properly. The goal is to treat the pulp before it becomes necrotic. Once necrotic, the treatment of pulpal injury becomes a more significant challenge for the clinician. If the pulp is vital and the apex is open, apexogenesis should be considered as the first option of treatment, not conventional endodontic treatment.

Apexogenesis is a vital pulp therapy that can be done to encourage continued physiological development and root end formation.

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Dr. Rico Short graduated from Morris Brown College with a BS in 1995. He received his DDS from Medical College of Georgia (MCG) School of Dentistry in 1999. In 2002, he earned his postdoctorate degree in endodontics from Nova Southeastern University. Dr. Short became a board certified endodontist in 2009. He is a Diplomate of the American Board of Endodontics and his private practice, Apex Endodontics PC, is located in Smryna, Ga. Dr. Short is also an expert consultant to the Georgia Board of Dentistry and an assistant clinical professor at MCG School of Dentistry.

A Comparative Study of the Surface Defects of Two Rotary NiTi Instruments Using Reciprocating and Continuous Rotation

Dr. Moataz Bellah Ahmed AlKhawas

Dr. Ashraf Samir Refai

Dr. Taher Medhat Islam

ABSTRACT

This study was done to evaluate the surface defects and incidence of instrument fracture and permanent deformation of the ProTaper and Revo-S instruments used in either continuous 360º motion or reciprocating motion. Forty ProTaper and Revo-S instruments (20 each) were divided into two main groups and further divided into 2 subgroups each according to the rotary motion used with the file. The Files were evaluated before use and after use in 3, 6 and 9 canals. The instruments were evaluated using a stereomicroscope under 16x magnifications. The results showed that both instruments showed less deterioration in continuous 360º motion than in reciprocating motion. Furthermore, the ProTaper instrument showed less surface deterioration than the Revo-S instrument with multiple uses.

INTRODUCTION AND REVIEW OF LITERATURE

One of the main objectives of root canal preparation is to clean and shape the root canal system effectively whilst maintaining the original configuration of the root canal without creating any iatrogenic errors such as instrument fracture, transportation, ledging or perforation[1] In severely curved root canals, proper cleaning and shaping may be difficult to achieve, and file distortion or breakage is likely to occur. Before the appearance of rotary nickel titanium (NiTi) instruments, these canals were prepared using stainless steel hand instruments which was generally time-consuming and difficult. Currently, these canals can be prepared using rotary driven instruments or in combination with hand instruments[2, 3, 4]. Nowadays, rotary instrumentation has become a mainstay for preparation of the root canal system[5]. In the last decade several rotary NiTi instruments with different configuration and designs have been developed to reduce the preparation time, simplify the preparation procedure and maintain the original canal shape without creating severe irregularities such as ziping, ledging or perforation, particularly in narrowly curved canals[6, 7]. Currently, these instruments have been used in continuous rotation at low speed in a low or high torque handpiece depending on the design of the instrument. The use of automation for root canal instrumentation has been very limited until recently. Historically, the motion used for this automation was continuous 360º rotation, reciprocation or reciprocation with a vertical up and down motion. With regards to continuous 360º rotation, several stainless steel instruments have been used such as gates gliden drills and pesso reamers for orifice widening and coronal two thirds preparation. On the other hand reciprocating handpieces were introduced in an attempt to prepare root canals to the full length to decrease instrumentation time and simplify canal preparation i.e. Giromatic, Dynatrak and M4 handpieces. Although the reciprocating handpieces produced acceptable preparation, some errors such as apical perforation, ledges and packing of debris occurred. The reason for these errors as suggested by Ingle and Taintor was attributed to the instrument type[8, 9]. Also, a combination of reciprocating with a vertical up and down motion was developed (canal finder system) which has a lengthwise, vibratory motion. It was used with k file #10 and modified hedstrom files .Some investigators found that the canal finder system performed better than or equal to hand instrumentation[10, 11]. Other researchers in 2007 compared the type of defects and mode of material failure of engine-driven and hand-operated ProTaper instruments after clinical use. A total of 401 hand-operated and 325 engine-driven ProTaper instruments were discarded from an endodontic clinic over 17 months. The discarded instruments were examined using scanning electron microscope. The mode of fracture was classified as 'fatigue' or 'shear' failure. They found that, 14% of all discarded hand operated instruments and 14% of engine-driven instruments were fractured. About 62% of hand instruments failed because of shear fracture, compared with 66% of engine-driven instruments because of fatigue. Approximately 7% of hand instruments were discarded intact but distorted; all were in the form of unscrewing of the flutes. They concluded that the failure mode of ProTaper engine-driven and hand-operated instruments appeared to be different[12]. On the other hand, Troian et al. evaluated the deformation and fracture of rotary NiTi RaCe and K3 instruments. The results revealed that, no fractures occurred with K3 instruments, whereas six RaCe instruments fractured. Distortion of spirals and wear increased with progressive use of RaCe instruments, whereas K3 instruments remained relatively undamaged after their fifth use. They concluded that, a significant difference was found between RaCe and K3 in terms of deformation and fracture, K3 instruments had more favorable results[13]. As previously mentioned rotary NiTi instruments with continuous 360º rotation has become the acceptable standard of care in endodontics yet they still produce procedural errors and the files show surface defects and incidences of fracture[14]. In 2010, Taha, et al. compared the cleaning ability and final canal shape of three techniques for preparing oval-shaped root

canals including Anatomic Endodontic Technology (AET) using AET shaping and finishing files in a reciprocating handpiece, hand instruments (Hedstrom files) and rotary NiTi EndoWave instruments using a continuous rotation handpiece. The results showed that, none of the techniques resulted in completely prepared and cleaned canals. They concluded that, AET did not perform better than rotary NiTi or hand instruments in oval-shaped canals[15]. Alternatively; little research has been done to evaluate surface defects and incidence of instrument fracture when using reciprocating motion in conjunction with NiTi instruments.

Aim of the Study

This study was done to evaluate the surface defects and incidence of instrument fracture and permanent deformation of two different NiTi rotary systems used in either continuous 360º motion or reciprocating motion.

Materials and Methods

Two types of rotary nickel-titanium (NiTi) instruments were used in this study the ProTaper (Dentsply-Maillefer) instrument and the Revo-S (Micromega) instrument. Ten boxes of each instrument were purchased to be used in this study. The rotary NiTi instruments were divided into 2 main groups according to the instrument type. Then they were further subdivided according to the rotary motion used Continuous 360° rotary motion and reciprocating motion. Two file sizes for each instrument were evaluated in this study ProTaper (F1 and F2) and Revo-S (SC2 and SU).The mesiobuccal root canals of 180 freshly extracted human mandibular first molars with fully formed apices and root canal curvatures ranging between 15-40º degrees, were selected to be used in this study. Prior to preparation of the root canals, a size # 10 hedstrom file was used to check patency as well as canal configuration in the mesiobuccal root canal. The working length was recorded by placing a size # 10 hedstrom file into the root canal, until it was visible at the apical foramen and subtracting 1 mm from that length. The root canals were instrumented using a crown-down technique in the file sequence recommended by the manufacturers. Instrumentation was done using either a continuous 360° rotation , powered by a torque-limiting electric motor (Nouvag TCM Endo II) at a standard speed of 340 rpm with torque control settings for each file set according to the specific manufacturer's instructions or a 90º reciprocating handpiece (NSK, TEQ-E10R) powered by a standard electric motor at a speed of 12000 rpm.

During instrumentation, irrigation of the root canals was accomplished between each file using 1.8 ml of sodium hypochlorite solution (2.6 %), in a 30 gauge endodontic irrigating syringe to within 1-2 mm of the working length. After each use, the instruments were washed under tap water and cleaned in a digital ultrasonic cleaner and sterilized in an autoclave at 131° C at 2 atmospheres for 20 minutes. Examination of the surface topography of each instrument used in this study was done using the stereomicroscopy 16x (Olympus – Japan SZ-PT). Throughout the course of this study, each instrument used was examined four separate times, Pre-instrumentation, after use in 3 canals, 6 canals and 9 canals. The instruments were examined and evaluated using the scoring system modified from the scoring system used by Refai[16] Table 1. The cutting portion of each instrument was divided into 3 equal imaginary parts (apical, middle and coronal). Each part was scored separately. The data was tabulated and statistically analyzed using the Mann-Whitney U test p-value ≤ 0.05.

Table 1. The Scoring System Used to Evaluate the Instruments

Score	Type of Surface Defect
1	Milling marks
2	Metal rollover
3	Any changes affecting the edge of the flutes: pits, groups, notches, denting, blunting and/or metal flash or stripping
4	Unwinding of the flutes or permanent deformation of the instrument
5	Instrument Fracture

RESULTS

Comparison between Instrument types

The mean surface defect scores, standard deviation and p-values when comparing the different files are shown in Table 2. After 3 uses, most of the ProTaper and Revo-S file groups showed no significant difference between mean surface defect scores when used in either continuous 360º motion or reciprocating motion along the different instrument parts. The main exception to this was when comparing the F1 and SC2 file at the apical part in reciprocating motion, the SC2 instrument showed a significantly lower mean surface defect score (1 ± 0) when compared with the F1 instrument (2.6 ± 0.5) p-value 0.005. Furthermore, after 6 uses, when comparing the F1 and SC2 file at the apical part in continuous 360º motion and reciprocating motion, the F1 instrument showed a significantly lower mean surface defect score (1 ± 0 & 2.6 ± 0.5 respectively) when compared with the SC2 instrument (3 ± 0 & 4 ± 0 respectively) p-value 0.003 and p-value 0.005. Also, after 6 uses, when comparing the F2 file and the SU file at the apical part in continuous 360º motion and reciprocating motion, the F2 instrument showed a significantly lower mean surface defect score (1 ± 0 & 2.7 ± 0.5 respectively) when compared with the SU instrument (2.2 ± 1 & 4 ± 0 respectively) p-value 0.021 and p-value 0.002. On the other hand, after 9 uses, when comparing the F1 and SC2 file at the apical, middle and coronal parts in continuous 360º motion the SC2 showed significantly higher mean surface defect scores when compared to the F1 file. Finally, after 9 uses, when comparing the F2 and SU files at the apical, middle and coronal parts in both motions the SU file showed significantly higher mean surface defect scores when compared to the F2 file.

Table 2. Mean Surface Defect Scores, Standard Deviations (SD) and P-values Comparing the ProTaper and Revo-S Files After the Different Uses

After 3 Uses	Instrument part	Motion	Instrument type				P-value
			ProTaper		Revo-S		
			Mean	SD	Mean	SD	
F1 vs. SC2	Apical	Continuous	1	0	2	1	0.053
		Reciprocating	2.6	0.5	1	0	0.005*
	Middle	Continuous	1	0	2	1	0.053
		Reciprocating	3	0	1	0	0.003*
	Coronal	Continuous	1	0	1	0	1.000
		Reciprocating	1.6	0.9	1	0	0.136
F2 vs. SU	Apical	Continuous	1	0	1	0	1.000
		Reciprocating	2.4	0.5	2	1	0.502
	Middle	Continuous	1	0	3	0	0.003*
		Reciprocating	2.6	0.5	2	1	0.307
	Coronal	Continuous	1	0	2	1	0.053
		Reciprocating	1	0	2	1	0.053
After 6 Uses	**Instrument part**	**Motion**	**Instrument type**				**P-value**
			ProTaper		Revo-S		
			Mean	SD	Mean	SD	
F1 vs. SC2	Apical	Continuous	1	0	3	0	0.003*
		Reciprocating	2.6	0.5	4	0	0.005*
	Middle	Continuous	1	0	2	1	0.053
		Reciprocating	3	0	2	0	0.003*
	Coronal	Continuous	1	0	2	1	0.053
		Reciprocating	1	0	2.4	0.5	0.005*
F2 vs. SU	Apical	Continuous	1	0	2.2	1	0.021*
		Reciprocating	2.7	0.5	4	0	0.002*
	Middle	Continuous	1.3	0.8	3	0	0.005*
		Reciprocating	2.5	0.5	3	0	0.056
	Coronal	Continuous	1	0	2.2	0.4	0.001*
		Reciprocating	1.2	0.4	2.5	0.5	0.005*
After 9 Uses	**Instrument part**	**Motion**	**Instrument type**				**P-value**
			ProTaper		Revo-S		
			Mean	SD	Mean	SD	
F1 vs. SC2	Apical	Continuous	1	0	3	0	0.003*
		Reciprocating	4	0	4	0	1.000
	Middle	Continuous	1	0	3	0	0.003*
		Reciprocating	3	0	2.6	0.5	0.134
	Coronal	Continuous	1	0	3	0	0.003*
		Reciprocating	2.4	0.5	2.6	0.5	0.549
F2 vs. SU	Apical	Continuous	1	0	3.5	0.6	0.013*
		Reciprocating	3	0	4	0	0.008*
	Middle	Continuous	1.8	1	3	0	0.046*
		Reciprocating	2	0	3	0	0.008*
	Coronal	Continuous	1	0	3	0	0.008*
		Reciprocating	2	0	3	0	0.008*

Comparison between the Rotary Motions

The mean surface defect scores, standard deviation and p-values when comparing the different rotary motions are shown in Table 3. After 3 & 6 uses, at the apical and middle parts, the ProTaper instruments used in continuous 360º motion showed significantly lower mean surface defect scores than when used in reciprocating motion. On the other hand, after 3 uses, at the apical, middle and coronal parts, the Revo-S instruments showed no significant difference in the mean surface defect scores between the different motions. Furthermore, After 6 uses, at the apical and middle parts, the Revo-S instruments used in continuous 360º motion showed significantly lower mean surface defect scores than when used in reciprocating motion. However, after 9 uses in general, at the apical, middle and coronal parts, ProTaper instruments used in continuous 360º motion showed significantly lower mean surface defect scores than when used in reciprocating motion. Finally, after 9 uses, at the apical middle and coronal parts, there was no significant difference between the different motions when using the Revo-S instrument, with the exception of the SC2 file at the apical part, which showed significantly lower mean surface defect scores when used in continuous 360º motion (3 ± 0) than when used in reciprocating motion (4 ± 0) p-value 0.003.

DISCUSSION

Instrument Wear

As previously mentioned, the aim of this study was to evaluate the surface defects and incidence of instrument fracture and permanent deformation of the ProTaper and Revo-S NiTi files used in either continuous 360º motion or reciprocating motion. For Endodontists and general practitioners alike, the allure of using a rotary NiTi instruments that have a lower possibility of fracture is a major requirement. Manufacturers have been trying to fulfill this need for nearly 20 years since the introduction of Rotary NiTi technology. Very recently, researchers have been advocating the use of reciprocating motion to minimize the stress on the instruments and to improve root canal preparations. Furthermore, some manufacturers have begun to design instruments specifically for use in reciprocation[17, 18].

During the course of this study, the instrument surface was evaluated using modified scoring system similar to other surface analysis research[13, 16]. The method used to examine the files was the stereomicroscope. The stereomicroscope is still a valid tool for analysis and the literature is replete with research using it for evaluation of different files[16, 19]. Furthermore, in Egypt in 2006, research was done to compare the surface topography of various rotary NiTi instruments using Stereomicroscopy and SEM. The research concluded that there was no significant difference in the surface analysis using either technique[16].

Within the parameters of this study, after 3 uses both the ProTaper and Revo-S instruments showed no significant difference between in surface deterioration in both tested motions, this may be attributed to the fact that the instrument had not yet been used sufficiently to warrant a noticeable change in the surface of the files. The exception to this was when comparing the F1 and SC2 file at the apical part of the instrument. In this case, the SC2 file showed less degradation, this may be attributed to the fact that the SC2 has a 4% while the F1 has a 7% taper in its apical portion. Making the SC2 more flexible than the F1 file and having lesser in contact with the canals wall reducing torque on the instrument and therefore reducing the amount of deterioration of the file[20, 21& 22].

On the other hand, after 6 uses in both motions, although both instruments showed an increase in the degree of surface degradation, the ProTaper instrument showed significantly less surface deterioration when compared to the Revo-S instrument. This may be attributed to the variable taper of the ProTaper instrument which reduces the contact with the canal wall reducing torque on the instrument when compared to the Revo-S instruments. After 9 uses, further degradation of the used instruments occurred, in reciprocating motion there was no significant difference between ProTaper and Revo-S files. Except in the case of the F2 instrument which showed less deterioration than the SU instrument. This may be attributed to the variable taper along the length of the F2 file and the difference in taper between the F2 and SU instruments 8% and 6% respectively.[20, 21]

When comparing between rotary motions, after 3, 6 and 9 uses the ProTaper instrument showed less deterioration when used in continuous 360º motion than in reciprocation. This may be attributed to the fact that the ProTaper instrument is specifically designed to be used in continuous rotation. The comparative deterioration may also be due to the speed used when using reciprocating motion (12,000 RPM). On the other hand, after 3 uses, the Revo-S instrument showed no significant difference between the motions. Similarly to the ProTaper instrument, after 6 uses, the Revo-S instrument showed less deterioration when used in continuous 360º motion than in reciprocation. This can also attributed to the original design concept. After 9 uses, when using Revo-S instruments there was no significant difference when using both motions. This may be attributed to the expected deterioration of the instruments after multiple uses.

CONCLUSION & RECOMMENDATION

Generally, both instruments showed less deterioration in continuous 360º motion than in reciprocating motion. Furthermore, the ProTaper instruments showed less deterioration than the Revo-S instruments after multiple uses. Little research has been done to evaluate the Revo-S file this leaves ample space for more research comparing the Revo-S instrument to other commonly used rotary systems. The optimum speed for reciprocation is not yet known, further research should be done to evaluate the optimum speed.

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Table 3. Mean Surface Defect Scores, Standard Deviations (SD) and P-values Comparing Continuous 360º Motion and Reciprocating Motion After the Different Uses

After 3 Uses	Instrument parts	Instrument	Rotary motion				P-value
			Continuous		Reciprocating		
			Mean	SD	Mean	SD	
ProTaper	Apical	F1	1	0	2.6	0.5	0.005*
		F2	1	0	2.4	0.5	0.005*
	Middle	F1	1	0	3	0	0.003*
		F2	1	0	2.6	0.5	0.005*
	Coronal	F1	1	0	1.6	0.9	0.136
		F2	1	0	1	0	1.000
Revo-S	Apical	SC2	2	1	1	0	0.053
		SU	1	0	2	1	0.053
	Middle	SC2	2	1	1	0	0.053
		SU	3	0	2	1	0.053
	Coronal	SC2	1	0	1	0	1.000
		SU	2	1	2	1	1.000
After 6 Uses	Instrument parts	Instrument	Rotary motion				P-value
			Continuous		Reciprocating		
			Mean	SD	Mean	SD	
ProTaper	Apical	F1	1	0	2.6	0.5	0.005*
		F2	1	0	2.7	0.5	0.002*
	Middle	F1	1	0	3	0	0.003*
		F2	1.3	0.8	2.5	0.5	0.021*
	Coronal	F1	1	0	1	0	1.000
		F2	1	0	1.2	0.4	0.317
Revo-S	Apical	SC2	3	0	4	0	0.003*
		SU	2.2	1	4	0	0.002*
	Middle	SC2	2	1	2	0	1.000
		SU	3	0	3	0	1.000
	Coronal	SC2	2	1	2.4	0.5	0.502
		SU	2.2	0.4	2.5	0.5	0.241
After 9 Uses	Instrument parts	Instrument	Rotary motion				P-value
			Continuous		Reciprocating		
			Mean	SD	Mean	SD	
ProTaper	Apical	F1	1	0	4	0	0.003*
		F2	1	0	3	0	0.008*
	Middle	F1	1	0	3	0	0.003*
		F2	1.8	1	2	0	0.505
	Coronal	F1	1	0	2.4	0.5	0.005*
		F2	1	0	2	0	0.008*
Revo-S	Apical	SC2	3	0	4	0	0.003*
		SU	3.5	0.6	4	0	0.127
	Middle	SC2	3	0	2.6	0.5	0.134
		SU	3	0	3	0	1.000
	Coronal	SC2	3	0	2.6	0.5	0.134
		SU	1	0	1	0	1.000

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Dr. Moataz Bellah Ahmed AlKhawas
Lecturer of Endodontics, Faculty of Dentistry, Al-Azhar University
Dr. Ashraf Samir Refai
Lecturer of Endodontics, Faculty of Dentistry, Al-Azhar University
Dr. Taher Medhat Islam
Associate Professor & Head of Endodontic Department, Faculty of Dentistry, Al-Azhar University

The Antibiofilm Activity of Extract Propolis Against Biofilm Enterococcus Faecalis as Herbal Medicine Potential in Root Canal Treatment

Dr. Dian Agustin Wahjuningrum

Ari Subijanto

ABSTRACT

Background

Endodontic root canal treatment is a treatment that can be performed in the dental pulp necrosis. Failure in endodontic root canal treatment can still occur, although it has been done in accordance with procedures. One cause of failure of root canal treatment is bacterial resistance to conservative treatment. Some microorganisms in pulp necrosis were able to form biofilm to enhance pathogen virulence. This happens because the necrotic pulp tissue is an opportunistic environment for development of microorganisms due to organic residues or nutrients, which serve as a substrate or microorganism culture. One of these microorganisms is Enterococcus faecalis. Medicament needed to eliminate microorganisms in the root canal pulp necrosis, especially in the form of bacterial biofilms. The problem faced by this time almost all the materials used in dentistry is a chemical and it has side effects, it is necessary for natural ingredients from nature that has antibacterial or antibiofilm. Antibiofilm or antibacterial agent can be found in propolis. Propolis contains tt-farnesol and apegenin that have mechanisms for inhibiting growth and development of bacterial biofilm.

Purpose

The aim of this study was to know the antibiofilm effects of propolis extracts by determining its minimum inhibitory concentration to Enterococcus faecalis biofilm.

Methods

This study is an in-vitro experimental research laboratory. Propolis extract used is propolis extracted by maceration method, and dilution into several concentrations using aquadest. Biofilm formation was observed using the microtitter plate method then continued reading of Optical Density (OD) using ELISA reader to determine the minimum inhibitory concentration of propolis extracts to Enterococcus faecalis biofilm

Results

Minimum concentrations of propolis extract can inhibit the growth and development of Enterococcus faecalis biofilm is 5,75%.

Conclusion

Influence of propolis extract in inhibiting the formation of biofilm produced by Enterococcus faecalis, compared with no propolis extract. Propolis extract concentration by 5,75% is Minimum Inhibitory Concentration to Enterococcus faecalis biofilm in vitro.

INTRODUCTION

Pulp necrosis is death of part or all of the pulp tissue, usually caused by inflammation or traumatic injury. Pulp necrosis is also a process of bacterial infection. The treatment plan can be made in the treatment of pulp necrosis is a root canal treatment. Root canal treatment aims to restore the state of the sore tooth to be accepted by the biological surrounding tissues. This means that the tooth can function and no signs of other pathology.[1,2]

Root canal treatment failure can still occur despite conducted in accordance with procedures. Root canal treatment failure can be caused of bacteria resistant to conservative treatment. Allegedly some microorganisms in endodontic infections able to form biofilms as a significant mechanism in avoiding the host defense system and increase the virulence of the pathogen.[3,4]

Biofilms can be defined as microbial populations containing organic or inorganic substrate, which is coated by extracellular microbial products, which form the matrix inter microbial. In biofilms, microorganisms showed higher resistance, both on antimicrobial agents and host defense mechanisms when compared in the form of planktonic cells. Biofilm formation is a complex process involving the formation of attachment and immobilization, cell to cell interactions, forming micro colonies, confluent biofilm formation, and biofilm formation of three-dimensional structures. Bacteria in biofilms have different properties to the planktonic form. Biofilm production is regulated by quorum sensing system in several pathogenic bacteria. Quorum sensing is a regulatory system of bacterial gene expression in response to population density of microorganisms obtained through the production of extracellular signaling molecules called auto inducers.[3,5]

Biofilm formation on root canal may be started after the first invasion of the pulp chamber by oral planktonic microorganism. Necrotic pulp tissue into a favorable environment for the proliferation of microorganisms due to the presence of

organic residues or nutrients, which serves as a substrate medium or culture microorganisms. In the study of microbial biofilm communities found some root canal one is *E. faecalis*.[6,7]

E. faecalis is a microorganism that despite persistent small amounts of necrosis in the root canal, but it plays a role in the occurrence of persistent periradicular lesions after root canal treatment. *E. faecalis* can survive in adverse conditions, such as root canal instrumentation and obturation was done with only a few nutrients are available. Model of growth through the formation of biofilms.[8]

There are three basic stages in the definitive root canal treatment has known as the "Triad of Endodontic", which consists of the biomechanical preparation, irrigation and disinfection, and obturation. Eliminating the remaining pulp tissue in dentin and eliminate microorganisms contained in the root canal is dominant during root canal treatment. Irrigation and biomechanical preparation can't eliminate the entire microorganisms in the root canal. Thus, the use of root canal sterilization is required for root canal treatment. Problems encountered in the field of dentistry today is almost all materials used in dental treatment is a chemical and has side effects.[9,10,11]

Studies in Indonesia today is mostly done to find substitute materials chemicals using basic ingredients of traditional plant or materials which may be obtained from the natural environment in Indonesia. Indonesia has known to have various types of local bees. Honeybees produce some products that have utility both for itself and for the human. One of their products is bee glue or propolis. Bee glue or propolis has known to have antibacterial activity that can be used for both pulp therapy in primary teeth and permanent.[11,12]

Propolis is a sticky resin that comes from a tree trunk or bark, collected and processed by bees salivary fluid secretion. Each type of bee has a specific resin existing resources in their respective areas so that the composition of propolis varies. The main components of propolis are flavonoids and phenolic acids, including caffeic acid phenylesthylester (CAPE) that its content reaches 50% of the entire composition. Based on the results of the study, in the commercial propolis and extract contained the same active compound, which contains flavonoids, phenolic, hidroquinon, tannins, volatile oils, steroids, saponins and reducing sugars. In the propolis extract also contained tt-farnesol (terpenoid) and apigenin.[13,14,15]

The purpose of this study was to determine the minimum inhibitory concentration of propolis extract against bacterial biofilms of *E. faecalis*, which later can be considered the use of propolis extracts as an ingredient for the success of the sterilization of the root canal treatment to inhibit bacterial biofilm formation of *E. faecalis*.

METHODS AND MATERIALS

This research is an experimental research laboratory in-vitro with post-test only control group design. Samples of this research are propolis extracts which diluted in various concentrations using distilled water diluent. The materials used are oese, brander spirits, incubators, anaerobic jar, test tube, test tube rack, petri dish, pipettes, microscopes, 96-well flat-bottomed plastic tissue culture plate, ELISA reader, Tryptone Soy Broth (TSB) medium, the stock of *E. faecalis* bacteria, a solution of phosphate-buffered saline (pH 7,3), propolis extract, sterile distilled water, crystal violet 0,2 ml of 2%, and isopropanol.

Propolis extract obtained from Balai Penelitian dan Konsultasi Industri (BPKI) Surabaya which extracted by maceration method (number of laboratory test results 03573/KI/VI-2012). Furthermore, the method of thinning of the series to get a wide range of concentrations, ie 11,45%, 5,75%, 2,86%, 1,43%, 0,715%, 0,38%, 0,19%, and 0,10%. E. faecalis bacteria were used obtained from Balai Besar Laboratorium Kesehatan (BBLK) Surabaya.

Biofilm formation and determination of minimum inhibitory concentration: Culture *E. faecalis* in Trypticase Soy Broth (TSB) diluted to 1:100 in TSB glu overnight. Then 0,1 ml of *E. faecalis* at the concentration of 1x 106 bacteria/ml loaded on 96-well flat-bottomed plastic tissue culture plate and 0,2 ml of *E. faecalis* loaded in 96-well flat-bottomed plastic tissue culture plate as a positive control. Furthermore, microtitter was incubated for 24 hours at the temperature of 37°C. After 24 hours, propolis extract was applied into each microtitter in 11,45%, 5,75%, 2,86%, 1,43%, 0,715%, 0,38%, 0,19%, and 0,10% and then incubated for 24 hours at a temperature of 37°C and the contents of each microtitter plate aspirated and washed 3 times with 0,2 ml of phosphate-buffered saline (pH 7,3) by using a pipette. Biofilm microorganisms which attached to the well were painted with crystal violet. Flushing is done by using distilled water and dried. To analyze biofilm formation, added 0,2 ml of isopropanol in each well then measured by Optical Density (OD) at 570 nm using an ELISA reader.

The data was obtained from the quantitative data in the form of readings on spectophotometric Optical Density (OD) of each well plates which treated differently that propolis extract with a concentration of 11,45%, 5,75%, 2,86%, 1,43%, 0,715%, 0,38%, 0,19%, 0,10%, and the positive control well without application of propolis extract. After that, the data were analyzed using one-way ANOVA test.

RESULTS

Researcher did the study using a bacterial biofilm-forming *E. faecalis* and subsequently given propolis extract concentration of 11,45%, 5,75%, 2,86%, 1,43%, 0,715%, 0,38%, 0,19%, 0,10%, and 0% as the positive control treatment given to the microtitter plate.

The results showed that the propolis extract is able to inhibit *E. faecalis* biofilm formation. In this study, concentration of the extract was ranging from 0,10% to inhibit biofilm growth (Table 1). From the analysis, it is known that at the concentration of 5,75% of propolis extract, contained biofilm bacteria less than 10%, so the concentration of 5,75% is the minimum inhibitory concentration of propolis extract against E. faecalis biofilm.

DISCUSSION

Biofilm formation on root canal may be started after the first invasion of the pulp chamber by oral planktonic microorganisms. Necrotic pulp tissue become a favorable environment for the proliferation of microorganisms due to the presence of organic

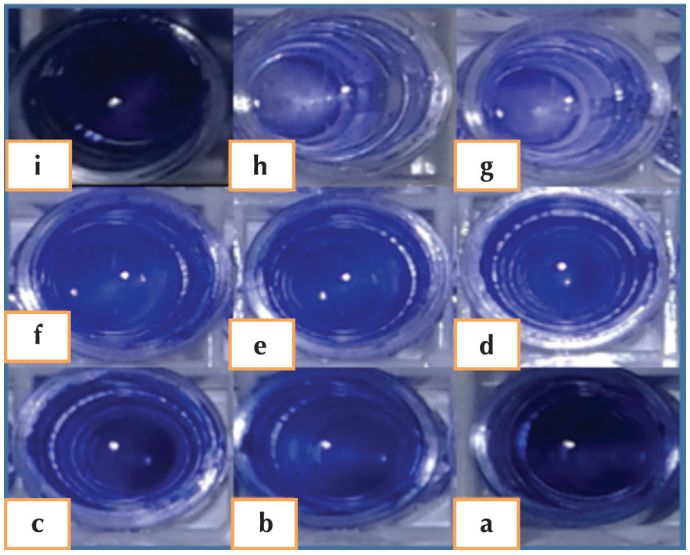


Fig 1. The results of staining with Crystal Violet on *E. faecalis* Biofilm Bacteria Application of Different Concentrations with Propolis Extract
a. Control
b. Propolis extract at the concentration of 11,45%
c. Propolis extract at the concentration of 5,75%
d. Propolis extract at the concentration of 2,86%
e. Propolis extract at the concentration of 1,43%
f. Propolis extract at the concentration of 0,715%
g. Propolis extract at the concentration of 0,38%
h. Propolis extract at the concentration of 0,19%
i. Propolis extract at the concentration of 0,10%

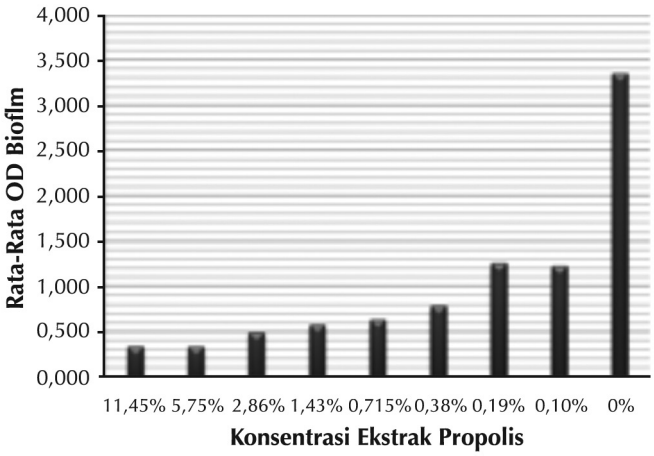
Table 1. Measurement Result of ELISA reader OD *E. faecalis* Biofilm

Extract concentration	n	Mean OD	OD
0%	5	3,344	100%
0,10%	5	1,2264	36,67%
0,19%	5	1,2536	37,48%
0,38%	5	0,7802	23.33%
0,715%	5	0,6292	18,81%
1,43%	5	0,5706	17,06%
2,86%	5	0,4898	14,65%
5,75%	5	0,3304	9,88%
11,45%	5	0,3360	10,04%

residues or nutrients, which serves as a substrate or culture medium mikroorganism.[6]

Research in the field of health to propolis have been carried out, both in vitro and in vivo. Fokt et al 2010, the study showed propolis has multiple biological and pharmacological activity, propolis in addition to act as antibacterial against Gram positive and Gram negative, propolis also has anti-inflammatory, anti-fungal, antiviral, anti-oxidant, anti -protozoal, anti-tumor, hepatoprotective, anti-ulcer, cardio-protective, neuroprotective, radioprotective, immunomodulatory, lowering blood pressure and cholesterol levels of the body. Propolis also promote the regeneration of tissue, bone, and cartilage. Propolis can also stop

Fig 2. Graphs Measurement Results OD ELISA Reader Biofilm



the formation of bacterial biofilms.[16,17,18,19]

Tt-Farnesol and apigenin content in propolis have instrumental in stopping the formation of biofilm microorganisms. This is consistent with the study of Koo et al., 2003, which found that the content of propolis, namely apigenin (4',5,7-trihydroxyl-flavone) and tt-farnesol (3,7,11-trimethyl-2,6,10-dodecatrien-1-ol), it causes a decrease in the amount of polysaccharides in the biofilm microorganisms without interfering with the survival of the bacteria. Because apigenin and tt-farnesol have bacteriostatic capability. This means being able to overcome the infection without killing the microorganisms of the oral cavity of normal and not cause resistance of bacteria.[15]

Apigenin and tt-farnesol affects one of the polysaccharides in the biofilm, which is alkali-soluble glucan, so that will inhibit biofilm formation. Alkali-soluble glucan is a function of extracellular glucan to adherence to the cell surface. Insoluble glucans synthesized from sucrose by GTFs (glucosyltransferases) also play an important role in the attachment and colonization of microorganisms. Apigenin and tt-farnesol have a significant impact on the further development and biofilm accumulation by influencing the synthesis of polysaccharides in the biofilm.[15]

Apigenin and tt-farnesol have different mechanisms to reduce the synthesis of glucan. The main targets for apigenin is GTF enzymes (glucosyl transferase). Inhibition of glucan synthesis by tt-farnesol have an effect on the cell membrane, rather than enzymatic activity, because tt-farnesol is poor for GTFs inhibitor. The chemical structure and lipophilic nature of tt-farnesol support for membrane damage, which is caused by changes in permeability and fluidity of cell membranes. Agents are capable of causing damage to the cell membrane not only reduces the metabolism of bacteria, but it also affects the synthesis of glucan by microorganism.[15]

The results showed that the extract of propolis is able to inhibit the formation of biofilms by E. faecalis bacteria. At extract concentrations ranging from 0,10% can inhibit biofilm growth (Table 1). From the analysis, it is known that the concentration of propolis extract contained 5,75% of biofilm bacteria with a percentage of less than 10% or at this concentration of propolis extract could inhibit biofilm by 90%, resulting in a concentration

of 5,75% is the minimum inhibitory concentration of the extract of propolis against *E. faecalis* biofilm bacteria. This is because propolis extract contains tt-farnesol/terpenoid and apigenin that can cause disorders of biofilm membrane and cause a decrease in the amount of polysaccharides in biofilms that occur subsequent release of cellular content of biofilms. It is characterized by elevated concentrations of proteins and polysaccharides outside cells.[15,19]

It can be concluded that propolis extract plays an important role in the inhibition of biofilm formation produced by the *E. faecalis* bacteria, compared with no extract of propolis and propolis extract the minimum inhibitory concentration against *E. faecalis* biofilm bacteria in vitro of 5,75%.

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The Difference of Biofilm Activity of Mangosteen Pericarp Extract (Garcinia mangostana L) 25% and NaOCl 2,5% Against Porphyromonas Gingivalis Biofilm

Prof. Dr. Adioro Sutojo

Dr. Dian Agustin Wahjuningrum

INTRODUCTION

Root canal infection caused by some bacteria which each species has a varied virulence factor[1]. Porphyromonas gingivalis is a gram negative black-pigmented anaerob bacteria which is a primer bacteria that infected root canal. Bacterial culture test shows that P.gingivalis frequency in root canal is less than 10%, while PCR metode which is more sensitive shows that the presentation of P.gingivalis in necrotic pulp reach 28%[3]. Porphyromonas gingivalis and some bacteria in oral cavity, on in vivo studies, is not a free planktonik bacteria, it formed a biofilm in root canal surface[4]. Bacteria in biofilm has a different characteristic from the planktonic form, this bacteria has a protective barrier as a cellular matrix which allowed the biofilm formed bacteria more resistant against fagositic cells or medications[5]. Due of that reason an antibiofilm materials is needed to obliterate biofilm formed bacteria from the infected root canal. An antibiofilm agents such as NaOCl or Sodium Hypoclorite can be used as irrigation solution in a root canal treatment.

Chlorin compound in NaOCl is a biofilm dispersant which may damage extracellular matrix in biofilm6. Recommended concentration for NaOCl is between 0,5% - 5,25%. In general, the most common concentration is 2,5%, because it has the lowest toxicity but it still could maintain the tissue solubility and has an antibiofilm ability[7].

More over, a herbal agents been used and it been expected to be more compatible for root canal due to the low toxicity, and good antibiofilm ability. Mangosteen pericarp contains some active components such as alkaloid, saponin, triterpenoid, tannin, fenolic, flavonoid, glycoside, steroid and xanthone as the major component[8,9]. The active component from this extract known to have a antibiofilm ability. Saponin is a surfactant agent which act as a biofilm dispersant by disintegrate bacterial bond in biofilm[6]. In a previous study shows that mangosteen pericarp extract has a antibiofilm activity which could inhibit the Porphyromonas gingivalis biofilm in concentration 25%[10].

The aim of this study is to show the difference of antibiofilm activity between mangosteen pericarp extract and NaOCl against Porphyromonas gingivalis biofilm.

METHOD

This study is a in vitro laboratories research with a post test only control group design. This using a microtitter plate test method to know the difference of the antibiofilm activity between mangosteen pericarp extract 25% and NaOCl 2,5% against Porphyromonas gingivalis biofilm.

The sample of this study is Porphyromonas gingivalis strain ATCC 33277 from RSPTI Airlangga University and were incubated 16 days until the biofilm appear on TSB (Tripticase Soy Broth). It received an application of mangosteen extract solution 25% and NaOCl solution 2,5%.

The mangosteen pericarp prepared from balai material medika, Batu City were extracted at pharmacy laboratory Widya mandala university. The mangosteen pericarp were baked at 50oc for 24hours, and processed into powder. Then it soaked in 70% ethanol, wraped with alumunium foil and left for 24 hours before it ready to being filtered. This process repeated for few times until we get a clear filtrate then it can be evaporated to get a thick-alcohol-free extract[8].

The antibiofilm activity test performed by adding each tester material into the microtitter plate flat-bottom 96 well which contain the Porphyromonas gingivalis biofilm, before it being incubated at 37oc for 24hours. After that, the contains of each well were aspirated and washed 4 times with 200ml phosphate buffer saline. Then it ready to stained by crystal violet and incubated in room temperature for 15min and washed 3times by aquadest then let dried. 100ml DMSO 100% were added. Then tapped the microtitter plate for 1 minute and placed in a microplate reader. A quantitative analysis is performed by measuring the optical density with a microplate reader. It repeated 8times for each isolate.

The result was analyzed by non-parametric kruskal-wallis test and Mann-whitney test using SPPS 21.0 for windows.

RESULT

The results obtain from Porphyromonas gingivalis strain ATCC 33277 biofilm which formed on TSB media with addition 25% mangosteen pericarp extract and 2,5% NaOCl. The antibio-

film activity of each tester which may decrease Porphyromonas gingivalis biofilim were showed by the optical density imaging from microplate reader. Each group contains 8 samples with mean value shows on the table below.

	N	X	SD
Kontrol	8	0,190	0,026
Mangosteen pericarp extract 25%	8	0,151	0,007
NaOCl 2,5%	8	0,368	0,134

The first statistical analysis used is Komolgorof smirnov test to define the data distribution and levene test to see the homogeneity. Both test shows that the data has a normal distribution and heterogene so a non-parametric statistical analysis, kruskal-walls test, is needed to know the differences of the entire data. From the last analysis we get that signification value 0.000 which mean p is smaller than 0.05 ($p<0.05$) it shows that there is a significant differences from each group.

The statistical calculation by mann-whitney test among the group shows the signification value 0,006 between mangosteen pericarp extract 25% and the control group and 0,003 between NaOCl 2,5% and the control group. This indicates the P value is smaller that 0,05 ($P < 0,05$) which means that there is a significant differentiation between both test group and control group. Then by the statistical calculation using mann-whitney test between mangosteen pericarp extract 25% and NaOCl 2,5% obtain a signification value 0,001. So P is smaller than 0,05 and shows that there is a different between two groups.

	Group I	Group II	Group III
Group I	-	+	+
Group II	+	-	+
Group III	+	+	-

DISCUSSION

P.gingivalis is a microorganism who has a capability to form biofilm, and found in a necrotic root canal. This bacteria attached in root canal surface by some filamens called Fim A and communicate with other bacteria and form a defense called biofilm, which resistance to antimicrobe[2]. Porphyromonas gingivalis biofilm has a protective layer named extracellular polimer matrix (EPM) which stand of polisacharide, protein, and DNA. The major part of biofilm is water which take 90% of its structure[12].

In this study we know that the optical density from the mangosteen pericarp extract 25% has the smallest value among the NaOCl and Control group. It indicates that mangosteen pericarp extract has a good effectivity in degrading a biofilm. Mangosteen pericarp extract known to has some active component such as saponin, xanthone, flavonoid, and tannin which has an antibiofilm activity. Saponin is a surfactant agent who degrading biofilm matrix by disturbing biofilm metabolism then release the bond between the bacteria on the biofilm[6]. Saponin has a molecul which could attract water or hydrophilic, this thing will make extracellular matrix in Porphyromonas gingivalis biofilm dispersed. When the biofilm"s matrix dispersed the other active compound such as xanthone, flavonoid, and tannin will come in and damage the bacteria. Xanthone which is the biggest component from this extract, has a carbonil which can react with the amino acid recidu in membrane cell protein, extracellular enzyme or cell wall protein thus made them lose its function and the bacteria lysis[9]. Beside of that xanthone is also effective in eliminate anaerob gram negative bacteria which more resistant to antimicrobial agent. Flavonoid and tannin are also have a role in creating a complex compound with protein through hydrogen bond thus disturbing cell metabolism and cell permanently dmage[13]. Tanin have a role in coagulating bacteria protoplasm and make a settle bond with protein[14].

NaOCl is the most used irrigation agent in clinic. Clorin is a biofilm this person which can degrading Porphyromonas gingivalis biofilm by disturbing the metabolism and relies the bound between bacteria in biofilm[6]. The characteristic of NaOCl obtain from the Choloroamination reaction between clorin and amino acid which may interrupt the cells metabolism do to strong oxydating activity of chlor which case and oxidation of protein and cell enzyme. Chlorin could oxydating a sulphydryl compound irreversibly from the essential bacterial enzyme, cistein. This thing would inhibit enzyme work and then disturbing cell metabolism and damage the integrity of sytoplasmic membrane[15].

This study discovered that the OD value from NaOCl 2,5% group are higher comparing to the mangosteen pericarp extract and control group. It means that the number of Porphyromonas gingivalis biofilm after the adding of NaOCl solution is raising. It didn't match with the theory which said that NaOCl is the most effective solution in dismissing biofilm from root canal. As we know that in absorbancy calculation need a simple staining with crystal violet to know the OD value from each group. Meanwhile this crystal violet not only could stain the active bacteria but also death bacteria. Due to that situation the amount of the OD value from the NaOCl group has a false negative value.to prove that statement then we may perform a study to count the bacterial colony (CFU / Colony Forming Unit). From previous journals discovered that after the colony counting the NaOCl group is sterile.

Beside that, the other possibility which may case the false negative result on OD reader is the value of degradation of biofilm layer on NaOCl group is small, so that the biofilm layer which read on spectophotometric shows a high optical density value, but the active component from NaOCl can penetrate into the biofilm and adequate in killing the bacteria. Otherwise the mangosteen pericalp extract has an active component called saponin. Saponin is a surfactant agent or known as natural detergent which has a capability to disperse the biofilm layer so that the OD value whom readed on spectophotometric is smaller. This thing is match with the theory which said that an agent which has an antibiofilm activity could damage biofilm through lots of way. Such as penetrating the extra cellular matrix, dispersing cell from biofilm or interrupting the stability of EPS on biofilm[6].

The statistical analysis result from this study shows that each group has a significant differentiation. It means that there is a chance in biofilm optical density after the adding of specific antimicrobial agent. But it cannot define which group has the strongest antibiofilm activity because the varian value of the

result are not homogen. So the analysis perform in non parametric way. The unhomogen result may because of the difference of the time variable on sample preparation, such when the mixing of the testing agent and Porphyromonas gingivalis biofilm. There is possibility among the well has a few second time difference when they are start to mix. Otherwise there is a mistake in incubation process which case a variation in result due to the characteristic of P. Gingivalis which is an obligate anaerob bacteria and really hard to being incubated. Then it may also case by the washing procedure of each well before the optical density were read in a different microplate reader. A different washing result where one sample is clearer than the others were also resulting a different absorbancy reading in microplate reader. The clearer one will make the light easier to go through testing agent and make a bigger absorbancy and lower optical density value.

CONCLUSION

From this study we can conclude that there is a differences in antibiofilm activity between mangosteen pericarp extract 25% and NaOCl 2,5% against Porphyromonas gingivalis biofilm where the extract could degradating biofilm layer better than NaOCl 2,5%.

Apical Periodontitis Treatment: Surgical - Non surgical?

Dr. Juan Gaston Robledo

INTRODUCTION

Clinical Endodontics is defined as the prevention and/or elimination of apical periodontitis[1-3]. Epidemiologica studies have also shown that post treatment diseases is very common. The high rate of apical injuries is probably caused by deficient root canal treatments. Among these problems we can include: residual infection in inaccessible areas in the apex[4,5]; intraradicular infection[6]; extrusion of dentin remains with prescense of bacteria in dentinal tubules[7]; poor endodontic practices with or without altering the morphology of the root[8-10] canal and root vertical fractures[11-13]. Insufficient treatment of the root canal can be treated without surgery, while other problems may require surgery. Apical surgery offers immediate access to the root apex. The pathology is removed by curettage and section of the apex with frequent infections contained in the ramifications of the canals[5,14]. A full healing of the apical area is possible after the endodontic treatment. However, it has been observed that in some cases the swelling persists (Figure 1).

It is known that when carrying out the cleaning and disinfection of the canal, some biofilms can remain; these have been classified as different types of organized microorganisms included in a matrix[5]. These biofilms were the most common cause of persistence of the swelling and apical periodontitis[15]. They were also mentioned as inducers of chronic canal disease[5]. It is probable that tose bacteria are prsent in dentinal walls[5,16].

Procedures to carry out the root canal treatment, including root access, instrumentation, irrigation, intracanal medication and sealing of the canal are are carried out in an attempt to eradicate the infection from the canal system and eliminate spaces to avoid reinfection.

In infected root canals, the interior dentinal layer, next to the pulp, contains a great number of microorganisms[17,18].

Likewise, in some cases the bacteria have penetrated deeply into dentinal tubules, so much that they cannot be removed mechanically[19-21]. Clearly, there is no technique available capable of removing the entire infected internal dentin layer in a root canal; therefore, the bacteria remain in dentinal tubules after the instrumentation[21].

Since current procedures cannot remove the bacteria, the sealing of the canal can provide two types of solutions:
1- Prevent a new coronary infection
2- Bury remaining bacteria

Most ink penetration tests, have found colorant at least 1 mm from the foramen[22] indicating that there are spaces between the apical filling and the dentinal wall.

It has been proven that these empty spaces allow the movement of bacteria along the sealing of the canal[23-25].

a. Pre Op. **b.** Post Op. **c.** Recall 1 year

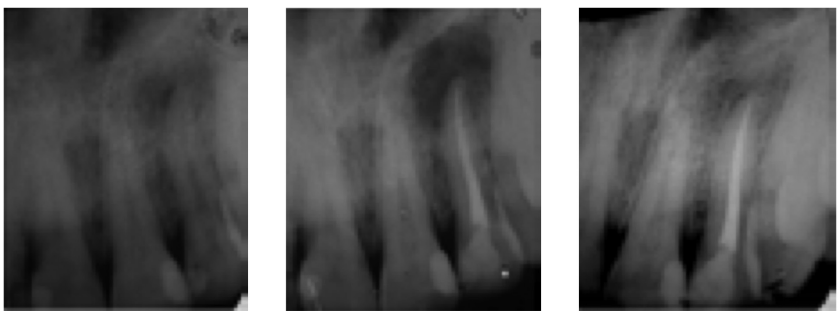

Fig 1. Endodontic treatment (Case courtesy Dr. Juan Jose Fernandez)

When the root is poorly sealed, inflammatory cells can be found in the residual pulp tissue. If there is extrusion of sealing material outside the limits of the rood apex, there will be swelling in the periapical area. This irritation of sealing material can be the factor causing the inflammatory response[26,27].

SURGICAL TREATMENT

The purpose of this surgery is to clean and seal all communication of the root canal near the apex. Indications for apical surgery usually include cases in which canal obstructions do not allow the checking (retreatment) or those in which it would not be advisable to do so (Figure 2).

The conservation of the natural dental piece is still the main goal. For this, we should evaluate, among other things, the possibility of restoration and return of the function of the dental piece.

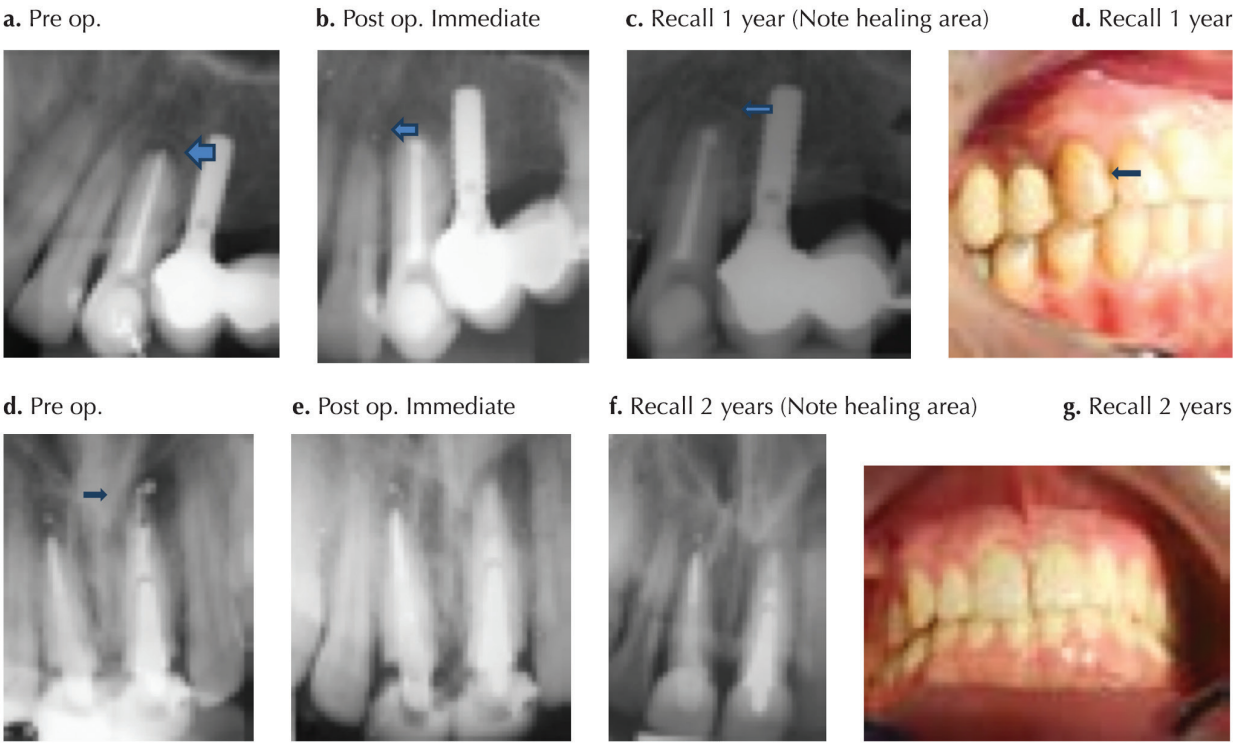

Fig 2. Endodontic Apical Surgery using MTA.

Dr. Juan Gaston Robledo
Endodontist, Department of Operative and Prosthodontics,
School of Dentistry, University of Buenos Aires, Argentina,

Evaluation of Fiber Post-Supported Restorations Under Simulated Occlusal Loading

Dr. JWW Chang

Dr. Irwan Soo

Dr. Gary S.P. Cheung

STATEMENT OF PROBLEM

There is a lack of information comparing the effect of a rigid versus flexible post on the mar- ginal seal of post-and-core supported crowns subjected to long-term repeated loading.

PURPOSE

The purpose of this study was to examine the leakage pattern of complete coverage restorations retained with either a metal or fiber-reinforced resin post under simulated occlusal loads.

MATERIAL AND METHODS

Thirty-six maxillary central incisors were endodontically treated and provided with a post- and-core supported crown. One group was restored with a fiber-post (EasyPost Lux) and another was restored with a metal post (Parapost) (n=12). Both groups were loaded for 120 000 cycles to 70 N while immersed in a dye solution. A control group (n=12), similarly restored with a fiber post but not loaded, was also included. All teeth were transversely sectioned serially from the tooth-core interface towards the apex. Digital photographs were made to determine the extent of leakage on the buccal, mesial, palatal, and distal aspects along the depth of the post. A nonparametric Kruskal-Wallis test was used to determine any difference between groups (α=.05).

RESULTS

Dye penetration occurred in all stress-cycled specimens and was more extensive on the palatal than other aspects. The fiber-post group cyclically stressed to 70 N showed a significantly greater amount of leakage than the control or the Parapost group (P<.05).

CONCLUSIONS

In in vitro testing, the rigidity of the post influenced the seal of post-and-core-supported crowns at the palatal margin. (J Prosthet Dent 2012;108:158-164)

CLINICAL IMPLICATIONS

Marginal leakage invariably precedes loss of retention or fracture of the restoration, and therefore, may be regarded as a precursor to the failure of the treated tooth. The modulus of elasticity of the post is an important factor in the prevention of marginal leakage. Caution should be exercised in the use of fiber posts in teeth with minimal coronal tooth structure.

Endodontic posts were used to restore endodontically treated teeth as early as the 1870s.[1] Various proprietary systems have evolved over the years: some actively engage the post space wall, others are passively cemented into position. It is accepted that the primary functions of an endodontic post are to retain the core that supports the coronal restoration and to distribute the functional (and parafunctional) loads to the supporting structures.[2] Fracture of the post or the restored tooth are among the most common reasons for the failure of a restored endodontically treated tooth.[3,4] To overcome this issue of fracture, newer post materials have been introduced with a modulus of elasticity similar to dentin. The use of a rigid (metal) post may result in an unfavorable pattern of root fracture,[5] whereas posts made of materials (fiber-reinforced resin) with a modulus of elasticity similar to dentin seem to reduce the incidence of unrestorable fractures.[6] This hypothesis has been supported by in vitro[7-10] and clinical studies.[4,11] Studies using finite element analysis have reported that the maximum stress concentration was found at the cervical region of maxillary central incisors restored with fiber posts or the apical end of the post space for metal (stainless steel) posts,[12-14] which may explain the different patterns of root fracture for the 2 types of post. Before fracturing, a greater value of measurable strain was recorded at the buccal surface of teeth restored with a glass-fiber post than with a cast metal post, especially in the absence of a ferrule.[15]

The microleakage of restorations for endodontically teeth has been examined.[9] However, the effect of mastication on the post-and-core-supported restoration has seldom been reported. Masticatory force ranges from 50 N to 75 N in the anterior region and 145 N to 200 N in the molar region.[16] This magnitude of load has been shown to be sufficient to deform even an unrestored tooth to a measurable extent.[17,18] Libman and Nichols[19] reported the presence of micromovement of post-and-core-retained crowns under a cyclic load of 4 kg (about 40 N), although they did not evaluate leakage. In that regard, crown margins finished in metal usually exhibited a smaller gap than those finished in porcelain.[20] Freeman et al[21]

evaluated the movement at the crown margins and the pattern of leakage for various types of post under a cyclic load of 3.5 kg (35 N) and concluded that none of the systems (ParaPost; Coltène/Whaledent Inc, Cuyahoga Falls, Ohio), (Flexi-post; Essential Dental Systems Inc, Hackensack, NJ), or a cast post) could prevent microleakage, the extent of which was not significantly different among systems. In a similar study by Jung el al,[22] it was found that there was no significant difference in leakage among the various brands of posts examined (ParaPost; Coltène/Whaledent Inc, FRC Postec; Ivoclar Vivadent, Schaan, Liechtenstein, and Cosmopost; Ivoclar Vivadent) under a cyclic load to 9.8 kg (96 N). Micromovement has been implicated in the initial breakdown of marginal seal during fatigue loading, although no loss of retention or detectable marginal gap could be noted for restored, endodontically treated teeth after 250 000 to 1 000 000 cycles of simulated occlusal impact.[19,21-26] Therefore, the breakdown would remain clinically undetectable unless accompanied by mar- ginal discoloration or (at a much later date) recurrent caries.

Macroscopically, a post may still be retained in the tooth because of sliding friction, even though the integrity of the luting cement has been disrupted.[27] Microleakage and bacterial invasion would occur in such instances of a partially broken cement layer. This condition may remain clinically undetectable for a significant period before any clinical signs or fracture of the tooth (or the post) occurs. Leakage via the coronal restoration, however, would continue throughout this period. In a tooth with a vital pulp, the outward flow of dentinal fluid can limit the diffusion of noxious stimuli or bacteria through the tubules,[28,29] but such a protective mechanism would be absent in endodontically treated teeth. The acid-etching of the tooth preparation before cementation of the post and the crown would have removed the smear layer and facilitated dye penetration into the dentinal tubules. Indeed, bacterial invasion of dentinal tubules has been reported to occur more readily after the smear layer has been removed than with smeared dentin.[30,31] A study of the pulpal status following extracoronal restoration indicated that about 16% of teeth became pulpally involved after some 14 years of service intraorally.[32] That is, bacterial invasion of the pulp can occur even when a vital tooth is protected by a complete-coverage restoration. Bacterial invasion via the dentinal tubules cannot be overlooked. Microlea age tests would be useful to indicate the relative sealing ability of the endodontic material or restorations.[33,34]

It has been suggested that fatigue has a role in the clinical failure of dental restorations,[35] and that tooth fracture due to simple overloading is rarely seen clinically.[36] Incorporation of a ferrule of at least 1.5 mm height in the tooth preparation has been recommended for the final restoration of endodontically treated teeth.[2,5] However, many in vitro studies examining the microleakage of post-and-core restorations have been done without restoring the tooth with the definitive crown.[9,22,37-39] These authors argued that placement of a crown would interfere with the true extent of leakage for the various types of post being evaluated. However, such an experimental design would only test the seal of the luting cement for the post (and the bonding of the composite resin foundation); this is not a true representation of the clinical situation, where a complete-coverage restoration is present to "protect" the foundation and participate in occlusal function. Thus, the purpose of this study was to examine the leakage pattern of a complete-coverage restoration retained with either a metal or a fiber-reinforced post for an endodontically treated anterior tooth under simulated occlusal loads. The null hypothesis was that there would be no difference in the leakage pattern between the 2 post materials evaluated.

MATERIAL AND METHODS

Thirty-six maxillary central incisors, freshly extracted for periodontal reasons, were selected. All teeth had a similar root length and mesiodistal and buccolingual widths. They were examined under an operating microscope to confirm the absence of crack lines. The teeth were cleaned by immersion in 6% sodium hypochlorite for 3 minutes to remove organic debris, followed by ultrasonic scaling to remove hard deposits before storage in 1% chloramine-T (Sigma-Aldrich, St. Louis, Mo) solution until use. Radiographs were made from the buccolingual and mesiodistal directions to evaluate the root canal curvature with a method described by Schneider.[40] The mesiodistal and buccolingual diameters at the cementoenamel junction (CEJ) of each tooth were measured to the nearest 0.01 mm with a digital micrometer (Digimatic caliper; Mitutoyo American Corp, Aurora, Ill). The teeth were divided into 3 groups of 12 teeth each by using a stratified sampling method so that the mean dimension and cur vature were similar for each group.

All teeth were decoronated at 1.5 mm above the CEJ in a saw microtome (SP1600; Leica Microsystems, Nussloch, Germany) under a constant stream of water. The overall (remaining) tooth length was determined by inserting a size 10 K-file (Mani, Tonchgi, Japan) until it was just visible at the apical foramen; this was reduced by 1 mm as the working length. All root canals were prepared with files (Senseus FlexoFiles; Dentsply Maillefer, Ballaigues, Switzerland) to size 60 at the working length and then stepped back at 1 mm intervals to size 80 file. A fixed volume (3 mL) of 3% sodium hypochlorite was used in a 27-gauge needle to irrigate the canal after each instrument. The final rinse comprised 3 mL of 17% ethylenediaminetetraacetic acid (EDTA) to remove the smear layer, followed by 3 mL of deionized water to remove any residue in the root canal system. After drying with paper points, the canal was obturated with warm vertical compaction of gutta-percha with sealer (AH Plus sealer; Dentsply DeTrey, Konstanz, Germany), leaving a post depth of approximately 9 mm.

All teeth were then prepared at high speed with an air-water spray coolant for a metal ceramic crown with a ferrule height of 1.5 mm.[41] The preparation was finished to a chamfer margin on the palatal and a 1 mm-wide shoulder on the buccal, mesial, and distal aspects. A post space was prepared with proprietary drills (of the selected system) to a depth of 9 mm (measured to the flattened surface of the decoronated tooth). Group FP0 (fiber-post, not loaded) and FPL (fiber-post loaded) were restored with a prefabricated, quartzfiber-reinforced resin post system (EasyPost Lux; Dentsply Maillefer). This post was parallel in the coronal part but tapered at its apical portion (1.3 mm diameter at the tip and 2.0 mm diameter at the cervical area). The last group, PPL (ParaPost loaded), was fitted with a parallel-sided, stainless steel post (Ø 1.5 mm, ParaPost; Coltène/Whaledent). The fiber-post was cleaned with alcohol, whereas the stainless steel post was airborne particle abraded with 50-µm alumina particles. The post space was etched with 37% phosphoric acid for 15

seconds, flushed with 3 mL of deionized water, and dried with paper points. All posts were luted in place with an adhesive cement (Panavia F 2.0; Kuraray Medical, Okayama, Japan): Primer A and B were mixed according to the manufacturer's instructions and 2 coats were applied on the post and to the post space. Excess primer was removed with an absorbent paper point, followed by a gentle stream of air from a 3-in-1 syringe across the decoronated surface. The cement was mixed and applied with a Lentulo spiral (Dentsply Maillefer). The post was smeared with the cement and seated firmly to position with a slow, steady motion. It was held in place with firm finger pressure for 5 minutes, and excess cement was removed with a scalpel blade. A polymerizing light (Optilux; Kerr Corp, Orange, Calif) with an intensity of 600 mW/cm2 was applied for 40 seconds from the coronal end of the post. Then, a core was prepared incrementally with a composite resin (Fluorocore; Dentsply Caulk, Milford, Del) to a height of 5 mm and finished with a fine-grit diamond rotary cutting instrument (Prima Dental, Gloucester, UK) under air-water spray. All composite resin foundations were prepared 2 weeks before the leakage test to prevent degradation of the composite resin due to storage[42] and to allow time for fabrication of the crown. A vinyl polysiloxane impression was made to fabricate a complete-coverage restoration that was similar to a metal ceramic crown; however, metal was used instead of the porcelain facing because esthetics were not relevant to this study. A custom-made index was used during waxing so that the crown had a step on its palatal surface 1 mm above the foundation. This provided a stable platform for the application of cyclic load from a stylus made of tempered stainless steel (Fig. 1). The platform was 2 mm deep and 2 mm in height. Thus, the incisal edge of the crown was 8 mm above the decoronated root face for a clinical crown height of 9.5 mm. The crowns were evaluated for fit with ×6 magnification before cementation. Those showing discrepancy at the margin were remade. The crown was luted with an adhesive cement (Panavia F 2.0; Kurray Medical) according to the manufacturer's instructions.

Before testing, 2 coats of clear nail varnish were applied with a brush on the root surface just below the crown margin under ×2.5 magnification. A layer of silicone sealant (Sista F109; Henkel AG, Düsseldorf, Germany) was painted on top of the varnish to about 2 mm short of the CEJ for all specimens to stimulate the periodontal ligament.[20] An acrylic resin (Lucite Intl, Southampton, UK) block was prepared with 1 line angle flattened at 45 degrees; a 12 mm-deep hole of 8 mm diameter was drilled into this inclined face to house the tooth that was embedded in position with an autopolymerizing acrylic resin (Rapid Repair; Dentsply DeTrey) to the level of the silicone sealant. The load was applied vertically to simulate an interincisal angle of 135 degrees as in an Angle's Class I occlusion.

Groups FPL and PPL were subjected to cyclic loading at a frequency of 2.0 Hz43 for 120 000 cycles while immersed in a 2% basic Fuchsin dye solution throughout the experiment (Table I). As a control, Group FP0 was immersed in the dye but not loaded, thereby assessing the extent of leakage without simulated occlusal loading. After 7 days in the dye (the load cycles might have been completed earlier), the specimens were retrieved and left to dry at room temperature for 48 hours. They were then examined for clinical signs of failure by evaluating for loss of retention, root fracture, and any marginal gaps with the aid of a sharp probe under ×2.5 magnification. The acrylic resin block, together with the mounted tooth, was then embedded again in the autopolymerizing acrylic resin (Rapid Repair; Dentsply De-Trey) in such a manner that the long axis of the tooth was parallel to the side of the mold. The orientation for each specimen was encoded before it was serially sectioned in a microtome (SP1600, Leica Microsystems) with a 280 µm-thick blade; the specimen was fed slowly (about 50 µm per min) to avoid disrupting the cement lute. The first transverse cut was made at 8 mm from the incisal edge to coincide with the location of the natural tooth structure.

Any discrepancy in the location of this first cut was found to be within 100 µm. Then, each subsequent section was made at 1 mm intervals, producing slices of approximately 700 µm thick. Both the top and bottom surfaces of each section were photographed with a digital camera (Finepix S2 Pro; Fujifilm, Tokyo, Japan) with macro lenses (Nikkor 60mm macro f/2.8D, Nikon, Tokyo, Japan) attached to an auto-extension ring (PK-12, Nikon) at a fixed magnification and orientation. The digital photographs were enhanced with software (Photoshop 7.0, Adobe, San Jose, Calif). A target cross-grid was pasted to indicate the center of the (circular) post, dividing each crosssection into 4 regions for evaluation: buccal, palatal, mesial, and distal.

The extent of dye penetration was scored on an ordinal scale as follows:
Score 0 – No dye penetration; Score 1 – Dye penetration into tooth restora- tion interface but not extending into the dentinal tubules; Score 2 – Dye penetration into the crown margin and extending less than half the width of the root; Score 3 – Dye penetration into

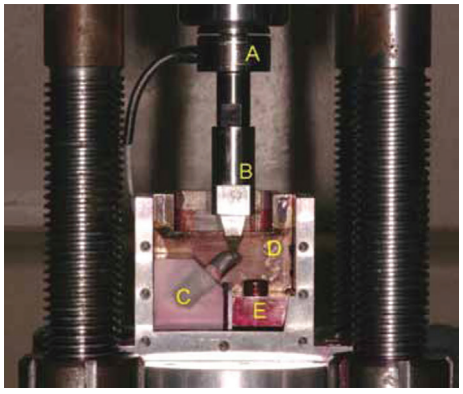

Table 1. Various groups tested in study

Groups	Type of Restoration	Loading	Tracer Exposure Time
FP0	Fiber-post and complete crown	Not loaded	Placed in dye solution for 7 days
FPL	Fiber-post and complete crown	120000 cycles (min. 10 N, max. 70N)	3 days loading + 4 days immersion (total 7 days)
PPL	ParaPost and complete crown	120 000 cycles (min. 10 N, max. 70N)	3 days loading + 4 days immersion (total 7 days)

Fig 1. Assembly for cyclic loading of restoration (with front cover of container removed).
A - load-cell; **B** - loading stylus; **C** - acrylic resin mold embedding root of specimen; **D** - reservoir for dye solution; **E** - locking device.

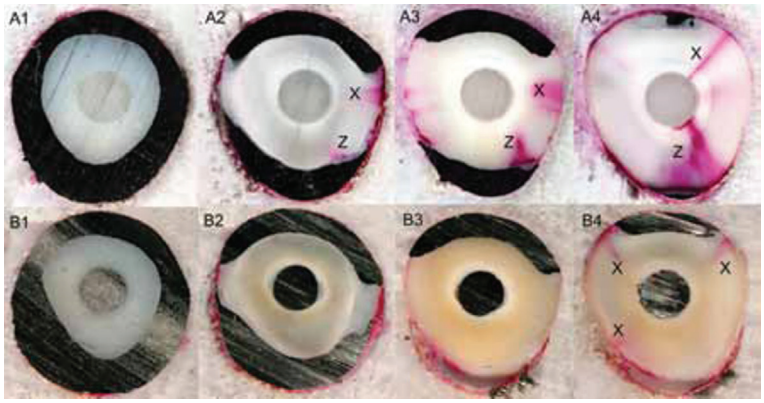

Table 2. Comparison of mean (SD) leakage score among groups (n=12)

Groups	Mean (SD)	Kruskal-Wallis Grouping
FP0	0.21 (0.07)	*A*
FPL	2.19 (0.76)	*B*
PPL	0.35 (0.28)	*A*

#No significant difference among groups with same letter (P>.05)

Fig 2. Photographs of surfaces after sectioning: A1 to A4 - Loaded fiber-post retained restorations; B1 to B4 - Loaded ParaPost restorations (X - leakage from root surface not recorded; Z - leakage recorded for dye penetra- tion from restorative interface into dentin).

the crown margin and extending more than half the thickness of the post space wall; Score 4 – Dye pen- etration into the post space or the post-dentin interface.

During evaluation, it was noticed that some leakage not related to the crown margin (Fig. 2) had originated at the root surface. This appeared to be related to that part of the root not covered with nail varnish. As the leakage there was not related to the margin of the restoration, it was not scored. That is, leakage was assessed only when it could be traced to the tooth-restoration interface. Results were compared by using a nonpara- metric Kruskal-Wallis test with the Dunn multiple comparison test at α=.05 by using software (GraphPad InStat, v3.06 for Windows; GraphPad Software, San Diego, Calif).

RESULTS

All crown margins were found to be intact after the cyclic loading regime and none of the crowns were dislodged. There was no tooth or root fracture. Dye penetration was noted at the cervical region or at the crown margin of all restored teeth. Group FP0 (fiber-post unloaded but immersed in dye for 7 days) showed a mean leakage score of less than 1 at various locations of the tooth. Leakage was evident in all FPL specimens (fiber-post, loaded to 70 N). The dye was seen to follow the path of dentinal tubules from the cervical dentin (corresponding to the location of the ferrule), reaching the post space at the palatal aspect of all specimens of this group. A lesser amount of leakage was noted at the mesial or distal aspect, whereas the least was at the buccal aspect for this group. The PPL (ParaPost, loaded to 70 N) group showed a mean leakage score of less than 1 (Table II) with none extending into the post space.

DISCUSSION

When the 2 different but similarly loaded (70 N) post systems were compared, teeth restored with a stainless steel post showed significantly less leakage than those restored with a fiber post. Thus, the null hypothesis was rejected.

Cyclic loading is a better simulation of masticatory function than monotonous loading that merely evaluates the static load-bearing capacity of the tooth.[9] Tooth fracture due to simple overloading is rarely seen clinically,[36] casting doubts on the usefulness of data generated by a monotonous load.

In vitro studies of restorative materials generally include some artificial aging process to simulate the ser vice of the restoration in the clinical situation. This is done either with thermocycling, cyclic loading, or a combination of the two. In the case of a post and core, thermocycling is arguably not applicable because the material is protected beneath the final restoration. Therefore, cyclic loading only was applied in this study. The frequency of the load cycles used in other studies has varied from 1 Hz to 5 Hz[24,25]; some did not mention the frequency of load application.[8,26] It has been reported that opposing teeth contact each other once to twice per second during mastication,[43] and thus a frequency of 2 Hz was used here to make the study clinically relevant. The use of a higher frequency to shorten the test period, as was done in some other studies, assumes that the fatigue life of the tooth or restoration is not frequency dependent, an assumption that has not been verified.

In the present study, a ferrule of 1.5 mm in height was included in the restoration, a procedure that is recommended for clinical practice.[41] A crown was provided for each tooth to mimic the clinical situation. There is a chance that this might have obscured the difference in the extent of leakage between groups because the underlying post and core were "protected" by the complete-coverage restoration. Yet, the results suggested some differences in the leakage pattern between a rigid, metal post and the more flexible, fiber-reinforced post. The ceramic portion of the crown was not fabricated, primarily for convenience, but this was judged by the authors not to have any adverse effect on the result. The margin of the metal substructure has been reported to exhibit a smaller gap than ceramic margins.[19] This might have partly contributed to the small amount of leakage seen on the facial aspect of the loaded specimens. However, and more importantly, the facial margin (of maxillary anterior teeth) is under a compressive load during function, and so there is a lesser chance for marginal gap opening to occur in this location.

Fiber posts have been proposed to reduce the stresses developed within the root structure during loading,[13,14] and this may result in a more favorable fracture pattern after failure.[22] A fiber post with a relatively low elastic modulus would induce higher stresses and strain in the cervical region than a stiffer metal post[12,15] which, however, would induce the highest stress at the apical end

of the post space. Fiber posts would allow a similar amount of movement of the crown as intact unrestored teeth.[18] Such micromovement could lead to marginal percolation and leakage. One study reported no difference in the extent of microleakage between ParaPost and fiber posts (FRC Postec or Cosmopost) after 50 000 load cycles.[22] However, the present study found that specimens restored with the metal post had a lesser leakage score than those restored with the fiber post. This may be due to the much greater number of load cycles applied in the present study, which has helped to demonstrate the small but significant difference between a rigid and a flexible post.

A dramatic increase in the extent of microleakage was observed for the cyclically loaded fiber-post specimens when compared with those similarly restored but unloaded specimens and those restored with the ParaPost. It is interesting to note that leakage may proceed not only along the toothrestoration interface but also through the dentinal tubules (once it manages to reach the dentin surface of the ferrule). In some specimens, the dye was seen to follow the dentinal tubules, penetrating the thickness of the ferrule to reach the postspace, instead of merely tracking along the toothrestoration interface.

There was a significant difference in leakage between fiber-post and ParaPost where microleakage of the overlying complete-coverage crown is concerned. This may be related to the high modulus of elasticity of stainless steel, which may have prevented the build-up of stresses and hence micromovement at the cervical region of the tooth, such movement being able to cause percolation at crown margins. Mechanically, the palatal aspect of the tooth is under (cyclic) tension, which explains the increased amount of leakage at the palatal aspect for all loaded specimens. The authors are aware that various dyes may show a different extent of penetration[33,34] and the results of any leakage test may not be directly correlated to the clinical outcome of treatment. However, the experimental design here was regarded as appropriate to compare the sealing ability among various materials or techniques instead of quantifying the amount of leakage.

CONCLUSION

Within the limitations of this study, the following conclusions were drawn:

1. Parapost is associated with improved sealing of the final complete-coverage restoration in maxillary anterior teeth.
2. The mechanical property of the post has an effect on the marginal seal.
3. The restored tooth (with a post-and-core, followed by a complete- coverage crown) should be regarded as an integral unit when evaluated for its simulated clinical performance.
4. Marginal leakage invariably precedes the loss of retention of the post-and-core supported restoration and may be regarded as a precursor to failure of treatment, be it restorative or endodontic.

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Dr. JWW Chang, BDS, MDS
Assistant Professor, Comprehensive Dental Care (Endodontics), Faculty of Dentistry, The University of Hong Kong
Dr. Irwan Soo, DDS, MDS
Lecturer, Endodontics Unit, Department of Operative Dentistry, Faculty of Dentistry, The National University of Malaysia
Dr. Gary S.P. Cheung, BDS, MDS, MSc, PhD
Professor, Comprehensive Dental Care (Endodontics), Faculty of Dentistry, The University of Hong Kong

The beneficial antioxidant effect of minocycline 0,1% reduced bleeding on gingival inflammation

Dr. Ernie Maduratna Setiawati

ABSTRACT

Background

Minocycline, have been shown to suppress the growth of bacteria plaque. Minocycline was reported to induce cytoprotective effects in gingival epithelium induced Agregatebacter actinomyctemcomitans. The beneficial effects of the minocyclines were shown to be related to a reduction of the inhibition of inducible nitric oxide synthase and interleukin (IL)–1β expression. The rationale of the study is based on our previous studies demonstrating the beneficial antioxidant effect of minocycline 0,1% in vitro.

Purpose

The aim of the present study is to assess the clinical efficacy of minocycline 0,1% oral rinse in managing of gingival inflammation.

Material and method

Patients with bleeding on gingiva will randomly receive minocycline rinses. Thirty adult chronic periodontitis patient divided into two groups . group 1 : comprised fifteen chronic periodontitis involved sites managed by scaling root planing alone. And group II : comprised fifteen chronic periodontitis involved sites treated by the same technique in adjunct with the application of antioxidant mouth rinse minocycline. Clinical examination include bleeding on probing (BOP) with papilla bleeding index.

Result

These findings suggest that minocycline oral rinse 0,1% may actually decrease bleeding on gingiva significantly ($p<0,05$).

Conclusion

We report that minocycline provides inhibitor effect against bleeding on gingiva. Minocycline 0,1% as an antioxidant effect potential as adjunct theurapetic agent to reduce gingival bleeding.

INTRODUCTION

Oxidant and bacterial deposits play an essential role in pathogenesis of gingival inflammation. Gram negative anaerobes were predominantly isolated than gram positive in periodontitis cases.[1,2] The presence of pathogen alone is not sufficient to cause periodontal inflammation. Bacterial pathogen gram negative anaerobes stimulate host cells to release proinflammatory cytokines. This cytokines recruit PMNs to produce proteolytic enzymes such as elastase, collagenases and molecular oxygen by oxidative burst.[3-5] Free radicals highly reactive and diverse species, capable of extracting electrons and thereby oxidizing a variety of biomolecules vital to cell and tissue functions. Periodontal tissue destruction leads to overproduction of lipid peroxides, inflammatory mediator and oxidized proteins. These products further activate macrophages, neutrophils and fibroblast to generate more ROS.[6] The disturbance of this equilibrium between the free radicals and antioxidant is the prerequisite for healthy periodontal tissue, so has led to search for appropriate antibacteri therapy and anti oxidant therapy for prevention and treatment of periodontal inflammation.[7,8]

Minocycline is a semi-synthetic tetracycline with broad-spectrum antibacterial activity in addition to their antimicrobial effect have been shown to anti oxidant effect. In addition to antimicrobial activity, minocycline exerts immunomodulatory effects via suppression of T lymphocytes and PMNs leading to reduction of tissue destruction attributed to active T cells and PMNs. Minocycline delays T cell proliferation associated with IL-2 activity and suppresses T cell production of interferon-gamma (IFN-γ) and tumor necrosis factor-alpha (TNF-α), which play a role in the epithelial damage. Minocycline in vitro delayed the migration of PMNs and reduced phagocytic activities of the PMNs. It also was reported that incubation of PMNs with minocycline suppressed the tissue damage linked to PMN activity.[8] Bleeding on probing (BOP) is a widely used criterion to diagnose gingival inflammation. BOP useful prognostic indicator in clinical diagnosis for patients in periodontal disease. The purpose of this study was to evaluate the clinical efficacy of a minocycline mouth rinse in reducing bleeding on probing in gingival inflammation.

Method

Thirty patients with gingival inflammation were enrolled for this study. All subjects signed institutional approved informed consent and were clinically diagnosed with chronic periodontitis. All subjects were otherwise healthy individuals as documented in health history. None had any contraindication to use of tetracycline medications (allergy, breast-feeding, pregnancy and age less than 12 years). Using a random numbers computer program, qualified patients were randomly, starting the treatment

with minocycline 0,1% mouth rinses. They were divided into two groups, where group 1 : comprised fifteen chronic periodontitis involved gingival bleeding sites managed by scaling root planing alone. And group II : comprised fifteen chronic periodontitis involved gingival bleeding sites treated by the same technique in adjunct with the application of antioxidant mouth rinse minocycline 0,1%. Clinical examination include bleeding on probing (BOP) with sulcus bleeding index. The rinses were prepared based upon the effective antioxidant dosage of the medications, subjects used 0.1 % aqueous solution of minocycline as mouthrinse. The preparations were of similar consistency without color. The subjects were instructed to begin mouthwashes as randomly assigned. They were instructed to rinse their mouth with tap water prior to the administration of the study rinse and then to rinse with 5ml of the solution for 30 second, two times a day avoiding any food or drink for at least ½ hour after the rinses. Therapy continued for up to 14 days. Examiner A using a standardized periodontal probe (CP11 Hu Friedy, Europe) detected Bleeding on Probing (BOP). The BOP was considered positive if bleeding occurred between 30 seconds after probing and used Sulcus Bleeding Index (SBI).

Sulcus Bleeding Index (SBI)

An early sign of gingival inflammation is bleeding on probing. Muhlemann and Son (1971) described the Sulcus Bleeding Index (SBI). The criteria for scoring are as follows:

Score 0 – health looking papillary and marginal gingiva no bleeding on probing;
Score 1 – healthy looking gingiva, bleeding on probing;
Score 2 – bleeding on probing, change in color, no edema;
Score 3 – bleeding on probing, change in color, slight edema;
Score 4 – bleeding on probing, change in color, obvious edema;
Score 5 – spontaneous bleeding, change in color, marked edema.

Four gingival units are scored systematically for each tooth: the labial and lingual marginal gingival (M units) and the mesial and distal papillary gingival (P units). Scores for these units are added and divided by four. Adding the scores of the undivided teeth and dividing them by the number of teeth can determine the sulcus bleeding index. Statistical analyses were conducted using the T-test for independent samples.

Results and Discussion

Table 1: sulcus bleeding index score at minocycline oral rinse treatment and SRP treatment sites

Treatment	Sample size	Day 0 SBI score	Day 14 SBI score	p value
SRP	15	4,6	0,73	$p < 0,05$
SRP + MINOCYCLINE	15	4,7	0,17	$p < 0,05$

Periodontal diseases are primarily inflammatory in nature, the ability to detect inflammatory lesions in gingival tissues is essential for the diagnosis and monitoring of changes in periodontal status. One of the first clinical signs of progressivity of gingival inflammation is the bleeding on probing. Bleeding occurs because of frequent micro-ulcerations in the epithelium probing that lines the gingival sulcus/periodontal pocket. Bleeding on probing has been used as a key parameter in the evaluation of periodontitis because of its objectivity and ease of clinical access. Analyses of gingival biopsies with an inflammatory cell infiltrate in the gingival tissues are correlated with visual signs of inflammation and bleeding on probing. Bleeding on probing (BOP) is an indicator of tissue inflammatory response to bacterial pathogens. Due to anatomical limitations, the entity and physical state of microbial aggregations located under the gingival margin and their relations to BOP have been hardly investigated till now. The bleeding on probing (BOP) is a widely used clinical sign as indicator of the periodontal condition and disease progression.[9]

Reactive oxygen species (ROS) are physiologically produced by the cellular metabolism. Exogenous sources of ROS are smoking, ultraviolet light, heat, ultrasound, ozone, radiation, bacteria infection, excessive exercise, trauma, and drugs, whereas endogenous sources include products of metabolic pathways and products of immune and connective tissue cells. Antioxidants are substances that can inhibit the action of oxidant species. There is a physiological fine balance between oxidant activities and antioxidant defenses, but when this equilibrium is disrupted to the advantage of ROS, or to increased ROS activity or to want of antioxidant defenses, the result is oxidative stress. An amplified activity of ROS implies a large spectrum of molecular and cellular damage. This results in covalent binding with proteins, which alters their structure and function. Some oxidized proteins are difficult to remove by cells and tend to accumulate with aging and in the presence of chronic diseases such as chronic periodontitis.[7,8]

Minocycline is a semi-synthetic tetracycline with broad-spectrum antibacterial activity in addition to their antimicrobial effect have been shown to anti oxidant effect. Minocycline prevents oxidative protein modifications and damage in disease models associated with inflammatory activation and oxidative stress. Although the drug has been assumed to act by preventing the up-regulation of proinflammatory enzymes, minocycline is direct chemical interaction with reactive oxygen species. The antibiotic did not react with superoxide or •NO radicals, but peroxynitrite. The antioxidant activity of minocycline extended to cellular systems, because it prevented mitochondrial DNA damage and glutathione depletion.[10,11]

Its clinical relevance has been shown that the decrease of mean level of bleeding on probing favor of minocycline starting on 7 day ($p < 0.05$). A study on this topic, demonstrates that the absence of BOP represents a reliable indicator of periodontal stability. Besides, the value of BOP as predictor of future periodontal deterioration seems to significantly increase when associated with periodontal pocket depth. Bleeding on probing (BOP) is a widely used criterion to diagnose gingival inflammation. Many factors can influence bleeding, including medications, systemic diseases, and smoking. In this study showed that significant decrease BOP was seen with minocycline mouthrinse compared to control. These findings suggest possible use of minocycline for prevention of progressivity of periodontitis. The concentration of minocycline rinse in the current study (0.1%). It was based upon the minimum inhibitory concentration of the subgingival bacteria and antioxidant effect as used in a previous study. In high doses, systemic minocyclines may be associated with changes in cutaneous pigmentation and accumulation of derivates may occur in bones and developing teeth. Topical minocyclines for chronic periodontitis also report a lack of major side effects. The topical use of minocycline was based on the assumption that a bacterial etiology accompanies the onset of chronic periodontitis. However, the impact of minocycline upon

cytokine production, cellular degranulation and collagenase activity may represent the mechanisms of action has been documented in periodontal disease.[12] The current study, strongly suggests that topical minocycline may have greater impact upon the tissue damage and healing. Administration of minocycline 0,1% as an adjunct to scaling and polishing resulted in statistically significant improvements in periodontal clinical status, and significant reductions of pocket depth and bleeding on probing. The results of the present study show that minocycline rinses 0,1% are significantly effective for management of gingival inflammation.

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Discuss How Pain is Controlled in Endodontic Therapy

Dr. Jarvis "Trigger" Pulpman

INTRODUCTION

Pain is a word synonymous with dentistry. Indeed, one could argue that the primary objective of a dentist is to ensure that their patients are free of toothache; the most common oro-facial pain. In turn, it is fear and anxiety of pain whilst visiting the dentist that is a primary driver of dental phobia[1].

The International Association for the Study of Pain's widely used definition states: "Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage."
Fig 1.[2]

It is important to appreciate that pain is both a physiological and psychological phenomenon (Fig 1). The endodontist is faced with a great challenge given that the sequelae of pulpal damage to require endodontic therapy is likely to mean the severity of pain is high or there has recently been significant discomfort emanating from the tooth in question; leading the patient to be apprehensive of further treatment once acute symptoms have dissipated. To complicate matters further, RCT is an intricate procedure, requiring high patient cooperation, often at substantial financial costs[3]. Additionally, multiple appointments are often necessary[4], flare-ups may occur[5] and in any case the long-term prognosis of the tooth may be guarded-particularly in retreatment procedures[6].

Successful pain management lies at the core of efficacious root canal therapy and overall patient satisfaction; for it is the pain; pre-operatively, intra-operatively and post-operatively that the patient shall recall-as opposed to any textbook sign of clinical and radiological resolution of periapical infection.

This essay shall explore the literature to evaluate pain control in endodontic therapy in the three phases highlighted above; which each broadly fit into 3 lines of management-diagnosis, dental treatment (verbal, behavioural and operative aspects) and drug therapy; or the "3 Ds".

PRE-OPERATIVE TREATMENT

Diagnosis and Case Selection

Inevitably, successful pain control can only begin once the correct diagnosis has been established. This necessitates a thorough history, clinical examination and appropriate special investigations. Dental pain can present as a consequence of multiple pathology, such as a "perio-endo" lesion[7]. Additionally, more than one tooth may be causative and non-odontogenic causes must also be taken into consideration[8]. Where diagnosis proves inconclusive, definitive treatment cannot commence and the patient must be re-assessed on a separate occasion or referred for a specialist opinion.

With a diagnosis established, the prognosis of a successful outcome is important. Can the tooth be restored post-treatment[9]? Are there pulp stones or calcifications[10,11]? Are the canals highly curved and likely to prove difficult to negotiate? It must be determined whether the clinician is competent to carry out the RCT in question to a high standard; that will in turn relieve symptoms, or if a specialist referral must be sought.

Informing the patient

With a diagnosis now established, the patient can now be informed of what is the aetiology of their pain; by means of various aids-such as verbal, written, animation. Fear of the unknown is a key mediator of pain and for the patient to be re-assured that their pain will get better, is perhaps the first step along the pain control pathway. This necessitates an empathetic practitioner, with good communication skills, to acknowledge their distress and help alleviate any concerns they have[3].

The patient should be made aware of all treatment options available; their associated risks and benefits; the prognosis of achieving a successful outcome (both for general dentist and specialist) and associated costs-including definitive restoration. Failure to address the latter issue may result in acute financial pain for the patient and chronic financial woes for the clinician.

An attempt should be made to de-mystify endodontic treatment; with a brief explanation as to the use of rubber dam, various files, irrigants and the justification for taking multiple radiographs. This can again be achieved by the aids highlighted above and is an additional important step in pain management, given that education of the procedure, in lay man's terms, shall help eliminate doubt in the patient's mind and help foster more trust in the clinician-patient relationship[3]. Evidently, some patients are keen to know as little as possible and this should be respected.

Antibiotics

It is generally regarded that antibiotic misuse is widespread in the field of dentistry; which has concurrently contributed to increased antibiotic resistance[12]. There is a strong element of truth to this statement and it is important to act against the source of infection to relieve pain in an endodontic emergency-be it drainage of a swelling, extirpation of the pulp or a combination of the two. Drugs; be they analgesics or antibiotics are only adjuncts to operative treatment.

Whilst a careful approach to antibiotic prescription is thus encouraged, they may be required in certain circumstances. This includes the following scenarios: Evidence of spreading infection and systemic involvement[13], supplementative therapy for an immunocompromised patient (leukaemia, AIDS, poorly controlled diabetes)[14], inability to achieve adequate drainage, inability to achieve anaesthesia from tooth associated with acute periapical abscess and un-cooperative patients with acute symptoms; where there is likely to be a delay in operative intervention[15].

Unfortunately, antibiotic sensitivity tests are not routinely carried out for endodontic infections and thus the evidence base for the efficacy of antibiotics often prescribed in practice is low[16]. Further research is warranted in this area, particularly in the elimination of a chief culprit in endodontic failure; E.faecalis[17].

Analgesics

Although analgesics are predominantly used to help ease post-operative symptoms, studies indicate that NSAIDs given pre-treatment to RCT can help to achieve a more profound anaesthesia; which is at the heart of achieving pain free endodontic therapy and thus with cases that present with "hot pulps", gaining a helping hand to tackle the inflammatory mediators can only be beneficial[18, 19].

INTRA-OPERATIVE TREATMENT

Anaesthesia

Effective anaesthesia remains at the epicentre of successful pain control during the procedure and to a smaller degree post-operatively; but is often challenging to achieve in the face of acute symptoms. It requires the operator to have a range of local anaesthetics at their disposal; alongside knowledge of different anaesthetic techniques and patience[20].

Crucially, determining and maintaining anaesthesia should always be patient centred-if they can feel pain; appropriate anaesthesia has not been accomplished and this must be addressed immediately. Below par anaesthesia is likely to result in the patient being in a tension state, feeling nervous about any sensations they feel. Thus; a "top-up" within therapeutic limits, is often indicated.

Studies indicate that ID blocks; with the gold standard Lidocaine 2%, 1:80,000 adrenaline are at an elevated level of failure in endodontics, as result of acute infections. It has been demonstrated that utilisation of buccal Articaine 4%, 1:100,000 adrenaline has helped to achieve anaesthesia in such cases[21]. Additionally, the provision of secondary methods of local anaesthesia; which should be carried out sequentially, if necessary, as follows: intraligamentary injections, intraosseous injections and pulpal injections (see Fig 2); the latter which is particularly unpleasant for the patient[20, 21]. All such methods could be carried out with the more potent Articaine[22] or more widely used Lidocaine.

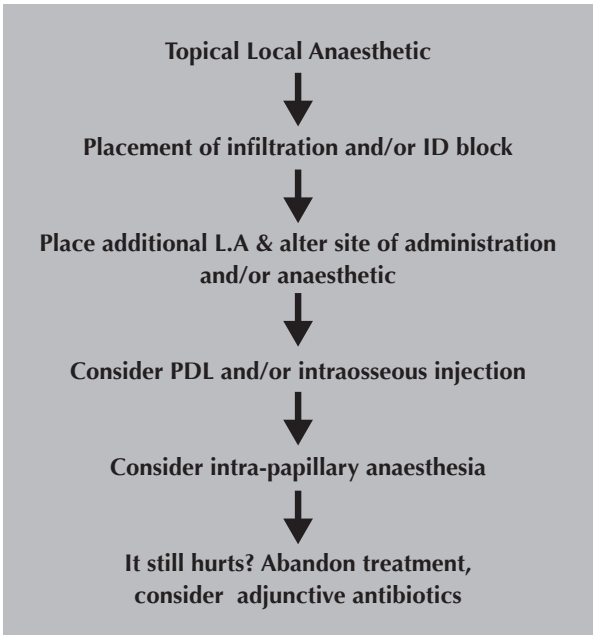

Fig 2. A sequelae of local anaesthetic administration that may be necessary to follow in endodontic therapy.
Adapted from[20]

A major challenge results from the presence of an indurated swelling. It is essential that injection is not made directly into this region, as this would generate severe pain. The injection should begin at the outer periphery of the swelling and advanced further as the area numbs, continuing inwards towards the centre of the swelling once contact with bone has been made.

In the event that appropriate anaesthesia cannot be achieved, treatment must be abandoned and the provision of drug therapy considered.

High quality endodontic treatment

With anaesthesia achieved, it is vital for the endodontic procedure to be carried out in a methodical manner; on the basis of established evidence-based protocols, by a suitably trained clinician with adequately trained staff. If such mechanisms are not present; the procedure will inevitably be more prone to fail and symptoms are likely to persist and flare-ups be more common place. For the purposes of this essay; only the most salient features of treatment shall be addressed; albeit briefly.

Ideally, the clinician would be highly experienced and knowledgeable. They would carry out the procedure with the benefit of a microscope/magnification loupes-despite dubious evidence on the utility of magnification in RCT[23, 24]. The treatment would be carried out under rubber dam for safe practice and to prevent bacterial contamination; which in turn leads to a more successful long-term outcome[25].

Thorough irrigation of the canals with sodium hypochlorite (~5%) and EDTA (17%) would be carried out to remove the bacteria, necrotic pulp, debris and clear the smear layer; which collectively are the source of infection and pain[26,27,28]. The canals must be

carefully instrumented, so as to avoid instrumentation beyond the apex, which will lead to chronic inflammation of the peri-radicular tissues and extended post-operative discomfort[29].

An appropriate temporary dressing must be placed to prevent marginal leakage before a 2nd stage of treatment or till a definitive restoration is placed[30]; which should also seek to avoid hyper occlusion and irritation of the periodontal ligament by reducing the bite. There is no remains no evidence to suggest multi-visit treatment is more successful than single appointment RCT[4].

Intra-canal medicaments

Although calcium hydroxide continues to be widely used as an intracanal medicament, recent evidence suggest this practice does not have as significant an impact on eliminating bacterial biofilms as previously thought[31].

The use of Ledermix paste (triamcinolone dimethyl chlorotetracycline in a water soluble cream) as an intracanal medicament, is widely accepted to help alleviate symptoms of acute periapical periodontitis and in turn lead to rapid reduction of pain post-operatively[32].

A supportive environment

The patient is likely to be in the chair for a considerable period. Thus, ensuring that they are comfortable and as relaxed as possible is necessary. This may include simple measures such as re-assurance, inquiring whether they require rest or the need for bite blocks to prevent jaw ache. Distraction techniques, such as 3D glasses with a movie or relaxing music may help[33]. Additionally, anxiety and pain control in the form of hypnosis or sedation techniques may be necessitated in highly anxious individuals[34, 35].

POST-OPERATIVE TREATMENT

Post-op Instructions

With the procedure completed, the patient and the clinician may be fatigued; both keen to part ways. Yet, the job is not over and time spent informing the patient of how the procedure went and any symptoms they may face over the next few days is invaluable[36], alongside an appropriate analgesic regimen and point of contact, in the event of a flare-up.

Discussing Post-operative Pain

Patients may be under the illusion that once root canal therapy commences; their symptoms shall vanish and evidently this is not the case. In discussing, post-operative pain before the patient has left, the patient becomes primed for some discomfort, as opposed to believing the clinician is making up excuses and the procedure has failed. Studies indicate that post-operative pain is greatest after the first day of treatment, with a reduction on the second day and a significant decline in discomfort after a week[36]. Thus, the patient should be informed accordingly.

Whilst numerous studies have tried to establish a model for post-operative pain; be it tooth type, gender, periapical radiolucency, emergency, access etc) this has largely proved inconclusive[37]. However, the extent of pre-operative pain is invariably a strong marker for the degree of post-operative discomfort[38]. There remains no strong-evidence to suggest that a single visit RCT results in greater pain than a multiple-visit treatment[39, 40].

Analgesics

A discussion on an appropriate analgesic regimen should then follow. Analgesics, such as Paracetamol and Ibuprofen, have a key role to play in easing symptoms after the procedure has been completed[41]. In severe cases, an analgesic in combination with an opioid drug, may be necessary and judicious prescription and advice in this field is warranted to account for patient variability in pain thresholds[42]. Effectively, we can categorise pain into mild, moderate and severe; with an analgesic strategy for each severity (see Fig 3). It can thus be demonstrated that a flexible analgesic strategy is essential. As ever, accounting for allergies, pregnancy, drug interactions (e.g. warfarin and NSAIDs), and contraindications to analgesic therapy (e.g. gastric ulceration and NSAIDs) is mandatory[43].

Whether prescription is made for a specified number of days or to be taken as necessary, remains open to the clinician's decision. There is a tendency to lean towards the latter and this may lead to lead to poor compliance. Studies indicate that taking analgesics, specifically NSAIDs, straight after the procedure and regularly for the first couple of days is most beneficial[43].

Type of pain	NSAIDs Acceptable	NSAIDs Contraindicated
Mild Pain	200-400mg Ibuprofen OR A combination of 1000mg Paracetamol QDS and Ibuprofen 400mg TDS (Mild-moderate)	500-1000mg Paracetamol
Moderate Pain	Ibuprofen 400mg TDS and opiate drug therapy e.g. 30-60mg codeine QDS	A combination of 1000mg Paracetamol QDS and opiate drug therapy e.g. 30-60 mg codeine QDS
Severe Pain	A combination of Ibuprofen 400mg TDS and opiate drug therapy equivalent to 5 mg Oxycodone	A combination of 1000mg Paracetamol QDS and opiate drug therapy equivalent to 5 mg Oxycodone

Fig 3. A table demonstrating analgesic management of post-operative pain, ranging from mild to severe pain. Adapted from An Update on Analgesics for the Management[43]

Flare-ups

The patient should be made aware of the possibility of a flare-up and that this is not a marker of unsuccessful treatment[44]. This may necessitate re-instrumentation, cortical trephination, further incision and drainage, intra-canal medicaments, an occlusal reduction, analgesic prescription or simply re-assurance[44]. Essentially, by giving a point of contact and having a system in place to allow the patient to be seen in the event of an endodontic emergency will help ease any concerns the patient may have.

Persistent pain

This has been described as pain that has persisted 6 months after an endodontic procedure and has been estimated to be prevalent in 7% of all cases[45]. Where this has occurred, the diagnosis must be re-investigated. A multi-disciplinary approach may be

necessitated to rule out non-odontogenic pain; which is thought to account for half of all persistent pain cases[46].

Follow-up

This should include appropriate clinical and radiological findings to determine whether the apical infection has resolved and in turn; whether a definitive restoration can be placed to give a better coronal seal; which will in turn help prevent endodontic failure and the precipitation of symptoms[47].

CONCLUSION

Endodontic therapy is a highly intricate procedure; of which pain control is a fundamental factor that must be addressed pre-operatively, intra-operatively and post-operatively. Operative intervention is the mainstay of treatment and therapeutics; be they analgesics and antibiotics, should only be used carefully as adjuncts to definitive treatment. As with much of dentistry, good communication skills and behavioural management techniques, go hand-in hand with clinical intervention.

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