

Ablation and sulcular debridement utilizing the CO₂ laser for denture-induced gingival hyperplasia

Drs. Joel L. Rosenlicht and Peter Vitruk discuss gingival hyperplasia and peri-implant pocket treatment using a CO₂ laser

Introduction

The term *gingival hyperplasia* refers to excess gingival tissue growth. It can be caused by numerous factors, most common being periodontal disease, poor oral hygiene, medications, smoking, and ill-fitting denture prostheses.^{1,2} The treatment of hyperplasia includes elimination of the causing factors and surgical removal of the lesion.¹ If the cause persists, the tissue becomes more fibrous over time and can ulcerate and cause further pathology.

This article presents a case report of the surgical removal of gingival hyperplasia along with the sulcular debridement for peri-implantitis using the flexible fiber CO₂ laser with a variety of dental and surgical laser handpieces.

Hyperplasia can be treated conservatively (by improving oral hygiene) or surgically (by scalpel, electrosurgery, carbon dioxide [CO₂], Er:YAG, Nd:YAG, and diode lasers).¹⁻³ The greatest disadvantage of the conventional scalpel is intraoperative hemorrhage and the need to suture the wound (patient discomfort).⁴ The CO₂ laser in the case described in this article did not require sutures and allowed the surgeon to perform vestibuloplasty with a palatal mucosal graft during the same visit. Electrosurgery was not an option in the case described in this article because of the

close proximity to the titanium implants.⁵ The CO₂ laser is an excellent tool for removal of gingival hyperplasia because of its ability to induce hemostasis, speed, lack of the need for sutures, and excellent healing with reduced wound contraction without scar tissue resulting in healthy pliable tissue.⁶⁻⁸ In comparison with scalpel wounds, healing in the CO₂ laser-treated wounds is characterized by a higher fibroblastic proliferation with young fibroblasts actively producing collagen. Only a small number of myofibroblasts (the cells responsible for wound contraction) are found in the CO₂ laser-treated wounds compared with scalpel wounds.^{9,10} Thus, diminished wound contraction and reduced possibility of scar tissue formation are attributed to the insignificant amount of myofibroblasts.

In addition, the CO₂ laser can be effectively used for sulcular debridement due to its bactericidal properties along with the safety of the 10,600 nm wavelength around titanium implants.¹¹⁻¹³

Soft tissue laser surgery

The CO₂ laser is a “**what you see is what you get**” surgical soft tissue cutting laser with minimal collateral thermal effects sufficient for sealing blood vessels, lymphatics, and nerve endings; the surface bacteria are efficiently destroyed on incision/ablation margins. The current generation dental CO₂ laser technology features a small foot-print, compact unit with flexible hollow fiber beam delivery (Figure 1A), and a variety of straight and angled handpieces (Figure 1B). The handpieces are pen-sized, disposable-free, autoclavable, and easily adapted to switching between (1) incision with coagulation, (2) superficial ablation with coagulation, or (3) coagulation modalities.

CO₂ laser photo-thermal ablation and coagulation

Soft tissue photo-thermal ablation is a process of vaporization of intra- and extracellular water near the surface where the



Figure 1A: Articulated arm (left) and flexible fiber (right) dental soft tissue 10,600 nm CO₂ lasers. (Photo courtesy of LightScalpel, LLC)



Figure 1B: CO₂ laser surgical and dental handpieces with tipless and tip-retainer nozzles. (Photo courtesy of LightScalpel, LLC)

laser beam intensity is at its maximum (Figure 2). For a fixed laser beam diameter (or spot size), the volume of the tissue exposed to the laser beam is proportional to the optical penetration (i.e., absorption or Near-IR attenuation as defined earlier) depth. The shorter the penetration depth



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SEEING THE LIGHT

— the less energy is required to ablate the tissue. The longer the optical penetration depth — the greater the volume of irradiated tissue, and therefore, more energy is required to ablate the tissue within the irradiated volume of tissue. The 10,600 nm CO₂ laser is highly energy efficient at ablating the soft tissue photo-thermally with very low ablation threshold intensities due to extremely small volume of irradiated tissue because of extremely short absorption depth around 15 µm.¹⁴

The coagulation zone is located immediately below the ablation zone (Figure 2). Coagulation occurs as a denaturation of soft tissue proteins that occurs in a 60°-100°C temperature range leading to a significant reduction in bleeding (and oozing of lymphatic liquids) on the margins of ablated tissue during laser ablation (and excision/incision) procedures. The coagulation depth value relative to the blood vessel diameter is an important measure of coagulation and hemostasis efficiency. For CO₂ laser, its excellent coagulation efficiency is due to the close match between

the photo-thermal coagulation depth of approximately 50-100 µm¹⁴ and oral soft tissue blood capillary diameters of approximately 20-40 µm.¹⁵

Thermal Relaxation Time

The rate of how fast the irradiated tissue diffuses the heat away is defined by Thermal Relaxation Time, which equals approximately 1.5 msec for 75% water rich soft tissue irradiated by 10,600 nm CO₂ laser. Practical implications of the Thermal Relaxation Time concept are simple and yet very powerful for appropriate application of laser energy. The most efficient heating of the irradiated tissue takes place when laser pulse energy is high, and its duration is much shorter than T_R. The most efficient cooling of the tissue adjacent to the ablated zone takes place if time duration between laser pulses is much greater than T_R. Such laser pulsing is referred to as SuperPulse and is a must-have feature of any state-of-the-art soft tissue surgical CO₂ laser that minimizes the depth of coagulation.

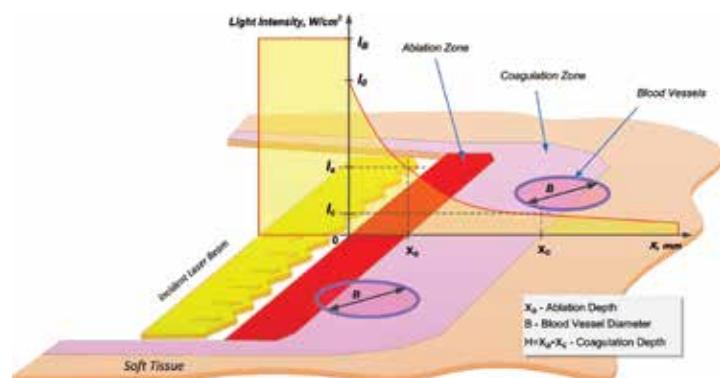


Figure 2: Simplified graphical representation of laser beam intensity attenuated inside the soft tissue

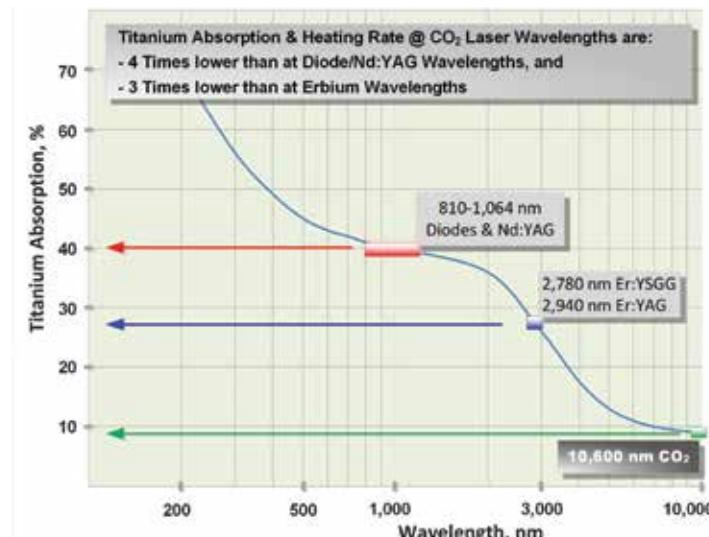


Figure 3: Titanium surface optical absorption spectrum derived from Wolfe and Zissis¹⁷

Laser beam spot size

Just as the sharpness of the steel blade defines the quality and the ease of the cut, the size of the laser beam focal spot defines the quality of the laser cut. The smaller (or sharper) the focal spot of the beam, the narrower and the deeper the incision. Just as a dull blade cannot produce a quality incision, an oversized laser beam spot cannot produce a precise and narrow incision. For a rapid switch from cutting to just photo-coagulation, the laser beam can be defocused either by selecting a larger spot size or by simply moving the handpiece away from the tissue by approximately 10 mm and "painting" the "bleeder" for enhanced hemostasis.

Laser power density and depth of ablation

Consider a steel blade: Regardless of how sharp the blade is, there will be no interaction between the blade and the tissue unless mechanical pressure is applied to the blade, forcing it through the tissue surface. For a laser scalpel, the power density of the focused laser beam is equivalent to the mechanical pressure that is applied to a cold steel blade: **the greater the laser power density, the greater the depth and the rate of soft tissue removal.**

Controlling thermal effects

The SuperPulse setting (see preceding explanation) minimizes the amount of the heat transfer from the cutting/ablation zone to surrounding tissue; it results in minimal char on the margins of the cut, facilitating better healing and reduced postoperative scarring of the surgical wounds. For a superior hemostasis effect through photo-coagulation by laser light, turning the SuperPulse mode off is recommended; such a capacity of the CO₂ laser is especially useful for procedures involving highly vascular tissues and patients with coagulation disorders or undergoing anti-coagulant therapy.

Laser-implant interaction

In a recent study on CO₂ laser removal of biofilms from implant surfaces,¹⁶ both titanium and titanium oxide (the most common implant materials) are reported to be unaffected when treated by high power 10,600 nm CO₂ laser. Figure 3 presents the absorption spectrum of the titanium surface. It illustrates that titanium implants,

when treated by the CO₂ laser, are affected (heated) approximately 4 times less than with diode and Nd:YAG wavelengths (circa 1,000 nm) and approximately 3 times less than with Erbium laser wavelengths (circa 3,000 nm).

A case report

Patient

The 66-year-old female patient presented for discomfort and pain, associated with her full arch mandibular implant-supported prosthesis. The patient had had the prosthesis for 10 years. Over that period of time, a significant amount of gingival hyperplasia developed around

and between the implants along with a decrease in vestibular depth (Figure 4). Hyperplastic tissue around one of the implants was inflamed with 5 mm of pocket depth and some circumferential bone loss (cotton swab in Figure 4 points at the involved implant). It was decided to perform the following procedures utilizing the CO₂ laser: (1) ablation of gingival hyperplasia, including the inflamed peri-implant tissue; (2) sulcus sterilization around the involved implant; and (3) vestibuloplasty with a palatal free gingival mucosal graft. Vestibular release and hemostasis for the palatal graft donor and recipient sites were done with the CO₂ laser. The focus of this article is only on the reduction of gingival

hyperplasia and sulcus sterilization immediately preceding the vestibuloplasty.

Laser equipment and settings

LightScalpel LS-2010 — the 20-watt carbon dioxide laser — (LightScalpel, LLC, Woodinville, Washington) was used with the following settings: 2-4 watts Super-Pulse, F1 repeat pulse modes 3-8. Three handpieces were used during the procedure: a fixed spot tipless handpiece, an angled tipless handpiece, and an angled tip retainer handpiece with ceramic perio-focusing tip. All three of the handpieces had the laser beam spot size of 0.25 mm (the smallest available).

Surgical procedure

Topical anesthesia was applied to the site (Figure 4). Then local anesthesia was administered by infiltration (2% lidocaine with 1:100,000 epinephrine). Ablation of hyperplastic tissue was performed on the gingival tissue between the implants (Figure 5). The straight tipless handpiece was held at a 3-5-mm nozzle-to-tissue distance (Figure 5). The surgeon's hand quickly moved in overlapping strokes as though "erasing" the excess tissue. Depending on the tissue amount and thickness, a number of passes were required to remove the hyperplasia from the gingiva.

After the hyperplastic tissue was vaporized in the spaces between implants, the inflamed tissue around the implant was ablated (Figure 6). The traces of carbonized ashes were rinsed off, and the surgical area was blotted off with damp gauze pad to ensure better penetration of the laser energy. In order to gain better access to the lingual part of the peri-implant tissue, the surgeon switched to the angled tipless handpiece (Figure 7). Once the inflamed tissue was removed and the surgical site rinsed off, touch-up ablation was performed to finish the hyperplastic tissue reduction between the implants (Figure 8).

For sulcular debridement, the surgeon switched to the angled handpiece with



Figure 4: Gingival hyperplasia – immediate pre-op view. The applicator with topical points at the inflamed tissue with the deep pocket around one of the implants



Figure 5: Tissue ablation with the LightScalpel straight tipless handpiece in progress. Note lack of bleeding



Figure 6: Ablation of the inflamed peri-implant gingival tissue. Note the small beam spot size on the target tissue



Figure 7: The tipless angled handpiece provided better access for ablation around implant



Figure 8: Last touch-ups of the hyperplasia ablation



Figure 9: Angled handpiece with a ceramic perio tip



Figure 10: The perio tip was slowly moved inside the peri-implant pocket during the sulcular debridement procedure

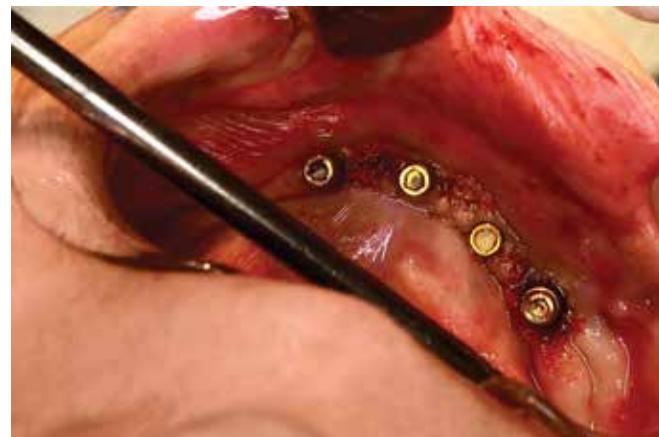


Figure 11: Immediate postoperative view

a ceramic periodontal tip (Figure 9). The laser power was reduced to 2 watts in the SuperPulse mode with repeat pulsing F1-3 mode. The periodontal tip was placed into the depth of the pocket and tracked slowly circumferentially around the implant to ablate the diseased tissue and eliminate the bacterial load within the pocket. Approximately 8-10 seconds were spent on both the buccal and lingual areas, with the tip smoothly gliding around the implant to ensure the laser energy reached all aspects of the peri-implant pocket (Figure 10).

After the peri-implant pocket treatment was finished, the pocket was thoroughly irrigated, and all residual intrasulcular material within the pocket was removed with implant curettes to make sure that all granulation tissue and residual epithelium had been eliminated.

The handpiece with the perio tip was then replaced by the tipless angled handpiece. Defocusing the laser was used to achieve hemostasis inside the peri-implant pocket where mild hemorrhage occurred from the mechanical debridement. Finally, the walls of the sulcus were smoothed out with the laser. The surgical area was rinsed off, and the procedure was completed (Figure 11 shows the surgical site immediately postoperatively). The patient was ready for the next stage of the surgery — vestibular tissue release and vestibuloplasty, which by doing so may contribute to the continued long-term success of this 10-year old prosthesis.

Postoperative assessment

The use of the laser for the tissue reduction, sulcular debridement, and vestibuloplasty effectively reduces postoperative pain and discomfort by the sealing off and ablation of the exposed tissue.

This reduces postoperative complaints of swelling and bleeding and minimizes the need for excessive post-surgical analgesia. The patient's prosthesis was immediately reinserted following the procedure and function restored.

Follow-up exam

The patient was seen 1 week after the surgery. Healing was uneventful, and the patient was pleased with the outcome. Typically, the tissue reduction site is well healed within 7-10 days and the vestibuloplasty site within 2-3 weeks.

Conclusion

The CO₂ laser was efficiently used for the hyperplastic gingival ablation and sulcular debridement. The ability of the CO₂ laser to achieve hemostasis proved especially important for the procedures described in this article for the following reasons:

- The laser maintained the dry bloodless operatory field with excellent visibility.
- Ability to see ensured precise tissue removal with very little collateral damage to the surrounding unaffected tissues.
- No sutures were required reducing overall surgery time.
- Patients report less post-op pain and swelling, thus less analgesia is necessary.
- With bactericidal effects, many at-risk implants can be treated early, before too much of the supporting bone is lost. **IP**

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