COMPARATIVE EVALUATION OF SEALING ABILITY OF FOUR DIFFERENT ROOT REPAIR MATERIALS USED FOR FURCATION PERFORATION REPAIR: AN INVITRO STUDY.

Abstract

Aim: The present study aimed to evaluate and compare the sealing ability of Hidense, Bio MTA, Biodentine and Bio c repair in furcation perforations using protein leakage assessment.

Materials and methods: The present study was conducted using eighty extracted human maxillary and mandibular molars with intact furcation. The samples were randomly allocated into five groups (n = 16) based on repair material used: Group 1 – Hidense, Group 2 – Bio MTA, Group 3 – Biodentine, Group 4 - Bio c repair and Group 5 - Control group. Using the leakage assessment apparatus, the presence of protein was detected with a reagent (Coomassive Brilliant Blue) every day for 60 days.

Results: The data was analysed using paired t test, one way ANOVA and p-value was set at 0.05. Highest mean protein leakage was seen for control group 0.81±0.03. Followed by the control group, HIDENSE exhibited the next highest values during the assessment i.e; 0.57 ±0.56. the least score was elucidated by Bio C repair , which is 0.25±0.01.

Conclusion: The newer biomaterials, Bio c repair and Bio MTA have shown better sealing ability when compared with Biodentine. Because of the better handling properties, could be used as alternatives while repairing furcation perforations.

KEY WORDS: Furcation, Perforation, Protein leakage assessment, UV spectrophotometer.

Introduction

One of the most unpleasant and frequent accidents that can occur during endodontic treatment is furcal perforation. Perforations from the pulp chamber and root canals to the surrounding periodontium may occur from resorptive defects, caries or iatrogenic events

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during endodontic treatment. Furcal perforation refers to a mid-curvature opening into the periodontal ligament space and it is the worst possible outcome in root canal treatment. Root perforation can be repaired surgically or non-surgically, but furcal perforation is surgically inaccessible so it has a more unfavourable prognosis than perforations occurring in the middle and apical root thirds. However; if such perforations are immediately diagnosed and sealed with a biocompatible material, the prognosis is usually good.[1]Hence it is our aim, through this study, to explore the sealing ability of four different root repair materials in the furcation perforation repair.

Materials and Methods:

The present study was conducted in the Department of Paediatric and Preventive Dentistry of SVS Institute of Dental Sciences after obtaining approval from ethical committee of the institution.

STUDY DESIGN:

A total number of 80 extracted caries free permanent molars were taken for the study.

INCLUSION CRITERIA:

1. Caries free permanent maxillary and mandibular molars.
2. Intact furcation root surfaces.

EXCLUSION CRITERIA:

1. Molars with visible fractures or cracks.
2. Carious lesions
3. Dental pathologies or erosion.

Sample preparation:

All the samples were categorized into five groups of sixteen teeth each.

1. Metal Modified GIC (Premixed HIDENSE, Shofu),
2. Bio MTA (Nexo Bio, MTA CEM, Korea),
3. Biodentine (Septodont, Saint Maur des Fosses, France),
4. Bio Ceramic Material (Angelus Bio C Repair, Londrina, Brazil),
5. Control group.

Access cavities were prepared and the roots were horizontally sectioned in the apical third with the taper fissure bur to facilitate their attachment into the glass vial apparatus. The whole tooth was covered by two coats of nail varnish (Nail Trend, Fiabila India Ltd.) except at the furcation. The exposed root tips were sealed with a cyanoacrylate resin (FeviKwik, Pidilite, India), all the orifices of the root canal were sealed with cyanoacrylate resin. An artificial defect measuring 2 mm in diameter was made from the external surface. The chamber and perforation of all the samples were flushed with water and dried. And the perforations were repaired with the root repair materials that are mentioned above except the control group which left without placing any root repair material.

The access cavities of all the samples were filled with IRM and left for 72 h at 37°C in an incubator. Before leakage assessment, the temporary filling material was removed from the access cavities of the samples. Leakage assessment apparatus was made for each sample. A hole was created in the rubber stopper of a 15 ml glass vial, and the teeth were inserted through it and sealed with cyanoacrylate paste through the rubber. Another glass vial was attached around the crown of the rubber stopper. The glass vial was filled with 9.5 ml of redistilled water, and the other vial was filled with 1 ml of 22% bovine serum albumin (BSA) solution. The apparatus was prepared for all the experimental and control groups and placed in an incubator at 37°C for 7 days. The water in the glass vial was changed, and BSA in the reservoir was replenished daily during the experiment. The presence of protein was detected with a reagent (Coomassive Brilliant Blue) every day for 60 days. Color conversion of the protein reagent was considered to indicate leakage. Protein concentration was quantified with an ultraviolet spectrophotometer (Lab India).

Statistical analysis: Data was analysed by SPSS VERSION 23.0 software. Data was summarized by mean ± SD for continuous data and percentages for categorical data. The comparison between groups was done by One way ANOVA. Intragroup comparisons were done by One way ANOVA. All p-values were set at 0.05 considered as statistically significant.

Results: Table 1 and graph 1 outline the mean protein leakage assessment of different root repair materials for furcation perforation repair. Highest mean protein leakage was seen for

control group 0.81±0.03. Followed by the control group, HIDENSE exhibited the next highest values during the assessment i.e; 0.57 ±0.56. the least score was elucidated by Bio C repair , which is 0.25±0.01.

Table 2 presents the results of ANOVA comparing the protein leakage assessment of various materials like HIDENSE, BIO MTA, BIO C REPAIR and control group with Bio dentine. All the groups showed a statistically significant difference ($p \leq 0.05$) when compared with biodentine. However materials such as BIO C Repair and Bio MTA showed values of 0.26 and 0.197 which is suggestive of a significant reduction in the protein leakage properties when compared to Biodentine. When the values of protein leakage of control group and HI DENSE were compared with Biodentine it was observed that the control group and HIDENSE showed values of -0.46 and -0.39, which suggests that Biodentine had shown better sealing ability than these two groups.

Discussion:

Management of deep caries has traditionally been complete caries removal and in the event of pulp exposure root canal treatment (RCT) rather than minimally invasive biologically based approaches aimed at maintaining the vitality of the pulp.[2] One of the most unpleasant and frequent accidents that can occur during endodontic treatment is furcal perforation.[3] Root perforation is characterized by a communication between the root canal system and the external tooth surface. This issue can be caused by a pathological process (dental caries, root resorption) or an operative procedural accident. Pathological perforations are found in routine clinical exams, whereas iatrogenic root perforations may occur during access cavity opening or during post preparation which accounts for 53% according to Kvinnslandet al.[4]

Mostly, high percentage of perforations (around 47%) occur in the furcation areas of multirooted teeth during the removal of dentin from the pulp chamber floor while searching of root canals.[5] Depending on the size and location of the perforation, repair can be accomplished using either a conservative, non-surgical technique or surgical intervention.

Access cavity preparation in the posterior teeth should relate the pulp chamber to the occlusal morphology. Most commonly teeth requiring endodontic treatment in the posterior region will be having extensive caries or heavily restored and the occlusal anatomy may have no

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significance to the location of the underlying pulp chamber. Intra orally, it takes more knowledge to observe the external outline of the tooth at the level of the CEJ which is rarely involved by caries or other dental procedures.

Once the orifices were sealed furcal perforations of 2 mm diameter were made from the external surface, to ensure that each perforation was centered between the roots. In a study by Askerbeyli et al, perforations with 1, 2 and 3 mm diameter were simulated. Perforations larger than 3 mm could not be evaluated since it was observed that the root canals were not accessible in such situations.[6]The results indicated that as the perforation diameter increased the biomechanical prognosis of the tooth was adversely affected. So taking into consideration the findings of the above study the perforation diameter for the present study was kept at 2mm.

Root repair materials play a key role in the perforation repair. In the present study, four different root repair materials (HI DENSE, Bio MTA, Biodentine, Bio C repair) were used for the furcation perforation repair to evaluate which material had the maximum and minimum protein leakage. Cooley and others stated that the addition of silver alloy powder in the Miracle Mix system permitted less microleakage than the three other glass ionomer cements tested. Nakajima and others showed an increase in dynamic flexural strength when silver alloy powder was added to the type II restorative glass ionomer cement.[7]

MTA is a potent material in endodontics that has changed the prognosis of patients with the worst clinical condition of their teeth (Kaur et al., 2017). Many researchers suggested changes to MTA and the introduction of new biomaterials for use in perforation repair, root-end filling, pulp capping and other procedures. Recently, Bio MTA+ is used as a filling material and for remineralization of root canals due to its smallest-size particles that contain hydroxyapatite. It becomes plastic after mixing and gives concrete consistency with advantage of three times higher durability in comparison of traditional MTA.[8]

Biodentine is fast setting material (approximately 12 minutes), so if perforations are communicated to the oral cavity, use is recommended. Another factor to consider the Biodentine is their coloration, similar to the dental tissues and produces no staining of these.

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Biodentine cement is selected as perforation filing material due to its satisfactory bond strength to dentin compared with the MTA, as in repair furcation perforation situations.[9]

Recently, Bio-C Repair (Angelus, Londrina, Brazil), a new ready-to-use bioceramic material was introduced to endodontics in a threaded syringe, which offers handling and insertion improvements, collaborating with the practice and saving time. Due to the limitations of MTA, bioceramic endodontic materials have emerged as an alternative cement that can be used for repair.

IRM was selected as the material of choice to seal the access openings to allow the setting of the root repair materials.[10]The intention of incubating the teeth for 72 hours was to allow the setting of the root repair materials. The samples are now placed in the incubator for 7 days at 37°C. Protein leakage method was used to assess the microleakage which is based on the observation that Coomassie Brilliant Blue G is converted to blue color when it comes in contact with the protein. The use of protein-dye complex in this experiment provided the advantage of eliminating the problems involved with radioisotope, dye and bacterial leakage identification method (Bradford, 1976; Lagow, 1994; Malcic, 2006).[11] The most widely used methods to test the quality of furcal repair materials are the dye penetration techniques. Most dye leakage studies have measured the degree of leakage in one plane, making it impossible to evaluate the total leakage, (Saidon; Matloff, 1982) whereas protein assay enables the estimation of furcal repair microleakage in all planes. PH and chemical reactivity may also influence the degree of dye penetration. The protein-dye complex method had great sensitivity in protein identification and low sensitivity to interference from nonprotein compounds (Kersten, 1989).[12]

UV/VIS spectrophotometer has been used in the present study to measure the amount of dye leakage from the perforation area of each tooth to evaluate the sealing ability of tested materials, A UV/VIS spectrophotometer measures the intensity of light passing through a sample solution in a cuvette and compares it to the intensity of the light before it passes through the sample. The main components of a UV/VIS spectrophotometer are a light source, a sample holder, a dispersive device to separate the different wavelengths of the light (e.g. a monochromator) and a suitable detector.[13]

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The results of this study were similar to the observations of the study conducted by Campi LB et al., Bio-C Repair had some different physicochemical and biological properties than Biodentine and MTA. The hydration of Bio-C Repair depends on the contact with the humidity. Although Bio-C Repair had the longest setting time, the results showed values lower than the 120 minutes informed by the manufacturer. This is the first study evaluating the setting time of Bio-C Repair, with no parameters for comparison.[14]

In the research by Das et al, the highest sealing capacity was noted with the use of Biodentine. Likewise, Aggarwal et al elucidate that Biodentine showed the least microleakage and sealing capacity since Biodentine is a calcium silicate-based substance that has a polycarboxylate-based hydro-soluble polymer structure depicted as a water-reducing substance to decrease the water content of the mix in general, plus calcium chloride as a setting enhancer. All these factors might have contributed to the least leakage observed in the Biodentine and Bio C Repair groups.[15]

Conclusion:

The present study concluded that Bio C Repair and Bio MTA have significantly better sealing ability compared to Biodentine and HIDENSE when used to repair furcal perforations, assessed using a protein leakage model. Hence, the newer biomaterials, Bio C Repair and Bio MTA with better handling properties, could be used as alternatives while repairing furcal perforations.

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TABLE1:Meanproteinleakageassessmentofdifferentroot repair materials for furcation perforation repair.

GROUP	MEAN	SD
HIDENSE	0.57	0.56
BIO MTA	0.32	0.01
BIO DENTINE	0.52	0.009
BIOCREPAIR	0.25	0.01
CONTROL	0.81	0.03

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GRAPH1:Meanproteinleakageassessmentofdifferentroot repair materials for furcation perforation repair.

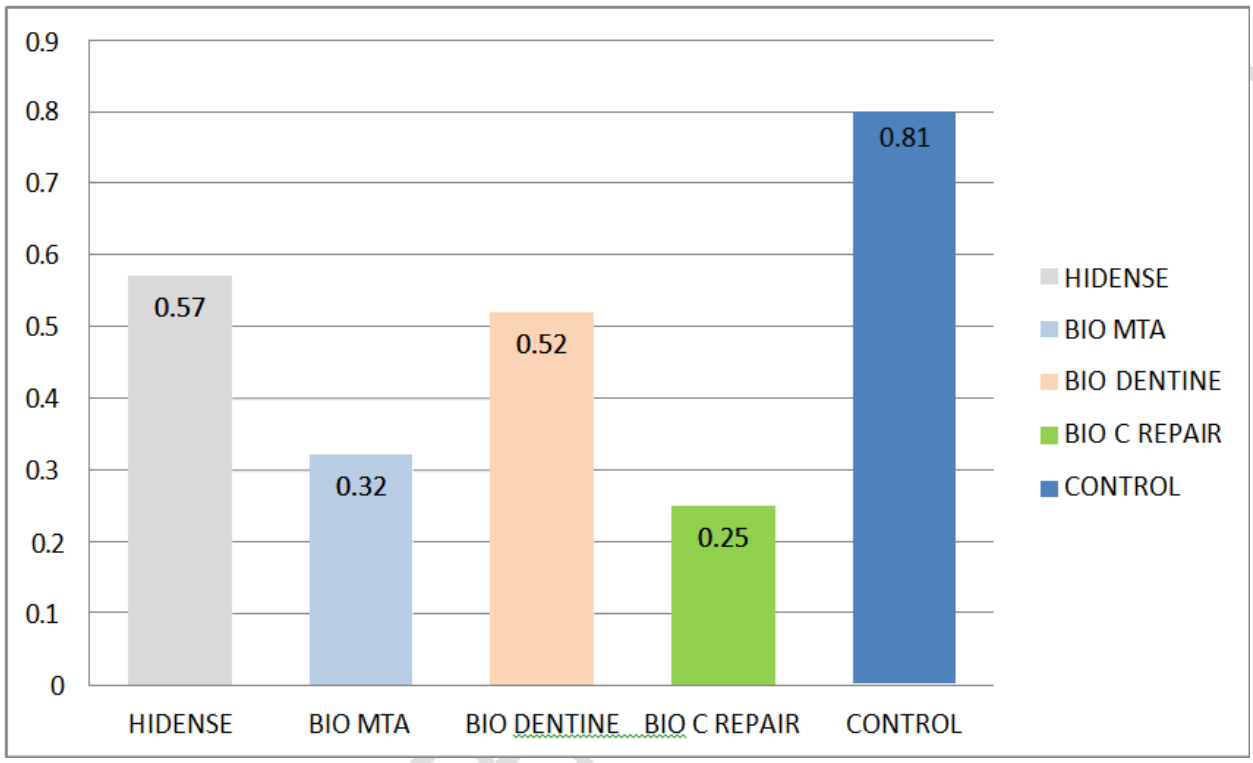

TABLE2:Meanproteinleakage assessmentofdifferentroot repair materials for furcation perforation repair in comparison with biodentine

ROOT REPAIR MATERIAL	ROOTREPAIR MATERIAL	MEAN DIFFERENCE	P VALUE
BIO DENTINE	HI DENSE	-0.39	0.05
	BIO MTA	0.197	0.001

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	BIOCREPAIR	0.26	0.001
	CONTROL	-0.49	0.05

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