

SUCCESS RATE OF PULPOTOMY IN CARIOUSLY EXPOSED MATURE PERMANENT TEETH USING MINERAL TRIOXIDE AGGREGATE

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ABSTRACT

OBJECTIVES

This study aimed to determine the success rate of pulpotomy in cariously exposed mature permanent teeth using mineral trioxide aggregate.

METHODOLOGY

A cross-sectional study was conducted at the Department of Operative Dentistry, Ibn-e-Sina Hospital, Multan, over nine months from July 1, 2023, to March 31, 2024. A consecutive 114 patients with irreversible Pulpitis were enrolled after informed consent. Following rubber dam isolation and local anaesthesia, coronal caries and pulp were removed; hemostasis was achieved with 5.25% sodium hypochlorite (NaOCl). A 2-4 mm layer of mineral trioxide aggregate (MTA) was placed over canal orifices, followed by temporary CAVIT restoration. After 24 hours, definitive amalgam restoration was completed. Immediate and six-month postoperative radiographs were used to assess the periapical status. SPSS v25 was used for data analysis. Medians and interquartile ranges are reported for non-normal data, and frequencies and percentages are reported for categorical variables.

RESULTS

The median patient age was 30.5 years (IQR, 21-36); 55.3% were 30 years or older; and 50.9% were female. The median symptom duration was 2 days (IQR, 1-3). Right-sided (50.9%), maxillary (52.6%), and molar teeth (53.5%) predominated. Overall, MTA pulpotomy succeeded in 88.6% of cases. Stratified analysis demonstrated higher success in patients <30 years (96.1% vs. 82.5%, $p=0.036$), maxillary compared to mandibular teeth (95% vs. 81.5%, $p=0.036$), and those treated within 48 hours of symptom onset (100% vs. 68.3%, $p<0.01$).

CONCLUSION

Pulpotomy with MTA in adults presenting with recent irreversible Pulpitis yields high mid-term success, particularly in younger patients, maxillary teeth, and early interventions.

KEYWORDS: Pulpotomy, Mineral Trioxide Aggregate (MTA), Permanent Teeth, Dental Caries, Pulpitis

INTRODUCTION

Epidemiological studies indicate that dental caries is highly prevalent worldwide, especially in adults. This can lead to pulp necrosis, abscess formation, and ultimately, tooth loss if treatment is not received.¹ The radicular pulp does not get inflamed, but the coronal pulp does. Therefore, by resecting just the infected dental pulp tissue using a vital pulp therapy process, the cariously exposed pulps can be preserved.² vital pulp therapy aims to eliminate the tooth's symptoms while maintaining the tooth's functionality and vitality.³ According to a 2019 policy statement from the European Society of Endodontology, conservative vital pulp treatment may be beneficial for teeth without symptoms that have deep lesions and carious pulp exposures.⁴ One of the vital pulp therapies (VPT) is pulpotomy. It entails the coronal pulp being surgically removed.³ The proper

material is applied over the remaining vital radicular pulp. That substance promotes healing and shields the radicular pulp from additional harm.⁵ The substance ought to shield against bacterial invasion and encourage the growth of dentin tissue. Calcium hydroxide was the gold standard material in the past. However, research has shown that diminishing results are unpredictable and vary over time.⁶ Mineral trioxide aggregate (MTA) is resistant to dissolution and possesses sufficient structural integrity. Compared to calcium hydroxide, it produces a dentin bridge that is thicker, more uniform, and localised.⁷ Seventy-five individuals with curiously exposed adult permanent teeth, aged 15 to 26 years, were examined in a study by Shafi N et al. Ninety-two per cent of cases achieved success at the 6-month mark, and 69 of those cases showed no periapical radiolucency on the periapical radiograph.⁸ The clinical suitability of several MTA materials as partial pulpotomy materials in

permanent teeth (104 permanent teeth) was compared by Kang C et al. Up to a year after the procedure, partial pulpotomy maintained a higher success rate, with no discernible variations in results between the three MTA materials: Prorok MTA (96.0%), OrthoMTA (92.8%), and RetroMTA (96.0%).⁹ Region-specific studies are scarce in low-resource settings evaluating pulpotomy as a viable, cost-effective alternative. The current study aimed to determine the success rate of pulpotomy using MTA in patients with cariously exposed mature permanent teeth (irreversible Pulpitis), presenting in our local setting. This study aims to address the gap in local clinical data that supports the use of MTA pulpotomy as a conservative, tooth-preserving alternative to root canal treatment. Ultimately, the study results would promote the procedure of pulpotomy using MTA with confidence in the future. The preservation of teeth would improve the quality of life in the affected patients. The study results will offer a less invasive and more affordable treatment option compared to root canal therapy, especially beneficial in resource-constrained populations. This will also encourage early intervention and awareness among adults to preserve their natural teeth.

METHODOLOGY

This prospective observational study was conducted at the Department of Operative Dentistry, Ibn-e-Siena Hospital, Multan, following approval from the institutional ethics review committee (ERC# C-60-1010-01, dated June 13, 2023) over a period of nine months from July 1, 2023, to March 31, 2024. A total of 114 patients, 18-65 years of age, either male or female gender, with irreversible Pulpitis of ≤ 7 -days, American Society of Anesthesiologists (ASA) physical status I/II and able to understand Visual Analogue Scale (VAS) pain scoring were consecutively enrolled in the study after written informed consent (as per Declaration of Helsinki) for pulpotomy using mineral trioxide aggregate. Patients with known allergy or contraindication to the study drug were excluded. Irreversible Pulpitis was diagnosed in the presence of tooth sensitivity to percussion, a pain score of ≥ 4 on VAS, and an intraoral periapical X-ray showing discontinuity in the lamina dura and apical radiolucency. Age, gender, side of the face, jaw location, and type of affected tooth (premolar/molar) were recorded. The affected tooth was isolated using a rubber dam after administration of local anaesthesia. A slow-speed, large round bur was used to remove the caries. Coronal pulp up to the pulp chamber floor and orifices was removed using a high-speed round diamond bur. Haemorrhage control was achieved using cotton pellets damped in 5.25% NaOCl. A 2-4 mm thick film of mineral trioxide

aggregate (MTA) was laid down on root canal orifices and condensed with moistened cotton pellets. A temporary filling was achieved using zinc oxide cement (CAVIT, 3M, USA). After 24 hours, filling was removed, and the tooth restoration was done with amalgam. A reference radiograph was obtained immediately postoperatively. Patients were then called for follow-up six months later. The absence of periapical radiolucency on a radiograph obtained six months postoperatively was used to indicate the success of the procedure. A minimum sample size of 114 was calculated using the WHO sample size calculator, based on the one-proportion formula, with the following assumptions: a success rate of 92%, a 95% confidence level, and a 5% margin of error.⁸ SPSS version 25 was used for data analysis. Normality of numerical data was assessed through the Shapiro-Wilk test. Age and symptom, being non-normally distributed, are presented as median and interquartile range. Categorical data is presented as frequency and percentages. Confound and effect modification are controlled through stratification by patient characteristics, and stratified groups are compared using a chi-square test at a 5% significance level.

RESULTS

The median age of the patients was 30.5 (21-36) years, and 55.3% (n = 63) were 30 years of age or older. There were 50.9% (n = 58) female patients in the study. Median duration of symptoms was 2 (1-3) days. In 50.9% (n=58) of patients, the right side of the face, in 52.6% (n=60) of patients, the upper jaw, and in 53.5% (n=61) of patients, the molars were affected by irreversible Pulpitis [Table 1]. Pulpotomy using mineral trioxide aggregate was successful in 88.6% of the patients affected by irreversible Pulpitis due to caries [Fig. 1]. Success rate of pulpotomy was significantly higher in < 30-year-olds (96.1% vs. 82.5%, p-value = 0.036), upper jaw affected teeth (95% vs. 81.5%, p-value = 0.036), and in patients undergoing treatment within 48 hours of symptom onset (100% vs. 68.3%, p < 0.01) [Table 2].

Table 1: Characteristics of Patients Presenting With Irreversible pulpitis (N=114)

Age (years)	Median (IQR)	30.5 (21 - 36)
Age groups	< 30 years	51 (44.7)
	≥ 30 -years	63 (55.3)
Gender	Male	56 (49.1)
	Female	58 (50.9)
Symptoms duration (days)	-Median (IQR)	2.0 (1 - 3)
Laterality of face	Right	58 (50.9)
	Left	56 (49.1)
Jaw Position	Upper	60 (52.6)
	Lower	54 (47.4)
Tooth type	Premolars	53 (46.5)
	Molars	61 (53.5)

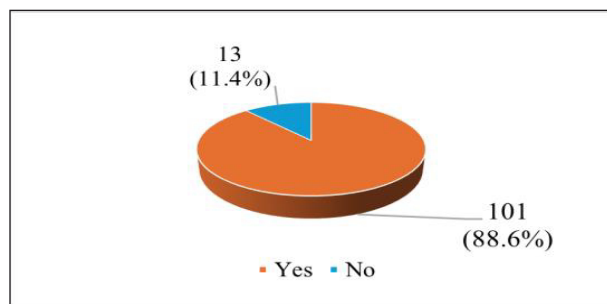


Figure 1: Success rate of pulpotomy in cariously exposed mature permanent teeth using mineral trioxide aggregate (N=114)

Table 2: Factors affecting the Success rate of pulpotomy in patients presenting irreversible pulpitis due to cariously exposed mature permanent teeth (N=114)

Associated Factors		Success of Pulpotomy		P-Value
		Yes	No	
Age Groups	< 30-years	49 (96.1)	02 (3.9)	0.036
	≥ 30-years	52 (82.5)	11 (17.5)	
Gender	Male	49 (87.5)	07 (12.5)	0.717
	Female	52 (89.7)	06 (10.3)	
Facial laterality	Right	48 (82.8)	10 (17.2)	0.075
	Left	53 (94.6)	03 (5.4)	
Jaw Position	Upper	57 (95)	03 (5)	0.036
	Lower	44 (81.5)	10 (18.5)	
Tooth type	Premolar	46 (86.8)	07 (13.2)	0.572
	Molar	55 (90.2)	06 (9.8)	
Symptoms duration	≤ 48-hours	73 (100)	0 (00)	< 0.001
	> 48 -hours	28 (68.3)	013 (31.7)	

chi-square test (Fischer's exact test where cell count < 5)

DISCUSSION

The preservation of pulpal health must be the primary objective when treating deep carious lesions, according to a 2015 collaboration meeting held in Leuven, Belgium.¹¹ In adults, the most frequent reason for pulp invasive procedures like root canal therapy is deep carious lesions. Traditionally, deep caries has been addressed with either total excision of the caries or, in cases of pulp exposure, with Root Canal Treatment (RCT).¹² Compared to pulpotomy, RCT is technically more involved and invasive, and it can have unfavourable effects such as tooth breakage, discolouration, and infection-causing vestigial periapical inflammation.¹³ According to data from epidemiological studies, failure rates of poorly executed RCTS ranged from 24% to 66%. RCT thereby shortens the lifespan of teeth that have had endodontic treatment, particularly molars.¹⁴ Preserving the vital pulp and providing a physiologically grounded concept that sustains the pulp's development, proprioception, and defensive capabilities is the primary goal of operatory dentistry. Additionally, by teaching less aggressive dentistry, overtreatment can be decreased and the "restoration cycle" shortened. This keeps the tooth structure intact and makes treatment more affordable.¹⁵ Preserving the tooth's vitality and

integrity is the primary goal of the pulpotomy. To preserve the vitality of the radicular pulp before it becomes non-vital and necessitates extraction and root canal treatment, pulpotomy is performed.¹⁶ MTA was used in the current investigation to perform a pulpotomy on a mature permanent tooth. Mineral trioxide aggregate (MTA) pulpotomy was successful in 88.6% of patients with caries-induced permanent Pulpitis. This result is consistent with an increasing amount of data that shows pulpotomy to be a good substitute for conventional RCT in these situations. Li et al. conducted a comprehensive study and meta-analysis to assess the effectiveness of pulpotomy in treating irreversible Pulpitis in adult permanent teeth. According to the survey, pulpotomy can be a successful treatment option in contrast to non-surgical root canal therapy (NSRCT), with a pooled clinical success rate of 92.9% and a radiographic success rate of 78.5%.¹⁷ In a study of 20 patients between the ages of 25 and 50, Hussain MI et al. examined the results of pulpotomy with MTA in 20 permanent mandibular third molar teeth with completely formed roots and identified irreversible Pulpitis. Overall, there was a 95% success rate at the end of the year, and 100% clinical and radiographic success was achieved at both three- and six-month follow-ups.¹⁸ The effectiveness of pulpotomy in adult permanent teeth with irreversible Pulpitis was also assessed in a systematic study performed by Zafar K et al. The possibility of pulpotomy as an alternative to RCT was further supported by the study, which comprised six studies and reported success rates ranging from 68% to 100%.¹⁹ The use of bioactive materials promotes odontoblast-like cell development. This promotes healing and lessens inflammation. The pulp cap material should provide a good marginal seal. Asgari et al examined the effects of pulpotomy with MTA and calcium-enriched mixture (CEM) cement in permanent molars with irreversible Pulpitis in a randomised clinical experiment. The study demonstrated excellent treatment outcomes, with clinical and radiographic success rates of 98% and 95% for MTA, respectively.²⁰ Additionally, Taha and Khazali's study assessed partial pulpotomy in adult permanent teeth that had clinical symptoms of irreversible Pulpitis. After a 2-year follow-up, the study discovered an 85% success rate for MTA, demonstrating the material's efficacy in these treatments.²¹ Case selection, operator expertise, and follow-up time are among the factors that contribute to the minor differences in success rates between studies. A study by Qudeimat et al. highlighted the significance of appropriate patient selection and technique, reporting a 100% success rate with MTA pulpotomy in permanent molar teeth showing signs of irreversible Pulpitis.²² Ninety bilateral primary molar teeth from forty-five healthy children aged 5 to 8 years were pulpotomized with Theriacal in one bilateral tooth and MTA in the other, at random, according to a study by Hassanpour S

et al. They discovered that the overall success rates for Theriacal and MTA, respectively, were 98.1% and 99.3% among the 82 teeth available at the last follow-up appointment.²³ In summary, the results of this study support the effectiveness of MTA pulpotomy in adult permanent teeth with irreversible Pulpitis and are in line with previous research. According to the excellent success rates documented in multiple studies, pulpotomy can be a dependable substitute for conventional RCT if it is carried out with the right case selection and technique. The strengths of our study included its prospective observational design, which reduced recall bias and enhanced the quality of data collection and internal validity. Pulpotomy was performed according to an established protocol that included follow-up radiographic evaluations, haemostatic protocol, and the use of MTA. Clear inclusion criteria and stratified analysis helped identify factors associated with better outcomes (age, tooth location, and early intervention).

LIMITATIONS

Assessing long-term success or failure, such as internal resorption or late periapical disease, may require a more extended follow-up period than six months. Because the study was limited to a single hospital, its findings cannot be applied to larger or more diverse populations, and generalizability may be limited to similar clinical settings and populations. Contextual comprehension of efficacy is limited when a reference group (such as root canal therapy or another pulpotomy material) is not available. Absence of a control group (e.g., calcium hydroxide or full pulpectomy) limited the ability to compare MTA's efficacy against alternative treatments.

CONCLUSIONS

Pulpotomy using MTA in mature permanent teeth with carious pulp exposure and recent irreversible Pulpitis demonstrated a high short-term success rate of 88.6%, especially in younger patients, maxillary teeth, and those managed within 48 hours of symptom onset. These results support MTA pulpotomy as a conservative and effective alternative to RCT in appropriately selected adult cases.

CONFLICT OF INTEREST: None

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AUTHORS CONTRIBUTION

Sheeza Manan - Concept & Design; Data Acquisition; Drafting Manuscript; Final Approval

Ambreen Azad - Concept & Design; Data Acquisition; Data Analysis/ Interpretation; Final Approval

Qurat Ul Ain - Concept & Design; Data Acquisition; Drafting Manuscript; Critical Revision; Final Approval

Sharina Naz - Concept & Design; Data Acquisition; Drafting Manuscript; Critical Revision; Supervision; Final Approval

Mustafa Sajid - Concept & Design; Data Acquisition; Data Analysis/ Interpretation; Drafting Manuscript; Critical Revision; Final Approval

The authors accept responsibility for all aspects of the work and will ensure that any concerns regarding the accuracy or integrity of any part are properly investigated and resolved.



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