A Comparative Study of the Sealing Ability of Different Root End-Filling Materials

(An in vitro study)

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BY

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Dedication

This work is dedicated to my mother and father (god bless his sole) the kindest people in the world. Thanks for everything you ever did to me. My brothers, I love you so much. My bride, you are the best thing happened to me in my whole life.

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Introduction

The objectives for successful endodontics are total debridement of the pulpal space, development of fluid tight seal at the apical foramen and total obturation of the root canal system.

Root end resection and the placement of root end fillings have been performed when nonsurgical endodontic therapy has failed or is considered unfeasible, apical surgery may be the only treatment available other than extraction. Endodontic surgery usually involves exposure of the apex, root resection, root-end preparation, and root-end filling. An ideal root-end cavity preparation can be described as a class I cavity at least 3 mm deep with parallel walls

The main objective of a root-end filling material is to provide an apical seal that prevents the movement of bacteria and the diffusion of bacterial products from the root canal system into the periapical tissues.

An ideal root-end filling material should be easy to manipulate, radiopaque, dimensionally stable, non absorbable, insensitive to moisture, adhesive to dentin, nontoxic, and biocompatible.

Many materials have been used for root-end fillings in endodontic surgery. However there is no one material that is universally accepted as the best. MTA is an interesting root-end filling material that has received much attention recently. MTA has been shown to have less leakage than amalgam or zinc oxide-eugenol materials in leakage tests. Other properties that have been investigated include its in vitro cytotoxicity and biocompatibility when embedded in bone and subcutaneous connective tissue. Although MTA has superior biocompatibility when compared to the traditional materials used in root-end filling and root repair, it is a costly material and has poor handling characteristics.

Composite resin has been used as a root-end filling material with two-step adhesive bonding agent as a substitute for the Amalgam filling many years ago.

Clearfil SE (Kuraray) two-step self-etching adhesive reported no significant decrease in dentin bond strength after 100,000 thermocycles and an unchanged interfacial ultrastructure. Both the in-vitro and in-vivo studies show favorable bonding efficacy for the two-step self-etching adhesive than one-step adhesive with phosphoric acid etching.

Apicoectomy is difficult to achieve with the classical method in surgical endodontic procedure because of a number of difficulties: limited access, root anatomy, and tooth angulation. Piezoelectric ultrasonic devices for root-end preparation were developed to overcome these difficulties and are used today as standard tools for retrograde cavity preparation.

Thus, the purpose of the present study was to compare the sealing ability of three different root-end filling materials, namely: MTA, composite resin with Clearfil SE (Kuraray) two-step self-etching adhesive and composite resin with Excite (Ivoclar-Vivadent) two-step adhesive with phosphoric acid etching in root-end filling cavities prepared by burs or ultrasonic retrotips. The resected roots is resected in different angulations, 45^{o} beveled and non-beveled resected roots.

Review of Literature

The three dimensional sealing of the root canal system, mainly in the apical third is one of the major objectives of endodontic therapy.

Ingle [1] stated that 60% of the root canal failures are due to incorrectly filled root canals. Thus, the promotion of fluid tight seal at apical foramen and the complete filling of the root canal space are of prime importance.

Surgical root canal therapy, including root-end resection, has been practiced since at least the mid-1800s. In 1906 Schamberg described using radiographs to assist diagnosis and the use of surgical burs to perform a rapid osteotomy and root-end preparation.[2]

Cohen[3] stated that root-end resection is indicated for the cases that have persistent Periradicular disease, overextended filling materials, teeth with long posts or irretrievable separated instruments, non negotiable ledges and canal blockages or transportation, hard cement filling materials, failure of previous non surgical retreatment.

I- Root-end resection and bevel angles:

Elimination or minimization of the bevel angle is one of the most important benefits of microsurgery. With the traditional rotary bur, the steep bevel angle of 45 to 60 degrees was recommended. The purpose of this steep bevel was simply for accessibility and visibility, since the surgical instruments were large. In fact, beveling causes significant damage to the tissue structure that the surgery was designed to save. [4]

Gilheany et al. [5] evaluated the apical leakage associated with various depths of retrograde fillings in root apices resected at different angles. Leakage was assessed with hydraulic conductance apparatus. Three groups of teeth are divided corresponding to the angles of resection (0, 30, and 45 degrees to the long axis of the root). Increasing the depth of the retrograde filling significantly decreased apical leakage. The result of this examination was significant increase in leakage as the amount of bevel increased.

O'connor et al. [6] tested the root-end sealing ability of amalgam with varnish and Super-EBA using two root-end preparation techniques and surgical microscopy. Sixty- four single rooted teeth were instrumented and obturated with gutta-percha. Teeth were placed into four groups. Two groups received perpendicular root-end resections, 3-mm-deep ultrasonic root-end preparations, and either amalgam with varnish or Super-EBA root-end fillings. The other two groups received beveled root-end resections, 3-mm-deep micro-handpiece preparations, and either amalgam with varnish or Super-EBA root-end fillings. Statistical analysis showed that, regardless of technique, Super-EBA leaked significantly less than amalgam with varnish. There was no significant difference between the two root-end resection and preparation technique.

Lloyd et al. [7] compared Diaket sealer when used as root-end filling material with that of amalgam using linear microleakage of Indian ink. Eight groups of 20 extracted teeth each were formed, plus 12 control teeth as follows: 1) root-end resection of 45^{o} bevel, root-end cavity preparation with 008 round bur, amalgam root end filling; 2) 45^{o} bevel, bur, Diaket; 3) 45^{o} bevel, using sonic retro-prep tip, amalgam; 4) 45^{o} bevel, sonic, Diaket; 5) no bevel, bur, amalgam; 6) no bevel, bur, Diaket; 7) no bevel, sonic, amalgam; 8) no bevel, sonic, Diaket. Specimens were immersed in Indian ink for 2 weeks. Results showed that Diaket provided a superior seal to amalgam irrespective

of the root-end preparation. The degree of bevel of the resected root-end did not influence leakage.

Mauger et al. [8] examined the prevalence and location of two canals and to describe the canal anatomy that may be encountered during apical surgery. Sections of the root were cut at 1, 2, and 3 mm from the apex, simulating 20-degree beveled surgical resection. The prevalence of two canals was 2% at 1mm, 0% at 2 mm, and 1% at 3 mm. Authors studying roots with two canals commonly report an isthmus, fin, or corridor, which may be present between the two canals. Nonsurgical root canal therapy failure has been attributed to an inability to debride this area adequately so periapical surgery is required to facilitate cleaning and sealing the root canal system. Historically, steep facial bevel has been required during surgical endodontics to visualize the canal space. Recently introduced surgical microscopy and ultrasonic root-end resection allow the clinician to visualize better the apex and resect the root-end more perpendicular to the long axis of the root.

Gagliani et al. [9] evaluated how the apical root resection angle and the cavity made by ultrasonic retrotips may influence the apical seal. A total of 48 extracted teeth were endodontically treated and sealed by gutta-percha: 24 were resected with a 45^{o} angle and 24 with a 90^{o} angle. Apical leakage was determined using fuchsin and assessed after the roots were sectioned longitudinally. Linear dye penetration in dentin and at the interface between dentin and cement was measured with stereomicroscope. Results showed that there was less infiltration both in dentin and in the space between the filling and the dentinal wall in the group with the 90^{o} angle. None of the samples showed leakage greater than the depth of the preparation. An apical cavity of 3 mm or more along the vertical axis can produce a safe and effective seal.

Sauvuer et al. [10] examined the effect of root-end resection beveling on the healing of periapical lesions after endodontic surgical procedures. Root-ends were sectioned at different angulations and analyzed using photoelastimetry. Results showed that a section of the root-end through a plane perpendicular to the long axis of the tooth offers a better distribution of the stresses exerted on the apical region than the use of an inclined plane.

Kim et al. [11] observed through their anatomical study of the root apex that at least 3 mm of the root-end must be removed to reduce 98% of the apical ramifications and 93% of the lateral canals. As these percentages were not varied significantly on resection of 4 mm from the apex, they recommended root-end amputation of 3 mm, since the remaining of the root would be about 7 to 9 mm that would not affect the stability and strength of the tooth.

Tsesis et al. [12] compared the outcome of surgical endodontic treatment performed using the traditional versus the modern techniques. The traditional technique included root-end resection with a 45^{o} bevel angle, and retrograde preparation using a carbide bur. The modern technique included root-end resection with minimal or no bevel, and retrograde preparation using ultrasonic retro-tips with the aid of dental operating microscope. The retrograde filling material for both techniques was intermediate restorative material. The results showed that modern surgical endodontic technique included the non-beveled root resection and ultrasonic prepared retrocavity improves the outcome of the therapy compared to traditional technique.

Kim and Kratchman [13] compared between 45^{o} beveling on root resection and no beveling. The non beveled roots showed less amount of dentinal tubules compared to 45^{o} beveled roots. Non beveled roots needed small osteotomy and minimal loss of buccal bone plate in the endodontic surgery compared to 45^{o} beveled roots. There was no danger of periodontal