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DIODE LASER PULPOTOMY VS. FORMOCRESOL PULPOTOMY IN PRIMARY TEETH: A 6 MONTH RANDOMIZED CLINICAL TRIAL

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ABSTRACT Pulpotomy is a widely used procedure in primary teeth. This is a split mouth single blind study to investigate the radiographic and clinical effects of diode laser (810nm) pulpotomy compared with formocresol pulpotomy at the end of 9months. Clinical and radiographic follow ups was performed at 1, 3, 6 months. The data is subjected to statistical analysis to evaluate the clinical and radiographic success of the treatment modality. The teeth in the diode laser group had a clinical success rate of 100% and a radiographic success rate 95.5% at the end of 6months.The teeth in the formocresol group had a clinical success rate of 90.9% % and radiographic success rate of 77.3% at the end of 6 months. There were no statistically significant differences between laser and formocresol group with regard to both clinical and radiographic success rates.

KEYWORDS : pulpotomy, diode laser, formocresol, radiographic evaluation

INTRODUCTION

Pulpotomy entails the removal of infected coronal pulp followed by placement of a suitable medicament to preserve the health of remaining radicular pulp[1]. Pulpotomy on a primary tooth is a procedure performed when the coronal pulp tissue is exposed during caries removal or trauma. Formocresol pulpotomy has remained a treatment of choice in primary teeth and is widely accepted[2]. Studies have demonstrated the potential for local and systemic distribution of formocresol with associated potential toxic effects[3] like mutagenecity[4,5], carcinogenecity[5], immune sensitization[6] and a definite relationship between formocresol pulpotomies and enamel structure changes in permanent successors[7,8]. For a number of years there has been a debate about the appropriateness of formocresol as a vital pulpotomy material, regarding the safety of its principal component: formaldehyde. Therefore, there is great interest in the alternative materials to replace formocresol[2]. Diode laser is widely used in dentistry, especially on treating soft tissues. Diode LASER suits the tissue resistant temperature values of pulp due to its high absorbance at 810nm wavelength which avoids excessive heating and charring of pulp. Furthermore diode LASER is a contact LASER, i.e. the LASER-emitting tip is applied in immediate contact with soft tissues, and hence only the site of application (micrometer range) is affected, leaving the remaining tissue unaffected. There is only one study reported using diode laser irradiation for pulpotomy procedure. The investigator has used 980nm diode laser with MTA as sealing medicament in experimental group. The 810nm diode laser is closer to argon ion laser and would be a better coagulator than the 980nm wavelength diode laser[17] .Based on this literature the present in vivo study to evaluate the clinical and radiographic comparison of diode laser (810 nm) pulpotomy with formocresol pulpotomy.

METHODOLOGY

The present in-vivo study was carried out in the Department of Pedodontics and Preventive Dentistry.

Method:

A sample of 22 patients each with atleast two vital primary molar teeth that are indicated for pulpotomy were selected for the study. 44 teeth were divided in two groups i.e. formocresol group the control group and laser group the study group. In formocresol group caries removal and pulp chamber was opened with a sterile high speed hand piece followed by excavation of coronal pulp with sharp spoon excavator, complete haemostasis in canal orifice was achieved by applying 1:5 dilution of formocresol wetted cotton pellet In study group excavation of coronal pulp and complete haemostasis in canal orifice was achieved by using diode laser (810nm). Zinc oxide eugenol paste was used to restore the pulp stumps in both study and control group. Clinical and radiographic follow ups were performed at 1, 3, 6 months. The selection criteria was based on children who required pulpotomies in a primary first or second molar in at least two bilateral quadrants.

All teeth treated were anaesthetized using 2% lidocaine with 1:100 000 epinephrine. The teeth were then isolated with a rubber dam and dried with a sterile gauze pad. Initial occlusal access was prepared using a high-speed dental hand-piece and a #245 bur under water spray. In the formocresol pulpotomy group (FC-ZOE), pulp amputation was completed with a #4 slow-speed round bur and spoon excavator, followed by copious irrigation with saline. After haemostasis was achieved, a cotton pellet dampened with 1:5 dilution of formocresol was placed in contact with the pulp for 5 min, followed by the placement of a zinc oxide and eugenol base In the experimental diode laser pulpotomy group, the pulp was excavated to the level of the root canal orifice using the 810-nm diode laser set at 1.5-2 W of power with a continuous pulse mode. All patients and clinical staff wore appropriate eye protection during the procedure by laser. The laser energy was delivered through a 0·5-mm-diameter optical fiber in contact with pulp tissue.

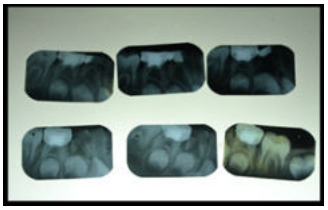
A ZOE base was placed on the amputated pulp stumps.

In both the groups SSC (3M Iso-Form, 3M Dental Products,) was cemented in place using GIC.

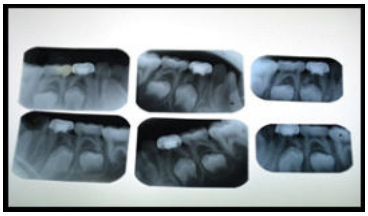
All teeth in both categories were to be followed up clinically and radiographically at 1, 3, 6 months. Clinical outcome assessments were made by the primary investigator at each follow-up visit, while radiographic outcome assessments were made by the primary investigator and one independent experienced clinician who was blind to the treatment

Diode Laser unit (810nm)

Haemostasis achieved after laser irradiation



1, 3 and 6th month follow up radiographs – Success in both FG and LG groups



Internal resorption seen at the end of 6 months in FG group

Radiographic results:

Table 1: Represents the radiographic success rates at the end of 1st, 3rd and 6th month follow-up

Group		Radiographic		p-value
		Absent	Present	
1st month	FG	22	-	-
		100%	-	
	LG	22	-	
		100%	-	
3rd month	FG	21	1	1 (NS)
		95.5	4.5%	
	LG	22	0	
		100%	.0%	
6th month	FG	17	5	0.19 (NS)
		77.3%	22.7%	
	LG	21	1	
		95.5%	4.5%	

Chi-square test with yates continuity correction

The radiographic success of teeth in the laser group was 100% at 1 month, remained 100% at 3 months and 95.5% at 6 months. The teeth in the formocresol group had a radiographic success rate of 100% at 1st month follow-up, 95.5% at the end of 3rd month, and 77.3% at the end of 6months. The success observed for each group was compared at each of the three follow-up periods. Statistical analysis of the data, using Chi-square test with yates continuity exact test, revealed no statistically significant differences between the two groups.

Clinical results:

Table 2: Represents the clinical success rates at the end of 1st, 3rd and 6th month follow-up

	Group	Clinical		p-value
		Absent	Present	
1st month	FG	22	-	-
		100%	-	
	LG	22	-	
		100%	-	
3rd month	FG	22	-	-
		100%	-	
	LG	22	-	
		100%	-	
6th month	FG	20	2	0.47 (NS)
		90.9%	9.1%	
	LG	22	0	
		100%	.0%	

Chi-square test with Yates continuity correction

The clinical success of teeth in the laser group was 100% at 1 month, remained 100% at the end of 3 months and 6 months. The teeth in the formocresol group had a clinical success rate of 100% at 1st month and 3rd month follow-up and 90.9% at the end of 6months. The success observed for each group was compared at each of the three follow-up periods. Statistical analysis of the data, using Chi-square test with Yates continuity exact test, revealed no statistically significant differences between the two groups.

Table 3: Represents the clinical findings seen in the failed teeth.

		Group		p-value
		FG	LG	
Mobility	0	21	22	1
		95.5%	100%	
	1	1	0	
		4.5%	.0%	
Tenderness	0	20	22	0.469
		90.9	100%	
	1	2	0	
		9.1%	.0%	
Swelling	0	22	22	-
		100%	100%	
Fistula	0	22	22	-
		100%	100%	
Premature Tooth loss	0	22	22	-
		100%	100%	

Chi-square with yates continuity correction
0=absent. 1=present

All the teeth in the laser group remained symptom free .The most common clinical symptom which was found positive in the formocresol group was tenderness which was found in 2 out of the 22 teeth i.e. 9.1% and mobility was found in 1 out of the 22 teeth i.e 4.5% of the teeth. None of the teeth showed the presence of any swelling, fistula and no premature tooth loss was recorded in both the groups..None of the clinical findings showed statistical significance between the two groups.

Table 4: Radiographic features at the end of 6 months

		Group		p-value
		FG	LG	
Root resorption	0	18	22	0.116
		81.8%	100%	
	1	4	0	
		18.2%	.0%	
Furcation	0	20	21	1
		90.9%	95.5%	
	1	2	1	
		9.1%	4.5%	
Pdl	0	21	22	1
		95.5%	100%	
	1	1	0	
		4.5%	.0%	
Abnormal physiologic root resorption	0	21	22	1
		95.5%	100%	
	1	1	0	
		4.5%	.0%	

Chi-square with yates continuity correction
0=absent. 1=present

The most frequently observed radiographic findings were pathologic root resorption (18.2%), followed by furcation radiolucencies (9.1%); widened periodontal ligament (4.5%) and abnormal physiologic root resorption (4.5%) in the formocresol group whereas only furcation radiolucencies (4.5%) were recorded in the laser group. Statistical analysis of the data, using Chi-square test with yates continuity exact test, however revealed no statistically significant differences between the two groups.

DISCUSSION

Pulpotomy is advocated in primary and young permanent teeth with pulp exposure either due to caries or trauma. An ideal pulpotomy medicament should preserve the vitality and function of radicular

pulp. Histologically, it should show an intact odontoblast lined dentin chamber which will help the tooth to enter into the exfoliative process at the appropriate time.[19] Based on medicaments used pulpotomy is classified by Ranly as: devitalization (formocresol, glutaraldehyde, electrocoagulation), preservation (ferric sulphate, calcium hydroxide, mineral trioxide aggregate, lasers) and regeneration (indirect pulp therapy, bone morphogenic proteins, collagen).[22]

Among all the medicaments used during pulpotomy, formocresol is proved to be most successful clinically and considered near ideal in its properties. Its histological reactions from pulp chamber to apex are tissue fixation, coagulation necrosis and vital pulp. When histological events discovered by various investigators are reviewed, formocresol showed necrosis of the coronal portion of pulpal tissue next to a thin, superficial fixation layer. It also showed poor and inadequate fixation in few of the experimental samples. According to Beaver, the penetration of formaldehyde into the pulp is a slow diffusion process. Initially, it fixes the tissue to which it has been topically applied. As it diffuses apically, areas of coagulation necrosis, dilated blood vessels and inflammation appear[23]. Block in few of experimental samples showed that coagulation necrosis was followed by liquefaction necrosis of the pulp which ultimately led to periapical abscess with resorption of root surface.[24] Though these reactions do not depict a complete histological failure, Ogilvie and Ingle stated that the conversion of an inflamed pulp into a necrotic mass may occur in a matter of hours or years. Apart from this the debate over carcinogenicity and mutagenecity of formocresol in experimental animals became a major concern for its use.[26]

The research for preservative , reparative and biological approach to pediatric pulp therapy over the devitalization approach of formocresol pulpotomy led to the use of lasers. Lasers because of their absorption effect on tissues cause cellular vaporization and ablation, which helps in proper hemostasis. Apart from that its properties like cellular vaporization causes molecular bond breaking and photobiochemical disruption which leads to complete bacterial destruction.

Laser has advantages when used as a pulpotomy agent such as control of hemorrhage, sterilization, preserveing the vitality of the dental pulp and faster pulpal wound healing. It can stimulate the dental pulp cells without affecting either the inflammatory function of monocytes and endothelial cells or the adhesion of endothelial cells. Laser sterilization reinforces the overall sterilizing procedure, and laser coagulation produces a thin necrotic layer over the vital remaining pulp. This could be attributed to the minimal penetration of diode laser into the pulp tissue. The depth of penetration reported with the diode LASER was 100 - 300µm.[١٨]

Formation of a thin laser-induced necrotic layer stops the pulp from having direct contact with the covering materials and reduces the possible chemical or toxic effects of the materials used.

Based on this evidence the present study was done where diode laser (810nm) was clinically and radiographically evaluated as a pulpotomy agent.

The chief advantage of the diode lasers is the smaller size of the instrument making the units portable and compact which can be easily moved with minimum setup time and are the lowest-priced lasers currently available[15]. Diode LASER suits the tissue resistant temperature values of pulp due to its high absorbance at 810nm wavelength which avoids excessive heating and charring of pulp.

Whereas other lasers which fall in high infrared wavelength such as Er:YAG laser, and Er,Cr:YSGG have shown carbonization and charring of pulp in experimental animals. As these lasers are hard tissue lasers they have a high affinity for hydroxyapatite so they tend to affect the adjacent hard tissues and therefore they are not much recommended for soft tissue procedures.

Furthermore diode LASER is a contact LASER, i.e. the LASER-emitting tip is applied in immediate contact with soft tissues, and hence only the site of application (micrometer range) is affected, leaving the remaining tissue unaffected. In diode laser, energy is released as photons, while in most other lasers such as CO_2 laser, ruby laser, Er Cr :YSG, Er: YAG, energy is released as heat which may damage the remaining radicular pulp tissue. This makes diode laser as a suitable laser for soft tissue incision and ablation, now as a pulpotomy agent[25].

The tip of the laser used in our study is only ٣٠٠micrometers in diameter which is accessible for its use in contact mode in primary teeth. Whereas in other non-contact lasers such as CO, laser, Er.Cr YSGG, Er.YAG, Nd.YAG the delivery system is either a hollow wave guide or fiber optics in free running pulse or non pulse mode where the laser light is applied from a minimum of 4mm of distance from tissue thus the removal of coronal tissue is not precise. Apart from this in non-contact lasers there is unnecessary collateral damage to the adjacent tissues.

The result of our study showed that the clinical success rate of diode laser (810nm) pulpotomy after 6 months was 100% and the radiographic success rate was 95.5%, which was statistically insignificant than that of formocresol pulpotomy group which showed a success rate of 90.9% clinically and 77.3% radiographically. However, there are very few human clinical trial studies using laser as pulpotomy tool for the purpose of outcome comparison.

The lasers commonly used for pulpotomy procedure are carbon dioxide laser ,Nd:YAG[15] , Er:YAG laser[16], and Er,Cr:YSGG[17] laser. All these lasers on clinical, radiographic and histopathologic evaluation demonstrated insignificant difference in success rates when compared with formocresol.

The age of the patients included in our study ranged from 4-9years but mean age of failed teeth were 6.9years. Among the 44 teeth which successfully completed 6months follow-up, 5 failures were observed in formocresol group and 2 failures occurred in laser group. Among the 7 failed teeth 2 failures were seen in primary second molars whereas 5 were primary first molars. One of the factors associated with success of pulpotomized tooth is its location in the arch. First primary molars failed more often than second molars, the probable reason may be its anatomical variations.

In our study the most frequently observed pulpal responses radiographically were pathologic root resorption (18.2%), followed by furcation radiolucencies (9.1%), widened periodontal ligament(4.5%) and abnormal physiologic root resorption(4.5%) in formocresol group whereas 4.5% of furcation radiolucencies and no pathologic root resorption in laser group. Clinically all teeth remained asymptomatic in laser group whereas in formocresol group tenderness was seen in 9.1% and mobility was seen in 4.5% of teeth.

Among the formocresol group one of the failed tooth had pathologic root resorption and furcal radiolucencies and clinically it showed pain and mobility at the end of 6 months. It was treated with extraction and placement of suitable space maintainer. Another failed tooth in the same group showed interradicular radiolucency and pain on percussion. It was treated with pulpectomy followed by a permanent restoration. All the teeth which showed radiographic changes and remained sound clinically were kept under observation and monitored regularly.

Failure of pulpotomy in primary molars can be attributed to several factors, one of which was erroneous diagnosis of a chronically inflamed radicular pulp as non inflamed and noninfected.[15] One of the other factors is the leakage of the final restoration of pulpotomized primary molars. Although Croll and Killian recommended stainless-steel crowns as the treatment of choice for teeth that have undergone pulpotomy, Holan et al. Suggested that pulpotomized primary molars could be successfully restored with one surface amalgam if their natural exfoliation is expected after not more than 2 years.[21] However all the teeth in both the control and study group were restored with stainless steel crowns. Poorly adapted SSCs, a thin base, voids within cement and areas of residual caries or coronal pulp tissue may have a more detrimental effect on the long-term success of the teeth. These errors are likely to occur in both the study and the control group.

In most of laser studies done till now there were multiple operators whereas in our study all the procedures were performed by single operator thus reducing the operator variation. The radiographs at each follow up were assessed by an experienced paediatric dentist apart from the principle operator.

In light of present findings diode laser (810nm) can be considered as an alternative to conventional therapeutic medicaments. However the cost effectiveness of the various pulpotomy procedures should be considered. Only with a continued reduction of equipment prices the

diode laser unit can make the pulpotomy acceptable when compared to the other relatively inexpensive treatment alternatives. Usage of diode laser is technique sensitive and the operator should be trained enough for its usage.

In conclusion, diode laser (810nm) may be considered as an alternative to formocresol for pulpotomies in primary teeth. Within the parameters used in this study, pulpotomy by diode laser did not seem to lead to any adverse pulp reactions. However, further investigations should be performed in order to determine safe and optimal laser parameters, and these results should be confirmed in longer follow-ups.

CONCLUSION

This study was an un-pretentious attempt to evaluate the clinical and radiographic effects of diode laser (٨١٠nm) pulpotomy compared to that of formocresol pulpotomy. Within the experimental limitations of the study, the following conclusions were drawn :

- The clinical success rate in the laser group was found to be 100% at 1 month and remained 100% at the end of 3 and 6 months respectively.
- In the formocresol group the clinical success rate was 100% at 1st and 3rd month follow-up and 90.9% at the end of 6months.
- The radiographic success rate in the laser group was 100% at 1 and 3 months and 95.5% at 6 months.
- In the formocresol group the radiographic success rate was 100% at 1st month follow-up, 95.5% at the end of 3rd month, 77.3% at the end of 6months.
- The diode laser (810nm) pulpotomy showed improved success rates both clinically and radiographically compared to formocresol pulpotomy after 6 months of follow-up. However the results were statistically insignificant.

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