Comparative evaluation of the sealing ability of two different retrograde filling materials using dye penetration method: An In-Vitro study

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Abstract

Introduction and objectives: The seal provided by root-end filling materials determines the success of endodontic surgery since prevents penetration of tissue fluids into the root canals. Therefore, the aim of this study is to compare the sealing ability of two different root‑end filling materials.

Materials and Methods: Forty-Five mandibular premolars were obturated with laterally condensed gutta‑percha and AH plus sealer. The roots resected 3 mm perpendicular to the long axis of the tooth. Root‑end cavities were prepared no.2 ultrasonic tip. The teeth were then divided into two experimental and one control group, and cavities restored as per the groupings. The teeth were immersed in India ink for 72 hrs, split longitudinally, and dye penetration was measured under stereomicroscope.

Results: There was no statistically significant difference among the two groups.

Keywords: Biodentine, Giomer, Root-end preparation, Dye penetration.

Introduction

The goal of root canal treatment is the cleaning, shaping, and complete obturation of the root canal system, thus preventing the proliferation of microorganisms and their by-products.[1]

Endodontic surgery is a surgical procedure that consists of eliminating pathological periapical tissue via excision of the root surface (including apical accessory canals), and finally a sealant or closing of the root canal or canals against the entry of pathogens, thus achieving its objective of creating optimal conditions for tissue regeneration, and the formation of a newer supporting structure for the tooth.[2] Therefore, placement of root-end fillings in the roots of almost all the teeth that require root-end resection is needed. The aim of placing root-end filling material is to develop an apical seal. The steps of periapical surgery includes surgical removal and debridement of pathological lesion, root-end resection, root-end preparation and root-end sealing; the sealing provided by root-end filling materials is the primary determinant of success of this type of treatment.

In endodontic surgery, many materials have been used for retro-filling, such as amalgam, super-EBA, composite resin and glass ionomer. However, most of them exhibit significant shortcomings in one or more properties such as leakage, solubility, biocompatibility, handling properties and moisture incompatibility.[3]

Biodentine™ with Active Bio silicate Technology™ was introduced by Septodont (Dental material manufacturing company) in the year 2010 which is a calcium silicate based material is not only used repair of crown-root perforations or resorptions but also for apexification and root-end fillings. Biodentine when compared to others has good handling properties, shorter setting time and improved mechanical properties.[4]

Giomer has fluoride-releasing, also resin-based dental adhesive material that contains PRG fillers. Giomer decreases acid production of cariogenic bacteria, helps in formation of an acid-resistant layer, has an anti-plaque effect and reduces solubility of tooth mineral.[5]

Hence, this in-vitro study was conducted to evaluate the sealing ability of Biodentine and Giomer as a retrograde filling materials.

Materials and Methods

Forty-five mandibular premolars extracted for orthodontic reasons were selected. All soft tissue remnants on root surface were cleaned and debris removed with the help of Ultrasonic scaler and teeth were stored in distilled water until use.

The samples were decoronated using a diamond disc mounted on a mandrel with the help of a micromotor and a straight handpiece. Access cavities were prepared and the canal was prepared upto size 25

k file. The root canal shaping was carried out using ProTaper Universal rotary instruments (Dentsply Maillefer, F2 being the last apical file. The root canals were flushed using 1 mL of 5.25% NaOCl solution between each instrument change.

Canals were dried with the use of absorbent paper points and obturated with gutta percha using lateral compaction technique with AH plus being the sealer. The samples were then stored in saline for 1 week. They were resected apically at 90° angle to the long axis of the root using diamond disc mounted on a mandrel with micromotor and straight handpiece removing 3 mm of the apex. The 3 mm deep retrograde cavity was prepared using no.2 ultrasonic tip (ProUltra Endo

Tip, Dentsply).The cavities were irrigated with saline and dried. The teeth were then randomly grouped into 3 groups of 15 specimens each.

1. Group A (n=15): Control Group
2. Group B (n=15): Biodentine
3. Group C (n=15): Giomer

These materials were manipulated as per the manufacturer's instructions and the cavities were filled. The specimens were then coated with 2 coats of nail varnish except at the apical 1mm & then were allowed to dry. The specimens were then placed in India Ink for 72hours. After this the teeth were rinsed under running water for 15 minutes. The teeth were then sectioned longitudinally using diamond disc, and the dye penetration was examined under stereomicroscope & microleakage was evaluated in millimetres. The specimens were scored for linear measurement of dye penetration along cavity walls using the scores given below-

0 = No dye penetration

1 = Dye penetration into apical one third of retrograde filling material

2 = Dye penetration into apical middle third of retrograde filling material.

3 = Dye penetration into full length of retrograde filling material.

4 = Dye penetration beyond retrograde filling material.

Fig. 1: Retrograde Preparation

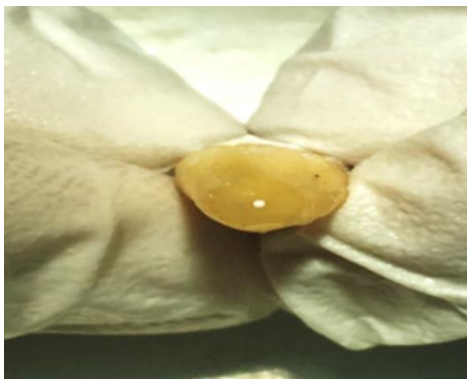

Fig. 2: Biodentine placed inside the cavity

Fig. 3: Placement of samples in india ink dye

Fig. 4: Longitudinal sectioning

Fig. 5: Stereomicroscope with 10x magnification

Table 1: Sepicts Comparison of microleakage in terms of {Mean (SD)} among different materials using ANOVA test

Group	N	Mean	Std. Deviation	F value	P value
Biodentine	15	0.780	0.2715	90.272	<0.001**
Giomer	15	0.856	0.6010		
Control	15	2.838	0.4935		
Total	45	1.491	1.0695		

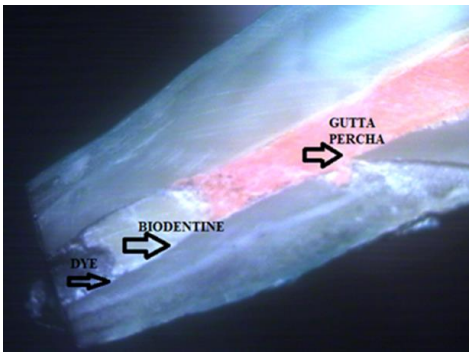

Fig. 6: Dye penetration seen in biodentine

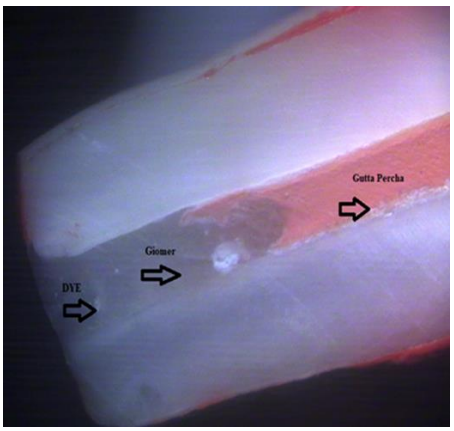

Fig. 7: Dye penetration seen in giomer

Results

Group A: As it is a control group, no material was placed. All stereomicroscopic images for the control group showed a substantial amount of dye penetration. Both Group B and C showed microleakage, although Giomer and Biodentine showed microleakage the difference was not statistically significant.

Biodentine showed lesser microleakage than Giomer it is better.

Statistical analysis

Descriptive and also inferential statistical analyses were carried out in the present study.

Results during continuous measurements were presented on Mean ± SD. Level of significance was fixed at p=0.05 and any value less than or equal to 0.05 was considered to be statistically significant.

Analysis of variance (ANOVA) was used to find the significance of study parameters between the groups (Inter group analysis). Post hoc analysis was done to evaluate if the values of ANOVA test were significant.

The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY,

USA) was used for analyses of the data and also Microsoft word,Excel to generate graphs, tables etc.

Discussion

Ideal root-end filling material ought to produce a complete apical seal, and should be non-toxic, non-resorb able, easy to manipulate, dimensionally stable, well-tolerated by the periradicular tissues and radiopaque. In addition, it should be bacteriostatic or bactericidal. Selection of an efficient root-end filling material after root-end resection is a major factor in surgical endodontics.[6]

Today, many materials are available as root end filling material. Giomer and Biodentine are amongst them.

Giomer is a specialized restorative material with the properties of both glass ionomer cement and composites. The S-PRG technology used in it not only provides the benefits of mechanical strength of a composite material but also provides release of multiple ions i.e Sodium ions, Silicate ions, Aluminium ions, Fluoride ions, Borate ions and Strontium ions which in turn provide multiple biological functions like Fluoride release and recharge, anti-plaque effect, anti-biofilm effect and modulation of pH.

Giomer has been introduced with its benefits to decrease acid production by cariogenic bacteria, formation of an acid-resistant layer, an anti-plaque effect and reduction in tooth mineral solubility.

Biodentine™ a calcium silicate-based material is often used for crown and root dentin repair treatment, perforations repairs or resorptions, apexification and root-end fillings.

Biodentine have shown biocompatibility and also ability to induce odontoblast differentiation and mineralization in cultured pulp cells.[7] Main benefits of

Biodentine as compared to other calcium silicate-based materials are its reduced setting time, and better handling as well as mechanical properties. Marginal adaptation may have an indirect correlation with the sealing ability of retrograde-filling materials. Jung et al has proposed that the quantity of PDL cells were more in Biodentine attributing its repair and better biocompatibility, since it contains of tri- and dicalcium silicate which enhances the bioactivity of the material on osteoblast and osteoclast-like cells, and also lead them to the release of silicon from the cement. Furthermore, Biodentine has been suggested to show considerably higher levels of calcium and silicon ion release in comparison to other materials being used.

In view of above criteria, this in-vitro study was conducted to evaluate and compare sealing ability of two root-end filling materials Giomer and Biodentine in teeth using dye penetration method under stereomicroscope.

The samples were resected apically at 90° angle to the long axis of the root using diamond disc mounted on a mandrel with micromotor and straight handpiece removing 3 mm of the apex. Tidmarsh and Arrowsmith under scanning electron microscopy examined that the resected root ends of sample, and suggested, that the number of dentinal tubules apparently communicating between the resected root face and the root canal were more when the angle of the bevel was kept maximum (45^0) and that the retrograde filing should extend coronally into the canal, at least till the level of the coronal end of bevel.[8]

Although at least 2-3 mm of root end removal is recommended as apical resection,

Philip et al showed in their studies that 2 mm or 4 mm of the apex resection did not show a significant difference in apical dye penetration.[9]

Then 3 mm deep retrograde cavity was prepared using no.2 ultrasonic tip.

Previously, the root-end cavities were prepared with small, round, and using inverted conical burs in high-speed micro hand-pieces. But, this technique was proved to cause several problems such as nonparallel cavity walls, difficulty reaching the root tip, and lingual perforation of the root also Khabbaz M G et al observed emergence of micro cracks on the surface of the apical root and formation of smear layer on the surface of the cavity.

Improved sonic and ultrasonic (US) retrotips have been of great benefit to root-end treatment. US retrotips has more advantages over traditional apical surgery.High-speed handpieces and burs in that smaller, better-centered, have shown better-shaped root-end cavities.[10]

These materials were manipulated according to the manufacturer's instructions and the cavities were filled because in a study carried out by Pankaj Kumar Gupta et al suggested that more microleakage was likely seen when Biodentine was manipulated manually as compared to its machine trituration. This can be attributed to the fact that mechanical trituration produces a more homogenous mix as compared to manual mixing.[11] The specimens were then coated with 2 coats of nail varnish except at the apical 1mm & then were allowed to dry. The specimens were then suspended in India ink for 72hours.Evaluation of microleakage with India ink dye penetration is one of the most commonly used methods. This dye not only has smaller particles that easily penetrates by simple diffusion but also has negligible influence on the sealer of root canal obturation. The hydroxyapatite crystals of dentin have not shown its absorption and thus this dye has been frequently used for microleakage studies.

Following this the samples were rinsed for 15 minutes under running water. The samples were then sectioned longitudinally using diamond disc, and the dye penetration was examined under 10X stereomicroscope & microleakage was evaluated in millimetres.

In this way, results obtained were statistically evaluated and following inferences were drawn.

Table 1 shows the comparison of microleakage among different groups. The results of this study showed that there was more microleakage in Group A (2.83 mm) when compared to Group B (0.78 mm) and Group C (0.85 mm). There was highly significant difference between all the three groups ($p<0.001$). This result could be attributed to the fact that there was no retrograde filling done in Group A. Whereas, in group B Biodentine was placed which has been proved to have chemicomechanical bonding with the tooth and thus, has a better sealing ability and least microleakage amongst all the other groups. Recently introduced Giomer has been newly used as a retrograde filling material showed significant lesser microleakage compared to group A.

Giomers or hybrid restorative materials which employ the use of pre-reacted glass ionomer technology to form a stable phase of GIC, also known as PRG composites.

The fluro-alumino-silicate glass in these materials is reacted with polyalkanoic acid in water prior to inclusion into silica filled urethane resin.

Lenander-Lumikari and Loimaranta, 2000; Camilleri, 2008 have also proved that the interaction between the calcium silicate cement in Biodentine and

the phosphate ions present inside saliva has resulted in the formation of apatite deposits which has shown increase in the sealability of the material.

Biodentine is found to be associated with high pH (12), it releases calcium and silicon ions which create "mineral infiltration zone" along dentin-cement interface by stimulating mineralization imparting a better seal.[12]

Giomer showed slightly greater microleakage when compared to Biodentine. It is a compound of Composite and Glass ionomer cement. This may be due to the fact that being resin-based, it exhibits polymerization shrinkage.

In support of this finding a similar result a study was conducted by Lakshmi

Narayan et al. According to him, polymerization stress during curing of Giomer resulted in gap formation between the tooth and the restorative surface leading to microleakage.[13]

Though Giomer can bond with tooth structure it showed slightly higher microleakage values when compared to Biodentine. And hence, its use as retrograde filling material is not as effective as Biodentine.

However, this is an in vitro study and it may differ from clinical situations, which could affect the performance of materials. Further studies should be conducted to evaluate its effectiveness in clinical conditions.

Conclusion

Within the limitations of this study following conclusions were drawn:

1. Both the root-end filling materials showed microleakage.
2. Though Giomer and Biodentine showed microleakage the difference was not statistically significant.
3. Biodentine showed lesser microleakage than Giomer it is better. Hence it can be efficiently used as retrograde filling material.

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Conflict of Interest
None.

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