Treatment Outcome Following Direct Pulp Capping Using Bioceramic Materials in Mature Permanent Teeth with Carious Exposure: A Pilot Retrospective Study

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Abstract

Introduction: The aim of this study was to investigate the sequelae of direct pulp capping (DPC) using mineral trioxide aggregate (MTA) and Biodentine in mature permanent teeth with carious exposure. **Methods:** Clinical records of 30 patients (15 each with MTA and Biodentine) treated with DPC technique from January 2015 to June 2015 were retrieved. Success rates (based on symptoms, sensibility tests, and radiographic analysis) and adverse events were analyzed. **Results:** The patients were reviewed at 1, 3, 6, 12, and 18 months after treatment. Four cases (2 each of MTA and Biodentine) were lost to follow-up. MTA and Biodentine groups showed success rates of 84.6% and 92.3%, respectively, with overall success rate of 88.5%. Radiographically visible dentin bridge formation was observed in 69.2% (9/13) and 61.5% (8/13) of cases done with MTA and Biodentine, respectively. The cases done with MTA showed coronal discoloration on review. Diffuse calcifications of the pulp chamber were observed in 1 (7.7%) case done with MTA and 3 (23.1%) cases done with Biodentine. **Conclusions:** The advent of bioceramic materials with better biocompatibility and sealing properties can make the outcome of DPC technique in mature permanent teeth with carious exposure more predictable. The success rate observed in this study should be confirmed through randomized controlled trials with long follow-up periods. Effects of adverse events like coronal discoloration and calcifications of the pulp chamber also need to be evaluated. *(J Endod 2017;■:1–5)*

Key Words

Bioceramic materials, direct pulp capping, mature permanent teeth

Significance

Traditionally, direct pulp capping was performed in young permanent teeth with traumatic or iatrogenic pulp exposure, and carious exposure was managed by pulpotomy or pulpectomy. The advent of newer bioceramic materials has made the procedure in teeth with carious exposure more predictable, even in mature permanent teeth.

The dental pulp is protected from the oral environment by a rigid enclosure made of enamel, dentin, and cementum (1). Other than forming the tooth during childhood, an intact dental pulp could provide several defense mechanisms possibly preventing bacterial invasion, hence it is valuable to sustain an exposed pulp rather than meticulously replacing it with a synthetic root filling material (2, 3).

Vital pulp therapy is aimed at preserving and maintaining pulpal health in teeth in which pulp exposure has occurred due to trauma, caries, or restorative procedures (4). The treatment options for a pulp-exposed permanent tooth include direct pulp capping (DPC), pulpotomy, and pulpectomy. DPC is defined as "placing a dental material such as calcium hydroxide or mineral trioxide aggregate (MTA) directly on a mechanical or traumatic vital pulp exposure, thereby sealing the pulpal wound to facilitate the formation of reparative dentin and maintenance of the vital pulp" (5). Traditionally if the tooth is exposed by caries, vitality can be preserved by partial pulpotomy after removing coronal pulp to the level of healthy pulp tissue (6).

The lack of predictability of the outcome of DPC procedures following carious pulp exposure (3, 7) has been stated based on traditional protocols and materials that did not generate a favorable environment for hard tissue formation. Success rates usually ranged from 30% to 85% (3, 7–11). The introduction of MTA and other bioceramic or calcium silicate–based cements (CSCs), along with advanced treatment strategies, have markedly changed the long-held concept that pulp capping after carious pulp exposures should be avoided (2, 12, 13).

MTA powder is a mixture of dicalcium silicate, tricalcium silicate, tricalcium aluminate, calcium sulfate, tetracalcium aluminoferrite, and bismuth oxide that is mixed with distilled water during manipulation (14, 15). Dicalcium silicate, tricalcium silicate, calcium carbonate, calcium oxide, and zirconium oxide constitute the powder of Biodentine and the liquid contains water, calcium chloride, and a plasticizing agent (16). BioAggregate, EndoSequence root repair material, calcium-enriched mixture cement, and TheraCal are a few other CSCs

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used in endodontics. During manipulation of CSCs, calcium hydroxide and calcium silicate hydrate are the primary compounds formed and the calcium silicate hydrate gel solidifies to form a hard structure (15, 17).

Although a few studies have been published assessing the outcomes of DPC using bioceramic materials in young permanent teeth, not much literature is available in relation to the procedure in mature permanent teeth (MPTs). The purpose of the present study was to assess the outcome of DPC with MTA and Biodentine in MPTs with carious exposure.

Materials and Methods

Patient Selection

The Department of Conservative Dentistry and Endodontics, Government Dental College, Thiruvananthapuram, has a set clinical protocol for DPC using bioceramic cements. In the current study, the treatment profile of patients who were treated with DPC technique following this protocol from January 2015 to June 2015 were retrieved regardless of the outcome. Cases that fulfilled the following criteria were included in the outcome analysis:

1. Patients in the age group of 15 to 30 years
2. Complaints of cavity in MPTs and/or sensitivity to cold food and/or food lodgement in cavity at presentation
3. No history of night pain or spontaneous pain
4. Mandibular molars with caries restricted to occlusal surface
5. Pulp sensibility tests elicited a positive response
6. Radiographic examination showed deep caries approaching pulp, with no signs of periapical pathology
7. Patients who were systemically healthy

Teeth with excruciating/lingering pain in response to pulp sensibility tests and iatrogenic pulp exposure were excluded. A total of 30 MPTs that met the criteria were selected for the analysis.

Clinical Procedure

Informed consent was obtained from all patients. Sensibility of the tooth was assessed with a digital electrical pulp tester (Digitest II Pulp Vitality Tester; Parkell Inc, Edgewood, NY). Local anesthesia (lignocaine 2%, adrenaline 1:200000; Aculife Healthcare Pvt. Ltd, Gujarat, India) and rubber dam (Hygienic; Coltene Whaledent AG, Altstatten, Switzerland) isolation was achieved. Cleaning and disinfection of the tooth surface was achieved using pumice slurry, rubber cup, and sodium hypochlorite 5% (Pyrex Exports, Roorkee, India). The caries was removed initially with a sterile round diamond bur (BR 31; Mani Inc, Utsunomiya, Japan) at high speed, followed by a sterile low-speed carbide round bur, no. 4 and no. 6 (SS White, Lakewood, NJ), on nearing the pulp. In cases with evident pulp exposure on caries removal, hemorrhage was controlled by using a cotton pellet soaked with 5% sodium hypochlorite for 10 minutes. After controlling hemorrhage, DPC was done with MTA (ProRoot MTA; Maillfer, Dentsply, Switzerland) or Biodentine (Septodont, Saint-Maur-des-Fosses, France). Materials were mixed according to the manufacturer's instructions. In cases treated with MTA, the material was placed over the exposure site and surrounding dentin as a 1.5- to 3.0-mm-thick layer. Resin modified glass ionomer (GC Fuji II LC; GC Corp, Tokyo, Japan) was placed over the MTA. Final restoration was done with resin-bonded composite (3M ESPE, St. Paul, MN) a week later. In cases treated with Biodentine, the cavity was bulk filled with the material. On a 2-week recall visit, the Biodentine was reduced to a base or dentin substitute level and the teeth were permanently restored with resin-bonded composite.

TABLE 1. Comparison of Demographic and Baseline Clinical Characteristics

Variable	DPC material	
	MTA, *n* (%)	Biodentine, *n* (%)
Age, y		
15–20	5 (38.5)	9 (69.2)
21–25	5 (38.5)	4 (30.8)
26–30	3 (23.1)	0
Gender		
Male	3 (23.1)	2 (15.4)
Female	10 (76.9)	11 (84.6)
Type of teeth		
Mandibular first molar	7 (53.8)	6 (46.2)
Mandibular second molar	6 (46.2)	7 (53.8)
Presence of preoperative pain		
Present	11 (84.6)	10 (76.9)
Not present	2 (15.4)	3 (23.1)
Follow-up period, month(s)		
1	2 (15.4)	1 (7.7)
12	6 (46.2)	7 (53.8)
18	5 (38.5)	5 (38.5)

DPC, direct pulp capping; MTA, mineral trioxide aggregate.

TABLE 2. Comparison of Treatment Outcome

Variable	DPC material	
	MTA, *n* (%)	Biodentine, *n* (%)
Treatment outcome		
Success	11 (84.6)	12 (92.3)
Failure	2 (15.4)	1 (7.7)

DPC, direct pulp capping; MTA, mineral trioxide aggregate.

Evaluation of Follow-up

Patients' records were analyzed for clinical and radiographic recall data at intervals of 1, 3, 6, 12, and 18 months. The data comprising pain (on percussion/spontaneous/night) after treatment, sensibility status of the teeth, radiographic signs of periapical pathology, and dentin bridge formation were assessed. Teeth that remained asymptomatic with positive response to sensibility tests and/or radiographic evidence of hard tissue bridge formation with no radiographic signs of periapical pathology were considered successful.

Statistical Analysis

The statistical calculations were performed using the software SPSS for Windows version 19.0 (Statistical Presentation System Software; SPSS Inc., New York, NY). Appropriate descriptive statistics

TABLE 3. Comparison of Other Treatment Outcomes

Variable	DPC material	
	MTA, *n* (%)	Biodentine, *n* (%)
Radiographically visible dentin bridge		
Visible	9 (69.2)	8 (61.5)
Not visible	4 (30.8)	5 (38.5)
Coronal discoloration*		
Present	9 (69.2)	0
Not present	4 (30.8)	13 (100)
Diffuse calcification of pulp chamber		
Present	1 (7.7)	3 (23.1)
Not present	12 (92.3)	10 (76.9)

DPC, direct pulp capping; MTA, mineral trioxide aggregate.

*$P < .05$ (statistically significant).