



Pulpotomy of Immature Permanent Teeth using Two Different Sealing Materials: A Comparative Study

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ABSTRACT

Objective: To compare the outcome of pulpotomy of immature permanent teeth using calcium hydroxide (CH) and mineral trioxide aggregate (MTA) as sealing materials. **Methods:** This randomized controlled trial was carried out in the Department of Pediatric Dentistry, Punjab Dental Hospital, Lahore. Duration of the study was 9 months: 6 months data collection (February 01, 2016 to May 31, 2016, and August 01, 2016 to September 09, 2016) and 3 months follow up period (October 01, 2016 to December 31, 2016). Total of 110 patients was included in this study. They were divided into 2 groups; A and B, each comprising of 55 patients. All cases were treated by the same operative team. Conventional access cavity was formed and coronal pulp was removed to the cervical level using a sharp spoon excavator and a sterile round diamond bur. **Results:** There were 25 males (45.4%) and 30 females (54.6%) in calcium hydroxide group, while in the mineral trioxide aggregate group, there were 26 males (47.2%) and 29 females (52.8%) with a male to female ratios 1:1.2 and 1:1.1 respectively. The mean \pm SD ages were 8.93 ± 1.82 and 8.89 ± 1.97 years. Total 44 patients (80%) have success and 11 patients (20%) have a failure in calcium hydroxide group, while in mineral trioxide aggregate group, 48 patients (87.2%) have success and 7 patients (12.8%) have a failure. Statistically, there was no significant difference ($p > 0.05$) between the two groups. **Conclusion:** Mineral trioxide aggregate showed good clinical and radiographic success as a pulpotomy agent in immature permanent teeth and seems to be a suitable alternative to calcium hydroxide.

Keywords: Pulpotomy, Immature permanent teeth, Sealing material, Calcium hydroxide, Mineral trioxide aggregate

INTRODUCTION

Pulpotomy is a treatment of choice for traumatized or carious teeth with vital pulp and open apices, on pulp exposures [1-3]. The procedure is performed by amputating infected coronal pulp and covering the remaining with a sealing biomaterial to maintain its vitality and allow continued root formation [1,4,5]. The operative procedure and the sealing material both can influence the outcome of the therapy, however, the success of the treatment largely depends upon the properties of the sealing material because it not only protects the pulp against bacterial invasions but also influences the biological behavior of the pulp [5,6].

For decades calcium hydroxide (CH) has been the material of choice for use in vital pulp therapies and still it is the most frequently used one [1,3,5]. Meligy, et al., reported a success rate of 86.7% when CH was used as sealing material in pulpotomy of immature permanent teeth [1]. However, some studies show that there were shortcomings when using this material, such as superficial necrosis when placed in contact with vital pulp due to its high alkalinity (pH=12) and caustic effect, degradation over time and poor setting and sealing ability. Moreover, a dentinal bridge

formed beneath the CH layer has tunnel defects which act as pathways for bacterial leakage and inflammatory changes of the pulp [4,7].

Mineral trioxide aggregate (MTA) is an alternate recommended for use in pulpotomy procedures due to its better sealing ability, marginal adaptation and biocompatibility and in comparison with CH it showed a success rate of 100% as reported by Meligy, et al., [1]. Histologic evaluation showed that MTA produces a thicker dentinal bridge, less inflammation, less hyperemia, and less pulpal necrosis when used in pulpotomy procedures. Teeth with carious pulp exposure can be treated successfully by MTA pulpotomy [8,9]. Unlike CH the calcified bridge formed by MTA is continuous and has no evidence of tunnel defects [3,4,7].

Literature shows highly variable success rate of pulpotomy using CH and MTA in different studies e.g. 86.7% for CH and 100% for MTA by Meligy, et al., 91% for CH and 93% for MTA by Witherspoon and 100% for CH and 90% for MTA by Aguilar, et al., [5,8]. The aim of the study was to search for any significant difference in the outcome of these 2 materials when used as pulpotomy agents in the local population, so that it may recommend one of them to get either cost-effectiveness or better efficacy.

PATIENTS AND METHODS

The randomized controlled trial was carried out in the Department of Pediatric Dentistry, Punjab Dental Hospital, Lahore. The duration of the study was 9 months: 6 months data collection (February 01, 2016 to May 31, 2016, and August 01, 2016 to September 09, 2016) and 3 months follow up period (October 01, 2016 to December 31, 2016). The sample size of 110 cases was divided into 2 groups; 55 cases in each group, was calculated with 5% level of significance, 80% power of the test and taking an expected percentage of success of pulpotomy treatment 86.7% and 100% in CH and MTA groups, respectively [10]. Sampling technique was non-probability purposive sampling.

Data Collection Procedure

Patients meeting the inclusion criteria were selected from the Out Patient Department (OPD) of Operative Dentistry, Punjab Dental Hospital Lahore and approval of the ethical committee were sought before implementing the clinical procedures. All subjects and accompanying parents were informed of the aim of the treatment and the clinical results expected, as well as the advantages and disadvantages, and informed consent was obtained from the parents. After recording demographic, clinical and radiographic findings of the patients, they were divided randomly into 2 groups; A and B, each comprising of 55 patients, using a random number table. All cases were treated by the same operative team. Conventional access cavity was formed and coronal pulp was removed to the cervical level using a sharp spoon excavator and a sterile round diamond bur. CH (Calcium Hydroxide USP, Pulpdent USA) and MTA (ProRoot-MTA, Dentsply Tulsa, USA) was mixed according to the manufacturer's instructions to make a thick paste. After controlling the bleeding 1-2 mm thick layer of CH and MTA, in Group A and B respectively, were used to cover the exposed surface of the radicular pulp, and finally, coronal restoration was done following the standard protocols. The outcome of the treatment was evaluated after 3 months of completion of the treatment as per the operational definition and findings were recorded in the performance.

Inclusion Criteria

- Pediatric patients of both genders in an age range of 6-12 years with any immature permanent tooth with two third or more of root completion but with open apical foramen will be considered immature and assessed by periapical radiograph [11]
- Teeth with traumatic or carious pulp exposure presenting with reversible pulpitis i.e. no spontaneous signs and symptoms but provoked pain of short duration on clinical examination when hot or cold stimulus will be applied, and pain relieved upon the removal of stimulus [3,8,12]

Exclusion Criteria

- Teeth exhibiting signs and symptoms of irreversible pulpitis or necrosis i.e. spontaneous unprovoked pain, a sinus tract, pain on percussion and periapical radiolucency, assessed by history, clinical examination and periapical radiograph [10]
- Mentally retarded and uncooperative patients who will refuse or hamper the proceedings of the operative procedure

Data Analysis

All collected data was entered in statistical package for social sciences (SPSS) version 14 and the results were analyzed. The quantitative data that is age was presented as mean \pm standard deviation. The qualitative variables like gender and outcome of treatment i.e. success and failure were presented as frequencies and percentages. Chi-Square test was used to test the significance of the difference of success between the two groups, $p \leq 0.05$ was considered significant.

RESULTS

The study was carried out over a period of 9 months. Total 110 patients were included and they were divided into 2 groups. Group A treated with calcium hydroxide (CH) and group B treated with mineral trioxide aggregate (MTA) as sealing materials.

According to genders, there were 25 males (45.4%) and 30 females (54.6%) in calcium hydroxide group, while in the mineral trioxide aggregate group, there were 26 males (47.2%) and 29 females (52.8%). Male to female ratios were 1:1.2 and 1:1.1 respectively (Table 1).

Table 1 Frequency and percentage of genders in both groups (n=110)

Gender	Calcium hydroxide (n=55)		Mineral trioxide aggregate (n=55)	
	No.	%	No.	%
Male	25	45.4%	26	47.2%
Female	30	54.6%	29	52.8%
Male to female ratio	1:1.2		1:1.1	

According to age, there were 23 patients (41.8%) in the age group 6-8 years, 18 patients (32.7%) in the age group 9-10 years and 14 (25.5%) in the age group 11-12 years in calcium hydroxide group. While in the mineral trioxide aggregate group, there were 23 patients (41.8%) in the age group 6-8 years, 18 patients (32.7%) in the age group 9-10 years and 14 patients (25.5%) in the age group 11-12 years. The mean \pm SD ages were 8.93 ± 1.82 and 8.89 ± 1.97 years respectively (Table 2).

Table 2 Frequency and percentage of age in both groups (n=110)

Age (years)	Calcium hydroxide (n=55)		Mineral trioxide aggregate (n=55)	
	No.	%	No.	%
6-8	23	41.8%	23	41.8%
9-10	18	32.7%	18	32.7%
11-12	14	25.5%	14	25.5%
Mean \pm SD	8.93 ± 1.82		8.89 ± 1.97	

Table 3 showed the outcome of success or failure of patients, 44 patients (80%) have success and 11 patients (20%) have a failure in the calcium hydroxide group, while in mineral trioxide aggregate group, 48 patients (87.2%) have success and 7 patients (12.8%) have a failure. Statistically, there was no significant difference ($p > 0.05$) between the 2 groups.

Table 3 Frequency and percentage of outcome in both groups (n=110)

Outcome	Calcium hydroxide (n=55)		Mineral trioxide aggregate (n=55)	
	No.	%	No.	%
Success	44	80.0%	48	87.2%
Failure	11	20.0%	7	12.8%

DISCUSSION

Pulpotomy is an effective treatment for infected (as a result of the carious process) or mechanically exposed vital pulps in primary and immature permanent teeth [13,14]. Due to its high success rate, it is an acceptable clinical technique for treating inflammation of coronal pulp. Treatment usually consists of removal of coronal pulp followed by application of medicament such as mineral trioxide aggregate, formoterol, calcium hydroxide, ferric sulfate, glutaraldehyde and then final restoration [13].

This study examined the clinical and radiographic outcome of permanent tooth pulpotomies with mineral trioxide

aggregate (MTA), a material with evidence-based success in many endodontic procedures, as compared to calcium hydroxide (CH). Several *in vitro* and *in vivo* studies have shown that MTA prevents microleakage, is biocompatible and non-resorbable, has low solubility and high comprehensive strength, and promotes tissue regeneration when it is placed in contact with dental pulp or periradicular tissues [15,16]. However, using MTA as a pulpotomy agent is somewhat expensive. One suggestion to improve the cost-effectiveness of using MTA is to carefully store unused portions of the powder from an opened packet in sterilized empty film canisters to keep it fresh and prevent hydration [17].

Calcium hydroxide was selected as the control pulpotomy agent because it is currently considered the standard therapeutic agent for apexogenesis procedures in immature permanent teeth. Calcium hydroxide has a long and proven record as an effective pulp therapy agent, including pulpotomies, and it is not expensive. On the other hand, calcium hydroxide has high solubility and low strength. Calcium hydroxide has been reported to produce more inflammation and lower quality bridge formation, when compared with MTA in monkeys and dogs [18,19]. Similar results were found when human third molars were used to compare the effect of pulp capping with MTA and Calcium hydroxide [20].

Mineral trioxide aggregate prevents microleakage, is biocompatible, and promotes regeneration of the original tissues when it is placed in contact with the dental pulp [21]. Several *in vivo* studies have reported excellent results when using MTA as pulp dressing agent for human permanent or primary dentition [22,23]. A recent long-term study on primary molars demonstrated favorable biologic response after pulpotomy with both gray and white MTA during 7-year follow-ups [24].

This trial is designed to compare the clinical and radiographic outcome of pulpotomy with CH to MTA, in order to determine the effectiveness of this novel endodontic biomaterial (MTA). Several properties are necessary when choosing a pulp capping agent including sealing ability, antibacterial activity, and more importantly, dentinogenesis [25]. The favorable treatment outcome for CH in comparison with MTA in the present trial can be due to a compound of factors. This includes possible general factors, i.e. complete caries/bacteria removal as well as prevention of bacterial recontamination and specific factors, i.e. good sealing ability, antibacterial activity, hydroxyapatite formation, low cytotoxicity and induction of hard tissue formation [26-28].

Mineral trioxide aggregate pulpotomy has had a favorable success rate as it does not induce internal root resorption, which has been observed in teeth treated with calcium hydroxide [29]. However, MTA is prohibitively expensive for routine uses in clinical pediatric dentistry [21]. Calcium hydroxide has been introduced as an endodontic biomaterial that has similar biological features to MTA but reasonable price. There are as yet no reports of the arrest of internal resorption after vital pulp therapy. Recent reports showed that internal resorption had ceased, dentin formation had occurred and condensing apical periodontitis had healed as a result of pulpotomy with CH [30]. Besides, CH can be used as a pulp-capping agent in apexogenesis of immature teeth as well as management of external root resorption and regenerative endodontic treatment [30]. Surprisingly, recent randomized multicenter non-inferiority trials revealed that CH pulpotomy in comparison to root canal therapy in human permanent molars with established irreversible pulpitis had significantly greater pain-relieving effect initially, as well as higher radiographic success rates after 6-month follow-up [26].

In the present trial, (due to time and resource constraints) period of 3-months was used to evaluate the treatment outcome of pulpotomy with the two biomaterials. While many studies used the 6-month time interval, several other studies evaluated treatment outcomes at different time intervals, including up to 42 months [31,32]. Matsuo, et al., found that success rates were similar at 3 and 18 months follow-ups; they suggested that 3 months was adequate [33].

It is well established that healing of the dental pulp is directly related to the capacity of both the pulp dressing and definitive restorative material which should provide a biological seal against microleakage along the entire restoration interface. Overall, the teeth in the MTA group had more restorations as compared to the CH group. Despite this difference, the radiographic success in MTA at 3 months follow up was higher than the CH group. The good sealing ability of MTA may be responsible for this favorable result [27].

These results suggest that, although MTA and calcium hydroxide both are suitable for pulp capping agents in infected or mechanically exposed pulp, MTA is more biocompatible on pulp tissue than calcium hydroxide.

CONCLUSION

Based on this clinical and radiographic evaluation study at 3-months follow-up, although there is no statistically

significant difference between the outcome of the 2 groups, mineral trioxide aggregate pulpotomy still showed high success rate as compared to calcium hydroxide pulpotomy. So, along with the recommendation that mineral trioxide aggregate is a safe material for pulpotomy and could be a suitable substitute for calcium hydroxide, it is highly suggested that furthermore organized randomized controlled trials with larger sample size and longer follow up periods should be conducted to clarify the difference between the two materials.

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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