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The Transition From Painful To Painless: Laser Pulpotomy As A Boon To Pediatric Endodontics: A Review

Gupta K[1], Sharma A[2] , Chauhan S [3],Gupta N[4]

[1]Senior Lecturer, Department of Pedodontics, Himachal Institute of Dental Sciences, Paonta Sahib.

[2]Government Dental Officer, Department of Pedodontics, Regional Hospital, Bilaspur.

[3]Dental Surgeon, Himachal Head and Neck Hospital, Hamirpur.

[4]Postgraduate Student in Department of Prosthodontics, Himachal Institute of Dental Sciences Paonta Sahib.

Correspondence Author: Kritika Gupta, Senior Lecturer, Department of Pedodontics, Himachal Institute of Dental Sciences, Paonta Sahib, Himachal Pradesh-173025

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Abstract

Vital pulpotomy can be defined as the surgical amputation of infected and inflamed coronal pulp followed by placement of a suitable medicament over the radicular pulp to preserve the vitality and function of the tooth. This review is intended to provide an overview and scientific literature on different approaches of laser pulpotomy in primary teeth. Pulpotomy can be performed using different techniques including formocresol, calcium hydroxide, enriched collagen solution, ferric sulphate, mineral trioxide aggregate, growth factors or by non pharmacological hemostatic techniques like electrosurgery or lasers. The application of lasers to dental tissues have shown their potential to increase healing, stimulate dentinogenesis and preserve vitality of the dental pulp. Various studies led to the use of the Nd:YAG laser for pulpotomy in primary teeth as given in the following article.

Keywords: pulpotomy, laser pulpotomy, primary teeth

Introduction

Primary teeth are very important for child's smile, proper chewing, and for developing permanent dentition[1]. Premature loss of primary teeth can cause a number of problems including arch perimeter loss, supra eruption of opposing teeth and changes in the patient's occlusion. Whenever feasible, dental treatment should attempt to maintain pulp vitality, particularly in immature permanent teeth. Pulp vitality leads to development of a favorable crown-to-root ratio, apical closure and formation of secondary radicular dentin. The long term survival of tooth is also greater when pulp vitality is maintained. When irreversible pulpitis or pulp necrosis occurs, nonvital pulp therapy procedures are required to alleviate patient symptoms and maintain a functional tooth in the dental arch. Therefore, the duty of pediatric dentist is to diagnose early and give proper treatment to the child to prevent various complications. Due to the complicated anatomy of the root canals in primary teeth, the proximity of the permanent tooth germ and the difficulties in finding a root-canal filling material compatible with physiological root resorption, pulpotomy has become a dominating pulp therapy procedure[2].

Pulpotomy is defined as the surgical removal of the entire coronal pulp presumed to be partially or totally inflamed and quite possibly infected, leaving intact the vital radicular pulp within the canals[3]. The American Academy of Pediatric Dentistry (2006-2007) defines pulpotomy as when the coronal pulp is amputated, and the remaining vital radicular pulp tissue surface is treated with a medicament such as formocresol or ferric sulfate or with electrocautery or laser to preserve the radicular pulp's health [4] . Pulpotomy is recommended when the young pulp already is exposed to caries and the roots are not yet fully formed (open apices).Cooperation from child and behaviour management in such children who needs extensive treatment can be difficult for the dentist, so pulpotomy seems to be a reasonable treatment option to meet these situations as it certainly require less time than complete root canal treatment hence avoiding the long chair side time [3].

Indications for pulpotomy in primary tooth are (1) caries involving pulp but not causing severe irreversible pulpitis. The inflammation and infection should be limited to coronal portion of pulp. (2) mechanical exposure of pulp while cavity preparation (3) traumatic exposure of pulp after accident or fall, provided the patient is reports to the dentist within 24hrs and (4) intentional pulpotomy can be done in traumatic primary teeth where remaining crown is very small and needs support for retention of a restoration. Contraindications to pulpotomy are abnormal sensitivity to heat and cold, chronic pulpalgia, tenderness to percussion or palpation because of pulpal disease, periradicular radiographic changes resulting from extension of pulpal disease into the periapical tissues and marked constriction of pulp chamber or root canals.

According to Ranly (1994), pulpotomy for primary teeth has been developed on three lines: devitalization (mummification, cauterization), preservation (minimal devitalization, noninductive), regeneration (inductive, reparative). The reparative and biologic approach to pediatric pulp therapy is the devitalization approach of formocresol pulpotomy

An ideal pulpotomy material to be placed on the radicular pulp should be bactericidal, harmless to pulp and surrounding structures, promote healing of remaining radicular pulp without interfering with the physiologic root resorption and not possess any toxicity [5] . In search of an ideal pulpotomy medicament, various materials and techniques have been explored.

This treatment can be performed using different techniques including formocresol, calcium hydroxide , enriched collagen solution, ferric sulphate, mineral trioxide aggregate, growth factors or by non pharmacological hemostatic techniques like electrosurgery or Nd:YAG laser. Traditionally formocresol has been regarded as the gold standard pulpotomy medicament, however its use has been questioned recently owing to several concerns viz. carcinogenicity, mutagenecity and cytotoxicity.[6] However, concerns regarding the formocresol have led investigators to search for safe and effective alternatives, laser being one of them. So the present quest is for the research of newer materials and technologies which can provide more biocompatible alternatives to formoresol [7].

Lasers in Pediatric Dentistry

Treating infants and young children is a rewarding experience, especially when we guide parents and children down the path of prevention and interception of oral disease[8].

The American Academy of Pediatric Dentistry recommends that a child's first visit to the dentist occur no later than 6 months after the first teeth erupt, or around a child's first birthday[8] . During the initial visit, the pediatric dentist can assess medical history, educate parents on healthy oral practices (e.g, brushing, flossing, diet, oral habits, and fluoride) evaluate a child's risk of developing oral problems and, when appropriate, determine necessary preventive or interceptive actions. Oral examinations by 1 year of age allow for earlier recognition and treatment of soft-tissue pathologies and anomalies, such as tongue-ties, that appear at birth[8] .

Guidance of the eruption and development of the primary and permanent dentition is an integral part of treating children and contributes to the development of a permanent dentition that is harmonious, functional, and esthetically acceptable. Soft-tissue procedures that once were rejected because they necessitated general anesthesia can be safely and quickly treated with lasers in the dental office. [8] .

Clinical experience indicates that restorative treatment in most children can be accomplished with little or no local anesthetic agents and their associated concerns, such as lip or tongue biting, which often occur when the child is numb[8] . Postoperative problems, such as dehydration when a child refuses adequate fluid intake after treatment, can be avoided.

Laser technology allows the dentist to perform microdentistry, removing only diseased dental tissue and preserving the remaining healthy tooth structure.

Lasers offer advantages like reduced chair side time, elimination of high speed drill and controlled energy. It is quick, efficient, self-limiting, has good visibility of the operating field and shows no systemic effects at the site of application. The use of laser also eliminates the pain of injections, which is considered to be a barrier to effective dental treatment.

With the development and introduction of the erbium family of lasers, the pediatric dentist has a safe and efficient laser to treat hard and soft tissue of the oral cavity. The erbium laser's shallow depth of tissue penetration, high affinity for water, lack of thermal damage, and minimal reflective property make it ideal laser for pediatric dentistry. There are two wavelengths, Er,Cr:YSGG at 2790 nm and Er:YAG at 2940 nm, that are similarly effective in treating soft-tissue and hard-tissue lesions[8].

The word laser is an acronym standing for "Light Amplification by Stimulated Emission of Radiation". An amaging paradigm shift is occurring in dentistry with the technology breakthrough that gives dentists the capability to perform a wide range of hard-and- soft tissue procedures with improved patient outcomes, less trauma, reduced post-op complications- and in most cases, with no need of injections[9] . As much as any wish to explore the envelope of possible laser-tissue interaction, much of the hype surrounding laser use in dentistry has centered on the possibility to encourage patient uptake through the avoidance of peri- and post-operative pain and discomfort. Certainly, however, today's lasers offer an opportunity to deliver hard and soft tissue treatments that, make the patient experience somewhat easier[10] .

The first laser was developed by Theodore H. Maiman in 1960. Using a theory originally postulated by Einstein, Maiman created a device where a crystal medium was stimulated by energy, and radiant, laser light was emitted from the crystal. This first laser was a Ruby laser[9] .

Since the introduction of lasers to dentistry, several studies have shown the effect of different laser devices on dentin and pulpal tissue. Application of laser irradiation in vital pulp therapy has been proposed as another alternative to pharmaco- therapeutic techniques[3] .

Lasers like CO2, argon and Nd:YAG were used to perform pulpotomies on dogs and swine. Subsequent to these animal studies, many studies were done to perform pulpotomies in primary teeth[11] .

Some studies investigating the application of lasers to dental tissues have shown their potential to increase healing, stimulate dentinogenesis and preserve vitality of the dental pulp.

In 1985, **Ebimara** reported the effects of Nd:YAG laser on the wound healing of amputated pulps[12] . He reported better wound healing in pulps exposed to the laser than in controls during the first week and facilitation of dentinal bridge formation in the fourth and twelfth postoperative weeks.

In 1996, **Wilkerson et al**. evaluated the clinical, radiographic and histologic effects of argon laser on vital pulpotomy of swine teeth[12] . The results showed that all soft tissue remained normal and all teeth exhibited normal mobility. Reparative dentine formation was noted histologically. They concluded that use of argon laser for pulpotomy did not appear to be detrimental to pulp tissues. These studies led to the use of the Nd:YAG laser for pulpotomy in primary teeth. Although the first Er:YAG laser system (Kavo Key Laser, Kaltenbachand Voigt GmbH & Co., Biberach/Riss, Germany) was introduced into the medical market in Germany in 1992, it was not until 1997 that erbium dental lasers received FDA clearance in the United States. However, other studies on lasers led to the use of the Nd:YAG laser for pulpotomy in primary teeth.

Jeng-fen liu in 2006 compared the effects of Nd:YAG laser Pulpotomy to formocresol pulpotomy on human primary teeth. Sixty-eight teeth were treated with Nd:YAG laser and followed up for 6 to 64 months. Clinical success was achieved in 66 out of the 68 teeth (97 %), and 94.1% were radiographically successful. In the control group, 69 primary molars were treated with formocresol and followed up for 9 to 66 months; 85.5 and 78.3% achieved clinical and radiographic success, respectively. The success rate of Nd:YAG laser pulpotomy was significantly higher than that of formocresol pulpotomy.

Procedures For Laser Pulpotomy

Various authors performed laser pulpotomy using different lasers at varying wavelengths, some of which are listed below.

Liu et al (1999)[12] published a case report of 23 teeth that received pulpotomy treatment with an Nd:YAG laser with the following settings, 2W, 20Hz, 100mJ and followed for 12 to 24 months. Following access opening and coronal pulp extirpation, initial hemorrhage control was achieved using dry, sterile cotton pellet. Complete homeostasis was achieved by exposure to Nd:YAG laser at 2 W, 20 Hz, 100mJ (124J/cm2) (The SunLase 800, pulsed Nd:YAG Dental Laser System Sunrise Technology, CA, USA) for 15 approximately seconds. This was introduced into the canal orifice through a standard quartz 320μm optical fiber. Then, IRM paste was placed over the pulp stumps, and the tooth was restored with either composite resin or a stainless steel crown. Clinical and radiographic evaluations of the success of Nd:YAG laser pulpotomy were based on the following: absence of pain, fistula, swelling and abnormal mobility; lack of internal or external root resorption, periapical or furcal radiolucency. In conclusion, the results of this study showed that the clinical success rate of a Nd:YAG laser pulpotomy was 97%, and the radiographic success rate was 94.1%. Compared to a formocresol pulpotomy, the success rate of Nd:YAG laser treatment was significantly higher. Furthermore, Nd;YAG laser did not cause any damage to the permanent successors. Therefore, the Nd:YAG laser pulpotomy can be considered for use as a pulpotomy technique in clinical practice[12] . **Adrian** reported that irradiation of the buccal toothsurface with the neodymium: yttrium-aluminum-garnet (Nd:YAG) laser produced less pulp damage than the ruby laser with less histologic evidence of coagulation and focal necrosis[6] .

Melcer et al. (1987) showed that the CO2 laser produced new mineralized dentin formation without cellular modification of pulpal tissue when tooth cavities were irradiated in beagles and primates.

Kato et al. (1989) studied the effects of the Nd:YAG laser on pulpotomized rat molars at low (5 watts) and high (15 watts) power settings. At 2 weeks, histologic evidence showed osteodentin covering the amputated pulps with the low power setting and fibrous dentin formation at the orifice wall of the root canal with the high power setting [3] .**McGuire et al**. compared the Nd:YAG laser with formocresol in permanent tooth pulpotomies in dogs at 6- and 12-week post-treatment periods. No significant differences in radiographic pathology were found between the two groups. Histologically, the frequency of pulpal inflammation was higher for the laser group (29%) at 12 weeks than for the formocresol group (0%). No differences were found with respect to periradicular inflammation and root resorption[3] .

Jukic et al. (1987) used CO2 and Nd:YAG lasers with energy densities of 4 J/cm2 and 6.3 J/cm2, respectively, on exposed pulp tissue. In both experimental groups, carbonization, necrosis, an inflammatory response, edema, and hemorrhage were observed in the pulp tissue. In some specimens, a dentinal bridge was formed[11] .

Ebimara et al. (1988, 1992) used the Nd:YAG laser in rats and dogs. Their results showed that lasers facilitated pulpal healing after irradiation at 2 W for 2 s [13] .

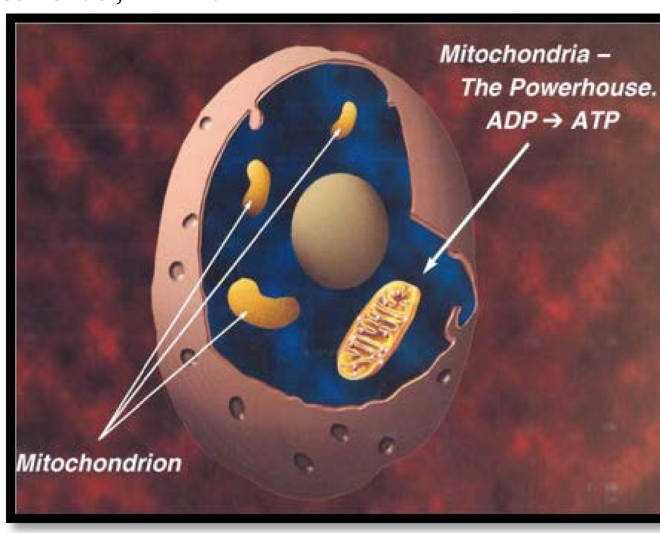
Moritz et al. (1998) reported that the CO2 laser was a valuable aid in direct pulp capping in human patients[14].

Low Level Laser Therapy (LLLT)

Armamentarium of LLLT

One promising alternative to FC pulpotomy is low level laser therapy (LLLT), which has been shown to accelerate wound healing process in exposed dental pulp tissue. [10] Therapeutic laser treatment, also referred to as LLLT, has been used for the last 3 decades[15,16] .The principle of using LLLT is to supply direct biostimulative light energy to the body's cells.

Cellular photoreceptors (eg, cytochromophores and antenna pigments) can absorb low-level laser light and pass it on to mitochondria, which promptly produce the cell's fuel, ATP [16].



Low level laser therapy has potent anti-inflammatory, analgesic and hemostatic abilities. It implicates a positive healing outcome thus preserving the vitality of the radicular pulp. In addition to this LLLT gives a whole new dimension to primary endodontics as it is non invasive and non pharmacological entity offering therapeutic benefits such as lack of bleeding, faster healing, adequate analgesia and reduced postoperative infections. LLLT also provides many other postoperative outcomes like accelerated wound healing, regeneration, relief of pain and enhancement of local immunity[17] . The principle of using LLLT is to supply direct biostimulative light energy to the body's cells. The positive effect of LLLT on reactional dentinogenesis induction in human teeth was reported by Ferreira et al. [18] The application of LLLT in dentistry is included with various clinical conditions. The general rule for intra-oral treatments is to use 2 to 4 J with the intra-oral probe and 4 to 10 J for extra-oral treatments[11] .

Various applications are

1. Temporomandibular disorders.
2. Hypersensitive dentin
3. Postextraction and bone-healing therapy
4. Orthodontics
5. Herpes labialis
6. Aphthous ulcers
7. Trigeminal neuralgia etc.

Summary and Conclusion

With the rapid development of laser technology, new lasers with a wide range of characteristics are now available and being used in various fields of dentistry and laser pulpotomy is one of them. Various studies have proved it as 100% success both clinically and radiographically. So it becomes most important for the dental practitioner to become familiar with the principles and then choose the proper laser(s) for the intended clinical application.

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