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ENDODONTICS

COLLEAGUES FOR EXCELLENCE

Coronal Leakage

Clinical and Biological Implications in Endodontic Success

Welcome to ENDODONTICS: Colleagues for Excellence…*the newsletter covering the latest in endodontic treatment, research, and technology. We hope you enjoy our in-depth coverage on the issues and possible treatment solutions for* Coronal Leakage—Clinical and Biological Implications in Endodontic Success. *We hope this information will be valuable to you in your practice and that you will be looking forward to future issues of* ENDODONTICS *to keep you up to date on the state of the art in endodontic treatment.*

The purpose of this issue of *ENDODONTICS: Colleagues for Excellence* is to provide clinical guidelines for ensuring long-term success in endodontic treatment.

THE CONCEPT OF CORONAL LEAKAGE having an effect on the outcome of root canal treatment has been known for nearly 90 years. Early endodontic research focused on the quality of the preparation and obturation to ensure long-term treatment success, and the effects of poor coronal restorations on endodontic outcomes received little attention.

The contamination of previously filled root canals secondary to restorative failures finally received serious attention in the mid-1980s. Numerous studies have examined this phenomenon, identified many sources of possible contamination and emphasized the role of the clinician in preventing coronal leakage following root canal treatment.

Pulpal and periradicular diseases develop when microorganisms and/or their by-products contaminate these tissues. Therefore, a major goal of both preventive and restorative dentistry is to prevent penetration of microorganisms into the coronal pulpal space and root canal system. The root canal system, once invaded, may harbor many species of microorganisms, their antigenic by-products and variable amounts of inflamed or necrotic tissues.

The major goals of root canal treatment are to ***1)*** remove irritants from the root canal system; ***2)*** fill or obturate the cleaned and shaped system; and ***3)*** prevent future recontamination of sealed root canals.

Even well filled root canals can be recontaminated. This can occur when ***1)*** there has been a delay in the restoration of a tooth following root canal treatment; ***2)*** the coronal temporary filling, placed immediately following root canal treatment, is compromised; ***3)*** the tooth is fractured and the canal system is exposed prior to final restoration; ***4)*** the final restoration, regardless of type or design, lacks ideal marginal integrity or cannot withstand the forces of occlusal function, and deteriorates; or ***5)*** recurrent decay is present at the restoration margin(s).

In these situations, the coronal and/or radicular portion of the root canal system is exposed to oral micro flora and their by-products. Both *in vitro* and *in vivo* investigations show that postendodontic coronal leakage can allow bacterial penetration in the filled root canal system, causing recontamination and failure of treatment. A major concern for all clinicians is the speed at which the entire root canal system becomes contaminated, requiring retreatment of the canal prior to placement of a new restoration.

How Long is Too Long?

When to retreat is the question that continues to plague dentists. Although we have studies that compare coronal leakage over time, no conclusive timeline has been determined. *In vitro* studies have shown a correlation between the length of time of coronal leakage and complete reinfection of the obturated root canal. Since multiple factors influence leakage, time alone is not the issue. The basic tenets of root canal treatment—thorough cleaning, shaping, disinfection and obturation—are other factors that influence achieving successful results.

Your endodontic colleague can be a wonderful resource in the evaluation process when considering whether retreatment is warranted before restoration. This team approach to endodontic treatment can result in a more successful outcome and a happier patient.

Preventing Coronal Leakage

Clinicians have six major opportunities to prevent coronal leakage in endodontically treated teeth:

- *Pre-endodontic tooth preparation*
- *Thoroughness of the root canal obturation technique*
- *Temporary seal of the root canal system, during and after treatment*
- *Choice and integrity of the final tooth restoration*
- *Timeliness in restoration and establishment of atraumatic occlusion*
- *Long-term follow-up to evaluate the integrity of the definitive treatment*

1a. Clinically, the mandibular molars give the impression of adequate restoration following root canal treatment.

1b. Coronal leakage under an ill-fitting crown may lead to periapical pathosis, regardless of the type of filling material in the root canal.

1c. Elimination of bacterial contamination can be predictably corrected with retreatment. Crowns should be removed prior to treatment for proper control of coronal leakage.

This case illustrates three deficiencies in controlling leakage: poor crown margin, inadequate seal in the chamber, and obturating material that does not conform to the coronal canal walls.

Pre-Endodontic Tooth Preparation

Multiple issues regarding the potential for coronal leakage must be addressed in this phase of treatment because of the importance of asepsis in the prognosis of root canal treatment. Complete removal of caries and defective restorations, establishment of sound tooth margins above the gingival tissues for both rubber dam placement and ultimate tooth restoration, and examination of tooth structure for cracks or fractures using dyes or fiber optics are the major factors for prevention of coronal leakage during treatment planning and before root canal treatment.

Thoroughness of the Root Canal Cleaning, Shaping and Obturation Techniques

A perfect seal of the root canal system is desirable, but contemporary materials and techniques available for obturation do not always support this physical or biological achievement. The clinician must focus initially on the thorough cleaning and shaping of the root canal system. Once this process is completed, all clinicians should be able to achieve high quality, three-dimensional obturation. Three procedures that foster leakage are single cone obturations, lack of or improper sealer usage, and short or incomplete obturations.

Temporary Seal of the Root Canal System, During and After Treatment

A faulty temporary filling during or following root canal treatment is one of the major causes for coronal leakage. Failure of the temporary restoration can be due to an inadequate thickness of material, improper placement of the material and failure to evaluate the occlusion after placement. Commonly

2a. Radiographically, proper temporization is evident upon completion of root canal treatment.

2b. One year later, a radiograph illustrates loss of the temporary restoration and recurrent caries extending into the pulp chamber.

used temporary filling materials are Cavit, TERM and IRM. After placing a cotton pellet in the pulp chamber, practitioners should place temporary materials in the access cavities with no gaps or voids. The cotton must be minimal and placed securely into the access cavity prior to placement of the filling to prevent a potential lifting or dislodgement of the temporary material.

When a dentist places a temporary during multiple-appointment endodontic treatment, an intracanal medicament, such as calcium hydroxide, should be placed in the root canal. This antimicrobial material may act as a barrier to the ingress of microorganisms into the root canal system. The medicament should not be used as a substitute for a well-placed temporary restoration, nor should it be used to enhance the long-term use of temporary restorations.

Materials used between appointments or immediately following root canal treatment are temporary in nature and do not provide an impervious barrier for long periods. Most studies that have examined the effectiveness of these materials have done so under artificial conditions that do not mimic true clinical parameters. Therefore, their use is based on *in vitro* outcomes and expectations, as opposed to their *in vivo* realities and true capabilities.

A minimum of four millimeters of material thickness provide an adequate seal. Based on current evidence, this seal can be expected to remain effective no longer than three weeks. Allowing a temporary material to remain longer than this period is an invitation to coronal leakage and future failure.

Choice and Integrity of the Final Tooth Restoration

Not all endodontically treated teeth require complete rebuilding, *i.e.*, post and core, followed by crown placement. The routine use of posts and cores in anterior teeth following root canal treatment is discouraged, unless there is gross loss of coronal tooth structure. Contemporary research has shown that teeth restored with bonded composites in the lingual access openings are not only stronger than those with posts, cores and crowns, but also have minimal coronal leakage when compared to anterior teeth in which glass ionomers or nonbonded composites have been placed. This latter concept also holds true for those anterior teeth with access openings made through ceramic or metalloceramic crowns.

3a. This radiograph shows a tooth that has been restored to minimize any chance of coronal leakage and provides an excellent example of teamwork between the endodontist and restoring dentist.

Endodontically treated posterior teeth, unlike anterior teeth, usually require a bonded core and the placement of a post when there is need to enhance core retention. Bonded cores using amalgam, core pastes and reinforced composites are ideal core buildup materials. Glass ionomers do not have sufficient strength to provide the necessary integrity for cores in posterior or anterior teeth. When using a core buildup in either anterior or posterior teeth, the interface of the core material and the tooth structure must be at a position at least two millimeters above the free gingival margin to allow for the placement of a crown on at least two millimeters of sound tooth structure—ferrule effect. The margin of the crown must not impinge on the biological width.

Some readers may wonder what this imperative has to do with coronal leakage. If there is impingement on the biological width, the patient may have discomfort, especially during brushing or flossing, and as a result may not clean this area properly. Not only does this predispose to bacterial accumulation and plaque formation but also to periodontal pocketing, recurrent decay and ultimate loss of marginal integrity with pursuant coronal leakage.

Treatment planning for appropriate restoration of endodontically treated teeth is only part of the equation for success. Ultimate prevention of coronal leakage requires consideration of additional criteria:

- *Retain sound tooth structure to enhance structural integrity.*
- *Protect cusp in areas of significant function to minimize forces and potential fracture.*
- *Stabilize the core within the tooth by using the pulp chamber and coronal aspect of the canals for bonded core retention.*
- *Retain a minimum of four-to-five millimeters of dense gutta-percha filling apically when placing a post.*
- *Avoid posts that will cause wedging effects in the root during function.*
- *Avoid post widths that exceed one-third of the entire cross sectional root width.*
- *Prepare post space with rubber dam isolation to prevent contamination.*
- *Use heat to remove the bulk of gutta-percha in the preparation of post space.*
- *Place the post immediately after post space preparation to minimize contamination.*
- *Avoid placing posts in roots that have little or no bony support. Forces on posts, both during insertion and function, focus at the apical extent of the post. The post should preferably extend at least four millimeters below the crestal bone without compromising the apical gutta-percha seal.*
- *Consider carefully the effects of post design on post retention and stability within the root. Parallel-sided, serrated, cemented posts are best able to distribute the forces placed on the root.*
- *Consider using a dentin-bonding agent compatible with dual-cured cements for resin-reinforced posts with carbon, polyethylene or glass. Glass ionomers and resin-modified glass ionomers or composites are not indicated for post cementation.*

Timeliness in Restoration and Establishment of Atraumatic Occlusion

The restoration of an endodontically treated tooth should commence as soon as possible after root canal treatment. Delaying definitive restoration allows teeth with a periradicular radiolucency to demonstrate healing prior to restoration; however, this action is unnecessary with today's advancements in root canal treatment.

An important issue with the restoration of endodontically treated teeth is to ensure the tooth is in atraumatic occlusion. If aberrant forces are present, the coronal seal of the restoration, or the seal of the post or core, can be disrupted in time and could result in coronal leakage or tooth fracture.

Long-Term Follow-up to Evaluate the Integrity of the Definitive Treatment

Follow-up evaluation of all endodontic and subsequent restorative procedures is essential because of coronal leakage and its impact over time. Either the general dentist or endodontist can do the follow-up evaluation. This process includes evaluation of signs, symptoms, radiographic indicators of pathosis and examination for the evidence of coronal leakage, *e.g.*, recurrent decay, loss of marginal integrity and other parameters discussed in this newsletter. Prevention of coronal leakage in endodontically treated teeth is most important for patients who rely on the combined expertise and quality care of dentist/endodontist colleagues.

4a. A preoperative radiograph depicts periapical pathosis due to pulpal necrosis and microorganisms.

4c. Radiographic evidence five years posttreatment shows complete periapical healing and sound restoration. Long-term follow-ups should be done to assess healing and integrity of the coronal restoration.

4b. A radiographic image shows the tooth immediately upon completion of root canal treatment. Note the proper depth of the temporary restoration.

Because many important and integrated concepts have been addressed in this issue of ENDODONTICS: Colleagues for Excellence, *the AAE encourages readers to review the enclosed reading list to obtain further information or support for the clinical parameters regarding the importance of coronal leakage in prognosis of endodontically treated teeth.*

The information in this newsletter is designed to aid dentists. Practitioners must use their best professional judgment, taking into account the needs of each individual patient when making diagnoses/treatment plans. The AAE neither expressly nor implicitly warrants any positive results, nor expressly nor implicitly warrants against any negative results associated with the application of this information.

If you would like more information, call your endodontic colleague or contact the AAE.

Did you enjoy this issue of *ENDODONTICS*? Did the information have a positive impact on your practice? Are there topics you would like *ENDODONTICS* to cover in the future? We want to hear from you! Send your comments and questions to the American Association of Endodontists at the address below.

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