A Professional Courtesy of:

WESTSIDE ENDODONTICS
b.503.693.6163 • f.503.693.6073

The offices of Dr. Steven Singh

HILLSBORO OFFICE
434 S. First Avenue
Hillsboro, OR 97123
(503) 693-6163

WASHINGTON SQUARE
9735 SW Shady Lane, Suite 308
Portland, OR 97223
(503) 693-6163

www.westsideendo.com

Chronic Apical Periodontitis and the Autoimmune Loop

Citrullination, a posttranslational protein modification, contributes to the ongoing inflammatory process in periodontal disease. The presence of Gram-negative bacteria, catalyzed by prokaryotic peptidylarginine deaminases, results in anticitrullinated autoantibodies, including anticitrullinated cyclic protein antibodies (anti-CCP). Citrullinated proteins have been detected in the gingival tissue and gingival crevicular fluid of patients with periodontic disease and are related to the presence of *Porphyromonas gingivalis*.

Gram-negative anaerobic bacteria inside the root canal system cause apical periodontitis and may reach periodontal ligaments and periapical tissue via the apical and lateral foramina. If the endodontic infection is not halted, microbes and their antigens and toxins migrate to the apical periodontal ligament and trigger an immunological defense mechanism.

Martos et al from the University of Debrecen, Hungary, sought to show that citrullinated proteins may be formed in chronic apical periodontitis and may act as autoantigens inducing the production of anti-CCP, creating an autoimmune loop.

Included in the study were 25 periapical lesions in teeth with chronic apical periodontitis from patients with no ongoing medical problems and who were not regularly taking drugs that would interfere with inflammatory reactions. Six noninflamed periodontal tissue samples, obtained from extracted third molars in healthy patients, served as a control. Levels of-citrulline and anti-CCP antibodies in periapical granuloma samples were determined.

The test and control groups matched well for age, sex and protein concentrations. -citrulline levels in the chronic apical periodontitis samples were >3× greater than in the controls, showing a significant association between the presence of periapical granuloma and peptidyl-citrulline levels. A similar result was found in levels of anti-CCP antibodies, again with >3× greater levels in the chronic apical periodontitis samples than in the controls (Table 1). Two-thirds of all samples in the chronic apical periodontitis group tested anti-CCP positive, while only 1 sample in the control group tested anti-CCP positive. Being in the chronic apical periodontitis group

Inside this issue:

Table 1. *Levels of citrullinated proteins and anti-CCP antibodies (AU/L).*

	Chronic apical periodontitis group	Control	*p* value
Peptidyl-citrulline levels	161,597	47,889	.042
Anti-CCP antibodies levels	1.72	0.52	.008

was a significant risk factor for levels of anti-CCP antibodies.

Conclusion

The presence of citrullinated peptides and anti-citrullinated autoantibodies supports the creation of an autoimmune loop that contributes to the development and perpetuation of inflammation in the periapical area.

Martos R, Tar I, Nagy AC, et al. Hypercitrullination and anti-citrullinated protein antibodies in chronic apical periodontitis, a laboratory investigation. Does autoimmunity contribute to the pathogenesis? Int Endod J *2023;56:584-592.*

How Laser-activated Irrigation Effectively Cleans Canals

For hard-to-reach places of a root canal system, thorough irrigation must be used to effectively remove the bacteria that form highly resistant biofilms, complex communities of microorganisms that adhere to canal walls. Standard irrigant delivery uses a syringe through a needle, which can fail to thoroughly clean and disinfect the root system, especially in isthmuses, lateral extensions and apices.

To improve irrigant dispersal, the use of erbium lasers for laser-activated irrigation results in the creation and growth of vapor bubbles that implode when the laser pulse ends. This process creates fluid motion that contributes to canal debridement. While innumerable studies have shown the efficacy of laser-activated irrigation in removing the smear layer, it has proven difficult to discover precisely how it works when at a significant distance from the laser tip and how bacterial biofilms in the root canal are affected by laser-induced cavitation bubbles.

Swimberghe et al from Ghent University, Belgium, created a root canal model using a single-rooted bovine tooth, with a concavity to simulate a pulp chamber. Glass cover slides were placed on both sides of the dentin sections. Three different biofilms were cultured in the root canal model:

- an undefined biofilm taken from the floor of the mouth of 2 individuals
- an *Enterococcus faecalis* biofilm
- a multispecies biofilm that included *E. faecalis*, *Fusobacterium nucleatum*, *Porphyromonas gingivalis* and *Prevotella intermedia*, anaerobes typically associated with root canal infections

Four different experimental conditions were created:

- root canal model filled with water
- root canal model filled with water containing glass microspheres
- root canal model with various biofilms grown on the dentin surface and filled with water
- a free water environment

The researchers made high-speed recordings of laser-assisted irrigation under each experimental condition.

Quantitative analysis measured the lifetime and maximum dimension of the primary cavitation bubble, the onset and lifetime of cavitation bubbles in the root canal, and the velocity of the vertical movement of the root canal content. There were no significant differences in the size of the primary cavitation bubble regardless of the tip location or the presence of glass particles or biofilm. Both the lifetime of the primary bubble and the time for it to reach its maximum size were significantly shorter in the free water environment than in a root canal environment; no significant differences were found among any of the root canal models.

In qualitative analysis, the bubbles expanded and imploded along the entire canal, from the coronal to the apical end of the root canal. Canal content displaced coronally produced significant turbulence and liquid movement along the canal walls, dislodging the attached biofilms.

Conclusion

The study results demonstrated the hydrodynamic effect of laser-activated irrigation based on the generation of small cavitation bubbles in the root canal. This effect created an effective mechanism for removal of canal content, including biofilms.

Swimberghe RCD, Tzourmanas R, De Moor RJG, et al. Explaining the working mechanism of laser-activated irrigation and its action on microbial biofilms: a high-speed imaging study. Int Endod J *2022;55:1372-1384.*

Risk Factors for Endodontically Treated Teeth

A tooth's clinical condition may negatively impact the outcome of endodontic treatment, even with thorough root canal debridement and canal filling. Reviewing the records of patients treated in a dental school setting, Chang et al from the University of Pennsylvania compared the impact of multiple local and systemic risk factors on the survival rate of endodontically treated teeth.

The study included all patients treated at a postgraduate endodontic clinic and faculty practice over a 4-year period, excluding those who had been treated elsewhere and those treated by undergraduate dental students. Risk factors were evaluated at the patient level (age, sex, American Society of Anesthesiologists [ASA] Physical Status Classification, smoking history, diabetes status, presence of amoxicillin allergy) and the tooth level, before treatment (tooth position, probing depth) and during the follow-up period (scaling and root planing, osseous surgery, crown lengthening, core buildup, placement of posts in canals, placement of prosthetic crowns, extractions).

Patients were separated by treatment modality: those undergoing initial root canal treatment, nonsurgical retreatment or surgical retreatment. Failure to retain the treated tooth was determined using the American Dental Association's CDT 2020: Current Dental Terminology codes for tooth extraction.

The final data set encompassed 8788 teeth, including 84 teeth that underwent nonsurgical endodontic retreatment and 80 teeth that underwent surgical endodontic retreatment; median follow-up was >2 years. During follow-up, 365 teeth had to be extracted (7 in the nonsurgical retreatment group and 2 in the surgical retreatment group). Success rates were high, with a survival rate of 96.2% after initial root canal treatment, 92.4% after nonsurgical retreatment and 97.8% after surgical retreatment. Median time to extraction was 413 days.

Several factors were correlated with higher tooth extraction rates, including

- higher age
- worse ASA Physical Status Classification
- smoking
- diabetes
- amoxicillin allergy
- diagnosis of periodontitis either before or after treatment

Improved survival was seen in teeth with core buildup and with full-crown coverage (Table 2). After adjusting for other covariates and confounders, as well as the timing of tooth extraction, these factors—except smoking and diabetes—had a significant impact on outcomes, while the additional variables of being female and scaling and root planing were important covariates. However, both smoking and diabetes status were self-reported, without reference to the quantity and duration of smoking or the glycated hemoglobin levels in the diabetic patients, which can vary significantly and may have influenced those results. Tooth type and location were not significant factors in the success of root canal treatment, except as a reflection of the complexity of the root canal system in molars.

Table 2. ***Risk factors for failure of endodontically treated teeth.***

Factor	*p* value
Patient level	
Age	<.001[a]
Treatment (primary vs retreatment)	.119
Sex	.443
ASA Physical Status Classification	<.001[a]
Smoking	.007[a]
Diabetes	<.001[a]
Amoxicillin allergy	<.001[a]
Tooth level	
Core buildup	<.001[a]
Full-coverage crown	<.001[a]
Probing depth ≥5 mm before treatment	<.001[a]
Probing depth ≥5 mm after treatment	<.001[a]
Post-and-core buildup	.502
Osseous surgery, crown lengthening	.637
Scaling and root planing	.424
Tooth position	.267

[a]Results significant at <.05.

Conclusion

Endodontic treatment failure results primarily from missed canals, failure to properly shape and clean canals, and inadequate obturation. The impact of systemic and dental conditions must be considered when planning and executing treatment, yet the overall tooth retention rate of >95% underscores the ability of endodontic treatment to preserve teeth from the need for extraction.

Chang Y, Choi M, Wang Y-B, et al. Risk factors associated with the survival of endodontically treated teeth: a retrospective chart review. J Am Dent Assoc *2023;doi:10.1016/j.adaj.2023.09.022.*

Repairing Cervical External Resorption Cavities

Typically associated with dental trauma, tumors, chronic infection of the pulpal and periodontic structures, orthodontic tooth movement, and increased pressure on the periodontal ligament, cervical external root resorption originates as cell lysis in the cementum or cementoenamel junction of the tooth. It is progressive, destructive and irreversible, and may result in significant loss of the tooth structure. Left untreated, it forms pockets in the adjacent periodontal tissues, with concurrent bone destruction. It is also typically asymptomatic and difficult to diagnose because it is only detected incidentally during clinical or radiographic examination. Treatment includes the use of various repair materials, each of which has its strengths and weaknesses.

Öksüzer and Çıkman from Recep Tayyip Erdoğan University, Türkiye, undertook a finite element analysis to identify the effect of static force on teeth with repaired cervical external resorption cavities. The researchers designed a model of a maxillary central tooth, the most common site of cervical external root resorption, with an elliptical cavity that came into contact with the root canal at a single point. The coronal side of the cavity with composite and the radicular side of the model were restored with a variety of different materials:

- mineral trioxide aggregate (MTA)
- Biodentine
- BioAggregate
- calcium-enriched cement
- glass ionomer cement
- resin-modified glass ionomer cement

Two models, 1 healthy tooth and 1 tooth with untreated cervical external root resorption, served as controls.

A static force was applied to the palatal crown surface along the long axis of the tooth to simulate the bite force. The stress distribution in the dentin was then analyzed.

The greatest levels of stress in the dentin were in the model of the untreated control and the lowest levels in the model of the healthy control. Teeth restored with Biodentine and calcium-enriched cement demonstrated similar stress levels in the dentin, which were lower than the stress transmission to dentin seen with MTA, glass ionomer cement and resin-modified glass ionomer cement; stress levels for BioAggregate fell between those for these 2 groups.

The greatest stress levels applied to the root by the repair materials were found for BioAggregate, followed in descending order by calcium-enriched cement, Biodentine, MTA, resin-modified glass ionomer cement and glass ionomer cement. The composite used to restore the coronal direction of the resorption absorbed more stress and transmitted less stress to the dentin when used in combination with Biodentine, BioAggregate and calcium-enriched cement.

Conclusion

Advanced resorption leads to a decrease in fracture resistance; thus, materials used for restoration require mechanical properties that support the tooth and surrounding tissue while strengthening the tooth structure to the greatest extent possible. One important finding was the significant reduction of stress in the dentin after repair of the resorption cavity, regardless of the material chosen for repair.

Öksüzer MÇ, Çıkman AŞ. Evaluation of fracture strength after repair of cervical external resorption cavities with different materials. J Endod *2024;50:85-95.*

In the next issue:

- Chronic apical periodontitis in smokers
- Selective root canal retreatment
- Effect of post type to restore endodontically treated teeth

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