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RESEARCH ARTICLE
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ANALYSING THE EFFICACY OF MINERAL TRIOXIDE AGGREGATE VERSUS DENTINE AS DIRECT PULP CAPPING AGENTS IN PERMANENT TEETH WITH SEVERE CARIOUS LESIONS

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ABSTRACT

Background: MTA is bioactive, biocompatible, antibacterial, and has excellent sealing ability, promoting pulp cell proliferation and reparative dentin formation. Despite its long setting time, poor hold properties, and high cost, MTA has proven reliable for direct pulp capping in carious exposures when using a two-visit treatment protocol. **Objective**: To evaluate the efficiency of Mineral Trioxide, aggregate & bio-dentine in direct pulp capping of patients reporting to Frontier Medical and Dental College. **Methodology**: Total of 80 subjects were divided randomly into two groups i.e. of Mineral Trioxide aggregate and Biodentine. Patients aged 18-40 years, both genders, with deep carious lesions, symptoms of reversible pulpitis, 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 VAS scale. Pulp vitality was assessed by EPT test. Absence of subjective pain and presence of pulp vitality on EPT test was considered success (effectiveness) of that specific treatment. Chi-square test was applied for a 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 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 different statistically 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 from caries, trauma, or tooth preparation can lead to pain & infection, often requiring removal of culprit tooth or root canal therapy. An alternative to more extensive treatment is pulp capping, which aims to preserve pulp vitality. Direct pulp capping involves placing biocompatible materials over exposed pulp to protect it from bacteria and harmful stimuli to maintain pulp health. Choosing the right self-healing, biocompatible material is essential for success. Materials used for pulp capping include calcium hydroxide, hydrophilic resins, resin-modified glass ionomer cement, mineral trioxide aggregate (MTA), and Biodentine.

MTA is bioactive, biocompatible, antibacterial, and has excellent sealing ability, promoting pulp cell proliferation and reparative dentin formation. Despite its long setting time, poor handling properties, and high cost, MTA has proven reliable for direct pulp capping in carious exposures when using a two-visit treatment protocol[(1)]. Biodentine, a newer calcium-silicate-based material, stimulates pulp tissue regeneration, has a shorter setting time, and can be applied directly without preconditioning[(2)]. Studies show that pulp inflammation in deep caries may remain reversible, allowing for pulp healing if they are treated with direct pulp capping, preserving tooth vitality [(3)]. Recent studies have compared MTA and Biodentine for direct pulp capping. A clinical trial by Sajid et al. found MTA to be more effective than calcium hydroxide [(4)] while Cuadros-Fernandez et al found MTA and Biodentine equally effective in pulpotomies for children. [(5)] . A study by Katge et al showed both materials are effective in permanent first molars[(6)]. However, a study by Shaista et al found MTA effective in 91.7% of cases, compared to Biodentine's 83.3% effectiveness[(7)]. Despite mixed reviews, the preference of material plays a crucial part in the success of direct pulp capping, making it vital to select the right biomaterial to avoid costly and painful root canal treatment.

MATERIAL AND METHODS

This current study was conducted on patients consulted to the Department of Operative Dentistry and Endodontics, Frontier Medical and Dental College. Before data collection, approval was obtained from the Institutional Ethical Review Committee. 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 clusters: Cluster 1 (MTA group) and Cluster 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 anesthesia 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 Cluster 1, once hemostasis was established within 2 to 10 minutes, a 2mm thickness of mineral trioxide aggregate (MTA) was placed over the exposure site, followed by a moist cotton pellet. As MTA requires a day for complete setting, the cavity was temporarily sealed with zinc phosphate cement. In Cluster 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 18-40 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).

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

Variable	Characteristic	Biodentine	MTA
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)

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).

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

Characteristic	Biodentine	MTA	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)	

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).

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)	

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).

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 current researech study aimed to evaluate the efficiency of Mineral Trioxide Aggregate (MTA) and Biodentine in direct pulp capping (DPC) among patients presenting to FMDC. The findings revealed no statistically significant differences amongst Biodentine and MTA in terms of pain, pulp capping efficacy, or pulp vitality.

Pulp exposure may result from trauma, mechanical factors, or dental caries. Direct pulp capping is a conservative treatment approach intended to orbit the vitality of the dental pulp and prevent pulpal necrosis.[8] An ideal pulp capping material should sustain pulpal vitality and stimulate the formation of reparative dentin.[9] Both MTA and Biodentine are tricalcium silicate-based cement recognized for their bioactivity and biocompatibility. Their antibacterial properties, high compressive strength, strong adhesion to the tooth structure, and ability to promote reparative dentin formation make them excellent candidates for vital pulp therapy.[10]

Although relatively recent additions to restorative dentistry, both MTA & Biodentine have been extensively studied. Katge A.F. et al.[11] compared their effectiveness in direct pulp capping of permanent first molars in children and reported 100% success for both materials. A more recent study by Shaista et al.[7] also compared MTA and Biodentine for DPC procedures, reporting an efficacy rate of 91.7% for MTA and 83.3% for Biodentine. Similarly, a study by Abuelniel et al.[12] assessed the clinical and radiographic outcomes of MTA & Biodentine as pulpotomy agents in traumatized immature anterior permanent teeth with pulp exposure. 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 are in line with the present study, with the exception that the current research excluded traumatized teeth.

CONCLUSION

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.

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