Journal of Dentistry 60 (2017) 8–13

Contents lists available at ScienceDirect

Journal of Dentistry

journal homepage: www.intl.elsevierhealth.com/journals/jden

A randomized controlled trial of various MTA materials for partial pulpotomy in permanent teeth

Chung-Min Kang, DDS, PhD, Clinical research assistant professor[a,1], Yeji Sun, DDS, Graduate school student[a,1], Je Seon Song, DDS, PhD, Associate professor[a], Nan-Sim Pang, DDS, PhD, Clinical Assistant professor[b], Byoung-Duck Roh, DDS, PhD, Professor[c], Chan-Young Lee, DDS, PhD, Professor[c], Yooseok Shin, DDS, PhD, Clinical Assistant professor[c,*]

[a] Department of Pediatric Dentistry, College of Dentistry, Yonsei University, Seoul, Republic of Korea
[b] Department of Advanced General Dentistry, College of Dentistry, Yonsei University, Seoul, Republic of Korea
[c] Department of Conservative Dentistry, College of Dentistry, Yonsei University, Seoul, Republic of Korea

ARTICLE INFO

Article history:
Received 17 May 2016
Received in revised form 22 July 2016
Accepted 26 July 2016

Keywords:
Partial pulpotomy
MTA
Randomized controlled trial
Permanent tooth

ABSTRACT

Objectives: The aim of this study was to evaluate and compare the clinical applicability of various MTA materials as partial pulpotomy materials in permanent teeth.
Methods: Partial pulpotomy was performed on 104 permanent teeth from 82 people (mean 29.3 ± 14.8 years old), who met the inclusion criteria in randomized clinical trial. The teeth were divided into three groups: ProRoot MTA (n = 33), OrthoMTA (n = 36), RetroMTA (n = 35). Clinical examination and radiographic comparison were carried out at 1, 3, 6 and 12 months after the treatment. Survival analysis was performed using the Kaplan-Meier survival curves and log rank tests.
Results: Partial pulpotomy sustained a high success rate up to 1 year with no significant differences in the outcomes treated with three MTA materials: ProRoot MTA, 96.0%; OrthoMTA, 92.8%; RetroMTA, 96.0%. The Kaplan-Meier survival function curves showed no significant differences among three groups concerning clinical and radiographic cumulative survival rates. In addition, no potential prognostic factors related to the success rate of partial pulpotomy among age, sex, tooth type, root apex status, the site and type of pulp exposure, and the type of restoration were observed in log rank analysis.
Conclusions: Partial pulpotomy with ProRoot MTA, OrthoMTA and RetroMTA had favorable results and clinical and radiographic results were not significantly different in three groups after 1 year.

1. Introduction

There have been researching into a range of treatments for the management of exposed vital pulp in extensively decayed or traumatic teeth: direct pulp capping, partial pulpotomy and complete (cervical or coronal) pulpotomy. Partial pulpotomy is a procedure in which the damaged and inflamed pulp tissue beneath an exposure is removed to a depth of two millimeters to preserve vitality of the remaining coronal and radicular pulp [1,2]. Partial pulpotomy has certain advantages by comparison with direct pulp capping including removal of infected pulp that would increase the success rate of treatment [3]. In addition, partial pulpotomy is more preferable than complete pulpotomy because it preserves cell-rich coronal pulp tissue and enhances physiologic dentine deposition at the cervical area [4].

Partial pulpotomy establishes a biologic environment for the pulp tissue and prevents bacterial infection by proper pulp-capping materials. The material should be bactericidal, biocompatible, provide a biologic sealing, and effect calcific tissue formation. There has been a recent movement towards using mineral trioxide aggregate (MTA), the new gold standard for vital pulp therapies [5], which provides a very good sealing [6], acceptable biocompatibility, and dentin bridge formation in animal [7] or human teeth [8]. ProRoot MTA (Dentsply Tulsa Dental, Tulsa, OK, USA) is a conventionally used material for vital pulp therapy, but has some drawbacks: a discoloration potential [9], presence of heavy metals (arsenic, chromium, and lead) [10],

* Corresponding author at: Department of Conservative Dentistry, Oral Science Research Center and Microscope center, College of Dentistry, Yonsei University, 50-1 Yonseiro, Seodaemun-Gu, Seoul, 03722, Republic of Korea.
E-mail address: densys@yuhs.ac (Y. Shin).
[1] C.-M. Kang and Y.-J. Sun equally contributed to this work.

http://dx.doi.org/10.1016/j.jdent.2016.07.015
0300-5712/

difficult handling characteristics, long setting time [11], and high material cost.

OrthoMTA (BioMTA, Seoul, Korea) and RetroMTA (BioMTA) have been developed recently to overcome these disadvantages. OrthoMTA has been known to contain lower concentrations of heavy metals for a biocompatible property [12] and has a low expansion rate as well as a good sealing ability [13]. Also, it can prevent pulpal environment from bacterial contamination by intratubular mineralization and reduces microleakage by forming an amorphous tag-like structure formation at MTA/dentin interface [14]. However, an in vitro study showed OrthoMTA showed lower cell viability compared with ProRoot MTA [15]. The clinical advantage of RetroMTA is its shortened setting time, about 180 s. Fast setting time may be caused by zirconium complex, which has been reported to modify the chemistry for setting and change physical properties [16,17]. In addition, less discoloration was observed with RetroMTA than ProRoot MTA in an Ex Vivo study [18]. Lee and Shin et al. found that RetroMTA resulted in a slightly higher pulpal inflammation and lower calcification reaction when compared with ProRoot MTA; however, the differences were not statistically significant [19]. We have already researched clinical outcomes comparing the effects of ProRoot MTA, OrthoMTA and RetroMTA in primary molar pulpotomy [20]. Because no studies in permanent teeth using these MTAs can be found in the literature, this study was a subsequent study to compare the effects of partial pulpotomy in permanent teeth.

The aim of this study was to investigate the clinical and radiographic outcomes of partial pulpotomy using various MTA materials on exposed pulp tissue of human permanent teeth in a randomized controlled trial. Therefore, we assumed the null hypothesis was that there was no significant difference in treatment effectiveness with ProRoot MTA, OrthoMTA and RetroMTA as partial pulpotomy materials.

2. Materials and methods

2.1. Participants

Patients aged (mean 29.3 ± 14.8 years), who went to the Yonsei University Dental Hospital having no systemic diseases and permanent teeth with advanced caries or dental trauma with pulp exposure, were subjects for this study. Teeth were included if they met the following criteria:

Inclusion criteria

A. Tooth has no history of spontaneous pain.

B. Tooth has acute minor pain that subsides with analgesics.

C. Tooth has no discomfort to percussion, no vestibular swelling and no mobility.

D. Radiographic examination shows normal appearance of periodontal attachment.

E. Pulp is exposed during caries removal or subsequent to recent trauma.

F. Bleeding from the pulp excision site stops with NaOCl within 5 min

Teeth with irreversible pulpitis or pulp necrosis were not included in the study. Teeth found to have unexposed pulp during the procedure and those that exhibited uncontrolled pulpal hemorrhage during the procedure lasting more than 5 min were also excluded. Informed consent was acquired from all patients. This clinical protocol was supervised by the IRB of Yonsei University Dental Hospital (approval no. 2-2012-0053).

2.2. Randomized patient allocation

A randomized, controlled, single-blinded clinical trial was carried out. For the randomization, a random number table was used by a clinical coordinator while the principal clinician did not decide the group to which the teeth belong. The clinicians just selected the proper cases of indications for partial pulpotomy. The clinical coordinator arranged the involved permanent teeth to one of the following MTAs: ProRoot MTA, OrthoMTA or RetroMTA.

2.3. Clinical procedure

Treatment was performed by several dentists at the Department of Pediatric Dentistry and Conservative Dentistry at the Yonsei University Dental Hospital. After application of local anesthesia (2% lidocaine with epinephrine 1:80,000; Huons, Seongnam, Korea) and rubber dam isolation, the outline formation of sound enamel was carried out using a sterile flame shape diamond bur (Blasseler, FL, USA) at high speed and the carious dentin was completely removed with a low speed round carbide bur (no. 6, Prima Classic RA6, Prima Dental Group, Gloucester, UK).

In teeth with pulp exposure, the exposed tissue was removed with a sterile high-speed round tapered diamond bur (Komet Dental, Gebr. Brasseler, Lamgo, Germany) under water-coolant to a depth of 1.5–2 mm. After the pulp amputation, the preparation is thoroughly washed with 3% NaOCl to disinfect and control hemorrhage. Upon successful hemostasis within 5 min, the MTA materials were used in accordance with the recommendation by the manufacturer. The compositions of three MTA materials are shown in Table 1 [20].

In the ProRoot MTA and OrthoMTA groups, a wet cotton pellet and IRM filling over the MTA materials were applied in. In a subsequent visit within 2–3 days, cotton pellet and IRM were removed and the cavity was restored with resin-modified glass ionomer (RMGI; GC Fuji II LC, GC Corp, Tokyo, Japan) as a base By contrast, the teeth in the RetroMTA group were covered with RMGI after 5 min for setting of the MTA. In all groups, the teeth were restored with final restoration. When isthmus of cavity form was smaller than two-thirds of intercuspal width, teeth were restored directly with composite resin (Premisa, KERR Corporation, Orange, CA, USA) using etch-and-rinse adhesive system. Other than that, teeth were restored indirectly with inlay, onlay, or crown, depending on the shape and size of the cavity

2.4. Follow-up

When it was 1, 3, 6 and 12 months after partial pulpotomy, all participants were recalled whether they had symptom or not. Follow-up examinations were performed clinically and radiographically, including pulp vitality test and percussion. The clinical and/or radiographic fail criteria were determined like follows: (1)

Table 1
Composition and ingredients of ProRoot MTA, OrthoMTA and RetroMTA.

Material	Composition	Content (wt%)
ProRoot MTA	Calcium oxide (CaO)	44.2
	Silicon Dioxide (SiO_2)	21.2
	Bismuth oxide (Bi_2O_3)	16.1
	Aluminum oxide (Al_2O_3)	1.9
	Magnesium oxide (MgO)	1.4
	Sulfur trioxide (SO_3)	0.6
	Ferrous oxide (FeO)	0.4
OrthoMTA	Tricalcuim silicatie ($3CaO{\cdot}SiO_2$)	76.3
	Dicalcium silicate ($2CaO{\cdot}SiO_2$)	11.8
	Tricalcium aluminate ($3CaO{\cdot}Al2O_3$)	8.0
	Tetracalcium aluminoferrite ($4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$)	0.8
	Free calcium oxide (Free CaO)	0.7
RetroMTA	Calcium Carbonate ($CaCO_3$)	60–80
	Silicon Dioxide (SiO_2)	5–15
	Aluminum oxide (Al_2O_3)	5–10
	Calcium zirconia complex	20–30