

Laser-assisted osseointegration with a diode laser in Type I implant placement

Authors Dr Maziar Mir, Prof. Norbert Gutknecht, Dr Masoud Mojahedi, Dr Jan Tunér, Prof. Ramin Mosharraf & Dr Masoud Shabani, Germany, Sweden & Iran

_Implant placement is conventionally performed after healing of the extraction socket. However, with this method, undesirable outcomes can occur owing to the substantial period that elapses before clinicians can continue treatment, for example a reduction in bone level and the collapse of soft tissue. These unwanted results can compromise aesthetics in the anterior region significantly. Therefore, immediate (Type I) implant placement can be a golden opportunity to preserve the aesthetics. Fear of failure, especially in the case of an infected socket, is the greatest barrier to selecting Type I implant placement.¹⁻⁵

_Laser in implantology

Lasers have several applications in implantology, for example:⁶

- Recontouring of peri-implant soft tissue
- Sculpting of the emergence profile for prosthetic components
- Rising of surgical flaps
- Osseous recontouring
- Creation of parabolic tissue architecture
- Bone harvesting of block grafts
- Window preparation in sinus lift procedures
- Ridge splitting
- Debridement of extraction sockets for immediate implant placement.

Research reports show that the mineralisation of the socket may not be adequate after three months. Therefore, additional support to achieve the best bone density and better osseointegration after implant placement is needed, specifically in Type I implant placement.⁷ It appears that diode lasers have some potential benefits in helping clinicians to obtain the best results in implant placement into a fresh socket.

- Atraumatic uncovering of submerged implants to prevent crestal bone loss

Fig. 1 Crown-root fracture.
Fig. 2 Diagnostic impression.

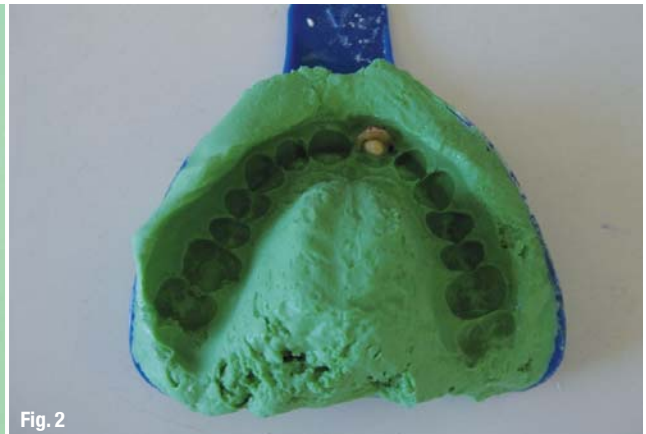
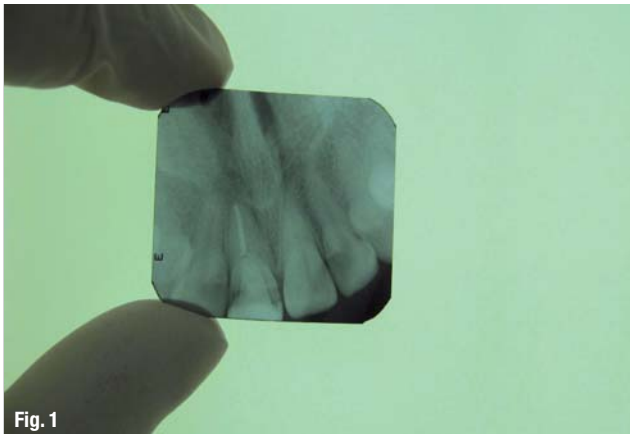




Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7

On the one hand, the high intensity of a diode laser can remove epithelial cells for 2 or 3 mm at the gingival crest and delay epithelial cell migration to the implant surface, preventing pocket formation around the implant and creating a sterile area for implant placement. On the other hand, a diode laser can often be set at a low output to perform biostimulation (low-level laser therapy, LLLT), accelerating the healing process. Laser-assisted osseointegration without the use of any bone substitutes is presented in this article.

Anamnesis and diagnosis

A 25-year-old female patient with the complaint of a right incisor fracture presented for treatment. The patient's medical history showed no systemic medical problems, no allergic reaction, no medicaments and no history of past surgical procedures, and thus it was not necessary to refer the patient for medical consultation.

An oral and maxillofacial examination of the patient found no temporomandibular joint or myofascial disturbances, as well as no functional or para-functional habits, but a Class I occlusion and poor oral hygiene. As shown by the clinical findings, the tooth was infected and a crown-root fracture was obvious (Fig. 1). The apical area showed the orifice of a fistula, but there was no pain or swelling.

The radiographic examination showed a radiolucent lesion at the apical part of the involved teeth. The tooth was diagnosed as not worth preserving and thus the final decision was to perform an atraumatic extraction followed by dental implant placement (Fig. 2).

The consent form was completed and the patient's information was reviewed (examination sheet and radiograph, consent form, etc.). Thereafter, antibiotic prophylaxis was prescribed (penicillin V 500 mg, q.i.d., orally, starting one day before extraction).

Initial treatment

After the diagnosis, the treatment plan was to first extract the tooth and then accelerate wound healing

using a laser device. The surgical area was anaesthetised with infiltration of 1.8 ml of 2 per cent lidocaine with 1:100,000 epinephrine in order to perform an atraumatic tooth extraction. The controlled area was then defined and the laser warning signs placed properly to secure the operating room. Furthermore, eye protection was provided for the patient, as well as for the patient's guardian and the assistant.

Having extracted the tooth (Figs. 3 & 4), socket debridement and irrigation with normal saline were performed. The laser system was then calibrated in order to irradiate the treated area with a low-intensity laser (LLL) for acceleration of wound healing. The laser parameters were as follows: wavelength of 980 nm, output power of 1 W, irradiation time of 20 s, spot size of 3 mm, power density of 1.41 W/cm² at the end of the low-level handpiece, socket diameter of 8 mm, irradiation area of $\pi r^2 = 0.5024 \text{ cm}^2$, power density of 0.199 W/cm² at the target surface, dose of 3.98 J/cm², non-contact mode (1 mm from the orifice) and rotating at the orifice of the socket, single dose.

After the treatment, the patient was advised to keep the area clean and plaque free with gentle brushing, continue using the antibiotic and take over-the-counter analgesics as needed. The next visit was scheduled for one week after the initial treatment in order to perform the implant placement.

Implant placement

One week after the initial treatment, the implant was placed. After revision of the consent form and establishing safe laser delivery conditions, the surgical area was anaesthetised with infiltration of 1.8 ml of 2 per cent lidocaine with 1:100,000 epinephrine.

Fig. 3_Clinical view.

Fig. 4_Atraumatic extraction.

Fig. 5_De-epithelialization and implant site preparation.

Fig. 6_Implant placement without any bone substitutes.

Fig. 7 & 8_Two months after implant placement.



Fig. 9 Healing implant site two months after implant placement.

Fig. 10 Immediately after crown seating (ten weeks after implant placement).

Fig. 11 Six months after implant placement.

First, the laser system was recalibrated, which entailed cleaving of the fibre, aiming of the beam, and initiation of the fibre with articulating paper and test-fire of the laser, in order to create a hole at the socket orifice for starting the drilling and for de-epithelialisation of the attached gingiva for approximately 3 mm around the socket orifice. During the treatment, high-volume suction was used to evacuate the vapour plume and objectionable odours at the site of operation. The carbonised tissue was then removed with a micro-applicator brush soaked in a 3 per cent hydrogen peroxide solution.

The hole creation and gingival de-epithelialisation (Fig. 5) were performed with a 980 nm diode laser, with a power of 1 W, fibre of 400 μ , initiated fibre, continuous wave and in contact mode. After this procedure, the implant placement was performed (Fig. 6).

The laser parameters for the acceleration of the osseointegration were as follows: wavelength of 980 nm, output power of 0.1 W, irradiation time of 20 s, spot size of 3 mm, power density of 1.41 W/cm² at the end of the low-level handpiece, socket diameter of 8 mm, irradiation area of $\pi r^2 = 0.5024$ cm², power density of 0.199 W/cm² at the target surface, dose of 3.98 J/cm², non-contact mode (1 mm from the orifice) and rotating at the orifice of the socket.

Both the labial and palatal surfaces of the socket were irradiated at the same dose immediately after implant placement (the total dose for three sites in the first session was 11.94 J/cm²) and then twice weekly with the same protocol, but with an irradiation time of 15 s, consequently with a dose of 2.985 J/cm² (the total dose for three sites per session was 8.955 J/cm²). The LLLT was performed at intervals for two weeks.

Finally, a temporary bridge made of composite materials was fabricated and seated in order to preserve the aesthetics.

_Final result and follow-up

Excellent implant placement was observed with no bleeding, carbonisation or char. The primary stability of the implant was excellent. The patient did not experience any discomfort and was satisfied with the treatment.

The first visit after Type I implant placement was scheduled for two days after the procedure. The healing process was as expected in that the healing was progressing well and without any swelling or pain. LLLT was performed and the next visit was determined after two days for the next LLLT session two weeks later. Finally, after two months of follow-up, a suc-

successful treatment outcome was observed with excellent osseointegration and sufficient soft tissue to ensure the aesthetics at the site (Figs. 7–11).

Discussion

LLLT is used extensively in many dental practices.^{8,9} Laser-tissue interaction in LLLT is not photo-thermal.^{10,11} This treatment is dose dependent^{12,13} which means that the laser parameters have to be respected.¹⁴ The precise molecular mechanisms of LLLT are not well understood, but its clinical effects on pain control, inflammation reduction and wound healing have been well researched.^{15–17}

Diode lasers can be used for soft-tissue management in implantology.¹⁸ Our results in this case demonstrate that a diode laser can be applied in Type I implant placement in order to establish osseointegration successfully.

Gomes et al. have shown that LLLT enhances peri-implant bone repair, thereby improving stability and bone formation.¹⁹ De Vasconcellos et al. have reported that infrared LLLT may improve the osseointegration process in osteopenic and normal bone, particularly based on its effects in the initial phase of bone formation.²⁰

LLLT can promote implant stability and improve healing around the surgical site through increasing ATP synthesis and angiogenesis, reducing inflammation and increasing osteoblast proliferation.^{21–23} Furthermore, LLLT can improve the attachment of the fibroblast to implant surfaces²⁴ and promote osteoblast activity.²⁵

Conclusion

Based on the laser protocol applied in this study, the diode laser can be used in Type I implant placement with or without bone substitutes in order to achieve better osseointegration and implant stability.

Editorial note: A list of references is available from the publisher.

contact

Dr Masoud Shabani

Oral Health Department, Official Complex of Ardebil University of Medical Sciences, Daneshgah Street 5618985991 Ardebil, Iran
Tel.: +98 451 5521417
Fax: +98 451 5522196
m.shabani@arums.ac.ir

Kurz & bündig

Konventionell wird eine Implantatplatzierung nach der Heilung der Extraktionsalveole vorgenommen. Mit dieser Methode kann es jedoch zu unerwünschten Resultaten kommen, wie einer Reduzierung des Knochenniveaus und einem Zusammenbruch von Weichgewebe, was auch die Frontästhetik sehr stark beeinträchtigen kann. Eine sofortige Implantatplatzierung (Typ I) kann dabei eine gute Möglichkeit sein, die Ästhetik zu bewahren.

Im Fallbeispiel wurde eine 25-jährige Frau mit einer Fraktur des rechten Schneidezahns vorgestellt. Die Anamnese offenbarte eine Okklusion der Klasse I sowie eine schlechte Mundhygiene. Der Zahn war infiziert und zeigte eine Krone-Wurzel-Fraktur (Abb. 1). Apikal war eine Fistelöffnung zu sehen, jedoch gab es keine Schmerzen oder Schwellungen. Eine radiologische Untersuchung zeigte eine strahlendurchlässige Verletzung im apikalen Bereich des betroffenen Zahns. Der Zahn wurde als nicht erhaltungswürdig diagnostiziert, und daher fiel die Entscheidung auf eine atraumatische Extraktion mit anschließender Implantatplatzierung (Abb. 2).

Nach der Zahnextraktion (Abb. 3 & 4) wurde die Wunde gesäubert und mit Kochsalzlösung ausgespült. Das Lasersystem wurde dann kalibriert, um den behandelten Bereich zur Beschleunigung der Wundheilung mit niedriger Intensität (LLLT) zu bestrahlen. Eine Woche später wurde das Implantat inseriert. Die Erstellung des Lochs und die gingivale Epithelisierung (Abb. 5) wurden mit einem 980 nm Diodenlaser durchgeführt. Im Anschluss wurde das Implantat platziert (Abb. 6). Abschließend wurde eine temporäre Kompositbrücke aufgesetzt, um die Ästhetik zu bewahren.

Nach einer zweimonatigen Follow-up-Periode mit regelmäßiger LLLT konnte ein erfolgreiches Behandlungsergebnis beobachtet werden mit einer exzellenten Osseointegration und ausreichendem Weichgewebe (Abb. 7–11).

Wie diese Studie zeigt, eignet sich ein Diodenlaser für eine Typ I-Implantatplatzierung mit oder ohne Knochenersatzmaterialien zur Erreichung einer besseren Osseointegration und Implantatstabilität.