The use of the Er:YAG in laser-assisted periodontal surgery

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_Introduction

Periodontal diseases are some of the most widespread of oral pathologies. Chronic periodontitis, characterised by local inflammation owing to infection with pathogenic bacteria, destroys the supporting structures of the teeth including periodontal ligaments, cementum and alveolar bone. Untreated periodontal disease then leads to tooth loss because the attachment apparatus and tooth-supporting structures are destroyed. The goals of periodontal therapy are to arrest the progression of periodontal disease and regenerate those structures lost to disease. Since periodontal diseases are considered both chronic and destructive, the sooner diagnosis and treatment begin, the better the prognosis is for the patient.

Periodontal inflammation is reversible when limited to soft tissue areas (gingivitis), but when supportive bone tissue becomes involved (periodontitis), the situation does not reverse if left untreated. To accomplish these goals, it is essential to eliminate etiological factors such as adherent plaque, dental calculus, and diseased cementum from the root surface and infected connective tissue within intra-bony defects around the teeth. Recently, various regenerative therapies in conjunction with flap surgery have come into use for the treatment of advanced periodontitis. Basically, however, the success of these therapies still depends on thorough debridement of the contaminated root surface and removal of infected granulation tissue. The aim is to preserve the natural teeth. Many variables are considered to determine whether surgically reducing the depths of the pockets will benefit the patient's oral hygiene.

_Periodontal surgery with the Er:YAG laser

Usually, the removal of calculus and diseased soft tissue is performed with mechanical instruments. However, conventional mechanical instrumentation using curettes is still technique dependent, time consuming and occasionally ineffective, and power scalers are a source of uncomfortable stress such as noise and vibration for the patient. Laser-assisted periodontal therapy has attracted attention recently as a potential alternative to conventional mechanical treatment.

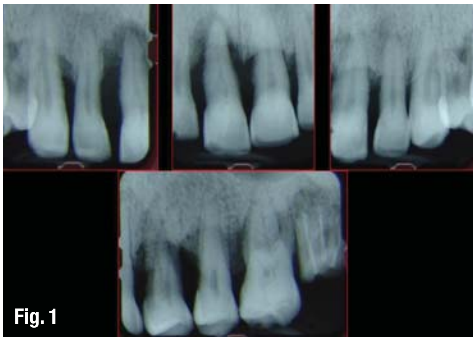
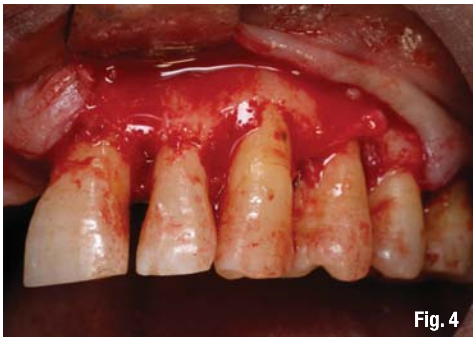


Fig. 1


Fig. 2


Fig. 3

Fig. 1_X-ray image at presentation.
Fig. 2_Periodontal probe indicate pockets around 8 to 7 mm.
Fig. 3_Er:YAG laser incision with 600 μ sapphire tip, contact mode, power 200 mJ, 35 Hz.



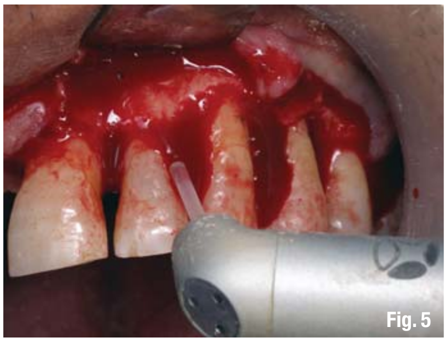


Fig. 4_Immediately after raising the flap.

Fig. 5_Granulation tissue ablation with 1,300 µ sapphire tip, non-contact, 400 mJ, 20 Hz.

Fig. 6_Immediately after ablation.

Various types of lasers have been investigated as an adjunct to periodontal therapy. The Er:YAG laser, which emits at a wavelength of 2.94 µ, has been demonstrated to be useful for both hard and soft tissue. The Er:YAG laser has produced the most promising results[32] and has come to be one of the most promising lasers used in periodontics with a wide range of applications such as:

- incision for flap lifting;[2, 4, 26]
- calculus removal;[18]
- high bactericidal capacity;[9]
- granulation tissue ablation;[1, 27]
- detoxification effect on lipopolysaccharides of the diseased root surface;[7, 30, 31]
- bone ablation: remodelling and shaping, without major thermal side-effects; and
- favourable root conditioning for the adherence of fibroblasts.[20, 2, 26, 1, 28, 29]

A controlled clinical trial was performed by Schwarz *et al.*[23] They demonstrated that periodontal pocket therapy with an Er:YAG laser obtained equivalent or better results compared with conventional mechanical therapy with Gracey type curettes. Also, Sculean *et al.*[24] have reported that Er:YAG laser debridement of granulation tissue within intra-bony defects during periodontal flap surgery was as effective as with conventional mechanical instruments. Therefore, the clinical safety and effectiveness of the Er:YAG laser have been demonstrated for both non-surgical and surgical periodontal therapy, and this laser has become one of the most promising lasers used in periodontics.[2, 24]

The purpose of this case study is to demonstrate the effectiveness of using an Er:YAG laser for periodontal surgery. The conventional approach is to make an incision with a scalpel and then use a periosteal elevator to lift a flap, then to remove the granulation tissue with mechanical tools. Bone reshaping and remodelling are then performed with rotary instruments and assorted chisels. The use of an Er:YAG laser for periodontal surgery is faster and more comfortable for the patient. This case study demonstrates the use of the LiteTouch Er:YAG laser system (Syneron Dental) for the entire procedure, both hard and soft tissue.[4, 8, 9] This article will demonstrate that the Er:YAG laser may be used as a treatment alternative when working with bone.[8, 14]

_Surgical case study

A 55-year-old healthy male patient presented with complaints of halitosis and recurrent bleeding. Clinical examination showed bleeding on probing with pocket probing depths of 5 to 6 mm (Fig. 1), stable teeth with no mobility, and exudation. An X-ray revealed vertical and horizontal bone loss (Fig. 2). Therefore, this case was classified as severe periodontitis. The dental hygienist initiated treatment through plaque removal and scaling and root planing, and then instructed the patient in more aggressive oral hygiene. Six weeks later, the situation was re-evaluated: there was no significant clinical improvement in pocket depth and bleeding on probing. A surgical procedure was decided that involved lifting a flap.

_Laser apparatus

The laser apparatus used was the LiteTouch Er:YAG laser system. The features of this system are a wavelength of 2.94 µ, an output energy range of 50 to 700 mJ/pulse, a pulse frequency range of 11 to 50 pulse/second (Hz) and pulse duration of 200 microseconds. The system does not employ a fibre delivery system; the laser medium is in the applicator. The system also uses a special water spray system to cool the irradiated area. Air-mixed water is released coaxially to the contact tip, covering the target area during irradiation, providing precise and adequate water delivery. An optional feed bottle system is integrated into the system for sterile saline water supply during surgery. Intrasulcular palatal and buccal incisions were performed with a 600 µ tip 4 under local anaesthesia (Fig. 3). Water spray was used for tissue cooling throughout the entire laser procedure. The 600 µ sapphire tip was used at settings of 200 mJ/35 Hz

(= 7 W) in contact mode at intrasulcular depth. After the flap had been lifted (Fig. 4), the granulated tissue was removed by ablation and vaporisation using a 1,300 µ tip, in non-contact mode, at a distance of 1 to 1.5 mm from the target tissue (Fig. 5). The energy used for this procedure was 400 mJ/20 Hz (= 8 W). In narrow embrasures where the tip was too wide, the 1,300 µ tip was replaced with a narrower conical tip (800 µ) and the energy was decreased. Since the laser fires from the end of the tip and not from its sides, even when the side of the tip is touching another tooth while firing, no damage occurs to the adjacent tooth. After ablating the soft tissue,[2] the hard tissue was treated: for bone remodelling the power set was 300 mJ/20 Hz[1, 2, 8] (= 7 W). The tip of choice is a 1,300 µ sapphire tip applied in non-contact mode.[8, 14] For bone smoothing, the energy applied is 150 mJ/50 Hz (= 7.5 W), 1,300 µ sapphire tip in non-contact mode. Before closing the flap, laser energy should be applied to the exposed roots in non-contact mode on the buccal, palatal and interproximal sites at a very low energy of 100 mJ/35 Hz (= 3.5 W), using a 1,300 µ sapphire tip in non-contact mode (Fig. 6).

This step is important because it improved the attachment of the soft tissue to the root and greatly reduced bacterial endotoxin from the root's surface.[5, 7, 9, 10, 12, 13, 15, 18, 19] A vertical release incision was not necessary because flap reflection was adequate. This particular procedure was performed without the assistance of curettes, rotary equipment or chisels. Were sub-gingival calculus present, however, I would have removed it with a chisel tip sapphire (Fig. 11).

Studies show that sub-gingival calculus can be removed with an Er:YAG laser.[15–19] The patient returned the following day and reported that he was no longer in pain. No swelling was observed.[3, 9] The patient was scheduled for maintenance therapy at three-month intervals for a period of three years. Fifteen months after the interventions, clinical attachment levels, pocket probing depths, recession, full-mouth plaque scores and full-mouth bleeding scores were assessed. No pocket depths exceeded 3 mm. The photographs and X-rays presented in Figures 1 to 11 show the various stages of this case study.

_Several observed advantages of using lasers in periodontal surgery

The following are observed advantages of using lasers in periodontal surgery:

- less bleeding during the procedure;
- surgical site decontamination—the laser is bactericidal[18] (no antibiotics necessary after surgery);
- comfortable post-operative outcome—less swelling and less pain (studies show this may be partly due to the closure of smaller blood vessels, lymphatic vessels, and exposed nerve endings);[3]
- more effective bone cleaning;[1, 2, 14]
- faster completion of the surgical procedure[3] and easy handling;[2]
- no rotary tool vibrations—patient comfort;[3]
- the Er:YAG laser produces no smear layer, leaving a bone surface that is absolutely clean, thus reducing the possibility of secondary infection.

Many studies have shown that when Er:YAG and other lasers are applied to bone, growth factors are released that enhance bone regeneration:[1] faster bone repair after irradiation than conventional bur drilling. Implants inserted into Er:YAG laser-placed holes can exhibit greater bone contact than those prepared by conventional methods.[14]

_Particular points of attention

There are particular points that require attention when using lasers for bone tissue:

- constant hand motion during laser emission—avoid applying the laser beam on any one spot longer than necessary (dental lasers are thermal devices by nature; therefore, long interaction between the laser and target tissue raises the temperature of the tissue—studies show, how-

Fig. 7_Immediately post-op.
Fig. 8_Six months post-op.
Fig. 9_Fifteen months post-op.


Fig. 7


Fig. 8


Fig. 9

ever, that when properly used the temperature generated by a laser beam is no higher than that generated by rotary tools);[6, 8]
- the use of saline solution as opposed to distilled water as a cooling liquid; this is to provide the bone tissue with an isotonic environment;
- the Er:YAG laser energy setting should stay below 400 mJ (8 W), keeping the applicator in constant motion;
- laser application to bone tissue should be in non-contact mode at a distance of 1 to 2 mm between the applicator tip and the target tissue—when the overlying tissue incisions are performed, operating in contact mode until you feel contact with the bone it is recommended;
- tissue-cooling water spray should be used throughout the entire Er:YAG laser procedure.

_Discussion

Surgery with the Er:YAG laser takes less chair time, and invariably delivers better results than conventional approaches, making for an all-around happier patient. The definition of a well-rounded dental laser surgeon is the one who knows how to match the wavelength to the procedure, but that is not enough! The energy of the wavelength and the motion and position of the beam must be suited to the procedure as well (power energy, energy density and duration of irradiation). The surgeon should be well trained and skilled. A higher quality level of granulation tissue removal was achieved with the laser,[2, 4, 8] the bone was free of a smear layer, the tissue healed faster, and the patient felt better after laser-assisted periodontal surgery.[3]

_Conclusion

In conclusion, the LiteTouch Er:YAG laser can be safely and effectively utilised for degranulation and root debridement in periodontal flap surgery, without causing major thermal side-effects on the root and bone surfaces, and pulpal damage. The LiteTouch laser possesses characteristics particularly suitable for periodontal treatment, owing to its dual ability to ablate soft and hard tissue with minimal damage. The LiteTouch Er:YAG laser has proven itself to be an effective and promising tool for periodontal therapy and surgery, and has a sterilising effect upon dental structures._

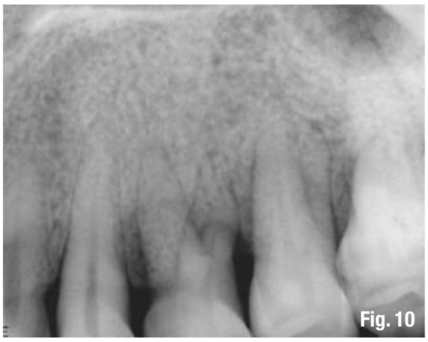


Fig. 10_X-Ray image 15 months post-op.

Fig. 11_The chisel tip for calculus removal.

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