

Comparative Analysis Of Sealing Ability Of Biodentin And Calcium Phosphate Cement Against Mineral Trioxide Aggregate (Mta) As A Furcal Perforation Repair Material (An In Vitro Study)

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Abstract : Introduction: The ability of mineral trioxide aggregate (MTA), Biodentin and Calcium phosphate cement to seal large furcation perforations were evaluated using a dye-extraction leakage method. Method: 30 extracted human mandibular first molars were divided into three experimental groups (n -10) according to the repair material used. Dye leakage was tested from an orthograde direction, and dye extraction was performed using full concentration nitric acid. Dye absorbance was measured at 550 nm using spectrophotometer. Result : ProRoot MTA (Maillfer, Dentsply) showed the least dye absorbance. Calcium phosphate showed the highest dye absorbance. and Biodentin came at intermediate level then other groups [Sanghvi T et al NJIRM 2013; 4(3) : 56-60]

Key Words: Dye extraction, furcation perforation, MTA, Biodentin, Calcium phosphate

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Introduction: Maintaining the integrity of the natural dentition is essential for full function and natural esthetics.¹ Endodontic therapy can play a vital role in achieving this goal. Technical problems do occur occasionally during endodontic treatment, one of which is perforation of the root canal wall. This can significantly impact the long-term prognosis of the tooth.

Perforations may be induced by iatrogenic causes, resorptive processes, or caries. Perforations can be defined as mechanical or pathological communications between the root canal system and the external tooth surface.²

Furcation perforation refers to a mid-curvature opening into the periodontal ligament space and is the worst possible outcome in root canal treatment.³ It has been reported that perforations were the second greatest cause of failure.⁴

Several materials have been used to repair furcation perforations, including zinc oxide-eugenol cements (IRM and Super-EBA), glass ionomer cement, composite resins, resin-glass ionomer hybrids, and mineral trioxide aggregate (MTA).⁵

An ideal endodontic repair material should seal the pathways of communication between the root canal system and its surrounding tissues. In addition, it should be nontoxic, noncarcinogenic, nongenotoxic, biocompatible, insoluble in tissue fluids, and dimensionally stable.

Today, most preferred furcal perforation sealers are bioactive materials like MTA.

MTA is non-resorbable, anti-bacterial, osteoconductive, radio-opaque and biocompatible. Principle components of MTA are tricalcium silicate, tricalcium aluminate, tricalcium oxide, silicate oxide, mineral oxide, bismuth oxide^{6,7}.

The sealing ability of MTA has been shown to be superior to amalgam, zinc - oxide eugenol, resin modified GIC and resin materials. Also Cytotoxicity of MTA has been found to be less than Super EBA⁸. Despite its many advantages, MTA has some drawbacks such as a long setting time (around 24 hours), less compressive and flexure strength, non-bonding to enamel and dentin and discoloration of teeth. So, Efforts have been made to overcome these shortcomings; new experimental Ca3SiO5-based bioactive restorative cement has been developed, put on the market under the name of "BIODENTINE™". The main component of the powder is a tricalcium silicate, with the addition to the powder of CaCO3 and ZrO2. The liquid is a solution of CaCl2 with a water reducing agent. Advantages of this material are chemico-mechanical bonding with tooth and composite, high compressive and flexure strength.⁹

So, this new bioactive material Biodentin is taken as a one of the furcation perforation sealer in comparison with MTA.

Also, Calcium phosphate cement (CPC) is a synthetic bone graft material that was invented in 1986 by L. C. Chow and W. E. Brown, scientists at the American Dental Association. The cement is a white powder consisting of equimolar amounts of ground $\text{Ca}_4(\text{PO}_4)_2\text{O}$ (tetracalcium phosphate, TTCP) and CaHPO_4 (dicalcium phosphate anhydrous, DCPA). The hardening reaction, which forms nanocrystalline hydroxyapatite (HA) as the product, is isothermic and occurs at physiologic pH so tissue damage does not occur during the setting reaction.¹⁰

Here, we used Calcium phosphate cement which generally use in orthopedic or neurosurgery purpose as it's also having same properties as the one which are use in dentistry.

Thus, the present study is designed to evaluate the sealing ability of MTA against Biodentin and Calcium phosphate cement in repair of furcation perforations, using dye extraction method.

Methods & Materials: This study was conducted in the department of Conservative dentistry, K. M. Shah Dental College and Hospital, Vadodara. Dye extraction method was done at microbiological laboratory in College of Pharmacy, sumandeep vidhyapeeth, Vadodara.

30 extracted human Intact Permanent first and second permanent mandibular molar extracted purely for periodontal reasons were included and divided into 3 groups; 10 teeth in each experimental groups.

Group 1: Perforation repaired by biodentin. (Septodent)

Group 2: Perforation repaired by calcium phosphate cement. (Science For Bio Materials)

Group 3: Perforation repaired by MTA cement. (Pro-root MTA)

Teeth specimens were cleaned of any tissue remnants on the roots and scaled by periodontal scalers and was disinfected in 0.5% chloramine T for 15 days and subsequently stored in 0.9% normal saline solution. Endodontic access cavity was prepared by high speed long shank round bur no.4 for initial entry followed by long tapered non end cutting bur for lateral extension and finishing

of cavity walls with the use of the high speed air turbine hand piece.

Orifices of the canals were negotiated and temporary filling material was placed over the orifices of each canal. Perforation was created between the orifices to the furcation area by using a high speed long shank round bur no 4. Every molar were completely covered including cavity walls and pulpal floor by two successive layers of clear nail varnish except the area 1 mm approximately around the margin of the perforation.

Group 1: Biodentin was mixed according to the manufacturer's instruction and was carried to the perforation site with help of amalgam carrier and was adapted to the perforation defect with buckanun plugger.

Group 2: Calcium phosphate cement granules were converted into 50um fine powder and will be carried to the perforation site and will be adapted to the perforation defect with the help of Machtaeu hand pluggers.

Group 3: MTA was mixed according to the manufacturer's instruction and was carried to the perforation site with the help of MTA gun and was adapted to the perforation defect with the help of Machtaeu hand pluggers. Moist cotton pellet was placed over MTA to allow setting of MTA for 24 hours.

After sealing of perforation and setting of all the material, all specimens will be kept in 100% humidity for 24 hours. Molars were then placed in petri dishes according to each group. 2% Methylene blue dye was applied inside the access cavity of all samples for 24 hours for checking the micro leakage by dye extraction method. Molars were placed under running tap water for 30 minutes to remove all residues of methylene blue. Molars were placed in vials containing 1 ml of concentrated (65%) nitric acid for 3 days for the extraction of the dye. Centrifugations of vials were done at 14,000 rpm for 5 minutes to separate debris from the extracted dye. 200 μL of the supernatant was transferred from each sample to a 96 -well plate. Then the sample absorbance was

determined by an automatic microplate spectrophotometer at 550nm.

Statistical analysis was conducted using a one way analysis of ANOVA to detect and compare the sealing ability of material in furcal perforation area.

Results: A Multiple Comparisons using Tukey HSD test was used for pair-wise comparison between the means when analysis of variance test was significant. The significance level was set at $p < 0.05$. Statistical analysis was performed and found that MTA showed the least dye absorbance (0.472) followed by Biodentin (1.33) and Calcium phosphate (2.085). However, they were significant difference is present between the groups. (figure 2)

Discussion: The dye-penetration technique has long been used in endodontics because of its ease of performance and difficulty of other available techniques. However, it has several drawbacks including the smaller molecular size of the dye molecules than bacteria, which do not measure the actual volume absorbed by the sample but merely measure the deepest point reached by the dye.¹¹ It relies on randomly cutting the roots into two pieces, without any clue of the position of the deepest dye penetration. Despite these drawbacks, Torabinejad et al. stated that a material that is able to prevent the penetration of small molecules (dye) should be able to prevent larger substances like bacteria and their byproducts.¹² Based on this, the dye-extraction method seems to be a reliable technique. It takes into account all absorbed dye by the samples. Camps and Pashley reported that the dye-extraction method gave the same results as the fluid-filtration method and also saved much laboratory time.

Furcation perforations were induced by a #4 long shank carbide round bur from pulpal floor to furcation area. This resulted in perforations of almost 2 mm in diameter. This size is considered large compared with the 1-mm perforation size induced by the carbide bur #2 in Hamad et al. study

The excellent and unique property of MTA is its ability to promote regeneration of cementum, - thus facilitating the regeneration of the

periodontal apparatus. The enhanced proliferation of periodontal ligament (PDL) fibroblasts on MTA compared with other root end filling materials has been reported. It was found that the presence of moisture in perforations during the placement of MTA increases its adaptation to perforation walls.¹³

Also Biodentin can induce the synthesis of a dentin-like matrix by human odontoblast-like cells in the form of mineralization nodules that have the molecular characteristics of dentin.¹¹ Additionally, the FTIR analysis has previously shown that this mineralized material was a specific deposition, which had the same mineral and organic composition of dentin. This can also stimulate cells growth and induce Hydroxyapatites (HA) formation on the surface of the material when exposed to the simulated body fluid.⁸ HA have been shown to induce bone formation, growth and maintenance at the bone-material interface *in vivo* and this can be reproduced and demonstrated *in vitro* by soaking HA *in vitro* in simulated body fluids.^{14,15} This is of prime importance during the process of healing as Silica can induce the mineralisation function of cells by affecting cell proliferation and genes expression.^{16,17}

So, this new bioactive material Biodentin is taken as a one of the furcation perforation sealer in comparison with MTA. but As such Biodentin showed high dye absorbance then MTA.

Here we have taken calcium phosphate cement which generally use in neuro or orthopedic purpose as it is already proven that it can induce bone formation in that respective fields. As such it is available in granules we have converted it into fine powder (50um).

As calcium phosphate cement formulation is observed to act as a cohesive and a viscous mass. The cohesive property makes it suitable to seal a bleeding perforation site. Even if the cement extruded, due to its biocompatibility, it would not possibly adversely affect the healing of the local tissues in the apical area. In fact, calcium phosphate cement will be effective in stimulating bony repair through osteoconduction.^{18,19}

Based on the results of this study, we can conclude the following: ProRoot MTA has excellent sealing ability the use of Biodentine and Calcium phosphate cement to repair large furcation perforations should be limited.

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