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Case Report

The assistance of Er,Cr:YSGG laser in pulp injury related to anterior teeth trauma

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ABSTRACT

Background: *Erbium chromium or erbium lasers constitute preferred instruments for the preparation of that section of tooth adjacent to the pulp chamber rather than high-speed drills, especially in cases of dental injury. Their advantages can support modified operations in achieving optimum recovery and avoiding complications related to the healing process.* ***Purpose:*** *The aim of the study was to describe another modality of the assistance of erbium, chromium:yattrium-scandium-gallium-garnet (Er,Cr:YSGG) laser in trauma-related pulp injury affecting the anterior teeth.* ***Case:*** *The results of laser treatment applied to four pulp injuries of three children were analyzed in this case report.* ***Case Management:*** *Er,Cr:YSGG laser-assisted cavity preparation was performed without resort to a local anesthetic, the cavities being sealed with mineral trioxide aggregate (MTA). None of the cases demonstrated symptomatic or peri-radicular pathology during clinical or radiographic examinations.* ***Conclusion:*** *The results contained in this case report support the application in pediatric dentistry of a Er,Cr:YSGG laser to pulpotomy cavities as part of the treatment of traumatic pulpal injuries to permanent incisors.*

Keywords: *dental trauma; Er,Cr:YSGG; pulp therapy; MTA; permanent incisors*

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INTRODUCTION

The majority of dental trauma affects the anterior teeth due to the high level of activity among school age children.[1] Pulp therapies play an important role in maintaining pulp vitality and avoiding impeded root development or root resorption in young permanent teeth. Dental lasers constitute efficient tools within the essentialal therapy required to lower the risk of complications such as inflammation and infection.[2] Oral laser applications also offer the prospect of painless procedures that address the concerns which children may harbor regarding the operation.[3]

Compared to other forms of laser, erbium chromium or erbium lasers produce superior tooth preparation results. However, the heat generated during the procedure may cause irreversible damage to pulp tissue as well as pain and discomfort to the patient. Erbium, chromium:yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser, emits light at a wavelength of 2780 nm, is effective in cutting hard and soft dental tissues due to its water-mediated ablation mechanism.[4] Moreover, a hydrokinetic system serves to minimize the mechanical damage to the structure of teeth without any thermal risk.[5-6] This photo-thermal interaction within tissue ablation produces a therapeutic effect by removing organic material and the smear layer, while also ensuring a decontaminated operation site.

Pulpal inflammation following acute injury is due to interrupted neurovascular supply[7] or localized increase in intestinal fluid pressure, rather than bacterial invasion.[8] As far as is known, laser irradiation is effective in wound control by minimizing hematoma formation in soft tissue.[9] It is assumed that Er,Cr:YSGG laser represents the optimum choice for essential pulp therapy (including pulp capping and pulpotomy) in the treatment of traumatized teeth due to its overcoming of deficiencies in the procedure and reduction of complications during the healing process.

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CASES

The patients constituting the subjects of this report were treated at the Department of Pedodontics, Faculty of Dentistry, Marmara University, Istanbul, Turkey. All cases presented anterior teeth fracture with trauma-related pulp injury. No extraoral impairment was clinically identified and no pocket was located intraorally and the patient demonstrating mixed dentation with well-articulated occlusion. Radiographic examination indicated no other abnormalities such as jaw or condylar head fractures in any of the subjects. Clinical views and periapical radiographs of traumatized upper incisors are shown in Figure 1.

Case I: A healthy boy aged 8 years 9 months attended the clinic chiefly complaining of anterior fractures to teeth #11 and #21 due to an accident at school five hours earlier. From a clinical perspective, an oblique crown fracture line was observed in tooth #21 and a horizontal fracture adjacent to the pulp chamber without exposure in tooth #11 (Figure 1A). Radiographic examination of the teeth indicated complete root development without apex formation (Figure 1B). Figure 2A and B represents the pictures of case management steps of Case I.

Case II: A healthy girl aged 9 years 11 months visited the clinic seven hours after an incident at school chiefly complaining of fractured anterior upper incisors. During clinical examination, it was observed that teeth #11 and #21 had an exposed pulp zone less than 2 mm in diameter, accompanied by severe dentinal caries on all upper incisors and significantly poor oral hygiene (Figure 1C). Radiographic examination confirmed complete root formation and an oblique fracture line adjacent to the pulp chamber in both teeth #11 and #21(Figure 1D). Figures 2C and D demonstrate stages in the case management, relate to Case II.

Case III: A boy aged 9 years 5 months visited the clinic 16 hours after an accident on the front porch of his house. During clinical examination, a crown fracture with pulp injury and an exposed area less than 2 mm in depth was observed in tooth #21 (Figure 1E). Radiographic examination further indicated an open apex with 3/4 incomplete root formation and an oblique fracture line extending below the gingival margin adjacent to the pulp chamber (Figure 1F). Figure 2E and F represents the stages in case management, relate to Case III.

CASE MANAGEMENT

On the same visit day, a pulpotomy was performed on the teeth which had been determined as vital after a cold test. The method involved two stages: laser-assisted cavity preparation of the exposed dentin and pulp zone followed by sealing of the cavity with mineral trioxide aggregate

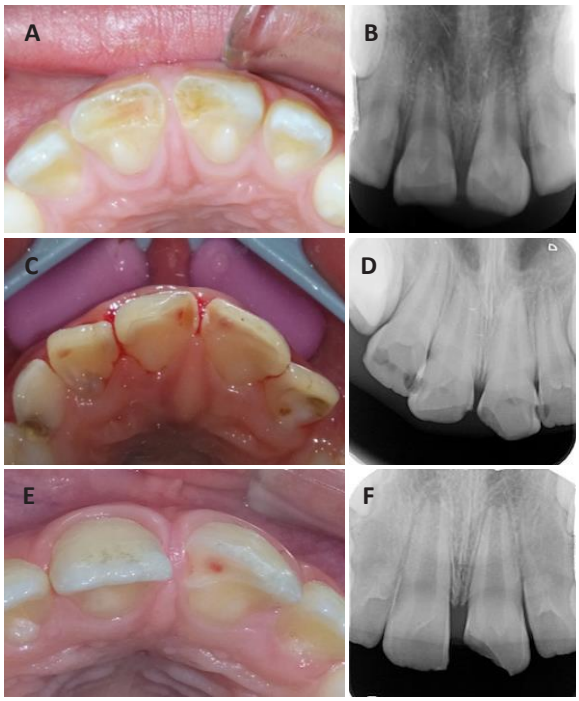

Figure 1. A) Clinical view of the crown fractures and B) the periapical radiograph of Case I. C) Clinical examination of the upper incisors and D) the periapical radiograph shows decayed and fractured teeth of Case II. E) Clinical examination of the crown fractures and F) radiograph of #21 showing an open apex with 3/4 root development of Case III.

Figure 2. A) Heamorrhage seen after intentional cavity preparation and B) MTA placement for #11 of Case I. C) Preparation of the cavity with laser beam and D) MTA application for #11 and #21 of Case II. E) Haemorrhage seen after cavity preparation and F) MTA application on #21 of Case III.

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(MTA) which precedes the constructing a restoration of the missing part. Figure 2 represents the clinical pictures of case management steps.

Therapy was initiated by means of a cotton-roll isolation without resort to local anesthesia. A modified partial pulpotomy was conducted with the assistance of a 2780 nm Er,Cr:YSGG (Waterlase MD, Biolase, USA). The laser in question operated at 1 W-2.5 W and 20 Hz in 140 µs pulse duration (H mode), with a MGG6 sapphire tip (6 mm long, 600 micron) directed with 90% water and 80% air. The tip was applied to the surface at a 45-degree angle in order to ease the running stream and avoid misplacement of the infected dental parts into the pulp chamber. The dentine border of the exposed zone was ablated to a depth of 1 mm below the fracture until the cavity formed extended to represent a barrier (Figure 2A,C, and E). White-MTA (Angelus, Londrina, PR, Brazil) was applied to the cavity after hemostasis had been achieved (Figure 2B,D, and F) and covered a thin layer of light-cured glass ionomer cement liner (Ionoseal, Voco, Germany). A transitional restoration (Ketac Molar, 3M, USA) was implemented as an emergency measure. Occlusion (bite) was not increased and dental splints were not required. The crown restorations were completed by means of resin composite fillings completed during subsequent visits.

Over the course of the following months, panoramic and periapical radiographs were exposed for examination and vitality tests were performed with the following results: absence of symptoms and pathology, crown discoloration and the tooth being vital and non-responsive to percussion and palpation. The patient was recalled at intervals of one, three and six months during the subsequent two years for clinical and radiographic examination, irrespective of his/her not having subsequently presented symptoms.

In Case I, because the fracture line was flat and extremely close to the vital structure it proved necessary to prepare a cavity capable of accommodating the biomaterial. Moreover, in the opinion of the authors, the trauma may have caused inflammation and precipitated a localized increase in both intestinal fluid pressure and blood flow in the low-compliant pulp that could induce pulp necrosis.[8] An intentional partial removal of hard tissue mode dentine was concurrently performed with a partial pulpotomy resulting in a haemorrhage and no attempt was made to set other lasering parameters for pulp vaporization in soft tissue mode. Follow-up on the condition of the tooth was conducted for two years without any subsequent pathology. However, tooth #21 experienced both enamel and dentine fracture without exposure and required root canal treatment after three months due to its presenting symptoms of pulpitis (Figure 3A and B).

In Cases II and III, the teeth already possessed exposure sites, although these had been not fully opened which resulted in pulp vaporization. Therefore, it was the intention of the authors to prepare cavities in the hard tissue, all of which were filled with MTA to produce a hermetic seal. The blood in the pulp was considered the liquid source necessary to complete setting of the biomaterial. The teeth in Case II were monitored for more than 18 months (Figure 4A and B). In Case III, the immature tooth referred to in the report showed evidence of continuous root development and apex formation throughout the monitoring period without presenting pathologic symptoms (Figure 5A and B).

DISCUSSION

In cases of traumatic dental injuries, pulp therapy is planned according to the time between trauma and therapy, the size of pulpal exposure and the type of bleeding. If the pulp examined is considered vital, a pulpotomy procedure involving partial removal (2 mm) of the pulp tissue using a sterile diamond bur housed in a high speed hand piece

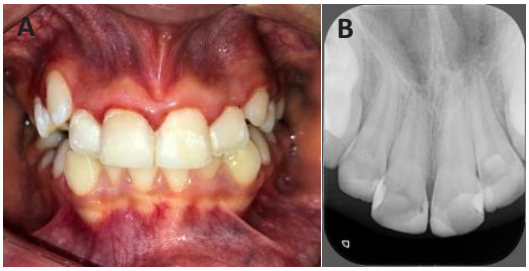

Figure 4. A) Clinical and B) radiological evidence of #11 and #21 of Case II indicate no periapical or pulpal pathology after

Figure 3. A) Clinical and B) radiological view of the central incisors of Case I. #11 shows completed apex formation after a two-year follow-up period, and root canal filling of #21 is shown in the radiologic picture.

Figure 5. A) Clinical and B) radiological pictures of #11 of case III, show completed root development and apex formation without pathology, reviewed over a period of almost two years.

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followed by the application of a pulp dressing prior to restoration is usually performed.[10] Furthermore, a partial pulpotomy might be advisable in cases of young patients with complicated trauma involving exposure larger than 1 mm or/and occurring within 48 hours of therapy.[6-10] Because the treatment includes surgical removal of soft tissue and preparation of the hard dental structure, the research investigated laser-assisted partial pulpotomy as an atraumatic and aseptic technique which represents an alternative to conventional procedures.

The majority of the clinical studies reported in the literature highlight the laser coagulation procedure relating to mechanically-exposed pulp during the removal of caries. However, there is limited data on Er,Cr:YSGG-assisted pulp therapy applied to traumatized permanent teeth with the result that it can be confused with the pulpotomy procedure employed on primary teeth. Olivi *et al.* (2015) have recently argued that Er,Cr:YSGG laser applications for vital pulp therapy involved initial removal of deep dentin caries (150 mJ, 15-20 Hz, short pulse duration (with water/air spray) usually followed by indirect pulp capping practice which includes decontamination of dentin melting at lower energies (25 mJ, 10 Hz and short pulse duration (with low water and air spray). Direct capping involves another treatment strategy intended to protect pulp from the irritants at as early a point as possible. Laser-assisted pulp capping differs from the practice of dentin melting which coagulates the pulp tissue by means of 10-25 mJ, 10 Hz with short pulse duration and a 600 mm diameter tip in defocused mode and requires a hermetic seal of the exposed area. A partial pulpotomy performed on permanent teeth involves a similar exposure of pulp for deep dentin caries, but differs with regard to the practice of vaporization of the pulp tissue (150 mJ, 10 Hz, short pulse duration with active water/air spray) for traumatic injuries.[6]

Although laser irradiation increases the alkaline phosphatase activity of osteoblasts responsible for the production of dentinal hard tissue,[11] pulp therapy demands a non-degradable and bioactive cement such as MTA, Portland cement, or biodentine, to avoid potential complications during the healing process. One histological study highlighted the role of the capping material and MTA+laser in producing superior results from the perspective of preserving pulp vitality and preventing necrosis than MTA alone or $Ca(OH)_2$ with a laser.[12]

The patients reported no pain during the cavity operation, although they did experience mild sensitivity to the tactile stimulus during the barrier placement. The findings of this case report concur with those of previous studies that Er,Cr:YSGG laser ablation simplifies clinical procedures, while contributing to effective behavior management in children by reducing discomfort and inducing a pain threshold.[2]

Furthermore, such treatment positively affects the healing of these teeth over a period of 18-22 months. No pathological symptoms or crown discoloration occurred during the follow-up period. The fact that no root resorption was observed in any cases which constituted a positive result of the investigation. Although the current report is based on a limited sample of participants, the findings suggest that Er,Cr:YSGG laser applications in pulpotomy practice constitute extremely delicate surgical operations during which both hard and soft dental tissue should be protected.

In conclusion, this case report was intended to assess the importance of laser-assisted pulpotomy in dental trauma. As with all dental applications, accurate diagnosis and an appropriate treatment plan play significant roles in the successful management of traumatic injuries. Therefore, being aware of medical advances, such as those concerning the application of lasers and the range of available treatment, is crucial.

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