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Evaluation of dentinal bridge formation and canal obliteration after pulpotomy in primary molars using MTA and bioceramic putty (well-root-pt)

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Abstract:

Summary: Preserving the primary teeth is important, as it plays an important role in the integrity of the dental arch, the development of the craniofacial complex, and the integrity of speech and chewing, as early loss of primary teeth leads to cosmetic, functional and verbal problems.

Objective: This study aimed to evaluate the formation of the dentinal bridge and canal obliteration after pulpotomy n in the primary molars using both mineral trioxides aggregate and Bioceramic putty (Well_Root PT) in the pulpotomy of the primary molars.

Materials and Methods: The study sample included forty second lower primary molars with non-response pulpitis, randomly
distributed into two groups in children aged 6-8 years. Mineral trioxides aggregate (MTA) were applied in the first group, while bioceramic was applied in the second group.

Results: There was no statistically significant difference in the formation of the dentinal bridge between the two study groups, while there was a statistically significant difference in canal obliteration between the two study groups.

Conclusions: This study found no difference between mineral trioxides aggregate and Bioceramic putty (Well_Root PT) in bridge formation, while a difference was noted in canal obliteration, where a greater number of cases was recorded in the mineral trioxides aggregate group.

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Keywords: Pulpotomy, Primary Molars, Dentinal Bridge, Canal Obliteration, Mineral Trioxide Aggregate, Bioceramic Putty (Well_Root PT).

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تقييم تشكل الجسر العاجي وامتلاء القناة التالي لبتر اللب باستخدام كل من مادتي ثلاثي الأكاسيد المعدنية (MTA) و Bioceramic putty (well-root-pt) في الأرحاء المؤقتة السفلية

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الملخص:

يعد المحافظة على الاسنان المؤقتة امراً مهماً، حيث تلعب دوراً مهماً في سلامة القوس السنية وتطور المركب القحفي الوجهي وسلامة النطق والمضغ، حيث يؤدي فقد الأسنان المؤقتة المبكر الى مشاكل تجميلية، وظيفية و لفظية.

الهدف: هدفت هذه الدراسة الى تقييم تشكل الجسر العاجي وامتلاء القناة بعد بتر اللب في الأرحاء المؤقتة باستخدام كل من مادتي ثلاثي الاكاسيد المعدنية و بيوسيراميك Bioceramic putty (Well_Root PT) في بتر لب الارحاء المؤقتة .

المواد والطرائق: شملت عينة الدراسة أربعين رحى مؤقتة سفلية ثانية عرضية symptomatic مشخصة بالتهاب لب غير ردود Irreversible pulpitis موزعة عشوائياً الى مجموعتين لدى أطفال تراوحت اعمارهم بين 6–8 سنوات، طبقت مادة ثلاثي الاكاسيد المعدنية في المجموعة الاولى(MTA) بينما طبقت مادة بيوسيراميك في المجموعة الثانية بعد إجراء بتر اللب.

النتائج: لم يكن هناك فرق دال احصائياً في تشكل الجسر العاجي بين مجموعتي الدراسة، بينما لوحظ وجود فرق دال احصائياً في امتلاء القناة بين

الاستنتاجات: وجدت هذه الدراسة عدم وجود فرق بين مادتي ثلاثي الأكاسيد المعدنية و بيوسيراميك Bioceramic putty (Well_Root PT) في تشكل الجسر بينما لوحظ وجود فرق في امتلاء القناة حيث سجل حدوث عدد حالات أكبر في مجموعة ثلاثي الاكاسيد المعدنية.

الكلمات المفتاحية: بتر اللب، الارحاء المؤقتة، جسر عاجي، امتلاء القناة، ثلاثي الأكاسيد المعدنية، Bioceramic putty (Well_Root PT)

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Introduction:

Pulp treatment primarily aims to preserve the health and integrity of oral tissues. Premature loss of primary teeth can lead to malocclusion and aesthetic, speech, and functional problems, which may be permanent or transient. Therefore, it is crucial to preserve pulp vitality as much as possible (Fuks et al., 2019, 349). Root canal treatment is indicated for primary teeth showing signs of irreversible pulpitis, but it is challenging, time-consuming, and expensive. Furthermore, the child's behavior may negatively impact treatment outcomes. The anatomy of the molar root canals also makes treatment more difficult, as complications may result in the extraction of the primary tooth. Endodontic treatment also requires the skill of both the general practitioner and the specialist, considering the potential for damage to the permanent bud during therapy due to the instruments used or filling materials (Pinheiro et al., 2012, 382). Vital pulp therapy (VPT) using bioreceptive materials is a proposed alternative to pulpectomy in cases of irreversible pulpitis. Studies have shown a weak correlation between the tissue condition of the pulp and the patient's symptoms. Bioreceptive materials, such as mineral trioxide, have been shown to achieve a high success rate in such cases. These materials have high receptive properties and have been applied in several studies to permanent molars with irreversible pulpitis (379, Koli et al., 2021), (130, Qudeimat et al., 2017).

Mineral trioxide and bioceramic putty have been proposed as alternative bioreceptive materials for pulpotomy in primary molars and have shown a high success rate (Naik and Hegde, 2005, 13); (Lei et al., 2019, 72).

In 2007, a group of Canadian researchers presented a material called Ready-to-use bioceramic, which uses calcium silicate-based material and is available in three forms: hard, soft, and flowable. This material consists of tricalcium silicate, zirconium oxide, titanium pentoxide, and monophasic calcium phosphate, in addition to fillers and thickening agents (Debelian and Trope, 2016,75).

Ethical approval was obtained from the Ethical Board of the Faculty of Dentistry, Damascus University. This study was registered with the Australian New Zealand Clinical Trials Registry under number 12621001631897.

The study sample consisted of forty mandibular second primary molars randomly assigned to two equal groups.

Inclusion Criteria

1. Children aged 6-8 years.
2. Physiological resorption of less than one-third of the root.
3. Presence of penetrating caries with extended carious lesions and symptoms of non-reversible pulpitis.
4. Absence of symptoms or signs of pulpal necrosis.
5. Absence of radiographic signs (pathological internal or external resorption or periapical lesion).
6. Cooperative child.

Exclusion Criteria:

1. Children with special needs.
2. Teeth that cannot be isolated.
3. Children with systemic diseases.
4. Children with poor oral hygiene.

Procedure Steps:

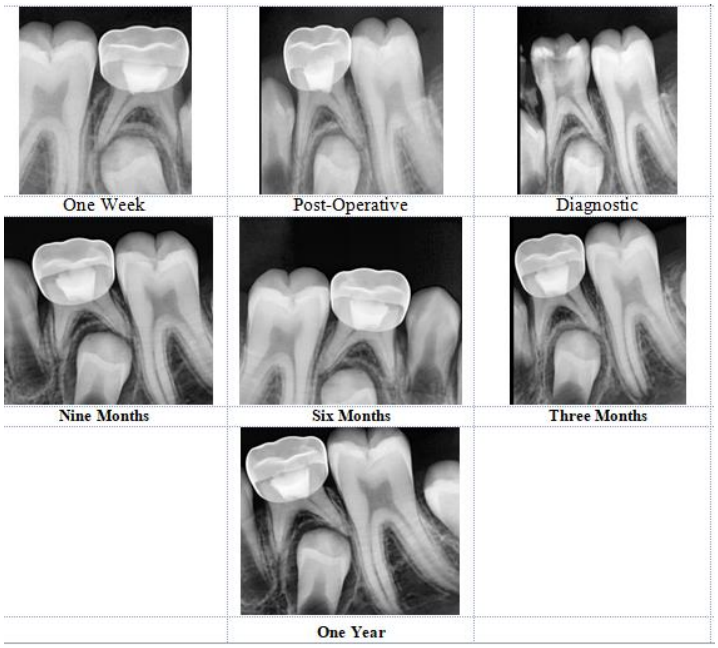
1. After applying the local anesthetic gel, anesthesia was performed using 2% lidocaine with 1:80,000 epinephrine.
2. Isolation using a rubber dam.
3. Enamel and dentin were removed using a high-speed, water-cooled, spherical diamond bur mounted on a high-speed handpiece. Caries were removed near the pulp using a dentin curette from the periphery toward the center to minimize contamination.
4. Penetrating the pulp chamber using a bur (Dentsply Maillefer, Ballaigues, Swiss Endo_z) with cooling.
5. Remove the remaining coronal pulp using a sharp dentin curette.
6. Irrigate the pulp chamber with distilled water (normal saline) to remove preparation residue.
7. Hemostasis by applying pressure using cotton balls soaked in 2.5% sodium hypochlorite for two minutes. Repeat the process if necessary until the bleeding stops within 10 minutes (Taha & Khazali, 2017, p. 1420). If hemostasis is not achieved, the case is excluded and the pulp is completely removed (pulpectomy).

8. Apply Well-Root ST™ Bioceramic Putty or MTA Angelus mineral trioxide to the canal orifices and the floor of the pulp chamber.
9. Apply a base layer of glass ionomer cement (GC Fuji IX). GP).
10. Application of a stainless steel crown (kidscrown (Seoul, Korea).
11. Performing a periapical radiograph of the treated tooth immediately after restoration.

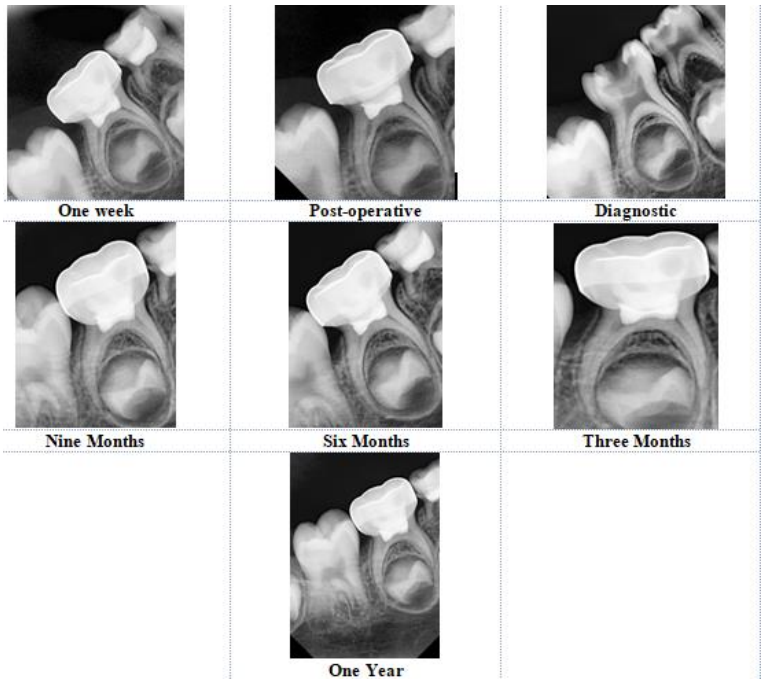
Radiographic Evaluation:

Radiographic evaluation was performed after 3, 6, 9, and 12 months by two outcome assessors to assess canal obliteration and dentin bridge formation, even though they were unaware of the applied material.

Data for each group were described using frequency (percentage). Fisher's Exact Test was used to examine differences between study groups using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA).



Figure(1): Primary second molar pulpotomy (MTA group).



Figure(2): Primary second molar pulpotomy (Bioceramic putty group).

Results:

The sample included forty lower primary molars divided equally into two groups, where each group included twenty primary molars. MTA was applied in the first group, while the bioceramic putty was applied in the second group. The children's ages ranged between 6-8 years, where the mean age of the children in the first group was 6.94 ± 0.558, while in the second group, it was 7.19 ± 0.417, as shown in Table 1. The follow-up period was for a year, and the radiographic evaluation was conducted after 3, 6, 9, and 12 months of treatment. Cases of dentin bridge formation and canal obliteration were recorded. A dentin bridge was formed in 55% of the primary molars in which MTA was applied. Dentin bridge was observed in 40% of the primary molars in which the bioceramic material was applied, without a statistically significant difference between the two groups, as shown in Table 2. Canal obliteration was observed in 60% of the primary molars treated with MTA compared with 10% in the bioceramic group, with a statistically significant difference as shown in Table 3

Table(1): Descriptive statistics of the participants age.

Groups	Mean ± SD	Minimum	maximum
MTA	6.94 ± 0.558	6	8
Bioceramic putty	7.19 ± 0.417	8	7.9
Irreversible pulpitis	7.06 ± 0.502	6	8

Table(2): Dentin bridge formation after one year.

Groups	Frequency			Percentage			p-value
	0	1	Total	0	1	Total	
MTA	9	11	20	45%	55%	100%	0.342
Bioceramic putty	12	8	20	60%	40%	100%	

Table(3): Pulp canal obliteration after one year.

Groups	Frequency			Percentage			p-value
	0	1	Total	0	1	Total	
MTA	8	12	20	40%	60%	100%	0.031
Bioceramic putty	18	2	20	90%	10%	100%	

Discussion:

Teeth with irreversible pulpitis are usually treated by removing the entire pulp, including all its inflamed, necrotic, and healthy parts. This procedure is considered invasive and non-biological, resulting in a loss of the reparative and regenerative properties of a vital pulp (Taha and Khazali, 2017, p. 1418). Furthermore, this procedure requires more time and effort in children and requires more experience from the dentist. These factors may lead to the decision to extract the primary tooth, resulting in a loss of tooth function. Therefore, vital pulp therapy techniques have been proposed for treating cases with irreversible pulpitis. This technique has the following advantages (Wolters et al., 2017, p. 827): It preserves the immune and vital functions of the pulp while also preserving the integrity of the remaining parts of the tooth. The treatment procedures are simple and avoid complications resulting from the complex anatomy of the root canals. It causes less pain.

Pulpotomy has proven effective in treating teeth with symptoms and signs of non-reversible pulpitis, whether in permanent or primary teeth. In 2017, Taha found a 100% success rate after one year of follow-up and a 92% success rate after three years of follow-up when performing pulpotomy using MTA in permanent molars with non-reversible pulpitis (Taha and Khazali, 2017, p. 1420).

The study sample consisted of forty lower-second primary molars randomly divided into two groups. Lower second primary molars were selected in this study to avoid differences resulting from the primary molar type. Molars diagnosed with non-reversible pulpitis based on the patient's symptoms, such as spontaneous and persistent pain that required the child to be given analgesics, were included. The time required for hemostasis was between 5 and 10 minutes after coronal pulp removal. Cases exceeding 10 minutes were excluded and converted to a complete pulpectomy. Bleeding that exceeds 10 minutes indicates severe pulpitis, which requires complete pulpectomy, according to the Wolters classification (Wolters et al., 2017, 827). Sodium hypochlorite was used as a 2.5% disinfection solution after coronal pulp removal, based on the recommendations of the American Association of Endodontists, which recommended the use of sodium hypochlorite solutions at concentrations ranging from 0.5% to 5.25% in the context of treating living pulps. Sodium hypochlorite is safe without causing pulp damage or toxicity to pulp cells, their proliferation, and their differentiation. It also did not show any negative effects on hard tissue deposition (Duncan et al., 2021,2147).

This study used MTA, which is considered the standard material in vital pulp therapy due to its high bioactivity and success rate (Hussain and Bashar, 2022, 226). Bioceramic putty, an improved generation, was also used, characterized by high bioreceptivity and excellent physical properties (Hirschman et al., 2012, 386).

Stainless steel crowns were used as the final restoration due to their high sealing capacity and durability. The quality of the restoration plays an important role in improving treatment prognosis. Some studies have shown the importance of crown sealing, and it may be more important than materials used in vital pulp therapy (Qudeimat et al., 2017, 130). Bioceramic putty outperformed MTA in its ability to induce less obliteration in primary molar canals, with a statistically significant difference. However, there

was no difference in dentin bridge formation between the two materials.

This study is one of the pioneering studies comparing bioceramic and MTA in the context of pulpotomy in primary molars diagnosed with irreversible pulpitis. The concept of dentin bridge formation and canal obliteration is controversial. Their formation can be considered a healing response or a reaction of the pulp to irritation. The formation of a dentin bridge is a sign of treatment success, but its absence does not necessarily mean treatment failure. There are other signs of treatment failure, including pulp canal obliteration, which is not considered treatment failure. It results from the gradual deposition of regenerated dentin secreted by odontoblasts and odontoblast-like cells within the canal, leading to the narrowing of the canal lumen (Nair et al., 2008, p. 135). Pulp canal obliteration is one of the most common radiographic findings observed in teeth with calcium silicate-based materials. This is a disadvantage of these materials, as canal filling increases the difficulty of performing endodontic treatment when complete endodontic treatment is required, such as when teeth with these materials fail or when restorative treatments are required. Advanced endodontic treatment is required in teeth that have undergone pulpotomy using materials that are based on calcium silicate (AKDAĞ and DEMİR, 2022, 35), (Mass and Zilberman, 2011, 42), (Nair et al., 2008, 135).

Conclusion:

MTA and bioceramic putty materials demonstrated the ability to form dentin bridges, with the bioceramic putty group superior in producing less obliteration in the molar canals where they were applied. However, long-term studies with larger sample sizes and a histological assessment. are needed to investigate the nature of the mineralized tissue formed within the canals

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