*A Professional Courtesy of:*

VIRGINIA ENDODONTICS


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# Intracanal Calcification Following Regenerative Endodontic Treatment

Treatments for immature teeth with pulp necrosis may include calcium hydroxide apexification, mineral trioxide aggregate (MTA) apical barrier technique or regenerative endodontic treatment. While the advantage of regenerative treatment includes potential for future root maturation with increased canal wall thickness, root length and apical closure, a recent study with an average follow-up of 25 months revealed a high incidence of revascularization-associated intracanal calcification that progressed over time.

Clinical considerations published by the American Association of Endodontists (AAE) in 2016 for regenerative endodontic procedures define 3 outcome measures (ranked from most to least essential):

- **Primary:** elimination of symptoms and evidence of bony healing
- **Secondary:** increased root wall thickness and/or increased root length
- **Tertiary:** positive response to vitality testing

The AAE also noted possible adverse effects, e.g., staining of crown/root, lack of response to treatment and pain/infection. However, the clinical considerations make no mention of intracanal calcification or ingrowth of bone.

Kahler et al from the University of Queensland Oral Health Centre, Australia, reported the case of an 11-year-old girl who underwent regenerative endodontic treatment in 2 mandibular premolar teeth after a diagnosis of an infected root canal system, pulp necrosis and symptomatic apical periodontitis. The root canal widths of the teeth increased by 72.1% and 39.7%, respectively, at 18 months after surgery. Annual follow-ups over 8 years showed complete calcification with a 100% increase in canal width and no substantive change in root length, along with no evidence of pathosis. Both teeth remained unresponsive to electric pulp testing until the 8-year recall, at which time both teeth had become responsive.

### Conclusion

In this case, along with complete revascularization-associated intracanal

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calcification, all 3 treatment goals established by the AAE clinical considerations were achieved in the 2 treated teeth, although both teeth required internal bleaching to alleviate discoloration. Revascularization-associated intracanal calcification carries with it the potential to cause complications in subsequent endodontic treatment. Because most studies of regenerative endodontic treatment have had comparatively short follow-up times, larger long-term studies are required to enable the AAE to update its clinical considerations and include the potential for revascularization-associated intracanal calcification following regenerative endodontic treatment.

*Kahler B, Kahler SL, Lin LM. Revascularization-associated intracanal calcification: a case report with an 8-year review.* J Endod *2018;44:1792-1795.*

## Choosing Between Endodontic Treatment and Implant Placement

Patients with diseased dental pulp have traditionally received nonsurgical root canal treatment. However, the development of modern osseointegrated dental implants has changed the calculus for many of these patients, and current trends appear to favor implants as the standard procedure in cases that would have previously undergone endodontic treatment. Although many studies have been conducted comparing outcomes from the 2 treatment options, establishing which procedure is more predictable remains problematic due to significant differences in study design and definitions, especially the differing measures of outcomes between treatment options.

**Table 1.** ***Statistically significant (p < .001) differences in treatment***

| Variable | Nonsurgical root canal treatment | Implant treatment |
|---|---|---|
| Adjunct treatment (%) | 3.5 | 74.7 |
| Additional treatment (%) | 11.0 | 42.0 |
| Number of appointments (%) | 3.9 | 13.6 |
| Elapsed time to final restoration (months) | 4.8 | 13.5 |
| Prescribed medication (%) | 2.0 | 100.0 |
| Cost of treatment ($) | 1176.12 | 2649.61 |

Outcome criteria used in studies of nonsurgical root canal treatment include function, clinical signs and symptoms, and radiographic evaluation of periapical lesion healing; thus, even asymptomatic and fully functional treated teeth may be classified as failures if radiographs detect anything other than complete healing. Studies of implants, on the other hand, usually evaluate success based solely on implant survival. Vahdati, a private practitioner from California, et al compared outcomes in nonsurgical endodontically treated teeth and surgically placed implants using the same outcome measures in patients who had undergone both treatments in different teeth.

The authors analyzed the records of 3631 patients treated from 2001 through 2016 at the Loma Linda University School of Dentistry. The database included 170 patients aged ≥18 years (85 men, 85 women; mean age at last follow-up visit, 72 years) who met the following inclusion criteria:

- ≥1 single-tooth implant surgery and subsequent restoration
- ≥1 nonsurgical root canal treatment and subsequent restoration
- both restorations had to be performed in the matching area of the mouth (anterior maxilla, posterior maxilla, anterior mandible, posterior mandible)
- at least a 5-year follow-up

The authors recorded the patients' demographic data and medical status, along with all subsequent treatment. Surviving implants were defined as being functional and present in the mouth at the time of final recall without definite signs of absolute failure. Surviving endodontically treated teeth were defined as being functional and asymptomatic at the time of final recall.

Both procedures had a 95% survival rate at 5 years. The large majority of the failures in both the implants and the endodontically treated teeth were located in the molar area. Demographics, tooth location, pretreatment diagnoses, pretreatment presence of periapical radiolucency, proximal contact, immediate vs delayed implant placement, implant size, and type of restoration after root canal or implant

placement had no statistical significance and no effect on survival rate. However, there were significant differences between treatment options in necessity for additional treatments, and cost and time to final restoration, all of which favored endodontic treatment (Table 1).

### Conclusion

Given the equivalent survival rate of the 2 treatments and the significant differences to the patient in time, convenience and money, nonsurgical root canal treatment should be considered as a viable alternative for any tooth that can be saved and is deemed restorable.

*Vahdati SA, Torabinejad M, Handysides R, Lozada J. A retrospective comparison of outcome in patients who received both nonsurgical root canal treatment and single-tooth implants.* J Endod *2019;45:99-103.*

## Sequelae to Permanent Teeth After Primary Tooth Trauma

A recent study showed that approximately 180 million children worldwide have experienced at least 1 traumatic dental injury in the primary teeth. For nearly 50 years, articles appearing in the dental literature have noted a correlation between these traumatic injuries and sequelae in successor permanent teeth, perhaps due to the closeness between the apices of primary teeth and the germ of permanent teeth, ranging from minor (a slight disturbance in the mineralization of enamel) to major (sequestration of the entire tooth germ). Reported prevalence of these subsequent problems ranges from 20% to >40%.

The most recent guidelines for traumatic injury treatment in the primary dentition issued by the International Association of Dental Traumatology recommend a continuation of follow-up to diagnose possible problems in the permanent successor tooth. Such issues may not manifest themselves until later, when they may have a negative impact on a patient's quality of life. A recent systematic review found that children with trauma, who are younger, and who suffer intrusion and avulsion injuries in the permanent incisors, may be at greater risk for sequelae in the permanent teeth. However, very few studies in this area have included a control group, making it difficult to determine whether a cause-and-effect relationship exists.

Lenzi et al from the Federal University of Rio de Janeiro, Brazil, reviewed the dental records of 1500 children who suffered dental trauma to the primary teeth over a 10-year period, from 2005 to 2015. From this group, the authors selected 214 injured teeth in 124 children who had a history of trauma to primary incisors and/or canines and who subsequently had full eruption of their permanent dentition. As a control, the authors included from the same children 247 anterior teeth that had not undergone dental trauma. The study compared the erupted permanent teeth whose antecedent primary teeth had suffered trauma with those whose antecedent primary teeth had not suffered trauma.

Collected data included patient's age and sex, type of tooth and type of injury. Sequelae in the permanent dentition, such as discoloration, enamel hypoplasia, dilacerations, malformations, arrest of root formation, sequestration of permanent tooth germ and eruption disturbances, were recorded.

Successor permanent teeth to traumatically injured primary teeth were >5× more likely to demonstrate sequelae than were the successors to uninjured primary teeth. More than a quarter of the injured primary teeth were succeeded by permanent teeth showing sequelae; the most common sequelae were enamel discoloration, enamel hypoplasia and eruption disturbance (Table 2). The most serious damage resulted following intrusion to the primary teeth; more than half of these successor permanent teeth demonstrated sequelae. Younger age at the time of trauma appeared to be associated with a higher rate of sequelae.

### Conclusion

Trauma to the primary teeth is a risk factor for the development of sequelae

**Table 2. *Type of sequelae in permanent successors* (n = *675*)**

| Type of sequelae | Control group | Trauma group |
|---|---|---|
| No disturbance | 229 (92.7%) | 152 (71.0%) |
| Enamel discoloration | 14 (5.7%) | 24 (11.2%) |
| Enamel hypoplasia | 3 (1.2%) | 21 (9.8%) |
| Eruption disturbance | 0 | 10 (4.7%) |
| Other | 1 (0.4%) | 7 (3.3%) |

in succeeding permanent teeth. The risk appears to be greater in children who suffer injury at younger ages, with disturbances of enamel development the most common manifestation. These children should be given radiographic examinations during follow-up of their traumatic injuries to detect any sequelae in the permanent successors.

*Lenzi MM, da Silva Fidalgo TK, Luiz RR, Maia LC. Trauma in primary teeth and its effect on the development of permanent successors: a controlled study.* Acta Odontol Scand *2018;doi:10.1080/00016357.2018.1508741.*

## Endodontic Irrigant Effect on Biofilm Removal

The goal of endodontic treatment is the eradication of microorganisms located in the root canal system that lead to apical periodontitis. These microbes colonize the intraradicular space as biofilms. While complete elimination is unrealistic, the practitioner needs to aim for the greatest practical reduction of these biofilms, usually via the use of endodontic irrigants. However, not all biofilms are the same. Biofilm—a matrix of extracellular polymeric substances that houses the microorganisms—varies in viscosity and diffusion resistance to antimicrobials.

Previous studies have focused on biofilms whose bacterial composition was identified, but have done so without reference to their structural organization. Most of these studies have used confocal laser scanning microscopy (CLSM), which effectively evaluates the efficacy of various endodontic irrigants to remove bacteria but has limited application when evaluating the removal of biofilms. Low load compression testing (LLCT) has been used to measure the viscosity of biofilms, information necessary to explain how well disinfectants penetrate and neutralize biofilms. Optical coherence tomography (OCT) can be used to image biofilm samples, measuring their height and illustrating their structure.

Busanello et al from the Federal University of Rio Grande do Sul, Brazil, designed a study that employed CLSM, LLCT and OCT to investigate the impact of biofilm structure on the efficacy of endodontic irrigants. They cultured *Streptococcus oralis* and *Actinomyces naeslundii*, 2 bacterial species that have been shown to be resistant to root canal disinfection procedures and that form robust biofilms with viscoelastic properties similar to those found in the mouth. The bacteria were then allowed to form 3 different biofilms with varying densities. Each of these biofilms was treated with 3 different endodontic irrigants:

- 2% sodium hypochlorite (NaOCl)
- 17% ethylenediaminetetraacetic acid (EDTA)
- 2% chlorhexidine (CHX)

Samples were evaluated using OCT to assess biofilm removal, LLCT to assess biofilm viscosity and CLSM to evaluate biofilm composition.

Biofilm structure significantly affected biofilm removal. NaOCl removed significantly less biofilm in the samples that had denser biofilms than it did in the less dense samples, while no relationship existed with density for biofilm removal when EDTA and CHX were applied. However, in samples with less dense biofilms, NaOCl was significantly more effective in removing biofilm than were the other 2 irrigants. Regardless of biofilm density, EDTA was more effective than was CHX in removing biofilm and killing bacteria; indeed, OCT video showed that CHX merely rearranged biofilm structure, rather than removing it.

### Conclusion

Given the proven inability of instruments to debride the entire root canal system, this study further illustrated the need for an effective irrigation regime to remove the biofilms that harbor endodontic bacteria. The results of this study suggest that the use of CHX in endodontic treatment should be questioned. On the other hand, the use of NaOCl for biofilm removal, along with adjunctive treatment with EDTA, may prove highly effective.

*Busanello FH, Petridis X, So MVR, et al. Chemical biofilm removal capacity of endodontic irrigants as a function of biofilm structure: optical coherence tomography, confocal microscopy and viscoelasticity determination as integrated assessment tools.* Int Endod J *2018;doi:10.1111/iej.13027.*

**In the next issue:**

- Nonsurgical treatment of necrotic teeth
- Association between apical lesions and cardiovascular risk in young adults

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