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Evaluation the Marginal Adaptation for the Bio C Repair and Other Root end Filling Material by Using Scanning Electron Microscope (A Comparative In Vitro Study)

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Research Article

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ABSTRACT

Background: The ability of the retrograde filling material to adhere to dentin has a substantial impact on the success of endodontic procedures. The marginal adaptation of the root end filling materials is considered an important factor, since it demonstrates adaptation of the material to the dentinal walls.
Objective: Assess the marginal adaptation of Bio-C Repair material in contrast to MTA (Angelus) and Amalgam.
Material and method: A total of thirty human maxillary central incisors teeth that each had a single root were chosen. To keep the root canal length at 15mm, the crown was resected. The teeth underwent endodontic treatment, along with the resection of their root ends and preparation of root-end cavities. Based on the type of filling, the teeth were categorized into one of three groups, as follows: (A) Bio-C repair (Bioceramic reparative material), (B) MTA Angelus, (C) Amalgam. Teeth were sectioned longitudinally, and marginal gaps were measured by the use of a scanning electron microscope. Data was statically analyzed using ANOVA and Tukey Honestly Significant Difference (Tukey's HSD).
Results: Bio-C Repair material and MTA show better marginal adaptation with significant difference between them and amalgam, and no significant difference between the Bio-C repair group and MTA group.
Conclusions: Marginal adaptation is better for Bio-C Repair in comparison to MTA Angelus and Amalgam.

Key words: Bioceramic, Marginal Adaptation, MTA, Scanning Electron Microscope.

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Introduction

The main objective of endodontic treatment is to get a seal that prevents any fluid from leaking between the periodontium that surrounds the root canal system.[1] The routine endodontic treatment was done in orthograde approach, and if that is not possible, a retrograde approach, root-end preparation and filling with a surgical approach is recommended. Retrograde root-end filling, which comes following apicoectomy, is crucial. A sufficient amount of retrograde filling material must be used to fill the retrograde cavity to ensure that the root canal system is hermetically sealed, and for preventing the entrance of microorganisms and byproducts to the periradicular tissue.[2] numerous studies had examined the surgical endodontic treatment's clinical results, and most of these studies show that, The clinical outcomes of endodontic surgery are significantly influenced by the selection of retrograde materials.[3] Root end filling material should be antimicrobial, nontoxic, and biocompatible, radiopaque, non-resorbable, dimensionally stable, resist dislocating forces, withstand breakdown or dissolution by tissue fluids, be easily handled, and be able to adapt to the dentinal walls of root canal system .[4] Numerous materials had been used as root end filling material, Amalgam is one of the most used root-end filling materials its remain the standard to which other materials are evaluated .It is durable, less technically sensitive, easy to handle, has minimal technical time compared to other materials and its corrosion products seal the apex surface and prevent leakage of bacteria. Some of the disadvantages are local allergic reactions, mercury toxicity and lack of chemical bonding with dentin.[5]

Mineral trioxide aggregate (MTA) is one of the materials developed as retrograde filling material that has a noncytotoxic effect and promotes cementogenesis its presently utilized as a material for root-end filling.[6] However, MTA has certain drawbacks, including difficult handling, a prolonged setting time, an expensive cost, poor antibacterial properties, and discoloration.[7] MTA's composition was changed, and MTA Angelus was released in 2001, with calcium sulphate removed from its composition to improve utilization and decrease the setting time.[8] To overcome the problems of MTA the Bio-C Repair material have been created, its new material for root-end filling and because they become bioactive when they come into contact with vital tissues, they help with tissue repair and biomineralization.[9] Bio-C Repair have

better properties such as decreased moisture sensitivity, insolubility, and tissue inductive properties, They are the ideal substances for endodontic treatment.[10] It is simple to use , not provided in powder-and-liquid form; instead, it is offered as a single product stored in a syringe, thereby eliminating the need to manipulate the material and time saving.[11] CAMPI *et al.*[12] was the first investigate the physicochemical characteristics, bioactivity and cytotoxicity of the Bio-C Repair material, in comparison with MTA Angelus .The materials utilized as root end filling in this study are described in [Table1]. The success of surgical endodontic treatment is mostly dependent upon on how well a root end filling material adheres to the dentinal walls.[13] Given the importance of adequate marginal adaptation for the success of regenerative endodontics, studies should be performed to provide well-grounded information on the mechanical properties of Bioceramic cements, especially those recently released to the market were the Bio-C Repair material still in experimental phase. Therefore, the aim of the present study was to evaluate the marginal adaptation of Bio-C Repair material when used as root end filling material and compare it with MTA angelus, and Amalgam.

The null hypothesis stated that there is no significant difference in marginal gaps that found between dentin and root end filling material (Bio-C Repair, MTA, Amalgam).

Material and Methods

Ethical approval from the research ethics committee of the College of Dentistry-University of Baghdad (Ref. number: 56, Date: April 20, 2022). was gained for the use of extracted human teeth. The sample size calculation was performed by using G power 3.0.10 (Program written by Franz-Faul, Universitatit Kiel, Germany) with power of study=95%, alpha error of probability=0.05, doing pilot study on three groups find that the effect size of F is 1.11 (Large effect size), thus requiring 6 teeth for each group, 10 teeth were assigned for each group thus more calculated than G power.

The main steps in the methodology of this study summarizing in [Figure 1]. Thirty human maxillary central incisor, all the teeth extracted for patient treatment, that have the following criteria: single roots with completed root formation, without any anatomic variation, crack, or any resorption and without any previous endodontic treatment. The sample was cleaned by using scalar and pumice, and disinfected with NAOCL solution (Promida, Odunpazarı, Turkiye) in a concentration 2.5% for 30 minutes after disinfection the sample was stored in normal saline until used .[14]

The crown was sectioned by a diamond disc to standardize the root length (15mm), and a K-file of size 10 (DENTSPLY Maillefer, Ballaigues, Switzerland) was inserted in each root, the tip of the file was visible from the apical foramen at a distance of 1 mm. ProTaper rotary files (DENTSPLY, Maillefer, and Ballaigues, Switzerland) were utilized to prepare the root canals to the desired shape, the preparation began with the SX file and continued with the S1, S2, F1, F2, and F3 files. Between each file, the canal was irrigated with 2mL of 5.25% sodium hypochlorite canals was rinsed with 2ml of distill water then irrigated with 2 mL of EDTA at a concentration of 17% (Dental Produits Dentaires SA, Switzerland) canal was dried by using a paper point (DENTSPLY, Maillefer, and Ballaigues, Switzerland). Gutta-percha points (DENTSPLY, Maillefer, and Ballaigues, Switzerland) and MTA-Fillapex sealer (Angelus Odonto, Londrina, Brazil) were used to fill the canals using lateral condensation technique. The roots were kept at 100% humidity and 37°C for two days to ensure that the filling materials were fully set. The roots were precisely sectioned (3mm from the apex) Under continuous water cooling using a diamond disk. a root-end cavity measuring 3mm in depth and 1.5mm in diameter was prepared by using a fissure bur (FKG Dentaire, La Chaux-de-Fonds, Switzerland) with copious water. The root end cavities were irrigated by (EDTA) 17% (Dental Produits Dentaires SA, Vevey, Switzerland) for smear layer removal and rinsed with normal saline after that the cavities were filled with the root end filling material according to the manufacture's instruction. The samples were randomly classified (using www.random.org) into three groups according to the type of filling material that was utilized (n=10):

I. Bio-C Repair group: the retrograde cavities were filled with Bio-C Repair (Angelus Odonto, Londrina, Brazil).

II. MTA Angelus group: the retrograde cavities were filled with MTA (Angelus Odonto, Londrina, Brazil).

III. Amalgam group: the retrograde cavities were filled with Amalgam (NAIS, Sofia, Bulgaria).

Radiographs were taken to confirm the proper filling of the material. All teeth will be stored at 37º and 100% humidity for 7days.

The roots were then sectioned longitudinally using a slow-speed diamond saw and under continual water-cooling. The specimens have a gold sputter coating and analyzed by scanning electron microscope (Axia Chemisem, Thermo Scientific Fisher, USA,2021) without dehydration of the specimens.at six points on both sides of the specimen under magnifications 250X,500X,1000X,2000X,4000X.

The points are chosen so that points 1a, 1b and points 3a,3b represent the upper and lower edges of the preparation (0,5mm from the margin), points 2a,2b represent the mid distance between points 1 and 3 [Figure 2]. The full width of the marginal gaps was assessed in micrometers at magnification 2000X, gaps measured in micrometer (um) by using Image J software application (National Institutes of Health, Bethesda, MD).

Statistical analysis

The Statistical Package for Social Science (SPSS version -22, Chicago, Illinois, USA) was used for data analysis, Statistical tests included: Shapiro–Wilk test, ANOVA test, Tukey post hoc test**.**

Table 1. Materials' composition, manufacturers, and Technique of use.

Materials	Composition	Manufacturer	Technique of use
Bio-C Repair	Calcium silicate, calcium oxide, zirconium oxide, iron oxide, silicon dioxide, dispersing agent	Angelus, Londrina, PR, Brazil	Ready for use.
MTA-Angelus	Powder: Tricalcium silicate, dicalcium silicate, tricalcium aluminate, calcium oxide, calcium tungstate istead of bismuth oxide. Liquid: Distilled water	Angelus, Londrina, PR, Brazil	For 30 s, mix the content of 1 sachet of MTA-Angelus (or 1 spoon of MTA-Angelus with 1 drop of distilled water. The mixture should be homogeneous and with a consistency similar to wet sand.
Amalgam	Ratio of Alloy/ Mercury 1:1 Alloy: Silver 43%, tin 32%, copper25%.	NAIS, Sofia, Bulgaria	12-15 s, mix the Amalgam capsule in the amalgamator.

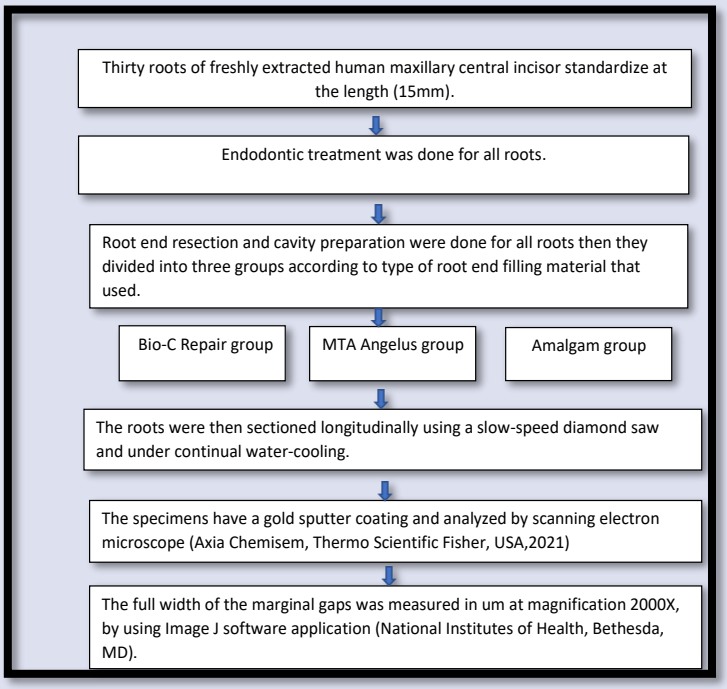

Figure 1. Flow chart summarizing the main steps in the methodology of this study.

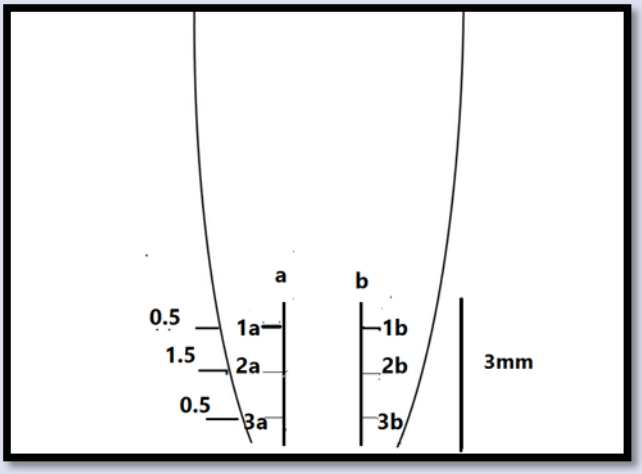

Figure 2. Flow chart summarizing the point of gaps measurement in SEM photomicrographs.

Results

The gaps at filling-dentin among three different groups tested for normality of disruption using Shapiro Wilk test at p >0.05 The results were revealed that the data were normally distributed.

The finding of each group including Minimum, Maximum, Mean, Standard Deviation, and Standard Error of gaps at filling-dentin among groups was shown in [Table 2] [Figure 3]. SEM photomicrographs of all groups are presented in [Figure 4].

The difference in mean value of marginal gaps between groups was evaluated using One way Analysis of Variance (ANOVA) [Table 3] The results showed that there was significant difference among groups (p<0.05). Further comparison using Tukey's HSD test after ANOVA revealed that the difference between Bio-C repair group and MTA angelus group is not significant(P>0.05), and there's significant difference between them and Amalgam group (p<0.05) as shown in [Table 4].

Table 2. Descriptive statistics of gaps among groups in um.

Groups	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Bio-C Repair	2.962	0.481	0.152	1.830	3.652
MTA ANGELUS	3.810	1.451	0.459	2.896	7.791
Amalgam	6.602	0.908	0.287	5.031	8.240

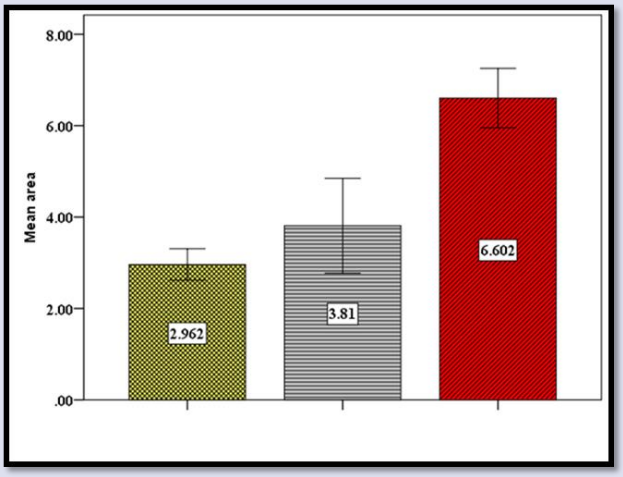

Figure 3. Means of gaps which measured in the groups in um.

Table 3. Statistical test of gaps among groups using One way Analysis of Variance.

	Sum of Squares	df	Mean Square	F	P value
Between Groups	72.553	2	36.277	34.440	0.000*
Within Groups	28.440	27	1.053		
Total	100.993	29			

*=significant difference
p=0.000

Table 4. Multiple pairwise comparison of SEM among groups suing Tukey HSD.

(I) Groups	(J) Groups	Mean Difference (I-J)	P value
Bio-C Repair	MTA ANGELUS	-0.848	0.174^
	Amalgam	-3.640	0.000*
MTA ANGELUS	Amalgam	-2.792	0.000*

*==^ non-significant difference
*=significant difference

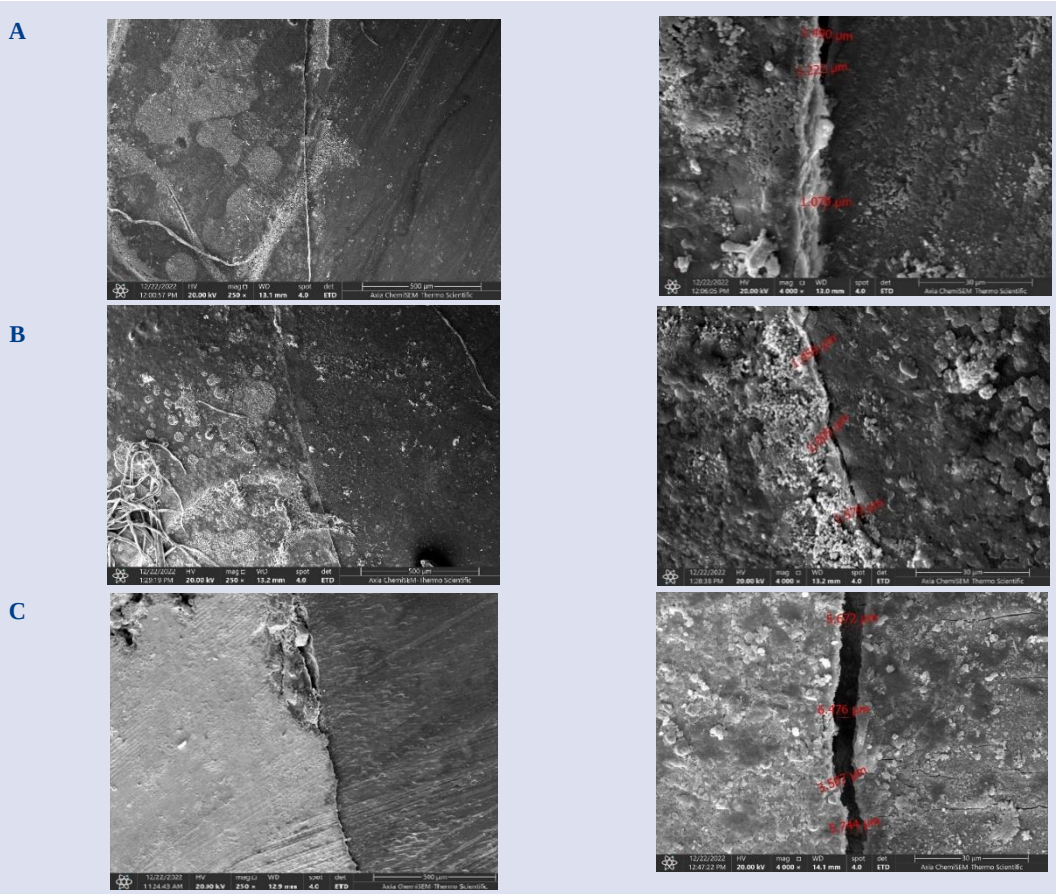

Figure 4. Scanning electron micrograph show marginal gaps between retrograde filling materials and dentin. (A) Bio-C Repair at magnification (a) 250x (b) 4000x. (B) MTA ANGELUS at magnification (a) 250x (b) 4000x. (C) Amalgam at magnification (a) 250x (b) 4000x.

Discussion

Marginal adaptation of the retrograde filling material considered the most significant factor for successful long-term treatment of surgical endodontics.[13] An optimal root-end filling material, as stated by Torabinejad *et al.*, should have the ability to adhere to the dentinal walls for complete seal of the root canal system. It must not be toxic, it cannot corrode, must not irritate the periradicular tissues, accelerate healing. It should be easy to manipulate and should be radiopaque, among other requirements, addition to these properties, it must be dimensionally stable, non-resorbable, and impervious to moisture.[4] Bioceramic root end filling material has shown to have success rate 86.4-95.6 in the last years and its showed high success rate in comparison to amalgam [2]. MTA was tested extensively in many vivo and vitro studies over the last years. These studies show better properties for the MTA, if compared with traditional retrograde filling materials.[15] Bio-C Repair material recently added in the marketplace, used as root-end fillings, because of their superior qualities such as insolubility, decreased moisture sensitivity, and tissue inductive properties, recently they are the materials of choice in the surgical endodontic treatment.[16] The addition of silicate-based materials leads to decrease setting times, this overcoming on the drawbacks of MTA. Bio-C Repair (Angelus)is not supplied in powder and liquid form; rather, it is sold as a single product that is packed in a syringe; as a result, there is no requirement for the material to be manipulated .[17] Bio-C Repair is not only biocompatible, but it also has the ability to biomineralize when it comes in contact with live tissues.[18,11] In this present in vitro study marginal adaptation of Bioceramic reparative material was evaluated and compared with MTA and amalgam which considered standard filling in this study. amalgam was used as root end filling material in the past, therefor it considers control when new root end filling material tested. In this study, 3mm from the apical part of the root was eliminated to reduce the apical ramifications and lateral canal. the retrograde cavity was prepared by bur to avoid crack formation in the root.[19] The marginal adaption test is an indirect method that is used to examine the sealing ability of different root-end filling materials. Studies of color penetration, bacterial leakage, fluid filtration, and radioisotope methods, along with confocal microscopy, micro-computed tomography (CT), and scanning electron microscopy were used in order to assess the quality of the material's marginal adaption. In many studies, Through the use of longitudinal sections of the tooth, scanning electron microscopy (SEM) has been utilized to examine the marginal adaptation of a variety of

root-end filling materials to the surrounding tooth structure. [20,21]

SEM show highest means value of gaps recorded in the Amalgam group the poor adaptation of amalgam may be due to contraction during setting, lowest mean of gaps in the Bio-C Repair group, gaps in MTA smallest than this which found in Amalgam that's confirm with results in other previous studies.[13]

The good marginal adaptation of MTA because its composition consists of tricalcium silicate, tricalcium aluminate, tricalcium oxide, silicate oxide, and various mineral oxides , all of which combine to produce a hydrophilic powder that solidifies in the presence of water.[22] It demonstrates the precipitation of calcium-phosphate at the interface of the two substances This interface layer lessens the likelihood of marginal percolation and paves the way for potentially long-term clinical success.[23,24] In the Bio-C Repair The capacity of these materials to seal is improved by the presence of mineral precipitate at the interface between calcium silicate-based cement and dentin.[25]

In this study Bio-C Repair show better marginal adaptation than MTA this may be due to volumetric change that occur in MTA is higher than this in Bio-C Repair as mentioned in other previous studies.[26,10]

Conclusions

The result of this study shows improved marginal adaptability for the Bio C repair; better handling this material make its better to use as retrograde material in comparison to other.

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Conflicts of Interest Statement

There is no potential for bias or conflict.

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