

ORIGINAL ARTICLE

To Compare the Effectiveness of Biodentine versus Mineral Trioxide aggregate as Direct Pulp Capping agent in carious exposed permanent tooth

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ABSTRACT

Aim: To compare the effectiveness of Biodentine versus mineral trioxide aggregate as direct pulp capping agent in carious exposed permanent tooth**Study Design:** Randomized controlled trial**Place and duration:** Operative Dentistry, Department of de'Montmorency College of Dentistry / Punjab Dental Hospital, Lahore From 29-07-16 to 30-01-17**Methods:** Sample size of 75 in each group (using non-probability) calculated using 80 percent power, 5% level of significance with expected percentage of effectiveness (lack of periapical radiolucency) among groups i.e. 92.68%¹⁹ in Biodentine group vs. 78%²⁰ in mineral trioxide group aggregate as direct pulp capping agent. Data was entered and analyzed with IBM SPSS 20. Level of significance was kept at p -value ≤ 0.05 .**Results:** Total 150 patients, 82 are male and 68 are female. The age of patients was 18-45 years. The Mean and SD of age of patients is 30 ± 7.916 . In group I, 57(75%) showed efficacy and 18(25%) showed failure of efficacy while in group II 72 (95%) showed efficacy and 3 (5%) showed failure of efficacy after 3 months. Comparison of efficacy shows that group II Biodentine has better efficacy as compared to group I.**Conclusion:** It is concluded that Biodentine is more effective than MTA. It can be used as bulk fill, simplify the pulp capping procedure.**Keywords:** direct pulp capping, vital pulp therapy, efficacy of newer pulp capping materials, MTA and Biodentine.

INTRODUCTION

Dental Pulp is highly sensitive vascular tissue protected by dentine, both work together as functional and formative complex. The response of tissue against different physiological forces, pathologic stimuli or developmental anomalies depends upon their severity. The dental pulp has ability to form reparative dentin continuously throughout life. This maintains pulp vitality and helps to compensate the enamel or dentin loss^{2,6}.

Pulp capping in carious exposure was questionable in the past. Recent studies show that carious exposed pulp in a vital permanent tooth can be successfully treated with vital pulp therapy (VPT)^{3,24}. Direct pulp capping is one of the procedure of VPT, observed 1 year: 87.5%, 2 years 95.4%, 3 years 87.7 % and more than 3 years 72.9%³.

The objective of pulp capping in a permanent tooth with deep carious exposure is vital, asymptomatic without radiographic evidence of periradicular lesion⁵.

Factors affecting the success of direct pulp capping include sustained blood supply, intensity of inflammation, adequate hemostasis, disinfection of the exposure site, antimicrobial/biocompatible property of the pulp capping agent, adequate seal, and skill of the clinician to use the material.⁶ Adequate vascularization with vital pulp is essential factor for the success of direct pulp capping.^{6,7}

The gold standard and premier material for direct pulp capping is Calcium hydroxide⁷. MTA was introduced in 1998, clinically indicated as perforation repair, root end filling material, apical barrier for immature apices, pulp vitality procedures in primary and permanent teeth. It has good sealing ability^{9,10}, biocompatible, bioactive, noncytotoxic, Hydraulic cement (ideal in wet climate)^{5,9}.

MATERIALS AND METHODS

The study was conducted on outpatient operative department of de 'Montmorency college of dentistry / Punjab dental hospital from 29th July 2016 to 30th Jan 2017 following approval from the institution's Ethical Committee. One hundred fifty teeth were selected in patients ranging from 18 to 45 years, Maxillary and Mandibular permanent teeth. All teeth exhibited deep caries with no prior restoration clinically. Each tooth was clinically and radiographically examined. Detailed history, Periapical radiographic assessment, periodontal status, percussion testing and vitality of teeth through electrical pulp testing was completed. An informed consent was obtained from patient. No ethical issue or risk was involved.

Treatment protocol was carried out in two visits. Patients were randomly divided (seventy five each) into two groups I and II. After anesthesia, the tooth was isolated with rubber dam, disinfected by 0.2% chlorhexidine mouthwash,¹⁴ removed all the carious lesion with a sterile round bur then carefully examined the exposure size ($<1\text{mm}$) with no persistent bleeding. Used 5.25% NaOCl soaked cotton pellet to achieve hemostasis within 5 minutes in all cases.

The area was then dried with cotton. In Group-I mix MTA according to manufacturer instructions and placed 2 mm thick layer of cement on the exposed site. Damp cotton placed on tooth was initially restored using temporary material (CAVIT, 3M ESPE) followed by amalgam replacement after initial setting (24 hrs).

In Group-II tooth pulp capped with Biodentine (Septodont, France) accordingly manufacturer's instruction. The Biodentine capsule triturated with its liquid in amalgamator for 30 sec then placed to a mixing pad then applied using an amalgam carrier to the cavity preparation. The whole cavity filled with Biodentine after 2 weeks restored by composite.

Data Analysis Procedure: Statistical analysis was performed with SPSS version 18.0. Standard deviation and mean calculated for quantitative variables like age, height, weight and BMI of patient. Frequency and percentage were calculated for qualitative variables

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like gender of patient and efficacy of material in terms of lack of development of Periapical Radiolucency (PR) on radiograph. Effect modifiers such as gender and age of patient are controlled through post stratification. Post stratification test (chi square test) used for p value 0.05. In this study 150 patients fulfill the inclusion criteria are included. 82 are male (54%) and 68 are female (45%).

The age range of patients was 18 to 45 years. The standard deviation and mean were calculated. The Mean and SD of age of patients undergoing direct pulp capping was 30 ± 7.916 respectively as shown in Table 1. P value of variables age (0.360) was not significant.

The patients were equally divided into two groups i.e., group I and II. MTA group was allocated as group I and Biodentine named as group II each group contained 75 patients. The follow-up time was 3 months. Periapical radiograph was used for radiographic evaluation of development of Periapical Radiolucency by comparing pre-and post-operative radiographs.

Out of 75 patients, 57(75%) showed success and 18(25%) showed failure of direct pulp capping with MTA group after 3 months. While in the group II, 72 teeth did not show any periapical radiolucency while 3 teeth showed signs of periapical radiolucency on periapical radiograph. In group II, out of 75 patients 72(95%) showed success and 3(5%) showed failure of direct pulp capping with Biodentine group after 3 months. To compare efficacy of both groups, Post stratification chi square test is applied. The P-Value was calculated as 0.001. The result was significant at $p < 0.05$ as shown in Table 3

Chi square test was applied to compare the efficacy of direct pulp capping agent according to age group. p value = 0.360 was found to be significant as in Table 2

Statistics: Mean and Standard Deviation of Age in Pulp Capping Patients - Table 1

Age (years)

N	Valid	150
	Missing	0
Mean		30.50
Std. Deviation		7.916
Minimum		20
Maximum		45

Table 2: Analysis of age and efficacy

Age (years) * Efficacy Cross tabulation
Count

Age in years	Efficacy		Total
	No	Yes	
20	1	29	30
25	4	26	30
30	4	26	30
35	7	23	30
40	2	13	15
45	3	12	15
Total	21	129	150

Chi sq = 5.482 df=5 p=0.360

Table 3: Analysis of Group and Efficacy

Material Groups * Efficacy Cross tabulation
Count

Material groups	Efficacy		Total
	No	Yes	
Group I	18	57	75
Group II	3	72	75
Total	21	129	150

DISCUSSION

In contemporary era advance technologies and materials introduced in dentistry which grant recommended treatments to the patient. This can be accomplished by good clinical practice and correct diagnosis. The principle of restorative treatment is to perpetuate pulp vitality and functionality.

Vital pulp therapy is a procedure to retain the vitality of dental pulp as well as to stimulate the remaining pulp tissue to function adequately. The VPT includes number of procedures: indirect and direct pulp capping, pulpotomy in young permanent dentition⁴.

The foremost objective of VPT is

- > To sustain the vascularity of pulp
- > To encourage and regulate the structure/function of the pulp-dentin complex.

At microscopic level the dentinal bridge is formed by the recruitment of odontoblasts from undifferentiated mesenchymal cells. The arrangement of fibrodentin followed by remineralization to form reparative dentine. However this biological seal prevents communication between the pulp and the oral environment⁴.

Certain contributing factors for efficiency of VPT such as adequate vascularity of pulp, young patient, hermetic coronal seal, antibacterial/biocompatible material previous pulpal and periodontal health, technique, infection control of exposure site with disinfectant, previous inflammation. An appropriate coronal restoration significantly affects the prognosis of VPT²⁴.

Inflamed tissue and healing of pulpal tissue are directly correlated; the mild inflammatory reaction act as a stimuli to release progenitors to initiate pulpal repair/regeneration²⁵.

Pulp may be exposed due to caries, trauma or mechanical exposure during aggressive cavity preparation. Pulp capping promotes pulp healing as well as reparative dentine formation.

Many studies show the survival of tooth after direct pulp capping if it is mechanically exposed rather than caries²². Microbial invasion at the carious site results in pulpal inflammation². Thus healing property of pulp is compromised in comparison to mechanical exposure. In mechanical exposure of asymptomatic tooth shows lack of any clinical or radiologic signs of pathology⁵.

In a review literature, the success rate of direct pulp capping has been observed 1 year: 87.5%, 2 years 95.4%, 3 years 87.7% and more than 3 years 72.9%³.

Control of haemorrhage is compulsory for the prognosis of tooth during pulp capping procedure. A veracious exposure at carious site is always associated with inflamed pulp. Some studies show that a tiny carious exposure can be associated with the signs of inflammation. The severity of inflammation vary from minimal to complete necrosis².

Disinfection of the exposure site and biocompatible material as pulp covering agent are indispensable factors for prognosis.

In this study I used silicate materials Biodentin and Mineral trioxide aggregate (MTA) as direct pulp capping agent in a carious exposure with clinical and radiographic. MTA was introduced in 1995 at Loma Linda University. U.S. Food and Drug Administration allowed its clinical application. At first time it was used as a root-end filling material during endodontic surgery ProRoot MTA (Tulsa Dental Products, Tulsa, OK). Recently, MTA Angelus (Angelus Solucoes Odontologicas, Londrina, Brazil) is used in dentistry worldwide. MTA is analogous to calcium hydroxide with antibacterial characteristics. It has alkaline pH, biocompatible properties radiopaque. MTA also shows good healing properties by releasing certain bioactive dentin matrix proteins^{2,13}.

In the term of sealing ability it is superior to other materials such as Ca (OH)₂. Some studies showed its regenerative potential in periradicular tissues. Other remarkable properties of MTA are initial setting during moisture and dimensional stability¹³.

MTA is difficult to use because of poor handling properties, high material cost, high alkaline pH (11.5-12), low compressive strength and has discoloration potential. MTA releases heavy toxic metal arsenic and ferric².

Second material, Biodentine is a new tricalcium cement with dentine like mechanical properties based on MTA with improvement in properties and handling^{14,19,21}. Compositional difference between MTA and Biodentine is calcium chloride

(accelerator) in liquid, Zirconium Oxide as radiopaque and polycarboxylate as superplasticizer.^{14,15} Biodentine calcium silicate gel and a calcium hydroxide are formed. It is bioactive material that induces reparative dentine synthesis by modulating pulp cells to secrete TGF- β 1. Thus stimulation of dental pulp mineralization occurs. It is also reported in a study it escalates carbonate content that diffuses into intertubular dentine followed by mineral tags formation.⁵

Remarkable reason behind its use is setting time which is faster i.e. 12 mins. It allows immediate coronal restoration. It serves as a dentine substitute. In comparison with Biodentine, MTA placement is more time consuming as longer setting time and technically difficult.¹²

The success rate of MTA as direct pulp capping is 78% in a study of Mente J et al.²⁰. This study was conducted at the University Hospital of Heidelberg from 2001 to 2006. Record of the patients was obtained from the Department of Conservative Dentistry. They compared MTA versus $\text{Ca}(\text{OH})_2$. The outcomes in this study were based upon clinical and radiographical assessments. Clinically positive to thermal (cold test (CO_2)), lack of sign and symptoms of irreversible pulpitis. Radiographically no sign of root resorption and periapical periodontitis. MTA (ProRoot MTA) and non-setting $\text{Ca}(\text{OH})_2$ paste were placed directly as pulp capping material. The probability value is not significant in this study. In my study 75% result of group I gave slightly less success rate.

Another study of Levin shows 92.68% success rate of Biodentine as direct pulp capping agent, in terms of lack of development of radiolucency.¹⁹ This study was performed on 50 teeth capped with Biodentine. According to Levin Biodentine is promising material with ease of placement and manipulation. In my study Biodentine (group II) shows 95%, which is slightly greater than Levin's study. However, my study showed more favourable results as larger sample size. This study was conducted in our local population. It was performed by operator and data was collected from outdoor department.

CONCLUSION

It was concluded that Biodentine is more effective than MTA. The can be used as bulk fill, simplify the pulp capping procedure. Ease of placement and good setting time give its preference. Its use is dependent upon its high cost. It should be cost effective to use as in routine procedures in our Asian countries. Further studies are required for its long-term success rate in our region.

Conflict of interest: The study has no conflict of interest to declare by any author

REFERENCES

- Willershausen B, Ross A, et al. Retrospective study on direct pulp capping with calcium hydroxide. *Quintessence International*. 2011 Feb; 42(2).
- Cohen S, Hargreaves KM, et al., editors. *Pathways of the pulp*. 10th ed. St. Louis, Missouri: Mosby Elsevier; 2011.
- Aguilar P et al. Vital pulp therapy in vital permanent teeth with cariously exposed pulp: a systematic review. *J endod* 2011 May, 37(5): 581-7
- Zhang W, Yelick PC. Vital Pulp Therapy—Current Progress of Dental Pulp Regeneration and Revascularization. *International Journal of Dentistry*. 2010 Feb; 2010(856087).
- Strassler HE, Levin R. Biodentine, Active Biosilicate Technology for Direct and Indirect Pulp Capping. *Oral Health Group*. 2012 Dec.
- Asgary S, Ahmadyar M. Vital pulp therapy using calcium-enriched mixture: An evidence-based review. *J Conserv Dent*. 2013 Mar-Apr; 16(2): 92-98.
- Hilton TJ. Keys to Clinical Success with Pulp Capping: A Review of the Literature. *Oper Dent*. 2009; 34(5): 615-625.
- Qureshi A, Soujanya E, et al. Recent Advances in Pulp Capping Materials: An Overview. *Journal of Clinical and Diagnostic Research*. 2014 Jan; 8(1): 316-321.
- Eskandarizadeh A, Shahpasandzadeh MH, et al. A comparative study on dental pulp response to calcium hydroxide, white and grey mineral trioxide aggregate as pulp capping agents. *J Conserv Dent*. 2011 Oct-Dec; 14(4): 351-355.
- Torabinejad M, Parirokh M. Mineral Trioxide Aggregate: A Comprehensive Literature Review-Part II: Leakage and Biocompatibility Investigations. *JOE*. 2010 Feb; 36(2): 190-202.
- About I, Laurent P, Tecles O. Bioactivity of Biodentine: a Ca_3SiO_5 -based dentine substitute. *J Dent Res (IADR Abstracts)*. 2010; 89: Abstract no. 165.
- Laurent P, Camps J, About I. BiodentineTM induces TGF- β 1 release from human pulp cells and early dental pulp mineralization. *International Endodontic Journal*. 2011 Nov; 45: 439-448.
- Parirokh M, Torabinejad M. Mineral Trioxide Aggregate: A Comprehensive Literature Review-Part I: Chemical, Physical, and Antibacterial Properties. *JOE*. 2010 Jan; 36(1): 16-27.
- Nowicka A, Lipski M, et al. Response of Human Dental Pulp Capped with Biodentine and Mineral Trioxide Aggregate. *JOE*. 2013 June; 39(6): 743-747
- Soundappan S, Sundaramurthy JL, et al. Biodentine versus Mineral Trioxide Aggregate versus Intermediate Restorative Material for Retrograde Root End Filling: An In Vitro Study. *Journal of Dentistry*. 2014 Mar; 11(2): 143-149.
- Arora V, Nikhil V, et al. Bioactive dentin replacement. *IOSR Journal of Dental and Medical Sciences*. 2013 Dec; 12(4): 51-57.
- Atmeh AR, Chong EZ, et al. Dentin-cement Interfacial Interaction: Calcium Silicates and Polyalkenoates. *J Dent Res*. 2012; 91(5): 454-459.
- Koubi GF, Franquin JC, Colon P. A clinical study of a new Ca_3SiO_5 -based material indicated as a dentine substitute. *Conseuro* 2009, Seville, Spain. March, 2009. OP065.
- Dammaschke T, Levin R, et al. Septodont Case Studies Collection No 3: A Clinical Review of 50 Pulp Capping Procedures with Biodentine. 2012 Oct.
- Mente J, Geletneký B, et al. Mineral Trioxide Aggregate or Calcium Hydroxide Direct Pulp Capping: An Analysis of the Clinical Treatment Outcome. *JOE*. 2010 May; 36(5): 806-813.
- Kojima K, Inamoto K, Nagamatsu K, Hara A, Nakata K, Morita I, et al. Success rate of endodontic treatment of teeth with vital and nonvital pulps. A meta-analysis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2004; 97:95-9.
- Baume L, Holz J. Long-term clinical assessment of direct pulp capping. *International Dental Journal* 1981; 31(4):251-260.
- Goldberg M, Smith AJ. Cells and extracellular matrices of dentin and pulp: Abiological basis for repair and tissue engineering. *Crit Rev Oral Biol Med*. 2004; 15:108-27
- Taha N, About I, Sedgley C, Messer H. Conservative Management of Mature Permanent Teeth with Carious Pulp Exposure. 2022.
- Ohshima H, Yoshida S. The relationship between odontoblasts and pulp capillaries in the process of enamel and cementum-related dentin formation in rat incisors. *Cell Tissue Res*. 1992; 268:51-63.