ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 2, Issue – 4, July – August - 2019, Page No. : 434 - 447

Evaluation Of Outcome Of Pulpotomy In Primary Teeth Using Formocresol, Copaifera Langsdorfii Oil And Diode Laser - An In Vivo Study

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Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Aim: The aim of this study was to compare the clinical and radiographic success for pulpotomy using Formocresol [FC], Copaifera langsdorfii oil resin [CLOR] and Diode laser [DL] in primary molars.

Material and method: Children within the age group of 4–8 years, with a total of 60 teeth were selected for the study. They were divided into three groups 20 each in FC,CLOR and DL and were restored with prefabricated crowns. Clinical and radiographic evaluation was done at 1,3,6 and 9 months using modified Zurn and Seale criteria. Data was statistically analysed.

Results: On comparison of clinical and radiographic scores of all three groups at 1, 3, 6 and 9 months interval, chi square value and p value was found to be insignificant.

Conclusion: Although the radiographic difference between the three groups is not statistically significant, clinically diode laser offers higher success rate as compared to others. Further studies need to be carried out with larger sample and a longer follow up period.

Keywords: Pulpotomy , Diode Laser, Copaifera langsdorfii oil resin, Formocresol

Introduction

It is important to preserve the primary dentition until permanent successors erupt in the oral cavity.[1] Pulpotomy procedure follows the rationale where the radicular pulp tissue is healthy or capable of healing after surgical amputation of affected or infected coronal pulp.[2] It is defined as “a clinical procedure to remove the infected coronal pulpal tissue in order to preserve the vitality and function of the radicular pulp”.[3] It can be difficult and often impossible to clean, give shape to, and properly obturate the root canals in procedure like pulpectomy. Moreover, cooperation from the child and behavior management can be difficult for the dentist attempting to provide extensive restorative treatment. Pulpotomy seems to be a reasonable treatment option to meet these situations.[4] asymptomatic primary teeth with large carious lesions that approximate the pulp and, therefore, are at risk of pulpal exposure, are frequently treated with pulpotomy. Ideal requirements of a pulpotomy agent is healing and preservation of vitality of the radicular pulp tissue.Variety of medicaments are used to perform pulpotomies, including diluted formocresol, electrosurgery, ferric

sulfate, lasers, sodium hypochlorite, mineral trioxide aggregate and a variety of phytochemicals to name a few.[33,34]

In this study pulpotomy was performed using FC,CLOR,DL which was clinically and radiographically assessed at 1,3,6,9 months to explore an archetypal pulpotomy procedure.

Material and Method

Ethical clearance was attained from the Ethical Committee, children within the age group of 4–8 years, who attended the Department of Pedodontics and Preventive Dentistry, with a total of 60 teeth were selected of which 20 teeth were considered for each material group

Inclusion Criteria:

- Cooperative healthy children of age group 4-8 Yrs.
- Each child having primary teeth that displayed carious exposure of pulp on caries excavation, but were asymptomatic and vital.
- No more than one-third physiological root resorption
- Teeth that were deemed restorable with a stainless steel crown.
- No clinical or radiographic evidence of pulp degeneration

Exclusion criteria

- History of systemic disease.
- History of spontaneous tooth pain or tenderness to percussion
- Teeth indicated for extraction or pulpectomy
- Presence of primary teeth without permanent successor.
- Haemostasis requiring more than 5 minutes.
- Physiologic resorption more than one third of the tooth root.

The treatment plan was discussed and explained to the child's parent and written consent for the treatment was obtained prior to clinical procedure. Topical anesthesia using Precaine gel[Pascal Int., WA, USA] was applied to the area of needle insertion using a cotton applicator tip followed by 2% lidocaine injection. Rubber dam isolation was performed and the tooth was prepared for receiving the stainless steel crown and appropriate crown was selected. Dental caries was excavated with a large slow-speed round bur before pulpal exposure.If a carious pulpal exposure was evident the entire roof of the pulp chamber was removed using a No.330 carbide bur or a high speed non-end cutting bur under copious water spray. All the coronal pulp was amputated with a sterile spoon excavator. The pulp chamber was thoroughly washed with saline to remove all debris and filaments of pulp to ensure that the amputation site was clean. Hemorrhage was controlled with slightly moistened cotton pellets [wetted and blotted almost dry] placed against the radicular pulp stumps. Dry cotton pellets were placed over the moist pellets and light pressure was exerted on it. Once the bleeding was controlled, the tooth were managed using formocresol, copaifera langsdorfii oil resin and laser pulpotomy techniques depending on the group to which the tooth belonged.

Results

Clinical and radiographic examination at 1,3,6 and 9 months from treatment was carried out. The criteria based on Zurn and Seale 2008 [Table 1], was used, to score the clinical and radiographic findings. Clinical and radiographic findings were submitted for statistical analysis.

On comparison of clinical scores of all three groups at 1 month, 3 months, 6 months and 9 months, chi square value was 0.54, 1.74, 1.11, 2.32 and p value[<0.05] was found to be 0.76, 0.42, 0.57 and 0.67 respectively which was not significant. On comparison of radiographic scores of all three groups at 1 month, 3 months, 6 months and 9

months, chi square value was 0.54, 4.75, 6.04, 6.46 and p value[<0.05] was found to be 0.76, 0.57, 0.64 and 0.59 respectively which was not significant [Table 2,3].[confidence interval was set at 95%, error at 5%]

The present study tried to find whether there is any difference in the success rates in three groups at different time intervals. Here there is coded data or graded data [1-4] where the rate of failure increased with the grade. This is called ordinal data. Hence the difference was assessed using non parametric equivalence of ANOVA namely Kruskal Wallis ANOVA test. It was found that there is no statistically significant difference in the three groups at 1 month[p=0.77], 3 months[p=0.42],6 months[p=0.58] and 9 months[p=0.69].

Table 1.1 : The clinical scoring criteria based on Zurn and Seale , 2008.

CLINICAL SCORE	DEFINITION
1=asymptomatic, 6-month recall	• Pathology: Absent • Normal functioning • Naturally exfoliated • Exfoliation prematurely due to ectopic eruption • Mobility (physiological) ≤1 mm
2=slight discomfort, short-lived 3-month recall	• Pathology: Questionable • Percussion sensitivity • Chewing sensitivity, short-lasting • Gingival inflammation (due to poor oral hygiene) • Mobility (physiological) >1 mm but <2 mm
3=minor discomfort, short-lived 1-month recall	• Pathology: Initial changes present • Chewing sensitivity, long-lasting • Gingival swelling (not due to poor oral hygiene) • Periodontal pocket formation (no exudate) • Mobility >2 mm but <3 mm
4=major discomfort, long-lived Extract immediately	• Pathology: Late changes present • Spontaneous pain • Gingival swelling (not due to poor oral hygiene) • Periodontal pocket formation (exudate) • Sinus tract present • Mobility ≥3 mm • Premature tooth loss, due to pathology

Table 1.2 : The radiographical scoring criteria based on Zurn and Seale , 2008.

RADIOGRAPHIC SCORE	DEFINITION
1=no changes present 6-month follow-up	• Internal root canal form tapering from chamber to the apex • PDL/periapical regions; normal width and trabeculation
2=pathological changes of questionable clinical significance 3-month follow-up	• External changes are not allowed (widened periodontalligament widening (PDL), abnormal inter-radicular trabeculation or variation in radio density • Internal resorption acceptable (non perforated) • Calcific metamorphosis is acceptable and defined as: uniformly thin root canal; shape (non tapering); variation in radio density from canal to canal (one cloudier thanthe other); dentin bridge formation (one or more canals)
3=pathological changes present 1-month follow-up	• External changes are present, but not large • Mildly widened PDL • Minor inter-radicular radiolucency with trabeculationstill present • Minor external root resorption; internal resorption changesare acceptable, but not if external change is also present (perforated form)
4=pathological changes present Extract immediately	• Frank osseous radiolucency present, endangeringpermanent successor

Table 2 : Clinical scores of both the groups at 1 month, 3 months, 6 months and 9 months, chi square value was 0.54, 1.74, 1.11, 2.32 and p value(<0.05) was found to be 0.76, 0.42, 0.57 and 0.67 respectively which was not significant

Time period	Radio score	CL	F	L	Chi square value	p value
Post Op	1	20	20	20	-	-
1M	0	1	1	2	0.536	0.765#
	1	19	19	18		
3M	0	1	3	1	4.754	0.576#
	1	18	16	18		
	2	0	0	1		
	3	1	1	0		
6M	0	1	3	2	6.040	0.643#
	1	17	16	17		
	2	1	0	1		
	3	0	1	0		
	4	1	0	0		
9M	0	2	2	3	6.460	0.596#
	1	14	16	16		
	2	2	0	1		
	3	1	2	0		
	4	1	0	0		

Table 3 : Radiographic scores of both the groups at 1 month, 3 months, 6 months and 9 months, chi square value was 0.54, 4.75, 6.04, 6.46 and p value(<0.05) was found to be 0.76, 0.57, 0.64 and 0.59 respectively which was not significant

Time period	Clinical scores	CL	F	L	Chi square value	p value
Post Op	1	20	20	20	-	-
1M	0	1	1	2	0.536	0.765#
	1	19	19	18		
3M	0	1	3	1	1.745	0.418#
	1	19	17	19		
6M	0	1	3	2	1.111	0.574#
	1	19	17	18		
9M	0	2	2	3	2.324	0.676#
	1	17	18	17		
	4	1	0	0		

Discussion

The present study examined the clinical and radiographic success rates of pulpotomies performed with Formocresol [FC], Copaifera langsdorffii oil resin [CLOR] and Diode laser [DL] to evaluate the relative effectiveness of the three different techniques. Despite the reported toxic, mutagenic and carcinogenic properties, FC is still used in pulp therapy of primary teeth due to its high clinical success rate.[5]

The rationale behind the 1 minute modified FC pulpotomy technique is to conclude that the length of exposure to the drug is critical in determining the pulpal response to FC. Histologic studies have shown that the one-minute application produces least inflammatory response with favourable clinical and radiographic outcomes.[6] One minute modified FC pulpotomy technique gave a clinical success rate of 100% and radiographic success rate of 90.91% in a study[7] which was comparable to the clinical and radiographic success rates reported by Kurji ZA,2011.[8] Barak Durmus,[20]; in his study showed the radiographic success rates of the FC group was 87% and ferric sulphate group was 79% when compared to DL group where it showed 75% with no significant difference. FC pulpotomies had a 100% radiographic success rate at 1 year and approximately 91% at 2 years. The clinical and radiographic evaluation at 6 months revealed total success rates of 100% in the MTA, FS, and FC groups and 96% in the ZOE group was seen in study done by Erdem et al,2011. [9] In present study in FC group, clinical success was not significant when compared with other groups[p=0.67]. Radiographic success was seen at 1 month,3 month, 6 month and 9 month follow up which was statistically insignificant when compared with other two groups with a p value of 0.76, 0.57, 0.64 and 0.59 respectively.

The Copaifera langsdorffii oil resin [CLOR] is a product from the trunks of trees belonging to the Copaifera genus. Chemically, CLOR might be defined as a solution of diterpene acids in an essential oil that is mainly constituted of sesquiterpenes. Copalic acid, which is a diterpene, possesses antimicrobial properties against cariogenic microbes[10]. These sesquiterpenes possess anti inflammatory and wound healing properties. Apart from its wound-healing properties, CLOR is also known for its biocompatibility. This biocompatibility has been demonstrated by Paiva and associates who observed acceleration in the healing of experimentally induced wounds on rat skin.[11] Lima et al,2011[32];conducted a study using fibrin sponge as a vehicle for application of CLOR in the pulpotomized teeth and hypothesized that replacement of fibrin sponge would result in a better healing outcome when using CLOR as a pulp capping agent. In the present study, instead of carrying CLOR in a fibrin sponge, direct application of CLOR using a cotton pellet to the pulp stumps for 1 minute was carried out. The impervious resinous layer of CLOR provides topical wound healing properties to the amputated radicular pulp tissue. There was statistically insignificant difference in the radiographic success [P=0.67] and clinical success [P= 0.59] at 9 months when compared with other pulpotomy techniques, thereby validating the use of CLOR as a pulpotomy medicament. The radiographic success rate for CLOR was statistically insignificant when compared with other two groups with a p value of 0.76, 0.57, 0.64 and 0.59 for 1, 3, 6 and 9 months respectively.

Lasers, including the diode laser, have found wide application in general and oral surgery procedures involving soft tissues.[12,13]Lasers have been widely applied in dental procedures, including pulpotomy.[14] In particular, diode lasers have been more frequently used in pulpotomy because of their reliability

and handiness. Use of laser for pulpotomy procedure has more superiority such as control of haemorrhage, sterilization of the lesion, stimulation of dental pulp cells causing dentinogenesis, preservation of tooth vitality and increased healing. It has been therefore suggested as an alternative for pulpotomy of primary teeth. Diode laser[DL] potentially has benefitted by the following: minimal or no bleeding, faster healing, reduced postoperative infection, and minimal or no anaesthesia. The diode laser uses nearly microscopic chips of gallium arsenide or other precious semiconductors to generate coherent light in a very small package. The energy level differences between the conduction and valence band electrons in these semiconductors provide the mechanism for laser action. It has a much higher overall efficiency and, therefore, is more practical.[15] It emits an infrared light beam where conversion of the laser energy to heat leads to development of a well localized ablation of soft tissue. This interaction is most frequently accompanied by peripheral thermal damage to the tissue, and charring of the tissues at the impact site.[16,17] The diode laser is more convenient for the pulpotomy technique because of the elevated absorbance of the wavelength [980 nm] at which energy is produced in tissues such as dental pulp which have a very high water content. In contact mode, only the soft tissues in immediate contact [micrometer range] with the laser-emitting tip are affected, leaving the remaining tissue unaffected. Early histopathological studies of various diode lasers have demonstrated reduced thermal damage of pulpal tissue and accelerated pulpal wound healing.[18,19] Based on these characteristics, the diode laser appears to be promising as an alternative for pulpotomy therapy.[27]Saltzman et al.[27] compared DL - MTA pulpotomy with conventional FC-ZOE pulpotomy. The FC-ZOE pulpotomy ensured a radiographic success rate of 87.5%, whereas this rate was reduced to 70.8% by DL-MTA pulpotomy. However, the radiographic assessment at 15 months revealed no significant difference between the two treatment types. In our studies similar results were found for DL pulpotomy with ZOE dressing. The successful outcome rates of diode laser pulpotomy vary across literature, depending on spectra of laser settings and modes in use.70 when pulp tissue is treated with laser irradiation a superficial zone of coagulation necrosis is created that is compatible with the underlying tissue and isolates the pulp from the harmful effects of the sub-base. Variation in laser application parameters, including the power, frequency, exposure time, and water/air dry-mode, yields different results in pulp tissue. These facts might be responsible for the variable results in the laser-assisted pulpotomy cases.[20] However, in general, favorable results of diode laser are at least as equal to those of other therapies such as ferric sulfate, NaOCl, mineral trioxide aggregate [MTA], Biodentine [21,22] or even better.[23] Golpaygeni et al.[24] evaluated the effects of 632 nm diode laser irradiation followed by zinc oxide eugenol filling. A 100% clinical success rate was found after 1 year in 18 primary molars. Radiographic success rates presented considerably lower for the test group of 80% as compared to 93% in control group.

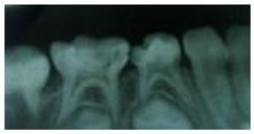
In the present study, 810 nm diode laser was directed onto the pulp stump at 1.5W in a continuous mode for 10 seconds in contact mode until the tissue was seen to be ablated. In the diode laser pulpotomy, different spectrums of laser setting and modes are used. Similar modes of diode laser was used, [970 nm, 3 W] in a study by Kuo et al [25] and [980 nm, 3 W] in the study by Gupta et al.[26], and both studies have 100% clinical success rate. The radiographic success rates of the two studies were 97.6% and 100% at one-year follow-up, respectively, and 90.9% at two-year follow-up in study by Kuo et al.[25]. Laser causes an instant and reversible decrease in blood flow for

3–6 minutes without any hyperaemic reaction in the pulp microcirculation. This laser-induced haemorrhage can mask the true hyperemia in the radicular pulp, which can be mentioned as one of the disadvantages with laser.[27] In present study, DL group showed no radiographic changes in the first month. The clinical and radiographic success at 1 month, 3 months, 6 months and 9 months was statistically insignificant when compared with other two groups with a p value of 0.76, 0.57, 0.64 and 0.59 for 1 month, 3 months, 6 months and 9 months respectively.

Reinforced zinc oxide eugenol was used as the base material for pulpotomy in all groups. The addition of polymethyl methacrylate in reinforced ZOE may decrease the effects of eugenol, which is thought to be an irritant to pulp tissue. In a retrospective study, Derkson and colleagues evaluated pulpotomies after placement of a reinforced zinc oxide-eugenol [ZOE] sub-base in the pulp chamber and subsequent restoration. They achieved a radiographic clinical and overall success rate of approximately 95%, 97%, and 94%, respectively.[28,29] Based on the aforesaid study, we used reinforced zinc oxide eugenol as the base material for pulpotomy in DL,CLOR and FC groups.

It is an investigated fact that the coronal dentin, deprived of its odontoblastic processes, as in cervical pulpotomies, becomes brittle and prone to cracks or fractures. Full coverage prevents these cracks, providing a leakage-free restoration.[30] Healing of the dental pulp is not exclusively dependent on the supposed stimulatory effect of a particular type of medicament but is directly related to the capacity of both the dressing and definitive restorative material to provide a biological seal against immediate and long-term microleakage along the entire restoration interface.[31] Stainless steel crown provides optimal coronal seal and restores tooth anatomy and function.[30] After the pulpotomy procedure, stainless steel crown was immediately placed.

Figure 1 : Shows tooth no 84 and 85 successfully treated with FC at 1,3,6,9 months

<table>
<tr><td>84,85- PRE OP
  </td><td>Score 1: No changes present (internal canal form tapering and normal width of PDL and no trabecular changes)

Score 2: Pathological changes
(internal resorption and , Calcific metamorphosis acceptable i.e. dentin bridge formation, intracanal radio density changes)</td><td>Score 3:External changes present(widened PDL, interadicular radiolucency, external root resorption, perforating internal resorption)

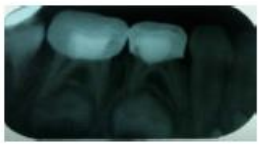
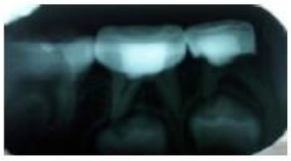
Score 4:Frank osseous radiolucency involving the crypt or endangering permanent successor.</td><td></td></tr>
<tr><td>1 MO</td><td>3 MO</td><td>6 MO</td><td>9 MO</td></tr>
<tr><td>  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td></tr>
</table>

Figure 2- Shows tooth no 54 successfully treated with CLOR at 1,3,6,9 months

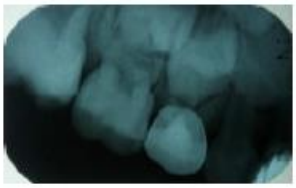
54- PRE OP	Score 1: No changes present (internal canal form tapering and normal width of PDL and no trabecular changes) Score 2: Pathological changes (internal resorption and , Calcific metamorphosis acceptable i.e. dentin bridge formation, intracanal radio density changes)	Score 3:External changes present(widened PDL, interadicular radiolucency, external root resorption, perforating internal resorption) Score 4:Frank osseous radiolucency involving the crypt or endangering permanent successor.	
			
1 MO	3 MO	6 MO	9 MO
			
1	1	1	1

Figure 3- Shows tooth no 85 successfully treated with DL at 1,3,6,9 months

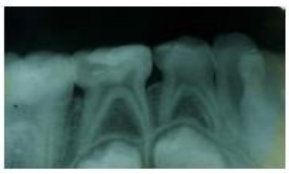
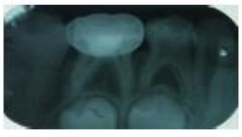
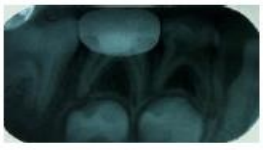
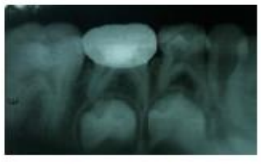
85- PRE OP	Score 1: No changes present (internal canal form tapering and normal width of PDL and no trabecular changes) Score 2: Pathological changes (internal resorption and , Calcific metamorphosis acceptable i.e. dentin bridge formation, intracanal radio density changes)	Score 3:External changes present(widened PDL, interadicular radiolucency, external root resorption, perforating internal resorption) Score 4:Frank osseous radiolucency involving the crypt or endangering permanent successor.	
			
1 MO	3 MO	6 MO	9 MO
			
1	1	1	1

Figure 4: Shows tooth no. 84 with interfurcal radiolucency(CLOR group) at 6 & 9 month follow up

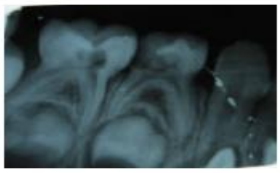
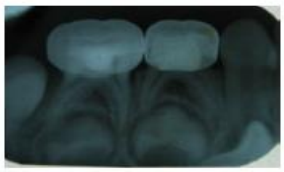
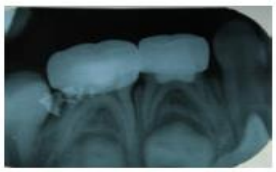
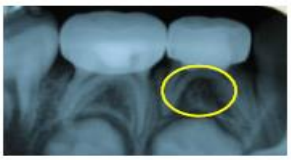
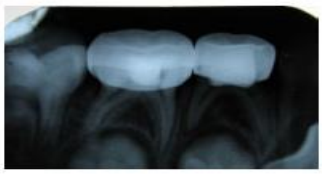
84- PRE OP	Score 1: No changes present (internal canal form tapering and normal width of PDL and no trabecular changes) Score 2: Pathological changes (internal resorption and , Calcific metamorphosis acceptable i.e. dentin bridge formation, intracanal radio density changes)	Score 3:External changes present(widened PDL, interadicular radiolucency, external root resorption, perforating internal resorption) Score 4:Frank osseous radiolucency involving the crypt or endangering permanent successor.	
			
1 MO	3 MO	6 MO	9 MO
			
1	3	3	3

Figure 5: Shows tooth no. 84 with internal resorption (CLOR group) at 6 & 9 months follow- up

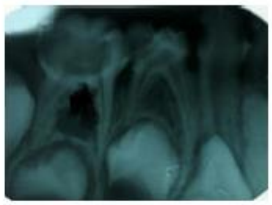
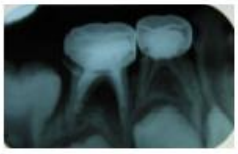
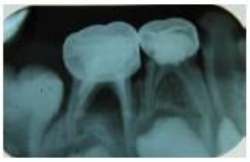
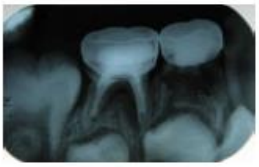
84- PRE OP	Score 1: No changes present (internal canal form tapering and normal width of PDL and no trabecular changes) Score 2: Pathological changes (internal resorption and , Calcific metamorphosis acceptable i.e. dentin bridge formation, intracanal radio density changes)	Score 3:External changes present(widened PDL, interadicular radiolucency, external root resorption, perforating internal resorption) Score 4:Frank osseous radiolucency involving the crypt or endangering permanent successor.	
			
1 MO	3 MO	6 MO	9 MO
			
1	1	3	4

Figure 6: Shows tooth no.75 with pulp canal obliteration (CLOR group) at 6 & 9 months follow up

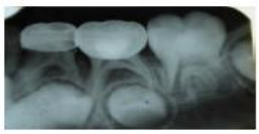
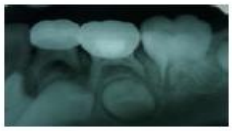
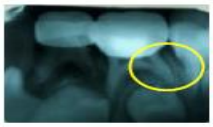
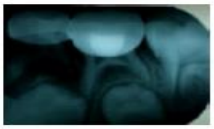
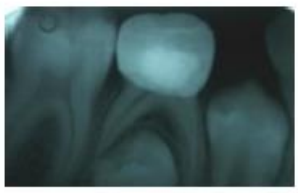
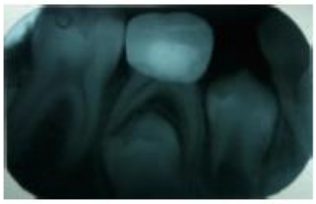
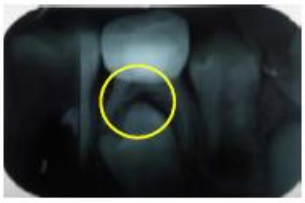
75- PRE OP	Score 1: No changes present (internal canal form tapering and normal width of PDL and no trabecular changes) Score 2: Pathological changes (internal resorption and , Calcific metamorphosis acceptable i.e. dentin bridge formation, intracanal radio density changes)	Score 3:External changes present(widened PDL, interadicular radiolucency, external root resorption, perforating internal resorption) Score 4:Frank osseous radiolucency involving the crypt or endangering permanent successor.	
1 MO	3 MO	6 MO	9 MO
 1	 1	 3	 3

Figure 7: shows tooth no.85 with external resorption (CLOR group) at 6 & 9 months follow up

85- PRE OP	Score 1: No changes present (internal canal form tapering and normal width of PDL and no trabecular changes) Score 2: Pathological changes (internal resorption and , Calcific metamorphosis acceptable i.e. dentin bridge formation, intracanal radio density changes)	Score 3:External changes present(widened PDL, interadicular radiolucency, external root resorption, perforating internal resorption) Score 4:Frank osseous radiolucency involving the crypt or endangering permanent successor.	
1 MO	3 MO	6 MO	9 MO
 1	 1	 3	 3

Conclusion

Clinically Formocresol, Copaifera langsdorfii oil resin and Diode laser pulpotomy

showed comparable results.Radiographically Formocresol, Copaifera langsdorfii oil resin and Diode laser pulpotomy showed comparable results. There was no significant difference observed in the overall clinical success using the three materials FC, CLOR, and DL [P=0.69] at 9 months. Significant differences were not observed in their radiographic success [P=0.42] also at 9 months. This study concludes that although there is difference seen in clinical and radiographic scores, there are no statistical significant differences found among all three groups i.e. Formocresol, Copaifera langsdorfii oil and Diode laser groups. Diode laser pulpotomy offers high clinical success rate. However ,in this study radiographical success did not differ. Hence further studies need to be carried out with larger sample and a longer follow up period.

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