Lasers in Implant Dentistry, Part 2

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Lasers in Implant Dentistry, Part 2

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About the Author

Dr. van As graduated from the faculty of dentistry at the University of British Columbia, Vancouver, Canada, and was an assistant clinical professor there from 1989 to 1999. His memberships include but are not limited to the British Columbia Dental Association, the Canadian Dental Association, the Academy of Microscope Enhanced Dentistry, the Academy of Laser Dentistry, and the American Academy of Cosmetic Dentistry. He has built a high-tech, high-touch, full-time dental practice where the entire dental team is committed to using the latest technologies available to provide the highest level of clinical excellence in dentistry. He has lectured internationally and provided hands-on workshops and has published internationally on multiple topics involving dental lasers and microscopes. He is an active member on many web forums dealing with lasers and microscopes in the general dental practice, acts as a consultant for many high technology companies, and is a reviewer of articles for dental magazines. He was distinguished with the Leon Goldman award in 2006 for worldwide clinical excellence in laser dentistry and has been one of Dentistry Today’s Leaders in Continuing Education since 2012. He can be reached via email at glennvanas@mac.com or the website drvanas.com.

Disclosure: Dr. van As discloses having received honoraria and equipment from the following companies: BIOLASE, Global Microscopes, AMD Lasers, and Zolar Lasers.

In the July 2015 issue of Dentistry Today, I began the first part of this 2-part article with a discussion of how lasers have become a go-to part of the dental armamentarium in many aspects of our practice. Diode lasers have become the “soft-tissue handpiece” and an electrosurgery replacement in many practices due to their portability, cost effectiveness, reliability, and ability to work around metals such as dental implants.1–2 The erbium family of lasers (Er:Cr:YSGG and Er:YAG), originally promoted for their ability to provide anesthetic reduced restorations,3 have become valuable for their ability to ablate anything with water in it, making them truly “all-tissue lasers.”3–5 These lasers can provide benefits to restorative dentistry and soft-tissue ablation, but their ability to safely remove bone and soft tissue and work around metals has made this family of lasers for many dentists their go-to device when contouring hard and soft tissue is necessary in conjunction with dental implants.

In the first part of this 2-part series, I covered my own classification of the role of lasers in implant dentistry by the stage of the procedure where the lasers are used (Figure 1). The initial article focused on the role of lasers in the earlier portions of implant surgical placement, including the benefit of lasers prior to implant placement for the degranulation and disinfection of extraction sockets. In addition, erbium lasers can be used early on for ablating bone for lateral window sinus lifts. During actual implant placement, these all-tissue lasers can be used to create flaps instead of scalpel blades, with improved visibility, due to their ability to provide hemostasis and for the fine mist of water + air spray that keeps the surgical site clean. All-tissue erbium lasers can ablate bone, which can allow them to be useful for the early stages of osteotomies. In addition, research from Kesler et al6 has shown that this family of lasers can be of benefit to guided bone regeneration (GBR) when used to decorticate the bone in allowing for increased release of osteogenic growth factors when compared to burs for perforation of the cortical plates.

The initial article closed with a focus on the value of erbium lasers to gently and safely level bone around fixtures, and to help with soft-tissue recontouring around healing abutments. The increasing interest in the value of low level laser therapy (LLLT) from 810-nm diode lasers to help with biostimulation (wound healing) and bioinhibition (pain decrease) as well as their effect on decreasing neurosensory deficits was broached.

In the second part of this article, the focus will be on the role of lasers within dental implantology after the surgical phase is completed. The importance of lasers to help with the recovery of buried fixtures, and during the prosthetic phase of impressions and final insertions cannot be underestimated where frequently soft tissue must be revised. Finally, and perhaps most importantly, new evidence in the last few years has shown that lasers might be a key portion of the growing need to treat ailing implants that have suffered bone loss and have peri-implantitis. The difficulty of detoxifying implant threads with traditional methods may be overcome with lasers, and studies show re-osseointegration onto laser treated surfaces is definitely possible, thus enabling practitioners to salvage cases which might otherwise be treated with explanation, grafting, and starting over at considerable time, expense, and discomfort for patients.7

LASER USAGE DURING IMPLANT UNCOVERY

After the surgical phase of implant therapy is complete, in some cases the fixtures are buried in a 2-stage approach. Although as clinicians we love to complete as many surgical placements in a single stage, with a healing abutment in place at the time of fixture placement so that soft-tissue modeling can occur from the very first step, this is not always possible.
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There are situations in which a cover screw must be inserted into the implant fixture and soft-tissue coverage with an uninterrupted healing period is required for a 2-stage surgical approach. Two-stage surgery may be required if initial primary stability is low, if less than 2 mm of soft tissue exists above the bony crest, or if bone grafting is done at the time of surgical placement.

Some clinicians feel that their trusty monopolar electrosurgery units can be used to remove overlying soft tissue above implants. Wilcox et al.\(^8\) showed that monopolar electrosurgery units could provide quickly localized heat effects above the critical 10°C range that could potentially damage the osseointegration of implants in bone. They\(^8\) suggested that monopolar electrosurgery units not be used around implants. Massiei et al.\(^9\) in their study in 2004, showed that a 3-second exposure to monopolar electrosurge on the fixture, applied without local anesthetic, was enough for all 20 implants in the study to be easily counter rotated with settings of less than 35 Ncm, and with minimal bone necrosis 2 weeks after exposure to the electrosurge. In fact, they\(^9\) discussed “thermo-explantation” due to electrosurgery as a method for perhaps simply removing implants when fixture removal was required. In contrast, studies show diode lasers, when used with lower settings, can be used safely around dental implants.\(^10\)\(^-\)\(^12\) Yeh et al.\(^11\) have shown that when diodes were used at settings of 0.5 to 1.0 W Continuous Wave that they could be used to uncover fixtures. Romanos et al.\(^13\) showed that caution must be used with diode lasers, as heat buildup can occur rapidly within 15 to 20 seconds, so the authors suggest stopping every 15 seconds or so and using water on the surgical site and a high-volume suction to control heat buildup in the surgical site when using diode lasers to uncover fixtures.

The author,\(^10\) in 2011, discussed 2 different methods for uncovering implants with a laser. The first technique is called the “manhole” technique and is best suited for the posterior region where adequate healthy attached and keratinized tissue exists. In this case, the overlying tissue can be removed in a circular fashion to expose the underlying cover screw. Diode lasers and other soft-tissue wavelengths offer precise ablation with ideal hemostasis, and when used in this technique, often impressions for the final implant restorations can be taken the same day as the uncovering appointment. The benefit of the diode laser uncovering in in limiting the number of sutures and shortening the number of appointments required as the traditional 2- to 3-week healing period after flap uncovering with sutures is avoided (Figures 2 to 5).

When working in the aesthetic zone or in areas where attached and keratinized tissue overlying fixtures is minimal,
Clinicians may be wise to utilize techniques that attempt to “move rather than remove” remaining tissue. Arnabat-Domínguez et al., in 2010, demonstrated a technique of using the Er,Cr:YSGG wavelength (BIOLASE) to uncover implants with a buccal roll technique to aid with augmenting tissue in situations where there was insufficient gingival attachment. The author has termed this technique the “trap door” laser uncovery, and it can be utilized to increase both volume of soft tissue or amount of keratinized tissue. To increase the amount of keratinized tissue, a soft-tissue incision is made with the laser in 2 interconnecting incisions on the mesial, palatal, and distal, and the overlying tissue over the implant is lifted up and displaced to the facial of the healing abutment (Figures 6 to 11). If the thickness of soft tissue needs to be augmented, the erbium laser is used first to de-epithelialize the overlying tissue and then the same incisions are made but the tissue is tucked into a pouch on the facial of the abutment to augment the amount of facial-lingual volume of tissue. This technique can be particularly valuable in the maxillary anterior in combination with connective tissue grafts to augment facial volume overlying the implant when remaining soft-tissue volume is thin and fixture shine-through is a distinct possibility.

**LASER USAGE DURING FINAL RESTORATIONS**

Soft tissue can be a significant barrier to the ideal seating of final implant restorations. Soft tissue can impede the full complete seating of both screw-retained restorations if the tissue covers the shoulder and connection of the fixture. In addition, in cemented restorations, soft tissue can be a significant problem when margins of abutments are subgingival for aesthetic reasons. A cemented restoration that comes loose can be a major headache for clinicians where rem cementing the restoration properly can be all but impossible with traditional means of soft-tissue management. In addition, at times, healing abutments can come loose during the healing phases of treatment or even can be lost, and soft tissue quickly invades the space; this tissue is easily removed with many lasers including diode lasers, CO₂ lasers, and the all-tissue erbium lasers. Since soft-tissue lasers are better absorbed by hemoglobin, they tend to be better from a hemostasis standpoint, but they do ablate through a photothermal effect without water, and this can lead to increased thermal damage if conservative settings are not utilized.

In an effort to simplify the management of soft tissue when seating implant restorations, many clinicians prefer to provide
screw-retained final restorations for their implants’ supported prosthesis. In theory, this reduces the need to remove soft tissue around an abutment as the crown can be cemented to the abutment under carefully controlled settings to minimize the risk of subgingival cement, which Wilson has demonstrated, can have serious negative sequelae to peri-implant mucosa and bone (cement sepsis).

All lasers can be used to modify soft tissue around both fixtures and abutments. Jin et al showed that the Er,Cr:YSGG was superior to the diode laser in soft-tissue surgery when it came to thermal damage, and Ryu et al demonstrated that the Er,Cr:YSGG laser has many advantages for oral surgery due to a low inflammatory response and minimal damage of the tissue compared to CO₂ lasers.

The ability to recontour soft tissue around both implant fixtures and abutments can be a true “lifesaver” for both initial placements of the final restorations and for recementation of restorations (Figures 12 to 14).

**LASER USAGE AFTER IMPLANT PLACEMENT**

Implant treatment has evolved during the last few decades with a tremendous advancement in our knowledge and, as a result, successful aesthetic and functional cases are now more routine. Having said this, there are still cases where inflammation in the peri-implant soft tissue (mucositis) or bone (peri-implantitis) causes significant problems such as persistent pain, bleeding, infection, bone loss, and (if left untreated) implant failure. Atieh et al looked at the frequency of peri-implant diseases and found that the frequency of peri-implant mucositis was in 63.4% of participants and 30.7% of implants. The more serious disease of peri-implantitis was found in 18.8% of participants and 9.6% of implants (Figure 15). Etiological factors for peri-implantitis include poor oral hygiene, occlusal overload, lack of attached keratinized soft tissue, smoking, subgingival cement, systemic factors (diabetes), and poor implant placement.

Padial-Molina et al classified early peri-implantitis as probing depths of 5 mm or less with less than 2 mm of bone loss. They suggested that nonsurgical treatment approaches might help in these early cases. They classified moderate bone loss cases as those where probing depths increased to 6 to 7 mm and there was greater than 2 mm of bone loss but less than 50% of total bone loss around the implant. In these cases, they suggested a surgical flap for visualization, with degranulation, and detoxification of the implant surface followed by GBR and where needed, augmentation of tissue with connective tissue grafting. In advanced cases, where probing depths were greater than 8 mm and bone loss exceeded 50% of the total amount around the fixture, then implant removal and GBR is the standard recommendation (Table 1).

For many cases, the most difficult part of treatment is the process of completely removing the soft tissue (degranulation) and detoxifying the implant surface. Traditionally, the process of implant detoxification has been completed through chemical approaches (saline, citric acid, chlorhexidine, hydrogen peroxide, and antimicrobials) or mechanical approaches (abrasive pumice, air abrasive powder, implantoplasty, or laser methods). Could lasers perhaps hold a better method for disinfection and degranulation of these difficult-to-treat sites?

**NONSURGICAL TREATMENT OF PERI-IMPLANTITIS**

Nonsurgical approaches to treating peri-implant diseases are preferred by most clinicians in that it offers a simpler and less
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invasive approach. Renvert et al.\textsuperscript{23} demonstrated that mechanical nonsurgical approaches could be beneficial when inflammation was contained to the soft tissue only (mucositis). Unfortunately, when bone loss starts to happen around dental implants, the disease has progressed from a mucositis to the more serious peri-implantitis and traditional minimally invasive nonsurgical techniques utilizing subgingival irrigation and mechanical therapy were not as effective for long-term resolution. Minor benefits were seen with a laser approach, so Renvert et al.\textsuperscript{23} suggested further research be done in this area.

Roncati et al.\textsuperscript{24} demonstrated that an 810-nm diode laser at the low level settings of 1.0 W pulsed with an uninitiated tip for up to 6 minutes per site, followed with hand scaling and subgingival irrigation with chlorhexidine rinse and done 2 days consecutively in a row, could be a feasible alternative in the management of early cases of peri-implantitis. The cases did have up to a 5-year follow-up, and the suggestion was that the diode laser was detoxifying implant surfaces, weakening the bond of calculus to the implant surface to allow for easier removal and that it might stimulate the production of fibroblasts and osteoblasts, increasing collagen production during healing through the benefits of LLLT (biostimulation).

Other wavelengths have been also investigated for the nonsurgical treatment of peri-implantitis lesions. Tosun et al.\textsuperscript{25} have shown that complete or near complete elimination of bacteria on the surface of implants can be completed in vitro using diode lasers as well as CO\textsubscript{2} and Er:YAG wavelengths. Based on the research for the effective and successful regeneration of periodontal lesions demonstrated by Yukna et al.\textsuperscript{26} known as LANAP (Laser Assisted New Attachment Procedure [Millennium Dental Technologies]) and confirmed in other studies,\textsuperscript{27-29} a similar protocol was developed for the closed flap laser treatment of peri-implantitis lesions using the soft-tissue Nd:YAG wavelength (1,064 nm) by Nicholson et al.\textsuperscript{30} This protocol is known as LAPIP (Laser Assisted Peri-Implantitis Procedure [Millennium Dental Technologies]) and utilizes the protocol developed for periodontitis with the Nd:YAG laser in a similar fashion for ailing implants. Nicholson et al.\textsuperscript{30} found that of the original 26 cases in their study, the final 16 cases that were followed to completion showed radiographic evidence of an increase in crestal bone mass around the implant and decreased probing depths. There was control of infection and reversal of bone loss and rescue of the incumbent implant in all cases (Figure 16).

In looking at the promising research for nonsurgical treatment using diode and the surgical pulsed Nd:YAG soft-tissue lasers, one must be careful to use well-defined operating parameters and training to avoid causing thermal reactions such as melting, cracks, and crater formation on the titanium surface.\textsuperscript{12,31}

Another wavelength with promise for nonsurgical treatment of early peri-implant lesions is the Er,Cr:YSGG (2,780 nm). This wavelength, with its water spray combined with tips that fire radially (Figure 17) has demonstrated promise in at least one study.\textsuperscript{32} The radially firing tip was used in a nonsurgical approach in 28 implants and 11 patients. Results at

### Table 1. Diagnosis and Treatment of Peri-Implant Diseases, per Padial-Molina et al.\textsuperscript{21}

<table>
<thead>
<tr>
<th>Classification</th>
<th>Clinical Parameters</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td>5 mm or less PD</td>
<td>Nonsurgical + Antibiotics</td>
</tr>
<tr>
<td></td>
<td>+ &lt; 2 mm bone loss</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>6 to 7 mm PD,</td>
<td>Surgical Flap</td>
</tr>
<tr>
<td></td>
<td>&gt; 2 mm bone loss</td>
<td>+ DD +/- GBR +/- CTG</td>
</tr>
<tr>
<td>Advanced</td>
<td>&gt; 8 PD</td>
<td>Implant Explanation</td>
</tr>
<tr>
<td></td>
<td>+ &gt; 50% bone loss</td>
<td>+ GBR</td>
</tr>
</tbody>
</table>

KEY: PD = probing depths, DD = degranulation and detoxification, GBR = guided bone regeneration, CTG = connective tissue grafting.

Figure 16. Pre-op and post-op Laser Assisted Peri-Implant Procedure (LAPIP) radiographs demonstrating significant radiographic healing (lanap.com/ lapip_home.php) (courtesy of Millennium Dental Technologies).

Figure 17. Radially firing tip used with Er,Cr:YSGG wavelength for peri-implantitis treatment.
short-term follow-ups of 2 and 6 months showed a significant decrease in bleeding on probing and pocket depths at 2 and 6 months. The technique relies on the removal of epithelium on both the inner wall of the pocket and the outer surface of the epithelium, as well as bacterial decontamination in the pocket and, in addition, the removal of calculus with the laser inside the pocket made possible with the use of the erbium family of lasers (Figures 18 to 21). Although nonsurgical treatment of peri-implantitis may show promise as a phase 1 treatment, particularly for early peri-implant lesions, further research is necessary to demonstrate which wavelengths are best, and ideal settings in clinical studies for those wavelengths.33

SURGICAL TREATMENT OF PERI-IMPLANTITIS

If the bone loss around a fixture is moderate or severe, then a decision must be made first if the implant is worth saving. Clinically, if 50% of the bone has been lost, then traditionally the treatment that is suggested is explantation of the implant and grafting to attempt another implant for long-term success.21 Froum et al34 has provided a landmark paper on surgical correction of 51 peri-implantitis cases with a follow-up of between 3 and 7.5 years. In their paper, Froum et al34 cite a 7-step protocol for surgical treatment of these lesions (Table 2) which has a detoxification procedure for the implant which is time intensive and messy (air abrasion) (Table 3).

The use of lasers to help with potentially disinfecting implants was discussed by Berk et al35 where they showed that: “The Er,Cr:YSGG laser seems to be an effective tool for peri-implant treatment by means of removal of biofilm; however, further in vivo and in vitro studies are also required to gain a better understanding of osteoblastic cell behavior on different types of contaminated implant surfaces, and to confirm clinical applications and to optimize parameters.”

Recent research, published in established journals by Yamamoto and Tanabe36 have demonstrated that the erbium family of lasers is able to completely remove the contaminated titanium oxide layer (Ti-Unite) when optimal settings are used (100 mJ/mm² + 20 Hz with water spray). In addition, there was a minimal 3°C rise in temperature with laser irradiation, and that the potential in beagle dogs existed for re-osseointegration to occur on the laser surfaces after 6 weeks was shown histologically. In a follow-up to this study, Nevins et al37 demonstrated with animal research (foxhounds) that the Er:YAG laser (2,940 nm) could strip away the contaminated titanium oxide layer in artificially induced peri-implant lesions and that both hard- and soft-tissue inflammation progression was arrested. In this research group’s most recent study,38 the Er:YAG laser was used on 2 patients clinically, with short-term follow-ups of 10 months with promising results. This case series of 2 patients showed that antibiotic therapy reduced the bacterial amount from the peri-implantitis sites significantly, and that Er:YAG laser therapy, along with the bone augmentation, enhanced bone regeneration in the peri-implant bony defects.

There are very few long-term clinical studies on patients and significant differences between laser and conventional therapies have not yet been shown. According to current research, although the erbium lasers show the most promise for surgical treatment of peri-implantitis—particularly in defects that are narrow and deep—there still is a need to clarify in detail the complete impact of these wavelengths on titanium and to prove superiority over traditional treatment modalities. Although these wavelengths do show technical and therapeutic advantages as both an adjunctive
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tool and possibly as an alternative to other methodologies, further clinical studies are necessary. Studies with longer periods of follow-ups, intense control of plaque index, and various sessions of laser treatments are needed to clearly illustrate the benefits of laser therapy for the treatment of ailing implants.39

CLOSING COMMENTS
This 2-part series was written to show, through a classification system designed by the author, how lasers available in dentistry might be beneficial to dental implantology based on the phase of treatment. The ability of lasers to be an adjunctive tool to improve treatment outcomes, before implant placement for extraction socket grafting (degranulation and disinfection) and for GBR (decoration), is exciting, possibly reducing the need for systemic antibiotics. During the surgical phase of implant placement, lasers are beneficial for starting osteotomies and for remodeling of hard and soft tissue around the fixtures. Increasing amounts of research are demonstrating that LLLT can help with biostimulation (wound healing) and bioinhibition (pain relief) in surgery while being beneficial when dealing with neurosensory deficits. The role of all lasers for uncover in stage 2, for soft-tissue recontouring around implant fixtures, and finally for the growing role of lasers in both the nonsurgical and surgical treatment of peri-implantitis demonstrates that lasers can be a significant “tool in the toolbox” for all aspects of implant therapy in helping to make the clinician’s life simpler with improved treatment outcomes.

References
1. van As GA. The diode laser as an electrosurgery replacement. Dentaltown. June 2010:56-64.
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POST EXAMINATION QUESTIONS

1. Er,Cr:YSGG and Er:YAG lasers have become valuable for their ability to ablate anything with water in it, making them truly “all-tissue lasers.”
   a. True   b. False

2. In fact, Massei et al discussed “thermo-explantation” due to electrosurgery as a method for perhaps simply removing implants when fixture removal was required.
   a. True   b. False

3. Tissue erbium lasers cannot ablate bone, rendering them useless for the early stages of osteotomies.
   a. True   b. False

4. Romanos et al showed that caution must be used with diode lasers as heat buildup can occur rapidly within 15 to 20 seconds.
   a. True   b. False

5. Wilcox showed that monopolar electrosurgery units could provide quickly localized heat effects above the critical 10°C range that could potentially damage the osseointegration of implants in bone.
   a. True   b. False

6. Studies show diode lasers, when used with lower settings, cannot be used safely around dental implants.
   a. True   b. False

7. Since soft-tissue lasers are better absorbed by hemoglobin, they tend to be better from a hemostasis standpoint, but they do ablate through a photothermal effect without water, and this can lead to increased thermal damage if conservative settings are not utilized.
   a. True   b. False
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8. Atieh et al looked at the frequency of peri-implant diseases and found that the frequency of peri-implant mucositis was in only 26.4% of participants and 10.7% of implants.
   a. True  b. False

9. Roncati et al demonstrated that a 810-nm diode laser at the low level settings of 1.0 W pulsed with an uninitiated tip for up to 6 minutes per site, followed with hand scaling and subgingival irrigation with chlorhexidine rinse and done 2 days consecutively in a row, could be a feasible alternative in the management of early cases of peri-implantitis.
   a. True  b. False

10. Recent research, published in established journals by Yamamoto and Tanabe, has demonstrated that the erbium family of lasers was not able to completely remove the contaminated titanium oxide layer.
    a. True  b. False

11. There are many long-term clinical studies on patients and no significant differences between laser and conventional therapies have been shown.
    a. True  b. False

12. Increasing amounts of research are demonstrating that low-level laser therapy can help with bio-stimulation (wound healing) and bio-inhibition (pain relief) in surgery while being beneficial when dealing with neurosensory deficits.
    a. True  b. False
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2. ☐ a. True ☐ b. False
3. ☐ a. True ☐ b. False
4. ☐ a. True ☐ b. False
5. ☐ a. True ☐ b. False
6. ☐ a. True ☐ b. False
7. ☐ a. True ☐ b. False
8. ☐ a. True ☐ b. False
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