A new approach to facilitate apexogenesis using soft tissue diode laser

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Abstract

Traumatic injuries occur commonly in children and adolescents and the prevalence of such injuries has increased over the last decade. Such injuries may result in pulpal exposure, which can endanger tooth vitality. Therefore, the treatment for such injuries should be carefully planned so as to preserve the pulp vitality. Teeth with immature roots pose a great challenge for the clinician and procedures like pulpotomy may prove effective as a treatment strategy. Such procedure may ensure continued root development and apexogenesis. Lasers have varied applications in the dental practice such as oral surgical procedures, cavity preparation, disinfection etc. This article is a case report on the use of diode laser for pulpotomy in a young permanent tooth with traumatically exposed pulp in an 8-year-old male.

Keywords: Apexogenesis, pulpotomy, soft-tissue laser

Introduction

Traumatic injuries to teeth are common in children and young adults and comprise 5% of all injuries.[1] Anterior teeth are most commonly involved in traumatic injuries.[2] These injuries may result in pulpal exposure, which can jeopardize the tooth vitality. The management of pulpally exposed immature teeth often proves to be challenging to the clinician. The management depends upon the size of exposure,[3] general condition of pulp tissue, stage of root development,[4] time period between injury and reporting to the clinic[5] and status of periodontal ligament.[4] In young patients with immature teeth, it is desirable to maintain pulp vitality so as to ensure continued root development.[6] This can be achieved by either pulp capping or pulpotomy depending upon the size of exposure.[4]

According to American Academy of Pediatric Dentistry (AAPD) guidelines, partial pulpotomy for traumatic exposures is a procedure, in which the inflamed pulp tissue beneath an exposure is removed to a depth of 1-3 mm or more to reach the deeper healthy tissue.[7] The main objective of partial pulpotomy is to preserve the pulp vitality so that teeth with immature roots show continued normal root development and apexogenesis. Several materials and techniques have been employed for pulpotomy such as calcium hydroxide,[8-10] mineral trioxide aggregate[11,12] electrosurgical pulpotomy.[13-15] However, none of these ensure 100% success.

Lasers have found numerous applications in the dental practice such as oral surgical procedures, cavity preparation, disinfection etc. Diode lasers are soft-tissue lasers with a wavelength of 810-980 nm. This wavelength is readily absorbed by soft-tissues with poor penetration in dental hard tissues thus making diode laser suitable for soft-tissue procedures such as pulpotomy in close proximity to enamel and dentin. This article is a case report on the use of diode laser for pulpotomy in a young permanent tooth with traumatically exposed pulp. Laser acts by ablation of the damaged pulp tissue in the immediate vicinity of the beam, disinfection of the remnant tissue by bacterial cell lysis and bio-stimulation of surrounding tissue, which promotes healing.

Case Report

An 8-year-old male child reported to the Pedodontics Out-patient Department at Center for Dental Education and Research, All India Institute of Medical Sciences with the history of trauma on the prior evening and complaint of fractured front tooth and sensitivity on eating and drinking. There was no history of pain or swelling. On clinical examination, it was found that the patient had a traumatic injury in relation to the right maxillary lateral incisor (tooth # 12) with an extensive fracture involving the entire crown (Ellis Class III fracture). The pulp was exposed and there was extensive loss of tooth structure with only about 3 mm of crown remaining [Figure 1a]. There was no other evidence of injury to the periodontal ligament or alveolar

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bone. The tooth exhibited normal physiologic mobility. The pulpal exposure was more than 2 mm in diameter. The intraoral periapical radiograph revealed an immature root with blunderbuss apex [Figure 1b]. The parents were explained the consequences of tooth extraction. The parents were very apprehensive about tooth extraction at an early age so it was decided to avoid tooth extraction and maintain pulp vitality by performing laser pulpotomy followed by prosthetic rehabilitation after completion of root formation. After an informed consent, it was decided to use a diode laser (940 nm, Ezlase, Biolase Technology Inc. USA) for the pulpal amputation. After administering local anesthesia, access cavity was prepared on tooth #12 using outward brush strokes of the bur to avoid further pulpal damage by laceration. A 400 nm focused tip was used after activation in pulsed mode at 2.0 W. Pulse length and pulse interval were set for 0.50 µs. The procedure was performed under standard aseptic conditions and recommended laser protection methods. The tip was moved in a contact mode just around the periphery of the exposed pulp so as to remove the coronal pulp without any damage to the underlying radicular pulp. Multiple applications of the laser energy were administered to ablate the pulp and achieve hemostasis. A sterile hemostatic pulp cap [Figure 2] was created using the diode laser, which was then covered by nano-ionomer cement (N-100, 3M) [Figure 3]. Patient was recalled again after 24 h, 72 h and 1 week. Patient remained asymptomatic during this period. There were no adverse clinical signs or symptoms of sensitivity, pain or swelling. Thereafter, the patient was recalled after 1 month, 3 months, 6 months and 10 months and radiographs were taken at each follow-up visit [Figure 4]. There were no radiographic signs of internal or external resorption, abnormal canal calcification or periapical radiolucency post-operatively. The radiographs showed continued root development with complete apical closure at 10 months. The tooth showed a normal response to electric pulp testing. After root completion, conventional root canal treatment was performed under local anesthetic and obturation with Gutta-percha followed by fiber post placement and ceramic crown.

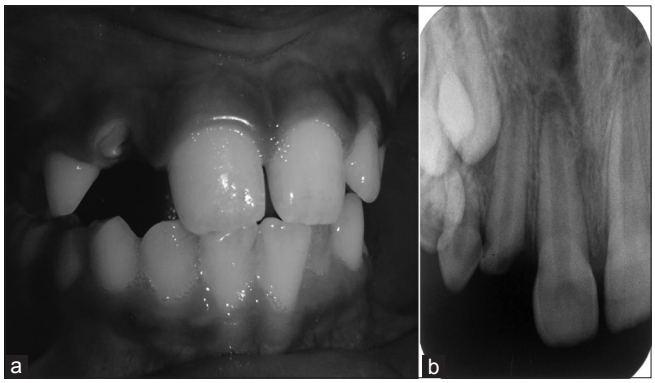

Figure 1: Pre-operative (a) 8-year-old male; tooth # 12; history of trauma (b) tooth # 12 on radiograph showing immature apex

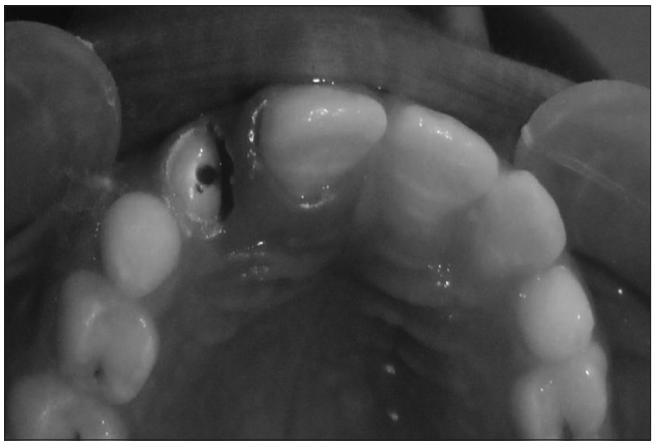

Figure 2: Laser used to create a hemostatic pulp cap wrt 12

Discussion

The management of exposed pulp depends upon various factors. Among these two critical factors are the time lapse between injury and treatment and the stage of root development. It is imperative that the management of immature teeth with exposed pulp should be as conservative as possible. This can be achieved by pulpotomy provided that there is a careful case selection. The patient's age is an important factor as older pulps are more fibrous with relatively less healing ability, whereas young pulps are more vascular with a greater healing capacity. In the present case, the reported trauma was less than 24 h and the wound site were not overly contaminated thereby it was assumed that the bacterial invasion may be minimal. The success of the case was judged according to AAPD criteria for the success of pulpotomy, which were as follows:[7]

- The remaining pulp should continue to be vital after partial pulpotomy
- There should be no adverse clinical signs or symptoms such as sensitivity, pain or swelling
- There should be no radiographic sign of internal or external resorption, abnormal canal calcification or peri-apical radiolucency postoperatively

Figure 3: Post-operative-12 restored with glass ionomer cement

Figure 4: (a) 1 month post-operative radiograph (b) 3 month post-operative radiograph (c) 6 month post-operative radiograph (d) 10 months post-operative radiograph

- Teeth having immature roots should continue normal root development and apexogenesis.

Various materials have been used as pulpotomy agents; calcium hydroxide has been the mainstay of pulpotomy procedures in permanent teeth for a long time. It acts by providing an alkaline pH which promotes the formation of a dentin bridge and thus seals off the healthy pulp from the external environment.[16,17] However, various disadvantages such as gradual disintegration and formation of tunnel defects in the newly formed dentin have been commonly witnessed with calcium hydroxide when followed-up for longer times.[18]

Lasers offer a conservative and biological alternative to other pulpotomy agents due to the regenerative or reparative effect of laser energy and exposure site sterilization. Various lasers have been reported to be used for pulpotomy including carbon dioxide (CO_2),[19] neodymium: Yttrium-aluminum-garnet,[20] erbium:Yttrium-aluminum-garnet (Er:YAG),[21] erbium-chromium:Yttrium scandium gadolinium garnet[22] and diode lasers.[23] The choice of laser type for any soft-tissue procedure is dependent upon the thermal relaxation time (TRT) of the tissue. It is the time required by the irradiated tissue to cool to 50% of the original temperature immediately after the laser pulse is applied.[24] It is dependent upon the vascularity of the tissue and is quite specific. Diode laser is a soft-tissue laser with a wavelength between 810 nm and 980 nm. This wavelength is readily absorbed by soft-tissues like dental pulp. This suits the TRT of pulp and thus prevents excessive heating and charring.[25] Moreover, diode laser is poorly absorbed by hard tissues such as enamel, dentin and cementum. This enables the clinician to work on soft-tissues such as pulp in close proximity to dentin during pulpotomy procedures without causing any damage to the hard tissue.

Diode laser is used in contact mode only for cutting so only the soft-tissue in close proximity with the tip is affected thus leaving the remnant pulpal tissue unaffected. CO_2 laser causes peripheral thermal damage to the surrounding pulp tissue. Er:YAG lasers are non-contact lasers so it reduces the tactile sensation and these can ablate the hard dental tissues also.

Another advantage of diode laser for pulpotomy is that even if there is some microbial contamination of the pulp stump, the laser can eliminate or significantly reduce bacteria and providing a relatively bacteria free environment. The laser also offers the advantage of hemostasis, which improves clinician's efficacy. The biostimulative effect of the laser also promotes rapid healing.

Thus, the major advantage in using diode lasers for pulpotomy is through the following actions:

- Precise control of hemostasis
- Minimal zone of thermal damage
- Disinfection of the surgical site.

The power settings used in this case was 2.0 W which is within the range given by various authors.[23,26,27] Lasers can be quite effective in children as they appear less threatening to the child and also improve post-operative healing.

Conclusion

In the present case, diode laser proved to be an effective technique for pulpotomy in an immature tooth. The use of soft-tissue diode lasers can influence the treatment outcome and should be seen as a predicable tool for vital pulp therapy.

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