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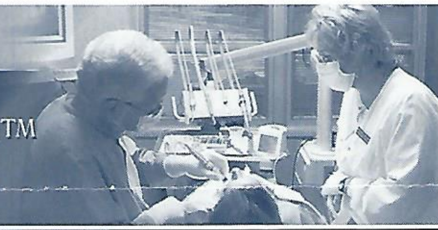
Endodontics Newsletter™

Spring 2018



Inside this issue

*Do you or your staff have any questions or comments about **Endodontics Newsletter?** Please write or call our office. We would be happy to hear from you.*

How Effective Is Sonically Activated Irrigation?

Not only do infected root canals have bacteria floating around the canal space but they also have a bacterial biofilm that forms and attaches to the canal surface. Removing bacterial biofilm from an infected canal surface is one of the most important steps in shaping and cleaning the root canal.

Manual irrigation with disinfectant solutions, such as sodium hypochlorite (NaOCl) delivered by a syringe, plays a significant role in disturbing and ultimately eliminating this biofilm. However, not only is such manual irrigation laborious but it has been shown repeatedly that the syringe can deliver the irrigant only 1 mm to 1.5 mm beyond the needle opening. Thus, if the needle tip is not placed close to the working length, the effect will be minimal in the apical quarter where critical bacteria are located.

When irrigation alone falls short, agitation of the irrigation solution aids in apical penetration beyond the stagnation plane. Both manual agitation, using a tapered gutta-percha cone in a push/pull motion, and automated agitation, using sonic and ultrasonic devices, have been investigated. The gutta-percha cone approach is simple and safe, but laborious and less effective than sonic or ultrasonic devices; however, the use of these devices risks damaging root dentin if the instrument tip touches the walls when activated. To avoid this risk, the use of lower frequency sonic devices (<200 Hz vs 20–40 kHz) and polymer tips has recently been advocated. Although it has been demonstrated that sonic level activation does not create cavitation or acoustic streaming, how well it removes biofilm remains unclear.

Bryce et al from Defence Primary Healthcare, United Kingdom, evaluated the efficacy of sonic irrigation using the EndoActivator (Figure 1) with 2 different polymer tips and 2 different power settings in an ex vivo model. To create a standard working length of 18 mm, they removed the crowns from 50 extracted teeth with single straight canals, instrumented them to size #40 with 0.08 taper and then split them vertically. The insides of the roots were coated with 4 collagen layers and left for 48 hours to be photographed for comparison later.

Figure 1. An EndoActivator sonic irrigation tool. (*Image courtesy of Dr. Noah Chivian.*)

After the roots were reassembled, 10 teeth were irrigated with 36 mL of 2.5% NaOCl, with the needle 4 mm short of the apex and moving in and out with an amplitude of 4 mm. The remaining 40 canals were irrigated with the same volume of NaOCl and were subjected to sonic agitation for 1 minute after delivery of every 9 mL of irrigant with #15 tip size with 0.02 taper or #35 tip size with 0.04 taper on both low and high power settings. The canals were then photographed again, and the area of residual stained collagen was compared with the preirrigation area.

The researchers found that supplementary sonic irrigation resulted in significantly less residual collagen than did irrigation with syringe only; the best results were achieved with the large tip and high power. Based on this ex vivo model, they concluded that sonic irrigation may help remove biofilm from the root canals; however, to confirm these results, an in vivo study needs to be conducted.

Bryce G, MacBeth N, Gulabivala K, Ng Y-L. The efficacy of supplementary sonic irrigation using the EndoActivator® system determined by removal of a collagen film from an ex vivo *model.* Int Endod J *2017;doi:10.1111/iej.12870.*

Bacterial Contamination of Endodontic Supplies

Failing endodontic therapy is almost always associated with bacteria that were not removed from the canal system or were allowed to reenter the canal after cleaning and shaping were completed. Thus, it is essential to ensure that all equipment and supplies used in endodontic care are bacteria-free.

There is, however, an issue with some routine endodontic consumables, such as gutta-percha, paper mixing pads and rubber dams, because the extent to which they are sterilized by the manufacturers is not known. They are often packaged in bulk, rendering their sterility impossible to maintain during clinical storage. And once contaminated, those consumables will continue to affect multiple patients. Previous studies have demonstrated this problem, but the available technology could not detect uncultivatable and/or inactive pathogens; thus, the true extent of this issue remained largely unknown.

Saeed et al from King's College London, United Kingdom, assessed possible bacterial contamination of consumables using 2 approaches shown to be superior to the more traditional culturing techniques in identifying contaminants:

- quantitative polymerase chain reaction
- matrix-assisted laser desorption/ionization time-of-flight mass spectrometry

Bacterial samples were collected from common endodontic consumables at 3 different time points:

- when first opened after being received from the manufacturers
- after 7 days of clinical storage and usage in a postgraduate endodontic clinic
- after 14 days of clinical storage and usage in a postgraduate endodontic clinic

Their findings were quite alarming. Many of the materials tested positive for a number of bacteria even before being introduced to the clinic, and once they were exposed to the clinical environment, contamination increased. The most isolated genera were

- *Propionibacterium*
- *Staphylococcus*

The authors found that one has to expect that endodontic consumables, such as gutta-percha points, rubber dams and caulking agents, are already contaminated when they are received from the manufacturers, and that once they are opened, the contamination may increase. Some opportunistic bacteria might affect the outcome of the endodontic therapy. All gutta-percha points should be disinfected immediately prior to use, by soaking in 5% sodium hypochlorite for 1 minute, then carefully dried with sterile gauze. Further disinfection will result from using presterilized paper points as well as wiping the rubber dam surface with chlorhexidine or iodine once it has been placed on the tooth.

Saeed M, Koller G, Niazi S, et al. Bacterial contamination of endodontic materials before and after clinical storage. J Endod *2017;43:1852-1856.*

Regenerative Treatment vs Apexification for Apical Periodontitis in Immature Teeth

Considering the lack of further growth or maturation of the root as well as the challenges posed by endodontic therapy, immature teeth with necrotic pulps pose a unique problem for clinicians. Extracting these teeth in patients <18 years can have serious consequences: The alveolus may not continue to develop, and placement of an implant once the patient is old enough can be difficult.

About 50 years ago, the best treatment option for these teeth was apexification with long-term calcium hydroxide ($Ca[OH]_2$) treatment; the root canal would be gently debrided, and a thick $Ca(OH)_2$ mixture would be placed and left in the canal for several months. This treatment was reasonably successful in healing the apical lesion and allowing formation of bony apical barriers, making endodontic obturation less challenging.

When mineral trioxide aggregate (MTA) was introduced in the 1990s, it was suggested that it could be used as an apical stop in these immature teeth, shortening the treatment time from months to weeks. Both approaches have retained teeth in 74% to 100% of cases. The main problem, however, is that no—or very limited—further root growth will occur, leaving the root walls thin and at increased risk for fracture.

In the past 15 years, regenerative endodontic treatment (RET), or revascularization, has been recommended for immature teeth. In this procedure, instead of obturating the canal space, the clinician, after minimal instrumentation and disinfection with copious irrigation, further disinfects the canal by placing antibiotic paste inside it for a few weeks. After the antibiotic paste is washed out, bleeding is induced, and a blood clot is allowed to form in the clean canal space, with the intent that blood vessels and tissue will grow into the blood clot and, over time, stimulate the root wall as the root end continues to grow (Figure 2).

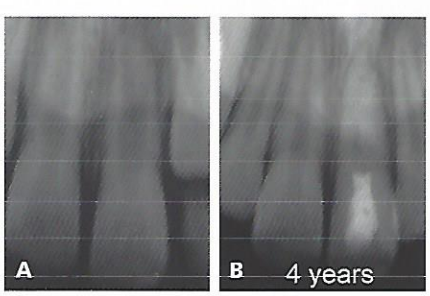


Figure 2. An 8-year-old girl, with history of dental trauma 2 years previously, reported experiencing spontaneous pain in the area. (A) On the day of first visit, the tooth was unresponsive to cold and presented with swelling in the vestibule facial to the tooth. Regenerative treatment was initiated, using antibiotic paste. (B) At 4-year reevaluation, the tooth was normal to percussion and palpation but did not respond to sensibility tests. (*Images courtesy of Dr. Asgeir Sigurdsson.*)

Table 1. Quantitative changes of root morphology at the 12-month follow-up measured by cone-beam computed tomographic imaging

Root change (mm)	RET ($n = 69$)	Apexification ($n = 34$)	p value[a]
Increase of root length	1.64 ± 1.43	0.60 ± 1.06	<.001[b]
Increase of root thickness	0.24 ± 0.25	0.08 ± 0.21	<.001[b]
Decrease of apical foramen size	1.49 ± 0.96	1.85 ± 0.67	.033[c]

[a]*The t test/rank sum test.* [b]$p < .001$. [c]$p < .05$.

Numerous prospective and retrospective studies have evaluated these 2 clinical procedures, but no large study had been published. Recently, Lin et al from Sun Yat-sen University, China, recruited 118 patients with immature apices and pulp necrosis (as a result of either dens evaginatus or trauma), and randomly assigned them to receive either apexification or RET. Prior to treatment, they noted the presenting clinical symptoms and complications during treatment. All teeth were evaluated with cone-beam computed tomography prior to treatment and at the 12-month reevaluation.

The researchers found that the 103 teeth available for reevaluation showed complete apical healing. With regard to continuation of maturation, the RET group showed significant root length and thickness increases compared with the apexification group (Table 1); however, not all RET-treated teeth showed continued root maturation. In the RET group, the teeth diagnosed with dens evaginatus did better than did those that had lost pulp vitality due to trauma.

The main complications in the RET group were calcification of the canal space and crown discoloration, mainly attributed to the use of MTA as a filling material in the cervical area. The authors recommended that alternative materials not associated with discoloration should be used.

This study demonstrated that RET can be offered as a treatment choice if the patient and/or caregivers accept the use of antibiotic paste in the canal for a few weeks. But care should be taken to frequently reevaluate the patient to ensure appropriate and timely intervention if complications or reinfection occur. For recommended treatment protocol, consult Clinical Considerations for a Regenerative Procedure, published by the American Association of Endodontists.

Lin J, Zeng Q, Wei X, et al. Regenerative endodontics versus apexification in immature permanent teeth with apical periodontitis: a prospective randomized controlled study. J Endod *2017;43:1821-1827.*

Warm Vertical Condensation and Temperature Rise on the Root Surface

Since its introduction by Schilder in the 1960s, vertical condensation of warm gutta-percha has been popular. It entails heating special "heat carriers" over open flame until cherry red and introducing them into the root canal where a prefitted gutta-percha cone has been placed. The softened gutta-percha can be vertically condensed by special pluggers.

To achieve good condensation, the gutta-percha has to be heated to the point where the heat causes phase transformation from beta to alpha at 42°C to 49°C and from alpha to amorphous at 53°C to 59°C. Heated gutta-percha can adapt to irregularities and accessory canals; however, with no clear control of how hot the carrier is prior to insertion, the technique risks damaging the tooth, alveolar bone and periodontal ligament (PDL).

To remedy this, electric heat carriers with preset or controlled temperature settings have been designed. Their effect on external root surface temperature has been extensively researched in ex vivo studies, but they did not simulate the biological factors that help regulate the temperature on the external root surface. More important, previous studies have shown no correlation between the temperature settings of many of these devices and the instrument's actual temperature.

Pilot studies have shown that the highest temperatures occur at the plugger tip. In clinical practice, however, the tip comes in contact with the gutta-percha.

Dimopoulos et al from Aristotle University of Thessaloniki, Greece, set out to determine the temperature change on the tip surface of different-sized pluggers using 2 commercially available gutta-percha heating devices:

- System B (Kerr Dental, Amersfoort, the Netherlands) with 4 different pluggers
- System B Cordless Pack Unit (Kerr Dental) with 1 plugger

The researchers created a custom measuring device that consisted of a polytetrafluoroethylene (PTFE) cylinder that measured plugger temperature at the tip, as well as 2 mm from the PTFE cylinder's upper end (approximately 7 mm). The System B was set at 200°C; the cordless, at low power.

After 10 seconds, the researchers measured the temperature and the time it took each plugger to reach 60°C. They found that the 5 pluggers

- reached 73°C to 87°C in 10 seconds
- reached 60°C in 1.3 to 3.3 seconds

Within this study's limits, the tested gutta-percha heating devices all achieved maximum temperatures ≤94°C. Because these devices can cause gutta-percha phase transformation within 4 seconds of activation, they should not remain in the canals for any longer than 4 seconds, or they might overheat the root and cause possible permanent damage to the PDL. Future studies may investigate the effect of these temperatures on the periodontal membrane and alveolar bone.

Dimopoulos F, Dervenis K, Gogos C, Lambrianidis T. Temperature rise on the plugger surface of 2 commercially available gutta-percha heating devices. J Endod *2017;43:1885-1887.*

In the next issue Summer 2018

- Post vs no-post placement in ferruled and unferruled teeth
- Torque generation and glide path establishment
- Efficacy of supine and upright positions

Our next report will focus on these issues and studies that discuss them, as well as other articles exploring topics of vital interest to you as a practitioner.