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Comparing the Effectiveness of Mineral Trioxide Aggregate and Biodentine as Direct Pulp Capping Agents in Permanent Teeth with Deep Carious Lesions

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ABSTRACT:

Objective: To compare the effectiveness of Mineral Trioxide aggregate and biodentine in direct pulp capping of patients reporting to Rehman College of Dentistry, Peshawar.
Study Design: A Randomized controlled clinical trial (RCT)
Place and duration of study. Department of Operative Dentistry and Endodontics, Rehman College of Dentistry, Rehman Medical Institute, Peshawar. From January 2022 to January 2023.
Material and methods: A total of 80 subjects were divided randomly into two groups, i.e., of Mineral Tri-oxide aggregate and Biodentine. Patients aged 18-40 years, both genders, with deep carious lesions, symptoms of reversible pulpitis, and vital teeth with no peri-apical radiolucency were included. Direct pulp capping was done with MTA in Group I (n = 40) and Biodentine in Group II (n = 40). All the patients were called for follow-up after 3 weeks, and subjective assessment of pain was done on the VAS scale. Pulp vitality was assessed by the EPT test. The absence of subjective pain and the presence of pulp vitality on the EPT test was considered the success (effectiveness) of that specific treatment. A chi-square test was applied for the comparison of outcome variables.
Results: The mean age was 24.69 (±4.95) years, with a range from 18 to 40 years. The females were 36 (45.0%), and the males were 44 (55.0%). The frequency of moderate pain was higher in MTA (n=5, 12.5%) than Biodentine (n=2, 5%), but the results were not statistically significant (p=0.49). Similarly, the efficacy of pulp capping (p=0.51) and pulp vitality (p=0.709) was not statistically

different between the two groups.
Conclusion: There is no difference between Biodentine and MTA in pain, pulp efficacy, and pulp vitality. No association was found with age group, gender, diabetes, and smoking.

Keywords: Biodentine, mineral trioxide aggregate, pulp vitality

Introduction:

Pulp exposure resulting from caries, trauma, or tooth preparation can lead to pain and infection, often necessitating extraction or root canal therapy. However, a more conservative approach, direct pulp capping, aims to preserve pulp vitality and avoid extensive treatment. This minimally invasive procedure is employed when a small pulp exposure occurs due to caries, trauma, or during tooth preparation (1). The fundamental principle involves applying a biocompatible material directly over the exposed pulp tissue, forming a protective barrier against bacterial infiltration and noxious stimuli, facilitating natural healing, and promoting reparative dentin formation.

The selection of an appropriate pulp capping material is crucial for the success of the procedure. The material must exhibit biocompatibility, antibacterial activity, the ability to stimulate pulp cell proliferation, and excellent sealing capability (2). Various materials have been used for pulp capping, including calcium hydroxide, hydrophilic resins, resin-modified glass ionomer cement, mineral trioxide aggregate (MTA), and Biodentine.

MTA is a bioactive, biocompatible material with antibacterial properties and excellent sealing ability, promoting pulp cell proliferation and reparative dentin formation. However, its drawbacks include a long setting time, poor handling properties, and high cost. Despite these limitations, MTA has demonstrated reliability for direct pulp capping, particularly in carious exposures managed with a two-visit treatment protocol (3). In contrast, Biodentine, a newer calcium-silicate-based material, offers advantages such as pulp tissue regeneration, a shorter setting time, and direct application without preconditioning (4). Studies indicate that inflammation in deep carious lesions may remain reversible, allowing for pulp healing and the preservation of tooth vitality when treated with direct pulp capping (5).

Comparative studies between MTA and Biodentine have yielded mixed results. Sajid et al.. found MTA to be more effective than calcium hydroxide (6), while Cuadros-Fernández et al.. reported that both MTA and Biodentine were equally effective in pulpotomies for children (7). Similarly, Katge and Patil demonstrated the effectiveness of both materials in permanent first molars (8). However, Shaista observed a 91.7% success rate for MTA compared to 83.3% for Biodentine (5). These findings suggest that while both materials are effective, MTA may offer a slightly higher success rate.

Beyond pulp capping, indirect composite restorations provide advantages for extensive posterior restorations (9). Following endodontic treatment, the absence of nutritive pulp support weakens the dentin protein framework, potentially leading to early bond failure with conventional adhesive

techniques (9). Direct composite restorations in large cavities may pose challenges in achieving proper proximal contacts and complete polymerization, which can result in functional and esthetic limitations. Despite these challenges, resin composite materials, especially those incorporating short fibres as fillers, are preferred for direct restorations due to their superior mechanical properties compared to conventional particulate filler composites (10). Conversely, indirect restorations offer improved control over cervical margins, anatomical form, marginal integrity, and occlusion, reducing postoperative sensitivity. Additionally, bioceramic cements provide biocompatibility and bioactivity, facilitating tissue healing and pulp regeneration (11).

Clinical studies comparing MTA and Biodentine for direct pulp capping highlight the importance of material selection in achieving successful outcomes. Some studies report MTA's superiority over calcium hydroxide (6), while others indicate no significant difference between MTA and Biodentine in pulpotomies for children (7). Additionally, Nowicka et al.. found that both materials elicit favourable histological responses in human pulp, reinforcing their viability for pulp capping procedures (4). These varying findings underscore the need for further research to determine the optimal material for specific clinical scenarios. Selecting the right biomaterial can prevent the need for costly and invasive root canal treatments, reinforcing the significance of MTA and Biodentine in direct pulp capping procedures.

Material and Methods:

This study was conducted on patients referred to the Department of Operative Dentistry and Endodontics, Rehman College of Dentistry, Rehman Medical Institute, Peshawar, from January 2022 to January 2023. Before data collection, approval was obtained from the Institutional Ethical Review Committee of Rehman College of Dentistry, Rehman Medical Institute. Informed written consent was acquired from all selected participants using a pre-designed consent form. Teeth meeting the inclusion and exclusion criteria were enrolled in the study and assigned to two groups: Group 1 (MTA group) and Group 2 (Biodentine group), using a consecutive non-probability sampling technique. All selected teeth were mechanically cleaned and disinfected using a 0.2% chlorhexidine solution. Local anaesthesia was administered with 1:100,000 lignocaine hydrochloride with adrenaline, followed by isolation with a rubber dam. Caries removal, including soft caries, was performed using a tungsten carbide fissure bur in a slow-speed handpiece. In cases where accidental pulp exposure occurred during caries excavation, hemostasis was achieved using a cotton pellet moistened with saline. In Group 1, once hemostasis was established within 2 to 10 minutes, a 2 mm thickness of mineral trioxide aggregate (MTA) was placed over the exposure site, followed by a moist cotton pellet. As MTA requires 24 hours for complete setting, the cavity was temporarily sealed with zinc phosphate cement. In Group 2, after achieving hemostasis, the exposed pulp site was capped with Biodentine. The cavity was then sealed temporarily in the same manner using zinc phosphate cement. All patients were recalled for follow-up after three weeks. Subjective pain was assessed using a Visual Analogue Scale (VAS), and pulp vitality was evaluated using an electric pulp test (EPT). The absence of pain and the

presence of a positive response to EPT were considered indicators of treatment success (effectiveness). Teeth were subsequently restored permanently with composite resin during the same visit.

Results:

The mean age of participants was 24.69 ± 4.95 years, with an age range of 18 to 40 years. Among the total sample, 18 (45.0%) were female, and 22 (55.0%) were male, distributed across both groups. In the Biodentine group, diabetes mellitus was present in 7 participants (17.5%), while in the MTA group, it was observed in 4 participants (10%). The habit of smoking was reported in 5 individuals (12.5%) in the Biodentine group and 6 individuals (15%) in the MTA group (Table 1).The frequency of moderate pain was higher in the MTA group (n = 5, 12.5%) compared to the Biodentine group (n = 2, 5%); however, the difference was not statistically significant (p = 0.49). Similarly, no statistically significant differences were observed between the two groups in terms of the efficacy of pulp capping (p = 0.51) or pulp vitality (p = 0.709) (Table 2). Further comparison of pain intensity, the efficacy of pulp capping, and pulp vitality between Biodentine and MTA across stratified age groups revealed no statistically significant differences for any of the three variables. Likewise, gender-based stratification demonstrated no statistically significant differences in pain, efficacy of pulp capping, or pulp vitality outcomes between the two groups. In both diabetic and non-diabetic patients, the differences in pain, pulp capping efficacy, and pulp vitality between the Biodentine and MTA groups were not statistically significant (p > 0.05) (Table 3). Similarly, smoking status did not significantly affect the outcomes; among both smokers and non-smokers, differences in pain, efficacy of pulp capping, and pulp vitality were also not statistically significant (p > 0.05) (Table 4).

Figure 01: Outcome Findings Comparison Between Biodentine and MTA

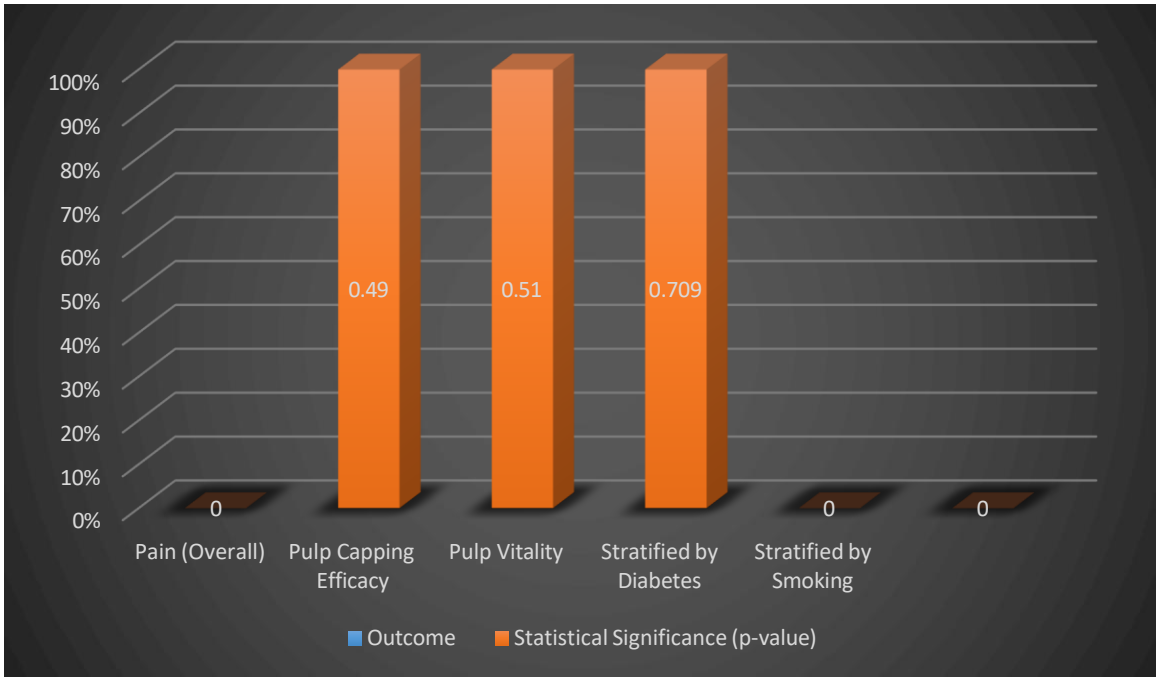

Table 1: Frequency of smoking and diabetes among MTA and Biodentine

Variable	Characteristic	Biodentine, n = 40	MTA, n = 40
Diabetes	absent	33 (82.50)	36 (90.00)
	present	7 (17.50)	4 (10.00)
Smoking	absent	35 (87.50)	34 (85.00)
	present	5 (12.50)	6 (15.00)

There was a higher occurrence of moderate pain reported by patients in the MTA group (n = 5, 12.5%) compared to the Biodentine group (n = 2, 5%); yet the results were not statistically different (p = 0.49). The comparison of pulp capping success and pulp vitality between MTA and Biodentine treatment yielded statistically equal outcomes (p = 0.51 and p = 0.709 respectively) per Table 2 findings.

Table 2: Comparison of pain, efficacy of pulp capping, and pulp vitality between Biodentine and MTA

Characteristic	Biodentine, n = 40[1]	MTA, n = 40[1]	p-value[*]
Pain			0.49
Absent	36 (90.00)	33 (82.50)	
Moderate	2 (5.00)	5 (12.50)	
Worst	2 (5.00)	2 (5.00)	
Efficacy			0.51
Absent	4 (10.00)	7 (17.50)	
Present	36 (90.00)	33 (82.50)	
Pulp vitality			0.709
Absent	3 (7.50)	5 (12.50)	
Present	37 (92.50)	35 (87.50)	

Pulp vitality assessments alongside capping success rates and pain severity evaluation produced equivalent results when measuring Biodentine and MTA against each other within demographically

grouped patients. The results from both gender-based stratification tests showed no significant differences between study groups regarding pulp vitality, the effectiveness of pulp capping, and pain experience. This clinical trial indicated that patient pain, together with both pulp capping success and vitality assessment, demonstrated no statistically meaningful differences between Biodentine and MTA treatment groups either for diabetic patients or non-diabetic patients ($p > 0.05$) (Table 3).

Table 3: Comparison of pain, efficacy of pulp capping, and pulp vitality between Biodentine and MTA stratified by diabetes

Diabetes status	Characteristic	Biodentine	MTA	p-value*
Non-diabetic	**Pain**			0.78
	absent	29 (87.88)	30 (83.33)	
	moderate	2 (6.06)	4 (11.11)	
	worst	2 (6.06)	2 (5.56)	
	Efficacy			0.79
	absent	4 (12.12)	6 (16.67)	
	present	29 (87.88)	30 (83.33)	
	Pulp vitality			0.45
	absent	2 (6.06)	5 (13.89)	
	present	31 (93.94)	31 (86.11)	
Diabetic	**Pain**			-
	absent	7 (100.00)	4 (100.00)	
	Efficacy			-
	present	7 (100.00)	4 (100.00)	
	Pulp vitality			>0.9
	absent	1 (14.29)	0 (0.00)	
	present	6 (85.71)	4 (100.00)	

The Study outcomes exhibited no substantial differences based on smoking status because both smokers and non-smokers matched in their pain levels and pulp vitality and pulp capping success (Table 4).

Table 4: Comparison of pain, efficacy of pulp capping, and pulp vitality between Biodentine and MTA stratified by smoking

Smoking status	Characteristic	Biodentine	MTA	p-value*
Non-smoker	**Pain**			0.9
	Absent	31 (88.57)	31 (91.18)	
	moderate	2 (5.71)	2 (5.88)	
	worst	2 (5.71)	1 (2.94)	
	Efficacy			>0.9
	absent	4 (11.43)	3 (8.82)	
	present	31 (88.57)	31 (91.18)	
	Pulp vitality			0.591
	absent	2 (5.71)	4 (11.76)	
	present	33 (94.29)	30 (88.24)	
Smoker	**Pain**			0.22
	absent	5 (100.00)	3 (50.00)	
	moderate	0 (0.00)	2 (33.33)	
	worst	0 (0.00)	1 (16.67)	
	Efficacy			0.21
	absent	0 (0.00)	3 (50.00)	
	present	5 (100.00)	3 (50.00)	
	Pulp vitality			>0.9
	absent	1 (20.00)	1 (16.67)	
	present	4 (80.00)	5 (83.33)	

Discussion:

This study aimed to compare the effectiveness of Mineral Trioxide Aggregate (MTA) and Biodentine in direct pulp capping (DPC) among patients presenting to Rehman College of Dentistry, Peshawar. The findings revealed no statistically significant differences between Biodentine and MTA in terms of pain, pulp capping efficacy, or pulp vitality. Pulp exposure may result from trauma, mechanical factors, or dental caries(8). Direct pulp capping is a conservative treatment approach intended to preserve the vitality of the dental pulp and prevent pulpal necrosis (9). An ideal pulp capping material should sustain pulpal vitality and stimulate the formation of reparative dentin (10). Both MTA and Biodentine are tricalcium silicate-based cements recognized for their bioactivity and biocompatibility. Their antibacterial properties, high compressive strength, strong adhesion to tooth structure, and ability to

promote reparative dentin formation make them excellent candidates for vital pulp therapy (11). Although relatively recent additions to restorative dentistry, both MTA and Biodentine have been extensively studied. Katge and Patil compared their effectiveness in direct pulp capping of permanent first molars in children and reported a 100% success rate for both materials. A more recent study by Shaista also compared MTA and Biodentine for DPC procedures, reporting an efficacy rate of 91.7% for MTA and 83.3% for Biodentine (12). Similarly, a study by Abuelniel et al.. (13) assessed the clinical and radiographic outcomes of MTA and Biodentine as pulpotomy agents in traumatized immature anterior permanent teeth. While no statistically significant differences were noted between the two materials across most clinical parameters, tooth discoloration was significantly more prevalent in the MTA group ($p < 0.001$). These findings align with the present study, with the exception that the current research excluded traumatized teeth. A randomized controlled trial by Nowicka et al.. (14) demonstrated similar inflammatory responses and dentin bridge formation in human dental pulp when capped with either MTA or Biodentine. However, Biodentine showed a faster setting time, making it a more convenient clinical option. Another study by Koubi et al. (15) supported this, noting that Biodentine can be applied in a single visit due to its shorter setting time, whereas MTA typically requires a two-visit protocol. In pediatric cases, a systematic review by Mente et al. (16) compared the success rates of different pulp capping materials and found that MTA had a slightly higher long-term success rate than Biodentine. However, a clinical study by Tran et al. (17) reported that both materials exhibited similar success rates when used in young permanent teeth, with no significant differences in patient-reported pain scores or pulp survival rates. Recent evidence also suggests that Biodentine may offer superior handling properties and ease of use compared to MTA. A study by Meraji and Camilleri (18) found that Biodentine demonstrated lower solubility and better sealing ability than MTA. In contrast, MTA has been associated with tooth discoloration, which can be a concern in esthetically sensitive areas (19). Further studies have continued to evaluate the performance of these materials. A randomized clinical trial by Çelik et al. (20) compared the outcomes of DPC using calcium hydroxide, MTA, and Biodentine in young permanent teeth with carious exposures and found no significant difference between MTA and Biodentine, both outperforming calcium hydroxide.

Conclusion:

Within the limitations of this study, it can be concluded that there is no significant difference between Biodentine and Mineral Trioxide Aggregate (MTA) in terms of postoperative pain, pulp capping efficacy, and pulp vitality when used for direct pulp capping. Furthermore, no statistically significant associations were observed between treatment outcomes and patient-related variables such as age group, gender, diabetic status, or smoking habits. These findings suggest that both Biodentine and MTA are equally effective options for vital pulp therapy across diverse patient subgroups. However, larger-scale studies with longer follow-up periods are recommended to further validate these outcomes and explore any long-term clinical differences between the two materials.

Disclaimer: **Nil**

Conflict of Interest: **Nil**

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