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Original Article

Dentistry Section

Clinical Evaluation of Success of Primary Teeth Pulpotomy Using Mineral Trioxide Aggregate®, Laser and Biodentine™- An In Vivo Study

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ABSTRACT

Introduction: Pulpotomy technique basically consists of removing the coronal pulp and fixing the radicular pulp with a medicament. It is the most widely accepted clinical procedure for treating primary teeth with coronal pulp inflammation caused by caries with no involvement of the radicular pulp.

Aim: To evaluate the success and efficacy of Mineral Trioxide Aggregate (MTA), Lasers and Biodentine as pulpotomy agents both clinically and radiographically.

Materials and Methods: In the present study, 60 primary molars in children whose pulpal status warranted pulpotomy were selected and randomly assigned into three groups that included MTA, Laser and Biodentine allocating 20 teeth to each group. The pulpotomy procedure was then performed on all selected teeth followed by restoration with stainless steel crowns. Later the patients were recalled for 3 months and 6 months for clinical and radiographic evaluation.

Results: Statistical analysis was done using Fisher exact test to determine pair wise comparison of three agents with respect to clinical and radiographic criteria. Kruskal-Wallis ANOVA, Mc Nemars test was applied to evaluate the efficacy of each agent between 3 months and 6 months. The results showed that maximum success rate was found in MTA group. However, the comparison between three groups was statistically not significant ($p>0.05$).

Conclusion: Pulpotomies performed with either MTA, Laser or Biodentine are equally efficient with similar clinical/radiographic success and hence can be considered as alternatives to Formocresol.

Keywords: Caries, Formocresol, Primary molars, Pulp therapy

INTRODUCTION

The primary objective of pulp therapy is to maintain the integrity and health of the teeth and their supporting tissues. One such pulp therapy technique used for preserving decayed primary molars from extraction is pulpotomy which is done in a primary tooth with extensive caries but without evidence of radicular pathology. In this technique, the coronal pulp is removed, and the remaining radicular pulp is opined to be vital and free of any pathological alterations [1,2]. According to Ranly, pulpotomy therapy for primary teeth has developed along three lines: devitalization (mummification, cauterization); preservation (minimal devitalization, non inductive); and regeneration (inductive, reparative) [3].

Formocresol (FC) introduced by Buckley, 1904 is considered as the "gold standard" pulpotomy agent. Owing to its bacteriostatic and fixative properties, it is the most frequently used pulpotomy agent with a huge success rate. Although, it is composed of formaldehyde (mutagenic and carcinogenic) and cresol (caustic agent), there is no evidence that its systemic distribution can cause pathology [4]. However, this has led scientific community to search for more biocompatible alternatives in the form of Mineral trioxide aggregate (MTA), laser irradiation and Biodentine. Laser use in pulpotomies was first reported by Shoji in 1985 [5], who used CO_2 laser. As a result of extensive use of diverse types of lasers in pediatric dentistry, and the therapeutic benefits offered by lasers including hemostasis, sterilization and hastened pulpal wound healing, laser irradiation has been suggested as a promising alternative to traditional pharmacotherapeutic approaches [6].

MTA, introduced by Torabinejad in 1993 [7], and a new bioactive cement, BiodentineTM (Septodont, St. Maur-Des-Fosses, France), launched recently in the dental market has been useful in a variety of clinical situations such as pulp capping, pulpotomy, and root end closures [8,9]. MTA and BiodentineTM offer the advantages of biocompatibility and the induction of apposition of reactionary dentine as a result of stimulation of activity of odontoblasts, and reparative dentine formation as a result of induction of cell differentiation [10]. The present study was aimed at evaluating the success of pulpotomy outcomes using MTA, Lasers and Biodentine; and comparing the efficacy of the agents used both clinically as well as radiographically.

MATERIALS AND METHODS

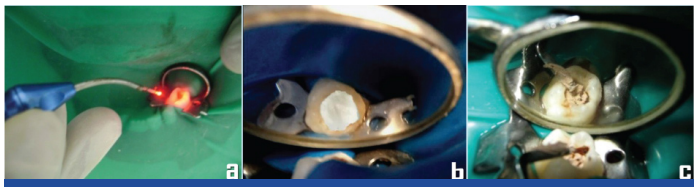
The present study was conducted on a group of 60 children aged from 5 to 9 y who had attended the outpatient Department of Pedodontics and Preventive dentistry, St. Joseph Dental College and Hospital, Eluru, Andhra Pradesh, India, with good general health and no history of systemic illness or hospitalisation. Written informed consent was obtained from the parents or guardians of children who required treatment. Sixty primary carious molar teeth of 29 males and 31 females were selected and randomly assigned into three groups that included MTA, Laser and Biodentine, allocating 20 teeth in each group using simple lottery method. The teeth selected were with deep carious lesion (radiographically the caries should be approximating to the pulp), vital with healthy periodontium and with absence of clinical signs or symptoms suggesting a non-vital tooth such as suppurating sinus, soft tissue swelling, mobility or tenderness to percussion. Pulpotomy was then completed by using one of the techniques which the case is assigned to. Diode LASER (Picasso, AMD Lasers, Indianapolis, USA) group: Hemostasis was achieved by exposing root canal orifices to Diode Laser (Picasso) of 810 nm with the pulsed contact mode of application for 2 seconds delivered by optical fiber tip and 1.5 watt power. The remaining portion of the pulp chamber and the access cavity was filled with a thick paste of Zinc Oxide Eugenol [Table/Fig-1a].

Mineral Trioxide aggregate (Angelus Indústria de Produtos Odontológicos S/A, Londrina, Brasil) group: After achieving

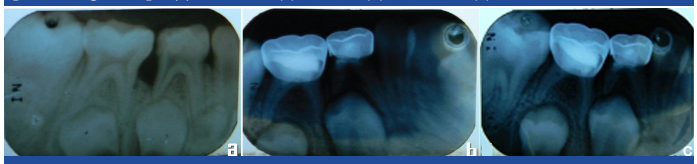
hemostasis with moist cotton pellet, the MTA paste was prepared and placed in the pulp chamber and condensed lightly with a moistened cotton pellet, followed by application of a layer of Zinc oxide Eugenol thick mix [Table/Fig-1b]. Biodentine™ (Septodont, St. Maur-des-Fossés, France) group: Hemostasis was achieved by placing moist cotton pellet. BiodentineTM mix was prepared according to manufacturer's instructions and placed in the pulp chamber and condensed [Table/Fig-1c]. All pulpotomized teeth were restored with stainless steel crowns. All cases were evaluated both clinically and radiographically at a period of 3 months and 6 months interval [Table/Fig-2-4].

RESULTS

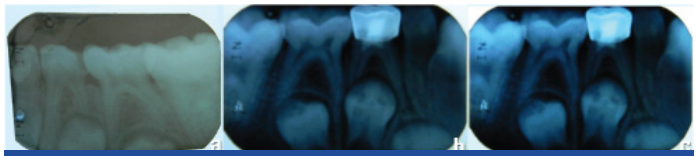
Among the 20 teeth treated with Lasers, pain and swelling were observed in two teeth at the end of 6 months. Whereas, in the teeth treated with Biodentine, pain and swelling were observed in two teeth after 6 months. In case of the teeth treated with MTA no tooth revealed abnormal clinical or radiographic findings and thus, this agent had shown 100% success rate within the available sample for follow up.



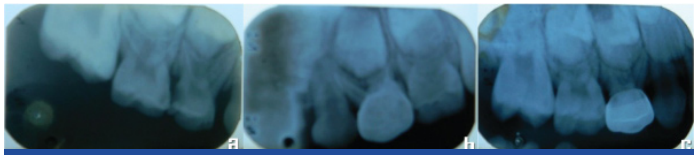
[Table/Fig-1a-c]: Application of (a) Lasers; (b) MTA; and (c) Biodentine



[Table/Fig-2a-c]: Laser group: (a) Pre-operative; (b) Follow-up after 3 months; and (c) Follow-up after 6 months



[Table/Fig-3a-c]: MTA group: (a) Pre-operative; (b) Follow-up after 3 months; and (c) Follow-up after 6 months



[Table/Fig-4ac]: Biodentine group: (a) Pre-operative; (b) Follow-up after 3 months; and (c) Follow-up after 6 months

Samples (leaving the dropouts) were subjected to Kruskal-Wallis ANOVA, the Mc Nemars test to evaluate the efficacy of each agent between 3 months and 6 months and significance was predetermined at $p<0.05$.

Comparison of clinical criteria i.e., status of pain, sinus tract, swelling and mobility, at 3 months, and 6 months interval showed a non- significant difference ($p>0.05$) for each agent [Table/Fig-5]. Furthermore, with respect to radiographic criteria i.e., premature exfoliation, PDL widening, internal/external resorption and periapical/furcal radiolucency, we observed a non- significant difference ($p>0.05$) for each agent after follow up [Table/Fig-6].

DISCUSSION

Vital pulpotomy is considered as a one-stage procedure with the objective of preserving the vitality, function of the remaining radicular portion of pulp and maintain it asymptomatic without adverse clinical signs or symptoms such as sensitivity, pain, or swelling [1,11]. So the ideal requisites of any pulpotomy material should be bactericidal, harmless to pulp and surrounding structures, promote healing of remaining radicular pulp without interfering with the physiologic root resorption and not possess any toxicity [12]. In search of ideal pulpotomy medicament, materials like formocresol, ferric sulfate, glutaraldehyde, calcium hydroxide, adhesive liners, enamel matrix derivative, MTA, bioactive glass, bone morphogenic protein, growth factors, pulpotech, collagen and other techniques like electro surgery and lasers had been tried out with variable clinical, radiological and histological success for pulpotomy procedure in both primary and permanent dentitions [13].

For decades, formocresol has been the drug of choice in pulpotomy of primary teeth due to the ease of use and high clinical success rate [14]. Inspite of its wide usage, it possesses a known toxic, mutagenic and carcinogenic potential risk in humans as it is systemically absorbed, and increases the prevalence of hypoplastic and/or hypomineralization defects, and is known to necrosis and sloughing of the tissue when it touches the gingiva [15]. Lasers and MTA have been used for pulpotomy in primary teeth and have showed clinical success rates comparable to formocresol [16,17]. Biodentine is new bioactive cement that is similar to the widely used MTA [18]. There are no studies reported in the literature regarding its clinical efficiency as a pulpotomy agent in human primary molars. This formed the basis for our current study.

The selection of teeth was done according to the criteria proposed by Fuks [19] which includes teeth with large carious lesion which is restorable, no spontaneous pain, at least 2/3rd of root length is still present, no sign of internal or other kind of root resorption and hemorrhage from amputated sites easy to control [2,3].

Groups	Status of Pain				Status of Sinus Tract				Status of Swelling				Status of Mobility			
	3 months		6 months		3 months		6 months		3 months		6 months		3 months		6 months	
	AB#	PT$	AB	PT	AB	PT	AB	PT	AB	PT	AB	PT	AB	PT	AB	PT
Biodentine	18.0	0.0	15.0	2.0	18.0	0.0	17.0	0.0	18.0	0.0	15.0	2.0	18.0	0.0	15.0	2.0
Laser	18.0	0.0	14.0	1.0	18.0	0.0	15.0	0.0	18.0	0.0	14.0	1.0	18.0	0.0	14.0	1.0
MTA*	18.0	0.0	16.0	0.0	18.0	0.0	16.0	0.0	18.0	0.0	16.0	0.0	18.0	0.0	16.0	0.0
p-value	p>0.05@		p>0.05		p>0.05		p>0.05		p>0.05		p>0.05		p>0.05		p>0.05	

[Table/Fig-5]: Comparison of three groups (i.e. Biodentine, Laser and MTA) with respect to clinical parameters assessed in the study
*MTA: Mineral trioxide aggregate, #AB: Absent, $PT: Present, @p>0.05: stastically non-significant

Groups	Status of Premature Exfoliation				Status of Periodontal Ligament Widening				Status of Internal/External Resorption				Status of Furcal / Periapical Radiolucency			
	3 months		6 months		3 months		6 months		3 months		6 months		3 months		6 months	
	AB#	PT$	AB	PT	AB	PT	AB	PT	AB	PT	AB	PT	AB	PT	AB	PT
Biodentine	18.0	0.0	15.0	0.0	18.0	0.0	15.0	2.0	18.0	0.0	15.0	2.0	18.0	0.0	15.0	2.0
Laser	18.0	0.0	15.0	0.0	18.0	0.0	14.0	1.0	18.0	0.0	14.0	1.0	18.0	0.0	14.0	1.0
MTA*	18.0	0.0	16.0	0.0	18.0	0.0	16.0	0.0	18.0	0.0	16.0	0.0	18.0	0.0	16.0	0.0
p-value	p>0.05@		p>0.05		p>0.05		p>0.05		p>0.05		p>0.05		p>0.05		p>0.05	

[Table/Fig-6]: Comparison of three groups (i.e. Biodentine, Laser and MTA) with respect to radiological parameters assessed in the study
*MTA: Mineral trioxide aggregate, #AB: Absent, $PT: Present, @p>0.05: stastically non-significant

Shoji et al., [5] demonstrated that bleeding from the pulp was controlled when CO_2 laser at ≥3 Joules was applied. Saltzman et al., [20] used a diode laser with 3W until hemostasis was achieved and reported less radiographic success compared to formocresol pulpotomy. Liu [21] found clinical success of the pulpotomy procedure with Nd: YAG laser at 2W. Thus based on these observations, our study was done using Diode Laser at 1.5W. Clinical and radiographic pathology was evident in 4 cases at the end of six month follow up. Of the cases reported as failures, two teeth belonged to Laser group and two teeth to Biodentine group. None of the MTA treated teeth presented evidence of clinical or radiographic signs of failure. The reason for the failures might be due to iatrogenic errors like poorly adapted stainless steel crowns, a thin base, voids in the cement and areas of residual caries or coronal pulp tissue. It is also quite possible that the Laser pulpotomy is more sensitive to operator technique.

The results of current investigation showed that there was no statistically significant difference between the groups. This confirms the findings of Hugar et al., [16] who evaluated the clinical/radiographic signs of MTA and formocresol on pulpotomized primary molars and concluded that there are no statistical differences in MTA and formocresol. Huth et al.,[22], found that the Er:YAG laser pulpotomies had a total success rate (78%) insignificantly lower than formocresol (85%) after 2 year follow-up study. In contrast Liu [21] reported higher clinical (97%) and radiologic (94.1%) success rates for Nd:YAG laser pulpotomy. The success rate of Laser pulpotomy in the present study can be correlated with the results of the aforementioned studies.

Saltzman et al., [20] investigated whether a diode laser pulpotomy with Mineral trioxide sealing (L-MTA) could be an acceptable alternative to conventional formocresol pulpotomy. They found that there were no statistical differences between both groups with regard to radiographic success criteria. A study that compared four pulpotomy techniques in primary teeth using Formocresol (FC), Ferric sulphate (FS), Calcium hydroxide and MTA reported a success rate of 76.9% for FC, 73.3% for FS, 46.1% for $Ca(OH)_2$, and 66.6% for MTA. However, there was no statistically significant difference between the groups [17]. This is in contrast to the present study that showed a success rate of 100% for MTA alone. Nowicka A et al., [23] compared the response of the pulp-dentin complex in human teeth after direct capping with this new tricalcium silicate–based cement with that of MTA. They observed statistically non-significant difference between the Biodentine and MTA groups. It was also observed that Biodentine had almost identical efficacy in the clinical setting and thus, may be deemed as an engrossing substitute to MTA as a pulp-capping agent. These results were similar to the present study where in the same materials were used as pulpotomy agents.

Based on our observations, MTA group had shown higher success rate followed by Biodentine and Laser. This might be due its excellent sealing ability, biocompatibility (Al-Hezaimi et al., 2005 [24]), cell adhesion (Huang et al., 2005 [25]) and also due to its pH which was found to be 11-12 even after 72 days, conferring antimicrobial effects against some facultative bacteria (Torabinejad et al., [26] 1995). However, there was no statistically significant difference among these three agents and hence all the three can be used as alternative pulpotomy agents to formocresol in primary teeth.

CONCLUSION

Among the three agents used for pulpotomy in primary molars, following conclusions were drawn from the study: MTA, Lasers and Biodentine used for primary teeth pulpotomy showed good success rate on follow-up; MTA, Lasers and Biodentine can be used as alternatives to Formocresol in primary molars. However, further in vivo studies with large sample size and long term follow up are required to evaluate the role of these agents in primary teeth pulpotomy.

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