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Published online 2015 November 23. **Case Report**

Reattachment of a Fractured Anterior Tooth Segment With Pulp Exposure via Er:YAG and Nd:YAG Lasers

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Abstract

Introduction: The reattachment of a dental fragment may be performed for treatment of traumatized anterior teeth, both in cases of simple coronal fracture (enamel and superficial dentin) and in those with complicated coronal fracture (deep dentin with pulp exposure). A major part of this procedure is the adhesion technique, which was described for the first time by Buonocore in 1955. This clinical case demonstrates the use of Er:YAG and Nd:YAG lasers in fragment reattachment of a traumatically fractured anterior tooth with pulp exposure, describes their advantages and highlights the steps involved in their use.

Case Presentation: A 14-year-old patient who came to our clinic with a traumatic crown fracture of the permanent, right central incisor is described. The patient had preserved the fragment that had broken off into his mouth and it was rebonded to the tooth using lasers (LightWalker device; Fotona, Ljubljana, Slovenia) with the following parameters: Er:YAG, SSP mode; 200 mJ; 10 Hz; quasi-contact tipless handpiece; Nd:YAG, SP mode; 4 W; 40 Hz; 300 μm contact fiber. The whole procedure was performed without the need for anesthesia.

Conclusions: The patient reported that he did not feel pain or discomfort throughout the intervention. Follow-up visits performed after one, three, six, twelve, and sixteen months demonstrated vitality of the tooth the absence of complications, as well as good esthetic results. Laser technology may be used in the treatment of traumatic anterior teeth injury with advantages in terms of quality of the restoration, esthetic results, and patient comfort.

Keywords: Er:YAG, Nd:YAG, Laser, Adhesion, Trauma, Conservative Dentistry, Etching

1. Introduction

Dental traumatology is a multidisciplinary branch of dentistry that requires a number of specific skills. In cases of emergency, decisions have to be made within a limited time frame and with effects that are only possible to evaluate at a later date (1). The technique of tooth fragment reattachment should be adapted to suit the situation, both in cases of simple coronal fracture (enamel and superficial dentin) and in those of complicated coronal fracture (deep dentin with pulp exposure) (2). In the first state, the fragment may be reattached immediately. On the other hand, in complicated coronal fractures, the main concern should be protection of the pulp and not necessarily the fragment (which should be kept hydrated in a refrigerator in a container marked with the patient's full name and the date of injury). The solution in the container should be changed at regular intervals and the seal checked, since in some cases fragments may be stored for several months before being reattached (3).

The field of adhesive dentistry was created in 1955 by Buonocore, with the description of the utilization of orthophosphoric acid and composite resin to obtain restorations with high bond strength and reduced microleakage (4). In 1990, laser technology was introduced in operative dentistry by Hibst and Keller, who described the possibility of using Er:YAG laser as an alternative to conventional instruments such as turbines and contra-angle handpieces (5). Widespread interest in employing this new technology is related to its significant number of advantages, as described in several scientific studies. Er:YAG laser technology allows for efficient ablation of hard dental tissues, thanks to the affinity of its wavelength for water and hydroxyapatite, without the risk of micro- and macro-fractures, which have been observed when using conventional rotary instruments. Dentin surfaces treated by lasers appear clean, without a smear-layer, and have open and clear tubules (6).

Under the same conditions of air/water spray, thermal elevation in the pulp recorded during Er:YAG laser irradiation is less than that recorded when using turbines and low speed handpieces. This wavelength of the laser also has an antimicrobial decontamination effect on treated tissues, which destroys both aerobic and anaerobic bacteria (7). The most interesting aspects of this new technology are related to the goals of modern day operative dentistry, including both minimally invasive dentistry and adhesive dentistry. Er:YAG lasers can reach spots with dimensions smaller than 1 mm, which allows for the possibility of performing selective ablation of the affected dentin while preserving the sound tissues.

Several in vitro studies have demonstrated that the preparation of enamel and dentin by Er:YAG lasers, followed by orthophosphoric acid etching, enhances the effectiveness of restorations in terms of reduced microleakage and increased bond strength (8). Several authors have also proposed the utilization of laser technology for the restoration of anterior teeth fractured by traumatic events.

The use of a laser for direct pulp capping offers several advantages and a higher success rate compared to conventional treatments (9). We chose to utilize the Nd:YAG wavelength because of its affinity with hemoglobin, which allows it to achieve coagulation in the exposed pulp. It also performs decontamination and biostimulation of the tissues, which enhance the success of direct pulp capping. Moreover, the possibility of using two wavelengths in the same device (LightWalker; Fotona, Ljubljana, Slovenia) is one more advantage of the use of lasers, from an ergonomic point of view. The aim of this clinical study was to demonstrate the usefulness of the combined utilization of Er:YAG and Nd:YAG lasers in the fragment rebonding of a traumatically fractured anterior tooth with pulp exposure by describing the advantages of this technique as well as the long-term success of the restoration, in terms of function, aesthetics and patient comfort.

2. Case Presentation

A 14-year-old male patient came to our clinic presenting a traumatic crown fracture of the permanent, maxillary right central incisor (Figure 1).

The patient had preserved the broken fragment in saline solution (Figure 2) and it was checked for goodness of adaptation to the tooth (Figure 3).

To lessen the ordeal for the already traumatized young patient, we decided to treat him using Er:YAG and Nd:YAG lasers we had at hand at our practice (Fidelis III Plus; Fotona, Ljubljana, Slovenia). Due to the patient's age, an informed consent form for the procedure was signed by his parents.

The trauma had left the pulp exposed (Figure 4); our first decision was to perform Nd: YAG laser (SP mode, 4 W, 40 Hz, 300 μm contact fiber) pulp capping (Figure 5).

We then proceeded to use the same Er:YAG device with a different wavelength (SSP mode, 200 mJ, 10 Hz, quasi-contact tip-less handpiece) to prepare the bonding surfaces of both the fragment (Figure 6) and the tooth (Figure 7).

The same surfaces were further prepared with orthophosphoric acid (Figure 8 and 9); bonding agent was applied, and flow composite resin was used to replace the fragment (Figures 10 and 11).

For esthetic purposes, we prepared the borderline area surface with the Er:YAG laser before applying orthophosphoric acid and flow composite resin once more (Figure 12).

No form of anesthesia was required nor requested by the patient. Follow-up visits performed after one, three, six, twelve, and sixteen months demonstrated the vitality of the tooth (Figure 13).

Figure 1. Pre-Operative View

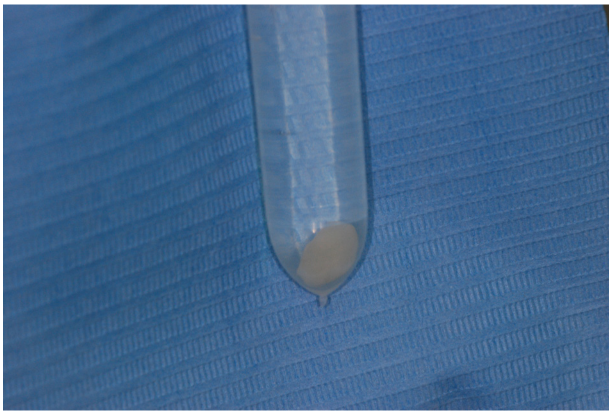

Figure 2. The Preserved Tooth Fragment

Figure 3. Checking the Adaptation

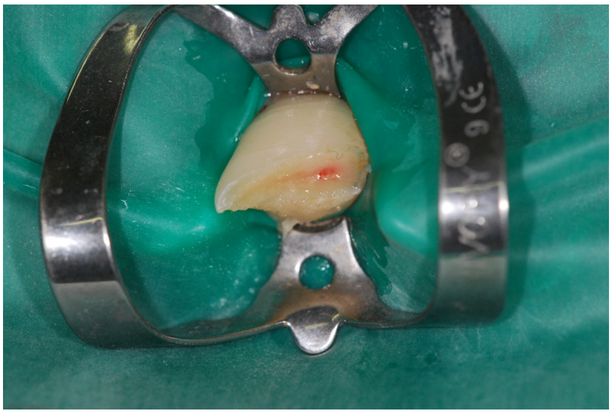

Figure 4. Pulp Exposure is Evident.

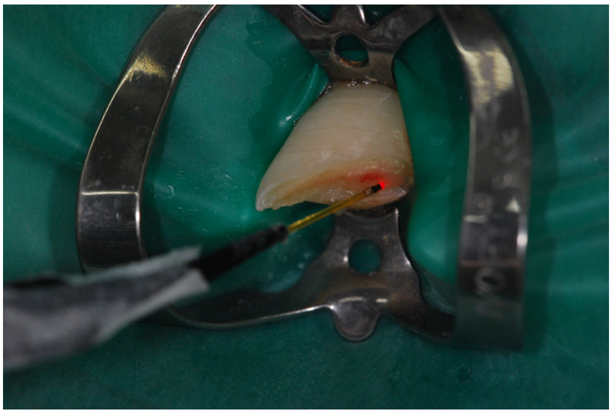

Figure 5. Pulp Capping Performed

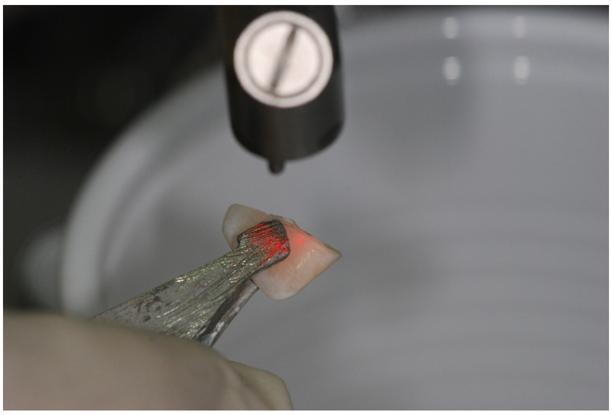

Figure 6. Fragment Laser Irradiation

Figure 7. Tooth Laser Irradiation

Figure 8. Tooth Acid Etching

Figure 9. Fragment Acid Etching

Figure 10. Tooth After Reattachment

Figure 11. Tooth After Polishing

Figure 12. Post-Operative View

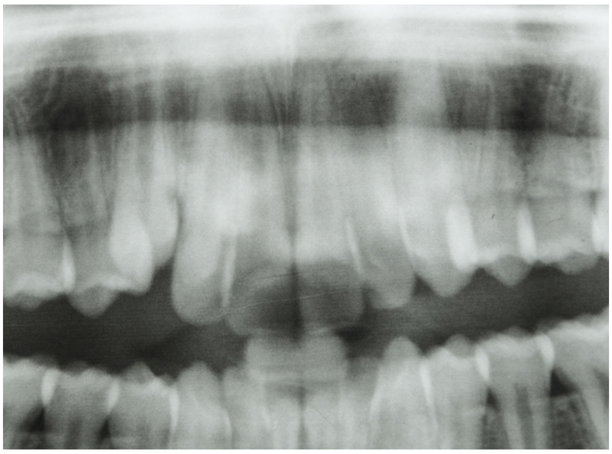

Figure 13. Post-Operative Orthopantomograph

3. Discussion

The Er:YAG laser played a pivotal role in this particular case; we were able to work without causing any additional pain to the patient, keeping anxiety for both the patient and the parents to an absolute minimum. In addition, the inherent laser action of the Er:YAG wavelength provided decontamination and increased bond strength. From an esthetic point of view, good vitality avoids the possibility of darkening of the incisor, which can necessitate prosthetic rehabilitation.

The synergy of the Er:YAG laser and orthophosphoric acid, as described in the literature (6, 8) allowed stronger adhesion between the fragment and tooth. This was important considering that in these kinds of restorations, it is not advisable to create a retentive preparation. Although no anesthetics were used, the patient reported that he did not feel pain or discomfort throughout the whole procedure, even during pulp capping.

Er:YAG lasers may be used in conservative dentistry in association with orthophosphoric acid as an alternative to conventional instruments. They have several advantages such as ensuring better bond strength, reduced microleakage, lower discomfort, and higher patient satisfaction (10).

Although this clinical study may be considered as preliminary and must be confirmed by other clinical cases, it showed that Er:YAG lasers can also be employed in dental traumatology, in association with Nd:YAG lasers, to restore anterior teeth with pulp exposure after coronal fracture. These lasers have the advantages of allowing for good cooperation by the patient, in particular when they are young, the absence of pain, sensitivity, and discomfort during the restoration process, and good final esthetic results.

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References

1. Andreasen JO, Andreasen FM. *Textbook and Colour Atlas of Traumatic Injuries to the Teeth.* Copenhagen: Munksgaard; 1994.
2. Ferrari CH, Ferreria de Mederios JM. Dental trauma and level of information: mouthguard use in different contact sports. *Dent Traumatol.* 2002;**18**(3):144–7. [PubMed: 12154770]
3. Glendor U. Epidemiology of traumatic dental injuries–a 12 year review of the literature. *Dent Traumatol.* 2008;**24**(6):603–11. doi: 10.1111/j.1600-9657.2008.00696.x. [PubMed: 19021651]
4. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. *J Dent Res.* 1955;**34**(6):849–53. [PubMed: 13271655]
5. Hibst R, Keller U. Experimental studies of the application of the Er:YAG laser on dental hard substances: I. Measurement of the ablation rate. *Lasers Surg Med.* 1989;**9**(4):338–44. [PubMed: 2761329]
6. Fornaini C. Er:YAG and adhesion in conservative dentistry : clinical overview. *Laser Ther.* 2013;**22**(1):31–5. [PubMed: 24155547]
7. Ando Y, Aoki A, Watanabe H, Ishikawa I. Bactericidal effect of erbium YAG laser on periodontopathic bacteria. *Lasers Surg Med.* 1996;**19**(2):190–200. doi: 10.1002/(sici)1096-9101(1996)19:2<190::aid-lsm11>3.0.co;2-b. [PubMed: 8887923]
8. Fornaini C, Petruzzella S, Podda R, Merigo E, Nammour S, Vescovi P. Er:YAG Laser and Fractured Incisor Restorations: An In Vitro Study. *Int J Dent.* 2012;**2012**:617264. doi: 10.1155/2012/617264. [PubMed: 23091491]
9. Moritz A, Schoop U, Goharkhay K, Sperr W. Advantages of a pulsed CO_2 laser in direct pulp capping: a long-term in vivo study. *Lasers Surg Med.* 1998;**22**(5):288–93. [PubMed: 9671995]
10. Fornaini C, Riceputi D, Lupi-Pegurier L, Rocca JP. Patient responses to Er:YAG laser when used for conservative dentistry. *Lasers Med Sci.* 2012;**27**(6):1143–9. doi: 10.1007/s10103-011-1012-0. [PubMed: 22041846]