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A. K. Bobby Mallik, D.M.D.

3719-B University Commons
Durham, North Carolina 27707
919-493-5332
www.durhamendo.com

Practice Limited to Endodontics

Endodontic Treatment Enhances Regenerative Potential

Pulpal and periodontal tissues communicate with each other via various pathways, such as the vascular system, apical foramen, lateral and accessory canals, and open dentinal tubules. These pathways can be potential communication routes for endodontic–periodontal inflammatory mediators. The similarity in the microflora composition also implies the close connection between the infected pulp and periodontal tissues. Taken together, these findings can support the notion of cross-contamination between the pulp and the periodontal tissues.

The term "endo–perio" lesion has been proposed to describe the destructive lesions resulting from disease processes in both the periodontium and the pulpal tissues. These lesions are often classified as follows:

- primary endo
- primary perio
- primary endo with secondary periodontal involvement
- primary perio with secondary endodontic involvement
- "true" combined lesions, which occur when the pathologic processes of both disease processes "meet"

Periodontal intraosseous lesions with secondary endodontic involvement will occur when the toxic products of the plaque biofilm adversely affect the pulp through open dentinal tubules, lateral and accessory canals, or the apical foramina. In these cases, the pulp may remain "vital" (i.e., sensible to thermal and/or electric pulp test) for quite some time, until the main canal becomes affected and undergoes necrosis.

The treatment modality of primary periodontal lesions with secondary endodontic involvement has been somewhat controversial regarding the initiation of endodontic treatment. Some studies agreed that primary periodontal lesions should be managed only with periodontal therapy; because of its origin, endodontic therapy would be unnecessary. However, other studies showed significant pulpal disease in cases with severe periodontitis, and the authors recommended the initiation of endodontic treatment to prevent pulpal and periapical infection and thereby facilitate the regenerative potential of the attachment

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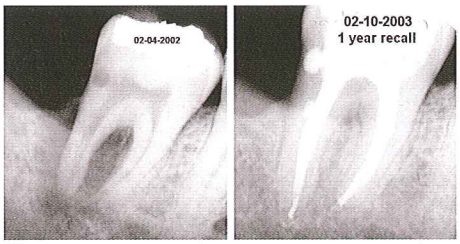

Figure 1. At left, preoperative radiograph of mandibular molar diagnosed with severe attachment loss. At right, 1-year follow-up radiograph after endodontic treatment. *(Images courtesy of Dr. Frederic Barnett.)*

apparatus (Figure 1). Kwon et al from Pusan National University School of Dentistry, South Korea, conducted a study to identify a role for endodontic intervention combined with periodontal treatment in teeth with severe periodontitis and secondary endodontic involvement to enhance the regenerative potential of the periodontal tissues.

Enrolled patients exhibited

- radiolucency extending to the periapical region
- abnormal electric pulp testing values
- deep probing depth derived from primary periodontal disease with secondary endodontic involvement

Intentional root canal treatment was performed on those teeth in which the apical lesions were presumed to communicate with the periodontal lesion of the teeth that remained vital.

In all 3 cases, regenerative periodontal therapy incorporating either bone graft or guided tissue regeneration was instituted 3 months after the endodontic intervention. At that time, anorganic bovine bone grafts or guided tissue regeneration with a nonresorbable barrier membrane successfully resolved the extensive intraosseous defects extending to the periapical region.

Conclusion

Within the limitations of the present observations, intentional endodontic intervention may be a potential approach for the sophisticated management of teeth suffering from severe periodontal attachment loss and alveolar bone destruction with concomitant secondary endodontic involvement.

Kwon E-Y, Cho Y, Lee J-Y, et al. Endodontic treatment enhances the regenerative potential of teeth with advanced periodontal disease with secondary endodontic involvement. J Periodontal Implant Sci *2013;43:136-140.*

Cytotoxicity and Antibacterial Efficacy of a Triple-antibiotic Combination

It has been well established that dental pulp plays a significant role in tooth development. During root formation, the apical papilla tissue has a significant collateral circulation and consists of various cell types (fibroblasts, immune cells, endothelial cells and stem cells)—cells that play an important role in tooth development as well as in the repair process subsequent to caries and trauma.

The invasion of bacteria and their toxins into the pulp induces inflammation and eventual necrosis. When pulp necrosis occurs during tooth development, root formation is arrested, leaving the immature tooth with thin canal walls and rendering it more susceptible to fracture.

Recently, pulp revascularization has been used to manage immature necrotic teeth using the "lesion sterilization and tissue repair" concept. A triple-antibiotic combination (3Mix) of minocycline, ciprofloxacin and metronidazole has been introduced for pulp revascularization procedures. Chuensombat et al from Chiang Mai University, Thailand, conducted a study to determine the cytotoxicity and antibacterial efficacy of 3Mix and each single antibiotic component of 3Mix.

For the cytotoxicity test, human dental pulp cells and apical papilla cells were exposed to either 3Mix or to each single antibiotic component of 3Mix, using concentrations of 0.024, 0.097, 0.39, 1.56, 6.25 and 25 µg/mL for 1, 3, 5 and 7 days, respectively. Cell viability was determined using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. For the antibacterial test, 25 µg/mL and 0.39 µg/mL 3Mix or single antibiotic were tested on bacteria isolated from necrotic teeth by measuring bacterial recovery on blood agar.

The 0.024-µg/mL concentration of all components generated the highest dental pulp cell or apical pulp cell viability at all time periods. On day 7, the authors reported the following:

- The 0.39 µg/mL 3Mix produced >90% cell viability.
- The 25 µg/mL 3Mix completely eliminated isolated bacteria, whereas 0.39 µg/mL did not eradicate all bacteria.
- The overall bacterial reduction was significantly decreased compared with the control group ($p < .01$).

Conclusion

3Mix, minocycline and ciprofloxacin were cytotoxic to cultured dental pulp cells and apical papilla cells. 3Mix induced a higher toxicity than

did minocycline, ciprofloxacin or metronidazole alone. The cytotoxicity of each antibiotic, except metronidazole, increased in a concentration- and time-dependent manner. The 0.39-µg/mL concentration of 3Mix had less cytotoxicity to dental pulp cells and apical papilla cells, yet it was able to significantly reduce bacteria isolated from necrotic teeth.

Chuensombat S, Khemaleelakul S, Chattipakorn S, Srisuwan T. Cytotoxic effects and antibacterial efficacy of a 3-antibiotic combination: an in vitro study. J Endod *2013;39:813-819.*

Imaging Extraradicular Biofilm

Pulp and periapical diseases are most frequently caused by infection from oral microflora (Figure 2). Several studies have shown that infected teeth with a pretreatment radiolucent lesion were 5% to 15% less likely to heal than were teeth with no preoperative radiolucency. The most commonly accepted reasons for endodontic failure are

1 persistent infection within the root canal system (missed canals, and incomplete cleaning, shaping and disinfection), the major cause of endodontic failure

2 development of extraradicular biofilm on the root surface

3 development of a "true" cyst

4 reaction to a foreign body in the periapical tissues

Several studies have previously revealed that bacteria can form a biofilm on the apical root surface, surrounding the apical foramina, on teeth associated with persistent periapical infections. However, no studies have described the distribution and localization of extraradicular biofilm in teeth with different stages of pulp and periapical pathosis.

Using scanning electron microscopy (SEM) and Brown and Brenn-modified Gram staining, Wang et al from Shanghai Jiao Tong University, China, evaluated the presence of extraradicular biofilm on the external surface of the root apex in teeth with different pulp and periapical pathological conditions (healthy pulp, pulp necrosis without radiographically visible periapical lesions, pulp necrosis with radiographically visible periapical lesions, and postendodontic persistent apical periodontitis).

Thirty-five teeth from patients attending the Shanghai Ninth People's Hospital or the Jiangsu Stomatological Hospital were used in this study. The teeth were selected after thorough clinical and radiographic examination. All procedures conformed to the institutional review board protocols approved by both institutions, and informed consent was obtained from every patient. The teeth were divided into the following 4 groups:

- **Group 1:** 5 healthy teeth with vital pulp that required extraction for orthodontic reasons and had intact crowns, no periodontal lesions and normal appearance on radiographs
- **Group 2:** 10 teeth with pulp necrosis and without radiographically visible periapical radiolucencies (These teeth were extracted for prosthetic reasons.)
- **Group 3:** 10 teeth with pulp necrosis and radiographically visible chronic periapical lesions (diameter <1 cm) that had not received root canal therapy (These teeth were extracted for prosthetic reasons.)
- **Group 4:** 10 teeth that had been previously endodontically treated and had persistent periapical periodontitis that required root-end surgery (Root ends were obtained during apicoectomy procedures.)

Under laminar airflow, the root surfaces of all teeth were washed with 0.9% sterile saline. In teeth with a periapical lesion adherent to the apical root surface, the lesion was carefully removed without touching the apical root surface. All teeth were evaluated with SEM, and serial transverse sections were stained using the Brown

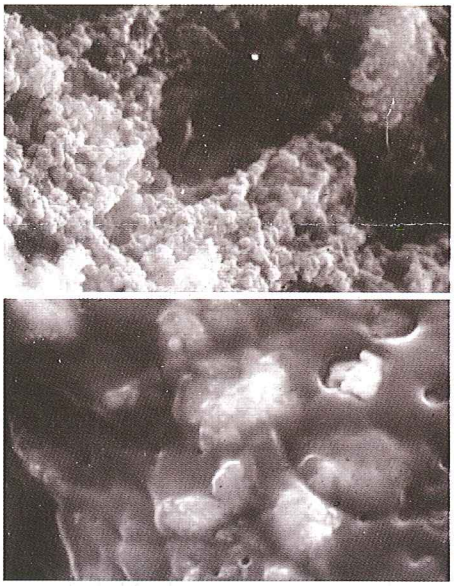

Figure 2. Top, higher-magnification SEM of root tip demonstrating extraradicular microbial colonies. Bottom, SEM of infected tooth root tip. A smooth polysaccharide material with microbial colonies is seen covering the root apex. *(Images courtesy of Dr. Frederic Barnett.)*

and Brenn-modified Gram-staining procedure. SEM observation of extraradicular biofilm revealed the following:

- **Groups 1 and 2:** Apical root surfaces appeared normal with intact cementum surfaces covered by a large quantity of collagen fibers running in various directions; no areas of exposed cementum or bacteria.
- **Group 3:** Three specimens were almost completely devoid of fibers. The cementum had both superficial and varying areas of resorption and microorganisms; 7 specimens did not have cementum resorption or the presence of microorganisms on the root surface. However, collagenous fibers were absent on some outside root surfaces.
- **Group 4:** All root tips with persistent periapical lesions had areas with varying degrees and depths of cementum resorption without any collagen fibers. Apical surfaces contained varying amounts of an amorphous extracellular material. Different bacterial morphotypes were found, including *cocci*, *bacilli* and filamentous bacteria in the form of biofilm (Figure 2).

Stereomicroscopy found positive bacterial staining around the external apical root surface in all samples with positive SEM results, including all samples in group 4, and 3 samples in group 3. Red-stained Gram-negative and violet-stained Gram-positive bacteria were observed in the extraradicular biofilm. On the root surfaces, some superficial and deep cementum resorption areas with a large number of microorganisms were observed.

Conclusion

Because extraradicular bacteria were found on the apical root surfaces of all human teeth that had had previous endodontic treatment with persisting periapical pathosis, the authors concluded that extraradicular biofilm may be an important cause of persistent periapical pathosis after endodontic treatment.

Wang J, Chen W, Jiang Y, Liang J. Imaging of extraradicular biofilm using combined scanning electron microscopy and stereomicroscopy. Microsc Res Tech *2013;doi:10.1002/jemt.22257.*

Apical Extrusion of Debris During Root Canal Treatment

Shaping and using irrigants to clean and disinfect the root canal system are major requisites of modern root canal treatment. Various techniques have been used, but an inherent problem related to all these procedures is the extrusion of intracanal debris and irrigants into the periradicular tissues.

Some debris extrusion is inevitable during root canal instrumentation; a methodology that completely avoids this phenomenon has not yet been developed. Tanalp and Güngör from Yeditepe University, Turkey, sought to provide an update on the apical debris extrusion concept in terms of debris, irrigant and bacterial extrusion. An initial search of PubMed, Ovid and MEDLINE electronic databases retrieved >3000 articles in English over a period of >30 years up to 2012; additional filtering narrowed the number to 59 articles.

In general, the questionable clinical relevance and scientific reliability of these studies made it difficult to draw definite conclusions. Apical extrusion should not be the sole decisive factor in selecting a specific methodology, because other parameters determine the clinical success of root canal treatment. Prevention of damage and irritation to surrounding tissues is one of a practitioner's major clinical responsibilities. One of the most significant complications related to or that occurs as a consequence of apical extrusion during root canal procedures is the development of interappointment flare-ups and postoperative pain.

Conclusion

Within the limitations of the evaluated studies, the authors concluded that rotary instruments used in a crown-down manner produced less apical extrusion than did conventional hand instruments. Selecting side-vented irrigation needles may prevent apical extrusion. Negative apical pressure-creating irrigating devices also seem promising in addressing the problem of extrusion.

Tanalp J, Güngör T. Apical extrusion of debris: a literature review of an inherent occurrence during root canal treatment. Int Endod J *2013;doi:10.1111/iej.12137.*

In the next issue:

- Reducing bacterial counts in infected root canals
- Effects of irrigation systems on wall shear stress

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