



## Clinical Outcome of Er: YAG Laser Application for Periodontal Surgery

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### Abstract

Clinical application of lasers in periodontal surgery has continued to expand in the last decade; however, controversies remain regarding their use. This article will describe the clinical application of erbium: YAG lasers for periodontal surgery: flap operations, osseous surgery, and semi-lunar coronally repositioned flap procedures, and peri-implantitis treatment by laser will be discussed.

**Keywords:** Oral biofilm; Osseous surgery; Peri-implantitis; Semi-lunar coronally repositioned flap procedure

### Introduction

Most diseases of the oral cavity are biofilm-associated infections [1]. Lasers are extremely effective tools for use in treating these diseases. In addition, lasers are not associated with side effects such as the development of infections with drug-resistant bacteria as may occur with antibiotic chemotherapy. The Er: YAG Laser (erbium-doped: yttrium, aluminum, and garnet) laser, emitting at a wavelength of 2.94  $\mu\text{m}$ , has been developed recently. The Er: YAG laser is expected to be useful in dental application because of its high absorption in both water and hydroxyapatite [2-4].

The aim of this case series was to describe novel periodontal treatments utilizing lasers for periodontal surgery: flap operations, osseous surgery, and semi-lunar coronally repositioned flap procedures and peri-implantitis treatment by laser.

### Case Series

#### Flap operations

Periodontitis-affected root surfaces are hyper-mineralized and contaminated with cytotoxic and other biologically active substances. It is not possible to decontaminate and debride such surfaces completely by mechanical means alone, because hand or ultrasonic scaling of the root surface always produces a smear layer after contact with the instruments used [5]. Because such surfaces are not biocompatible for periodontal cell proliferation, it is vital that the periodontal wound be allowed to heal completely. Some researchers have suggested that removal of the smear layer by conditioning the root surface may stimulate fibroblast attachment [6], whereas others have reported that root conditioning has little effect in enhancing cell attachment [7]. Laser therapy is considered effective for the management of periodontal disease because it enables debridement and treatment of dental hard tissues [8,9]. However, laser treatment might cause thermal side effects on the hard tissues, such as morphologic and chemical alterations, especially when using some types of lasers at a high power and/or in continuous-focus mode [10]. The application of lasers in periodontal therapy has continued to expand over the last two decades; however, its efficacy remains controversial [11-13]. We reported positive findings for the use of Er: YAG laser irradiation treatment alone or combined with recombinant human platelet-derived growth factor BB on periodontitis roots, but without using SRP [14,15]. Flap operations are used for removal of visible lesions. The removal of calculus using a laser is more effective because the target can be more easily confirmed. Hand-held instruments are not suitable for special purposes, but procedures are available that produce the same results as normal treatment. It is preferable to very gently strike the rhizoplane and move the laser tip in a sweeping motion at an angle of 30 degrees relative to the tooth plane. Although it is very difficult to remove diseased granulation tissue using conventional hand-held instruments, the use of a laser is more effective, has a shorter operation time, and is less stressful for the patient. In addition, irradiating the inside of the flap with the laser provides lasting disinfection, thus promoting rapid healing (Figure 1-3).

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Figure 1: Flap operation by laser. The patient was a 68-year-old woman.



Figure 2: Operation, to remove and debride calculus and infected granulation tissue and clarify an osseous defect. (68 Y, Female) 60 mJ, 20 Hz



Figure 3: One-year prognosis of flap operation by laser. X-ray showed no calculus on the root surface and remarkable bone regeneration.

**Osseous surgery**

Lasers are extremely effective tools for bone surgery. Mechanical instruments such as the Ocean Bean Bone Chisel are very inefficient and greatly stress patients. In contrast, lasers are ideal for osseous resection and osteoplasty due to the light contact pressure required, as demonstrated in the case of a 72-year-old man suffering from a gingival form abnormality of the buccal side of the maxillary left first premolar. The form abnormality, consisting of a bone-like shelf, was confirmed upon opening of the flap. Laser bone surgery was carried out at 80 mJ and 10 Hz with water irrigation. Excess bone was removed little by little from the upper part of the abnormality until the desired bone form was achieved. The patient suffered no adverse



Figure 4: Osseous surgery by laser. (72 Y, Male) 80 mJ, 10 Hz with water irrigation.

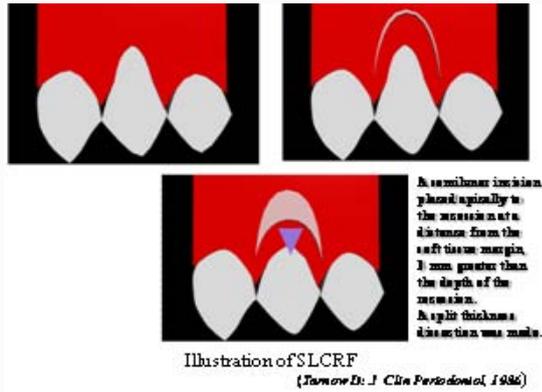


Figure 5: Laser osteoplasty during the flap operation.

effects as a result of the surgery (Figure 4). The advantages of laser osteoplasty can be demonstrated in the case of a flap operation in a 31-year-old woman. Laser irradiation was performed at 70 mJ and 10 Hz with water irrigation. Regression of inflammation and a decrease in the size of the periodontal pocket were remarkable, and the patient experienced no sharp pain during a 3-month convalescence period. Laser osseous surgery was not associated with any significant harm to the patient (Figure 5).

**Root coverage by semi-lunar incision**

The semi-lunar coronally repositioned flap (SLCRF) procedure is useful for covering shallow, localized recession defects [16]. The favorable performance of Er: YAG laser makes them ideal for use in the treatment of both hard and soft periodontal tissues. We therefore examined the effectiveness of lasers in SLCRF procedures. An Er: YAG laser (Erwin Adv ErL™, J. Morita Mfg. Corp., Japan) was used to treat 46 cases of shallow gingival recession in 31 patients (8 men and 23 women, average age 47.2 years). The laser was operated at an energy output of 50-100 mJ/pulse and 10-20 Hz with water coolant. Special laser tips (S600T, C600F, and Brush) were used for incision and root preparation. SLCRF procedures were performed for 9 incisors and 14 molars in the maxilla and 6 incisors and 17 molars in the mandible. The patients were followed postoperatively for an average of 1.1 years. The amount of gingival recession was 2-4 mm (average of 2.5 mm). Almost all cases were Miller class I or II [17]. A semi-lunar incision was made apically to the recession and at a distance from the soft tissue margin approximately 3 mm greater than the depth of the recession. A split-thickness dissection of the facially located tissue was then made by an intracrevicular incision. The mid-facial soft tissue



**Figure 6:** Scheme of the semi-lunar coronally repositioned flap procedure. Partial thickness flap was Performed using a semi-lunar incision 3 mm longer than the gingival recession from the gingival margin, and the mid-facial soft-tissue graft was coronally repositioned to the level of the cement-enamel junction and stabilized by application of light pressure for 5 min.

**Table 1:** Effectiveness of root coverage.

Treatment	Recession (mm)		Defect Coverage	
	Initial	Final	Effectiveness %	
	Defect	Defect	Defect coverage	
	Mean (SEM)	Mean (SEM)	Mean (SEM)	Mean (SEM)
Laser	2.5	0.6	1.9	76
	0.1	0	0.1	0.8
Control	2.6	0.7	1.9	73.1
	0.1	0.03	0.1	0.7



**Figure 7:** Two weeks after laser SLCRF.

graft was coronally repositioned to the level of the cemento-enamel junction and stabilized by application of light pressure for 5 min (Figure 6). The defect coverage was 0-3.5 mm (average of 1.9 mm), and the mean percentage of root coverage after surgery was 76.0% (Table 1). The prognosis after laser surgery was good. These results suggest that Er: YAG lasers are ideal for use in SLCRF procedures (Figure 7). Further study will be required to establish methods for periodontal plastic surgery using lasers, however.

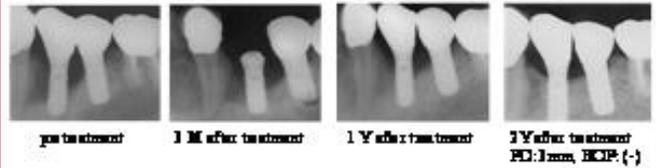
**Peri-implantitis treatment by laser**

Although the prevalence of peri-implantitis is increasing, suitable treatment methods have not been established [18,19] because it is difficult to remove the affected tissues due to the complex surface structure of dental implants. Peri-implantitis is defined as attachment

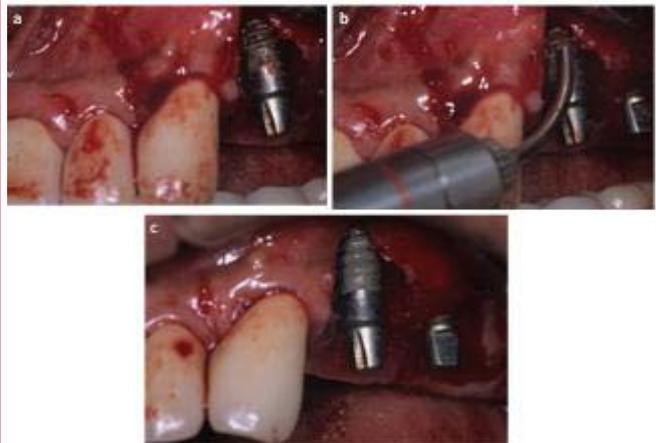


Ablaze inflammatory tissue  
20pps, 80 mJ, water irrigation  
  
Removal of encrustation of implant surface  
10pps, 30 mJ, water coolant

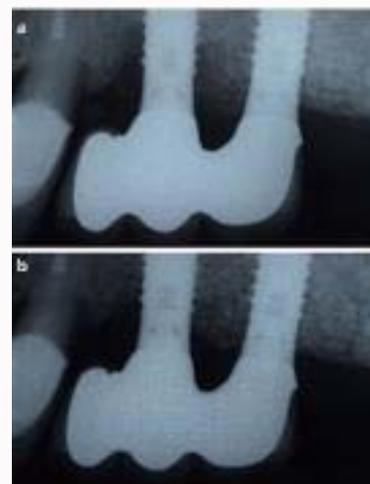
**Figure 8:** Laser treatment of peri-implantitis.



**Figure 9:** Process of wound healing after laser treatment over the course of 1 year.



**Figure 10:** Note implant fixture of peri-implantitis covered by calculus and biofilm. b: It is possible to safely remove the calculus and biofilm using an Er: YAG laser under water irrigation. c: Implant fixture immediately after laser irradiation.



**Figure 11:** X-ray before treatment. b: X-ray finding of 3 year prognosis. Note recovery of alveolar bone.

loss >6 mm or bone loss of >2.5 mm. Conventional treatment methods involve scaling using plastic or titanium scalers and the use of air abrasion. Treatment with antibiotics is also reported. However, no standardized methods have been established. It may be expected that the use of a laser for non-surgical treatment would have a disinfecting effect, but there are insufficient data to demonstrate such an effect. Er: YAG lasers can be used surgically to vaporize and remove biofilm and calculus associated with a dental implant. Laser removal of polyps attached to bone is advantageous with respect to the production of new bone because of no smear layer remains on the osseous surface. After suturing, occasional vaporization of neighboring epithelial tissue can be performed for the purpose of delaying invasion of the sub-implant by the epithelium. We present two cases to illustrate the use of Er: YAG lasers to cure peri-implantitis. The first case is that of a 68-year-old woman with a mandibular left-sided first premolar implant. The patient complained of sensing incongruity approximately 8 years after the implant was obtained. X-rays revealed bone resorption to the level of 5 threads. Clinical parameters were as follows: 8-9 mm PD, BOP (+), and no mobility for a connection implant was noted. A flap was opened and the tissue was irradiated at 20 pps and 80 mJ with water irrigation using an Er: YAG laser equipped with an ST tip. The inflamed tissue was vaporized and removed, and tissue encrusting the implant surface was removed at 10 pps and 30 mJ with water irrigation. The patient's progress was monitored after treatment (Figure 8 and 9). The bone completely recovered by 24 months after treatment, and the PD decreased to 3 mm and the patient became BOP (-). In a second case followed for 3 years after treatment, X-ray finding showed that the bone tissue was stable, with no recurrence of the peri-implantitis (Figure 10 and 11).

Advantages of using Er: YAG lasers for peri-implantitis treatment include greater accessibility to areas that cannot be reached using conventional instruments (hand-held scalers, ultrasonic scalers, rotary cutting tools, etc.) and greater ease of removal of inflamed tissue on the implant surface. However, additional research is needed to confirm that lasers do not adversely affect the titanium outer layer of dental implants.

## Conclusion

The 21<sup>st</sup> century is said to be the age of the photo sciences. Lasers are artificially oscillated electromagnetic waves that are superior to natural light in a number of respects important in periodontal surgery. In this article, the novel possibilities for the use of lasers in periodontal surgery were discussed. We would be delighted if in reading this article the reader gains a deeper appreciation of the potential of "laser dentistry".

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