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ORIGINAL RESEARCH

Analysis of Sealing Ability of Two Retrograde Filling Materials Using Dye Penetration Method: An Institutional Based Study

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ABSTRACT

Introduction: The primary objective of any root end filling material is to seal the apical region to avoid any kinds of bacterial infiltration or their by-products from the supporting periodontal structures into the root canal system.

Materials and Methodology: For the study purpose, sixty mandibular premolars were selected which were extracted for orthodontic reasons. The root surfaces were sought to be cleaned and the soft tissue remnants present as debris were removed help of Ultrasonic scaler and teeth were stored in distilled water until further use. The materials that were intended to be studied in this research were manipulated as per the manufacturer's instructions and the cavities were filled respectively. The specimens were then coated with 2 coats of nail varnish except at the 1 mm apical area & then they were allowed to be dried.

Results: Group A: Since it is a control group, no material was placed. All stereomicroscopic images for the control group demonstrated a relative amount of dye penetration. Both Group B and C showed microleakage, where Giomer and Biodentine showed microleakage but the difference was not statistically significant. Biodentine is considered as better root-end materials since it showed lesser microleakage than Giomer.

Conclusion: Both the root-end filling materials such as Giomer and Biodentine revealed the presence of microleakage but the results were not observed to be statistically significant. Comparatively Biodentine possessed lesser microleakage than Giomer and it is considered to be better. Therefore, it can be effectively used as a retrograde filling material with better results.

Keywords: Biodentine, Giomer, Root-End Fillings, Marginal Leakage.

INTRODUCTION

The term Endodontics could be defined as "the branch of dentistry which is frequently concerned with the morphology, physiology and pathology of the human dental pulp and the peri-radicular tissues." There are various treatment options presently available for the pulpal pathologies which mostly include nonsurgical and surgical approaches. And the reported

success rate with nonsurgical approaches is about 96%.[1]Whereas in the case of peri-radicular radiolucencies or cystic lesions, the probability of the success rate with nonsurgical approaches is estimated to be low which necessitates the need of surgical procedure for the achievement of the hermetic seal between the intra-radicular and extra-radicular root canal systems.[2]And the term Endodontic surgery is defined as a surgical procedure that involves in eliminating pathological periapical tissue, root surface excision and closing of the root canal against the entry of pathogens, thus attaining the objective of creating ideal conditions for health, tissue regeneration and formation of a new periodontal structure for a tooth.[3] The fundamental objective of root-end fillings is to achieve the seal at the apical region to effectivelyeliminate bacterial infiltration or their by-products from the peri-radicular tissues to the root canal system. The ideal properties which the root-end filling material should possess include biocompatibility, radiopacity, dimensional stability, antibacterial properties, adequate compressive strength and hardness, easy handling, osteo-inductive and osteo-conductive properties and thereby adhere to the root canal walls to achieve a good apical seal.[4] Insufficientand improper retrograde seal is considered as the major aetiological factor of treatment failure in endodontic surgeries. Hence, good sealing ability is a uniquepre-requisite of the root-end filling materials.[5]Many years, various restorative and endodontic materials have been proposed in the literature for the root-end filling which include amalgam, zinc oxide eugenol (ZOE) cement, gutta-percha, polycarboxylate cement, calcium hydroxide, glass ionomer cement (GIC) and composite resins. But owing to the various disadvantages like marginal leakage, moisture sensitivity and biocompatibility issues, associated with these materials have discouraged their applications as the retrograde filling materials in the recent endodontic practices.[6]

Biodentine™ with Active Bio silicate Technology™ was earlier launched by Septodont (Dental material manufacturing company) in the year 2010 which is considered to be a calcium silicate-based material which has not been only used in the repair of crown-root perforations or resorptions but also for apexification and root-end fillings. Biodentine has good handling properties, shorter setting time and improved mechanical properties when compared to various other root end filling materials.[7]Another root end filling material, Giomerwhich has fluoride-releasing, also a resin-based dental adhesive material which contains PRG fillers. Giomereffectively eliminates acid production from the cariogenic bacteria and helps in the formation of an acid-resistant layer, has an anti-plaque effect and decreasesthe solubility of the intact tooth mineral.[8]Therefore, this in-vitro study was conducted to evaluate the sealing ability of Biodentine and Giomerin the application as a retrograde filling material.

MATERIALS AND METHODOLOGY

For the study purpose, sixty mandibular premolars were selected which were extracted for orthodontic reasons.The root surfaces were sought to be cleaned and the soft tissue remnants present as debris were removed help of Ultrasonic scaler and teeth were stored in distilled water until further use. The samples were sectioned into two at the CEJ using a diamond disc mounted on a mandrel with the help of a micromotor and a straight handpiece. Access cavities were made and the canal was prepared upto the size 25 k file. The root canal shaping was then followed out using ProTaper Universal rotary instruments (Dentsply Maillefer, F2 being selected as the final apical file. The root canals were flushed using 1 mL of 5.25% NaOCl solution between each rotary file change. Canals were dried with the help of the absorbent paper points and then they were obturated using gutta percha with lateral compaction technique by AH plus being the sealer. The study samples were then stored in saline for a week. They were then resected apically at 90° angle to the long axis of the root using the same armamentarium which is to remove 3 mm of the apex. The 3 mm deep

retrograde cavity was prepared using no.2 ultrasonic tip (ProUltra Endo Tip, Dentsply). Thecavities were then irrigated with saline and allowed to be dried.

All the teeth were then randomly assigned into 3 groups of 20 specimens each.

1. Group A (n=20): Control Group
2. Group B (n=20): Biodentine
3. Group C (n=20): Giomer

The materials that were intended to be studied in this research were manipulated as per the manufacturer's instructions and the cavities were filled respectively. The specimens were then coated with 2 coats of nail varnish except at the 1 mm apical area & then they were allowed to be dried. The specimens were then placed in the dye which is India Ink for 72hours. After 3 days, 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 assessed in millimetres. The specimens were scored for linear measurement of dye penetration along the cavity walls using the scores given below0 = No detectable 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.

RESULTS

Group A: Since it is a control group, no material was placed. All stereomicroscopic images for the control group demonstrated a relative amount of dye penetration. Both Group B and C showed microleakage, whereGiomer and Biodentine showed microleakage but the difference was not statistically significant. Biodentineis considered as better root-end materials since it showed lesser microleakage than Giomer . Descriptive statistical analysis and also inferential statistical analyses were carried out in the present study. Results were presented as Mean ± SD on subsequent evaluation. Level of significance was set 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 the test which is used to detect the significance of study parameters between the groups (Inter group analysis). Post hoc analysis was done to assess whether the values of ANOVA test were significant. The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was applied for the analyses of the data and also Microsoft,Excel was used to generate tables.

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

Group	N	Mean	SD	F – value	P - value
Biodentine	20	0.792	0.2732	90.321	<0.001
Giomer	20	0.873	0.6133		
Control	20	2.877	0.4966		
Total	60	1.534	1.0722		

DISCUSSION

The ideal root-end filling material was intended to attain a complete apical seal and should be non-toxic, non- resorbable, easy to manipulate, dimensionally stable, biocompatible to the peri-radicular tissues and mostly radiopaque. Additionally, it should also possess bacteriostatic or bactericidal property. And there is no such material available nowadays to fulfil all the criteria to be used as a retrograde filling material. Appropriate selection of an efficient root-end filling material after root-end resection is a critical factor in performing surgical endodontics.[9]These days many materials are available commercially as root end filling material. Giomer and Biodentine are amongst them.

Giomer is a specialized restorative material which has the properties of both glass ionomer cement and composites. The S-PRG technology which is used in it not only provides the benefits of mechanical strength of a composite material but also makes it to release multiple ions i.e., Sodium ions, Silicate ions, Aluminium ions, Fluoride ions, Borate ions and Strontium ions thus they provide multiple biological functions like fluoride release and recharge, anti-plaque effect, anti-biofilm effect and pH modulation. Giomer has been launched as a rootend filling material 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™ is a calcium silicate-based product which is often used for the crown and root dentin repair treatment, perforations repairs or resorptions, apexification and root-end fillings. Biodentine have shown biocompatibility and also possesses ability to induce odontoblast differentiation and mineralization in tissue-cultured pulp cells.[10]the major benefits of Biodentinewhen compared to other calcium silicate-based materials are its reduced setting time and better handling property as well as high standard of mechanical properties.

Marginal adaptation usually has an indirect correlation with the sealing ability of retrograde-filling materials. *Jung* et al has advocated that the quantity of PDL cells were relatively high in Biodentinewhich is attributing to its repair and better biocompatibility, since it contains of tri and dicalcium silicate thereby enhancing the bioactivity of the material on osteoblast and osteoclast-like cells, and also lead them to the release of silicon from the set cement. Also, Biodentine has been suggested to show relatively higher levels of calcium and silicon ion release when compared to other materials rich have beenin use. Based on the above criteria, this in-vitro study was undertaken to assess and compare the sealing ability of two root-end filling materials such as Giomer and Biodentine in teeth using dye penetration method under stereomicroscope. The samples were apically resected 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 demonstrated that the resected root ends of sample and suggestedthat the number of dentinal tubules apparently communicating between the resected root face and the root canal were relatively higher when the angle of the bevel was kept maximum (45^0) and that the retrograde filing should extend coronally into the canal,till the level of the coronal end of bevel.[11] Although at least 2-3 mm of root end removal is usually recommended when consideringthe apical resection.*Philip* et al tabulated in their studies that no significant difference was noticed in apical dye penetration when 2 mm or 4 mm of the apical resection has performed.[12] Then 3 mm deep retrograde cavity was prepared using no.2 ultrasonic tip. Earlier, the root-end cavities were prepared with small, round, or by using inverted conical burs with the high-speed micro hand-pieces. But this technique was relatively ended to cause various problems such as nonparallel cavity walls, difficulty in reaching the root tipand also lingual perforation of the root.*Khabbaz* MG et al noticed the emergence of some micro cracks on the apical root surface and enables the formation of smear layer on the surface of the cavity.

Improved sonic and ultrasonic (US) retrotips have revealed some great advantages towards the root-end treatment. US retrotips has added advantages over traditional apical surgery.[13] These materials were manipulated based on the manufacturer's protocols and the cavities were filled because in a study carried out by *Pankaj Kumar Gupta* et al proposed that increased microleakage was probably seen when Biodentine was manipulated manually when compared to its mechanical trituration. This can be supported by the fact that the mechanical trituration produces a more homogenous mix as compared to manual mixing.[14] 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. In spite of having smaller particles in its composition which can easily penetrates into the tubules by simple diffusion but also has certain negligible impact on the sealer of root canal obturation. The hydroxyapatite crystals present in dentin have not observed to show its absorption and thus this dye has been most commonly used for thestudy purpose on microleakage. Following this the samples were rinsed for 15 minutes under running tap water. The samples were then sectioned longitudinally using diamond disc and the dye penetration was assessed under 10X stereomicroscope & microleakage was evaluated in millimetres. Likewise, the results obtained were statistically evaluated and following inferences were drawn. Astabulated in table – 1, this study results shows the comparison of microleakage among different groups. The results of this study showed that there was more microleakage in Group A (2.87 mm) when compared to Group B (0.792 mm) and Group C (0.87 mm). There was highly significant difference between all the three groups ($p<0.001$) This result could be accountable to the fact that there was no retrograde filling performed in Group A. Whereas, in group B where biodentine was placed has been proved to have chemico-mechanical bonding with the tooth and thus has a better sealing ability and the least of microleakage amongst all the other groups. Recently introduced Giomer has been recently used as a retrograde filling material which 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 which is also known as PRG composites. The fluro-alumino-silicate glass in these productshas effectively reacted with polyalkanoic acid in water prior to the inclusion into silica filled urethane resin.

Giomer had been observed to be showing slightly greater microleakage when compared to Biodentine. Since Giomer is a compound mixture of composite and glass ionomer cement which is being resin-based and it exhibits polymerization shrinkage to a certain extent. In support of this finding a similar result a study was performed by *Lakshmi Narayan* et al where polymerization stress during curing of Giomer ended up in a gap formation between the tooth and the restorative surface leading to the microleakage.[14]

CONCLUSION

Following conclusions were made out from this in-vitro study, Both the root-end filling materials such as Giomer and Biodentine revealed the presence of microleakage but the results were not observed to be statistically significant. Comparatively Biodentinepossessed lesser microleakage than Giomerand it is considered to be better. Therefore, it can be effectively used as a retrograde filling material with better results.

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