Physical and Biological Properties of Three Perforation Repair Materials

(A comparative study)

Thesis Submitted In partial fulfillment of the requirements of the doctor degree in Endodontics

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2017

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ACKNOWLEDGEMENT

Immeasurable appreciation and deepest gratitude for the support and encouragement are extended to everyone who has contributed to making this study possible,

Prof. Dr. Ehab Hassanein, I am honored and pleased to have had the chance to work under your supervision and learn from you valuable experience.

Prof. Dr. Ashraf Abu-Seida, for your tolerance, support and informative directions, I am greatly indebted to you and your hard work in making this study possible.

Assistant prof. Dr. Abeer El Gendy, for your remarkable supervision, sincere encouragement, kind guidance, valuable criticism, and enlightening suggestions

Finally, many thanks are due to my professors, my extended family, my friends and colleagues. Their support and encouragement were a valuable addition to my journey.

Mohamed Mahmoud Sami

INDEX

List of Tables

List of Figures

Introduction

Root perforation is an undesirable incident that can occur at any stage of root canal therapy. Although caries or resorptive processes may cause perforations, most root perforations are induced iatrogenically. According to the Washington study, root perforations result in endodontic failures accounting for approximately 10% of all failed cases [(1)]. Many materials have been used to repair perforations; they include amalgam, Cavit (SPE America 3M, Norristown, PA), Super-EBA (HI Bosworth Co, Skokie, IL), glass ionomer and others.

The success rate of these materials has been variable. Amalgam has been the most commonly used perforation repair material. However, studies have demonstrated that it has poor sealing ability, resulting in inflammation and inadequate regeneration of periradicular tissues (***Alhadainy and Himel***[(2)]).

In addition to providing a good seal, the material of choice for repair of root perforations must be biocompatible, nontoxic, insoluble in the presence of tissue fluids, and capable of promoting regeneration of the periradicular tissues. Mineral trioxide aggregate (MTA) has been recommended as a repair material for root perforations. The biocompatibility of MTA has been demonstrated in vitro and by being implanted in the mandible and tibia of guinea pigs [(3)].

An ideal endodontic repair material should seal the pathways of communication between the root canal system and its surrounding tissues. In addition, it should be nontoxic, noncarcinogenic, nongenotoxic, biocompatible, insoluble in tissue fluids, and dimensionally stable.

Because existing materials did not have these ideal characteristics, mineral trioxide aggregate (MTA) was developed and recommended for pulp capping, pulpotomy, apical barrier formation in teeth with necrotic pulps and open apexes, repair of root perforations, root end filling, and root canal filling.[(4),(5)].

During furcation perforation repair procedures, solubility, bond strength, sealing ability and biocompatibility are of the most important requirements of the repair materials. Since lately many furcation repair materials have been introduced other than MTA therefore, MTA is usually used as the control for comparing the outcomes of these materials. The current study was conducted tofind the optimum furcation root repair material with respect to some of the physical and biological properties.

Review of Literature

MTA was the first root repair material that fulfilled most of the ideal requirements of the furcation repair materials. Researches were and are still carried out to introduce new materials which overcome the drawbacks of MTA which include long setting time and difficulty of application.

I. Solubility of perforation repair materials:

Fridland et al.[6] conducted a study to evaluate the solubility of two powder liquid ratios of MTA and if it will be affected by this difference in powder /liquid ration in water medium and if the pH of the water in contact with the specimens would also remain consistent over time. Specimens were processed at 0.28 and 0.33 water/ powder ratios, and immersed in water according to the ISO 6876 standard. The specimens were periodically removed to assess salt content release and reimmersed in fresh water. Results showed that difference in the powder/ water ratio of MTA specimens did produce a difference in solubility. Also MTA did maintain high PH values over long period of time

Islam et al. [7] evaluated and compared the pH, radiopacity, setting time, solubility, dimensional change, and compressive strength of ProRoot MTA (PMTA), ProRoot MTA (tooth colored formula) (WMTA), white Portland cement (WP), and ordinary Portland cement (OP). The results showed that PMTA and

Portland cement have very similar physical properties. Given the low cost of Portland cement, it is reasonable to consider Portland cement as a possible substitute for PMTA in endodontic applications. However, no clinical recommendation can be made for its use in the human body yet

Danesh et al.[8] evaluated the solubility, microhardness and radiopacity of ProRoot mineral trioxide aggregate (MTA) with two Portland cements (PC: CEM I and CEM II). Solubility: for standardized samples ring moulds were filled with the cements. These samples were immersed in double-distilled water for 1 min, 10 min, 1 h, 24 h, 72 h, and 28 days. Mean loss of weight was determined. These samples were tested according to the ISO standards to compare their radiodensity to that of an aluminum step wedge (1-9 mm). Results showed that MTA had the least solubility.

Poggio et al.[9] tested solubility of 3 root-end filling materials (IRM, Pro Root, and Superseal) and an endodontic sealer (Argoseal) used as positive control. The test was performed according to the International Standards Organization 6876 [(]All retrograde filling materials were of low solubility. Results of this study showed that these materials are reliable in sealing root ends and hence might also be effective in sealing furcation perforations.

Singh et al.[10]conducted a study to evaluate the solubility of new calcium silicate based cements. They choose for the study Biodentine, intermediate restorative material (IRM), Glass ionomer cement (GIC) and mineral trioxide aggregate MTA. Solubility was determined in accordance with the International Standards Organization (ISO) 6876 method and with the American Dental Association (ADA) specification # 30. The solubility of the materials was recorded after 3, 10, 30 and 60 days. Results showed that Biodentine exhibited higher solubility than all other cements and the difference was statistically significant.

Espir et al.[11]conducted a study to evaluate the solubility and sealing ability of mineral trioxide aggregate MTA, zinc oxide and eugenol (ZOE) and calcium silicate cement with zirconium oxide. Solubility test was performed according to ANSI/ADA while sealing ability was evaluated using bacterial leakage method. The difference between initial and final mass of the materials was analyzed after immersion in distilled water for 7 and 30 days .Regarding the solubility after 1 week ZOE exhibited the highest solubility of all materials however the solubility after 30 days was not significant. Regarding the sealing ability, lower bacterial leakage was observed for MTA and CSC/ZrO2, and both presented better results than ZOE.