Outcome of Pulpotomy in Primary Teeth Using Diode Laser

Maheen N Shaikh¹, Mihir N Jha², Maryam I Undre³, Aliya Ershad⁴, Taufique N Shaikh⁵

ABSTRACT

Aim: The aim of this study was to compare the clinical and radiographic successes for pulpotomy using formocresol (FC), and diode laser (DL) in primary molars.

Materials and methods: Children within the age group of 4–8 years, with a total of 40 teeth, were selected for the study. They were divided into two groups of 20 each in FC and DL, and were restored with prefabricated crowns. Clinical and radiographic evaluations were done at 1, 3, 6, and 9 months using modified Zurn and Seale criteria. Data were statistically analyzed.

Results: On comparison of clinical and radiographic scores of all two groups at 1, 3, 6, and 9 months interval, Chi-square value and p value were found to be insignificant.

Conclusion: Although the radiographic difference between the two groups is not statistically significant, clinically DL 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: Formocresol, Laser, Primary teeth, Pulpotomy, Radiography.

Introduction

It is important to preserve the primary dentition until permanent successors erupt in the oral cavity.¹ Pulpotomy follows the concept in which the radicular pulp tissue is stable or able to recover following surgical amputation of the damaged or contaminated 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 deciduous teeth with large carious lesions approximating the pulp and thus at risk of exposure to the pulp are often treated with pulpotomy. Ideal requirements of a pulpotomy agent are healing and preservation of vitality of the radicular pulp tissue. Variety of medicaments is used to perform pulpotomies, including diluted formocresol (FC), electrosurgery, ferric sulfate, lasers, sodium hypochlorite, mineral trioxide aggregate (MTA), and a variety of phytochemicals to name a few.⁵,⁶

In this study, pulpotomy was performed using FC and diode laser (DL), which was clinically and X-ray evaluation at 1, 3, 6, and 9 months to explore an archetypal pulpotomy procedure.

Materials and Methods

Ethical approval from the Ethical Committee was received, and children within the age group of 4–8 years, who attended the Department of Pediatric Dentistry and Preventive Dentistry, with a total of 40 teeth, were selected of which 20 teeth were considered for each material group.

Sample Size Justification

We planned a study of cases and controls which will be divided into two groups.

Initial data indicate that the true in-stratum disease odds ratio (failure outcome) in exposed subjects is approximately 2.5, and

1,3,4Department of Pediatric Dentistry, MA Rangoonwala College of Dental Sciences and Research Centre, Pune, Maharashtra, India
2Department of Pediatric Dentistry, MGM Dental College and Hospital, Navi Mumbai, Maharashtra, India
5Department of Prosthodontics, MA Rangoonwala College of Dental Sciences and Research Centre, Pune, Maharashtra, India
Corresponding Author: Maryam I Undre, Department of Pediatric Dentistry, MA Rangoonwala College of Dental Sciences and Research Centre, Pune, Maharashtra, India, Phone: +91 8149683436, e-mail: dr.maheenshaikh@gmail.com
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Inclusion Criteria

• Cooperative healthy children of age group 4–8 years.
• Each child with primary teeth showing carious pulp exposure on caries excavation, but asymptomatic and vital.
• No more than one-third of the physiological resorption of the root.
• Teeth considered to be preserved with a crown of stainless steel.
• No clinical or radiographic evidence of degeneration of the pulp.

Exclusion Criteria

• Systemic disease history.
• Spontaneous tooth pain or tenderness to percussion.
• Teeth indicated for extraction or pulpectomy.
• Deciduous teeth existence without a permanent successor.
• It takes more than 5 minutes for the hemostasis.
• Physiologic resorption more than one-third of the tooth root.

The treatment plan was discussed and explained to the parent of the child and prior to clinical procedure, and written consent was obtained for treatment. 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. Before pulp exposure, dental caries was excavated with a large slow-speed round bur. If a carious pulpal exposure was evident, the roof of the pulp chamber was removed using a no. 330 carbide bur or a high-speed nonend cutting bur under copious water spray. A sterile spoon excavator was used to amputate all the coronal pulp. The pulp chamber was thoroughly washed with saline to remove all debris and pulp filaments to ensure sanitation of the amputation site. 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 was managed using FC and laser pulpotomy techniques depending on the group to which the tooth belonged.

**RESULTS**

At 1, 3, 6, and 9 months of treatment, clinical and radiographic analyses were performed. For the score of clinical and radiographic findings, the criteria based on Zurn and Seale 2008 (Table 1) were used. For statistical analysis, clinical and radiographic findings have been submitted.

On comparison of clinical scores of both the groups at 1, 3, 6, and 9 months, Chi-square value was 0.54, 1.74, 1.11, and 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 two groups at 1, 3, 6, and 9 months, Chi-square value was 0.54, 4.75, 6.04, and 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 (Tables 2 and 3) (confidence interval was set at 95% and error at 5%).

The present study tried to find whether there is any difference in the success rates in two 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 nonparametric equivalent of ANOVA, namely Kruskal–Wallis ANOVA test. It was found that there is no statistically significant difference in both the groups at 1 month (p = 0.77), 3 months (p = 0.42), 6 months (p = 0.58) and 9 months (p = 0.69) (Figs 1 and 2).

**DISCUSSION**

The present study examined the clinical and radiographic success rates of FC and DL pulpotomies to assess the relative efficacy of the two different techniques. Despite the reported toxic, mutagenic, and carcinogenic properties, due to its high clinical success rate, FC is still used in primary teeth pulp therapy.8

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 1-minute application produces least inflammatory response with favorable clinical and radiographic outcomes.9 One-minute modified FC pulpotomy technique gave a 100% clinical success rate and a 90.91% radiograph success rate in a study,10 which was comparable to the clinical and radiographic success rates reported by Kurji.11 Durmus and Tanboga,12 where the radiographic success rates of the FC group was 87% and ferric sulfate group was 79% when compared to DL group where it showed 75% with no significant difference. FC pulpotomies had a success rate of 100% at 1 year and about 91% at 2 years. The 6-month clinical and radiographic evaluations revealed total success rates of 100% in the MTA, ferric sulfate (FS), and FC groups and 96% in the zinc oxide eugenol (ZOE) group.13 In present study in FC group, clinical success was not significant when compared with other groups (p = 0.67). Radiographic success was seen in 1, 3, 6, and 9 months 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.

Lasers, including the laser diode, have found wide application of soft tissue procedures in general and oral surgery.14,15 Lasers have

| Clinical score | Definition |
|----------------|------------|
| 1 = asymptomatic, 6-month recall | • Pathology: absent |
| 2 = slight discomfort, short-lived, 3-month recall | • Normal functioning |
| 3 = minor discomfort, short-lived, 1-month recall | • Naturally exfoliated |
| 4 = major discomfort, long-lived, extract immediately | • Exfoliation prematurely due to ectopic eruption |

| Pathology: physiological ≤1 mm |  |
|-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 |  |
| Pathology: late changes present |  |
| Mobility ≥3 mm |  |
| Premature tooth loss, due to pathology |  |

Contd...
Outcome of Pulpotomy in Primary Teeth Using Diode Laser

been commonly used, including pulpotomy, in dental procedures.16 Due to their reliability and handiness, DLs were used more frequently in pulpotomy. Use of laser for pulpotomy procedure has more superiority such as control of hemorrhage, sterilization of the lesion, and stimulation of dental pulp cells causing dentinogenesis, preservation of tooth vitality, and increased healing. Therefore, it was suggested as an alternative for primary teeth pulpotomy. Diode laser potentially has benefited by the following: minimum or no bleeding, faster cure, reduced postoperative infection, and low or no anesthesia. In a very small package, the DL uses almost microscopic chips of gallium arsenide or other useful semiconductors to produce coherent light. The differences within energy level in these semiconductors between the conductive and valence band electrons provide the basis for laser action. The overall energy level in these semiconductors between the conductive and valence bands is produced in tissues such as dental pulp, which have a very high thermal conductivity. The laser induces an immediate and reversible decrease in blood flow in the microcirculation of the pulp for 3–6 minutes without any hyperemic reaction. This laser-induced hemorrhage can mask the true hyperemia in the radicular pulp, which can be mentioned as one of the disadvantages with laser.22 In present study, DL group showed no radiographic changes in the first month. Multiple spectrums of laser configuration and modes are used in the DL pulpotomy. Similar modes of DL were used (970 nm, 3 W) in a study by Kuo et al.27 and (980 nm, 3 W) in the study by Gupta et al.,28 and both trials have a clinical success rate of 100%. The two studies’ radiographic success rates were 97.6% and 100%, respectively, for 1-year follow-up and 90.9% for 2-year follow-up by Kuo et al.26

| Radiographic score | Definition |
|--------------------|------------|
| 1 = no changes present | Internal root canal form tapering from chamber to the apex |
| 2 = pathological changes of questionable clinical significance, 3-month follow-up | External changes are not allowed (widened periodontal ligament widening (PDL), abnormal radicular resorption or variation in radiodensity) |
| 3 = pathological changes present, 1-month follow-up | External changes are present, but not large |
| 4 = pathological changes present, extract immediately | |
to provide a biological seal against immediate and long-term microleakage throughout the restoration interface. Stainless steel crown provides optimal coronal seal and restores tooth anatomy and function. After the pulpotomy procedure, stainless steel crown was immediately placed.

**Conclusion**

Clinically, FC and DL pulpotomy showed comparable results. Radiographically, FC and DL pulpotomy showed comparable results. No significant difference in overall clinical effectiveness was found using the two resources FC and DL ($p = 0.69$) at 9 months. Significant
Table 2: Clinical scores of both the groups at 1 month, 3 months, 6 months and 9 months

| Time period | Clinical scores | F | L | Chi-square value | p value |
|-------------|----------------|---|---|------------------|--------|
| Postoperative | 1 | 20 | 20 | – | – |
| 1 month | 0 | 1 | 2 | 0.536 | 0.765^3 |
| 1 | 19 | 18 | 1 | 0.418^4 |
| 3 months | 0 | 3 | 1 | 1.745 | 0.574^4 |
| 1 | 17 | 19 | 1 | 0.676^4 |
| 6 months | 0 | 3 | 2 | 1.111 | 0.596^4 |
| 1 | 17 | 18 | 1 | 0.676^4 |
| 9 months | 0 | 2 | 3 | 2.324 | 0.765^4 |
| 1 | 18 | 17 | 1 | – |

^Nonsignificant result

Table 3: Radiographic scores of both the groups at 1 month, 3 months, 6 months and 9 months

| Time period | Radiographic scores | F | L | Chi-square value | p value |
|-------------|---------------------|---|---|------------------|--------|
| Postoperative | 1 | 20 | 20 | – | – |
| 1 month | 0 | 1 | 2 | 0.536 | 0.765^3 |
| 1 | 19 | 18 | 1 | 0.418^4 |
| 3 months | 0 | 3 | 1 | 4.754 | 0.576^4 |
| 1 | 16 | 18 | 1 | 0.676^4 |
| 6 months | 0 | 3 | 2 | 1.111 | 0.596^4 |
| 1 | 17 | 18 | 1 | 0.676^4 |
| 9 months | 0 | 2 | 3 | 2.324 | 0.765^4 |
| 1 | 18 | 17 | 1 | – |

^Nonsignificant result

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 two groups, i.e., FC and DL 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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