

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

Carlo Fornaini ^{1, 2, 3}, Jean-Paul Rocca ^{1, 2}, Naiwen Xu ², Elisabetta Merigo ^{1, 2}

1: UFR Odontologie, MicOralIS Laboratory EA 7345, Faculty of Dentistry, Université Côte d'Azur, Nice, France

2: Dept. of Stomatology, Shijiazhuang 2nd Hospital, Hebei Province, China

3: Group of Applied ElectroMagnetics, Faculty of Engineering and Architecture, University of Parma, Italy

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/cm² per pulse or 3, 18 J/cm².

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-

Addressee for Correspondence:

Carlo Fornaini
UFR Odontology, MicOralIS Laboratory EA 7345, Université
Nice Côte d'Azur, 24 Avenue des Diables Bleus, 06357 Nice
Cedex 4 (France)
Email: carlo@fornainident.it

Received date: January 16th, 2019

Accepted date: April 6th, 2019

CASE REPORT

mental disorder which affects the structure of enamel of all, or nearly all, the teeth in a more or less equal manner⁴⁾ and its prevalence has been reported to range from 1.4:1000 to 1:16,000, depending on the population studied⁵⁾.

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 tooth⁴⁾.

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 long⁶⁾. 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 common⁷⁻⁹⁾. Mild fluorosis enamel is characterized by narrow, diffuse, poorly demarcated and bilateral white lines and by an increase in the subsurface porosity¹⁰⁻¹²⁾. 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 them¹⁶⁾.

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 resonator 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/cm² per pulse or 3,18 J/cm² per second. This low fluence was



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



Fig. 2: The beginning of laser irradiation.

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-workers¹⁷⁾ 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 sensitivity¹⁸⁾. Furthermore, teeth with post-eruptive enamel breakdown are at higher risk of lesion develop-

ment due to the difficulty of cleaning these hypersensitive teeth¹⁹⁾.

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 structures²⁰⁻²²⁾.

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 1986²⁷⁾.

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 pellicle²²⁾. 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.

References

- 1: Opydo-Szymaczeka J, Gerreth K, Borysewicz-Lewicka M, Pawlaczyk-Kamieńska T, Torlińska-Walkowiak N, Śniatała R: Enamel defects and dental caries among children attending primary schools in Poznań, Poland. *Adv Clin Exp Med*. 2018; 27(11):1535-1540. doi: 10.17219/acem/73794. PubMed PMID: 30066500.
- 2: Kobayashi TY, Vitor LLR, Carrara CFC, Silva TC, Rios D, Machado MAAM, Oliveira TM: Dental enamel defect diagnosis through different technology-based devices. *Int Dent J*. 2018; 68(3):138-143. doi: 10.1111/idj.12350. Epub 2017 Nov 23. PubMed PMID: 29168574.
- 3: Jälevik B, Szegarty-Matei A, Robertson A: The prevalence of developmental defects of enamel, a prospective cohort study of adolescents in Western Sweden: a BarnITAnadvar-den (BITA, children in dental care) study. *Eur Arch Paediatr Dent*. 2018; 14. doi: 10.1007/s40368-018-0347-7. [Epub ahead of print] PubMed PMID: 29761341; PubMed Central PMCID: PMC5976686.
- 4: Crawford PJ, Aldred M, Bloch-Zupan A: Amelogenesis imperfecta. *Orphanet J Rare Dis*. 2007; 4: 2-17. Review. PubMed PMID: 17408482; PubMed Central PMCID:PMC1853073.
- 5: Seow WK: Developmental defects of enamel and dentine: challenges for basic science research and clinical management. *Aust Dent J*. 2014; 59, Suppl 1:143-154. doi: 10.1111/adj.12104. Epub 2013 Oct 27. Review. PubMed PMID: 24164394.
- 6: Bailey RW, Christen AG: Effects of a bleaching technic on the labial enamel of human teeth stained with endemic dental fluorosis. *J Dent Res* 1970; 49:168-70.
- 7: Cochran JA, Ketley CE, Arnadottir IB, et al. A: comparison of the prevalence of fluorosis in 8-year-old children from seven European study sites using a standardized methodology. *Community Dent Oral Epidemiol*. 2004; 32(Suppl 1): 28-33.
- 8: da Cunha LF, Tomita NE: Dental fluorosis in Brazil: a systematic review from 1993 to 2004. *Cad Saude Publica*. 2006; 22(9): 1809-1816.
- 9: Whelton HP, Ketley CE, McSweeney F, O'Mullane DM: A review of fluorosis in the European Union: prevalence, risk factors and aesthetic issues. *Community Dent Oral Epidemiol*. 2004; 32(Suppl 1):9-18.
- 10: Aoba T, Fejerskov O: Dental fluorosis: chemistry and biology. *Crit Rev Oral Biol Med*. 2002; 13(2):155-170.
- 11: Beltran-Aguilar ED, Barker L, Dye BA: Prevalence and severity of dental fluorosis in the United States, 1999-2004. *NCHS Data Brief*. 2010; 53:1-8.
- 12: Abanto Alvarez J, Rezende KM, Marocho SM, Alves FB, Celiberti P, Ciampini AL: Dental fluorosis: exposure prevention and management. *Med Oral Patol Oral Cir Bucal*. 2009; 14(2):E103-E107.
- 13: DenBesten PK: Biological mechanisms of dental fluorosis relevant to the use of fluoride supplements. *Community Dent Oral Epidemiol*. 1999; 27(1):41-47.
- 14: Beltrán-Aguilar ED, Barker L, Dye BA: Prevalence and severity of dental fluorosis in the United States, 1999-2004. *NCHS Data Brief*. 2010; 53:1-8.
- 15: Denbesten P, Li W: Chronic fluoride toxicity: dental fluorosis. *Monogr Oral Sci*. 2011; 22:81-96.
- 16: Fornaini C: Er:YAG and adhesion in conservative dentistry: clinical overview. *Laser Ther*. 2013; 22(1):31-5. PubMed PMID: 24155547; PubMed Central PMCID: PMC3799049.
- 17: Kühnisch, J, Kabary, L, Malyk, Y, Rothmaier, K, Metz, I, Hickel, R, ... Standl, M: Relationship between caries experience and demarcated hypomineralised lesions (including MIH) in the permanent dentition of 15-year-olds. *Clinical Oral Investigations*. 2017; 22(5), 2013-2019. doi:10.1007/s00784-017-2299-4
- 18: Americano GC, Jacobsen PE, Soviero VM, Haubek D: A systematic review on the association between molar incisor hypomineralization and dental caries. *Int J Paediatr Dent* 2017; 27(1): 11-21. https://doi.org/10.1111/ipd.12233
- 19: Crombie FA, Manton DJ, Palamara JE, Zalzniaik I, Cochrane NJ, Reynolds EC: Characterization of developmentally hypomineralised human enamel. *J Dent* 2013; 41(7):611-618. https://doi.org/10.1016/j.jdent.2013.05.002
- 20: Croll TP, Cavanaugh RR: Enamel color modification by controlled hydrochloric acid-pumice abrasion. I. Technique and examples. *Quintessence Int* 1986;17:81
- 21: Sundfeld RH, Croll TP, Briso AL, de Alexandre RS, Sundfeld Neto D: Considerations about enamel microabrasion after 18 years. *Am J Dent* 2007;20:67-72.
- 22: McKay FS, Black GV: An investigation of mottled teeth: An endemic developmental imperfection of the enamel of the teeth, heretofore unknown in the literature of dentistry. *Dent Cosm* 1916; 58:477-84.
- 23: Lynch CD, McConnell RJ: The use of microabrasion to remove discolored enamel: A clinical report. *J Prosthet Dent* 2003; 90:417-9.
- 24: Croll TP: A case of enamel color modification: 60-year results. *Quintessence Int* 1987; 18:493-5.
- 25: Balan B, Uthaiiah CM, Narayanan S, and Monnappa PM. Microabrasion: An Effective Method for Improvement of Esthetics in Dentistry. *Case Reports in Dentistry* 2013. p4. Article ID 951589.
- 26: McCloskey RJ: A technique for removal of fluorosis stains. *J Am Dent Assoc* 1984; 109:63-4.
- 27: Croll TP: Enamel microabrasion: The technique. *Quintessence Int* 1989; 20:395-400.
- 28: de Vasconcelos AA, Cunha AG, Borges BC, Vitoriano Jde O, Alves-Júnior C, Machado CT, et al: Enamel properties after tooth bleaching with hydrogen/carbamide peroxides in association with a CPP-ACP paste. *Acta Odontol Scand* 2012; 70:337-43.