Laser Assisted Surgical and Orthodontic Treatment of a Dilacerated Impacted Maxillary Incisor: A Case Report

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INTRODUCTION

Impaction of the permanent teeth is not commonly seen during the mixed dentition period, especially impaction of maxillary incisors. Among the incisors, the most prevalent impaction is seen in maxillary central incisors [1, 2]. There are various etiologic factors related to impaction of central incisors, such as supernumerary teeth, odontoma, and trauma. The most common cause is traumatic injury to the deciduous incisors [1, 3]. Disturbance in the eruption of anterior teeth will cause serious esthetic problems. Thus, treatment of maxillary incisor impaction is imperative [2]. Considering the possibility of alveolar bone resorption, it is preferred to preserve the impacted teeth instead of their extraction, as much as possible.

Different factors such as position and inclination of impacted teeth, degree of dilaceration, and possibility of providing space for the impacted teeth are effective on the success of orthodontic-surgical treatment of impacted teeth [2]. The use of laser has been suggested in orthodontics and pediatric dentistry, and it has been applied for different treatments such as surgical exposure of impacted teeth and application of low-level laser therapy (LLLT) for acceleration of orthodontic tooth movement. In this paper, the authors present treatment of an impacted and dilacerated maxillary central incisor with laser application for its surgical exposure and LLLT for acceleration of its orthodontic traction and eruption.

Keywords: Tooth, Impacted; Lasers; Low-Level Light Therapy; Orthodontics; Surgery
LLLT, also called photobiomodulation, has biostimulatory effects on bone regeneration and leads to acceleration of tooth movement by activating the proliferation of osteoclasts, osteoblasts, and fibroblasts [9, 10]. Numerous studies have confirmed the effect of LLLT on the velocity of tooth movement in rats [11] and also in humans [12-14]. The optimal parameters for orthodontic applications of LLLT have not yet been well established due to the great variations in parameters reported in the literature. Wavelength, power, energy density, and number of applications vary considerably. A recent literature review tried to find the most effective parameters [15].

Given the high importance of treatment of impacted maxillary central incisors, and considering the multiple advantages of laser application for surgical exposure and acceleration of orthodontic tooth movement, the aim of this study was to report successful treatment of an impacted maxillary central incisor with laser application beside surgical exposure and orthodontic traction.

Written informed consent was obtained from the patient and his parents for publication of this case report and the accompanying images.

**CASE REPORT**

A 10-year-old boy was referred to the Orthodontics Department of Shahid Beheshti Dental School with a chief complaint of delay in the eruption of an upper anterior tooth. The child was physically healthy, and extraoral and intraoral examinations were normal. His parents pointed to a history of trauma in the childhood.

**Diagnosis:**
The patient’s facial pattern was symmetric with skeletal class I relationship (Wits=-2 mms, ANB=1°). Clinical and radiographic examinations revealed impaction of the maxillary right central incisor (Figs. 1 and 2), which was horizontally positioned with a dilacerated root on cone-beam computed tomography scan. Dentally, the molar relationship was class I, with mild crowding in the upper and lower arch.
Fig. 2. (A) Panoramic radiograph showing the impaction of upper right central incisor, (B) lateral cephalometric radiograph

The upper dental midline was deviated due to drifting of the adjacent teeth, especially the upper right lateral incisor towards the missing area.

**Treatment objectives:**
1. To provide space in the maxillary arch for the eruption of impacted tooth
2. Orthodontic traction of impacted tooth after surgical exposure
3. To create acceptable occlusion after eruption of impacted tooth
4. To gain proper attached gingiva and normal appearance of maxillary anterior tooth

**Treatment alternatives:**
1. Surgical extraction of the impacted tooth, and regaining and maintaining space for prosthetic restoration
2. Surgical extraction of the impacted tooth and space closure through orthodontic treatment

**Treatment Procedure:**
In the first phase, brackets were bonded on all permanent teeth. After leveling and alignment of the upper arch and providing enough space for the impacted tooth, a relatively rigid stabilizing archwire (0.017 × 0.025-inch stainless steel) was placed.

Then, periodontal surgery was performed for exposure of the tooth. The crown of the tooth was impacted within the soft tissue; thus, there was no need for bone removal.

The procedure was conducted by a 975-nm pulsed laser (Laser HF® Standard, Hager Werken, Duisburg, Germany) with 3 W power and duty cycle of 50% with a fiber diameter of 0.4 mm (Fig. 3).

Fig. 3. Open exposure of impacted tooth through 975-nm pulsed laser (Laser HF® comfort, Hager Werken, Duisburg, Germany) at 3 W

The irradiation time was 150 s. After removal of the soft tissue, the attachment within a tied ligature wire was bonded to the facial surface of impacted tooth. There was no bleeding, edema or pain after surgery, and the patient reported no discomfort. After surgery, the patient was recalled for 3 sessions every month for surgical removal of the overgrowth of the gingiva and soft tissue over the tooth crown by using the same laser. Immediately after the exposure, light extrusive force (approximately 60 to 90 g) was applied by an elastomeric chain attached to the extension of the ligature wire.
Fig. 4. (A-E) Intraoral photographs at 15 months, showing successful eruption of the impacted tooth with optimal leveling and alignment and esthetically pleasing gingival margin

Laser with 975 nm wavelength was primarily used for surgical exposure. This wavelength has limited depth of penetration and is not traditionally used for biostimulation. However, each surgical laser has a halo of decreasing light intensities and in the periphery, the biostimulatory effects may occur [16].

The main effect of LLLT, however, was targeted with the pulsed 100 mW, 660 nm laser probe, with distance from the soft tissue. The aperture of the probe was 0.125 mm² (diameter of 0.4 mm) and the gradually scanned area was 7 cm² at the labial and lingual sides. Laser was irradiated for 150 s in each session, resulting in 15 J energy and approximately 17 J/cm² energy density. The patient received LLLT monthly until acceptable movement of the impacted tooth was achieved, which took 6 sessions to occur.

The 975 nm InGaAs diode laser (Laser HF® Standard, Hager Werken, Duisburg, Germany) that was used for surgery has secondary effects on bone regeneration and acceleration of tooth movement. During the surgery, the InGaAs laser was irradiated for 150 s (generally 120-180 s). In depth of bone, more than 25 J/cm² would be absorbed because this wavelength has high penetration in bone.

The impacted tooth was in relatively proper position after 7 months. The active treatment took 18 months. The final leveling and alignment was achieved by 0.018 × 0.025-inch stainless steel archwires (Fig. 4). The maxillary left central incisor was brought to the appropriate position, and the upper and the lower arches were coordinated with class I canine and molar relationship.

The patient’s smile was dramatically improved, and the final appearance of the anterior teeth and their gingival margins were esthetically pleasing. Also, cone-beam computed tomography radiographs taken at the final stage revealed no bone resorption and minimal root resorption. The position of the root and crown of the tooth was appropriate.
Improvement of the smile arc and good occlusal relationship were observed after treatment (Figs. 5 and 6). Unfortunately, due to migration of patient and his family to a foreign country, debonding was performed 2 years after cessation of the active treatment and the final records were taken at the mentioned time.

**Fig. 6.** Final panoramic radiograph

**DISCUSSION**

Impaction of the anterior teeth can cause serious esthetic and subsequent psychological problems for patients during the mixed dentition period. Impaction of central incisors is less frequent than other teeth but is more serious [2].

This paper aimed to describe the successful treatment of a 10-year-old boy with an impacted maxillary left central incisor. The exposure of the tooth was performed by laser irradiation, and LLLT was used during orthodontic traction to accelerate tooth movement. Eventually, the tooth was positioned properly in the maxillary arch with acceptable occlusion and esthetically pleasing appearance. In this patient, we had to finish the treatment with a minimum overjet and overbite and proclination of lower incisors at the end of orthodontic treatment, because of Bolton discrepancy and taking caution to prevent root resorption in upper incisors. Considering the remarkable improvement in the smile arc, we decided to compromise them. Previous studies by Pinho et al, [1] and Bayram et al, [2] both evidenced successful treatment of impacted central incisors treated by surgical exposure and orthodontic traction. Furthermore, Lin [17] succeeded to treat a horizontally impacted and dilacerated maxillary central incisor through two stages of surgical exposure and orthodontic force with final proper occlusion.

In our study, exposure of the impacted teeth was conducted by irradiation of 975 nm laser to facilitate painless surgery without the use of local anesthesia and to decrease post procedural pain, bleeding, and edema [18]. Asgari et al, [6] also reported surgical exposure of a maxillary central incisor impacted within the soft tissue through sequential 0.25 W, 0.5 W and 0.75 W soft tissue laser irradiation and exhibited successful results. The patient reported no pain and discomfort after surgery. Also, impacted incisors began to erupt to their proper position after surgery. More clinical trials are needed to establish the optimal wavelength and settings of laser for safe and efficient surgical use.

In the present study, the patient received LLLT at the same time at monthly recalls to induce tooth movement. LLLT is suggested to accelerate bone remodeling via increasing osteoclastogenesis at the pressure side during orthodontic tooth movement by stimulation of RANK/RANKL system and macrophage colony-stimulating factor [11]. Machado et al. [19] reported treatment of an impacted maxillary central incisor by LLLT at 780 nm wavelength and 35 J/cm² energy density immediately after surgical exposure and also 24 and 48 h after surgery. They reported that the patient had no pain after surgery and eruption of the impacted tooth occurred after 6 months, which confirms the acceleration effect of LLLT. In the present case, the movement of impacted tooth into its proper position took 7 months, which suggests the influential effect of LLLT. Surgical tissue removal by 975 nm laser was associated with LLLT with 669 nm wavelength and 12-18 J/cm² dosage in this study, which was close to the recommended dosage in previous studies [13, 20].

For post-surgical pain reduction, infrared LLLT has been well documented as monotherapy after application of brackets. For rapid bone remodeling, lower doses and frequent irradiation sessions have been
recommended [15]. In the current case, 975 nm surgical laser had some additional biostimulatory effects [21]; while, the 660 nm red laser light promoted initial wound healing and velocity of tooth movement. Use of red laser light for this purpose is not common but has been previously reported [22]. The most pronounced effects of LLLT are seen during the first phases of healing.

The acceleration effect of LLLT during orthodontic tooth movement has been confirmed in previous studies. Yoshida et al. [11] showed that the amount of tooth movement was significantly greater in rats who received LLLT as compared with the control group without laser irradiation. Other in vivo studies, evaluating the rate of tooth movement in humans, supported the same results and recommended LLLT during orthodontic treatment, which is consonant with the result of our study [10, 12-14, 23]. In contrast, Seifi et al. [24] examined the amount of tooth movement in rabbits after LLLT at 630 nm and 850 nm wavelengths and showed opposite results and claimed that LLLT caused a reduction in the speed of tooth movement. Also, a randomized clinical trial with split-mouth design evaluated the effect of LLLT on the rate of orthodontic tooth movement and found no significant difference between the irradiated and non-irradiated sides [25].

Thus, considering the controversy on the effects of LLLT and lack of enough evidence in this context, the results of relevant studies should be interpreted with caution. A closer analysis of all relevant laser and clinical parameters is needed to reach a final conclusion regarding the effects of laser.

CONCLUSION

Combining laser irradiation for surgical exposure of impacted teeth and LLLT for acceleration of tooth movement may provide a successful approach for treatment of impacted teeth, especially with dilacerated roots, and can bring about good prognosis for such teeth. Improved periodontal, occlusal and esthetic results might be achieved, especially in young patients.

REFERENCES

1. Pinho T, Neves M, Alves C. Impacted maxillary central incisor: surgical exposure and orthodontic treatment. Am J Orthod Dentofacial Orthop. 2011 Aug;140(2):256-65.
2. Bayram M, Ozer M, Sener I. Bilaterally impacted maxillary central incisors: surgical exposure and orthodontic treatment: a case report. J Contemp Dent Pract. 2006 Sep;7(4):98-105.
3. Montalvo-Polk A, Kittle P. Impaction and malformation of a maxillary central incisor: sequela of trauma. ASDC J Dent Child. 1993;60(1):29-32.
4. Boj JR. The future of laser pediatric dentistry. J. Oral Laser Appl. 2005 Jun;5(3).
5. Kravitz ND, Kusnoto B. Soft-tissue lasers in orthodontics: an overview. Am J Orthod Dentofacial Orthop. 2008 Apr;133(4):S110-S4.
6. Asgari A, Jacobson BL, Mehta M, Pfail JL. Laser exposure of unerupted teeth. N Y State Dent J. 2007 Apr;73(3):38-41.
7. Gutknecht N, Franzen R, Vanweersch L, Lampert F. Lasers in pediatric dentistry--A review. J. Oral Laser Appl. 2005 Sep;5(4).
8. Lim HM, Lew KK, Tay DK. A clinical investigation of the efficacy of low level laser therapy in reducing orthodontic postadjustment pain. Am J Orthod Dentofacial Orthop. 1995 Dec;108(6):614-22.
9. Nimeri G, Kau CH, Abou-Kheir NS, Corona R. Acceleration of tooth movement during orthodontic treatment-a frontier in orthodontics. Prog Orthod. 2013 Dec;14(1):42.
10. Jawad MM, Husein A, Alam MK, Hassan R, Shaari R. Overview of non-invasive factors (low level laser and low intensity pulsed ultrasound) accelerating tooth movement during orthodontic treatment. Lasers Med Sci. 2014 Jan;29(1):367-72.
11. Yoshida T, Yamaguchi M, Utsunomiya T, Kato M, Arai Y, Kaneda T, et al. Low-energy laser irradiation accelerates the velocity of tooth
movement via stimulation of the alveolar bone remodeling. Orthod Craniofac Res. 2009 Nov;12(4):289-98.
12. Doshi-Mehta G, Bhad-Patil WA. Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: a clinical investigation. Am J Orthod Dentofacial Orthop. 2012 Mar;141(3):289-97.
13. da Silva Sousa MV, Scanavini MA, Sannomiya EK, Velasco LG, Angelieri F. Influence of low-level laser on the speed of orthodontic movement. Photomed Laser Surg. 2011 Mar;29(3):191-6.
14. Genc G, Kocadereli I, Tasar F, Kilinc K, El S, Sarkarati B. Effect of low-level laser therapy (LLLT) on orthodontic tooth movement. Lasers Med Sci. 2013 Jan;28(1):41-7.
15. Cronshaw M, Parker S, Anagnostaki E, Lynch E. Systematic review of orthodontic treatment management with photobiomodulation therapy. Photobiomodul Photomed Laser Surg. 2019 Dec;37(12):862-8.
16. Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The nuts and bolts of low-level laser (light) therapy. Ann Biomed Eng. 2012 Feb;40(2):516-33.
17. Lin Y-TJ. Treatment of an impacted dilacerated maxillary central incisor. Am J Orthod Dentofacial Orthop. 1999 Apr;115(4):406-9.
18. Eversole L, Rizoiu I, Kimmel A. Osseous repair subsequent to surgery with an erbium hydrokinetic laser system. International Laser Congress, International Proceedings Division Athens, Greece; 1996 Sep;25-28.
19. Machado MAAM, Sakai VT, Silva TC, Tessarolli V, Carvalho FP, Moretti ABS, et al. Therapeutic laser in surgical procedures of pediatric dentistry. J Oral Laser Appl. 2010 Sep;10(4):175-180.
20. Bradley P, Groth E, Gursoy B, Karasu H, Rajab A, Sattayut S. Lasers in medicine and dentistry: basic science and up-to-date clinical applications of Low-Energy-Level Laser Therapy (LLLT). Croatia: Vitagraf 2000:385-402.
21. Sobouti F, Khatami M, Chiniforush N, Rakhshan V, Shariati M. Effect of single-dose low-level helium-neon laser irradiation on orthodontic pain: a split-mouth single-blind placebo-controlled randomized clinical trial. Prog Orthod. 2015 Dec;16(1):1-7.
22. Yassaei S, Aghili H, Afshari JT, Bagherpour A, Eslami F. Effects of diode laser (980 nm) on orthodontic tooth movement and interleukin 6 levels in gingival crevicular fluid in female subjects. Lasers Med Sci. 2016 Dec;31(9):1751-9.
23. Domínguez A, Gómez C, Palma JC. Effects of low-level laser therapy on orthodontics: rate of tooth movement, pain, and release of RANKL and OPG in GCF. Lasers Med Sci. 2015 Feb;30(2):915-23.
24. Seifi M, Shafeei HA, Daneshdoost S, Mir M. Effects of two types of low-level laser wave lengths (850 and 630 nm) on the orthodontic tooth movements in rabbits. Lasers Med Sci. 2007 Nov;22(4):261-4.
25. Dalaie K, Hamedi R, Kharazifard MJ, Mahdian M, Bayat M. Effect of low-level laser therapy on orthodontic tooth movement: a clinical investigation. Journal of dentistry. J Dent (Tehran). 2015 Apr;12(4):249-56.