Original Article

Low-Level Laser Therapy for Pulpotomy Treatment of Primary Molars

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Abstract:

Objective: Low-level laser therapy (LLLT) has been increasingly in use over the last few decades in both medicine and dentistry. It has been suggested that LLLT may be helpful in pulpal wound healing following pulp exposure. The purpose of this study was to compare the effectiveness of LLLT and formocresol (FC) application in healing of remaining pulp following pulp amputation in primary molars.
Materials and Methods: A total of 23 contralateral pairs of teeth from 11 children aged 4 to 7 years were selected and matched using clinical and radiographic criteria. One tooth from each pair was randomly assigned to the LLLT pulpotomy and the to FC pulpotomy group. During a 6-month follow-up period, the teeth were examined clinically and radiographically. Eight patients (four in each group) completed six-month and 6 patients (three in each group) completed one-year follow-up.
Results: Clinically, no complication was observed in the teeth. However, radiographic assessment revealed signs of periradicular radiolucency in two teeth in LLLT group.
Conclusion: Findings of this investigation show that LLLT can be used successfully as a complementary step to pulpotomy procedure in order to help the healing of amputated pulp. Longer follow-up periods are recommended to investigate long-term effect of LLLT pulpotomy on pulp.

Key Words: Lasers; Pulpotomy; Laser Therapy, Low-Level; Tooth, Deciduous; Clinical Protocols

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INTRODUCTION

One of the frequently used treatments for preserving decayed primary molars from extraction is pulpotomy [1]. Formocresol (FC) has long been considered as a widely approved pulpotomy medicament for treating teeth for decades. FC pulpotomy is universally the most preferred pulp therapy for primary teeth among dentists [2,3]. However, the use of FC as a pulpotomy agent has recently been challenged due to its systemic distribution, pulpal inflammatory response, cytotoxicity, and carcinogenic potentials [4-6].
Furthermore, the International Agency for Research on Cancer classified formaldehyde as carcinogenic to humans in June 2004, leaving the profession to look for other viable alternatives to FC. These include glutaraldehyde, ferric sulfate, MTA, calcium hydroxide, electrosurgery, laser, and biologic materials [7]. One promising alternative to FC pulpotomy is low-level laser therapy (LLLT), which has been

Fig 1. BTL 5000; diod laser device used in this investigation.

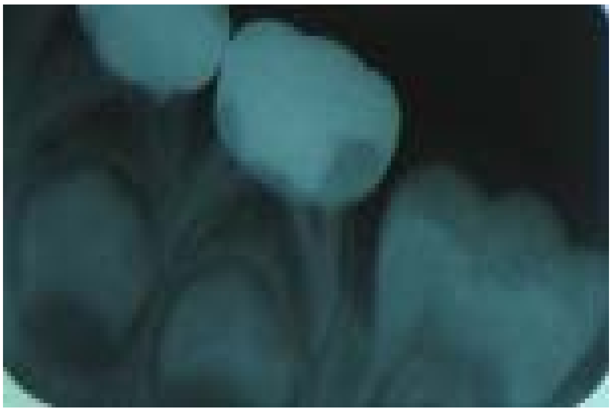

Fig 2. Radiographic view shows no pathologic sign of failure following pulp treatment using low-level laser therapy in 12 month follow up**.**

shown to accelerate wound healing process in exposed dental pulp tissue [8]. Therapeutic laser treatment, also referred to as LLLT, has been used for the last 3 decades [8,9]; but low quality of publications on this technique has partly led to lack of recognition of it among clinicians and researchers [9,10]. However, a growing number of clinicians are using LLLT in their daily practice because of visible success gained [9].

Low-level laser light seems to create many positive functions, such as accelerated wound healing, pain relief, regeneration, and immune enhancement through providing the energy that interacts with the cells [9]. It is noninvasive, nonpharmaceutical, and economical [9]. No side effects of such LLLT application has been reported yet [9]. Low-power lasers have been successfully used in dental practice, and it is known that wound healing is accelerated by their irradiation [10].

The purpose of this investigation was to compare the effectiveness of LLLT as a complementary step to pulpotomy process in primary molars with that of conventional FC.

MATERIALS AND METHODS

The present study was done on a group of healthy children attending Pedodontics Department, Faculty of Dentistry, Shahid Beheshti Medical University (SBMU). An ethic approval was obtained from Ethics Review Committee of SBMU to conduct this clinical study. Children aged four to seven years with at least two contra-lateral primary carious molars having similar size cavities were selected. The age range was specified in order to have more precise pulpal reaction following LLLT/FC application. Full detailed treatment plans were explained to the parents and informed consents were obtained prior to the investigation. Forty-six teeth were selected for this study. The criteria for tooth selection were: having a vital pulp with carious expo-

Table 1. Clinical assessment of the two treatment groups at six- and twelve-month follow-up visits.

Treatment	Clinical Success	6 months		12 months	
		n	%	n	%
FC	Success	18	100	14	93
	Failure	0	0	1	7
LLLT	Success	18	100	15	100
	Failure	0	0	0	-

FC=Formocresol, LLLT=low-level laser therapy

Fig 3. Radiographic view shows no pathologic sign of failure following pulp treatment using formocresol in 12 month follow up.

Fig 4. Pathologic sign of failure following pulp treatment using formocresol in 12 month follow up, note the forcation lesion.

sures, no clinical signs or symptoms of pulp degeneration (swelling, fistula, pathologic mobility, excessive bleeding from amputated radicular stumps. Spontaneous or nocturnal pain and tenderness to percussion or palpation was checked with any sign of internal and pathologic external resorption and periapical or intera-radicular radiolucency. Selected teeth were also showing physiologic resorption of no more than one third with restorable remaining tissue [11-15].

Preoperative periapical radiographs were obtained from each tooth prior to treatment. The contra-lateral teeth were randomly assigned to either the LLLT or FC group, in order to allow proper randomization eliminating possible bias.

Each tooth was isolated following administration of a local anesthesia. Caries removal was performed followed by coronal access opening to the pulp chamber using a no.330 high-speed bur with water spray. The coronal pulp was then amputated using a sharp spoon excavator or a slowly revolving round carbide bur. Pulp chamber was then irrigated with a light flow of distilled water. Cotton pellet moistened with saline was placed on the pulp stumps in order to achieve hemostasis. A cotton pellet with diluted FC (1:5 Buckley's solution) was placed in contact with the pulp in FC group and left for five minutes. This was while the pulp was irradiated using a semiconductor diode laser device (BTL 5000, Prague, Czech Republic), with wavelength of 632 nm in the experimental group (Fig 1).

The laser application was in continuous mode; with the total energy of one spot, corresponding to two minutes and 31 seconds exposure, was 4.0 J/cm^2. The laser beam was delivered through a 0.5 mm-diameter optical fiber with the distance from the tip of the fiber to the pulp stump being 2.0 mm. All patients and clinical staff were requested to wear appropriate eye protection goggles during laser appli-

Table 2. Radiographical assessment of the two treatment groups at six- and twelve-month follow-up visits.

Treatment	Radiographic Success	6 months		12 months	
		n	%	n	%
FC	Success	18	100	12	80
	Failure	0	0	3	20
LLLT	Success	16	89	10	67
	Failure	2	11	5	33

FC=Formocresol, LLLT=low-level laser therapy

Fig 5. Pathologic sign of failure following pulp treatment using LLLT in 12 month follow up, note the PDL widening along the root as well as signs of internal resorption.

cation.

Plain ZOE (the L.D. Caulk Division, Dentsply International Inc. Milford, Del) was placed over the pulp stumps as the base and a second layer of reinforced ZOE (the L.D. Caulk Division, Dentsply International Inc. Milford, Del) was then condensed on top for filling the pulp chamber space. Each tooth was then restored with SSC as planned.

All the treated teeth in both groups were examined at two time points of six months and one year after treatment using clinical and radiographic criteria. Clinical failure was defined as presence of any of the following signs and symptoms: pain, abnormal tooth mobility, swelling, sinus tract, or sensitivity to percussion or pressure [11-15]. Radiographic failure was defined as presence of any of these features: periapical radiolucency, inter-radicular radiolucency, pathologic external/internal resorption, or widening of PDL.

Clinical and radiographic outcome assessments were made by two independent experienced pedodentists who were blind to the treatment.

RESULTS

Data from eight patients (a total of 36 pulpotomized primary molars) with completed follow-up was analyzed. Remaining three children, with ten pulpotomized molars, failed to complete their 6 months follow-up period and were not included in the analysis. The mean age of the patients was 5.6 years with a range of four to seven years.

Type distribution of the teeth was as follows: 10 (27.8%) upper first molars, 12 (33.3%) lower first molars, 6 (16.7%) upper second molars, and 8 (22.2%) lower second molars.

At the end of six months, all the teeth in both LLLT and FC pulpotomy groups were clinically found to be sound and without complication (Table 1). Radiographic assessment showed some radiolucent changes in two cases (11%) of the teeth treated with LLLT at six month, which were subsequently extracted. The remaining 16 pairs of teeth had a second drop of a pair due to no attendance at one-year follow up. Of this remaining 15 pair, a single case reported spontaneous pain from FC pulpotomy. The rest had no sign or symptom. Most of the cases had evidences of both clinical and radiographic success with no complications (Fig 2 and 3). Radiographic review of cases in 12-month follow up revealed that three cases of LLLT group and five cases of FC group had at least one sign of pulp treatment failure (Fig 4 and 5)(Table 2).

No significant differences were found between the radiographic findings of the two groups in 12-month follow up visit using McNemar's test ($P>0.05$).

DISCUSSION

Dilute FC is still regarded as the "gold standard" for pulpotomy of the primary teeth [2,3], but concerns on cytotoxicity and potential mutagenicity of FC have been raised [4-6]. To date, several techniques for pulp treatment in primary teeth exist with a range of protocols and medicaments suggested for various clinical situations [16]. No consensus has been reached on the ideal pulpotomy technique, however, as the majority of the research has not involved randomized clinical trials [16].

The existing information is in conflict for its success to current pulpotomy technique. Furthermore, the need to find out an alternative to formocresol is still on top of the research list. Furthermore, the need to find out an alternative to FC is still on top of the research list. In this respect, Pescheck et al [17] studied the effect of a diod laser pulpotomy in primary teeth survival and concluded that the device could be considered as a favorable alternative to achieve a more precise and reliable hemostasis at pulp stumps. This investigation, to our knowledge, was the first to look at the effect of LLLT as a pulpotomy technique in primary molars through a randomized clinical trial.

The application of LLLT in dentistry includes various clinical conditions. The general rule is to use 2 to 4 J with the intra-oral probe and 4 to 10 J for extra-oral treatments [9]. The results of a meta-analysis study indicate that 632 nm wavelength has the most significant treatment effect on tissue repair, however the authors stated that these results should be interpreted with great caution as their effort to pinpoint the wavelength that is most beneficial for tissue healing was severely limited by the number of studies that met their inclusion criteria [16]. Contact mode is needed for all applications with one exception: treating an open wound requires a 2 to 4 mm distance between the laser and the target tissue under the condition called non-contact mode [9].

The results of the present study showed a high clinical and radiographic success rate with LLLT after six months (100% and 89%, respectively). Dilute FC as the control technique in this study also showed a clinical success rate of 100% with its radiographic findings representing success rate of 100%.

Since first described by Mester et al [18], low power lasers, generally, ≤500 mW in average power, have been found to have useful medical applications in the field of wound healing [19,20]. The process of tissue repair can be classified into three major stages: (1) inflammation, (2) cell proliferation, and (3) tissue maturation. Previous reports showed that all these three phases are positively affected by low power laser treatment [19]. In addition, the biologic effects of LLLT have been studied through histopathologic evaluation of the pulp tissue by Utsunomiya [8]. Results of that study suggest that LLLT accelerates wound healing of the pulp and the expression of the lectins and collagens. Laser irradiation enhances the formation of calcified nodules in human dental pulp fibroblasts, alkaline phosphatase activity, and the production of collagen and osteocalcin [10]. The positive effect of LLLT on reactional dentinogenesis induction in human teeth was reported by Ferreira et al [20]. The use of GaAlAs laser with wavelength of 670 nm and energy density of 4.0 J/cm^2 caused biomodulation activity on the dental pulp cells, biostimulation of reactional dentinogenesis, and promotion of a less intense inflammation process when used *in vivo* on class V cavity preparations [20]. The authors concluded that laser use constitutes a therapeutic modality for vital pulp therapy. Kurumada [21] used GaAs laser light in vital pulpotomy procedures. Laser irradiation induced improvement in calcification in the wound surface and stimulated formation of calcified tissue. Nagasawa et al [22] observed that Nd:YAG and argon laser irradiation with low level doses strongly stimulated the formation of secondary dentin. Another study applying a low-level laser on dentine pulp interface of a series of permanent premolars suggested that this energy accelerate the recovery of the dental structure following cavity preparation [23].

Overall, the evidence presented by previous studies, along with the findings in this study, lends support to the use of LLLT as a complement in pulpotomy process of primary molars. A larger sample size and longer-term follow-up could enhance the findings for a better and more appropriate comparison of the two treatment modalities.

CONCLUSION

LLLT can be used successfully as a complementary step to pulpotomy procedure in order to help the healing of amputated pulp in primary molars, especially in absence of FC.

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