Published online: 2019-09-04

The use of Erbium: Yttrium-aluminum-garnet laser in cavity preparation and surface treatment: 3-year follow-up

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ABSTRACT

From the currently available choices, esthetic restorative materials for posterior teeth are limited to composite and ceramic restoration. Ceramic inlays/onlays are reliable solutions for both of these treatments. For successful treatment planning, usable ceramic and adhesive systems should be chosen by the dentist. Since the Federal Drug Administration approval of the erbium: Yttrium-aluminum-garnet (Er:YAG) laser-for caries removal, cavity preparation and the conditioning of tooth substance-in 1997, there have been many reports on the use of this technique in combination with composite resins. In addition, cavity pretreatment with the Er:YAG laser (laser etching) has been proposed as an alternative to acid etching of enamel and dentin. This case report presents the use of the Er:YAG in cavity preparation for composite resin restoration and surface treatment for ceramic onlay restoration of adjacent permanent molars.

Key words: Ceramic onlay, erbium: Yttrium-aluminum-garnet laser, laser etching

INTRODUCTION

Selecting the right treatment option is often the most challenging step in the restorative phase. The continued evolution of dental materials has significantly increased the clinician's alternatives. The composite or ceramic restorations are esthetic restorative materials used for posterior teeth. Directly placed composite restorations are most operators' preferable treatment solutions. However, if an inexperienced operator overlooks their manipulation procedures, it can cause open proximal contacts, inadequate marginal adaptation and bulk fracture. In addition, postoperative sensitivity can occur. On the other hand, in a careful treatment, direct resin composites work extremely well and can be rewarding for both the patient and the treating dentist. The other treatment option is an indirect resin composite (IRC). IRCs offer the patient better stress distribution[1] and are less expensive than ceramic materials. Several researches have reported that IRCs present a good success and survival rate; however, their common disadvantage, as mentioned in the literature, is their unpredictable color stability and translucency.[2,3] Over the last few years, ceramic systems have advanced in dentistry. Ceramic inlays/onlays offer the opportunity to conserve tooth structure while taking advantage of the mechanical benefits of modern adhesive technology. Ceramic onlays offer a preferable alternative to resin composite restorations.

The adhesive restorative procedures are also an extremely important step in the bonding protocol. The clinical success of the dental restorations depends on the chemistry of the adhesive, the clinical application of the material and the knowledge of the morphological changes. Etch-and-rinse systems have been shown to be efficient strategies for smear layer removal and for exposing open dentinal tubules and a thin

How to cite this article: Buyukhatipoglu I, Secilmis A. The use of Erbium: Yttrium-aluminum-garnet laser in cavity preparation and surface treatment: 3-year follow-up. Eur J Dent 2015;9:284-7.

DOI: 10.4103/1305-7456.156843

superficial layer of demineralized intertubular dentin.[4] Nevertheless, a disadvantage attributed to acid etching is the demineralization of tooth structures, making them more permeable and prone to acid attacks, especially if the demineralized substrates are not completely filled with adhesive resins.[5] In order to overcome this limitation, new investigations point to alternative techniques that could produce better effects than acids. Among these innovations for dentinal surface treatment, the use of lasers has been widely advocated.[6,7]

The erbium: Yttrium-aluminum-garnet (Er:YAG) laser has been well investigated for the ablation of dental hard tissues. Ablation efficiency was evaluated by crater shape and mass loss measurements. The surface quality was observed by light and scanning electron microscopy.[8,9] The Er:YAG laser emits a wavelength (2940 nm) that coincides with the main absorption band of water and is also well absorbed in hydroxyapatite.[5] It is also particularly popular for removing caries and preparing micro-cavities with minimally invasive dentistry[10] or minimal intervention dentistry.[11] This wavelength is a good candidate for the safe and effective treatment of dentin surfaces, removing the smear layer – similar to acid etching – opening dentinal tubules and creating a microscopically rough surface with a micromechanical retention pattern, which is apparently ideal for adhesion.[5,12-14] Additionally, laser surface modification results in a good adhesion of the filling material, eliminating the need for acid etching, according to some recent reports published in the literature.[15,16]

In this case report, we presented an Er:YAG laser-assisted cavity preparation and an Er:YAG etching for adjacent posterior molars step by step and with a 3-year follow-up.

CASE REPORT

A 32-year-old male patient without specific problems visited our clinic for his old fractured amalgam restoration. He also reported sensitivity in his posterior region. In clinical examination, a fractured amalgam restoration was detected on the right mandibular first molar (36) and dentin caries on the right mandibular second molar (37) [Figure 1a]. Radiographic examination revealed healthy periapical tissues. The teeth were vital in the clinical vitality test, and he had moderate oral hygiene with no parafunctional habits.

At the beginning of the treatments, the effects, benefits and possible risks and complications of the Er:YAG laser treatment were explained in understandable terms to the patient. The treatment options were discussed with the patient. A ceramic onlay for 36 and a composite restoration for 37 were planned.

The treatment was applied under local anesthesia (Jetokain 2 ml, Adeka, Istanbul, Turkey). Fractured amalgam restoration was removed with a bur and a high-speed dental turbine [Figure 1b]. Cavity preparation was completed conventionally for ceramic onlay restoration. Impression was taken using the polyether impression material (Impregum Penta H DuoSoft and Impregum Garant L DuoSoft, 3M ESPE, Dubai, UAE) [Figure 2a]. Interocclusal registration was performed, and the temporary restoration (Systemp c and b II, Ivoclar Vivadent AG, Liechtenstein, EU) was placed.

At the second appointment, the Er:YAG laser (Fidelis Plus III, Fotona DD, Slovenia, EU) was used for composite and caries removal and surface treatment of 37 [Figure 3a and b]. A contact handpiece (R14) with a cylindrical tip (1.3 mm in diameter) was used. The laser parameters were as follows: Composite removal: MSP mode, 300 mJ, 30 Hz, 9 W, water: +, air: +; dentin ablation: MSP mode, 200 mJ, 20 Hz, 4 W, water: +, air: +; caries profunda ablation: SP mode, 175 mJ, 20 Hz, 3.5 W, water: 5, air: +; and surface conditioning: MSP mode, 120 mJ, 10 Hz, 1.2 W, water: +, air: +. After cavity preparation with the Er:YAG laser (37), a self-etching primer and bonding system (Clearfil SE Bond, Kuraray Co. Ltd., Japan) was applied to the dentin according to the manufacture's recommendations. The cavity was filled with Filtek™ Z250 Universal Restorative (3M ESPE Dental Products, MN, USA). Occlusion was checked with articulating paper, and restoration surfaces were polished with Sof-Lex™ Contouring and Polishing Discs (3M ESPE Dental Products, MN, USA) [Figure 3c].

At the same appointment, the temporary restoration was removed and the compatibility of lithium disilicate glass-ceramic (IPS e-max Pess, IvoclarVivadent AG, Schaan Liechtenstein) [Figure 2b] onlay was checked and glazed. The Er:YAG laser was used for surface treatment of 36 [Figure 2c]. The laser parameters were as follows: Surface conditioning: MSP mode, 120 mJ, 10 Hz, 1.2 W, water: +, air: +. No additional acid etching was applied for conditioning the enamel and dentine. The inner surface of the ceramic restoration was etched by IPS Empress Ceramic Etching Gel (IvoclarVivadent AG, Schaan, Liechtenstein) and silaned by Monobond Plus (IvoclarVivadent AG, Schaan Liechtenstein). Onlay restoration was cemented by a dual-curing luting composite system (Variolink II, IvoclarVivadent AG, Schaan Liechtenstein), and occlusion was checked [Figure 2d].

The patient was recalled 1-day, 6 months, 12 months, 2 years and 3 years after the treatment [Figure 4]. No marginal discoloration, recurrent decay, composite clefting or ceramic chipping was detected. The patient reported high functionality with no complications and no sensitivity.

DISCUSSION

There are certain advantages in bonding to an Er:YAG-lased dentin because of an apparently enlarged surface area for adhesion based on the scaly and flaky surface appearance.[17] Giray et al. evaluated the bond strength of resin cements to lute ceramics on Er:YAG laser-etched dentin and reported that lasers may provide comparable ceramic bond strengths, depending upon the adhesive cement used.[18]

The absence of a smear layer formation during the preparation of the superficial dentin by the Er:YAG laser may explain the improved adhesion values of self-etching adhesive systems.[19] Jiang et al. reported that the Er:YAG laser-prepared dentin can perform as well as a bur on TBS, and some of the one-step one-bottle adhesives are comparable to the total-etch adhesives in TBS on dentin.[20] In this case report, self-etching dental adhesive showed acceptable clinical performance during the three-year follow-up.

It is not easy to compare the laser parameters because different laser parameters, such as as output and

Figure 1: (a and b) Fractured amalgam restoration on the right mandibular first molar (36) and the secondary caries on the mesial side of the right mandibular second molar (37)

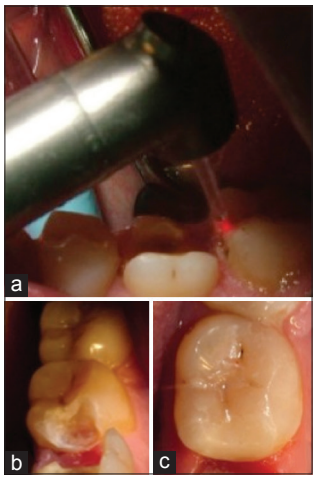

Figure 3: (a) Erbium: Yttrium-aluminum-garnet laser was used for composite and caries removal and surface treatment. (b) Cavity preparation. (c) Completed composite restoration

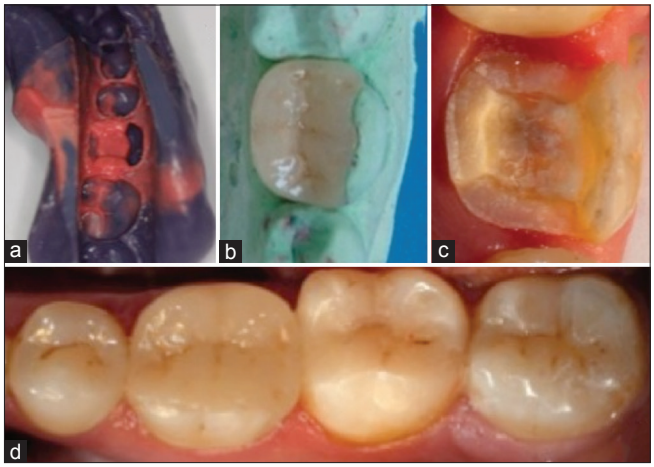

Figure 2: (a) Impression. (b) Ceramic onlay. (c) Surface treatment with erbium: Yttrium-aluminum-garnet laser. (d) Completed onlay restoration

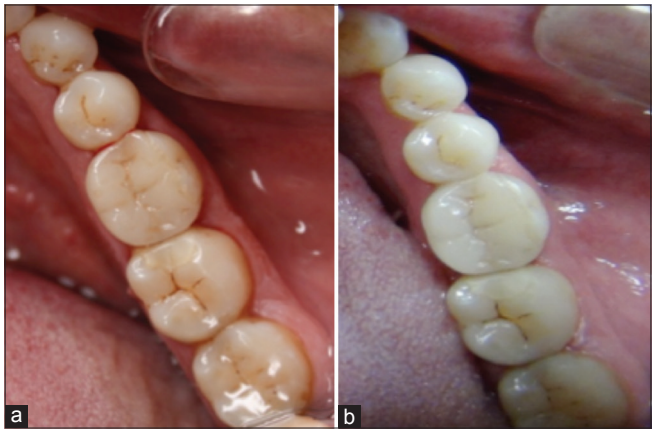

Figure 4: (a) Two years after treatment. (b) Three years after treatment (mirror image)

distance, can alter the effect of laser treatments. It is important to choose parameters to ablate the tooth tissue, otherwise, undesirable modifications, which negatively affect the bond strength between restorative materials and the tooth, in dentin collagen after laser irradiation can occur.[21] In the present case, settings were set according to the laser manufacturer's recommendations.

CONCLUSION

Although the observation time was limited to 3 years and just one case report was considered, the clinical performance of ceramic onlay and composite restoration assisted by the Er:YAG laser was acceptable.

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Quick Response Code:	Website: www.eurjdent.com
	Source of Support: Nil. Conflict of Interest: None declared