Micro leakage Assessment of A New Precision-Based System; Fluid Filtration Technique versus Silver Trace Penetration. In-Vitro Study

THESIS

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Introduction

A desirable property of a root canal sealer is good sealing ability. In the mean time, it possesses bonding and adherence to the sidewall of the root canal from one interface (dentine) and root canal filling. Adherence of the sealer to canal wall fills the irregularities that eliminate the space between the filling and the wall. Although sealers enhance sealing ability, the optimal obturation aims at maximizing the volume of the core material while minimizing the amount of sealer between the core and the canal wall.

A claim that the areas filled by the sealer are yet more vulnerable because as it dissolves over time; thus the conventional gutta-percha and endodontic sealer could not provide a long-term fluid-tight seal open a controversy on the use of well established root canal filling materials versus the newly introduced systems. This statement bought-up the new thoughts of utilizing adhesive cements that bond chemically as well as mechanically to interfaces, dentine and the solid core.

As there is no single universally accepted model of leakage testing in endodontics; the objective of this study was to examine the quality of the apical seal in Activ GP filled root canals; using silver tracer penetration protocol that has been employed in leakage evaluation of adhesive-bonded coronal dentine as compared to fluid filtration method.

Review of Literature

Gutta-percha is still the most commonly used root canal obturation material to date; it appears to be a weak point in endodontic therapy. Therefore, many techniques and materials, with objective to offer a higher sealing ability than gutta-percha, was introduced and recommended. Both the precision of filling and the elimination of voids in main root canals as well as filling of lateral canals after using different filling techniques is the target for attaining success of root canal treated teeth. Consideration was given in the review of literature to the following topics:

I. Sealing, adaptation and microleakage of root canal filling materials.

II. Inter- relation of root canal filling material with the surface of canal wall in presence or absence of the smear layer.

III. Newly introduced root filling materials(core, sealer and bonding characteristics).

I. Sealing, adaptation and microleakage of root canal filling materials;

Sealers have a major influence for leakage, without sealer, root fillings leak. Leakage may occur within the sealer or by its dissolution, either in the interface between sealer and dentine, or between sealer and gutta-percha. The areas filled by sealer are more vulnerable because gutta-percha is dimensionally stable, whilst sealer can dissolve over time. Microleakage is the passage of bacteria, fluids and chemical substances between the root structure and filling material of any type. Microleakage in the root canals is complicated as certain

variables may contribute, such as root filling technique and chemical properties of the sealer.

In the past, leakages of various root canals filling materials have been measured by penetration of dyes[8,74,95,120] isotopes[35], microorganisms[25,88,89,91], or electro-chemical means[74].

Antonopoulos et al[4] compared apical leakage obtained by passive dye-penetration to apical leakage using negative pressure of instrumented and obturated ninety maxillary incisors with either the lateral condensation technique or single cone technique. India ink passive and negative pressure penetration methods were used for determining the leakage pattern. Apical leakage was linearly measured by stereomicroscope. The study did not find a significant difference in apical leakage between teeth obturated with the lateral condensation technique and the single cone technique.

Pommel et al[74] performed a study to compare the apical leakage of three filling techniques: Thermafil, warm vertical condensation and single cone techniques. They used three evaluation methods, each successively used on the same teeth: fluid filtration, electrochemical method and dye-penetration. Results were as follows: fluid filtration showed that single cone has the highest leakage followed by Thermafil and then vertical condensation. Electrochemical method failed to show any difference. Dye-penetration ranked the obturation methods into two groups: single cone and vertical condensation. The study concluded that there was lack of correlation among the three techniques as each of them was governed by many phenomenal, and can be modified by many factors.

In a further study Pommel et al [73] determined the sealing ability of four sealers: Sealapex, Pulp canal sealer, AH-26 and Ketac-Endo. These materials bond differently both to dentin and gutta-percha, it is important for the sealer to adhere properly to dentine surface and the filling material to provide proper seal and prevent leakage. The 48 samples were prepared and filled by lateral condensation technique and divided into 4 groups, each using one type of the tested sealers. After that, they were stored for 24-hours at 37°C and 100% humidity to allow setting of the sealer and then apical leakage was evaluated using fluid filtration method.

Results showed that Sealapex has displayed the highest leakage values than AH-26, Pulp canal sealer or Ketac-Endo; there was no direct correlation between the bond strength of the sealer either to dentine or gutta-percha and between their sealing efficiency. They concluded that, adhesion of the sealer to dentine was more important than to gutta-percha. Many factors that did modify the sealing ability of a sealer: such as the smear layer that may interfere with bonding of the sealer to dentine, the rheological properties of the sealer, the type of adhesion and film thickness. All these are contributing factors that should be taken into consideration in leakage evaluation.

The study Camps and Pashely [8] was to compare the classical dye-penetration method to a dye-extraction, using fluid filtration method as control. The most common technique used for many years was the dye-penetration, where the tooth apex was dipped into a dye that penetrates through any gap or voids existing between dentinal walls and filling material. It was enhanced by negative or positive pressure or by working in vacuum chamber. The root was then cut longitudinally into 2 pieces and the depth of penetration of the dye was

recorded. However, this technique suffers from severe limitation, as the depth of penetration was not uniform. This was estimated by the two quantitative methods far better than the qualitative (dye-penetration).Therefore; they concluded that, the dye-extraction and the filtration technique had a good prediction value.

The goal of the study by Kardon et al [47] was to compare apical microleakage, using a fluid filtration model of teeth filled with new urethane methacrylate resin-based sealer, Endo-Rez, to those filled with single gutta-percha cones with AH-Plus sealer and warm vertically compacted gutta-percha with AH-Plus sealer. The Sixty-four single rooted premolar were decoronated, instrumented with greater taper profiles in a crown-down technique sequence and irrigation was performed using 1-ml of 5.25% NaOCl. Smear layer was removed from the canals by rinsing with 2-ml of 17% EDTA solution for 5-minutes, flushing again with 2-ml of 5.25% NaOCl. Teeth were divided into 3 groups of 20 each with 4 teeth as controls.

- Group A: roots were obturated with Endo-Rez filling system,
- Group B: roots were obturated with a single gutta-percha cone and AH-Plus sealer,
- Group C: roots filled with warm vertical condensation using the system B and Obtura II.
- Two positive controls filled with gutta-percha cone and no sealer and two negative controls were instrumented and obturated as group C.

Teeth were stored at 37°C at 100% humidity for 7-days to allow the sealing materials to set. The groups were compared for differences for leakage (mm\h) using a Chi-square test. The leakage of group A

was significantly higher at p=0.01 than the other two groups. There was no significant difference in leakage between groups B and C.

Kazemi et al [49] evaluated the sealing properties of Endo-Rez root canal sealer in comparison with AH-plus and zinc-oxide-eugenol (ZOE) root canal sealers. Eighty single rooted teeth were decoronated and roots were divided into 7 groups (n=10), a positive and a negative control groups (n=5). The root canals were filled AH-Plus with or without gutta-percha cone, thermoplasticized gutta-percha with or without AH-Plus, Endo-Rez with or without gutta-percha cone and ZOE with gutta-percha cone. The results suggested that Endo-Rez root canal sealer sealing properties were similar to AH-Plus and, Endo-Rez root canal sealer exhibited superior sealing properties in comparison to ZOE root canal sealer.

Karadag et al [44] evaluated the in-vitro apical leakage of fillings performed with a resin based root canal sealer used in conjunction with water and acetone-based dentine adhesives and laterally condensed gutta-percha. Thirty-nine teeth were decoronated at cemento-enamel junction and roots were chemo-mechanically prepared using step back technique and irrigation with 19% EDTA. Roots were divided into 3 groups of 13 teeth each:

- Group 1 roots filled with gutta-percha, AH-plus sealer and water based adhesive system (Syntac Single Component).
- Group 2 roots filled with gutta percha, AH-plus sealer and acetone based adhesive system (Prime & Bond NT.).
- Group3 specimens were filled with gutta-percha, AH-Plus sealer and no adhesive was applied.

Then the teeth were immersed into 2% methylene blue solution to measure the linear dye-penetration with stereomicroscope. Dentinal tubule penetration was observed under SEM. In this study group 3 (no adhesive system) leaked more than the other groups and SEM examination revealed dentinal tubule penetration was better in groups one and two than in group three.

Rajeswari et al [77] evaluated the apical microleakage of Thermafil and Obtura II in comparison with cold lateral condensation using fluid filtrations system, where 55 extracted human mandibular first premolars were de-coronated and prepared using profile NI-TI instruments. The teeth were randomly divided into 3-groups of 15 specimens. Positive controls were left unobturated and negative controls were filled with cyanoacrylate cement. The system assembled, a 15-psi pressure was applied to the saline reservoir, and the movement of the air bubble signifies fluid movement toward the root sample was recorded (mm\hr). Reading was converted into micro liters per minute. The results showed that group I has the highest leakage value followed by group III with moderate leakage and group II with least leakage.

Sevimay and Kalsygi [85] evaluated the sealing ability, adaptation to dentine of two resin based root canal sealers where extracted maxillary anteriors prepared, and irrigated with 17% EDTA and 5.25% NaOCl to remove smear layer. Roots afterwards divided randomly into two groups and filled by lateral condensation of gutta-percha and sealer. In the first group AH-Plus was used as a sealer while Endo-Rez was used in the second group. Estimated dye-penetration in teeth sectioned longitudinally using 2% methylene blue and then maximum dye-penetration from the apex to the most coronal part was evaluated

using stereomicroscope in each half. Reserved five samples from each group were prepared for SEM examination to reveal the sealer penetration into dentinal tubules and adaptation to dentinal walls.

Results showed that with dye test mean apical leakage for AH-Plus was significantly lower than that for Endo-Rez while SEM showed that both sealers have better adaptation and penetration to dentine in the coronal and middle thirds than apical one.

Orucoglu et al [69] studied the apical leakage of three sealers: AH-Plus, Diaket and Endo-Rez using computerized fluid filtration meter. This method overcomes the disadvantages of various techniques of leakage assessment as dye penetration, radioisotopes, bacterial penetration, electrochemical means and SEM. Fluid filtration method suggests pathways between coronal and apical end of a root filling, it indicates the diameter and the length of the void. The computerized fluid filtration meter presents controlling and digital air pressure arrangement, also air bubble can be observed by laser diodes rather than visually.The study concluded that:

- Diaket showed significant less leakage than AH-Plus and Endo-Rez.
- Computerized fluid filtration is simple and convenient in measurement.
- Further studies comparing traditional and computerized fluid filtration tests are required.

De-Deus et al [15] investigated the sealing ability of four sealers: Pulp canal sealer, Endo-Rez, Sealapex and AH-Plus. Upper central root canals in 82 teeth prepared and divided into 4 groups, each