Human Pulp Responses to Partial Pulpotomy Treatment with TheraCal as Compared with Biodentine and ProRoot MTA: A Clinical Trial

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Abstract

Introduction: Questions exist regarding the efficacy of resin-containing materials such as TheraCal directly applied on the pulp. This study sought to investigate the clinical efficacy of TheraCal as compared with Biodentine and ProRoot mineral trioxide aggregate (MTA) for partial pulpotomy. **Methods:** In this clinical trial, partial pulpotomy was performed for 27 sound human maxillary and mandibular third molars scheduled for extraction. The teeth were randomly divided into 3 groups (n = 9) and underwent partial pulpotomy with TheraCal, Biodentine, and ProRoot MTA. The teeth were then restored with glass ionomer cement. Clinical and electric pulp tests were performed after 1 and 8 weeks. The teeth were radiographed and extracted at 8 weeks. Histologic sections were prepared and analyzed for pulp inflammation and dentinal bridge formation. Data were analyzed by using one-way analysis of variance. **Results:** Clinical examination showed no sensitivity to heat, cold, or palpation in ProRoot MTA and Biodentine groups. Two patients in TheraCal group (20%) reported significant pain at 1 week. Periapical radiographs showed no periapical pathology, and electric pulp test revealed a normal pulp response with no hypersensitivity. Inflammation was absent with all materials at 8 weeks. Normal pulp organization was seen in 33.33% of the teeth in ProRoot MTA, 11.11% in TheraCal, and 66.67% in Biodentine group (P = .06). Biodentine group showed complete dentinal bridge formation in all teeth, whereas this rate was 11% and 56% in TheraCal and ProRoot MTA groups, respectively (P = .001). **Conclusions:** Overall, Biodentine and MTA performed better than TheraCal when used as partial pulpotomy agent and presented the best clinical outcomes. *(J Endod 2017;■:1–6)*

Key Words

Biodentine, partial pulpotomy, ProRoot MTA, TheraCal

Significance

Preservation of pulp vitality is a challenge in immature permanent teeth. Questions exist regarding the efficacy of resin-containing materials. This comparative study between Biodentine, TheraCal, and ProRoot MTA aims to provide a better insight into it. Overall, Biodentine and MTA performed better than TheraCal when used as partial pulpotomy agent and presented the best clinical outcomes.

Preserving pulp vitality after carious or traumatic injuries remains a challenge in immature permanent teeth because this vitality is important for complete root formation (1–3). To this end, vital pulp therapy should be considered in teeth with reversible injury.

ProRoot mineral trioxide aggregate (MTA) is mainly composed of tricalcium silicate, dicalcium silicate, tricalcium aluminate, tetracalcium aluminoferrite, and bismuth oxide (4). When applied directly onto the pulp, MTA as a bioactive material with high sealing ability (3, 5–10) stimulates the formation of dentinal bridge (1, 5–8) and leads to pulp healing, yielding high clinical success rate (6–9). However, MTA has a long setting time (11) and poor handling properties (12) and may lead to tooth discoloration (10, 11).

Biodentine is a tricalcium silicate–based restorative cement used for direct and indirect pulp capping. It has mechanical properties comparable to those of dentin and can be used as a dentin substitute in both the crown and root (3, 13–18). Biodentine is bioactive and nontoxic as tested on human pulp cells (1) and provides marginal sealing by adhering to both dentin and enamel (15, 16). When applied directly onto the pulp in entire tooth cultures, it induced mineralization within the pulp (1) and complete dentinal bridge formation after 6 weeks in human teeth (19). In addition, clinical trials have reported a high clinical success rate of pulpotomy with Biodentine comparable to that of ProRoot MTA (20). Clinical case reports have demonstrated a dentin bridge barrier formation when Biodentine was applied in partial pulpotomy of fractured mature teeth (21).

TheraCal is a new light-cured, resin-modified, calcium silicate–filled base/liner material designed for direct and indirect pulp capping (22). It contains 45 wt% mineral

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(type III Portland cement), 10 wt% radiopaque agent, 5 wt% hydrophilic thickening agent, and 45% resin (22).

Mechanical properties analysis indicates that TheraCal has the greatest compressive and flexural strengths, whereas Biodentine has a higher stiffness and flexural modulus. TheraCal has been reported to be toxic to pulp cells *in vitro* (23). In addition, an extensive inflammatory reaction was observed in 75% of the cases 4 weeks after TheraCal application in dog teeth, whereas a complete dentinal bridge was formed only in 33% of the teeth (24).

A recent study comparing solubility of 6 materials including TheraCal, ProRoot MTA, and Biodentine showed that all 6 materials showed low solubility (25, 26). Both Biodentine and MTA have excellent sealing properties and potential to prevent microleakage (19). However, formation of tunnel defects in reparative dentin underneath the capping material may fail to provide a permanent seal (27). Thus, sealing ability of a material may serve a more prominent role in clinical outcomes than its solubility.

ProRoot MTA is known for its prolonged setting time, which is significantly longer than that of Biodentine (26). It has been shown that TheraCal has a short setting time and releases significantly less calcium ions than Biodentine in aqueous solutions *in vitro* (24).

Because of the lack of clinical studies, questions regarding the safety of applying resin-containing materials such as TheraCal directly onto the pulp remain to be answered. Thus, the aim of this study was to compare the clinical efficacy of TheraCal in partial pulpotomy with that of Biodentine and ProRoot MTA.

Materials and Methods

Inclusion Criteria

Twenty-seven sound human maxillary and mandibular third molars scheduled for extraction were selected in patients between 18 and 32 years of age. Each tooth was radiographically examined to ensure absence of caries and periapical pathology (28).

Operative Procedure

Patients were informed about the experimental rationale, clinical procedures, and possible complications and signed consent forms. All experimental procedures were reviewed and approved by the Ethical Committee of Tehran Dental Branch of Islamic Azad University (code: IR.IAU.Dental.rec.1395,21), and the study was registered in IRCT (ID number: 2015082420004N2). Third molars were then randomly assigned to TheraCal (n = 9), Biodentine (n = 9), and ProRoot MTA (n = 9) groups. Thermal (M + W Dental Müller & Weygandt GmbH, Büdingen, Germany) and electric pulp tests (Sybron Endo, Orange) were performed to assess pulp sensitivity. A standard partial pulpotomy procedure was performed in each experimental group. Before cavity preparation, the teeth were mechanically cleaned and disinfected with 0.2% chlorhexidine solution. After local anesthesia with 2% lidocaine (Daroupakhsh, Tehran, Iran) and rubber dam application, occlusal class I cavities were prepared by using sterile round diamond bur and high-speed handpiece under air-distilled water spray. Pulp chamber was exposed (approximately 2 mm in diameter) with a 10-mm fissure diamond bur (837 L; D + Z GmbH, Frankfurt, Germany) under sterile saline coolant. New burs were used for each preparation. Bleeding was controlled with sterile cotton pellets placed over the pulp exposure site. Partial pulpotomy was performed for the 3 groups as follows.

For ProRoot MTA group, ProRoot MTA (Dentsply, Tulsa Dental, Tulsa, OK) was prepared by gradually mixing 1 mg powder with the liquid within 1 minute according to the manufacturer's instructions until a thick paste with creamy consistency was obtained. After its excision, the pulp was capped with a 2-mm-thick layer of ProRoot MTA, after which a flat, moist cotton pellet was used to shape the material.

For Biodentine group, excised pulps were capped with Biodentine (Septodont, Saint Maur des Fosses, France) per manufacturer's recommendations. The cement was applied as bulk in the cavity with a spatula and a plugger without any conditioning pretreatment.

For TheraCal group, excised pulps were capped with TheraCal (Bisco Inc, Schaumburg, IL) according to the manufacturer's recommendations. A 2-mm-thick layer of TheraCal was placed in the cavity and polymerized for 20 seconds after each 1-mm increment.

After partial pulpotomy, the cavities in all 3 groups were restored with glass ionomer cement (Ketac Molar; 3M ESPE, Seefeld, Germany) (19).

Patients in all groups returned to the clinic for clinical examination after 7 days. One experienced operator performed all the operative procedures.

Clinical Examination

The treatment period was 8 weeks, after which the teeth were extracted for histologic examinations. Radiographs were taken before extraction to determine any signs of periapical pathology. Clinical tests were performed after 1 and 8 weeks. Electric pulp test was performed to assess pulp vitality.

Histologic Examination

After extraction, 1 mm of the apex was cut, and the teeth were fixed with 4% formaldehyde solution and demineralized as previously described (29). Next, 5-μm-thick sections were made of formalin-fixed, paraffin-embedded teeth and stained with hematoxylin-eosin. Finally, the slides were assessed by a pathologist blinded to the patient groups under a light microscope (BX41; Olympus, Tokyo, Japan) by using modified criteria that were based on those of Nowicka et al (19).

Type of Pulp Inflammation

1. No inflammation
2. Chronic
3. Acute and chronic
4. Acute

Intensity of Pulp Inflammation

1. Absent or very few inflammatory cells
2. Mild, <10 inflammatory cells
3. Moderate, 10–25 inflammatory cells
4. Severe, >25 inflammatory cells

Extension of Pulp Inflammation

1. Absent
2. Mild, inflammatory cells only next to pulp exposure site
3. Moderate, inflammatory cells observed in part of coronal pulp
4. Severe, all coronal pulp is infiltrated

Dentin Bridge Thickness

1. >0.25 mm
2. 0.1–0.25 mm
3. <0.1 mm
4. Partial or absent bridge