Er:YAG laser for the aesthetic treatment of developmental enamel defects in frontal teeth: a case report

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Background and aims: Several studies highlighted how the ameloblasts, secretory cells responsible of the tooth enamel formation, are highly sensitive to changes in their environment. Due to enamel maturation, their dysfunctions during a limited period of tooth development may lead to permanent morphological consequences, namely Developmental Enamel Defects (DED). The aim of this study was to show the advantages of Er:YAG laser for DED treatment.
Subjects and methods: The case report presented describes the treatment, by Er:YAG laser, of some DED lesions present in the upper incisors of a young patient. The settings used were: 1W power, 100mJ energy, 10 Hz frequency corresponding to a Fluence of 0.318 J/cm^2 per pulse or 3, 18 J/cm^2.
Results: The patient, even in absence of local anesthesia, did not feel any pain or discomfort during and after intervention. Follow-up at 2, 6 and 12 months did not show any problems in an aesthetic point of view as well as regarding hypersensitivity.
Conclusions: The use of Er:YAG laser for the treatment of developmental enamel defects in frontal teeth is a safe, painless and minimally invasive; moreover, it is able to assure a good aesthetic result.

Key words: developmental enamel defects • Er:YAG laser, amelogenesis imperfecta • conservative dentistry • esthetic dentistry.

Introduction

Several studies highlighted how the ameloblasts, secretory cells responsible of the tooth enamel formation, are highly sensitive to changes in their environment. Due to enamel maturation, their dysfunctions during a limited period of tooth development may lead to permanent morphological consequences, namely Developmental Enamel Defects (DED). [1)]

Historically, a wide variety of terms and definitions has been used for describing DED, some of them simply descriptive while others linked to the causative agent, e.g., fluoride [2)]: the simplest classification is based on the presence of quantitative defects (hypoplasia) or qualitative defects (hypo-mineralization), sometimes present in the same lesion at the same time. [3)]

To clarify the definition, an FDI working group was established in 1982 and DED index was finally presented in 1992, classifying DED in three types: demarcated opaqueness, diffuse opaqueness, and hypoplasia.

Hypoplasia is defined as a quantitative defect of enamel involving the surface, with reduced thickness of the enamel. The defective enamel may occur as shallow or deep pits, rows of pits arranged horizontally or as small or large, wide or narrow grooves.

Opacity is defined as a qualitative defect of enamel, and it is identified, i.e., as an enamel hypo-mineralization and visually appreciated as an abnormality in the translucency of enamel. While a white or discolored area is characteristic, the enamel surface appears smooth and its thickness normal. Two different kinds of opaqueness may be distinguished: a demarcated opaqueness with a distinct and clear boundary into the adjacent normal enamel, white, cream, yellow or brown in color and a diffuse opacity with a linear, patchy or confluent distribution, without clear boundary into the adjacent normal enamel [2)].

Amelogenesis Imperfecta (AI) is a hereditary develop-

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mental disorder which affects the structure of enamel of all, or nearly all, the teeth in a more or less equal manner [4] and its prevalence has been reported to range from 1.4:1000 to 1:16,000, depending on the population studied [5].

The stage of enamel formation determines the aspect of the lesion: hypoplastic (thin enamel, surface pitting or vertical grooving), hypo-mineralized (soft enamel), or hypo-mature (mottled/opaque/altered enamel translucency). Hypo-mineralization and hypoplastic defects can coexist in the same patient and even in the same tooth [4].

All affected teeth are often discolored, creating aesthetic problems in addition to sensitivity, tooth

wear, loss of vertical dimension of occlusion, increased calculus formation, and the need for lifelong dental care.

The role of fluoride has been well documented for both of its benefits and detrimental effects on the dentition since long [6]. The detrimental effect caused by fluoride on teeth is usually in the form of dental fluorosis (DF) which is commonly seen as discoloration of teeth. Enamel discoloration in maxillary anterior teeth often raises the esthetic concerns in patients.

The prevalence of children and adolescents with DF ranges between 4% and 70%, with the mild forms being the most common [7-9]. Mild fluorosis enamel is characterized by narrow, diffuse, poorly demarcated and bilateral white lines and by an increase in the subsurface porosity [10-12]. The most severe forms may gain a yellow/brown coloration and the enamel may present pre-eruptive or post-eruptive breakdown, which leads to a greater susceptibility to dental caries. DF can occur in both the primary and permanent teeth [9, 13-15].

Er:YAG laser represents a good device for conservative use: it is well absorbed by water and hydroxyapatite and, for this reason has a low penetration in the tissues and, consequently, great respect for them [16].

The aim of this clinical case report is to demonstrate the advantages, in terms of aesthetic results and of minimally invasive technique, observed with the use of Er:YAG laser during the treatment of hypoplastic lesions in the frontal teeth.

Subjects and methods

Clinical case

The patient A.N., a 15 years woman, came to our clinics because of the white spots present on teeth 1.1, 2.1 and 2.2 requiring the correction of her defect causing important aesthetic problems **(Fig. 1)**.

It was decided to remove, by means of Er:YAG laser device, the surface coat of the lesions and to subsequently apply a layer of composite resin; after explaining the technique, the informed consent was signed by the parents, due the youth age of the patient.

The choice of the laser wavelength was oriented by its great absorption by water and hydroxyapatite, and consequently by the possibility to precisely control the removal of dental tissues, so limiting the ablation to the necessary volume and to preserve the healthy enamel.

The LiteTouch laser (Light Instruments, Israel), emitting at 2940 nm, with the handpiece AS7825X and the sapphire tip AS7073X (1.0 x 14 mm) was used.

This is a particular device where the optical reson2tor is located very close to the handpiece, in this way avoiding the problems related to the delivery system of the laser beam.

The settings used were: 1W power, 100mJ energy, 10 Hz frequency corresponding to a Fluence of 0.318 J/cm^2

Fig. 1: Clinical view of the upper incisors with white spots.

Fig. 2: The beginning of laser irradiation.

per pulse or 3,18 J/cm^2 per second. This low fluence was used to respect the minimal invasiveness of this procedure

The laser irradiation for removing the hypoplastic enamel **(Figs. 2 and 3)** performed under an air/water spray, had a duration of 84 seconds and the patient, even in the absence of local anesthesia, did not feel any pain or discomfort.

Orthophosphoric acid was then applied to the treated area and the restoration was completed with composite resin **(Fig. 4)**.

The follow-up at 2, 6 and 12 months did not show any problems in an aesthetic point of view as well as regarding hypersensitivity.

Discussion

The treatment of enamel lesions is justified, beyond the necessity to improve the esthetic aspect, also for reducing the possibility of carious lesions further formation.

In fact, Kühnisch and co-workers [17] demonstrated a significant relationship between caries and demarcated hypo-mineralized lesions, including MIH (molar-incisor hypo-mineralization), in the permanent dentition of 15-year-olds.

A possible explanation may be that individuals with demarcated hypo-mineralized lesions (DHL) sensitive molars are more susceptible to carious lesion development as they avoid cleaning their molar teeth appropriately allowing plaque accumulation and increasing caries risk. Another fact could be that the surface of the hypo-mineralized enamel may promote bacterial adhesion; even on 'intact' surfaces, the pores' size is increased which facilitates the invasion by cariogenic bacteria throughout the enamel and dentine, putatively increasing sensitivity [18]. Furthermore, teeth with post-eruptive enamel breakdown are at higher risk of lesion development due to the difficulty of cleaning these hypersensitive teeth [19].

In these last years, many kinds of treatment were proposed for enamel defects treatment.

Conservative non restorative methods such as casein-phospho-peptide-amorphous-calcium- phosphate (CPP-ACP) have been mentioned in the literature in treating such discolorations and hypo-mineralized enamel structures [20-22].

Micro-abrasion involves mild acid etching in combination with rotary application of an abrasive component which was first described by Dr. Walter Kane (Colorado Springs, 1916). In this method, the teeth were treated with hydrochloric acid under the alcohol flame aiming to treat enamel fluorosis [23, 24].

The technique was rejected by the clinicians for the reason of damaging or destroying the enamel by such invasive way using strong acid (HCl) and alcohol flame [25, 26]. The new modified micro-abrasion method was introduced by Mc Closkey in 1984 where acid was combined with pumice, hence avoiding the flame and it was named as micro-abrasion by Croll in 1986 [27].

The concept behind this less invasive method is based on the stains being present due to the affected outer layers of enamel. These layers if removed or treated can result in a more smooth and glassy enamel surface which is caries resistant than the original enamel.

The recently available re-mineralizing agent CPP-ACP stabilizes a high concentration of calcium and phosphate ions that bind themselves to the available plaque and pellicle [22]. Under the acid challenge, the reservoir thus created maintains a supersaturated mineral environment, thereby reducing demineralization and enhances remineralization of enamel. [28] CPP-ACP supplementation has proved to have beneficial effects by re-mineralizing

Fig. 3: Clinical aspect of teeth after laser irradiation.

Fig. 4: Aesthetic result at the end of the procedure..

the enamel affected by hypoplasia, resulting in an esthetic improvement too. Unfortunately, this technique requires longtime treatment that could last months or years, requiring the patient's cooperation [27].

The technique here proposed is very fast, it may be performed in one only session is painful, low-invasive and allows reaching a very esthetic restoration; moreover, the association of erbium laser and acid etching assures a strong adhesion between composite resin and enamel, so preventing the risk of micro-leakage and consequently, the carious lesions' formation.

Conclusions

The use of Er:YAG laser for the treatment of developmental enamel defects in frontal teeth is a safe, painless and minimally invasive, giving, at the same time, good aesthetic results.

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