

Biodentine™ Partial Pulpotomy in Adult Permanent Teeth with Cariously-Exposed Pulp: Case Reports (up to 30 Months Follow-Up)

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Abstract

A new calcium silicate-based cement, Biodentine™ (Septodont, Saint Maur des Fosses, France), has recently been introduced. With its biocompatibility and dentinal bridge-promoting properties comparable to those of the clinically well-accepted mineral trioxide aggregate (MTA), Biodentine™ could probably be an appropriate option for pulp capping procedures. However, clinical outcome studies on Biodentine™ are limited. Moreover, vital pulp therapy in cariously exposed permanent teeth is also controversial. These case reports describe clinical procedures and outcomes of partial pulpotomy using Biodentine™ as a pulp capping material in four cariously exposed adult permanent teeth in three patients aged 22 to 50 years. At 12 to 30 months follow-up, none of the patients experienced spontaneous pain, swelling or abscess formation. All teeth displayed a positive response to pulp testing and functioned normally. The radiographic evaluation revealed normal periapical areas.

Keywords: Biodentine™, Calcium silicate-based cement, Cariously exposed pulp, Partial pulpotomy, Mature permanent tooth

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Introduction

The partial pulpotomy for carious exposures is a procedure in which the inflamed pulp tissue beneath an exposure is removed to a depth of one to three millimeters, or deeper, to reach healthy pulp tissue.¹ Histological studies^{2,3} have shown that pulp adjacent to carious exposure may have only local damage, while the remaining pulp may be infiltrated with inflammatory cells to varying degrees, or may even be free from inflammatory change. If the cause of the inflammation is removed and bacterial microleakage is prevented, the inflamed pulp may heal.⁴⁻⁶ However, the procedure has not been popular for mature permanent teeth of adult patients, since there is a concern that increasing age may affect clinical success.⁷ A systematic review by Aguilar and Linsuwanont⁸ reported a weighted pooled success rate of 90.6 % for partial pulpotomy in permanent teeth with closed apices but with inconclusive information regarding age as a factor influencing treatment outcome.

It has been suggested that bioengineered medicaments may be useful for inducing reparative dentin, thereby decreasing the patients' advancing age as a negative factor.⁷ Mineral trioxide aggregate (MTA), a calcium silicate-based cement, has become a popular alternative to calcium hydroxide ($\text{Ca}(\text{OH})_2$) as a pulp capping material. The effectiveness of MTA as a pulp capping material in human permanent

teeth has been shown to outperform $\text{Ca}(\text{OH})_2$ in clinical and histological observations.^{9,10}

However, MTA has some known drawbacks, including long setting time, potential of tooth discoloration, high costs and handling difficulty.¹¹⁻¹³ Recently, a new calcium-silicate based material, Biodentine™ (Septodont, Saint Maur des Fosses, France), has become available with lower cost. Results from in vitro and in vivo studies have shown promising biocompatibility and bioactive properties as a pulp capping material¹⁴⁻¹⁸ with improved physical properties and handling characteristics compared to those of MTA.¹⁹⁻²¹ However, current evidence on clinical outcomes of Biodentine™ is limited.^{15,22} To the authors' knowledge, there is no report on clinical outcomes of cariously exposed human permanent teeth treated with Biodentine™. Therefore, the following case reports describe clinical procedures and outcomes of partial pulpotomy using Biodentine™ as a pulp capping material with up to 30-month follow-up.

Case reports

Four teeth in three patients who had undergone partial pulpotomy in the Comprehensive Dental Clinic, Division of General Dentistry, Faculty of Dentistry, Chiang Mai University, Chiang Mai, Thailand, during April 2013

through February 2014 were included in this report. Before treatment, the patients had been informed of the potential risks and benefits, costs and clinical procedures. Patients' questions had been answered and consent forms signed. Clinical and radiographic examination was performed and recorded. An electric pulp tester (Digitest Pulp Vitality Tester model no. D626D; Parkell, Edgewood, New York, USA) was used to assess pulpal vitality. Pre-operatively, all patients presented with deep carious lesions without severe or lingering pain and had normal periodontal spaces on periapical radiographs. Positive responses to electric pulp tester were also obtained from all included teeth.

One undergraduate and two postgraduate dental students performed all treatments under the supervision of a clinical teaching staff member with an endodontic background.

Clinical procedures

Following local anesthesia using 4 % articaine with 1:100,000 epinephrine (Ubistesin Forte, 3M ESPE, Neuss, Germany) and rubber dam isolation, the tooth to be treated and the operative field was disinfected with 2 % chlorhexidine gluconate solution. Dental caries was then excavated initially from the periphery toward the pulpal center of the lesion using a spoon excavator and a slow speed round bur until hard dentin was felt while probing with a spoon excavator, suggesting that complete caries removal was achieved. When pulpal exposure occurred, a high speed round diamond bur, sized

approximately to the exposure, was used with copious water coolant to brush away the superficial surface of the exposed pulp and the surrounding dentine. The exposed area was then rinsed with 5 ml of either 2.5 % sodium hypochlorite (NaOCl) or 2 % chlorhexidine gluconate solution. A cotton pellet dampened with the solution was then pressed over the area to control bleeding for 5 minutes. If bleeding control was not achieved at this stage, a high speed round diamond bur was used again to remove an additional 1 to 2 mm of pulp tissue and the irrigation and pressing was repeated. The rest of the cavity was blotted dry with a sterilized cotton pellet. After a clean and dry area was obtained, Biodentine™ was prepared according to the manufacturer's instructions and carried onto the exposure and surrounding dentin using an amalgam carrier or a plastic instrument. This first portion of Biodentine™ was pressed gently by a plugger or a ball-burnisher to ensure the adaptation of the material with the pulp tissue and the surrounding dentin. The rest of the cavity was filled with the remaining Biodentine™ to serve as an intermediate restoration. When the material was set, the occlusion was checked and post-operative periapical radiograph was made. Patients were appointed for placement of a direct composite restoration on their next visit, over the cut back Biodentine™, which served as a base material on their next visit.

Case 1

A healthy 50-year-old female presented with an isolated deep carious lesion extending under the distal gingival margin of tooth 47 (Fig. 1a). She reported a short-duration sensitivity to cold water without other symptoms. Clinical symptoms and signs were indicative of reversible pulpitis with normal periapical tissues. A surgical crown lengthening was done prior to a partial pulpotomy procedure to provide a suitable environment for rubber dam isolation and a manageable restorative margin. Upon caries removal, a 2.5-mm pulp exposure was found. A partial pulpotomy protocol as mentioned above

was followed with bleeding control achieved after the first five-minute pressure application (Figs. 1b-1d). Two days later, a direct composite restoration was placed over the partially cut back Biodentine™. Biodentine™ was found to be completely set with a hard consistency, similar to that of set glass ionomer cement. At the 26-month recall, the patient reported no symptoms and normal function, the tooth responded well to a cold test using Endo-Ice® (Coltène Whaledent, Cuyahoga Falls, Ohio, USA) and the restoration was still intact (Fig. 1f). Radiographic evaluation at 26 months showed clinically normal periapical tissues (Fig. 1e).

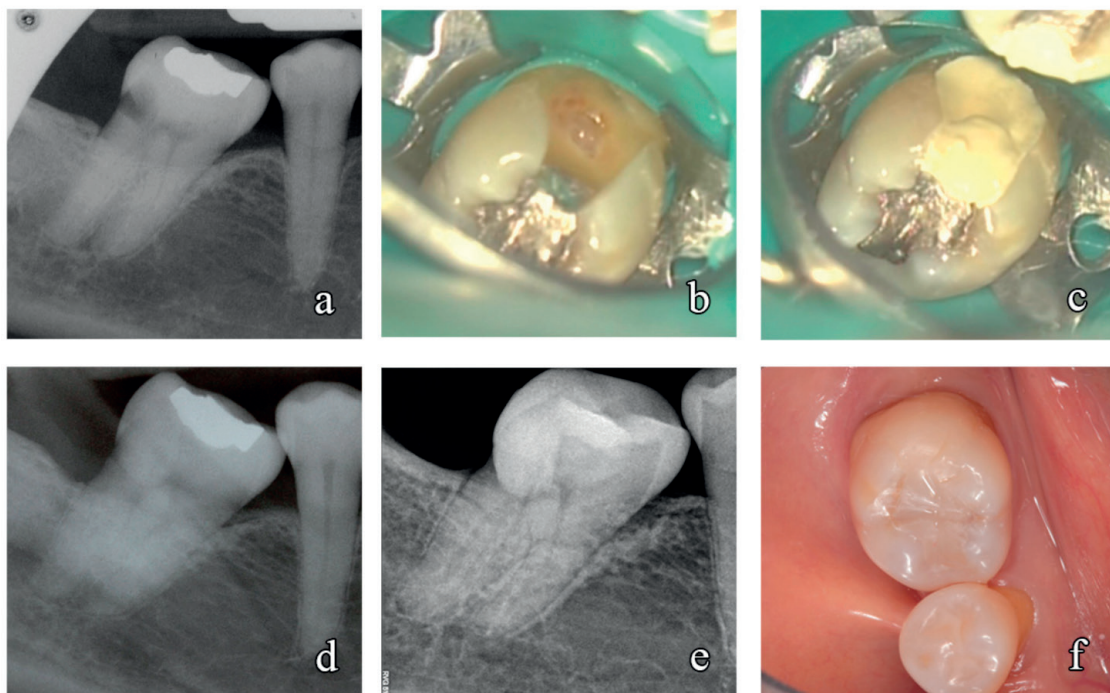


Figure 1 Partial pulpotomy on tooth 47 (a) Preoperative radiograph showing that the caries on the distal aspect was in close proximity to the pulp. (b) 2.5-mm pulp exposure was found after complete caries removal and the coronal pulp was amputated. (c) Biodentine™ was directly applied. (d) Immediate postoperative radiograph (e, f) 26-month postoperative radiograph and photograph

Case 2

A healthy 22-year-old female presented with tooth 25 showing a deep distal caries lesion without pain on biting. However, this tooth had a positive response to percussion without noticeable radiographic changes periapically (Fig. 2a). While removing caries, a 1.5-mm pulp exposure occurred. The clinical diagnosis was then made as asymptomatic irreversible pulpitis with symptomatic apical periodontitis. Complete caries removal using the partial pulpotomy protocol, using 2.5 % NaOCl irrigant as mentioned above, was performed with bleeding control

achieved within the first five-minute pressure attempt. Biodentine™ was applied as an intermediate restoration. Six days later, a direct resin composite was placed as a permanent restoration (Fig. 2b). At the 12-month recall visits, radiographic examinations revealed normal periapical tissue (Fig. 2c). Compared to the early post-operative radiograph (Fig 2b), a receded pulp chamber roof was noticed at 12-month recall (Fig. 2c), suggesting reparative dentine formation. At 30-month recall, the tooth was asymptomatic and responded positively to electric pulp test (EPT) and had an intact restoration (Fig. 2e).

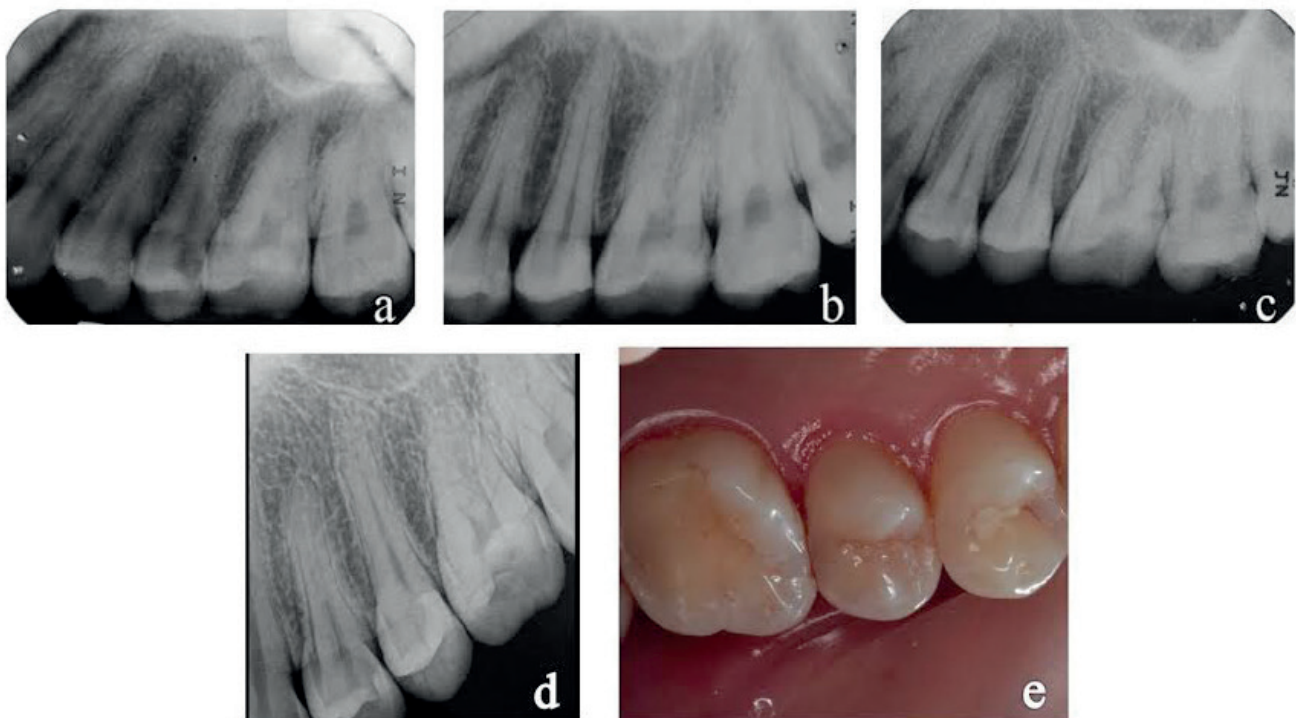


Figure 2 Partial pulpotomy on tooth 25. (a) Preoperative radiograph showing deep caries with normal periapical area, (b) Early postoperative radiograph showing good adaptation of Biodentine™ and resin composite restoration, (c) 12-month recall radiograph showing receded pulp chamber and normal periapical area, (d) 30-month recall radiograph, (e) Intraoral photograph showing restoration was intact at 30-month recall.

Case 3

A healthy 37-year-old female presented with deep caries on teeth 14 and 36 without clinical signs indicative of irreversible pulpitis. The pre-operative radiographs of both teeth demonstrated extremely deep caries that might have reached the pulp, with normal periapical areas (Figs. 3a, 4a). After complete removal of caries, a 1.5-mm pulp exposure on tooth 14 and two 1-mm pulp exposures on tooth 36 were found. A partial pulpotomy protocol, as mentioned above, was followed, with hemorrhage control achieved at the first attempt. A direct

resin composite restoration was placed on tooth 36 at the one-month recall visit but tooth 14 was not permanently restored because of time limitation. Contact with the patients was lost until 12 months after tooth 14 was treated. We found that the Biodentine™ intermediate filling on tooth 14 and the permanent restoration on tooth 36 were still intact at that time (Figs. 3b, 4b). Both teeth were also asymptomatic and responded positively to EPT. The radiographs of tooth 14 at 12 months and tooth 36 at 14 months postoperative, also showed normal periapical areas (Figs. 3c, 4c).



Figure 3 Partial pulpotomy on tooth 14. (a) Preoperative radiograph showing deep caries with normal periapical area, (b) Intraoral photograph showing good adaptation of Biodentine™ at 12-month postoperative, (c) 12-month recall radiograph showing normal periapical area.



Figure 4 Partial pulpotomy on tooth 36. (a) Preoperative radiograph showing deep caries with normal periapical area, (b) Intraoral photograph showing restoration was intact at 14-month recall, (c) 14-month recall radiograph showing normal periapical area.

Discussion

We observed successful outcomes of four teeth in three adult patients aged 22 to 50 years, with cariously exposed pulp, treated with a partial pulpotomy technique using Biodentine™ as a pulp capping material. All treated teeth showed no symptoms, positive responses to sensibility tests and normal periapical radiographic finding at 12 to 30-month follow-up.

Age-related changes in dental pulp, such as reduction in odontoblasts and fibroblast cell density while fibrous bundles of collagen increased, were evidenced.²³ These changes suggest that the reparative capacity of aging pulp was compromised. Choosing the innovative calcium silicate-based cements with well accepted biocompatibility and tissue repair promoting properties, such as MTA and Biodentine™^{14-18,24,25}, could probably be an appropriate option for pulp capping in adult patients, considering the reduced reparative potential of aging pulp.

Freshly-prepared MTA has a lack of cohesiveness, resulting in difficult handling.^{12,13} Biodentine™ has been reported to have better handling consistency.²⁶ We also found the pliable characteristics of Biodentine™ facilitated the application of the material over the exposure and surrounding dentin, particularly when the exposure was on the axial wall, as presented in all our cases. With its short setting time, high compressive strength and sealing ability, Biodentine™ can be simultaneously used as a base

material and intermediate restoration.²⁶⁻²⁸ The set Biodentine™ can be partially cut back to give room for a permanent restoration without the need for an additional layer of a lining cement.²² For use as an intermediate restoration, Biodentine™ has been reported to be successfully used as a posterior restoration material for up to six months.²² One tooth with a substantially impaired coronal structure in Case 3 was safely provisionalized with Biodentine™ for up to 12 months (Fig. 3b). We found intact Biodentine™ surfaces and hard consistency, similar to that of glass ionomer cement, when cut with a dental bur at the second visit in all teeth of our cases.

Complete caries removal and partial pulpotomy allowed clinicians to assess pulpal conditions based upon appearance, such as colour and occurrence of bleeding. The less predictable outcome of the direct pulp capping procedure, in which the medicament was applied over the exposure site without removal of the inflamed pulp underneath the carious lesion, compared to the high success rate of partial pulpotomy, suggested that removal of inflamed pulp is likely to be critical for a successful outcome.⁸ However, in clinical practice, evaluation of the extent of pulp inflammation remains a challenge. The most practical predictor of a successful outcome is the amount of pulpal bleeding at the time of exposure²⁹, which relates to the ability to achieve hemostasis. Bogen and Chandler³⁰ suggested using NaOCl for 5-10 minutes as a hemostatic agent and also as a diagnostic tool to differentiate reversible from

irreversible pulpitis. Among various solutions recommended for pulpal hemostasis³⁰, 2.5 % NaOCl and 2 % chlorhexidine solution are widely used endodontic irrigants with antimicrobial properties and have shown no negative effect on pulp healing.^{31,32} Hemostasis was obtained within the first five-minute attempt.

Patients with a clinical diagnosis of asymptomatic irreversible pulpitis with tenderness to percussion were included in this report. It is noted that clinical diagnosis based on patient's symptoms may not represent the true histopathological stage of the pulp.^{33,34} Moreover, patients may respond to the percussion test even though the teeth have minimal or no pulp inflammation.^{34,35} Whereas the relationship between clinical signs and symptoms and treatment outcome of vital pulp therapy cannot be established⁸, teeth with spontaneous pain, positive responses to percussion or widened periodontal spaces periapically have been treated successfully in several vital pulp therapy studies.^{4,29,36} It may not be appropriate to use symptoms such as positive responses to percussion alone to indicate exclusion from vital pulp therapy.

When caries extended subgingivally, as in Case 1, surgical crown-lengthening was needed to provide a manageable field of operation. Strictly-controlled treatment conditions, such as rubber dam placement, disinfection of the operating field and use of antimicrobial agents as irrigants, could have also contributed to our successful outcomes.

It should be noted that the successful results presented herein were based on a limited level of evidence resulting from a limited number of subjects selected from many successful cases. However, with innovative calcium silicate cements available at low cost, the results encourage additional long-term clinical studies to provide an increased level of evidence regarding potential prognostic factors for pulp preservation therapy, particularly in adults with carious pulp exposure.

Conclusions

The use of Biodentine™, with a specified protocol, including complete caries removal, use of disinfectants and hemostatic agents and treatment performed under controlled operating conditions, may have contributed to the successful outcome of our presented cases. To generalize, studies of prognostic factors, based on increased levels of evidence, are needed to develop patient selection criteria and a well specified procedure for partial pulpotomy in mature, permanent teeth with carious exposure.

Conflict of interest

The authors declare that there is no conflict of interest.

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