Quantum Square Pulse Er:YAG lasers in clinical practice

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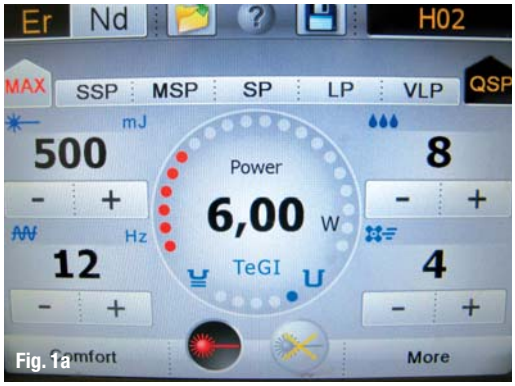

Fig. 1a

Fig. 1_ a) LightWalker AT settings for QSP mode; **b)** H02-C handpiece; **c)** H14-C handpiece.

_Introduction

Er:YAG lasers are becoming increasingly popular in every day dental practice due to a higher level of patient acceptance and greater precision and procedure quality. There are many advantages over conventional mechanical preparations, such as lower increases in pulp temperature, less pain for the patient, less risk of secondary caries,[1,2,3] and improved strength of adhesion of the composite resin to dentin prepared by low-energy SSP Er:YAG laser pulses.[4]

The ability tosetdifferent laser pulse durations represents a significant development that expands the versatility of Er:YAG dental lasers.[5,6] One of the recent advances in Er:YAG laser technology is the introduction of Quantum Square Pulse (QSP) technology. In QSP mode, low-energy, short pulses follow each other at an optimally fast rate, resulting in both higher efficiency and precision at the same time. Cavities made with QSP mode are sharp and well defined, with high surface quality as required for high bond strength.[7,8]

Fig. 1b & c

_Materials and methods

A LightWalker AT laser (Fotona, Slovenia) was used with a H02 non-contact handpiece (beam spot size in focus: 0.6 mm) for enamel and composite preparation, and with a H14 contact handpiece with a cylindrical fiber tip of 0.8 mm diameter for surface modification and dentine (Fig. 1b, 1c). For all clinical cases QSP mode was used: pulse energy varied from 120 mJ to 500 mJ, with repetition rates ranging from 10 to 15 Hz (Fig. 1a).

The composites used for fillings and bonding were supplied by Voco (Cuxhaven, Germany).

Prior to the beginning of the treatment, the effects of the Er:YAG laser treatment, benefits and possible risks and complications were explained in understandable terms to every patient. Laser safety rules were strictly observed by the LSO (laser safety officer, Dr. Evgeniy Mironov) during the treatments.

_Patient cases

All patient cases with chronic and acute conditions (described below) were taken from everyday practice. Patients signed informed


Fig. 2a


Fig. 2b

Fig. 2_ a) Tooth 16 after preparation with QSP;
b) Tooth 16 after complete restoration (Case I).
Fig. 3_a) Tooth 26 before treatment;
b) Tooth 26 after preparation with QSP;
c) Tooth 26 after complete restoration (Case I).
Fig. 4_a) Removal of old composite veneer with QSP mode; **b)** After complete surface preparation;
c) Clinical situation after complete direct restoration (Case II).


Fig. 3a


Fig. 3b


Fig. 3c


Fig. 4a


Fig. 4b


Fig. 4c


Fig. 5a


Fig. 5b

Fig. 5_a) Clinical situation on both premolars before the treatment; **b)** Clinical situation after surface modification with QSP mode and filling with flow composite (Case III).
Fig. 6_a) Clinical situation before the treatment;
b) The situation just after treatment with QSP mode showing completely untouched gingiva, even though high energy was used for the treatment;
c) Clinical situation after treatment.


Fig. 6a


Fig. 6b


Fig. 6c

Fig. 7_ a) Clinical situation before the treatment; **b)** The situation just after treatment with QSP mode showing an ideal surface for bonding; **c)** Clinical situation after the final filling (Case V).

consent forms after reading the explanation of the procedures to be performed with the LightWalker AT laser, and they permitted photos to be taken.

Case I

The filling on tooth 16 of a 26-year old female patient was to be changed due to discoloration and reported transitive hypersensitivity. For removal of the existing composite filling, the parameters were set to QSP, 500 mJ, 12 Hz, and for the dentine preparation, to QSP, 160 mJ, 15 Hz. The preparation with QSP mode was fast and precise: QSP mode is very suitable for the removal of secondary and chronic caries, which are not as rich in internal substrate water as acute caries. It is also beneficial to use QSP mode in deeper zones to reduce the risk of thermal damage due to insufficient water inflow. No anesthesia was used during the treatment, and the patient did not show any signs of discomfort or pain (Fig. 2).

A deeper abrasion on the filling of tooth 26 was made in the same patient. A fresh and sterile surface for changing its occlusal part was performed with QSP mode, with pulse energy of 300 mJ, 15 Hz, water and air spray (Fig. 3). The patient reported the disappearance of hypersensitivity at the fifth day post-op check-up, and after six months the stability and functionality of the restorations were confirmed.

Case II

A female patient required an aesthetic treatment on her front teeth. One week after undergoing a successful TouchWhite™ Er:YAG teeth whitening procedure, the replacement of her existing direct-made composite veneers was necessary to adjust the color to the new color of the bleached teeth. Because of the high precision of QSP mode, it was possible to keep the enamel untouched and to work in the previous composite layer only. The ablation was started with QSP mode, 150 mJ, 12 Hz (Fig. 4a). According to the material's response, the energy was raised to 180 mJ, and in areas with a thicker layer of the existing composite, the frequency was increased to 15 Hz. The preparation took 1.5 to 2 minutes for each central incisor and one minute each for the laterals (Fig. 4b).

After placing the rubber dam, direct adhesive restorations were made with a layer of Grandioso Heavy flow (VOCO, Germany) to establish a strong and uniform connection between the two kinds of composites. The patient was satisfied with her new look and felt relaxed after the painless procedure (Fig. 4c).

Case III

A 30-year-old patient reported hypersensitivity to mechanical irritation and cold liquids in the region of the lower premolars. The gums were healthy and no isolation cord was necessary. Using the laser's especially precise QSP mode assured keeping the gingival tissues untouched. The surface modification parameters were QSP, 120 mJ, 10 Hz. Easy accessibility with the non-contact handpiece and a clearly visible pilot laser beam allowed the preparation to be finished in less than 20 seconds for both teeth (Fig. 5). The restorations were made by flow composite. Some light gingival bleeding around tooth 44, which is seen in Fig. 5, was caused by polishing. This case demonstrates how fast and accurate treatments can be made using QSP mode.

Case IV

A deep cervical carious lesion on tooth 45 was treated in a 23-year-old male patient. Since the carious lesion was deep and the patient was very afraid of dental procedures, anesthesia was used and the fastest possible treatment parameters were set: QSP mode, 500 mJ, 12 Hz. The first step of the preparation was performed in 5 seconds, and then the energy was changed to 300 mJ because deep carious dentine was reached. To operate still faster, the frequency was increased to 15 Hz and the second step was also completed in 5 seconds. After placing the haemostatic cord, Calcimol LC (VOCO) was used as a liner, covered with Grandioso Heavy Flow and finally filled with Grandioso.

Case V

This is a case of localised single-tooth Amelogenesis Imperfecta due to excessive fluoride intake. The patient is an 18 year-old male and his only complaint is due to aesthetic reasons. After explanation of the laser treatment procedure, a decision was taken to make a filling, following Er:YAG ablation without anesthesia. The patient was afraid of dentists and denied injections in previous visits for dental treatment. The parameters on the Fotona Lightwalker AT were set in QSP mode, which is exceptionally fast and quiet. In cases such as this, enamel is much stronger and richer in mineral content, so a high energy setting of 500 mJ was used with a 12 Hz repetition rate. After preparation, the energy was lowered to 120 mJ at 10 Hz, still in QSP mode, for a marginal laser-etching procedure. The preparation was done in less than 30 seconds and the patient remained still and calm. The filling was done with GrandioSo and Futurabond M (VOCO).

_Conclusion

In the above-described clinical cases, QSP mode was used because fast, precise, and minimally invasive treatments were required. This is of great importance in pediatric dentistry and with highly anxious patients. The treatment provided good aesthetic results, and patients did not report any subsequent sensitivity.

All patients appreciated the lower noise generated by QSP pulses in comparison to other pulse modes as well as the speed of the treatments. A very important clinical benefit of the QSP mode are the resulting clear and sharp margins of preparations for fillings or for surface modification. This is of primary importance when working close to the pulp or near the gingiva. The quality of surfaces prepared by QSP mode seems to be excellent for the composites that were used._

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