Er, Cr: YSGG in laser-assisted aesthetic rehabilitation: A case report.

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Introduction

The Er, Cr: YSGG laser is beyond doubt a very helpful tool in the hands of a trained practitioner in everyday practice. It can be used safely both for hard- and soft-tissue treatment, with minimal or no use of anaesthetic. Patients are always positive about and eager to undergo laser treatment owing to the comfort they enjoy compared to classical treatments.

The following case report details the case of a young female patient aged 28 who visited the postgraduate dental clinic at the Department of Operative Dentistry of the Aristotle University of Thessaloniki in Greece complaining about the colour of her teeth. After obtaining the medical and dental anamnesis of the patient, clinical and radiographic examination was performed to address any therapeutic (caries, periodontal or endodontic) problems.

During anamnesis, it was mentioned that the patient had undergone tooth whitening in a private dental office three to four years ago, but observed that the whitening result had not lasted. Clinical examination revealed old Class IV restorations with visible discolouration. The patient was informed that composite restorations cannot be whitened and replacement after tooth whitening would be necessary. It was also observed that the patient’s smile extended up to the first premolars in both the maxillae and mandible. Moreover, soft-tissue melanchorosis was visible in several areas of patient’s gingivae. Clinical and radiographic examination found no problems concerning the posterior teeth.

Er, Cr: YSGG-assisted tooth whitening

Discoloured teeth are a common concern of patients in modern society, as aesthetic demands rise constantly and people dream of a bright white smile. In order for dentists to keep up with these needs, aesthetic dentistry is constantly evolving, as new materials and techniques are introduced, giving us the opportunity to implement them in our offices. These range from conservative to invasive and include composite veneers, porcelain veneers, all-ceramic crowns and tooth whitening. Since...
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Fig. 3. The whitening agent.
Fig. 4. Laser whitening.
Fig. 5. The silicone key.
Fig. 6. The final situation after laser treatment.
Fig. 7. Laser treatment of the soft-tissue melanosis.
Fig. 8. Soft-tissue melanosis in the mandible.
Fig. 9. Rubber dam placement.
Fig. 10. Silicone key adjustment.
Fig. 11. Additional etching with 37% phosphoric acid.
dental tissue is unable to regenerate, dentists should suggest the most conservative treatment that meets the patient’s needs, allowing for procedures that are more invasive in the future.

Tooth whitening is the process through which a dentist alters the colour of the patient’s teeth to appear whiter and brighter, and is considered one of the most conservative procedures in the field of aesthetic dentistry. This is made possible using various techniques and oxidising whitening agents to eliminate tooth discolouration. The main oxidising agents used are hydrogen peroxide in concentrations of 30–35% and carbamide peroxide in concentrations of 10–22%. The decomposition of these agents produces hydroperoxyl free radicals with a high whitening capability.

It is known that heating hydroxyl or carbamide peroxide accelerates its decomposition rate. By increasing the whitening agent’s temperature by 10°C, the speed of the decomposition is doubled. At this point, more hydroperoxyl free radicals are released and then the free radicals penetrate the porosities in the rodlike crystal structure of enamel and oxidise the inter-prismatic stain deposits.

Many different light sources, both coherent and incoherent, have been used to increase temperature during tooth whitening (e.g. plasma arc lamps, halogen lamps, light-emitting diodes and lasers). The advantages of the use of laser in tooth whitening include the speed of the procedure, the comfort of the patient and minimal to no post-treatment discomfort and sensitivity, which are often encountered in light-activated tooth whitening with incoherent light sources (e.g. plasma lamps). In a pulsed-mode operated laser, these advantages are more apparent owing to the fact that bursts of energy are directed to the whitening agent in a very short period, thus giving enough time for heat dissipation in the tissue and relief for the patient.

In order to achieve the best clinical results without harming teeth, it is crucial to follow the procedure carefully and to take all safety measures. Before starting the first session, the patient was informed that the result of the procedure is not permanent and is dependent on the age of the patient, the use of tobacco and extrinsic staining by the deposition of tannins found in coffee, red wine, tea and cola beverages. The average duration expectancy is three to four years for non-smokers. The patient was also informed that, if tooth sensitivity or pain was felt during tooth whitening, treatment could be paused or stopped.

Prophylaxis and tooth cleaning had been performed at a private dental office before the patient presented to our clinic. Before starting with the tooth whitening, it was checked that the teeth were free of plaque, calculus and extrinsic staining (Fig. 1). In order to prevent unwanted proteins interfering with the whitening agent, a mild polishing of the teeth to be whitened was performed with Hawe Cleanic Prophy paste (Kerr Corporation).
A review of the literature on Er:YAG laser whitening indicates that there is a significant difference between laser-assisted and conventional whitening in terms of the speed of the procedure. We consequently expected faster activation of the whitening gel with an Er,Cr:YSGG laser device compared with other laser devices. Owing to the similarities of the two wavelengths in terms of absorption in water, we expected to achieve the same results as those observed in Gutknecht’s study.

In the postgraduate dental clinic, we use an Er,Cr:YSGG laser (2,780 nm, Waterlase MD Turbo, BIOLASE) and a yellow whitening agent for in-office whitening with a concentration of 38% hydrogen peroxide (POWER WHITENING, WHITESmile). The tip used is a Z-type glass tip (MZ8) of 800 µm in diameter and 6 mm in length, used with the gold handpiece of the laser system. The power settings that we used for this case were an output power of 1.25 W, a pulse duration of 700 µs (S-mode) and a pulse repetition rate of 10 Hz.

The whitening agent was applied in a layer of 1–2 mm in thickness to each tooth (Fig. 3), starting with the maxillary teeth. With the power settings mentioned above, we activated the whitening agent for two intervals of 10 seconds for each tooth (Fig. 4), keeping the laser handpiece at a distance of 2.5 cm from the teeth. After the end of the procedure, the activated whitening agent was left on for 15 minutes and then removed from the teeth with high-power dry suction. The procedure was repeated twice during the same appointment. After completion of the procedure, soft-tissue irritation was noticed in the area of tooth 42, but the patient reported that she did not feel pain or tenderness.

The final colour evaluation was conducted by the dentist, dental assistant and patient. After two repetitions of the process during the same appointment, the colour of the teeth had been changed to Shade B1 according to the VITA classical shade guide. The patient was satisfied with the colour of her teeth and was advised to re-evaluate the colour after two to three days to allow for rehydration of her teeth. The patient informed us that she was satisfied with the final colour and a second appointment was arranged in order to replace the Class IV composite restorations on the mesial and labial areas of her central incisors.

Class IV restorations were scheduled to be performed after four weeks in order to allow for long-term colour evaluation by the patient. Colour differences were non-existent, as can be seen in the photograph of the restorations with a polarising filter. The restorations were performed with the silicone key technique, for which a palatal impression of the existing restorations was taken with a polyvinyl siloxane and trimmed to the incisal edges (Fig. 5).

Subsequently, the old composite was removed using an Er,Cr:YSGG laser (2,780 nm, Waterlase MD). The output power was set to 4.5 W, with a pulse duration of 140 µs (H-mode) and a pulse repetition rate of 20 Hz using an MZ6 tip under a water spray. Since there was no evidence of secondary caries or any other defect apart from colour and marginal integrity, it was decided to maintain the inner bulk volume of the old composite. However, all margins were placed on enamel (Fig. 6). Laser treatment of
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the aesthetic zone was finished with the elimination of the brownish-black pigments on the gingiva between the central incisors and in the areas of teeth 32 and 33 (Figs. 7 & 8).

A restorative procedure was performed after placement of a rubber dam (Fig. 9). The silicone key was tried in (Fig. 10) and the adjacent teeth were protected with PTFE tape before etching the enamel margins with 37% phosphoric acid (Figs. 11 & 12). The resin composite bond to enamel benefits from both laser etching and acid etching. The restorations were built up incrementally, starting with the palatal enamel surface with a translucent enamel shade, Shade E (CLEARFIL MAJESTY Esthetic, Kuraray; Fig. 13). The dentine shade, Shade OA2, was then placed, forming the internal dentinal lobes (Fig. 14). A final labial enamel layer in Shade A2 was placed and was anatomically formed to recreate the macrostructure. A small quantity of Shade E was placed at the incisal edge to increase the biomimetic effect of the restorations.

The microstructure was created by polishing with fine and ultra-fine diamond burs, polishing discs of decreasing roughness, silicone points and brushes coated with diamond paste for the final gloss (Fig. 15). The colour match was checked under the polarising filter (Figs. 16 & 17). The patient was recalled seven days post-operatively in order to check the aesthetic appearance of the restorations and the healing of the soft tissue in the areas of depigmentation (Figs. 18 & 19).

**Results**

The aesthetic rehabilitation of the case was performed entirely with the use of an Er,Cr:YSGG laser. Laser treatment was performed with no anaesthetic. The patient reported only minor sensitivity during whitening and when the composite was removed, adding that the low temperature of the whitening agent and of the water ejected from the laser handpiece, in conjunction with the cold air, had caused her discomfort. During depigmentation, no side-effects were reported. The Class IV restorations were built up incrementally to achieve better aesthetics. A silicone key was used to reproduce the rough shape of the old restorations and final adjustments were made during polishing to enhance the natural effect. A polarising filter was used to detect minor colour mismatches.

**Discussion**

The properties of the Er,Cr:YSGG wavelength (2,780 nm) are well known. Its characteristic absorption in water makes it an excellent tool not only for hard-tissue removal but also for soft-tissue and other aesthetic procedures.

One of the main components of a whitening gel is water. It can be found in percentages of up to 50% in any whitening gel. The advantage of using a laser system from the erbium family is obvious. The laser energy is fully absorbed by the water molecules in the whitening gel, thus increasing its temperature rapidly. This will result in rapid decomposition of the hydrogen peroxide and more hydroperoxyl free radicals will be produced. Consequently, the same expected result in terms of the final outcome of the whitening procedure is reached in minimal time compared with non-activated whitening gel treatment.

The laser’s pulsed operation delivers bursts of high energy to the gel over a relatively small area. Its high energy density is a prominent advantage over other light sources used for laser whitening in terms of heat dissipation and safety of the pulp.

As Er,Cr:YSGG is also absorbed by hydroxylapatite, it is of great importance to select the power settings carefully in order not to ablate the enamel of the teeth to be whitened. For that reason, we kept the laser system parameters at a laser energy density (fluence) of every pulse well below the enamel ablation threshold. Our setting was
0.4 J/cm² and the ablation threshold for enamel is close to 3.5 J/cm².

Conclusion

The Er,Cr:YSGG laser can be very useful as an activation medium of the whitening agent during the tooth-whitening process. The whole procedure is faster, the results are excellent and the patient feels comfortable throughout the appointment. No harmful side-effects have been recorded. Of course, more studies are needed to corroborate these preliminary results. Future developments are encouraging and we can expect better-designed handpieces for whitening and wavelength-specific whitening agents.

Besides aesthetic dentistry, lasers have been successfully used for restorations in operative dentistry, providing pain-free treatment. The Er,Cr:YSGG laser is a powerful tool in the hands of a trained dentist for performing both hard- and soft-tissue treatment, sometimes even during the same appointment. In conclusion, it is important for the clinician to take all safety measures during the procedure, to comply with the manufacturer’s guidelines, and to use the correct wavelength and the proper parameters of the laser device, depending on the therapy selected, in order to achieve the best results for the benefit of the patient.

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