Review Article

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METHODOLOGIES FOR ASSESSING ROOT CANAL SEALING: A REVIEW

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ABSTRACT

The primary objective of root canal therapy is the elimination of bacteria and its products from the root canal and thereby providing a hermitic seal between the oral cavity and apical tissue. Complex anatomy of the root canal system of tooth is one of the greatest challenges in dentistry. Root canal sealers are used as filler for canal irregularities along with core materials. Nevertheless leakage may occur in the interface between sealer, core material or dentine. There are several methods of estimation of apical sealing but most of the studies are limited to laboratories and are not standardized. In the present study various methodologies used for assessing root canal sealing has been critically analysed.

KEYWORDS: Apical sealing; assessment; leakage methods; root canal

INTRODUCTION

The primary objective of endodontic therapy is the elimination of bacteria and its products from the root canal. This is achieved by a perfect root canal preparation and adequate endodontic sealing, thereby preventing microorganisms and their toxins reaching apical and periapical tissues. Provision of a hermitic seal between oral cavity and the apical tissues blocks all portals of entries through which microorganisms and their irritants enter canal thereby causing reinfection.[1] Successful obturation of the complex anatomy of the root canal system of teeth poses to be one of the greatest challenges in dentistry. Complex system of finely tuned and synchronized small tributaries runs all through the length and breadth of the tooth dentine. Commonly encountered intricacies of the canal that include bifurcating canals, multiple foramina, fins, deltas, loops, cul-de sacs, inter-canal links, C-shaped canals and accessory canals have limited the available materials to successfully accomplish this procedure.[2] Root canal sealers are used as a filler for canal irregularities along with the core materials which consists of gutta-percha and silvercones. Apart from accurate filling of the 3-dimensional space within the canal endosealers eliminates the interface between the core material and dentinal walls. Nevertheless, leakage may occur in the interfaces between the sealer and dentin, sealer and core material and spaces within sealer itself.[3,4] There are several methods for estimation of apical sealing of root canal sealers, These methods use a tracer agent to penetrate the filled canal. Commonly used methods include dye penetration, bacterial penetration, fluid transport, vacuum method and dye extraction. Dye penetration tests, however, seem to be the most widely used.[5,6] The purpose of this review is to critically evaluate the different methods reported in literature for assessing root canal sealing abilities.

LITERATURE REVIEW

There is no standard method for leakage studies. There is no general consensus about the sealer and core material sealing capacity.

Dye penetration method

This method is used mainly for assessing apical leakage.The principle of capillarity is used in this method. Eosin, methylene blue, black India Ink and procion brilliant blue are the commonly used dyes. The different methods of dye penetration is recorded either by longitudinal sectioning,

transverse sectioning and clearing technique.

Longitudinal sectioning, Transverse and Clearing techniques of dye penetration

Longitudinal Sectioning method enables visualization of dye material between the interface of dentinal wall and filling material. Dye dissolution is a common problem with this technique. This can be avoided by visualizing the dye through thin layer of sliced dentin.[7] The disadvantage of this technique is that the sections are randomly sliced and may not truly represent deepest part of dye penetration.[8-10] Transverse sectioning method provides multiple cross sections through the canal .In this method because of sectioning technique called saw thickness there might be loss of dentinal tissues and dye but the advantage of this technique over longitudinal section is that there are multiple sections for visualization,[11] but the technique only allows one to determine whether or not there is penetration of dye in each section. Clearing Technique recommended by Okumura in 1927, involves a process of demineralization, dehydration and immersion of the tooth in methyl salicylate, following which the tooth becomes transparent facilitating easier view of the leakage area thereby providing a three dimensional view of the internal structure of root canals[12,13] without loss of dental substance.[14,15] Martin *et al*.,[16] also showed that the clearing technique was more precise than the transverse section for detecting apical leakage, as it allows leakage to be detected in tenths of millimeters, while transverse sectioning only determines whether or not leakage has occurred in each section. It is a fast, simple technique, requiring simple equipments and performed with substances low in toxins. The technique makes it easier to observe the lateral and accessory canals, and clearly reflects relation between sealing material and apical foramen. Transparency of the specimen may be affected by deficient demineralization caused by the procedure.[17] Demineralization time depends on the mineral content of the dentin. Incomplete dehydration during the procedure results in opaque areas on the teeth. Prolonged immersion in nitric acid and alcohol causes dye dissolution. Tracer ingress cannot be determined by the procedure. Particle size, pH and chemical properties of dyes influences the degree of penetration.

Vacuum method

Vacuum method is based on the principle that dye penetration studies should be done under vacuum as air entrapped in voids along the root canal filling may hinder fluid movement. Wimonchit et al comparing different coronal dye leakage test techniques, observed that vacuum method resulted in significantly more dye penetration than fluid filtration and passive dye penetration.[15] The results showed that fluid transport was a much more sensitive method of detecting voids along root canal fillings than dye penetration. Reduced air pressure is used for dye penetration. Passive dye penetration resulted in incomplete void filling regardless of void size where as vacuum dye delivery method resulted in complete void filling, however upright positioning of the tooth had a significant effect on dye penetration under reduced pressure. The above finding is important as teeth with apical leakage generally show leakage at all of their surfaces.

Fluid Filtration / Transport Method

This method was developed by Pashley's group in the year 1987 and modified by Wu *et al*., in 1993 for use in root canal. It consists of a filled canal that has its coronal portion and apical portion connected to a tube filled with water under atmospheric pressure and its apex to a 20ul glass capillary tube 170 mm long and having uniform caliber filled with water. Air bubble of 3mm is introduced to the open end of the capillary. All the connections are tightened with a stainless steel wire. Fluid is conducted through the root filling by applying a pressure for 3 hours after an interval period of 24 hours. This is necessary for air bubble stabilization. The fluid transport results were expressed in µl/min. As the samples can be stored for long both apical and coronal seal can be assessed. The recordings are automatic hence manual errors can be avoided.[18] The disadvantage of the above method is that it is not a standard method and there is a wide range in time (1-3 hours) and pressure (1-20psi) values.[19,20] Glucose leakage Model is an improvised method of fluid filtration method. The use of glucose adds value to the study as it simulates the glucose present in the oral cavity which leads to multiplication of bacteria.[21]

Dye Extraction or Dissolution Method

In this, teeth are dissolved in acids that release all dye from the interface and optical density of solution is measured by spectrophotometer. The fluid filtration technique gave similar results to those of dye extraction, because both take into consideration porosity of interface between filling material and the root. Though both are quantitative measurements dye dissolution method is not affected by diminished filtration over time.[22, 23] Dye dissolution method involves staining of the samples using 2% methylene blue and is stored in hermitically sealed vial containing nitric acid with a concentration of 65% for 3 days. The vials are centrifuged at high speed, this releases the dye from the interface leaving behind a supernatant solution which is observed under spectrometer for optical density.[24]

Bacteria and Toxin Infiltration Method

Timpawat et al considered use of bacteria to assess leakage to be of greater clinical and biological importance than dye penetration. Systems comprise of two chambers and each enables apical and coronal extremities of each specimen to be completely separated. The turbidity of broath in apical chamber is first indication of contamination by microorganisms. If the pulp chamber is contaminated, it may serve as a reservoir of microorganisms and toxins resulting in failure of root canal treatment and spread of infection through accessory canals to the periodontium. Many different strains of bacteria have been used to assess marginal leakage.The microorganisms have the ability to change their shape and size. So the size of the test agent or molecule represents the bacteria or its components. Similar representation cannot be done by aqueous dye solution. Streptococcus salvarius and Enterococcus Faecalis are commonly used as it is a part of normal oral flora. Some of the contraindications of this technique are that the results are affected by strains of bacteria used. This technique is not indicated for sealers with antimicrobial activity.[25-27]

CONCLUSION

From the above review it can be noted that though there are various methodologies available for assessing leakage ranging from simple methods like dye penetration to more complex methods like bacterial leakage. Most of the studies have been limited to laboratories and are not standardised and hence its clinical significance is questionable. Further research on clinical relevance will create better evidence base for application on patients.

CONFLICT OF INTEREST & SOURCE OF FUNDING

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