

COMPARISON OF EFFECTIVENESS OF MINERAL TRIOXIDE AGGREGATE (MTA) AND CALCIUM HYDROXIDE AS DIRECT PULP CAPPING MATERIALS

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ABSTRACT

Preservation of pulp vitality is an important objective in endodontics. Placement of a medicament or material against a direct pulpal exposure during caries excavation is known as direct pulp capping. The reluctance to place a direct pulp cap on an exposure in a carious field is based on unpredictable outcomes using traditional materials and treatment protocols. Mineral trioxide aggregate and Calcium Hydroxide are direct pulp capping agents. The objective of this study was to compare the effectiveness of mineral trioxide aggregate and calcium hydroxide for direct pulp capping in human permanent mandibular molars clinically and radiographically. Sample size was 60 cases. They were divided in two groups, 30 in Group A, 26 patients showed complete absence of objective and subjective pain while in Group B, all patients showed complete absence of objective and subjective pain. Data analysis also revealed significant differences between Group A and B for age, gender, tooth type and absence of lesion. The results showed that 79% success rate was seen in Group A and 100% success rate was seen in Group B. Conclusion was that MTA was found better for direct pulp capping material as evaluated by the qualitative comparison of MTA and Ca (OH)₂.

Key Words: Direct pulp capping (DPC), mineral trioxide aggregate (MTA), calcium hydroxide (CaOH).

INTRODUCTION

Preservation and maintenance of pulpal vitality is one objective in endodontics. Historically, the placement of a medicament or material against a direct pulpal exposure during caries excavation was controversial, and instead conventional endodontic therapy was recommended.^{1,2,3} The reluctance to place a direct pulp cap on an exposure in a carious field was based on unpredictable outcomes using traditional materials and treatment protocols. To date, researchers have been unable to identify a reliable non-resorbable bioactive

pulp capping material that consistently stimulates cellular repair mechanisms, seals the dentin and promotes formation of a biologically stable reparative dentin bridge. Success rates with direct pulp capping in a carious field varied depending on the technique and materials used. In humans, success rates ranged from 30 to 85 percent in two to 10 year retrospective studies.^{2,4,5}

Clinicians have used many materials and techniques for direct pulp capping, including CaOH, hydrophilic resins, resin modified glass ionomer cements, tricalcium phosphates and, more recently, mineral trioxide aggregate (MTA).⁴

Calcium hydroxide — once considered the standard for pulp-capping material — provides an option for reparative dentin formation, but long term studies have shown results were variable and somewhat unpredictable.⁴ The material does not provide close adaptation to dentin, does not promote consistent odontoblast differentiation and has been shown to be cytotoxic in cell cultures; the resultant reparative dentin formation can be characterized by tunnel defects.^{6,7} Tunnel defects within dentin bridges may provide a pathway for the

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penetration of microorganisms to activate circulating immune cells, induce pulpal irritation and produce subsequent dystrophic calcification.⁶

In 1995 Mineral Trioxide Aggregate (MTA) was introduced as direct pulp capping agent in Loma Lind University. Mineral trioxide aggregate has very high pH 12.5, great sealing ability, prevent bacterial penetration, inert and undissolvable.⁴ MTA is a bioactive silicate cement that has been shown to be an effective pulp-capping material in canine models and in nonhuman primates.^{8,9} The material is successful because of its small particle size, sealing ability, alkaline pH when set and slow release of calcium ions.¹⁰ Investigators have reported that MTA induces pulpal cell proliferation,^{11,12} cytokine release,¹³ hard tissue formation⁷ and the synthesis of an interface with dentin that resembles hydroxyapatite in composition.¹³ The material is nonabsorbable, sets in the presence of moisture, has a relatively high compressive strength and has a sustained high alkaline pH.¹⁴ Recent studies examining partial pulpotomies or direct pulp capping using MTA in humans have shown favorable short-term results.¹⁵

The objective of this study was: to compare the effectiveness of MTA and CaOH for direct pulp capping in human permanent mandibular molars clinically and radiographically.

METHODOLOGY

Patients were selected according to randomization in the Department of Operative Dentistry, Multan Medical and Dental College, Multan. Sample size was 60-30 cases in each group was calculated with 80% power of test, 3.5% margin of error and taking expected percentage of success i.e 100% in mineral trioxide aggregate group and 79.4% in calcium hydroxide group after 3 months of pulp capping. Patients were selected having age 15-40 years with exposure of vital pulp by caries / Trauma in permanent mandibular molars clinically. Pulpal exposure was pin point clinically. Bleeding was controllable at exposure site in 2 to 10 minutes with no visible caries around the exposure site clinically. Patients with presence of internal resorption, apical/furcal radiolucency radiographically, history of irreversible pulpitis and presence of sinus tract / external fistula on clinical examination were excluded. Informed consent was obtained from patients. Teeth were anesthetized and isolated by rubber dam. Caries were removed with tungsten carbide fissure bur with slow speed hand piece. In order to remove caries completely, if pulp was exposed accidentally, bleeding from exposure site was controlled by cotton pellet soaked with saline. Then the patients were divided into two groups by random number to either group A (CaOH) or to group B (MTA).

In group A (n=30) after control of bleeding in 2 to 10 minutes, calcium hydroxide was placed in

creamy consistency on the exposure site. After hardening of calcium hydroxide, glass ionomer cement was placed on CaOH as a lining agent. After the setting of glass ionomer cement, cavity was filled with amalgam.

In group B (n=30) when bleeding was controlled in 2 to 10 minutes, mineral trioxide aggregate was used on the exposure site in thickness of 2mm and moist cotton placed on MTA. Mineral trioxide aggregate took 24 hours for complete setting so the cavity was sealed temporarily with zinc phosphate cement. After 24 hours zinc phosphate cement was removed and cavity filled with amalgam.

Post operative radiograph was taken immediately after the procedure. That was a base line radiograph to compare it with radiographs taken on follow up. On follow up after three months subjective and objective assessment of pain was checked on basis of history and clinical examination which included percussion in horizontal and vertical directions. Pain which patient felt post operatively till follow up is called subjective pain. Pain on percussion was the indication of objective pain. Vitality was assessed by thermal test. Absence of signs and symptoms of irreversible pulpitis was indication of success of treatment. Periapical radiolucency of tooth was assessed on the radiograph taken at third month.

Material for direct pulp capping was considered successful if there was no pain subjectively and objectively on history and percussion respectively and tooth was vital by thermal test with no periapical radiolucency. All this information was recorded in pre-designed proforma. Data were entered in SPSS version 17.0. The variables were patient's age, gender and effectiveness. The comparison of effectiveness made using Chi-Square Test (X^2). P-value of 0.05 or less was considered as significant.

RESULTS

Sixty teeth were treated in sixty patients. Thirty five patients were male (58.33%) and Twenty five patients were female (41.67%). The age of patients ranged between 15 to 40 years. Details of results can be seen in Table 1-4.

TABLE 1: COMPARISON OF EFFECTIVENESS BETWEEN GENDERS

Gender	Effectiveness of material		
	CaOH	MTA	Total
F	2	23	25
M	4	31	35
Total	6	54	60

TABLE 2:

P value	0.63
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TABLE 3: COMPARISON OF EFFECTIVENESS BETWEEN GROUPS

Effectiveness of material	Calcium hydroxide	Mineral trioxide aggregate	Total
No	6	0	6
Yes	24	30	54
Total	30	30	60

TABLE 4:

P value	0.01
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DISCUSSION

In direct pulp capping the exposed pulp was dressed with a medicament or dental material, with the specific aim of maintaining pulpal vitality and health. Direct pulp capping has been practiced for more than 200 years.¹⁶ Clinicians have used many materials and techniques for direct pulp capping, including CaOH, hydrophilic resins, resin modified glass ionomer cements, tricalcium phosphates and, more recently Mineral Trioxide Aggregate.¹⁶

Success rate of calcium hydroxide in direct pulp capping is 79.4%¹⁷ while that of mineral trioxide aggregate for direct pulp capping is 100%¹⁸ after 6 months follow up. Johannes Mente et al compared the clinical and radiographic evaluation of CaOH and MTA in direct capping. Difference of effectiveness in this study was same as in this study.¹⁹

Mineral trioxide aggregate has been introduced as a superior material for dental pulp capping. MTA is an endodontic biomaterial with superior sealing ability and biocompatibility.²⁰ This material is less cytotoxic than other conventional materials currently used in direct pulp capping.²⁰

An important aspect of pulp treatment is the issue of selecting biological pulp capping material that affects the remaining vital pulp.²¹ Current clinical practice abounds with studies demonstrating high success rates of Mineral trioxide aggregate (MTA) administered as pulp capping agent.²¹ MTA has been shown to induce less pulp inflammation and more dentine bridge formation when compared with CaOH cement.²²

The application of the capping material at the exposure site is very important for the practitioners. MTA needs wet environment following use as pulp capping material, whereas, placing Calcium Hydroxide at the exposure site as hard setting calcium hydroxide

agent is very difficult.²² Therefore, in addition to the histologic superiority of MTA as pulp capping material, the material is easier to use in comparison to Calcium Hydroxide for pulp capping. A previously published article confirmed this easier clinical application.²²

The main reasons for replacing CaOH with MTA in these situations have generally been the delayed effect when using CaOH.^{23,24} Several in vitro and in vivo studies have shown that MTA prevents microleakage, is biocompatible and nonresorbable, has low solubility and high comprehensive strength, and promotes tissue regeneration when it is placed in contact with dental pulp or periradicular tissues.²⁵ This may be the reason present study showed better effectiveness for Mineral Trioxide Aggregate than Calcium Hydroxide.

CONCLUSION

Based on the results of this study, it seems that when an exposure site is immediately sealed with MTA, the prognosis is promising. Although calcium hydroxide is also used as a direct pulp capping material it is unstable and can degrade and dissolve under restorations, allowing potential ingress of microorganisms and subsequent bacterial contamination through tunnel defects in the dentin bridge. These events can induce continued pulpal irritation, dystrophic calcification and potential degenerative changes in the pulp. Treatment time is also very much reduced in MTA. But long term clinical trials are needed to prove its efficacy.

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CONTRIBUTIONS BY AUTHORS

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| 1 Mustafa Sajid: | Main article writer and performed all the procedure. |
| 2 Jamil: | Supervised all the procedure and took part in discussion. |
| 3 Isma Sajjd: | Helped in methodology. |
| 4 Bader Munir: | Wrote introduction. |
| 5 Reema Kouser: | Helped in correcting the mistakes in reviewed article. |