Management of open apex in maxillary incisors with MTA - a retrospective study

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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.

Keywords: Apexification; Incisors; MTA; Open apex; Trauma innovative technique

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 an intracanal dressing material to neutralize the bacteria and their products and to stimulate the apexification process during treatment by forming a mineralized apical barrier so that the subsequent condensation of gutta-percha can be properly achieved (Mommamadi 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 (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 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 Aydınbelge, 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 (Ramamoorthy, Niveditha 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 periapical 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 periodontal 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 Shihhaab and Pradeep, 2016).

Our department is passionate about research we have published numerous high quality articles in this domain over the past years (Abraham et al., 2005; Devaki, Sathivel and BalajiRaghavendra, 2009; Neelakantan et al., 2010, 2015; Arja et al., 2013; Ramshankar et al., 2014; Sumathi et al., 2014; Surapaneni and Jainu, 2014; Surapaneni, Priya and Mallika, 2014; Ramamoorthi, Niveditha and Divyanand, 2015; Manivannan et al., 2017; Ezhilarasan, 2018; Ezhilarasan, Sokal and Najimi, 2018; J et al., 2018; Ravindiran and Praveenkumar, 2018; Malli Sureshbabu et al., 2019; Mehta et al., 2019; Krishnaswamy et al., 2020; Samuel, Acharya and Rao, 2020; Sathish and Karthick, 2020) 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 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]. 51.06% of teeth belonged to patients <15 years of age and 48.94% belonged to those >15 years [Figure 2]. 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 periapical 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.

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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GRAPHS

Fig.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).

Fig.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).

Fig.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).