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Original Article

Dentistry Section

Clinical Evaluation of Low Level Diode Laser Application For Primary Teeth Pulpotomy

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ABSTRACT

Introduction: Inspite of latest advances in the materials and techniques practiced for the treatment of pulpally infected teeth with better reported success rate, still the question arises for safety and effectiveness of these medicaments.

Aim: The objective of the present study was to compare the effectiveness of the Low Level Laser Therapy to Mineral Trioxide Aggregate (MTA) when used for pulpotomy in vital human primary molars.

Materials and Methods: The sample consisted of 40 primary molars from 29 children aged four to seven years. The teeth were selected based on clinical, radiographic criteria and randomly allocated to two groups. All the 40 primary molars were subjected to standard pulpotomy procedure, where in 20 molars received MTA (Group I) and 20 molars received LLLT (Group II) pulpotomy. Children were recalled at 3, 6 and 12 months intervals and pulpotomised molars were examined clinically and radiographically. Data was analysed using chi-square test.

Results: MTA showed 94.7% success rate at all the three intervals, where as LLLT showed a success of 95% at three months, which decreased gradually to 85% at six months and 80% at 12 months. Intergroup comparisons were not significant.

Conclusion: Low level laser therapy can be considered for primary teeth pulpotomy and its success is comparable to MTA pulpotomy technique.

Keywords: Primary molars, Lasers, Mineral trioxide aggregate

INTRODUCTION

Conservation of primary dentition is essential for maintenance of arch length, aesthetics, mastication, speech and prevention of abnormal habits [1]. Since the thickness of enamel and dentin in primary teeth is less, dental caries progresses to involve the pulp more frequently. Such teeth with coronally inflamed vital pulps can be salvaged by vital pulp therapy. The commonly supported treatment for retaining cariously affected primary molars that would need extraction is pulpotomy [2].

The success of pulpotomy depends on the medicament or dressing used. The pulpotomy agent should be biocompatible, bactericidal, radicular pulp friendly and should not affect physiological root resorption process [1]. Formocresol (FC) has been considered as the most popular pulpotomy medicament for the past 60 years and the most universally taught and preferred medicament for primary teeth however its toxicity and carcinogenic potential has raised concern [3].

Torabinejad developed Mineral Trioxide Aggregate (MTA), a biocompatible material claimed to promote regeneration when it is placed in contact with the dental pulp [4]. MTA has been used as a pulp dressing agent in pulpotomized primary molars with high success rate and perhaps found to be a suitable alternative for formocresol [5].

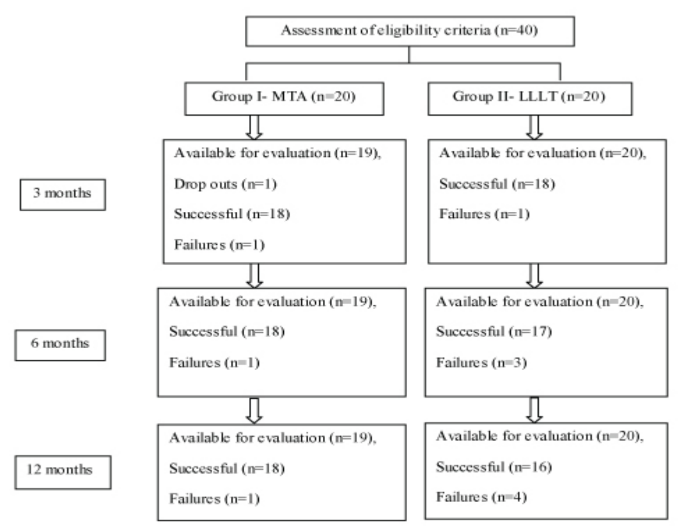
Laser applications in paediatric dental practice at times is an alternative, sometimes complements, and other time substitutes traditional techniques in various soft and hard tissue treatment procedures. From past few years, lasers in vital pulp therapy is used as the substitute to various conventional pharmaco-therapeutic techniques with several range of lasers being used in pulpotomy e.g. Carbon dioxide laser, Nd:YAG, Er:YAG, Diode laser etc. [6]. However Low Level Laser Therapy (LLLT) for vital pulp therapy has shown promising results with advantages of improved healing, dentinogenesis stimulation and preservation of pulp vitality [7]. There is a paucity of clinical studies done on Low Level Laser Therapy (LLLT) for pulpotomy in primary molars. Hence, the present study was carried out to compare the effectiveness of Low Level Laser Therapy (LLLT) with MTA for pulpotomy in primary molars.

MATERIALS AND METHODS

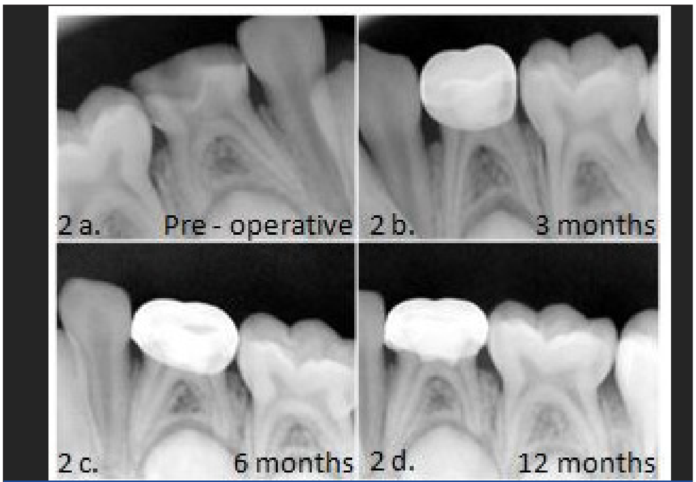
This clinical study was carried out in the Department of Paediatric Dentistry, Vishnu Dental College, Bhimavaram and was approved by Institutional review board in the year 2013. Twenty nine healthy children of age 4-7 years (mean age 5.6 years) from both the sexes were selected from patients who were referred to the department. Prior written informed consent was obtained from the parents. The inclusion criteria included, primary molars with vital carious pulp exposures that bleed upon entering the pulp chambers, primary molars with no clinical signs and symptoms of pulp degeneration such as swelling, pathologic mobility, excessive bleeding from amputated radicular stumps and tenderness on percussion. Teeth with history of swelling or sinus tracts and radiographic signs of internal or external resorption, furcation radiolucency and teeth with non-restorable crowns were excluded. A total of 40 infected primary mandibular molars were selected in 29 healthy children. Where 11 subjects required pulpotomy in both mandibular primary molars and 18 subjects required pulpotomy in only one mandibular primary molar. These teeth requiring pulpotomy were randomly allocated to Group I MTA and Group II LLLT [Table/Fig-1].

The pulpotomy procedure was performed following strict aseptic protocol under local anaesthesia. After isolating the tooth with rubber dam, access cavity was prepared on the occlusal surface with #4 round bur using high speed hand piece and water spray, coronal pulp was amputated using a sharp spoon excavator, followed by irrigation with saline to clear the debris. Cotton pellet moistened with saline was placed on the pulp stumps in order to achieve haemostasis and the teeth with evident haemostasis in less than five minutes were included in this study. Later MTA or LLLT treatment was preferred according to their respective group.

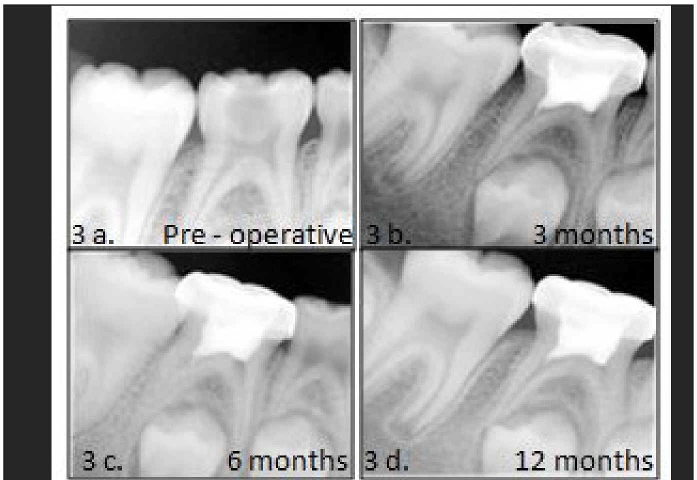
In MTA group, three parts of MTA powder was mixed with one part of distilled water to obtain paste. This mixture was placed on the



[Table/Fig-1]: Flow chart of sample allocation and group establishment.



[Table/Fig-2]: IOPA radiographs of 84 treated with MTA



[Table/Fig-3]: IOPA radiographs of 75 treated with low level laser therapy.

radicular pulp stumps and condensed lightly with a moistened cotton pellet. Whereas in LLLT group, DenLaseTM Diode Laser (China Deheng Group, Inc) of wavelength 810nm, under continuous mode, energy 2 J/cm^2 was applied over the radicular stumps for about 10 seconds. During laser application patients, operator and assistant were given protective eye shields. After pulpotomy procedure the access cavities were sealed with glass ionomer cement and finally restored with stainless steel crowns. Parents were advised to report in case of any postoperative symptoms or discomfort.

Children were recalled after three, six and tweleve months for follow up [Table/Fig-2,3]. During follow up visits, the pulpotomized teeth were considered to be successfully treated if they had no symptoms of pain, tenderness to percussion, swelling, fistulation or pathologic

Interval	MTA group		LLLT group		p -value
	Success	Failure	Success	Failure	
3 months	94.7%(n=18)	5.3%(n=1)	95%(n=19)	5%(n=1)	0.976 (NS)
6 months	94.7%(n=18)	5.3%(n=1)	85%(n=17)	15%(n=3)	0.316 (NS)
12 months	94.7%(n=18)	5.3%(n=1)	80%(n=16)	20%(n=4)	0.169 (NS)

[Table/Fig-4]: Clinical and radiographic outcome of pulpotomised primary molars with LLLT and MTA at three intervals.
*p-value≤ 0.05, NS- Not Significant

[Table/Fig-5]: Radiographs showing pathologic signs of failure (furcation lesions) following pulpotomy using: (a) MTA; (b)LLLT

mobility clinically and no evidence of radicular radiolucency, internal or external root resorption or periodontal ligament space widening radiographically.

Data from 28 children, with a total of 39 pulpotomised primary molars were available at 12 months follow-up evaluation and one child was not available for follow up since the parents moved out of the town. The obtained proportional values at intervals of three, six and 12 months were compared using chi-square test. Statistical significance was computed at p ≤0.05.

RESULTS

At three months follow up, 39 pulpotomised teeth were available for evaluation. LLLT and MTA yielded a success rate of 95% and 94.7% respectively with no statistically significant difference (p=0.976) [Table/Fig-4]. One failure was accounted in each group [Table/Fig-5]. At six months follow up, LLLT showed a success of 85% with two more failures as compared to MTA (which showed a success of 94.7%) and this difference is statistically not significant (p=0.316). MTA has shown the similar success rate as in third month.

At 12 months follow up, LLLT showed a success of 80% and MTA showed 94.7% success rate with overall failures of four teeth in LLLT and one tooth in MTA group. However, the difference is not statistically significant (p=0.169) [Table/Fig-4].

DISCUSSION

Pulpotomy is the most widely accepted clinical procedure for treating primary teeth when the coronal pulp tissue is exposed by caries during caries removal or trauma [8]. The goal of pulpotomy in carious primary teeth is to maintain their vitality until natural exfoliation by removal of infected coronal pulp and by preserving the uninfected radicular tissue. Currently there are numerous techniques for pulp therapy in primary teeth with a range of suggestive protocols and medicaments [2,5,9,10]. In modern day dentistry, the usage of regenerative materials have got the attention of many clinicians and materials like freeze-dried bone, bone morphogenetic protein, osteogenic protein and Mineral Trioxide Aggregate (MTA) are used as regenerative materials in pulpotomy [11,12].

Among the regenerative materials, MTA is considered as an ideal material with higher success rate ranging 97%-100% [11,12]. Peng L et al., found that in primary molar teeth with vital pulp exposure caused by caries or trauma, a pulpotomy performed with MTA results in better outcomes when compared with formocresol pulpotomy [13]. Kabaktchieva R et al., investigated that vital pulpotomy with MTA is a reliable biological method for pulpotomy in primary teeth and can be recommended for the clinical practice [14]. It has got good biocompatibility, antibacterial property, excellent seal and good tissue regenerating properties [11,12]. However, the drawbacks like long setting time and high cost has limited its use [15,16].

Quest for an ideal pulpotomy technique or medicament is never ending in a journey to obtain maximum benefit for good clinical performance. The modern world in recent years has conquered the use of laser techniques as an alternative to different traditional operative methods or in combination with these. In dentistry, different kinds of lasers with different wavelengths are used: carbon dioxide laser (CO_2), Erbium Yag Laser (Er:Yag), Erbium Chrome YSGG (Er-Cr:YSGG), Neodymium Yag (Nd: Yag), Argon, KPT laser and diode laser (Ga-As-A1) [17]. The latter is most frequently used due to its reliability, versatility and convenience, together with its handiness and simple set-up [17]. Various clinical and histological studies investigating the application of LLLT to dental tissues have shown its potential to reduce the pulpal inflammation, preserve the dental pulp vitality and improve healing [10,18,19]. Pescheck et al., have evaluated the LLLT pulpotomy in primary teeth and concluded it to be favourable due to accelerated wound healing, pain relief, regeneration, and immune enhancement. It is less invasive, non pharmaceutical, economical and there is no side effects reported [20].

LLLT is being used in different branches of regenerative medicine (e.g., tissue regeneration) and dentistry due to its biological effects on stimulation of wound healing, collagen synthesis, nerve regeneration, enhanced remodeling and repair of bone [7]. LLLT works on the principle of supplying direct bio-stimulative light energy to the cells. Here ATP is produced when the cellular photoreceptors (cytochromophores and antenna pigments) are absorbed by low-level laser light and pass it on to mitochondria [21]. LLLT accelerate the wound healing process by changing the expression of Platelet-Derived Growth Factor (PDGF), transforming growth factor beta (TGF-β), and blood-derived fibroblast growth factor (bFGF) genes that are responsible for the stimulation of the cell proliferation and fibroblast growth [22].

LLLT has a bio-modulatory effect on pulp cells and expression of collagen, fibronectin, and tenascin [23]. LLLT has also shown its potential to stimulate dentinogenesis and preserve the dental pulp vitality [7]. Pretel et al., reported that LLLT also accelerates dentin barrier formation and repair process after traumatic pulp exposure in monkeys [24]. LLLT has shown noble histopathological results in many studies where the pulp exhibited an increased neovascularization, regenerative tissue formation and also the proliferation of dental reparative cells like osteoblasts and fibroblasts [7]. Marques NC et al., investigated the effects of low-level laser therapy (LLLT) on pulpal response of primary teeth and revealed that low-level laser therapy preceding the use of calcium hydroxide exhibited satisfactory results on pulp tissue healing [25]. P Yadav et al., found that electrosurgery and diode lasers (Wavelength: 810 nm, output power: 7w) appear to be acceptable alternative to pharmaco-therapeutic pulpotomy agents [26].

Sun G and Tuner J suggested LLLT with a wavelength of 780–890 nm, energy of 2-3 J/cm^2, under a continuous mode with power output of 100mW for about 10 sec with 2-4 mm separation distance between the laser and the target tissue [21]. In the present study, we used diode laser of 810nm wavelength with energy of 2J/cm^2 under a continuous mode with power output of 100mW for about 10 sec and 2mm away from the radicular pulp. The 810nm wavelength showed an increase in DNA synthesis [27], proliferation of human gingival fibroblasts [28] and completion of root formation in an immature rat tooth following pulpotomy [29]. Krothapalli Niranjani et al., reported that teeth treated with Lasers and biodentine were observed with pain and swelling by six months of follow up period, whereas MTA treated revealed no abnormal clinical or radiographic findings with 100% success rate after six months [30].

In the present study, it showed a higher success rate with MTA compared to LLLT however the difference is statistically not significant in accordance with the result from meta-analysis by Lin PY, et al., The results from meta-analyses showed that MTA had, significantly higher clinical and radiographic success rate than laser therapy and calcium hydroxide outcomes than formocresol and calcium hydroxide, and calcium hydroxide [31]. Similar to our study Saltzman et al., found that diode laser pulpotomy with mineral trioxide sealing (L-MTA) can be an alternative to formocresol pulpotomy and no statistical difference was found between both groups with regard to radiographic success criteria [32].

In contrast to this study, Golpayegani et al., reported a radio graphical success rate of 67% with LLLT which was done using 632 nm wavelength under a continuous mode, with an energy of 4.0 J/cm^2 for about 30 seconds with tip of the fiber 2 mm away from root stumps [33] [Table/Fig-6]. Treatment outcome with LLLT is affected

Clinical application	Studies	Test pulpotomy agents	Evidence
Primary Teeth Pulpotomy	Olatosi OO, Sote EO, Orenuga OO2	Formocresol Vs MTA (white mineral trioxide aggregate)	Formocresol: Clinical success- 81% radiographic success- 81% MTA: Clinical success- 100% radiographic success-96% over 12 months.
	Hugar SM, Deshpande SD5	MTA Vs formocresol	MTA: Clinical success- 100% radiographic success-100% Formocresol: Clinical success- 100% radiographic success- 97% over 36 months.
	Erdem AP et al., [8]	MTA, ferric sulfate and formocresol	MTA- 96% Success, ferric sulfate- 88% success and formocresol-88% success rate over 24 months.
	Golpayegani MV, Ansari G, Tadayon N [10]	Low level laser therapy Vs formocresol	Low level laser therapy: 100% success and Formocresol: 100% success over 12months.
	Eidelman E, Holan G, Fuks AB [11]	MTA Vs formocresol	MTA: 100% success Formocresol: 94% success, 6% of revealed internal resorption over 17 months.
	Farsi N, Alamoudi N, Balto K, Mushayt A [12]	MTA Vs formocresol	MTA: Clinical and radiographic success-100% Formocresol: Clinical success- 98.6% radiographic success- 86.8% over 24 months.
	Liu JF [19]	Nd:YAG laser Vs formocresol	Nd:YAG laser: Clinical success- 97% radiographic success-94.1% Formocresol: Clinical success- 85.5% radiographic success- 78.3%
	Krothapalli Niranjani et al., [30]	Biodentine, Laser and MTA	Biodentine success- 90% Laser success- 90% MTA success- 100% over 9 months.
	P Yadav, KR Indushekar, BG Saraf, N Sheoran, D Sardana [26]	Ferric sulfate, Electrosurgical and Diode Laser	Ferric sulfate: Clinical success- 86.6% radiographic success-80% Electrosurgical: Clinical success-100% radiographic success-80% Diode Laser: Clinical success-100% radiographic success-80% over 9 months.
	Golpayegani MV, Ansari G, Tadayon N, Shams Sh, Mir M [33]	Low level laser therapy Vs Formocresol	Formocresol: Clinical success- 93% radiographic success- 80% Low level laser therapy: Clinical success- 100% radiographic success-67% over 12 months.

[Table/Fig-6]: Comparision of clinical and radiographic outcomes of studies with different pulpotomy agents.

by various factors like wavelength, power output, dose and pulse frequency [34]. Previous studies have shown that MTA has been consistently exhibiting high success rate and this could be due to its properties such as creation of antibacterial environment by its alkaline pH, formation of calcium hydroxide that releases calcium ions for cell attachment and proliferation and modulation of cytokine production [13]. It encourages differentiation and migration of hard tissue producing cells resulting in the formation of hydroxyapatite on the MTA surface which provides a biologic seal [13].

LLLT showed comparable results to that of MTA with a success of 80% at the end of 12 months. LLLT has biological effect of enhanced wound healing. It promotes cell proliferation, formation of granulation tissue and accelerates collagen synthesis by fostering the formation of type I and type III procollagen specific pools of mRNA [35]. LLLT also increases Adenosine Tri Phosphate (ATP) synthesis within the mitochondria and activates the lymphocytes [35]. All these factors might have played a role for better success of LLLT.

In the present study, it has been found that LLLT has shown a comparable success with that of MTA at the end of 12 months. However, long term clinical studies with larger sample size complemented with histological findings are warranted.

CONCLUSION

Findings of the present study confirms that low level laser therapy can be used successfully as a complementary step to pulpotomy procedure in order to promote healing of the amputated pulp in primary molars.

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