Evaluation of Push Out Bond Strength of Two Calcium Silicate Based Cements with Bone Cement in Retrograde Cavities Prepared by Ultrasonic Retro Tips

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ABSTRACT

Introduction: Surgical endodontic treatment comprises of thorough debridement of pathological periradicular tissue, root end resection followed by a Class I retrograde cavity preparation and insertion of root end filling material into the prepared cavity. The aim of this study was to evaluate the push out bond strength of Biodentine, Mineral Trioxide Aggregate (MTA) and Bone Cement used in the retro cavities, prepared with ultrasonic retro tips.

Material and methods: 60 human extracted single rooted teeth were selected and sectioned with a diamond disc (Horico, Germany) to standardize the root length of 15mm. The roots were instrumented with rotary ProTaper Universal (Dentsply Maillefer) system till size F2. The root canals were obturated using gutta percha (Dentsply, Maillefer) and AH Plus sealer (Dentsply, Germany). 3mm of root end resection was performed with high speed hand piece under water coolant. 3mm deep retro cavities were prepared with ultrasonic stainless steel retro tip (Woodpecker). All the specimens were divided into 3 groups (n=20) Group I: MTA (ProRoot, Tulsa Dental, USA), Group II Biodentine (Septodont, France), Group III Bone Cement (Depuy, Johnsons and Johnsons). Each material was mixed according to the manufacturers instructions and filled into the retro cavities. The specimens were sectioned perpendicularly to obtain 1mm thick slices from the apical portion and subjected to push out bond strength testing under Universal Testing Machine (Instron).

Results: Biodentine showed more push out bond strength than MTA and Bone Cement. There was no significant difference between MTA and Bone Cement groups.

Conclusion: Bone Cement can be considered as one of the potential retro filling material.

Keywords: MTA, Biodentine, Bone Cement, Protaper Universal , Root End Resection, Retro Cavities.

INTRODUCTION

Root end resection is an important component of endodontic surgery as it will aid in elimination of anatomical variations, resorptive defects, perforation defects, ledges, canal obstructions and separated instruments that may be present in the root. It has been reported that resection of the apical 3mm of the root apex will eliminate 98% of the apical ramifications and 93% of the lateral canals which contain material that would contribute to periradicular disease.[1]

Root end resection is followed by retro cavity preparation, round or inverted cone bur in slow speed hand piece was used earlier. According to Carr[2], root end cavities prepared using burs are often not deep enough and are poorly aligned along the long axis of tooth because of limited access. Inadequately prepared root end cavities predispose to poor root end filling and subsequently poor prognosis.

One of the prerequisites for the success of surgical endodontics relies on selection of an ideal root end filling material. The objective of the root end filling material is to prevent ingress and egress of the irritants back and forth from the root canal space. An ideal root end filling material should have beneficial properties such as biocompatibility, good strength, optimal sealing ability, promotion of healing, radiopacity, easy manipulation and should not get affected in the presence of moisture.[3]

Endodontic literature describes various materials used for root end filling such as silver amalgam, glass ionomer cement, cavit, intermediate restorative material, zinc oxide eugenol cement, composite resins, resin- glass ionomer hybrids, super ethoxy-benzoic acid and mineral trioxide aggregate. However till date no single material has been able to fulfil all the requirements of an ideal root end filling material.[4]

MTA has been a mainstay of clinical endodontics since its introduction in mid-1990s. It is the first restorative material that consistently allows for the overgrowth of cementum and formation of bone, and also facilitates the regeneration of the periodontal ligament. It is now accepted as the gold standard material for root end filling.[3]

Researchers developed a new active calcium silicate based material named Biodentine. It has excellent sealing ability, biocompatibility and good dimensional stability. It has added advantages like of short setting time, improved mechanical strength, good handling properties and is relatively economical.[5]

One of the recently introduced material, PMMA bone cement that is polymethyl methacrylate material has been widely

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used in the orthopaedic surgery, mainly for fixation of the prosthesis and also for the stabilizing compressive vertebral fractures or filling bone defects. This cement has excellent adaptation to the cavity margins, in spite of its well-known polymerization shrinkage property due to its increase in its volume during polymerization before shrinking slightly[6]

In order to provide a persistent apical seal, a root-end filling should adhere well to root canal dentin. The integrity of the filling material–dentin interface should be maintained not only under static conditions but also during function and operative procedures.[7]

Therefore the aim of this study was to evaluate the push out bond strength of two calcium silicate based cements with Bone Cement after ultrasonic retrograde cavity preparation.

MATERIAL AND METHODS

60 extracted human single rooted teeth without caries, fracture, resorption defects were selected. All the teeth were radiographed to verify the presence of single canal and mature apex. The crowns were sectioned below the cementoenamel junction using a water cooled diamond disc (Horico, Japan), leaving 16mm long roots. The canals were instrumented with ProTaper Universal instruments (Dentsply Maillefer) till size F3 using an electric motor (NSK, Japan). The smear layer was removed using 2 ml of 17% EDTA for 1 min. The final irrigation was carried out with 3% sodium hypochlorite using a luer lock syringe (Hindustan Unolock). The canals were dried using paper points and obturation was carried out using gutta-percha (Dentsply Maellifer) and AH Plus sealer (Dentsply, Germany) using a single cone technique. The specimens were incubated at 37 °C in a 100% relative humidity for 48 hours. 3mm of apical resection was carried out with high speed handpiece (NSK, Japan) using a straight fissure bur (Mani, Japan). Retro cavities having depth of 3mm and diameter of 2 mm were prepared using stainless steel ultrasonic retro tip (Woodpecker) connected to the ultrasonic hand piece (EMS, Piezon) at the power setting of 2 in a light brushing motion.

The retro cavities were prepared with light intermittent pressure with in and out motion to reach the depth of 3mm from the resected surface under water coolant and finally the ultrasonic tip was moved circumferentially to obtain a dimension of 2mm diameter.

The specimens were randomly divided into three groups (n = 20):

Group I : The retro cavities were filled with MTA.

Group II : The retro cavities were filled with Biodentine.

Group III : The retro cavities were filled with Bone Cement.

MTA: MTA powder was mixed with liquid supplied by the manufacturer in the powder liquid ratio of 3:1 into a thick putty like consistency. MTA was carried by an MTA carrier (GDC, India) to fill the retro cavities.

Biodentine: The capsule with powder and liquid were mixed in a mixing device to obtain a workable consistency of the mix. The mix was then carried to the retro cavities by a MTA carrier (GDC, India) and condensed.

Bone Cement: The powder and liquid was carefully mixed in ratio of 2:1 on a glass slab with a mixing spatula. It was mixed till the material acquired a consistency when it no longer adhered to the gloves. This mix was carried by the MTA carrier to fill the retro cavities.

Group	Specimen(n)	Mean (MPa)
MTA	20	10.650±4.504[a]
Biodentine	20	16.550±3.0308[b]
Bone cement	20	9.945±4.127[a]
Different superscripts represent statistically significant difference.		

Table-1: Mean push out bond strength

All the specimens were stored in saline (0.9%) for 3 months. The specimens were embedded in acrylic resin (DPI, India). The apical part of each specimen was cut perpendicular to the long axis into 1-mm thick slices with a diamond disc (Horico, Japan) under water coolant. The pushout bond strength was measured using a universal testing machine (Instron). The fillings were loaded using cylindrical stainless steel plunger with a diameter of 1 mm from the apical to coronal direction at a speed of 1 mm/min. The maximum force applied to materials at the time of dislodgement was recorded in Newtons. The push-out bond strength in megapascals (MPa) was calculated by dividing this force by the surface area of test material ($N/2\ prh$), where P is the constant = 3.14, r is the root canal radius, and h is the thickness of the root dentin slice in millimeters. Data were analyzed by using independent t-test and ANOVA. The significance level was established at 5% ($P = 0.05$) for all analyses.

RESULTS

The mean values of all the groups are shown in Table 1. The Biodentine group has maximum push out bond strength followed by MTA and Bone Cement groups and the results were statistically significant ($p<0.05$). Bone Cement group showed least push out bond strength but it was not statistically significant from MTA group.

DISCUSSION

For the root-end filling material to be successful , it should have a property to adhere to the apical root canal wall , prevent microleakage and remain in place under dislodging forces.[8] The factors that play a role in adhesion of root end fillings are the type of material used, burs used for the cavity preparation and the pH value of the environment.[9,10]

In this study push out bond strength of two calcium silicate based materials i.e ; MTA and Biodentine were used and compared against Bone Cement.

The characteristic of calcium silicate-based materials is to precipitate carbonated apatite in the presence of tissue fluids, followed by the formation of interfacial layer and tag like structures in the dentin.[11] According to Carmo et al.[12] the interfacial maturation layer and bond strength depend on the storage medium in the in vitro studies.

Higher bond strength of calcium silicate-based materials with smaller particle size is explained by better penetration

of their particles into the dentinal tubules.[13] better hydration is favoured by small particle size and consequent calcium ion release.[14] That leads to more calcium phosphate precipitates and tag-like structures which constitute micromechanical anchorage, thus increasing dislodgement resistance. This is in accordance with the findings of Han et al.[15] who reported that the depth of calcium and silicon incorporation into dentin was higher for Biodentine which has more homogenous and smaller particles than MTA.

One of the new materials that might have potential properties of a root end filling material is polymethylmethacrylate bone cement (Depuy, Johnsons and Johnsons). It was widely used in orthopaedic surgery for over 40 years, mainly for the fixation of the prosthesis, stabilizing compressive vertebral fractures or filling bone defects.

Bone cement has characteristics that makes it well suited as a retrofilling material. The cement exhibits low cytotoxicity, has short setting time of 15 minutes, and moist environment or blood contamination has no effect on its properties. Bone cement has been widely studied in the field of medicine, it does not seem to have any negative effects, even in the large quantities needed during total hip arthroplasty. The amount required in endodontics are much less than what would be needed in orthopaedics. The lesser amounts required would produce much lower exothermic reaction and a much reduced amount of free monomer.[6]

In our study Bone Cement has shown a comparable bond strength with MTA which is the gold standard material for rerro filling. Thus bone cement might be altered from medical to dental use.

CONCLUSION

Within the limitation of this study it was concluded that Biodentine showed maximum push out bond strength as compared to MTA and Bone Cement. The MTA and Bone Cement groups showed comparable push out bond strength i.e were not statistically significant. Therefore, Bone Cement can be considered as one of the potential retro filling material.

RERFERENCES

1. Kim S, Kratchman S. Modern endodontic surgery concepts and practice: a review. J Endod 2006;32:601
2. Cohen's Pathways of the Pulp 10th ed. [dentistry] - K. Hargreaves et. al. (Mosby 2011) BBS
3. Zuolo ML, Perin R, Ferreira MOF, Faria FP. Ultrasonic root end preparation with smooth and diamond coated tips. Endod Dent Traumatol 1999;15:265.
4. Howard MF, Marshell DP. Microleakage of root end filling materials. J Endod 2001
5. Khandelwal A, Kartik J, Nadig R, Jain A. Sealing ability of mineral trioxide aggregate and Biodentine as the root end filling materials, using two different retro preparation techniques- An in vitro study. Int J Contemp Dent Med Rev 2015;4:34-39.
6. Badr AE. Marginal adaptation and cytotoxicity of bone cement compared with amalgam and mineral trioxide aggregate as root end filling materials. J Endod 2010;36:1056-60
7. Tagger M, Tagger E, Tjan AHL, Bakland LK. Measurement of adhesion of endodontic sealers to dentin. J Endod 2002;28:351–354
8. Blum, J. Y., Esber, S., Parahy, E., & Franquin, J. C. Effect of masticatory cycles on tooth compression and resultant leakage of amalgam retrofills. Journal of Endodontics 1997;23:605–609.
9. Sobhnamayan, F., Sahebi, S., Naderi, M., Shojaee, N. S., & Shanbezadeh, N. Effect of acidic environment on the push-out bond strength of calcium-enriched mixture cement. Iranian Endodontic Journal 2014;9:266–270
10. Vivan, R. R., Guerreiro-Tanomaru, J. M., Bernardes, R. A., Reis, J. M., Hungaro Duarte, M. A., & Tanomaru-Filho, M. Effect of ultrasonic tip and root-end filling material on bond strength. Clinical Oral Investigations 2016;20:2007–2011.
11. Setbon HM, Devaux J, Iserentant A, Leloup G, Leprince JG. Influence of composition on setting kinetics of new injectable and/or fast setting tricalcium silicate cements. Dent Mater 2014;30:1291–1303.
12. do Carmo SS, Néspoli FFP, Bachmann L, Miranda CES, Castro- Raucci LMS, Oliveira IR, Raucci-NetoW. Influence of early mineral deposits of silicate- and aluminate-based cements on pushout bond strength to root dentin. Int Endod J. 2017;23:34-39.
13. Küçükkaya SE, Aksel H, Serper A. Effect of placement technique on the push-out bond strength of calcium-silicate based cements. Dent Mater J 2016;35:742–747.
14. Torabinejad M,Watson TF, Pitt Ford TR. Sealing ability of a mineral trioxide aggregate when used as a root end filling material. J Endod 1993;19:591–595.
15. Han L, Okiji T. Uptake of calcium and silicon released from calcium silicate-based endodontic materials into root canal dentin. Int Endod J 2011;44:1081–1087

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