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EVALUATION OF BIOCERAMIC PUTTY IN COMPARISON TO MTA ANGELUS REGARDING MARGINAL ADAPTATION (IN-VITRO STUDY)

Manar Mahmoud Abdulmegead Yassien* ,
Ehab Elsayed Hassanien** *and* Tarek Moustafa Abdelaziz***

ABSTRACT

Aim: The study aimed to evaluate and compare Neoputty MTA and MTA Angelus as perforation repair material regarding marginal adaptation.

Materials and methods: Twenty extracted human permanent mandibular molar teeth were collected and cleaned with sodium hypochlorite. Specimens were amputated 3 mm below the furcation area by using a tapered with round diamond size #12 and wheel stone. The height of the crowns of all samples were adjusted to 8 mm. Endodontic access cavity was made in each specimen by using a high-speed tapered with round diamond stone size #12 with air-water coolant. Impressions were taken for each tooth using condensation silicon to provide negative replicas of the perforation. Intentional perforation in all samples was made between the mesial and distal orifices using tapered with round bur size #12. The teeth were randomly divided into two groups each containing 10 teeth. The perforations were sealed as follows: Group A with MTA Angelus and Group B with Neoputty MTA. The repair materials of both groups were evaluated for marginal adaptation using SEM. Data were statistically analyzed using two sample t-test.

Results: Quantitative SEM observations illustrated that the mean gap at the dentin–furcation repair material interface was as follows: MTA Angelus showed higher mean gap distance (6.90±2.24μm) compared to Neoputty MTA (5.79 ±1.31 μm). Statistically there was no significant difference between MTA Angelus and Neoputty MTA concerning marginal adaptation.

Conclusion: Neoputty MTA could be used instead of MTA Angelus as perforation repair material.

KEYWORDS: MTA Angelus, Neoputty MTA, SEM, furcation perforation, Marginal Adaptation

* B.D.S, Faculty of Dentistry, Ain shams University, Cairo, Egypt
** Professor of Endodontics, Endodontic Department, Faculty of Dentistry, Ain shams University, Cairo, Egypt
*** Lecturer in Endodontics, Endodontic Department, Faculty of Dentistry, Ain shams University, Cairo, Egypt

INTRODUCTION

Several endodontic treatment techniques may result in iatrogenic accidents. For instance, one of the iatrogenic complications of endodontics is furcal perforation during access cavity preparation. If this error is not managed correctly, permanent periodontal damage would develop and tooth extraction would be the choice of treatment[(1)].

The success of treating such errors depends on rapid intervention and proper material selection. An intimate seal between the repair filling material and tooth structure is a significant component that influences treatment results[(2)].

The repair material should be able to support cell growth, the ability to form chemical bond with living tissues, insoluble and should have a bond strength with radicular dentin characteristics[(3)]. Traditionally, there were materials used as perforation repair fillings which failed to fulfill the required properties. Mineral trioxide aggregate (MTA) is the material of choice for repairing perforations. However, there are various drawbacks, such as difficulty in handling, increased setting time, discoloration and its form as a powder/liquid system, which raise the responsibility for major material waste[(4)]. To conquer these issues, bioceramic materials have been developed.

Bioceramics are dimensionally, and chemically stable within the biological environment. Bioceramics show excellent biocompatibility properties due to their similarity with biological hydroxyapatite. Bioceramics have the ability to induce a regenerative response in the human body. When placed in contact with the bone, it shows an osteoconductive effect, leading to the formation of bone at the interface. Recently, premixed bioceramics have been introduced to gain the advantage of uniform consistency and lack of waste[(4)].

Neoputty MTA® is a bioactive premixed bioceramic material with superior handling properties. It is composed of tantalite, tricalcium silicate, calcium aluminate, dicalcium silicate, tricalcium aluminate, calcium sulfate, proprietary organic liquid and stabilizers[(5)]. According to the manufacturer it is characterized by being bioactive, biocompatible, non-cytotoxic, non-genotoxic, initially high in pH (alkaline/basic) and antibacterial. In addition to that, it shows highest radiopacity in its class, promotes hydroxyapatite formation to support the healing process and it is resin-free so dimensionally stable with no shrinkage to ensure a gap-free seal. Non-staining so won't discolor teeth.

Considering this, the aim of the present study was to compare the marginal adaptation of MTA Angelus and Neoputty MTA in treating furcation perforation using scanning electron microscopy (SEM).

Our null hypothesis is that Neoputty MTA and MTA Angelus show no difference regarding marginal adaptation when used as perforation repair materials.

MATERIALS AND METHODS

Sample selection and preparation

Twenty permanent mandibular molar teeth were used. The teeth were cleaned with 2.5% sodium hypochlorite for 30 min after they were visually examined to make sure they did not exhibit any exclusion criteria (resorption, cavities, cracks, fusion, and curvatures).

Molars were amputated 3 mm below the furcation area by using a tapered with round diamond size #12 (Mani, Dia-Burs, Japan) and wheel stone. Endodontic access cavity was made in every molar by using a high-speed tapered with round diamond stone size #12 (Mani, Dia-Burs, Japan) with air-water coolant. Impressions (Zhermack Elite, Italy) were taken for each tooth to provide negative replicas of the perforation to facilitate efficient compaction of the material. Care was taken to centralize the perforation between the mesial and distal orifices as well as standardize the perforation size. Standardization was achieved by adjusting the height of the crowns of all samples to 8 mm, using high speed round bure size #12 in all samples and designing a cylindrical block from zirconium using CAD/CAM machine (Exocad software, Imes-core I 150 pro, Germany) of specific length and diameter that match round bur. The block was used together high-speed round bur size #12[6] (Mani, Dia-Burs, Japan) for perforating the furcal area under air-water coolant. The chamber and perforation were cleaned with water and dried. The diameter of the perforation was the same as the diameter of the bur in all samples. Post perforation, ten samples of teeth were randomly split into each of the two experimental groups.

Half of the samples were repaired with MTA Angelus (Angelus, PR Brasil). The material was prepared according to the manufacturer's instructions, then inserted in the perforation site, and compressed with pluggers (Dentsply, Switzerland). The other half was repaired with Neoputty MTA (NuSmile Ltd, Avalon Biomed, USA). Pieces of Neoputty MTA were drawn from the manufacturer-provided preloaded syringe[7], then inserted in the perforation site, and packed with pluggers (Dentsply, Switzerland). The amount of material added was equivalent to the size of perforation created.

After application of the materials, the perforation sites were covered with cotton pellet moistened with DW to provide ideal conditions during the setting[8]. All teeth were kept in their jars in an incubator (Hmg, India) adjusted at 37°C for 24 hours[8]. All teeth were removed from the jars after one day when the complete setting of the material is accomplished and washed with DW[8].

In new clean Eppendorf tubes (Eppendorf, Hamburg, Germany) 1.5ml of HBSS (Biochrom GmbH, Leonorenstr, Berlin, Germany) was injected. Teeth (n=20) were stored in the tubes containing the HBSS at 37°C for 7 days.

Sample evaluation:

The specimens were mounted on the stubs and examined with FEG-SEM (Quanta 250 FEG, FEL company, USA). Marginal adaptation was tested by examination of the samples under 1500X magnification to measure the gap distance between pulpal floor and repair material in micrometers. For the sake of accuracy, readings were taken along the whole gap length and mean gap distance was calculated as presented in **Figure 1** and **Figure 2**. The data was collected and statistically analyzed[8].

Fig. (1) Field emission gun scanning electron microscope image of gap at the dentin–furcation repair material interface of MTA Angelus.

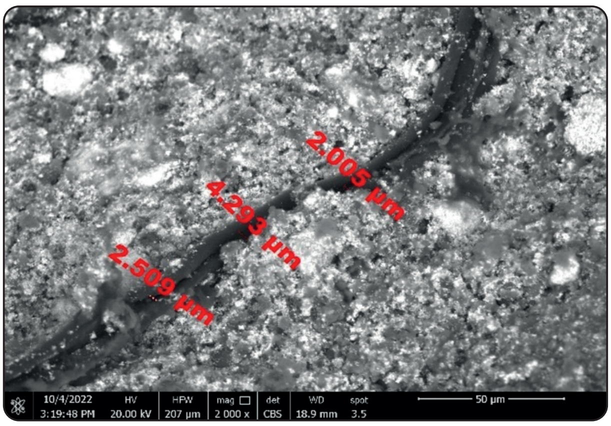

Fig. (2): Field emission gun scanning electron microscope image of gap at the dentin–furcation repair material interface of Neoputty MTA.

Statistical Analysis:

Results for marginal adaptation testing were obtained and analyzed using IBM SPSS statistical software. Comparison between two materials was performed using two sample t-test.

RESULTS

The mean gap at the dentin-furcation repair material interface was shown by quantitative SEM observations to be as follows: MTA Angelus (6.90 ±2.24 μm) as shown in **Figure 1** and Neoputty MTA (5.79 ±1.31 μm) as shown in **Figure 2**. Statistically there was no significant difference between MTA Angelus and Neoputty MTA concerning marginal adaptation as presented in **Table 1**.

TABLE (1) Mean and standard deviation of Gap distance between MTA Angelus and Neoputty MTA:

	MTA Angelus	Neoputty MTA
Average	6.90 ±2.24^{A}	5.79 ±1.31^{A}
P value	0.198	

Different upper-case letters in the same row indicate statistically significance difference. Different lower-case letters in the same column indicate statistically significance difference.

**** significant (p<0.05), ns; non-significant (p>0.05).***

DISCUSSION

Perforation is a pathologic or iatrogenic communication between the root canal space and the periodontium[9]. Perforations may occur because of iatrogenic errors occurring during root canal treatment or post-space preparation, resorptive processes, and caries. Most perforations result from iatrogenic errors due to misaligned use of rotary burs during endodontic access preparation and search for locating root canal orifices. For instance, furcal perforations occur in the furcation areas of posterior teeth, and thereby damage the attachment apparatus and can have a negative impact on the overall prognosis of the tooth[2,10].

The healing process and prognosis of any iatrogenic error depend on several factors, one of which is the correct choice of repair material. For example, clinically any material used as perforation repair filling is subjected to any kind of contamination such as tissue fluids throughout its placement and setting. Therefore, it is important to choose the material least likely to be affected by the environmental field. The properties required adequate seal, biocompatible, bioactive, bacteriostatic, and radiopaque. It should be non-toxic, non-cariogenic, easy to place and non-staining especially when used to repair perforations[3].

Therefore, Bioceramics were introduced into the endodontic field. The physico-chemical and biological characteristics of bioceramic materials have the potential to be the main repair materials in endodontics.

Following the adoption of bioceramic materials in clinical endodontics, the material which matched the ideal repair properties was mineral trioxide aggregate (MTA) due to its superior physico-chemical and biological properties. It has some drawbacks; requires mixing so there is considerable material loss, poor handling, and is difficult to remove from the root canal when set. In addition to that, gray and white MTA stain dentin[11,12]. Therefore, it is the material of choice for comparison when new materials are introduced in the market.

One of the recently introduced bioceramic is premixed tricalcium silicate-based repair putty materials characterized by being able to dissolve in water, easy to use and manipulate well[13].

NeoPutty MTA is one of the new materials in the market. It is premixed and optimized for more efficient handling and placement. Bioactive paste consists of an extremely fine, inorganic powder of tricalcium/dicalcium silicate in an organic medium. Its firm, low-tack consistency and bioactivity make it the premier putty for use as perforation repair in endodontics[14].

To evaluate the properties of such new material in relation to the ideal properties required, the study aimed to compare Neoputty MTA and MTA Angelus regarding marginal adaptation perforation repair fillings.

Mandibular posterior teeth were chosen for perforation preparation as they are wide mesiodistally so better accessibility, provide wide furcal area, so it was easier to perforate the furcal area as well as clinically, often inclined lingually and so greater risk of furcal perforations occur during access cavity preparation[6].

The size and location of the perforation are important in predicting the treatment outcome[2]. Therefore, it was important to take into consideration centralization of the perforation between mesial and distal canals as well as ensure that the size of the perforation in all samples are the same[15]. This was achieved by using high speed round bur of size #12 and length 8 mm in all samples, designing a 3D cylindrical block of specific diameter and length that match the perforating tool, sealing the block to the tooth to avoid its movement as well as minimal pressure was applied during perforation for optimum standardization.

The three- dimensional hermetic seal is the superior feature of material used for perforation repair[16]. It is a complicated outcome of applied materials' volume changes, solubility, adhesion, and marginal adaptation. The sealing ability of the repair material is evaluated by measuring the gap distance at material-dentine interface[17].For the sake of accuracy, readings were taken along the whole gap length and mean gap distance was calculated.

Generally, materials show different degrees of adaptation due to difference in composition of each material, different particle size and the environment at which material is set in[18].

The results of marginal adaptation regarding perforation repair showed that slight lower frequent distribution of gap presence was recorded for Neoputty MTA in comparison to MTA Angelus but statistically there was no significant difference between the two materials (P-value: $p= 0.198$).

The good adaptation property of Neoputty MTA may be attributed to differences of ingredients between these two cements. In Neoputty MTA, the decreased size of its constituents and the increase of its powder surface may contribute to faster reaction in comparison to MTA Angelus[19].

Our result matched with **Brenes-valverde, et al.**[20] who compared the marginal adaptability and microleakage of MTA and Biodentine and statistically there was no significant difference between two materials. Also, with **Dimitrova et al.**[17] in which the study involved comparing the adaptability potential of different calcium silicate based cements when used to treat large furcal perforations using SEM. According to the results, Bio Aggregate produced the smallest gap size followed by MTA while Biodentine produced the largest gap size but statistically there was no significant difference between them. The difference between our results and other studies may be related to a different method of sample preparation and method of evaluation.

Also, our result was in agreement with **Mahmoud Ahmed Abdelmotelb et al.**[7] who evaluated the marginal adaptability of MTA and Premixed Bioceramics and found no statistical difference between two materials.

On the other hand, **Nagmode et al.** compared three bioceramic material (MTA Angelus, Biodentine and Light cured MTA) as furcal repair and concluded that light-cure MTA exhibited significant good sealing ability to dentin when compared to conventionally used Biodentine and MTA[16]. This difference may be due to different materials used as well as different methodologies.

CONCLUSION

Under the circumstance of this in-vitro study, it can be concluded that MTA Angelus and Neoputty MTA showed similar results in terms of adaptability regarding perforation repair fillings.

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