

Sealing ability of biomaterials as apical plug, a literature review

Abstract

Endodontic management of the teeth with immature apices and necrotic pulps has always been challenging. Therefore fabrication of an artificial hard tissue barrier with a biomaterial has indicated as an alternative to more traditional apexification procedure. Successful endodontic treatment needs to prevent leakage of intracanal irritants into the peri radicular tissues. On the other hand, achieving an ideal tight seal in teeth with open apices is hard if not impossible. To reach this goal placement of a biomaterial with good sealing properties is suggested in such cases. The aim of this study is to review on sealing ability of biomaterials as apical plug. The resources were PubMed, and Google Scholar, using different keyword combinations including 'immature tooth', 'open apex', 'sealing ability', 'micro leakage', 'endodontic', 'CEM cement', 'apical plug', 'calcium silicate', 'Endocem', 'portland cement', 'MTA' and 'bio dentine'. All biomaterials used in apexification may leak in different concentrations. Because of the importance of apical seal on long-term success in endodontically treated immature teeth these materials should be applied carefully. The need for more research in this field and introduce new biomaterials with improved sealing ability is evident.

Keywords: sealing ability, micro leakage, apical plug, biomaterial

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Abbreviations: CH, calcium hydroxide; MTA, mineral trioxide aggregate; CEM, calcium-enriched mixture; NEC, new endodontic cement

Introduction

Endodontic management of the teeth with immature apices and necrotic pulps has always been challenging. Traditionally, Calcium hydroxide (CH) has been used for apexification and induction of an apical hard tissue matrix which the filling material being packed against.^{1,2} The main disadvantage of this procedure is the need for multiple visits and extended treatment time; this long-term treatment procedure makes the tooth susceptible to fracture.^{3,4} Therefore fabrication of an artificial hard tissue barrier with a biomaterial has indicated as an alternative to more traditional apexification procedure. Successful endodontic treatment needs to prevent leakage of intracanal irritants into the peri radicular tissues.⁵ Microbial tight seal of biomaterials as apical plug is mandatory.⁶ On the other hand, achieving an ideal tight seal in teeth with open apices is hard if not impossible. To reach this goal placement of a biomaterial with good sealing properties is suggested in such cases.^{7,8} The main destination for root canal therapy of immature teeth is to seal the wide apical portion of the canal, and provide a barrier against which filling material can be compacted.^{9,10} An important factor for successful endodontic treatment in open-apex teeth is the sealing ability of apical plug. The quality of apical sealing obtained by root-end filling materials has been assessed using different methodologies such as dye penetration,^{11,12} bacterial penetration,¹³ endotoxin,¹⁴ human saliva penetration¹⁵ and fluid filtration technique.¹⁶

A broad literature search from 2000 to 2015 was done. The resources were PubMed, and Google Scholar, using different keyword

combinations including 'immature tooth', 'open apex', 'sealing ability', 'micro leakage', 'endodontic', 'CEM cement', 'apical plug', 'calcium silicate', 'Endocem', 'portland cement', 'MTA' and 'bio dentine'. Nowadays, the widely used material as apical barrier is Mineral trioxide aggregate (MTA). MTA is a modification form of Portland cement and has few drawbacks including long setting time, tooth discoloration potential, and difficult manipulation.⁹ Several factors including biocompatibility, one visits application, hard tissue induction and good-sealing properties makes the MTA more popular.^{17,18}

Many researchers concluded that MTA and Portland cement had similar microbiological, chemical, physical and biological properties.^{19,20} De-Deus G et al.,²¹ showed in an *In Vitro* study that fluid movement test for apical plugs using white MTA Angelus, MTA Bio, Pro-Root MTA and Portland cement had no significant difference.²¹

Bidar M et al.,²² concluded in an *In Vitro* study that intracanal calcium hydroxide as inter appointment medicament had no adverse effect on sealing properties of a MTA plug.²² However, Adel M et al.,²³ showed intra canal calcium hydroxide therapy had adverse effects on sealing properties of MTA apical plug.²³ Stefopoulos S et al.,²⁴ showed in an *In Vitro* study on sealing ability of white and grey Pro Root MTA as apical plugs that both formulas were comparable but pretreatment by calcium hydroxide, reduces white MTA sealing properties.²⁴

Butt N et al.,²⁵ concluded in an *In Vitro* study that Bio dentine has superior sealing ability as apical plug compared to white MTA.²⁵ Mohammad Yazdizadeh et al.,²⁶ showed in an *In Vitro* study that immediate obturation of the entire root canal after MTA apical plug leads to more leakage compared to 24 hours interval between apical plug placement and obturation by gutta-percha.²⁶ Therefore, MTA requires adequate time for setting in the presence of the moisture, and

final obturation should be delayed until final MTA setting. In the other hand, Khalilak J et al.,⁴ showed in an *In Vitro* study that leakage of MTA apical plug using one- and two-step technique are comparable.⁴

Mehrvarzfar P et al.,²⁷ concluded in an *In Vitro* study on teeth with immature Apices that apical plug fabrication by Pro Root MTA Mixed with Normal Saline had least amount of micro leakage compared to MTA mixed with Calcium Chloride or KY Jelly.²⁷ Kim US et al.,²⁸ showed ultrasonically placed ortho grade MTA apical plugs were effective at reducing and delaying bacterial leakage.²⁸ Another biomaterial used for apical plug is calcium-enriched mixture (CEM) cement, which consists of different calcium compounds,²⁹ the sealing ability of CEM cement as retrograde filling material is satisfactory.³⁰ CEM cement has shown a similar, if not superior, sealing ability compared to MTA.³¹ CEM cement has osteo-conductive properties comparable to MTA.³² Bidar M et al.,³³ concluded that premedication with intra canal calcium hydroxide had no adverse effect on sealing properties of CEM cement as apical plug.³³

Mirhadi H et al.,³⁴ showed CEM cement sealing properties was comparable to MTA at both 5.5 and 7.4 pH levels. In addition, an acidic pH environment has adverse effect on sealing ability of MTA and CEM cement.³⁴ Tabrizzade M et al.,³⁵ showed in an *In Vitro* study on Sealing Ability of MTA and CEM Cement as Apical plug with Different Obturation Techniques that there were no significant differences between micro leakages of the both. The impact of lateral compaction or thermo plasticized injectable gutta-percha or obturation by filling the entire canal with apical plug material on micro leakage was not significant, either.³⁵ Adel M et al.,⁷ concluded that reducing canal diameter or increasing apical plug thickness and the time interval between plug and obturation reduces the micro leakage amount. Furthermore, CEM cement plugs demonstrated superior sealing ability compared to MTA plugs.⁷

Conclusion

All biomaterials used in apexification may leak in different concentrations. Because of the importance of apical seal on long-term success in endodontically treated immature teeth these materials should be applied carefully. The need for more research in this field and introduce new biomaterials with improved sealing ability is evident.

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Conflicts of interest

The author declares that there are no conflicts of interest.

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