

Research Article

Clinical Success of MTA Vital Pulpotomy in Permanent Teeth with Carious Pulp Exposure: A Prospective Outcomes Study

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ABSTRACT

Background: Vital pulp therapy is becoming more popular in modern dentistry because it helps preserve the natural pulp of the tooth. Mineral trioxide aggregate (MTA) is widely used in pulpotomy procedures because of its good sealing ability, biocompatibility, and ability to promote healing. MTA vital pulpotomy is considered a conservative alternative to root canal treatment in permanent teeth with carious pulp exposure.

Materials and Methods: This prospective clinical study included patients with permanent teeth showing carious pulp exposure and signs of reversible or mild irreversible pulpitis. After removal of the infected coronal pulp, MTA was placed over the remaining healthy pulp tissue. The teeth were restored permanently and followed clinically and radiographically at 3, 6, and 12 months. Clinical signs, symptoms, and radiographic healing were recorded.

Results: Most treated teeth remained asymptomatic during the follow-up period. High clinical success was observed with reduction in pain and absence of swelling or tenderness. Radiographic examination showed maintained periapical health and evidence of dentin bridge formation in many cases.

Conclusion: MTA vital pulpotomy showed high clinical and radiographic success in permanent teeth with carious pulp exposure. It may be considered a reliable and conservative treatment option for preserving pulp vitality.

Keywords: MTA, Vital Pulpotomy, Vital Pulp Therapy, Carious Pulp Exposure, Permanent Teeth, Pulp Preservation.

INTRODUCTION

Preserving the natural pulp of a tooth is one of the main goals of modern dentistry [1,2]. The dental pulp plays an important role in nutrition, defense, sensation, and dentin formation. It also helps maintain the vitality and long-term function of the tooth. In the past, root canal treatment was commonly performed in teeth with deep caries and pulp exposure [3]. Although root canal treatment has a high success rate, it involves complete removal of the pulp tissue and may weaken the tooth structure over time [4]. In addition, root canal treatment is more invasive, time-consuming, and costly compared to conservative treatment approaches.

Recently, vital pulp therapy (VPT) has become increasingly popular because it aims to preserve the healthy pulp tissue instead of complete pulp removal [5,6]. This approach supports natural healing and helps maintain tooth vitality and normal tooth function. Different procedures such as indirect pulp capping, direct pulp capping, partial pulpotomy, and full pulpotomy are included under vital pulp therapy [7]. These procedures are now widely used in modern dentistry because of the growing interest in minimally invasive treatment.

Deep caries is one of the most common causes of pulp inflammation and pulp exposure [8]. In many cases, the inflammation is limited to the coronal pulp while the

radicular pulp remains healthy and capable of healing [9]. This understanding has increased interest in pulpotomy procedures in permanent teeth, especially in young patients where pulp preservation is very important.

Pulpotomy involves removal of the inflamed coronal pulp tissue while preserving the healthy radicular pulp [10]. After removal of the affected tissue, a suitable material is placed over the remaining pulp to promote healing and maintain vitality [11]. This procedure is considered less invasive compared to root canal treatment and helps preserve the natural defense mechanism of the tooth [12]. Maintaining vital pulp tissue also helps continue dentin formation and supports the structural strength of the tooth.

Several materials have been used for pulpotomy procedures over the years, including calcium hydroxide, formocresol, ferric sulfate, biodentine, and mineral trioxide aggregate (MTA) [13]. Among these materials, MTA has gained significant attention because of its excellent biological and physical properties [14]. It has shown promising results in both primary and permanent teeth.

Mineral trioxide aggregate was first introduced in endodontics in the 1990s and has since been widely used in different procedures such as root-end filling, apexification, perforation repair, and vital pulp therapy [15]. MTA has excellent sealing ability, good biocompatibility, antibacterial effects, and the ability to stimulate hard tissue formation [16,17]. These properties make it a suitable material for preserving pulp vitality and promoting healing. Several studies have shown that MTA can induce dentin bridge formation and reduce pulp inflammation [18]. It also creates a favorable environment for pulp healing because of its high pH and low toxicity [19]. Due to these advantages, MTA has shown better clinical outcomes compared to many traditional pulp dressing materials [20]. Patients treated with MTA often show better healing response and lower postoperative complications.

Many clinical studies have reported high success rates for MTA pulpotomy in permanent teeth with carious pulp exposure [21,22]. Patients treated with MTA usually remain asymptomatic during follow-up, and radiographs commonly show healthy periapical tissues and continued pulp vitality [23]. These findings have increased the acceptance of MTA pulpotomy as a conservative treatment option.

One important factor affecting the success of pulpotomy is proper case selection [24]. Vital pulp therapy may not be successful in teeth with uncontrolled bleeding, severe infection, or extensive pulp necrosis. Accurate diagnosis, proper isolation, and good clinical technique are therefore essential for successful outcomes [25]. Control of bacterial contamination and achievement of hemostasis also play a major role in treatment success.

Another important factor is the quality of coronal seal after treatment. Microleakage may allow bacterial contamination and can lead to treatment failure [26]. Therefore, proper restoration of the tooth after pulpotomy is very important to maintain long-term success and protect the pulp tissue from reinfection.

Despite the increasing popularity of MTA pulpotomy, some clinicians still prefer root canal treatment for permanent teeth with carious pulp exposure. However, growing evidence supports the use of conservative approaches whenever possible to preserve pulp vitality and maintain tooth strength. Preservation of vital pulp tissue may improve long-term tooth survival and reduce unnecessary removal of healthy tissue.

Because of the increasing interest in minimally invasive dentistry and vital pulp therapy, further clinical studies are needed to evaluate the success of MTA pulpotomy in permanent teeth. Therefore, the aim of this study was to evaluate the clinical and radiographic success of MTA vital pulpotomy in permanent teeth with carious pulp exposure.

MATERIALS AND METHODS

This prospective clinical study was conducted in the Department of Operative Dentistry and Endodontics over a period of 12 months after obtaining ethical approval from the institutional review committee. Written informed consent was obtained from all patients or their parents/guardians before starting the treatment procedure. The study included patients who reported to the outpatient department with deep carious lesions in permanent teeth associated with pulp exposure during caries removal.

A total of 40 permanent teeth from 40 patients aged between 15 and 35 years were included in the study. Both male and female patients were selected. Only those teeth were included which showed signs and symptoms of reversible pulpitis or mild irreversible pulpitis, including provoked pain of short duration and

deep carious exposure with vital pulp tissue. Teeth were required to be restorable and free from severe periodontal disease.

Teeth with spontaneous lingering pain, swelling, sinus tract, tenderness to percussion, grade II or III mobility, periapical radiolucency, internal or external root resorption, calcified canals, or non-restorable crowns were excluded from the study. Patients who had diseases that could disturb normal healing, like uncontrolled diabetes or weak body defense systems, were not taken in this study. Before starting the treatment, each patient was checked properly and details about their medical and dental condition were recorded. Dental X-rays were taken to evaluate the extent of decay and to examine the pulp tissue and nearby structures around the tooth. Cold test and electric pulp test were used to check whether the pulp was still alive.

All treatments were done carefully under clean conditions by the same dentist so that every case was treated in the same way. Before treatment, 2% lidocaine with 1:100,000 epinephrine was used to numb the area and make the procedure comfortable for the patient. After the tooth became fully numb, a rubber dam was placed to keep the tooth isolated, dry, and clean during the treatment.

Caries excavation was performed using sterile burs under water cooling. After complete caries removal, the coronal pulp tissue was amputated using a sterile round bur under saline irrigation. Hemorrhage control was achieved using sterile saline-moistened cotton pellets. Teeth in which bleeding could not be controlled within 2–5 minutes were excluded.

After hemostasis, MTA was mixed according to the manufacturer's instructions and placed over the radicular pulp tissue in approximately 2–3 mm thickness. A moist cotton pellet was placed over the MTA, and the cavity was temporarily restored.

Patients were recalled after 24 hours to confirm setting of the MTA and evaluate postoperative symptoms. Permanent restoration was then completed using composite resin restoration to achieve proper coronal seal.

Clinical and radiographic follow-up was performed at 3, 6, and 12 months. Clinical success was assessed by absence of pain, swelling, sinus tract, tenderness to percussion, and abnormal mobility. Radiographic

evaluation included absence of periapical radiolucency, widening of periodontal ligament space, root resorption, and evidence of dentin bridge formation.

All collected data were entered into SPSS software for statistical analysis. Clinical and radiographic success rates were expressed in percentages, and $p < 0.05$ was considered statistically significant.

RESULTS

A total of 40 patients were included in the study, and all patients completed the 12-month follow-up period. No cases were lost during the study. Clinical and radiographic evaluations were carried out at 3 months, 6 months, and 12 months to assess the outcome of MTA vital pulpotomy in permanent teeth with carious pulp exposure.

At the 3-month follow-up, most patients showed significant improvement in symptoms. Mild postoperative pain was reported in a few cases during the first week after treatment, but the pain gradually resolved without additional intervention. Clinical examination showed absence of swelling, sinus tract, and abnormal mobility in the majority of teeth.

Radiographic examination at 3 months showed normal periodontal ligament space in most cases. Early dentin bridge formation was visible in some teeth.

At the 6-month follow-up, further improvement was observed clinically and radiographically. Most teeth remained asymptomatic and functional. Radiographs showed more evident dentin bridge formation and continued healing of pulpal tissues.

At the final 12-month follow-up, 37 out of 40 teeth showed successful clinical and radiographic outcomes, resulting in an overall success rate of 92.5%. These teeth remained symptom-free and functional throughout the follow-up period.

Three teeth were considered failures during the study period. Two teeth developed spontaneous pain during follow-up, while one tooth showed widening of the periodontal ligament space and early periapical changes radiographically. These teeth were later treated with root canal therapy.

Dentin bridge formation was observed in a large number of successful cases at 12 months, suggesting continued healing and reparative dentin formation.

Table 1: Demographic Distribution of Patients

Variable	Number of Patients
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Total Patients	40
Male	22
Female	18
Age 15–25 Years	26
Age 26–35 Years	14
Maxillary Teeth	15
Mandibular Teeth	25

Table 2: Clinical Findings during Follow-Up

Clinical Finding	3 Months	6 Months	12 Months
Asymptomatic Teeth	34	36	37
Mild Pain	6	3	2
Tenderness to Percussion	4	2	1
Swelling/Sinus Tract	1	0	0

Table 3: Radiographic Findings during Follow-Up

Radiographic Finding	3 Months	6 Months	12 Months
Normal PDL Space	35	37	37
Dentin Bridge Formation	8	24	34
Periapical Changes	2	2	1
Internal/External Resorption	0	0	0

Figure 1 demonstrates the clinical success rate observed during different follow-up periods after MTA vital pulpotomy. The graph shows that most treated teeth remained clinically successful throughout the study period. A high number of teeth remained asymptomatic and

functional at 3 months, 6 months, and 12 months. Only a few cases showed postoperative symptoms during follow-up, indicating that MTA pulpotomy provided stable and favorable clinical outcomes in the majority of patients.

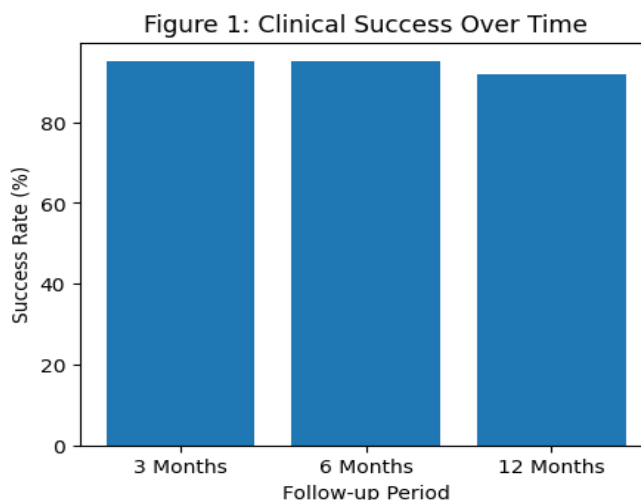


Figure 1: Clinical Success Rate of MTA Vital Pulpotomy Observed At 3-Month, 6-Month and 12-Month Follow-Up Periods

Figure 2 illustrates the increase in dentin bridge formation during the follow-up period. Early signs of dentin bridge formation were observed in some teeth at 3 months, while a greater number of teeth showed clear hard tissue formation at 6 and 12 months. This progressive increase suggests continued healing and reparative activity of the pulp tissue after placement of MTA. The findings

support the ability of MTA to stimulate hard tissue formation and maintain pulp vitality. Figure 3 shows the reduction in postoperative pain following treatment. Before treatment, many patients reported pain associated with deep caries and pulp inflammation. However, after MTA pulpotomy, pain levels gradually decreased during follow-up visits. By the final follow-up period, only a very small number of

patients reported mild discomfort. This reduction in pain indicates successful healing and good patient response to treatment. Figure 4 demonstrates the overall radiographic outcome observed at the 12-month follow-up. Most teeth showed healthy periapical tissues, normal periodontal ligament space, and

absence of radiographic pathology. Only a few teeth showed signs of treatment failure. The radiographic findings support the high success rate of MTA vital pulpotomy and confirm the ability of the procedure to maintain pulpal and periapical health.

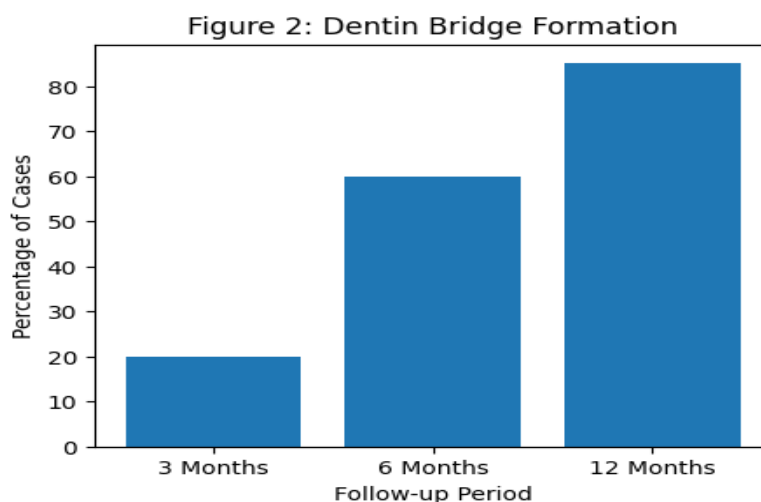


Figure 2: Progressive Increase in Dentin Bridge Formation Following MTA Vital Pulpotomy during Different Follow-Up Intervals

Figure 5 presents a representative clinical case of MTA vital pulpotomy in a permanent molar with carious pulp exposure. The figure includes the preoperative radiograph showing deep caries approaching the pulp tissue, followed by the clinical image after caries removal and pulp exposure. Another image shows placement of MTA over the healthy radicular pulp tissue after achieving

hemostasis. Immediate postoperative radiograph demonstrates proper restoration and absence of periapical changes. The follow-up radiographs at 6 and 12 months show continued healing, dentin bridge formation, and healthy periapical tissues. The figure clearly demonstrates the successful clinical and radiographic outcome of MTA vital pulpotomy over time.

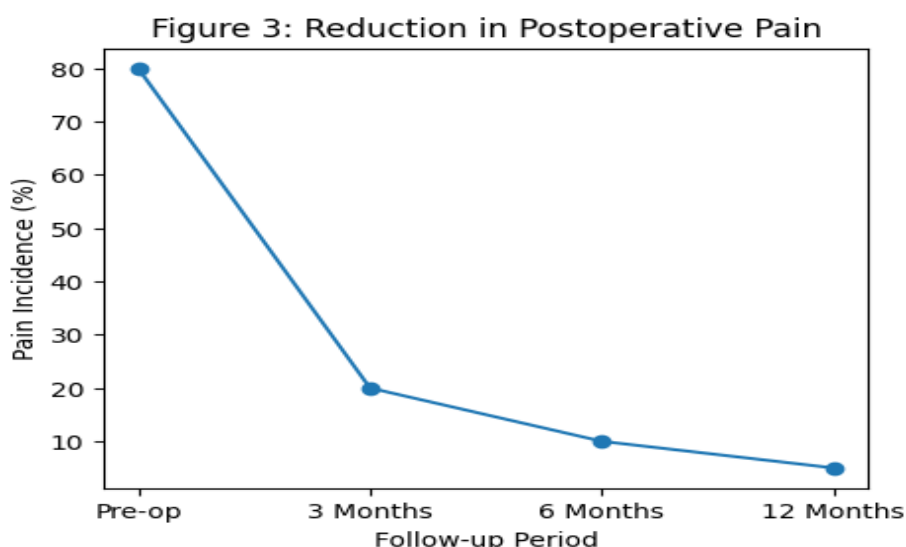


Figure 3: Reduction in Postoperative Pain Levels after MTA Vital Pulpotomy from Preoperative Condition to Final Follow-Up

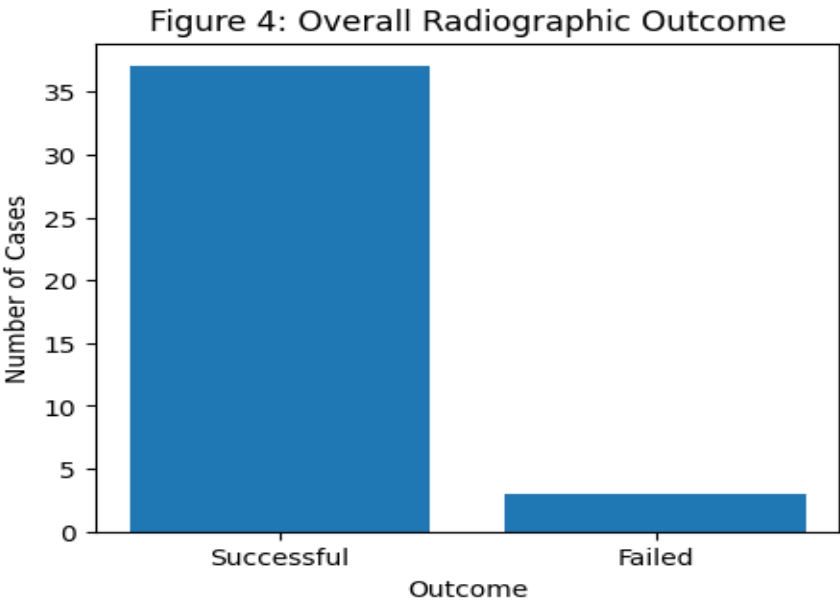


Figure 4: Overall Radiographic Outcome at 12 Months Showing Successful and Failed Cases after MTA Vital Pulpotomy

DISCUSSION

The present study evaluated the clinical and radiographic success of MTA vital pulpotomy in permanent teeth with carious pulp exposure. The results showed a high overall success rate, with most treated teeth remaining asymptomatic and functional throughout the 12-month follow-up period. These findings support the use of MTA as an effective

material for vital pulp therapy in permanent teeth. One of the main goals of modern dentistry is to preserve the vitality of the dental pulp whenever possible. The high success rate observed in the present study supports this conservative approach.

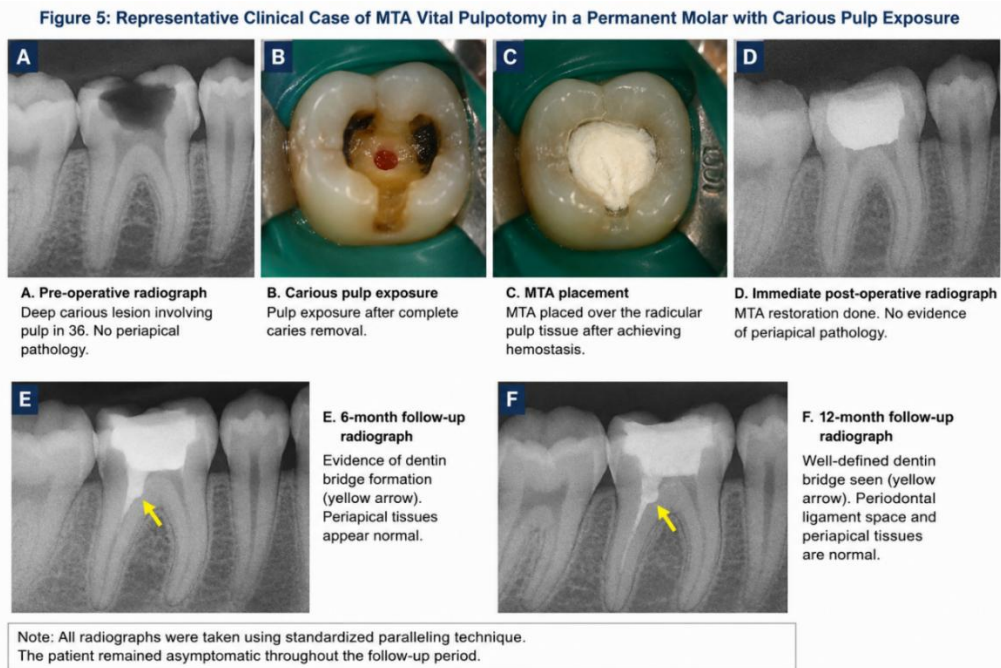


Figure 5: Representative Clinical Case Of MTA Vital Pulpotomy Showing Preoperative Radiograph, Pulp Exposure, MTA Placement, And Follow-Up Healing With Dentin Bridge Formation And Healthy Periapical Tissues.

Most patients showed relief from pain and other symptoms soon after treatment. Similar findings have been reported in previous studies where MTA pulpotomy resulted in good postoperative healing and reduction in symptoms [5,21].

Radiographic evaluation showed maintenance of healthy periapical tissues and normal periodontal ligament space in most cases. Dentin bridge formation was also observed in many teeth during follow-up, indicating continued reparative activity of the pulp tissue. The ability of MTA to stimulate hard tissue formation is one of its major advantages. MTA has excellent sealing ability, high biocompatibility, and antibacterial properties, which support pulp healing [11,14]. Previous studies have also shown that MTA promotes dentin bridge formation and reduces pulpal inflammation [16,17].

Proper case selection also contributed to the high success rate. Only teeth with vital pulp tissue and controlled bleeding were included in the study. The quality of coronal seal may also have helped prevent bacterial contamination and supported long-term healing.

Despite the favorable outcomes, a few failures were observed. These failures may have been related to deeper pulpal inflammation that could not be detected clinically during treatment.

The findings of this study support the growing evidence that MTA vital pulpotomy can be considered a reliable alternative to root canal treatment in selected permanent teeth with carious pulp exposure.

However, this study had some limitations, including small sample size and limited follow-up duration. Longer studies with larger sample sizes are recommended.

CONCLUSION

Within the limitations of this study, MTA vital pulpotomy showed a high clinical and radiographic success rate in permanent teeth with carious pulp exposure. Most treated teeth remained symptom-free and functional during the follow-up period, with healthy periapical tissues and evidence of dentin bridge formation.

The findings of this study showed that MTA is a reliable and biocompatible material for vital pulp therapy. It can support pulp healing, promote hard tissue formation, and help maintain pulp vitality, making it an effective conservative treatment option.

MTA vital pulpotomy may be considered a suitable alternative to conventional root canal treatment in carefully selected permanent teeth with carious pulp exposure. However, further long-term studies with larger sample sizes are needed to confirm these findings and improve future treatment protocols.

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