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Evaluation of Microleakage of Premixed Bioceramics and Bio MTA as Furcal Perforation Repair Materials in Primary Teeth

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Restorative Dentistry
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ABSTRACT

Purpose: The aim of this in vitro study was to evaluate the microleakage of premixed BioCeramics (BCs) and mineral trioxide aggregate (MTA) for sealing primary molar furcal perforations. **Materials and Methods**: This study was carried out on 30 extracted mandibular primary molars. Perforations of the furcation areas were created in the pulp chamber floor of the teeth. The molars were then divided randomly in two groups (n=15). Perforations were then repaired with biocompatible materials. After 72 h, the teeth were immersed in 2% basic fuchsine dye solution for 24h. The teeth were then sectioned longitudinally and evaluated for dye leakage. Data analyzed statistically using ANOVA test. **Results**: There was a statistically significant difference between the micro leakage of MTA (1669.25±140.59 μm) and premixed Bioceramics(1275.21±235.998 μm) groups (P>0.008). **Conclusion:** Premixed Bioceramics appeared to have superior sealing ability than MTA in perforation repair in primary teeth.

KEYWORDS

Microleakage, Furcal Perforation, Bio MTA, Premixed Bioceramics.

INTRODUCTION

Furcal perforation is a common problem that can occur in the primary teeth accidently, which can lead to premature tooth loss; however, if perforations are immediately diagnosed and sealed with a biocompatible material, the prognosis is usually good(1). Perforations can be managed surgically or non-surgically. In non-surgical treatment, perforations should be repaired with a biomaterial to prevent bacterial contamination and communication between perforation site and gingival sulcus(2).

An ideal sealing material should be biocompatible, non-toxic, bactericidal or bacteriostatic, radiopaque, non-absorbent, and maintain a good seal. Moreover, it should possess the ability to induce osteogenesis

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and cementogenesis[3].Several materials have been suggested for perforation repair such as amalgam, calcium hydroxide, MTA and (CEM) cement[4, 5].

MTA biomaterial was introduced in 1993 [6].The basic composition of MTA includes: tricalcium and dicalcium silicate, tricalcium aluminate, tetracalciumaluminoferrite, calcium sulfate and bismuth oxide ,it has alkaline pH after setting and hardens in ~4h,. MTA can induce cementogenesiswhen used to seal perforations , it also has superior sealing ability compared to other restorative materials, when used for perforation repair[7].

Recently, premixed BC materials have become available on the market in different forms with the same chemical structure. Premixed BCs are highly alkaline (pH = 12.7), so they offer sustained calcium release and ensure their antibacterial activity[8]. Premixed BCs possess the capability of inducing hydroxyapatite formation, indicating their tissue-inductive features[9]. Additionally, premixed BC sealing characteristics are attributed to its insolubility and dimension stability[9, 10].

Regarding furcal perforation in primary molars, there are no former clinical studies evaluating MTA or premixed BCs. Though few laboratory studies have assessed the sealing activity of MTA in repairing furcal perforation in primary molars, there are no in vitro studies that have aimed to evaluate the sealing properties of premixed BCs in primary molars. Therefore, the current study was designed to compare invitro sealing ability of premixed BCs versus Bio MTA.

MATERIALS AND METHODS

Thirty extracted human mandibular primary molars were used in this study. The teeth had minimal occlusal caries and normal furcation area. The teeth were kept in 5% sodium hypochlorite for 30 min. Then washed with tap water and stored in normal saline. A standard access cavity was prepared in each tooth using a diamond bur (#014, Mani co., Japan) in high speed hand piece with water spray. Root canal orifices and the apical end of each root were etched in all groups with 37% phosphoric acid gel (Meta Biomed Acid Etch, Korea) for 30s. Adhesive (3M-ESPE Adper single Bond 2, Germany) was then applied in two coats and photo polymerized with LED source. A light-cured flowable resin composite (Meta Biomed Nexcomp Flow, Korea) was then used to fill the root canal orifices and the apical end of roots.

To standardize the furcal perforations, the perforations were made with a size #10 round burs(Mani co., Japan) in a high-speed water cooled hand piece in the center of the pulp chamber floor. The bur was replaced after every five perforations. The width of all perforations was similar, but the length of the perforation depended on the dentine-cementum thickness from pulp chamber to the furcation area. The teeth were randomly divided into two experimental groups (n=15) of white MTA (Bio MTA, Cerkamed, Poland) and premixed BC (Well-Root PT, Vericom, Korea).

Furcation perforation sites in group I were sealed with Bio MTA, which was prepared according to the manufacturer's recommendations, powder/liquid ratio of 3:1 for 30 to 60 s. For the second group, the premixed BC material was tightly packed into the perforation site using a 1.5- mm-diameter amalgam condenser and adapted with a moistened cotton pellet and the access cavity was sealed with Orafil-G (Prevest Direct, India). The teeth were placed in an incubator at 37°C and 95% humidity for 72 h. The teeth were then covered with two layers of nail polish except ~1 mm around the perforated area so that, the dye would only penetrate through the furcation area. All the teeth were immersed in 2% basic fuchsin (Sigma-Aldrich Co., LLC, USA) for 24 h; they were removed from the solution, rinsed and then mounted in transparent acrylic. The teeth were sectioned mesio-distally parallel to their long axis, and linear dye penetration was measured on each wall from the apical end of the perforation to the pulp chamber floor using a stereomicroscope (70× Mag.; Carton optimal industries Ltd., SCW-E, Thailand). The microleakage was recorded and statistically analyzed by ANOVA test.

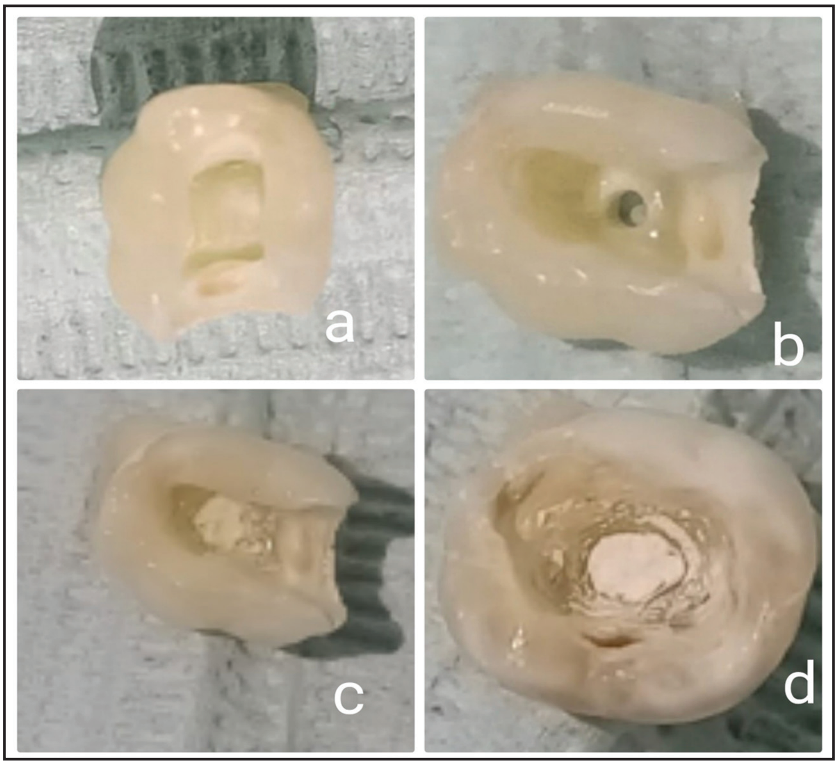

Figure (1): (a) Access opening (b) Artificial perforation which is standardized using a size 010 round bur (c)Artificial perforation repair using well-root (premixed BC) (d) Artificial perforation repair using Bio MTA.

Statstical Analysis

Statistical analysis was then performed using a commercially available software program (SPSS 18; SPSS, Chicago, IL, USA. Paired sample t-test of significance was used when comparing between related samples. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as P-value ≤0.05**,** P-value >0.05 was considered insignificant.

RESULTS

A higher mean value of microleakage (1669.25±140.59) was recorded in Bio MTA in comparison to Premixed BC (1275.21±235.998), with a significant difference between groups (p=0.008). The mean difference between both groups was (394.04±112.15)as shown in (Table 1 and Figure 2),the difference in the dye penetration in premixed BC and MTA as shown in figure 3 and 4.

Table (1): *Descriptive statistics and comparison of microleakage (µm) in both groups (Independent t test)*

Groups	Mean	Std. Dev	Difference				t test	P value
			Mean	Std. Dev	C.I. lower	C.I. upper		
Bio MTA	1669.25	140.590	394.04	112.15	144.16	643.91	3.51	.008*
Premixed BC	1275.21	235.998						

*C.I.=95% confidence interval ,Significance level p≤0.05, * significant*

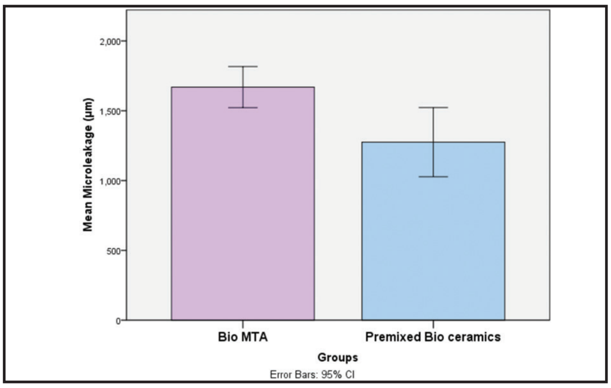

Figure (2): Bar chart illustrating mean microleakage (μm) in Premixed BC and Bio-MTA groups

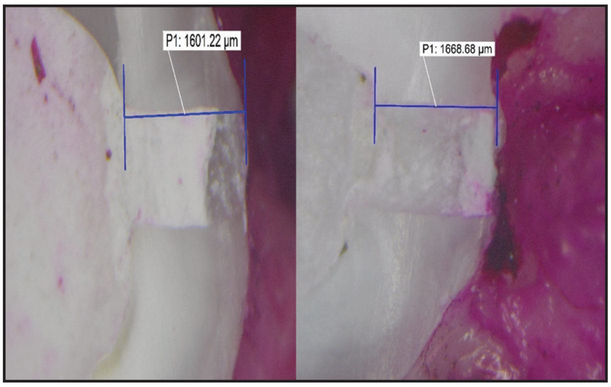

Figure (3):Linear dye penetration in premixed BC,
Figure (4):Linear dye penetration in MTA

DISCUSSION

The success of furcal perforation repair is dependent on the effective seal between the inner and outer tooth environment[11].Repair materials should stop the leakage of microbial irritants from the root canal into the periodontal tissues.Although MTA is the gold standard repair material to seal furcal perforation[12].Several materials have newly used to seal the furcal perforation ,as the premixed BC material [13].

Various models are currently used to evaluate the leakage. Dye penetration technique is one of the most common methods due to its easy performance [14].Several types of dyes have been suggested as Indian ink, fuchsin, methylene blue, silver nitrate and rhodamine B. The dye's pH, chemical reactions and molecular size affect the degree of dye leakage[15]. Methylene blue is a low-priced dye which has been commonly utilized; however, researchers demonstrated that optical density value of methylene blue decreases with MTA, which can cause underestimation in leakage studies[14]. The primary cause is the acidity of the methylene blue dye; therefore, alkaline dyes are more suitable for dye leakage studies on MTA. As studies have not reported any signs of dissolution of basic fuchsin by MTA, so this dye was used in the current study[16,17].

The results of the current study showed that the higher mean leakage value (1669.25±140.59) was recorded in Bio MTA, in comparison to Premixed BC (1275.21±235.998), with a significant difference between them (p=0.008). This could be attributed to nanoscale size of premixed BC the ,which causes deeper penetration of the material into dentinal tubules, thus rendering the fluid-tight seal ,also the consistency of the premixed BC material which reduces the air entrapment in the mix, gives better adaptability to dentinal walls and excellent handling of the material[18].

These results were in accordance with previous studies[19,20] which concluded that the premixed BC group had better sealing ability than the MTA group . Moreover these results were in agreement with previous studies [8,21] which evaluated the sealing ability of MICRO-MEGA MTA, Endosequence BC, and Biodentine as furcation repair materials using a dye extraction leakage method and concluded that the Endosequence BC showed the better sealing ability when compared with other root repair materials, this was due to the particle size, which allowed the premixed BC material to penetrate into the dentinal tubules and bond to the adjacent dentin easily. They also stated that the probable causes for more microleakage of MTA compared to Well-root premixed due to the long setting time of MTA ,difficult handling of the material and the presence of voids[8].

On the other hand, this result was in disagreement with a previous study which showed that the highest leakage was in the premixed BC more than MTA. This may be due to different in the study designs used in that study or different brands of the materials used[22].

The present study was also in disagreement with another study which compared the sealing ability of Pro-Root mineral trioxide aggregate (MTA) to the sealing ability of EndoSequence Bioceramic Root Repair Material (ES-BCRR) putty, using a bacterial leakage model and concluded that the samples in the ES-BCRR group leaked significantly more than the samples in the MTA group, this may be due to that the incubation of samples in that study was in 100% humidity chamber for 28 days and that the Endosequence BC putty is very sensitive to presence or absence of moisture, which could affect it's sealing ability and leads to leakage[23]. Also this difference may be due to different area that had been tested.

CONCLUSION

Premixed Bioceramics BC (well-root) appear to have superior sealing ability than MTA in repairing the perforation in primary teeth.

RECOMMENDATION

Further in vivo studies to evaluate the clinical and the histological outcomes of these materials in primary teeth are recommended

CONFLICT OF INTEREST: None declared.

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