Original Article

The 808 nm Laser-Assisted Surgery as an Adjunct to Orthodontic Treatment of Delayed Tooth Eruption

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Abstract:

Introduction: Failure of teeth to erupt from gingival tissues at usual developmental time is called delayed tooth eruption (DTE). Delayed tooth eruption lead to prolonged fixed orthodontic treatment and its eventual complications. The purpose of the present study was to evaluate the effect of laser-assisted (808 nm) surgical uncovering, on the tooth emergence and orthodontic treatment of DTE.

Methods: A total of 16 orthodontic patients were included in this study and were equally assigned to an experimental and a control group. Subjects for experiment consisted of eight patients (6 girls and 2 boys) with a mean age of 14±0.9 years. All patients exhibited delayed second premolar eruption. The laser wavelength was 810 nm and it was set in a continuous wave mode at a power output of 1.6 watt with a 0.3-mm diameter fiber tip. When the target tissue was sufficiently anesthetized, the tip was directed at an angle of 10 to 20 degrees to the tissue (light contact mode); and was applied continuously for approximately 12 Seconds until an acceptable tooth exposure area was visible. The facial axis of the clinical crown (FACC) line represents the most prominent portion of the facial central lobe for premolars. All orthodontic brackets are aligned along this reference and are located on FA (Facial Axis) point. The standard for adequate tooth eruption was the accessibility of facial axis of the clinical crown (FACC) for bonding the brackets. Data gathered from the patients were statistically surveyed and compared by means of Tukey's Test and Analysis of Variance (ANOVA).

Results: All patients showed good gingival status, no significant bleeding during or immediately after the surgery, and acceptable level of healing after laser surgery. The biologic width of the teeth was preserved and no violation of this important periodontal parameter was observed. The average time for accessing the FA point in experimental group was 11±1.1 weeks and the mentioned period was increased to 25±1.8 weeks in control group. The data analysis showed that in patients with DTE, laser intervention significantly accelerated tooth eruption ($P < 0.05$).

Conclusion: Laser-assisted surgical removal of the fibrous tissue over erupting premolars (DTE) with appropriate irradiation parameters appears to be a promising adjunct to orthodontic treatment for bringing the premolar to the aligned and leveled dental arch.

Keywords: tooth eruption; laser therapy; orthodontics

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Introduction

Failure of teeth to erupt from the gingival tissues at the usual developmental time is called delayed tooth eruption (DTE). Diagnosis of DTE is sometimes complicated and its treatment in orthodontics is more complicated. DTE is used in cases where eruption is inhibited, causing an interruption in the coordination of tooth formation and tooth eruption. The phenomenon may be local or general, and several etiological factors for retarded eruption have been listed, comprising a lack of space, ankylosis, cysts, supernumerary teeth, hormone and vitamin deficiencies and several developmental disturbances and syndromes[1]. Fundamental parameters that influence DTE phenomenon are; expected tooth eruption time (chronologic age as derived from population studies), and biologic eruption (as indicated by progression of root development). Chronologic age has been used quite often to describe DTE. The advantage of using chronologic norms of eruption lies in the ease of use[2]. When the emergence of a tooth is more than 2 standard deviations (SDs) from the mean of established norms for eruption times, it should be considered delayed. Skeletal pattern of the maxilla is a useful indicator for predicting the timing of maxillary molar eruption when considering treatment of skeletal Class III malocclusions[3]. Premolars rank third in frequency after third molars and maxillary canines in impacted or unerupted teeth. The succedaneous tooth should have a viable form, eruptive potential and viable orientation. The delayed eruption may be due to over-retained primary molars such as ankylosis and incomplete root resorption. The amount of space available for the succedaneous tooth to erupt and the presence of overlying soft tissue or bone should be considered. Space management and proper management of primary molars will frequently facilitate uneventful eruption of premolars[4].

Mucosal barrier has also been suggested as an etiologic factor in DTE[5-8]. Any failure of the follicle of an erupting tooth to unite with the mucosa will entail a delay in the breakdown of the mucosa and constitute a barrier to emergence. Histologic studies have shown differences in the submucosa between normal tissues and tissues with a history of trauma or surgery[6]. Gingival hyperplasia resulting from various causes (hormonal or hereditary causes, vitamin C deficiency, drugs such as phenytoin) might cause an abundance of dense connective tissue or acellular collagen that can be an impediment to tooth eruption[9].

The progress of orthodontic treatment is often delayed by the incomplete or late eruption of teeth, because there is insufficient access to the labial surface of the tooth for bracket placement. Without laser-assisted surgery, we must either wait for the tooth to erupt completely or refer the patient to a periodontist to have the tissue removed. Either choice could add significant time to the overall treatment[10]. Duration of fixed orthodontic treatment is so crucial for those who are prone to develop carious lesions or have poor oral hygiene.

Exposure of teeth to facilitate eruption can be performed by the diode laser as an alternative to flap surgery. It can be used by orthodontists to perform cosmetic gingival contouring, frenectomy, gingivectomy, gingivoplasty, operculectomy, the removal of redundant tissue due to poor oral hygiene or space closure, removal of soft tissues to uncover temporary anchorage devices, and for the treatment of aphthous ulcers or herpetic lesions[10-14].

The purpose of the present study was to evaluate the effect of laser-assisted (808 nm) surgical uncovering, on the tooth emergence and orthodontic treatment of DTE.

Methods

A total of 16 orthodontic patients were included in this study and were equally assigned to an experimental and a control group with simple randomization and single blindness. The subjects for experiment consisted of eight patients (6 girls and 2 boys) with a mean age of 14±0.9 years (Figure 1).

All patients exhibited delayed second premolar eruption. The samples had no congenital anomalies or endocrine problems. Subjects with congenitally missing teeth, supernumerary teeth, macrodontia, or microdontia were excluded from the sample. Subjects with any apparent signs of impacted teeth (eg, failure

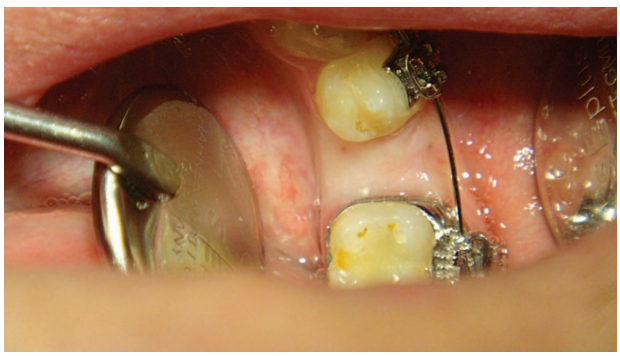

Figure 1. The space is sufficient for eruption of second premolar but clinical examination and radiographic evaluation determined a DTE condition.

of root resorption of a deciduous tooth, cysts, or odontoma) were excluded. Records of the DTE patients were compared with the age- and gender matched patients attending the orthodontic clinic as the control group. The latter patients did not receive any surgical (conventional or laser) intervention.

The laser wavelength was 810 nm and it was set in a continuous wave mode at a power output of 1.6 watt with a 0.3-mm diameter fiber tip ("Doctor Smile", Lambda Laser Products, Vicenza, Italy). The target tissue was dried and topical anesthetic agent was applied to the area with a cotton-tipped applicator and left in place for approximately 3 to 4 minutes. Also injection of a combination of local anesthetics (Lidocaine HCl 2%) along with the vasoconstrictor (Epinephrine 1:100,000) produced profound anesthesia in a relatively short amount of time with minimal amount of injection. When the target tissue was sufficiently anesthetized, the tip was directed at an angle of 10 to 20 degrees to the tissue (light contact mode); and was applied continuously with an action similar to brush strokes, "painting away" for approximately 12 Seconds until an acceptable tooth exposure area (occlusal surface) was visible and provided ideal tissue contours and a beveled gingival margin rather than an abrupt ledge (Figure 2).

Ablated tissues were removed by 2 × 2 gauze pad moistened with alcohol 97%. Once satisfactory tissue removal achieved, any remnants of slightly carbonized tissue (char layer) were removed with light pressure using micro-applicator brush or cotton-tipped applicator soaked in alcohol (Figure 3).

Patients in the experimental group were advised to keep the area clean and plaque free with gentle brushing and mouthwash chlorhexidine 0.2%.

The facial axis of the clinical crown (FACC) line represents the most prominent portion of the facial central lobe for premolars[15]. All orthodontic brackets are aligned along this reference and are located on FA (Facial Axis) point. The standard for adequate tooth eruption was the accessibility of this point on the clinical crown for bonding the brackets.

Figure 2. The laser tip was directed at an angle of 10 to 20 degrees to the tissue in light contact mode and was applied continuously for approximately 12 Seconds until the acceptable exposure area of tooth was visible.

Figure 3. Once satisfactory tissue removal achieved, any remnants of slightly carbonized tissue remaining (char layer) were removed with light pressure using micro-applicator brush or cotton-tipped applicator soaked in alcohol.

Data gathered from the patients were statistically surveyed and compared by means of Tukey's Test and Analysis of Variance (ANOVA).

Results

All patients showed good gingival status, no significant bleeding during or immediately after the surgery, and acceptable level of healing after laser surgery. The biologic width of the teeth was preserved and no violation of this important periodontal parameter was observed (Figure 4,5).

The average time for accessing the FA point in experimental group was 11±1.1 weeks and the mentioned period was increased to 25±1.8 weeks in control group. The data analysis showed, in patients with DTE; laser intervention accelerated the tooth eruption significantly ($P< 0.05$) (Figure 6).

Figure 4. After 2 weeks, occlusal surface of the second lower premolar tooth is apparent inside the mouth.

Figure 5. Since the second premolar is rotated and buccolingual aspect of the tooth occupies more space than its mesiodistal, a push coil can be used to create extra space for tooth eruption.

Figure 6. The FA point is accessible and orthodontic bracket can be placed in proper position.

The average rate of tooth movement was more observable within the first four weeks following the surgical intervention which did not have a significant difference with the remaining time of the experiment (P =0.357). Varieties of outcomes exist among the DTE patients that should be taken into account.

Discussion

Authors could not find any similar study to the present research to evaluate the effect of laser-assisted (808 nm) surgical uncovering, on the tooth emergence and orthodontic treatment of DTE.

In most cases, adequate soft tissue anesthesia required for removal of soft tissue by laser surgery is obtained via application of a compound topical anesthetic gel such as TAC 20% (Lidocaine 20%, tetracaine 4%, and phenylephrine 2%) or Profound PET (prilocaine 10%, lidocaine 10%, tetracaine 4%, and phenylephrine 2%)[16-18]. In the present study, topical anesthetic agent was applied to the area and left in place for approximately 3 to 4minutes. Then a combination of local anesthetics (Lidocaine HCl 2%) along with the vasoconstrictor (Epinephrine 1:100,000) was injected. Use of such combination produced profound anesthesia in a shorter time with minimal amount of injection.

Careful attention must be paid to the interaction of the laser energy with the target tissue. Leaving the fiber tip for a long time in one spot will result in carbonization and unnecessary collateral damage. On the other hand, moving the tip too quickly will result in an insufficient absorption of energy to produce ablation[19]. In our experiment, when the target tissue was sufficiently anesthetized, the tip was directed at an angle of 10 to 20 degrees to the tissue (light contact mode); and was applied continuously for approximately 12 seconds until the acceptable exposure area of tooth was visible. Laser wavelength can be related to collateral tissue damage. In general, the shorter wavelengths are more likely to penetrate deeper into soft tissues. To avoid unintended consequences, the least amount of power required to achieve the desired clinical result should be chosen. Hard tissues and periosteum subjacent to thin oral mucosa (thin biotype), the gingival margin, or gingiva overlying prominent roots, are particularly vulnerable to thermal insult[20,21]. Authors used 808 nm laser and tissue was removed with an action similar to brush strokes, “painting away” the desired amount with the fiber tip held at various angles to provide ideal tissue contours and a beveled gingival margin rather than an abrupt ledge.

By using the aforementioned intervention we found in our study that at least twelve weeks can be save on average that can be reduced from overall treatment time.

Differential diagnosis is very important in different type of DTE. The high metabolic demand on the growing tissues might influence the eruptive process[22]. Disturbance of the endocrine glands usually has a profound effect on the entire body, including the dentition. Hypothyroidism, hypopituitarism, hypoparathyroidism, and pseudohypoparathyroidism are the most common endocrine disorders associated with delayed tooth eruption. DTE has been found to be a feature in many genetic disorders and syndromes. Various mechanisms have been suggested to explain DTE in these conditions. A generalized developmental

delay in permanent tooth formation is seen in Apert syndrome[23,24]. Supernumerary teeth have been found to be responsible for DTE in Apert syndrome, cleidocranial dysostosis[25], and Gardner syndrome[26].

In general, dental eruption has the least correlation with the chronological events and skeletal measurements. In addition, individuals have vast diversities from the dental development perspective and etiologic factors like physical barriers can be added to this dispersion to make the image more complicated. Mesial migration of first permanent molars or rotation of erupting premolars and their buccolingual position instead of mesiodistal situation (premolars are wider in buccolingual aspect) can interfere in their eruption even when a laser-assisted surgery has removed the overlying fibrous tissue following early extraction of second primary molar. As a general rule, space should be created for the mentioned instances, biological width should be considered, and the intervention should be conducted in right time for right patient.

Conclusion

Within the limitations of this study, Laser-assisted surgical removal of the fibrous tissue over the erupting premolars (DTE) with the proposed irradiation parameters appears to be a promising adjunct to orthodontic treatment for bringing the premolar to the aligned and leveled dental arch that is the main orthodontic objective.

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