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Management of open Apex in Maxillary Incisors with MTA - A Retrospective Study

Running title: MTA apexification in maxillary incisors

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Abstract:
Open apices commonly arise secondary to pulpal necrosis as a result of caries or trauma in an immature tooth with incomplete root formation. The conventional method of apexification with calcium hydroxide has certain disadvantages such as a very long period of treatment, tooth fracture and an incomplete calcification of the bridge. MTA has gained importance as an alternative treatment for management of open apices as it overcomes these disadvantages. The aim of this study was to determine the number, age and gender distribution of MTA apexification done in maxillary incisors.This study included data of 41 patients who had undergone apexification using MTA in maxillary incisors. The data was collected from the case records of patients visiting Saveetha dental College for treatment. A total of 47 teeth that underwent MTA apexification were identified. Of the total subjects, 83% were males and 17% were females. 51.06% of the teeth that underwent MTA apexification belonged to the age group <15 years and 48.04% to the group >15 years. Statistical analysis was done using IBM SPSS software version 20.0. No significant association was found between gender and different age groups in patients that underwent MTA apexification (P value- 0.701 >0.05; Fisher's exact test). MTA apexification was done predominantly in males in both age groups.

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INTRODUCTION:

The presence of vital pulp plays a pivotal role in root development. Therefore, when the pulp is reversibly inflamed it is crucial to maintain pulp vitality, especially in immature teeth (Deleimburg *et al.*, 2004). Caries and trauma are the main cause for pulp inflammation and necrosis. If these occur prior to root maturation, the root development would be halted, and can lead to an open apex (Harty, Parkins and Wengraf, 1970). Trauma to the anterior teeth is a relatively common occurrence during childhood especially in children of age 8-12 years , as this is a period of maximum physiologic growth and development and the children are actively involved in a lot of outdoor activities. Depending on the magnitude, trauma to maxillary anterior teeth may cause concussion, luxation, fracture, or avulsion of the teeth, in more severe cases, leads to necrosis of the pulp tissue (Moore, Howley and O'Connell, 2011).The maxillary anterior teeth tend to undergo many impact injuries because of its position in the jaw.

Pulp regeneration i.e. apexogenesis is not possible when long-term history of trauma causes external root resorption. In such cases, the treatment of choice is apexification or root-end closure. The endodontic treatment of immature permanent necrotic teeth is more difficult than conventional procedures because these teeth present widened root canals and open apices (Moore, Howley and O'Connell, 2011) . The tooth roots may also suffer external infection-related (inflammatory) root resorption or alterations during treatment (Bakland and Andreasen, 2012). In such cases with infected pulps, it is necessary to use a intracanal dressing material to neutralize the bacteria and their products and to stimulate the apexification process by forming a mineralized apical barrier so that the subsequent condensation of gutta-percha can be properly achieved (Mohammadi and Dummer, 2011). Open apex complicates root canal treatment due to lack of apical stop, as there can be extravasation of irrigating solution and/or sealer into periradicular tissues, which can have a negative effect on the apical healing process. The main goal of treatment of teeth with pulpal necrosis is achieving an apical seal

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(Ghaziani, Aghasizadeh and Sheikh-Nezami, 2007) which is created by a barrier of hard tissue through a process known as apexification. (Floratos, Tsatsoulis and Kontakiotis, 2013).

Traditionally, apexification had been performed by using calcium hydroxide paste, due to its biological and healing performances (Yassen *et al.*, 2012). Calcium hydroxide has been successfully used for apical barrier formation in 74–100% of cases (Finucane and Kinirons, 1999). 86% of these treated teeth survived after a follow-up of 5 years. However, the use of calcium hydroxide paste use for apexification is not advocated these days as it involves a long treatment time and the prognosis is always uncertain (Hussainy *et al.*, 2018). The average length of time for apical barrier formation ranges from ~3 to 17 months, necessitating multiple visits for material replacement and delays the construction of the definitive restoration (Finucane and Kinirons, 1999). Exposure of the tissue to calcium hydroxide for long periods weakens the root structure, resulting in fractures, as well as induces periapical bone necrosis when there is overfilling of the material (Strom *et al.*, 2012). Another major disadvantage of apexification procedure using calcium hydroxide are the thin walls of the root which may fracture. Although the barrier is calcified it is actually porous and may contain a small amount of soft tissue (Manohar and Sharma, 2018; Teja and Ramesh, 2019).

As an alternative to traditional apexification using calcium hydroxide, a number of materials have been proposed in the literature (Ravinthar and Jayalakshmi, 2018; Teja, Ramesh and Priya, 2018). Among these materials, MTA is the most popular for open apex management (Janani, Palanivelu and Sandhya, 2020; Jose and Subbaiyan, 2020). MTA is composed of fine hydrophilic particles of tricalcium silicate, silicate oxide and tri calcium oxide. When mixed with sterile water it forms the colloidal gel and its setting time is about 3 to 4 hours in the presence of moisture (Nandakumar and Nasim, 2018) . MTA has less leakage, better antibacterial properties, high marginal adaptation and short setting time of 4 hours, pH of 12.5 and is more biocompatible (Kubasad and Ghivari, 2011; Güneş and Aydinbelge, 2012).

With the use of mineral trioxide aggregate (MTA) in dentistry, it is possible to optimize the treatment time of open apex management by immediate placement of apical plug and the root canal filling (Ramamoorthi, Nivedhitha and Divyanand, 2015; R, Rajakeerthi and Ms, 2019) . MTA has been shown to be a very effective root end filling material for sealing immature root canals with open apices that would otherwise impose technical challenges in obtaining adequate obturation (Kumar and Antony, 2018; Rajendran *et al.*, 2019). MTA has the ability to facilitate periradicular healing by inducing hard tissue formation (Camilleri and Pitt Ford, 2006). Mineral trioxide aggregate apart from being a root end filling material also has properties like regeneration of periradicular tissues like bone, cementum and periodontal ligament (Rajendran *et al.*, 2019; Siddique *et al.*, 2019). It has an excellent sealing ability, being a hydraulic cement material it sets even in the presence of moisture (Ramanathan and Solete, 2015; Noor, S Syed Shihaab and Pradeep, 2016). This study was undertaken to analyse the number of open apex management done in maxillary incisors using MTA and its distribution and association with age and gender.

MATERIALS AND METHODS:

Study Design and setting:

In this cross sectional study, the data of 41 patients who underwent treatment for open apex management in Saveetha dental college were collected from dental records. Totally 47 maxillary incisors where open apex management was done using MTA were

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included in the study. At data extraction all information was anonymised and tabulated into a spreadsheet.

Ethical Approval

The study was commenced after approval from the institutional review board (Ethical approval number : SDC/SIHEC/2020/DIASDATA/0619-0320).

Selection of study population:

Inclusion criteria:

- Patients with necrotic pulp and open apex
- Patients without previous history for the treatment
- MTA used for apexification

Exclusion criteria:

- Patients who underwent incomplete treatment .
- Use of other materials for open apex management.

Sampling:

Data collected from June 2019 to March 2020 comprised 41 patients who had undergone open apex management using MTA . The following data retrieved from the dental records: Patient's age, gender and tooth number .

Statistical analysis:

The statistical analysis was done using SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics (percentage and mean) and Inferential statistics (Fisher's exact test) were done.

RESULTS AND DISCUSSION:

Among the 47 teeth that underwent MTA apexification in our study, 82.98% belonged to males and 17.02% to females [Figure 1].

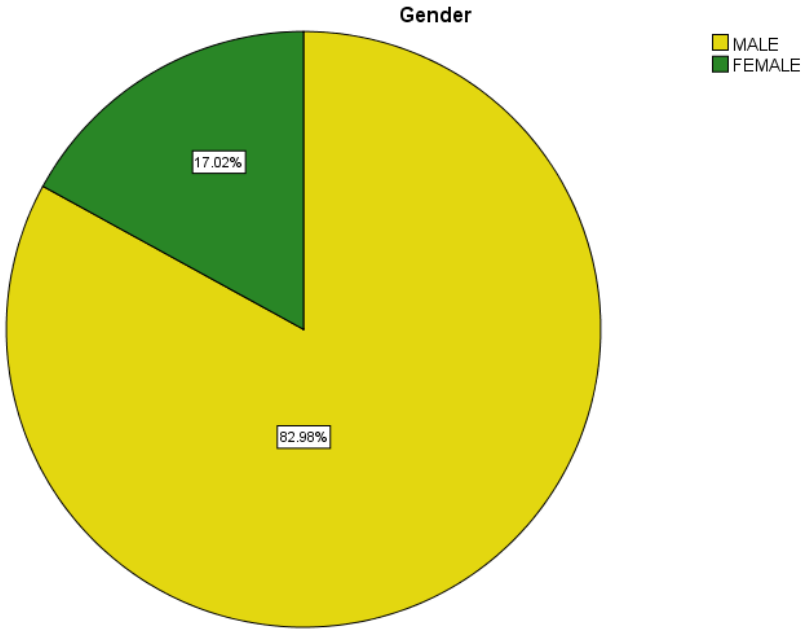

Figure 1: Pie chart representing the distribution of teeth that underwent MTA apexification based on gender. 82.98% of the teeth that underwent MTA apexification belonged to males (Yellow) and 17.02% to females (Green).

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51.06% of teeth belonged to patients <15 years of age and 48.94% belonged to those >15 years [Figure 2].

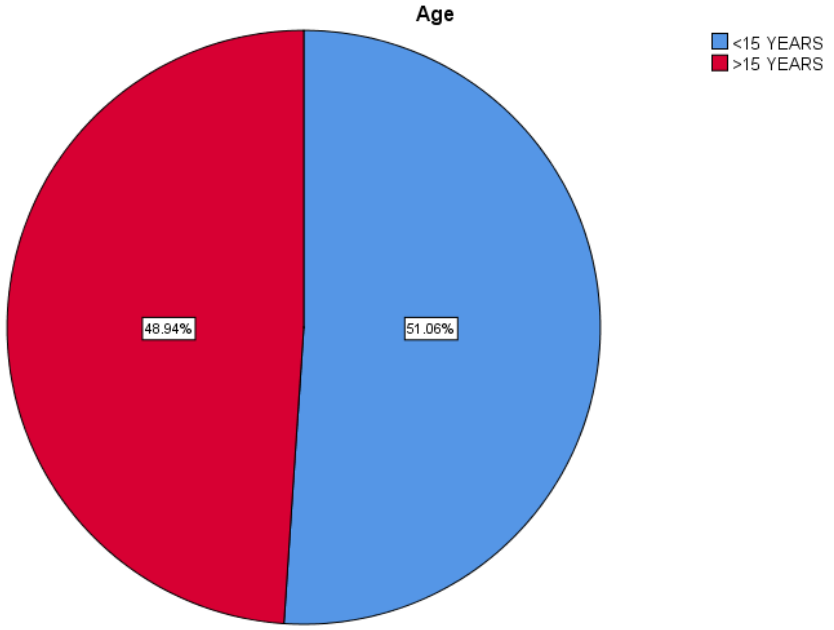

Figure 2: Pie chart representing the distribution of teeth that underwent MTA apexification based on age group. 51.06% of the teeth that underwent MTA apexification belonged to the age group <15 years (Blue) and 48.04% to the group >15 years (Red).

MTA apexification was done predominantly in males in both age groups. However, no significant association was found between gender and different age groups in patients that underwent MTA apexification (P value- 0.701 >0.05; Fisher's exact test).

Early necrosis of the pulp, incomplete root formation or external resorption of the root due to trauma results in blunted or shortened root with open apex (Pace, Giuliani and Pagavino, 2008; Araújo *et al.*, 2010). Apexification is the process of creating a hard tissue barrier at the root apex. Although calcium hydroxide was used most commonly for the process of apexification , the time duration for barrier formation was too long and the apical barrier formed was porous leading to reinfection (Ajwani and Saini, 2011). To overcome these disadvantages, MTA was introduced as a 'one visit Apexification material' (Stefopoulos, Tzanetakis and Kontakiotis, 2012).

MTA is one of the most effective materials for sealing the communication between endodontic and periodontal spaces (Torabinejad *et al.*, 1995; Al-Hezaimi *et al.*, 2005; Al-Kahtani *et al.*, 2005). MTA stimulates the production of interleukins and cytokines thereby promoting cementum like hard tissue formation, when in contact with the periradicular tissue. MTA plug in the apical portion of the root promotes apical repair and prevents root canal over-filling and increases the fracture resistance of immature teeth (Pace *et al.*, 2014).

Holland et al conducted a study and noticed biological closure of apical foramen and absence of inflammation in periapical tissue after the placement of MTA (Holland *et al.*, 2007) .Similarly , MTA has proven to be a successful material in acting as an apical barrier in many studies by eliminating the pre existing infection and promoting periodontal and bone healing.

(Güneş and Aydinbelge, 2012; Raldi *et al.*, 2009; Ajwani and Saini, 2011). In the study by Magro et al ,

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treatment of open-apex incisors with placement of an apical matrix with lyophilized collagen sponge against which MTA apical plug can be condensed, had favorable prognosis . The radiographic assessment indicated local anatomical normality and total regression of the initial radiolucent lesion (Graziele Magro *et al.*, 2017).

In a study done by Shrava et al , boys were found to have significantly higher numbers of tooth fractures than girls (Sharva *et al.*, 2017). Majority of previous studies also reported a higher frequency of dental trauma among boys than among girls, (Jesus *et al.*, 2010; Sulieman and Awooda, 2018; Carvalho and de Carvalho, 2019). This high incidence of trauma among boys could be a reason for a higher number of male patients seeking treatment for open apex as seen in our study [Figure 1]. A possible reason for male children being more prone to traumatic dental injuries than female children could be their participation and involvement in more aggressive sports and outdoor activities. The relatively low prevalence of trauma among females can also be explained by the fact that they are in general more mature in their behavior when compared with males, who tend to be more energetic and inclined toward exuberant outdoor activities.

The peak age to sustain traumatic dental injury was found to be in the age group of 13 to 14 years in a study conducted by Govindarajan et al (Govindarajan *et al.*, 2012). In our study, the number of teeth that underwent MTA apexification was slighter higher in the age group <15 years [Figure2]. No association was found between age and gender in teeth undergoing MTA apexification [Figure 3].

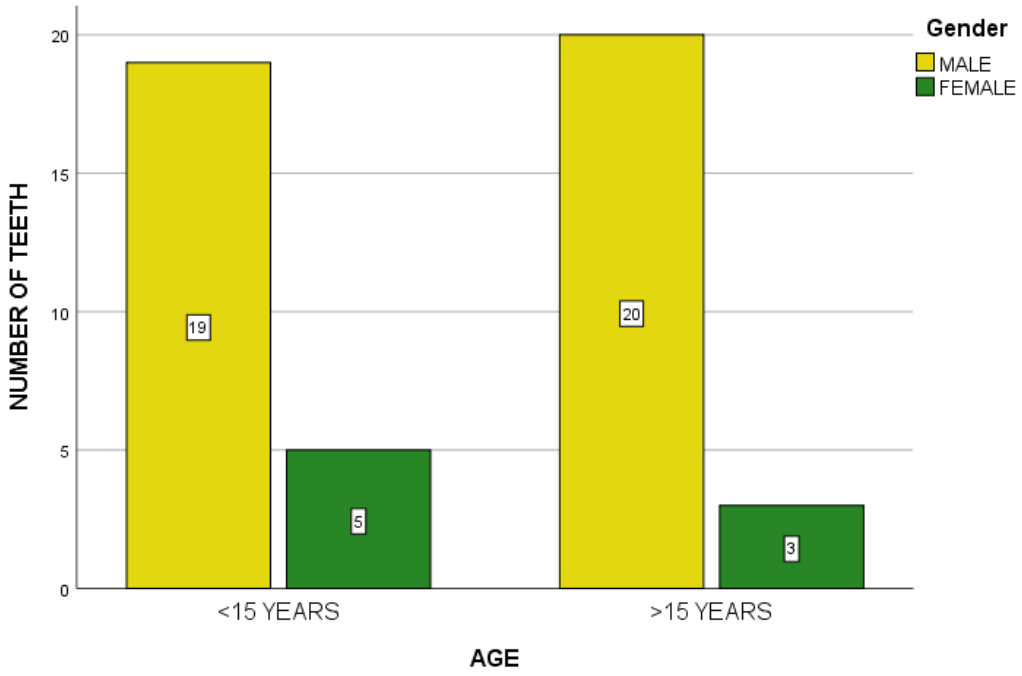

Figure 3**:** Bar graph representing the association between age and gender in patients that underwent MTA apexification. X-axis represents the age groups and Y-axis represents the number of teeth involved involved with respect to gender . MTA apexification was done predominantly in males (Yellow) than females (Green) in both age groups. However, no significant association was found between gender and different age groups in patients that underwent MTA apexification (P value- 0.701 >0.05; Fisher's exact test).

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The effect of the patients' age on the outcome of apexification is controversial. It has been reported that apexification is indicated in young children (Lin, Chance and Skribner, 1986) and provides more favourable results, as shown in an animal study (Weinstein and Goldman, 1977). However, successful biologic apexification with Calcium hydroxide in adults has been reported in several case reports (Rotstein, Friedman and Katz, 1990; Gutmann and Fava, 1992; Calişkan and Türkün, 1997) . Clinical apexification treatment studies with MTA reported favourable results in immature teeth of different age groups ranging from 6 to 82 years, and composed of mostly children (Simon, Rilliard and Berdal, 2007; Holden *et al.*, 2008; Witherspoon *et al.*, 2008) .

The present study suggests that MTA apexification is done mostly in males and in the lesser age group suggesting people's willingness to address the problem immediately and preserve the natural tooth.

CONCLUSION:

MTA apexification was mostly done in male population and in the age category less than 15 years. The placement of apical barrier using MTA is an alternative to conventional long-term calcium hydroxide which reduces the treatment time.

AUTHOR CONTRIBUTIONS:

Priadarsini T , Dr Sowmya K were the main contributors for the concept , design , literature analysis , workshop discussions , drafting and revising the manuscript. Dr. Sowmya K and Dr. Dhanraj Ganapathy contributed to drafting and revising the manuscript. All authors gave final approval of the version to be published.

CONFLICTS OF INTEREST:

There are no conflicts of interest.

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