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Original Research Article

Apical microleakage comparison using various sealers and different obturation techniques- An in-vitro study

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ABSTRACT

Aim: The aim of the study is to compare the apical microleakage of two Bioceramic sealers Ceraseal, MTA Fillapex and an Epoxy resin sealer (AH Plus) with two different obturation techniques single cone and thermoplastic obturation techniques using dye extraction method.

Materials and Methods : 80 mandibular single rooted premolars were decoronated, & biomechanically prepared. The samples were randomly divided into eight groups with ten samples (n=10). Group (A1) contained roots samples obturated with Ceraseal sealer and a single cone Gutta percha. Group (A2) constituted samples obturated using Ceraseal sealer and thermoplastic obturation. Group (B1) samples were obturated with MTA Fillapex sealer with a single cone. Group (B2) contained roots which were obturated using MTA Fillapex sealer with a thermoplastic obturation. Group (C1) contained roots samples obturated using AH Plus sealer with a single cone. Group (C2) samples were obturated using AH Plus sealer with thermoplastic obturation. Group D and Group E served as positive and negative control. Apical leakage was assessed using dye extraction method.

Results: Warm or cold obtuartion technique using sealers with different composition does not totally eliminate apical microleakage.

1. Introduction

Root canal is a three dimensional space that is obturated with a solid core material along with a sealer. Proper obturation plays a major role in achieving three dimensional sealing of the root canal system. Gutta-percha is a stiff material and does not have any adhesive properties to the root canal walls, so the role of a sealer is to provide bonding at sealer – dentine and sealer- core material interface is important. A poor obturation resulting in microleakage can results in re-entry and growth of microorganisms in the root canal system which infects the periapical tissue and compromises the long term prognosis of the teeth.[1]

Root canal sealers, have been shown to influence and improve the prognosis of endodontic treatment. Sealers are binding agents that fill up the voids, accessory canals and irregularities within the canal. Sealing ability and biocompatibility are two critical properties that an ideal root canal sealer should possess. Tricalcium silicate-based sealers[2] have been introduced after the favorable properties of (MTA) mineral trioxide aggregate ie, its calcium releasing ability and bioactivity were popularized in endodontics.[3] The first commercial tricalcium silicate-based sealer was MTA Fillapex (Angelus, Londrina, Brazil), which is mostly composed of salicylate resin rather than MTA.[4,5]

In 1984 Krell and Wefel[6] first introduced bioceramic material as a root canal sealer. The final chemical

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composition and crystalline structure of set cement due to the presence of calcium phosphate in the bioceramics makes it bio- compatible to tooth and bone apatite.[7] Ceraseal[8] (Meta Biomed Co.,Cheongju, Korea)is new premixed ready-to-use Bioceramic endodontic sealer based on calcium silicate and has good physiochemical properties. It is a premixed, hydrophilic product available in injectable form that use moisture within the dentinal tubules for its setting reaction.

Thermoplastic obturation such as the continuous wave (CW) technique which is based on use of Heated gutta-percha in the canal and has been shown to flow extremely well into all canal irregularities. Thermoplastic obturation is useful in cases with internal resorption, C- shaped canals, and those cases with canal aberrations. This technique is becoming the gold standard for hermetic endodontic obturation.[9] Though the Manufacturers' recommend, use of Single cone (SC) technique with calcium silicate–based sealers some practitioners use thermoplastic technique with these sealers. Therefore, the aim of the current study was to compared manufacturers' recommended SC technique to the other popularly used thermoplastic CW technique and its influence on apical microleakage of MTA Fillapex Sealer and Ceraseal Sealer by using dye extraction method.

2. Materials and Methods

2.1. Sample selection and preparation

80 non carious mandibular single rooted premolars with mature apices and no other non carious defects extracted for orthodontic reasons were decoronatedusing a diamond disc to a standardized root length of 12 mm. Working length was determined by inserting size #10 K file until it was just visible at the apical foramen and 1 mm was subtracted from it. The samples were stored in normal saline until use.

2.2. Root canal preparation

All canals were bio-mechanicaly prepared till apical size of 0.40mm and 0.04 taper using nickel-titanium rotary instruments. Side-vented needle were used for irrigation with 5.0% NaOCl (Safe Plus, Neelkanth, India) during change of every instrument. Final irrigant used was 3 mL 17% EDTA (Dent Wash, Prime Dental Products private limited, India) for 1 minute and then rinsed with5 mL saline for 1 minute and dried with paper points. After completing the biomechanical preparation, the outer surface of the roots samples were painted with two layers of nail varnish, a 10 k files was passed a 1mm beyond the apex to prevent the nail varnish from covering the apical foramen.

2.3. Grouping and obturation

The prepared samples were divided randomly based on the sealer material used and obturation techniques into six experimental groups, and two control group of ten roots (n=10) each:

Group A1: (Ceraseal-SC): The canals were thoroughly with coated with Ceraseal sealer using a 40/0.04 GP cone. Then the mastercone was coated with a thin layer of sealer and slowly inserted to the working length. The cone was seared off at the orifice level and lightly condensed with a plugger

Group A2: -(Ceraseal-CW): Then the mastercone was coated with a thin layer of Ceraseal sealer and slowly inserted one mm short of the working length. The master cone was sheared at 5mm from the canal apex. Then the rest of the canals was thoroughly coated with Ceraseal sealer followed by obturation with the CW technique (Elements system) at 200°C. Backfilling was performed with the (Elements system) at 200°C followed by condensation with a plugger.

Group B1: (MTA Fillapex–SC) The canals were thoroughly with coated with MTA Fillapex sealer using a 40/0.04 GP cone. Then the mastercone was coated with a thin layer of sealer and slowly inserted to the working length. The cone was seared off at the orifice level and lightly condensed with a plugger.

Group B2: (MTA Fillapex–CW)Then the mastercone was coated with a thin layer of MTA Fillapex sealer and slowly inserted one mm short of the working length. The master cone was sheared at 5mm from the canal apex. Then the rest of the canals was thoroughly coated with MTA Fillapex sealer followed by obturation with the CW technique (Elements system) at 200°C. Backfilling was performed with the (Elements system) at 200°C followed by condensation with a plugger.

Group C1: (AH Plus- SC) The canals were thoroughly with coated with AH Plus sealer using a 40/0.04 GP cone. Then the mastercone was coated with a thin layer of sealer and slowly inserted to the working length. The cone was seared off at the orifice level and lightly condensed with a plugger.

Group C2: (AH Plus–CW):. Then the mastercone was coated with a thin layer of AH Plus sealer and slowly inserted one mm short of the working length. The master cone was sheared at 5mm from the canal apex. Then the rest of the canals was thoroughly coated with AH Plus sealer followed by obturation with the CW technique (Elements system) at 200°C. Backfilling was performed with the (Elements system) at 200°C followed by condensation with a plugger.

Group D: Positive control: Ten samples were used in which the canals were samples obturated with gutta percha only and no sealer was used. The roots were coated with twolayers of nail varnish except the apical opening.Group E: Negative control: Ten samples wereleft unfilled. No coat of nail varnish was applied.

Radiographs were taken to evaluate the quality of root canal filling. The access cavities were sealed with Orafil G (Prevest Denpro) and all samples were stored for7 days at room temperature to allow the sealer to set.

2.4. Dye application and extraction

After the varnish coating had completely dried, all samples were immersed for 24hrs in 2% methylene blue solution (Ases Chemical Works, India). The samples were cleaned thoroughly with running tap water. After the Samples dried, and coating was removed with a BP blade. For next 72hrs the samples were stored in test tube containing 4.0 ml of 65% nitric acid. The solutions were centrifuged for 7 minutes at 4000 rpm (EBA, USA) and the supernatant was subjected to absorbance measurements.

2.5. Measurement of leaked dye concentrations

The absorbance of leaked dye, in nm, from each sample, was measured by using UV mini 1240 spectrophotometer device (Shimadzu, Japan) with photometric mode and 600 nm lambda in a standardized volume of 3.0 ml of a solution of each sample.

The absorbance of each sample of all groups was measured three times. Standard solutions of 1%, 0.5%, 0.1%, 0.05% and 0.01% of methylene blue in 65% nitric acid were prepared and stored for 72 hours in dark cabinet at room temperature.

The absorbance was converted to concentration (μg/ml) using Beers law as follows:

Cu / Cs = Au / As Cu = Cs (Au /As) Where Cs: The prepared Known concentration of methylene blue dye.

As: The absorbance of the prepared known concentration of methylene blue dye measured by spectrophotometer.Au: The absorbance of the unknown sample determined by spectrophotometer.

Cu: Concentration of the unknown sample.

All the samples absorption were applied to the equation to discover the amount of methylene blue dye concentration in it.

2.6. Method of statistical analysis

Data were collected and submitted to statistical analysis using a software program (IBM SPSS statistics, version 22). The mean and standard deviation of micro leakage in millimeters data were analyzed using One-way analysis of variance (ANOVA). Followed by multiple comparisons using Post-hoc Tukey test A P-value of < 0.05 was considered statistically significant.

3. Results

The test showed that all groups showed an apical leakage. The means and standard deviations of dyeconcentration were as follows: Ceraseal Sealer with a single cone (0.012 ± 0.012), Ceraseal Sealer with continuous wave condensation (0.016 ± 0.013), MTA Fillapex sealer with a single cone (0.013±0.011). MTA Fillapex sealer with a continuous wave condensation (0.014±0.012). AH plus with a single cone (0.011 ± 0.011), AH plus with continuous wave condensation (0.015 ± 0.009).

Table 1: One- way ANOVA statistics of the dye concentrations (μg/ml) in study groups.

Concentration	Sum of Squares	df	Mean Square	F	Sig.(P value)
Between Groups	.000	4	.000	.948	.437
Within Groups	.010	77	.000	-	-
Total	.010	79	-	-	-

4. Discussion

The aim of obturation is to achieve a water-tight barrier and protect the periradicular tissues from infection. It is accomplished using a gutta percha and a sealer.GP is either cold or thermo plasticized. Warm condensation (gutta-percha — sealer) technique resultsina friction fit, “cork-in-the-bottle” type sealing.[10] Sealers reduce the gap between the GP and the root dentine thus enhancing the apical sealability.

MTA Fillapex is a unique salicylate resin based sealer that contains 15% MTA powder.[11] Major ingredient of MTA-Fillapex is the salicylate resin matrix, whereas MTA is a minor additive. It is composed of oxide, resins, silica nanoparticles, and pigments.[12,13] MTA Fill apex absorbs less water, leaches significantly less $Ca^{2+,}$ and presents less alkalinizing activity and apatite deposition than calcium silicate cements. Salicylate resins aim to improve the physicochemical properties and handling characteristics of sealers with bioactive components but the resin matrix renders MTA relatively inert.[14] MTA-Fillapex shows considerably high flow ability and setting time because of the unbalanced ratio between resin and MTA when compared to Ceraseal sealer.

Ceraseal sealer is a pure bioceramic sealer composed of Tricalciumsilicates, Dicalciumsilicate, Calcium-aluminate, zirconium-oxide, thickening agent. The small size of its constituent grains it affinity towards water and low contact angle allow it to creep easily over the dentinal walls inside the canal and enter the lateral micro-canals. This results in a strong chemical bond between the sealer and dentinal walls.[15] The setting reaction of Ceraseal sealer is initiated by moisture and the final set contains a calcium silicate hydrate gel and calcium hydroxide. The calcium hydroxide then interacted with phosphate ions from dentine to form hydroxyapatite and water. The water produced continues to react with the calcium silicate to precipitate additional gel-

like calcium silicate hydrate.[16]

AH Plus is a epoxy paste-paste system with different radio-opaque fillers. AH Plus has better penetration into the micro-irregularities because of its creep capacity and long setting time, which increases the mechanical interlocking between sealer and root dentin.[17]

To evaluate the sealing ability of sealers, the dye penetration technique is among the most commonly used methods. This method is simple and easy to perform . Methylene blue dye has molecular size similar or smaller than that of bacterial products, so it had been considered suitable for the detection of apical microleakage.[18] In our study the flow of methylene blue dye in the tooth through the apex, determined the result for the sealers evaluated. Methylene blue dye has the potential to enter the obturated canals through complex anatomies of apical third of the root canal or space between dentin-sealer-corematerial interfaces.[19] The positive control group, Group D indicated that leakage testing was a suitable method for proving total dye penetration without a sealer. The negative control group, Group E showed nodye penetration, indicating that use of two layers of varnish was effective to prevent apical dye penetration, as in study conducted in accordance by Oliver et al.[20]

All the six groups showed no statistical significant differences among them ($P > 0.05$). The single cone obturation with MTA Fillapex sealer showed more apical leakage than single cone with AH Plus sealer. The changes in free surface energy of dentine walls due to use of EDTA irrigating solution can be a reason reducing the wettabilty and ultimately the adhesion of hydrophilic AH Plus sealer. Our results are in concordance with a study done by Polineniet al.[21] and found MTA Fillapex has less marginal adaptation when compared to epoxy resin based sealer Micro-Mega sealer (Epoxy resin sealer), and Endosequence sealer to dentine with single cone obturation technique using the scanning electron microscopy. AH Plus forms covalent bonds between the resin epoxide ring and amino group in exposed root collagen,[22] AH Plus due to its mild acidic character can self-etch the root dentine and resulting better bonding and adaptation. MTA Fill apex, is a combined bioceramic resin basedsealer, the reason for the slightly higher micro leakage could be due to incomplete polymerization of its resin components leading to formation of poor micro-tags and polymerization shrinkage on setting.[23]

The setting reaction of the Ceraseal, which is bioceramic-based, begins by absorbing water from the dentinal tubules. calcium silicate hydrates to calcium silicate gel and forms calcium hydroxide and ultimately releases various ions includingSi^{4+},Ca^{++}&OH^{-} ions during setting.[24] The freshly mixed elutes, release very high amounts of Ca^{++} and OH^{-}.Calcium silicate hydrogel and hydroxyapatite compound are created after this reaction. The calcium silicate hydrogel binds chemically to the hydroxyapatite via the hydroxyl groups. The hydroxyapatite in the sealer show a continuous process of crystal growth, and both compounds of the sealer form a strong chemical bond with the dentin, these sealers also flow inside the dentinal tubules without any shrinkage during the setting. This result in less apical microleakage and similar results were observed in a study done byZang et al.,[25] and Bayramet al.[26]

According to the manufacturer's instructions, both MTA Fillapex and Ceraseal sealer should be used in an Single cone technique. The method of obturation impacts the sealing ability of these calcium silicate sealers and support the manufacturers' recommendations. The higher microleakage values in group B2 ie, MTA Plus–CW can be explained that the heat used in the CW technique can possibly alter the physical, or chemical properties of the sealer. During the down-pack the heat source can physically remove the sealer, thus reducing it from the canal. The results of our study are in accordance with a study done by De Long et al.[27] which showed that calcium silicate sealers had higher mean bond strengths when used as an SC technique compared with the CW technique.

5. Clinical Implications

Within the shortcomings of the study, following clinical information is obtained:

1. Warm or cold obtuartion technique using sealers with different composition does not totally eliminate apical microleakage.
2. The manufacturer recommended use of single cone obturation technique with calcium silicate sealer results in less microleakage.

6. Source of Funding

None.

7. Conflict of Interest

None.

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