Original Article

Comparison between biodentine and light-cured mineral trioxide aggregate as an indirect pulp capping agent – A randomized controlled trial

Panna Mangat, Kartika Goswami, Mandeep Solanki, Neha Rajput

Department of Conservative Dentistry and Endodontics, Kalka Dental College and Hospital, Meerut, Uttar Pradesh, India

Abstract

Background: Indirect pulp capping (IPC) represents a pivotal therapeutic intervention directed toward preservation of pulp vitality, achieved through the placement of a biocompatible, bioactive material over the affected dentin to protect the pulp from further insult and encourage healing.

Aim: This study aimed to evaluate the clinical and radiographical success rates of Biodentin versus light-cured mineral trioxide aggregate (MTA) when used as an IPC agents. Evaluation was done on the basis of prognosis of the treatment after a period of 1 year.

Methodology: This randomized controlled clinical trial was based on a cohort of 20 individuals with deep carious lesions being subsequently divided into two experimental groups of ten cases each. Group I - Biodentin and Group II - Light cured-MTA as pulp capping agents, respectively. Clinical and radiographical assessment was done at baseline, 1, 2, 3, 6 months, and 1 year.

Results: Statistical analysis with the Chi-square test showed no statistically significant difference between the groups. The overall success rate of 1-year follow-up for both Biodentine group and Light-cured MTA group was 93.33%.

Conclusion: The results of this randomized controlled clinical trial support promising success of IPC independent of the pulp capping material used as the findings underscore a significant decrease in postoperative pain levels compared to preoperative states across all cases. However, more studies with long-term follow-ups are required.

Keywords: Biodentine; glass-ionomer cement; indirect pulp capping; light cured-mineral trioxide aggregate; vital pulp therapy

INTRODUCTION

Dentin erosion stands out as a significant detriment to overall structural integrity of the tooth. Replacing lost dentin with artificial material is necessary to restore the structural integrity of the tooth.[1] Loss of dentin in the coronal part can be because of deep carious lesion, trauma or unexpected tooth preparation.[2]

Address for correspondence:
Dr. Panna Mangat,
Department of Conservative Dentistry and Endodontics, Kalka Dental College and Hospital, Meerut, Uttar Pradesh, India.
E-mail: drpannamangat@gmail.com

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In situations where there is extensive dentin loss or a risk of pulp exposure, vital pulp therapy is performed to safeguard the pulp. As per Grossman, vital pulp therapy refers to the treatment commenced on an exposed pulp with the aim of repairing and preserving its vitality.[3] Vital pulp therapy includes four distinct therapeutic approaches such as indirect pulp capping (IPC), direct pulp capping, partial pulpotomy, and pulpotomy. There are various biocompatible materials which are used in such vital pulp therapy procedures.

Introduced by Herman in 1920, calcium hydroxide holds a prominent position as a pulp capping agent. Its recognition

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as the benchmark was firmly established after the influential research conducted by Zander in 1939.

There are many advantages of calcium hydroxide like it promotes the development of a reparative dentin bridge. This impactful substance encourages cellular specialization, initiating the transition of precursor cells into specialized secretory cells. These specialized cells kickstart the production of essential extracellular matrix elements necessary for dentin formation.[4]

But over time, disadvantages of this material were also observed like there is a progressive deterioration and the emergence of tunnel defects in recently developed dentin. Studies have indicated a rise in the presence of inflammatory cells and localized instances of pulp necrosis. Furthermore, its adherence to dentin margins is limited and its biocompatibility falls short of expectations. All these factors have spurred the development of enhanced pulp capping agents with superior compatibility and heightened bioactivity.

Therefore, mineral trioxide aggregate (MTA), a calcium silicate cement was introduced in 1995 by Dr. Mahmoud Torabinejad and White as a Gray Pro-root MTA and subsequently in 1998 White MTA was introduced.[5]

MTA has many advantages over calcium hydroxide as it demonstrates greater dentinal bridging and structural resilience within a shorter duration, while also eliciting notably reduced inflammation. It exhibits enhanced resistance against bacterial penetration in comparison to Ca $(OH)^2$ and possesses significant antimicrobial properties against certain facultative bacteria. It is highly compatible with pulpal and periodontal tissues and because of its hydrophilic nature, it solidifies in the presence of water and blood. Also being alkaline in nature with a pH of 12.5, set MTA has the potential to induce dentin formation.[3]

But due to MTA's prolonged setting duration and challenging handling, Dr. Byoung Suh, Dr. Rui Yin, and Dr. David Martin, alongside dentist and researcher Dr. Mark Cannon, initiated the development and experimentation of a hydrophilic resin-modified light-curable MTA-based material in November 2011.[6] It can be cured by using light-cured light emitting diode (LED) unit as soon as desired amount is placed in the desired position. Light-cured MTA Dentrigrate LC has been introduced by DentAct company (INDIA, Ahmedabad) and as there is not much literature available on it that's why in this study it was used as pulp capping agent.

Another material, Biodentine emerged as a novel category of dental material, introduced in 2010 by "Gilles and Olivier," Septodont company (FRANCE) aiming to harmonize superior mechanical attributes with exceptional biocompatibility and bioactive characteristics.[5] Biodentine is also referred as "Dentin in Capsule" because of its great biocompatibility. It has great micromechanical anchorage and there is no need for surface preparation or tedious bonding due to the micro-mechanical anchorage. It has higher compressive strength than dentin, preserves pulp, and promotes pulp healing. Furthermore, associated with high pH (12) and releases calcium and silicon ions which stimulates mineralisation and creates "mineral infiltration zone" along dentin-cementum interface imparting a better seal.[7]

Both biodentin and MTA form better dentinal bridge and are more biocompatible than calcium hydroxide. Therefore, this study aimed to evaluate whether light-cured MTA offers any further benefit because of its less setting time over biodentin when used as an IPC agent.

METHODOLOGY

Twenty subjects with deep carious lesions-seeking treatment formed the base of the present trial. The study protocol was carried out in accordance with the Ethical Standards outlined in Declaration of Helsinki (1964, revised 2008) and approved by the Institutional Ethical Committee. Patients aging 16–45 years with deep carious lesion in molars and premolars having signs and symptoms of symptomatic reversible pulpitis were selected for this randomised controlled clinical trial. Radiovisiography was employed to assess periodontium and hard tissues of the tooth. Following tooth selection, patients were provided a Visual Analog Scale (VAS) to record the extent of pain after which detailed information about the study was given to them and their consent was obtained both in English and Hindi.

Inclusion criteria

Patients aging from 16 to 45 years with deep carious lesion in molars and premolars having symptomatic reversible pulpitis were included.

Clinical findings as the absence of pulp exposure, fistula or sinus tract, swelling of periodontal tissues, abnormal tooth mobility, history of spontaneous pain, and tenderness on percussion.

Vital response of tooth to thermal (cold) test and electric pulp testing, healthy adjacent gingiva and normal color of tooth.

Radiographic findings as the absence of periapical or intra-radicular radiolucency, periodontal space widening or thickening, internal and external root resorption, and obliteration of pulp canals or pulp chamber.

Exclusion criteria

Patients with systemic disease[8] or specially-abled people.

Table 1: Clinical evaluation done on the follow-up appointments for Biodentine and light cured mineral trioxide aggregate cases

Sr. Material. No. used for. IPC.	No. of. follow up. Cases duration.	Pain.	Tenderness On. Percussion	Swelling or. Inflammation in associated Gingiva.	Mobility of tooth.	Sinus. Tract. or. fistula.	Response To pulp vitality Tests for Pulpitis
Biodentine15.	1,2,3,6. Months. And 1 Years	Present/ Absent	Present/. absent	Present / Absent	Present/ Absent	Present / Absent	Present/ Absent
Light 15. Cured. MTA.	1,2,3,6. Months. And 1 Years	Present/ Absent	Present/. Absent.	Present / Absent	Present/ Absent	Present / Absent	Present/ Absent

Table 2: Radiographical evaluation done on the follow-up appointments for Biodentine and light cured mineral trioxide aggregate cases

Sr. Material. No. used in. IPC.	No. of follow up. Cases duration.	Obliteration. Of pulp. Chamber or. Secondary Caries	Apical or Intra- Radicular radiolucency	Periodontal. widening or. thickening.	External or internal resorption
Biodentine 15.	1,2,3,6 Months. and 1 year	Present/Absent.	Present/. Absent.	Present/. Absent	Present/ Absent
Light. 15. Cured. MTA.	1,2,3,6. Months. and 1 year	Present/Absent.	Present/. Absent.	Present/. Absent.	Present/ Absent

Teeth with signs and symptoms of irreversible pulpitis, pulpal necrosis, calcifications in pulp, internal or external resorption, apical periodontitis, and abscess.

Discontinuation criteria

Patients who did not turn up for follow-up appointments were replaced by new patients to maintain the sample size.

Patient with persistent pain after treatment or radiographic findings such as apical or intra-radicular radiolucency, secondary caries under restoration, periodontal widening or thickening observed during follow-ups.

Clinical procedure

During initial appointment, 2% lignocaine anesthetic solution with epinephrine was administered. All the cases were done under rubber dam to ensure isolation during procedure. Following caries removal, teeth without pulpal exposure were identified for inclusion in the IPC procedure.

The cavity preparation phase involved the use of diamond burs and smart burs, leaving a layer of firm (affected) dentin over the pulp chamber. Subsequently, the prepared cavity was disinfected with 2% chlorhexidine[7] and filled with temporary restoration.

Patients were scheduled for second appointment 1 week after the initial treatment. Pulp-sensibility tests were repeated and in cases where the patients gave zero scores on VAS or reported reduction in the symptoms were selected. In cases where patients reported persistent pain, a recommendation for further invasive treatment was made.

Table 3: Chi square test (*P* value less than .05 is significant and more than .05 is non significant

	Normal, *n* (%)	Irreversible pulpitis, *n* (%)	χ^2	*P*
1 month				
Bio-dentine	9 (93.33)	1 (6.67)	1.034	0.341 (NS)
Light-cured MTA	10 (100)	0		
2 months				
Bio-dentine	9 (93.33)	1 (6.67)	1.034	0.341 (NS)
Light-cured MTA	10 (100)	0		
3 months				
Bio-dentine	9 (93.33)	1 (6.67)	1.034	0.341 (NS)
Light-cured MTA	10 (100)	0		
6 months				
Bio-dentine	9 (93.33)	1 (6.67)	0.370	0.534 (NS)
Light-cured MTA	9 (93.33)	1 (6.67)		
1 year				
Bio-dentine	9 (93.33)	1 (6.67)	0.370	0.534 (NS)
Light-cured MTA	9 (93.33)	1 (6.67)		

MTA: Mineral trioxide aggregate, NS: Nonsignificant

Simple randomization of the study was maintained by selecting biodentin randomly as the choice of material for the first case and second case was done with light cured-MTA and rest were alternatively assigned [Flow Chart 1].

Group I - Biodentine was prepared as per the manufacturer's instructions. One-two millimeter thick layer this mixture was applied onto the remaining dentin and allowed to set for a period of 12 min.

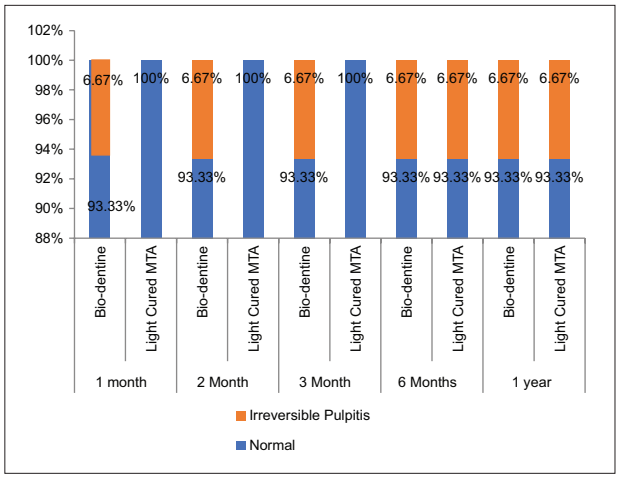
Group II - One-two mm thick layer of Light-cured MTA was directly applied over the remaining dentin and was cured using LED curing light for 20 s.

Glass ionomer cement (GIC) was applied over these materials as a base for sandwich technique following a standardized bonding procedure. Follow-ups were scheduled at intervals of 1, 2, 3, 6 months, and 1 year to assess the presence of any signs and symptoms and the treatment was declared successful if no signs and symptoms of disease were present on the clinical and radiographical inspection [Flow Chart 2].

A comparative analysis was conducted, based on the observed findings to ascertain the efficacy of Biodentine and Light-cured MTA as pulp capping agents in IPC procedures.

RESULTS

The results of this randomised controlled trail were based on the clinical and radiographical evaluation across 10 cases for each material for 1 year. The calculated evaluation for both the materials showed similar results after the duration of 1 year [Graph 1].



Graph 1: Evaluation of ten cases each with follow-up of 1 year for Biodentin and light-cured mineral trioxide aggregate

Statistical analysis

Clinical assessment of tooth vitality distribution (n = 10)

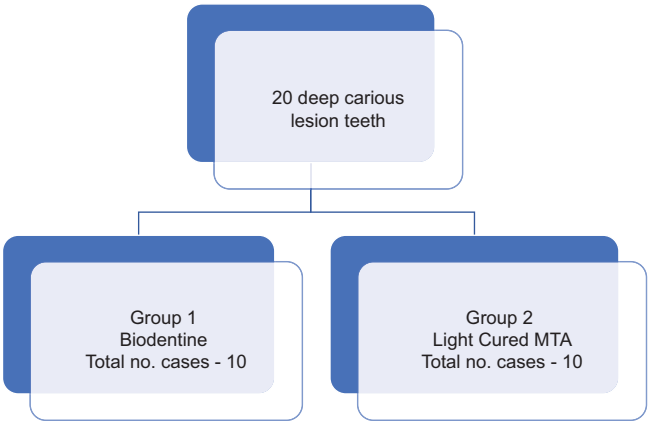
In both groups immediately after restoration with pulp capping agent, all study subjects were normal (without any symptom). At first, 2nd-, and 3rd-month interval, the success rate in Biodentine group was 93.33%, whereas in light-cured MTA group, there was 100% success rate. The difference between the groups was statistically nonsignificant when analyzed using the Chi-square test at 6 months and 1-year time interval, the overall success rate for both the groups was 93.33%.

Results were based on the clinical and radiographical assessment of teeth in which IPC was done. Both the groups gave similar results as only one case out of ten (in each) was unsuccessful [Tables 1-3].

DISCUSSION

In this randomized controlled clinical study, IPC procedure was opted as it is a conservative procedure which avoids the risk of any invasive procedure thus, vital pulp is preserved and a biocompatible material is used to conserve the tooth in its healthy state. It acts as the first line of treatment as even if the treatment fails the tooth can be saved through pulpotomy or pulpectomy. Vital pulp therapy helps in the retention of a vital tooth for a longer duration which can provide better treatment options in future as better materials are being introduced over time. According to a study done by Petrou *et al*., the success rates of IPC are as good as 73%–97% regardless of the materials used.[6]

Teeth selected for this study were the cases of symptomatic reversible pulpitis with no peri-apical findings. The diagnosis was made using thermal (cold) test, electrical pulp testing, and radiographs. Treatment was done with two visit approach, before commencing



Flowchart 1: Case distribution among two groups

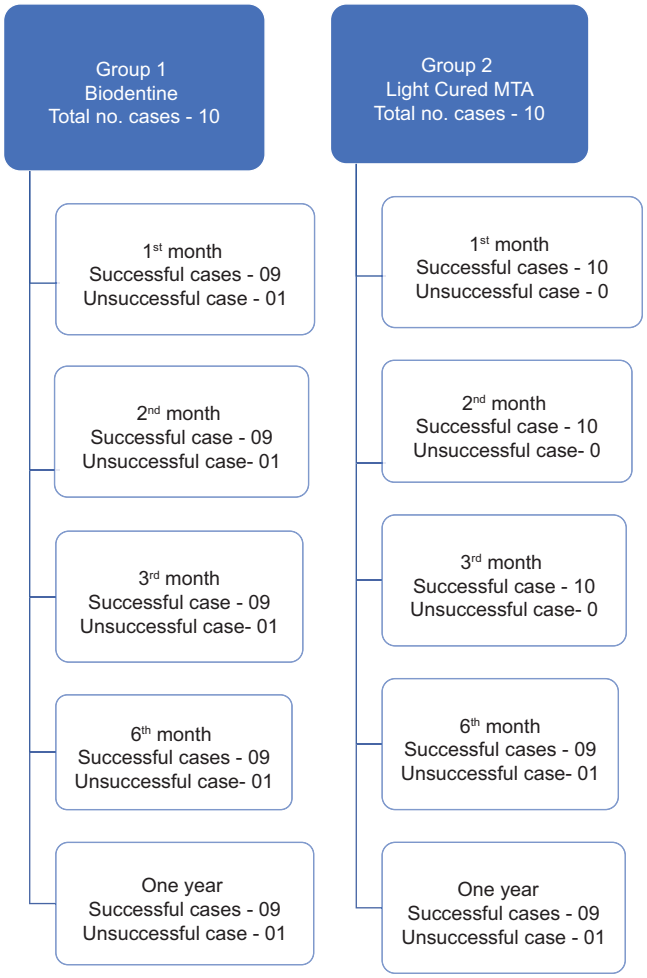
the treatment, patients were given a VAS to obtain the pain score values. The VAS is a widely used Pain Rating Scale. It is frequently employed in both epidemiological and clinical research to assess the intensity or frequency of various symptoms. For instance, it helps gauge the level of pain experienced by a patient, ranging from none to an extreme amount.

In the first visit, all the carious portion was removed from the walls of the cavity using diamond burs in conjunction with air-rotor and smart burs in conjunction with micro-motor to remove all the infected dentin from the base of the cavity, leaving a firm layer of affected dentin to prevent pulp exposure. Then, the cavity was disinfected by 2% chlorhexidine digluconate[7] and then filled with temporary filling material.

Smart burs were used to remove the infected dentin from the floor of the cavity as they are crafted from a medical-grade polymer reinforced with glass beads. These burs selectively remove soft carious dentin without affecting healthy tissues.[9] Smart burs have a knoop hardness of 50 Knoop hardness number (KHN), which is higher than carious, soft dentin (0–30 KHN) but is softer than healthy dentin (70–90 KHN).

Two visit approach was considered as in cases where the patients still complained of pain and gave similar (as preoperative) or higher scores in VAS after the removal of caries, indicated penetration of microbial toxins in the pulp chamber and such cases were excluded from the study and needed treatment was performed. Furthermore, teeth with pulpal exposure or signs of irreversible pulpitis were excluded from the study.

Patients were recalled after 1 week for the placement of final restoration and as for this study Biodentine and light-cured MTA were used as IPC agents. GIC was placed as the base for the sandwich technique over these materials in the prepared cavities given the lower initial compressive strength for 1st h for Biodentine is (100 MPa)[10] and for



Flowchart 2: Results obtained during follow-ups

light-cured MTA (61 MPa)[12] after which the standardized bonding procedure was followed.

Three out of ten patients of light-cured MTA group complained of sensitivity for 5–7 days after the procedure for which the attributed reason could be the resin component in the material according to the study done by Arandi and Rabi[11] One of these three cases went unsuccessful after 6 months as the patient complained of continuous pain and on radiographic inspection peri-apical radiolucency was observed so pulpectomy was chosen as the line of treatment.

In case of biodentine, one patient complained of continuous pain and intense sensitivity within a week of treatment. However, in this case, no periapical changes were seen on the radiograph and similar line of treatment was followed.

Biodentine is also known as "Dentin in capsule" was introduced in 2010 by "Gilles and Olivier," Septodont company (FRANCE). A study done by Kokate and Pawar concluded that Biodentine shows least microleakage when compared to MTA and GIC.[12] Despite many advantages

Biodentine still has some short comings like Biodentine exhibited notably greater solubility compared to MTA in a study done by Singh *et al*.[13] Among Biodentine, GIC, IRM, and MTA, Biodentine exhibited greatest susceptibility to ambient conditions. Dry storage of Biodentine resulted in alterations in its microstructure and the formation of cracks at the interface between dentin and Biodentine which had the capacity to permit entry and transfer of microorganisms. Also, Biodentine has water-based chemistry and thus bonds poorly with resin restoration i.e. forms micro-mechanical bonds given in a study done by Arandi and Rabi.[11]

Although solubility of MTA was less than Biodentine, MTA has longer set time, workability issues, and lesser bond strength.[14] which led to development of hydrophilic resin-modified light curable MTA in November 2011. Dentigrate LC has been introduced by DentAct company (INDIA, Ahmedabad) in 2019 and as there is not much literature available on it thus formed the base for the need of this study.

This randomized controlled clinical trial was done to assess the outcomes of two materials (Biodentine and light-cured MTA) which are used because of their biocompatibility, less cytotoxicity, and giving great results in previously done studies.[11,15-20]

In the present study, with follow-up of 1 year for all 20 cases (ten-Biodentine and ten-light-cured MTA), both the materials performed well and showed similar results with nine successful cases and only one unsuccessful case (for each material).

Irrespective of the materials utilized in the study, there was a substantial decrease in postoperative pain observed compared to preoperative pain levels as assessed on VAS. The findings of this study align with those of Baskaran *et al*., who compared Biodentine and MTA as pulp capping agents and both materials demonstrated the comparable outcomes.[21,22]

The statistical analysis of baseline parameters chosen for the current study revealed no significant difference between the two groups.

The study is subject to several limitations, including a small sample size and an insufficient duration for comprehensive evaluation. In addition, the C-factor may vary between Class 1 and Class 2 fillings, potentially affecting the results.

CONCLUSION

Within constraints of this randomized controlled clinical trial, it was noted that both materials demonstrated favorable outcomes (93.33%) during 1-year follow-up when evaluated across ten cases each. Regardless of the materials employed in the study, the results indicated a noteworthy reduction in postoperative pain when compared to preoperative pain values on the VAS. This study suggests that both materials used in the study show promise as IPC agents.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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