Dual-wavelength laser treatment of osteotomy site to increase the success rate of implant placement

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The focus of this case report is to demonstrate the efficacy of the dual-wavelength (2,940 nm Er:YAG and 1,064 nm Nd:YAG) laser protocol used in our office and its role in increasing the success rate of implant placement. Success is defined as the decreased risk of peri-implantitis and of resulting infections around the implant, the decreased risk of implant failure and of postoperative complications of implant placement, and the increased stability of implants placed into the surrounding bone.

It has previously been shown that the Er:YAG laser can be used for removal of granulation tissue in both the soft tissue and bone and for superficial disinfection of the implantation site. Furthermore, it can be used to roughen the osteotomy surface for surface modification and hence better cell attachment, as well as to stimulate healing. Decortication using the Er:YAG laser has been shown to increase blood supply to the bone surrounding the implant for increased healing capabilities and to support overlying grafts. The Er:YAG laser has a low risk of heating the bone and of carbonisation owing to its very nature of superficial ablation as well as owing to the use of water spray, which cools the site. This laser has also been found to have a superficial photo-biomodulation effect.

The Nd:YAG laser is used for deep disinfection inside the osteotomy by reducing the periopathogen load in the cortical bone after extraction of teeth and inadequate curettage or degranulation of the bone and socket. Multiple studies have reported comparisons with conventional drills and burs, which, when used alone without Er:YAG and Nd:YAG lasers, generate more thermal heat, increasing the risk of bone necrosis, decreasing the healing rate of the bone and osseointegration with the titanium implant surface, increasing inflammation, and decreasing the mechanical and biological stability of the implant.

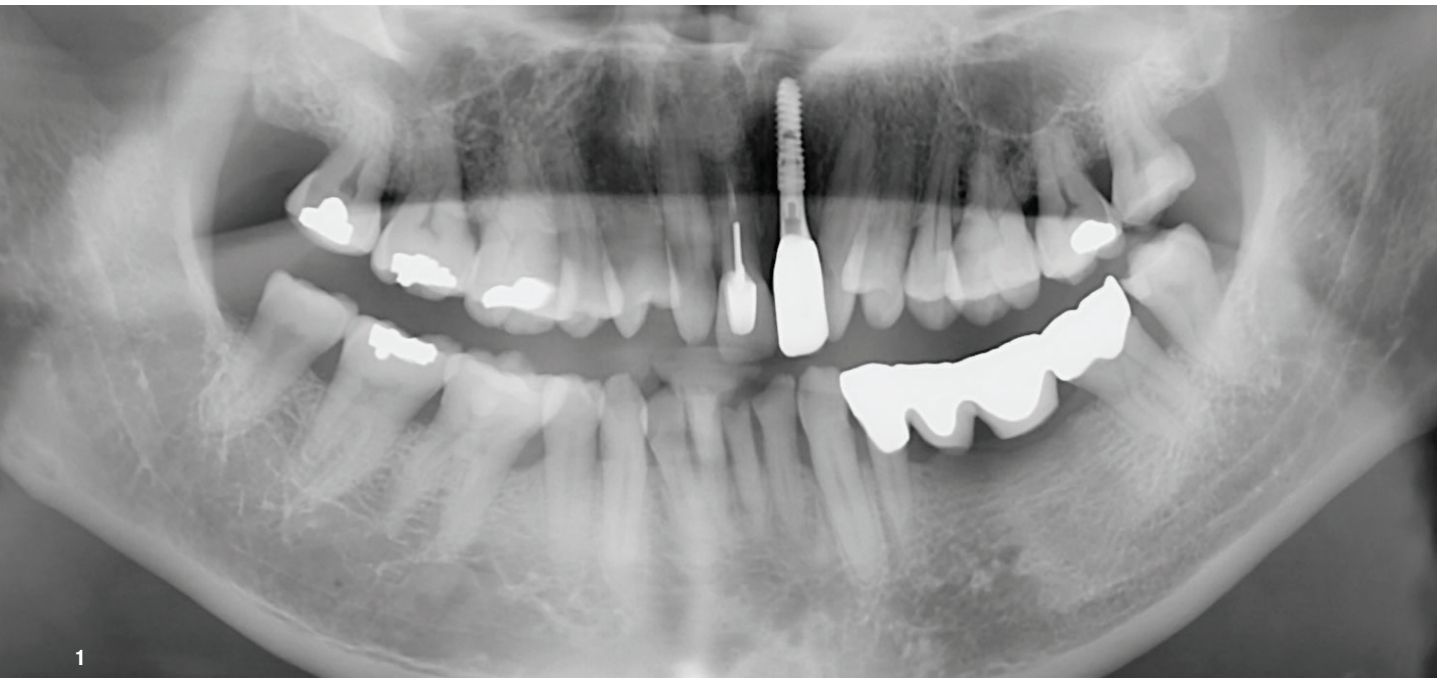

Fig. 1: Pre-op radiograph.

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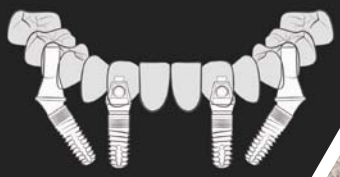

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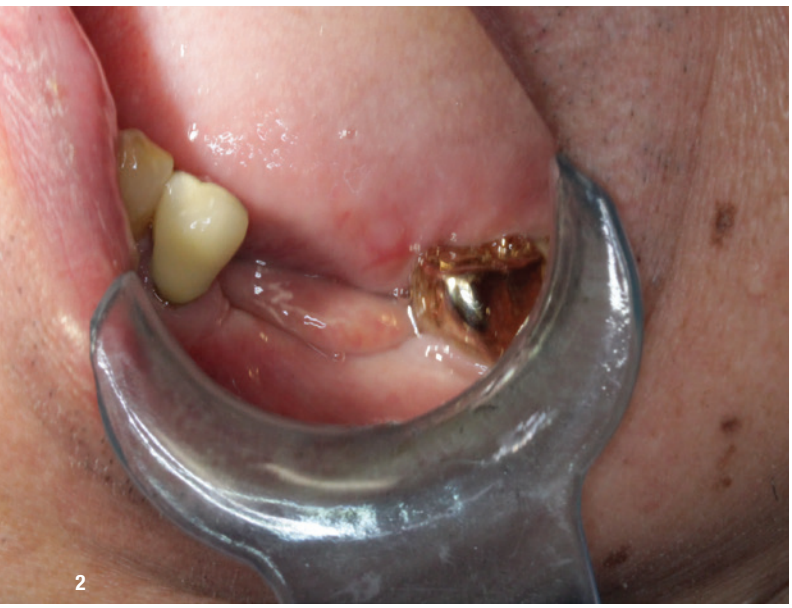

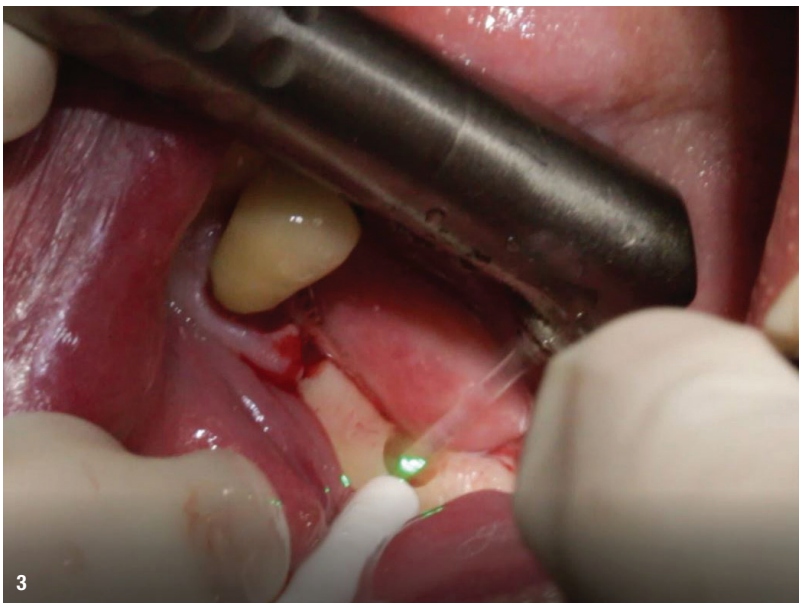

Fig. 2: Pre-op image of the treatment area. **Fig. 3:** During Er:YAG laser degranulation of the osteotomy site.

Patient description

The patient had mild hypertension and used antihypertensive medications such as ramipril (angiotensin-converting enzyme inhibitor), propranolol (beta-blocker) and amlodipine (calcium channel blocker). He also was taking levodopa/carbidopa for Parkinson's disease. He had an extensive history of previous dental work (Fig. 1). His oral hygiene was fair, as he brushed his teeth twice a day, but only flossed once or twice a week. He had general chronic moderate periodontitis. The TwinLight periodontal laser-assisted cleaning procedure using both Er:YAG and Nd:YAG lasers (Fotona) was completed on the patient to improve the clinical attachment of the teeth, reduce the pocket depths and improve periodontal bone regeneration.

The patient had had a bridge extending from tooth #34 to tooth #37 for over ten years (Fig. 2), but there had been extensive decay underneath the mesial surface of tooth #37 in the past. The patient wished to have implants placed in sites #35 and 36, to cut the bridge distally at tooth #34 to preserve the crown, to remove the old crown on tooth #37, to remove decay from mesial aspect of tooth #37 and to place a new complete gold crown. The treatment plan was to perform Er:YAG and Nd:YAG laser-supported degranulation, surface modification and disinfection of the osteotomy sites before implant placement in sites #35 and 36.

Treatment

On the day of surgery, the patient was prepared on the surgical chair with a bib and facial cover. The patient had already taken two capsules of amoxicillin (1,000 mg) a day before the surgery, and a 0.12% chlorhexidine rinse was given to the patient to rinse with before surgery. One carpule of 4% articaine and 1:200,000 adrenaline was administered for the left inferior alveolar nerve block and two carpules of 2% lidocaine and 1:100,000 adrenaline were administered for buccal and lingual infiltration all around the areas of the buccal and lingual mucosa of sites #35 and 36. Three tubes of leucocyte- and platelet-rich fibrin (L-PRF; 12-minute centrifuging at 2,700 rpm; EBA 200, Hettich) and one white tube of F-PRF (folded platelet-rich fibrin; 3-minute centrifuging at 1,500 rpm) resulted from blood drawn from the patient's arm.

A #15 scalpel was used to raise a full-thickness envelope flap along the gingival crest from the distal aspect of tooth #34 to the mesial aspect of tooth #37. A guided surgery kit with a fabricated surgical guide was used for preparation of the osteotomies with a sequence of osteotomy drills before placement of the implants. Specifically, for site #35, we used an initial regular-diameter osteotomy drill to mark the osteotomy site and then a 3.5×7.0 mm drill and a 4.0×7.0 mm drill. The osteotomy site was left for laser treatment before implant placement. For site #36, we used an initial wide-diameter osteotomy drill to mark the osteotomy site and then a 3.5×7.0 mm drill and a 4.5×7.0 mm drill. The osteotomy site was left for laser treatment before implant placement. The osteotomy drills were used at a setting of 800 rpm with saline water turned on at a medium setting.

Laser parameters

The following sets out the steps of using the Er:YAG and Nd:YAG laser system (LightWalker AT S, Fotona) on the osteotomy site. An Er:YAG H14 handpiece was used with

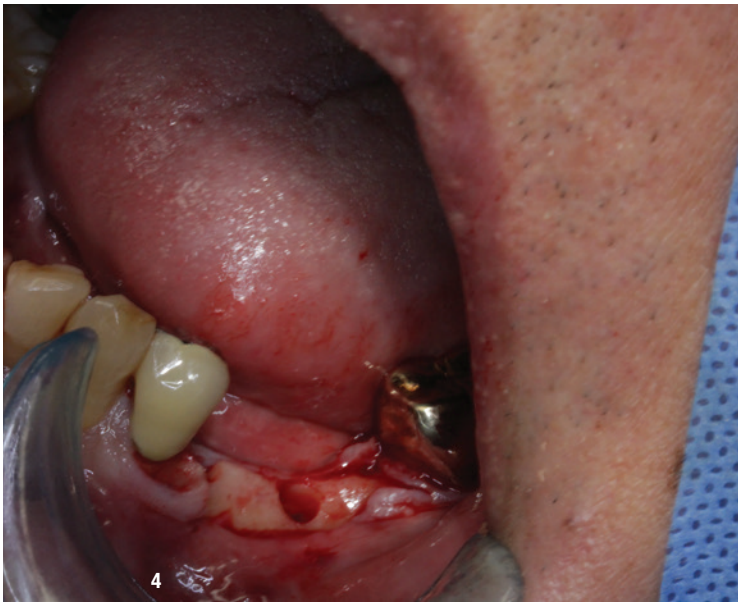

Fig. 4: Osteotomy site immediately after laser treatment.

a cylindrical 12/1.3 fibre tip at 160 mJ and 20 Hz, in SP (short pulse) mode and with a 5:4 water–air spray to degranulate the tissue, as well as provide superficial disinfection and ablation on both the bone surface and the soft tissue overlying the osteotomy site (Fig. 3). Degranulation mode removed all remaining soft tissue in and around the bone. An Er:YAG H14 handpiece with a cylindrical 12/1.3 fibre tip at 50 mJ and 30 Hz, in MSP (micro-short pulse) mode and with a 5:4 water–air spray was then used for superficial disinfection along the osteotomy socket and to conservatively open up the bone marrow spaces along the socket walls. Choosing this setting is gentler on the osteotomy site without removing more bone, which is critical for the stability of the implant and placement. This in effect will increase the speed of healing, decrease inflammation, increase bone–implant contact, increase mechanical stability, increase biological stability and increase surface modification for better cell attachment. An Nd:YAG 300 µm fibre tip non-contact with the bone at 2 W and 20 Hz and in MSP mode was then used for deep disinfection of the osteotomy site (Fig. 4). This allows for increased removal of any periopathogens that may contribute to the failure of implant osseointegration. Care was taken to ensure that blood in the socket site was removed with high speed and that it did not interfere with the Nd:YAG laser. No decortication of bone was required in this case, as there was ample bleeding from inside the osteotomy site. These steps allowed us to skip physical curetting, making it more comfortable for the patient and less time-consuming.

Using a surgical guide, a 4.5 × 7.0 mm Hiossen ETIII SA implant (Osstem Implant) was placed in site #35 with a regular no-mount driver and a 5.0 × 7.0 mm implant was placed in site #36 with a wide-diameter driver. L-PRF was

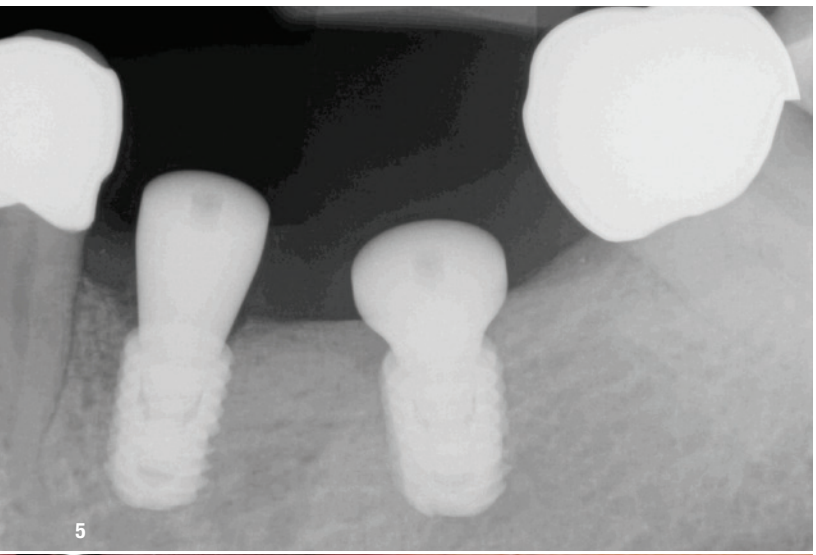

Fig. 5: Radiograph after 45 days of follow-up. **Fig. 6:** Almost complete primary closure of the tissue after 45 days of follow-up.

placed on top of each implant and then a 5×5 mm Hiossen long-necked healing abutment was hand tightened on to implant #35 and a 6×5 mm healing abutment on to implant #36. Cytoplast PTFE sutures were placed.

Postoperative instructions and pain management

Photo-biomodulation was performed twice, two days apart, with the Genova Nd:YAG handpiece in non-contact mode at 0.5 W/cm^2 and 10 Hz in MSP mode for 1 minute per spot at the implant sites for pain management and better regeneration of the tissue.

The patient was prescribed amoxicillin (500 mg) for one week and a 0.12% chlorhexidine rinse for one week. He only took ibuprofen (400 mg) twice for the first two days for pain management.

Observations and results

The patient was comfortable throughout the implant surgery and did not feel any pain. Mild bleeding was observed during the soft-tissue incision for the envelope flap. Moderate bleeding was observed after osteotomy preparation with the conventional osteotomy drills. The Er:YAG degranulation mode produced some increased bleeding on the bone surface. Surface modification of the socket site with Er:YAG also produced more bleeding. Ultimately, after the implants had been placed, the bleeding subsided. Moreover, placing membranous L-PRF underneath the healing abutments ultimately contained the bleeding.

The patient had mild chronic pain and mild localised oedema around the implant sites for two days after the surgery, and these symptoms resolved over time. Photo-biomodulation was performed for a second time two days after the surgery, and this further decreased the inflammation and pain. By this time, primary closure of the tissue had begun. Three weeks later, the patient returned for removal of the PTFE sutures. There was no more bleeding or oedema. The soft tissue was still in the process of healing, but the patient was asymptomatic, and there was almost complete primary closure of the tissue after 45 days of follow-up (Figs. 5 & 6).

Conclusion

The dual-wavelength approach using Er:YAG and Nd:YAG lasers for degranulation, surface modification, disinfection and photo-biomodulation of osteotomy sites is indispensable for the long-term success of implant placement.

about the author

Dr Sean Chiu completed his BS in molecular biology in 2002 and his DDS at New York University in the US in 2009. He was a BITES Institute implantology member from 2012 to 2018 and completed the Laser and Health Academy master's programme in laser dentistry between 2019 and 2021. He has been practising dentistry since 2009.

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