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Original Research Article

COMPARISON OF APEXIFICATION BY MINERAL TRIOXIDE AGGREGATE AND PULP REVASCULARIZATION IN IMMATURE NECROTIC TEETH

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Abstract: *Injuries to immature permanent teeth may cause pulp necrosis. Conventional treatment for such teeth is root canal treatment and apexification, but recently a new treatment option of revascularization has been introduced, also known as regenerative endodontic treatment. This study compared the treatment outcome of apexification and pulp revascularization in immature necrotic teeth. All the patients were treated, and data were acquired from the dental outpatient department of Shahida Islam Medical and Dental College, Lodhran, between November 15, 2021, to November 14, 2022, duration. To complete this research, Randomized Controlled Clinical Trial was used as a study design to collect the patients, later divided into two groups. Means age of all the patients in this study was 11.41 ± 4.20 years; the mean age of the patients in Group A=11.50 ± 4.24 years and Group B=11.32 ± 4.26 years. The success rate in Group A= 60 (87.32%) was lower than that of Group B= 67 (97.04%). The results of this study revealed that pulp revascularization has a higher success rate than apexification by mineral trioxide aggregate.*

Keywords: Apexification, Regenerative Endodontic Treatment, Pulp Revascularization, Mineral Trioxide Aggregate (MTA), Dental Trauma, Immature Teeth.

Introduction

Trauma to immature permanent teeth is common and usually results in pulpal necrosis. This may result in the arrest of root development. Pulp necrosis of immature teeth can have devastating consequences for the patient and immature teeth like an open apex of roots, thin radicular dentine, and small roots (Ree and Schwartz, 2017; Torabinejad et al., 2009). Root canal therapy is the treatment modality for such teeth (Parirokh et al., 2018). However, the reported success rate of RCT is 78-98% (Simon et al., 2007). Managing immature permanent teeth with pulpal necrosis is difficult because their root canal systems are usually complicated to debride, and their delicate dentin walls may get fractured. Therefore, an apical barrier should be used to ensure optimal obturation of the root canal system (Simon et al., 2007).

In previous attempts at forming an apical barrier, clinicians tried several different materials, such as calcium hydroxide powder or mineral trioxide aggregate, which can be used alongside collagen calcium phosphate. In addition, osteogenic protein and bone growth factors combined with oxidized cellulose are also utilized. Moreover, there is also a description detailing the consideration of instrumentation resulting in the creation of a blood clot which induces apical closure (Lin et al., 2017; Youssef et al., 2019). The conventional treatment options for immature non-vital teeth include surgical endodontics and apexification, as the immature roots are underdeveloped and have an open apex. A new treatment option of revascularization, regenerative endodontics, has recently been introduced. The standard treatment is the apexification procedure (El Meligy and Avery, 2006). This treatment option has been fairly successful. With MTA apexification, a primary barrier could be placed. The clinical success rate of MTA is 86% (Lin et al., 2017). In another study, the success rate of MTA was 94.1% (Sarris et al., 2008). This technique poses some problems that could be addressed as it leaves the roots with thin dentin walls and short overall root length

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(Coomaraswamy et al., 2007). Yet after successful apexification, these teeth are frequently susceptible to root fracture (de Oliveira et al., 2018; Sarris et al., 2008).

The pulp tissue of immature teeth with open apices is rich in blood and can regenerate under the right conditions after pulp injury. Several studies and case reports show that this approach has a good prognosis as an alternative to apexification (Jeeruphan et al., 2012; Yang, 2013). The survival rate of the revascularization-treated teeth was 98.6% (Jeeruphan et al., 2012). Another clinical research reported that the success rate was 100% (Cerqueira-Neto et al., 2021). Revascularization is a contemporary approach to addressing this problem (Jeeruphan et al., 2012; Sajjad et al., 2022). It is to create and deliver new tissues to replace the necrotic pulp (Nicoloso et al., 2019). It allows for continuous root development, large dentin wall, long root length, and closed junction, thus reducing the fracture risk during dental work (Xuan et al., 2018; Yang, 2013).

Methodology

One hundred thirty-eight patients visiting the dental outpatient department to treat their central incisors were selected after fulfilling inclusion criteria using the non-probability "consecutive selection technique."

Informed written consent was taken from the parents/ guardian of each patient after fully describing this study's objective. Patients were randomly allocated into two equal groups (A and B), each comprising 69 patients, using a random number table. The Young patient aged 6 to 18 years, with immature teeth with necrotic pulp and open apex, pulp space not needed for post/core, final restoration, and compliant patients were included in this study. Patients with a history of trauma with close apex, compromised immune status, e.g., uncontrolled Diabetes Mellitus, renal failure, Immunosuppression, Severe asthma, bleeding disorder, grossly carious teeth / unrestorable teeth / badly broken teeth, and eating disorder (anorexia, bulimia, malnutrition) were excluded from the study.

In Group A, patients were treated with Mineral trioxide aggregate (MTA), and in Group B, with pulp revascularization. Patients were randomly allocated into two equal groups (groups A and B), each comprising patients using a random number table. In Group A, patients were treated with Mineral trioxide aggregate and with pulp regeneration through revascularization in Group B. Pre-operative periapical radiographs of the central incisors were taken for each patient. Based upon history, clinical examination, and investigations, an acute apical periodontitis maxillary central incisor with open apex was diagnosed. The tooth was isolated, and an access opening was made. When the endodontic file was inserted gently into the canal, no resistance was felt in the apical area. The tooth was prepared biomechanically. Copious irrigation with sodium hypochlorite was used. Root canals in both groups were filled with calcium hydroxide. To ascertain whether the disinfection procedure successfully treats my tooth, it shall be sealed temporarily until our next appointment in two to three weeks. It was essential to perform repeated disinfections on the infected root canal until there was no more evidence of purulent discharge or sinus tract and the area was infection-free.

On the second visit, the canal was filled with MTA with a messing gun in group A. Bony chips or synthetic collagen, i.e., colla cote, were placed under MTA, introduced 3mm short of radiographic apex, and condensed in the apical third. The Radiograph was taken to check the MTA apical plug, and the sterile cotton pellet was placed in the access cavity. The coronal restoration consisted of IRM and composite. During alternate months there were two occasions when a radiographic examination was done on the tooth. By irrigating the canal in group B with sodium hypochlorite, then drying it out by employing paper points and finally over-instrumenting it; severe bleeding occurred, which extended past the open apex. Insertion and retention of a cotton pellet at that point for approximately seven to ten minutes encouraged clotting in the canal's top portion (2/3rds). This was key to aiding in viable tissue ingrowth into the pulpal space due to rich growth and differentiation factors within this blood clot's scaffold. Materials such as MTA and glass ionomer types of cement were used to close off the access by creating a 3–4 mm thick seal to prevent coronal leakage.

The tooth received two radiographic evaluations every other month. Despite this, bleeding occurred in group B's canal after using sodium hypo chloride for irrigation and paper points for drying due to over-instrumentation beyond an open apex. After this step, a cotton pellet is inserted and left inside for almost 7 to 10 minutes to allow a blood clot formation in the apical two-thirds of the canal. The presence of crucial growth and differentiation factors within this blood clot's scaffold makes it essential for promoting viable tissue ingrowth into the pulpal space. We sealed the access with MTA or glass ionomer cement to prevent coronal leakage.

The researchers themselves performed all the procedures described. Patients in both groups were assessed clinically and radiographically after 3 and 6 months on follow-up appointments. The final assessment was based on clinical vitality tests, i.e., cold test, heat test, EPT, and radiographical features, i.e., the researchers' thickening of root wall dentine, root growth, and apex formation at 6 months follow-up. The chi-square test was used as a significance test

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to find out the statistical significance of the results in both groups. A P-value equal to or less than 0.05 ($p \leq 0.05$) was considered statistically significant.

Results

The total sample size (n) was 138 patients. The mean age of the patients was 11.41 ± 4.201 years, the mean age in Group A was 11.50 ± 4.242 years, and those of Group B patients were 11.32 ± 4.267 years. (Table 1) . Out of 138 patients, the majority (57%) patients were in the age group 6-12 years, and the rest of the patients belonged to the age group 13-18 years (Table No.1). The total (69) patients in treatment Group A, most (58%) patients belonged to age group 6-12 years and the remainder to age group 13-18 years. In Group B, patients in the age group 6-12 years were outnumbered, and only a small percentage were in the age group 13-18 years.

Of the total male patients in group A (40), treatment was successful in just (85%) patients. While in group B patients (39), it was successful in most (97.43%) of patients. A statistically significant difference was noted between groups A and B for treatment success (p-0.0008) (Table No.2).

Of the total female patients in group A (29), treatment was successful in (89.65%) patients. In group B (30), treatment was successful in more patients (93.33%). A statistically insignificant (P = 0.0005) difference was noted between groups A and B for the success of treatment (Table No.3). Success rate in Group B was significantly higher than in Group A.

Table 1 Demographic Variable (N=138)

VARIABLE	STATISTICS
Age Distribution	
6-12 years	57 (41.30%)
13-18 years	43 (31.15%)
Means Age Group A	11.50±4.242
This means Age Group B	11.32±4.267
Gender Distribution	
Male	79 (57.24%)
Female	59 (42.75%)

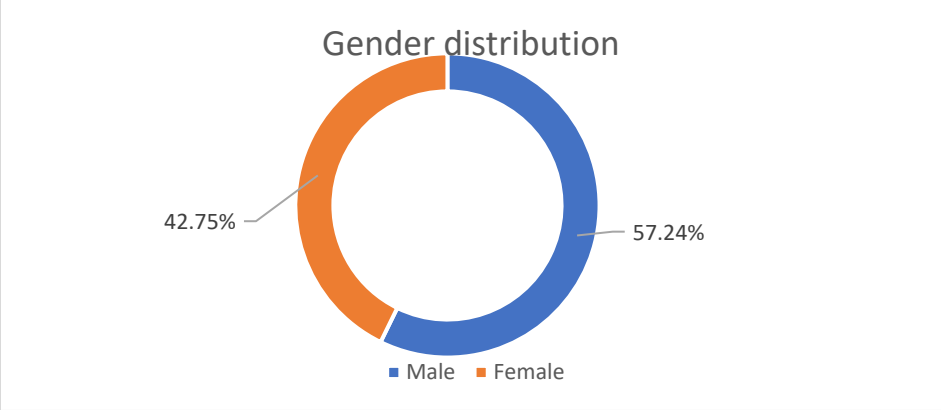

Figure 1 Distribution of gender in the study population

Table 2 Comparison of outcomes between Group A and B for male patients

Treatment Group	Outcome		Total	P. value
	Successful	Failure		
Group A (MTA)	34(85%)	6(15%)	40	**0.0008**
Group B (Revascularization)	38(97.43%)	1(2.56%)	39	

Table 3 Comparison of outcomes between groups A and B for female patients

Treatment Group	Outcome		Total	P. value
	Successful	Failure		
Group A (MTA)	26(89.65%)	3(10.34%)	29	**0.0005**
Group B (Revascularization)	29(96.66%)	1(3.33%)	30	

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Discussion

Young children commonly suffer from dental trauma leading to pulp death, and the percentage of all injuries that occurred in children under six was as high as 18%. Over sixteen percent of injuries that occur between ages seven- and ten-years result in damage to the permanent front teeth, and children's dentine has a high permeability which allows for easy ingress of bacteria from their oral environment into their pulp leading to pulpal necrosis (Chueh and Huang, 2006). Since the root development of growing permanent teeth is often incomplete. MTA has been introduced into the dental field, originally recommended for treating perforations and as a root-filling material. MTA has been recognized as a synthetic material that can be regenerated; it is inductive for hard tissue, conducive for hard tissue, and biocompatible. Resurfacing is a new treatment technique that falls under the category of pulp regeneration (Garcia-Godoy and Murray, 2012). There are many advantages to a revascularization approach as this approach is a simple technology, requires a short treatment time, is very cost-effective, and the tissue regeneration in the root canal system through the patient's blood avoids behavior that is no longer rejected (Garcia-Godoy and Murray, 2012; Jeeruphan et al., 2012).

The regenerative endodontic procedure aims to regenerate the tissue like pulp, and revascularization focuses on starting the bleeding in the free root canal and causing the blood clot to form in the canal cavity after it is done 'hopefully, this will lead to a similar process. of blood clots that trigger wound healing during the surgical procedure (Glynis et al., 2021). In the present study, treatment outcome (in terms of success/failure) was compared between two treatment modalities, i.e., Mineral Trioxide Aggregate (MTA)apexification and revascularization of pulp. The literature review shows that the clinical success rate of MTA is 86% (Lin et al., 2017). Other clinical studies show that the success rate of MTA apexification is 94.1%, which also aligns with our findings. Simon et al. reported the success rate of MTA after apexification as 81%, comparable to our study results (Simon et al., 2007). However, El-Meligy et al. reported a 100% success rate clinically and radiographically after 12 months of the procedure (El Meligy and Avery, 2006).

The survival rate of revascularization-treated teeth is 98.6% (Jeeruphan et al., 2012). In another clinical research, the success rate was reported to be 97%12, comparable to our study results. Rui Yu Ding et al. presented a clinical study of pulp revascularization of immature teeth with apical periodontitis (Ding et al., 2009). In their study, Glynis A et al. showed an effective success rate of revascularization with 97.2% (Glynis et al., 2021). Another study conducted by Sajjad I et al. showed that treatment results of pulp revascularization resulted in a better prognosis for the patient and tooth immediately, as well as in long-term scenarios for the survival and functionality of the tooth (Sajjad et al., 2022).

Conclusion

The results of this study revealed that the success rate of pulp revascularization of necrotic teeth was higher compared to apexification with Mineral Trioxide Aggregate (MTA). Although apexification using MTA is a treatment option in patients with open apex and necrotic pulp, pulp revascularization will result in not only closure of the apex but also an increase in radicular dentine thickness and length of the root which is beneficial for long-term prognosis.

Conflict of interest

The authors declared the absence of a conflict of interest.

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