Clinical procedures for immediate dental implant placement in post-extraction-infected sites decontaminated with Er,Cr:YSGG laser

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KEYWORDS

Laser therap;, Dental implant; Oral surgery; Tooth extraction.

ABSTRACT

Aim: *Placement of dental implants into fresh extraction sockets offers some advantages, such as reduced treatment times and enhanced patient comfort. The Er,Cr:YSGG (Erbium, Chromium-doped: Yttrium, Scandium, Gallium, and Garnet) laser can significantly reduce bacterial concentration after the extraction of a compromised tooth. The aim of this article is to provide a clinical protocol for the management of implants placed in infected extraction sites decontaminated with Er,Cr:YSGG laser.*

Methods: *A compromised tooth, which was an abutment for a fixed bridge, with clinical and radiological signs of infection was extracted. The infected site was treated and decontaminated with an Er,Cr:YSGG laser device (Biolase iPlus®) and two implants (Straumann®) were placed in the same surgery, in order to rehabilitate the edentulous area. The intervention was completed by tissue regeneration with biomaterials.*

Results: *Prosthetic rehabilitation after the surgical phase allowed us to provide correct function and satisfactory esthetics. In the follow-up visit, clinicians found good tissue healing and did not observe any complications, such as implant loss or peri-implantitis. The technique used in our study is repeatable and predictable, but patient selection is very important for this type of protocol as the presence of contraindications can lead to failure. The photoacoustic effect exerted by this type of laser has been proven to be effective against many pathogens. Several authors have previously demonstrated the effectiveness of this technique.*

Conclusion: *Immediate implantation in infected sites decontaminated with Er,Cr:YSGG laser does not seem to contribute to an increased risk of failure; however, it is necessary to follow a certain set of protocols and procedures to prevent peri-implantitis and other complications.*

Introduction

In recent years, the immediate insertion of an implant after tooth extraction (Type 1 implant insertion protocol) (1) has become a common treatment option. The surgical technique for immediate placement of a dental implant in an extraction socket was initially proposed in 1976 by Schulte and Heimke (2). Proponents of this protocol claimed that by reducing the patient's surgical exposure, there was limited physiological bone resorption after tooth extraction (3). Clinical studies have been conducted to confirm the validity of this technique (4) and it has been studied and successfully applied to different types of implant-prosthetic rehabilitation (5). Placement of dental implants into fresh extraction sockets offers advantages such as reduced treatment times and enhanced patient comfort (6).

The extraction of a tooth is often linked to the presence of a periapical lesion indicating an active infection. This is considered to be one of the main contraindications to immediate implant insertion because of the increased possibility of infection spreading to peri-implant tissues during the healing period (7). However, animal studies showed that the presence of active periodontal or endodontic infections did not compromise the osseointegration of immediately placed implants.

Additionally, bone-to-implant contact (BIC) was not compromised (8-12). An ever-increasing number of authors describe the possibility of implant placement in post-extraction-infected sites, if the indications exist and if a strict decontamination protocol is respected. In a systematic review of the literature, Corbella et al. identified nine human studies reporting survival rates ranging between 92% and 100% for a total of 497 implants placed in sites with endodontic infections; the follow-up varied from 3 to 117 months from loading (13).

Different approaches have been proposed by different authors for the decontamination of the post-extraction site prior to receiving the fixture. Marconcini et al. proposes tooth extraction with extreme care to preserve the alveolar bony integrity and careful curettage of the sockets to remove the remaining granulation tissue (14). Measures to decrease the bacterial load of infected sites include the administration of antibiotics and chlorhexidine mouth rinses. In a cohort study, Del Fabbro et al. described a similar protocol, but with the addition of plasma rich growth factors (PRGF) in infected sockets (15). Other authors, in order to obtain thorough decontamination and limit cases of failure, added the use of lasers to the clinical protocol. The first case series was described by Kusek with 10 immediate implants (16). Later, Montoya-Salazar et al., Crippa et al., and Kakar et al. performed different studies with 18, 94, and 110 immediate implants, respectively (17-19); all clinical trials used Er,Cr:YSGG lasers to decontaminate post-extraction sites.

The aim of this article is to provide a clinical protocol for the management of post-extraction implants placed in infected sites decontaminated with Er,Cr:YSGG lasers, accompanied by a case report which successfully demonstrates the technique. The clinical procedure described is the result of the authors' extensive experience in the field as well as the scientific literature supporting the topic.

Materials and methods

The case concerned a 61-year-old female patient in good general health, who presented with pain in the mandibular left first molar (36), which was a prosthetic element of a bridge (Fig. 1, 2). Clinical examination, periodontal probing, and radiographs suggested a root fracture in tooth 36. The patient consented to a treatment plan involving the extraction of the compromised tooth, decontamination of the site using the Er,Cr:YSGG laser, and the placement of two fixtures in the same clinical session, in order to replace the missing tooth 35 and the compromised tooth 36 with a fixed implant prosthesis. The treatment plan was agreed upon after a careful analysis that excluded the presence of contraindications, such as poor oral hygiene or smoking. The patient gave her informed consent for the study.

The patient had started antibiotic therapy (amoxicillin, 1 g twice daily for 6 days) the evening before surgery. The local anesthetic used in the intervention was Optocain® (Mepivacaine 1:100.000). After sectioning the bridge, tooth 36 was extracted as atraumatically as possible to safeguard the surrounding tissues, assisted by the Er,Cr:YSGG laser (Fig. 3, 4). The full-thickness flap was raised by the laser with the following settings: configuration for the soft tissue mode, which included tip MC-3, length 9 mm, air 20%, and water 80%. For bone tissue, the setting mode included tip MZ-8, length 6 mm, air 40%, and water 60%. Once extraction was completed, the decontamination phase of the infected site began (Fig. 5). The site was debrided and decontaminated after extraction using the same laser device but with another setting: 2.0W, 20% air, and 80% water, while mounting a MZ-6 tip, 9 mm in length. Debridement time depended on the amount

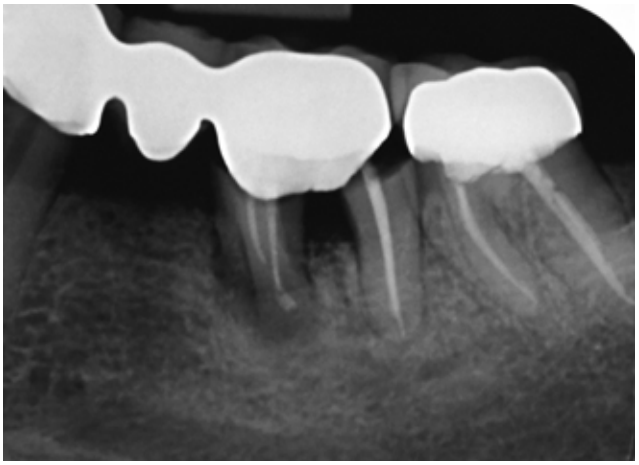

Figure 1 Preoperative x-ray

Figure 2 Preoperative clinical condition

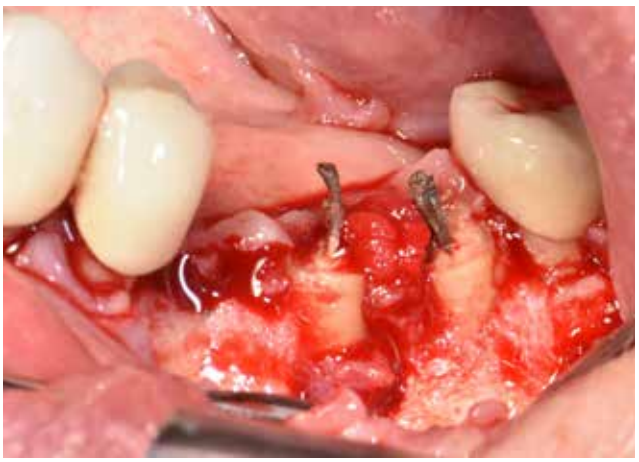

Figure 3 Root fracture

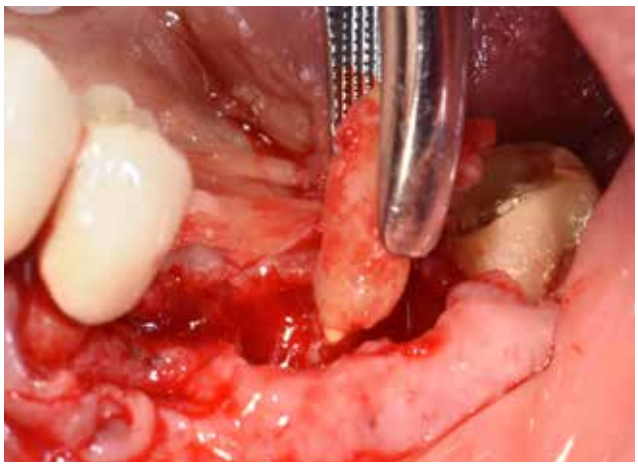

Figure 4 Tooth extraction

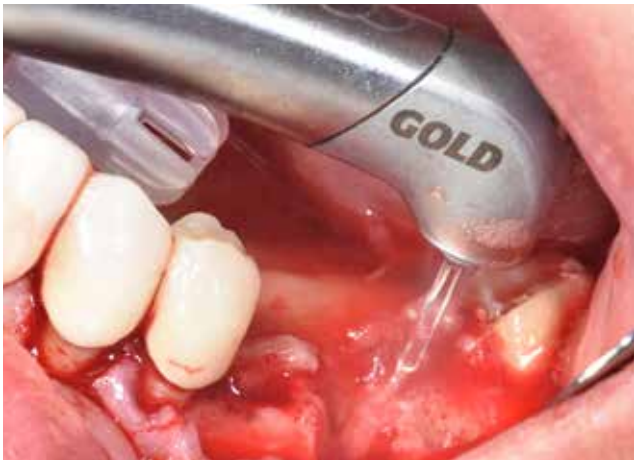

Figure 5 Socket debridement and disinfection

Figure 6 Suturing

of pathological tissue and bone volume, whereas decontamination lasted from 60 to 90 seconds per socket, ensuring no physical contact between the tip and the tissues. The Waterlase iPlus® (Biolase) device was used for all laser procedures.

The subsequent phases of the intervention involved the placement of two implants (Straumann®). The fixtures (SLActive® S, Ø 3.3 mm, RN, 10 mm length to replace tooth 35 and 8 mm to replace tooth 36) were placed with a minimum 35N torque and 1 mm below the most apical bone peak. It was also necessary to place biomaterials for the residual defect caused by the infection: collagen (Septodont®) and an absorbable membrane (Collprotect®) were used to improve tissue healing. Sutures (PTFE 3/0 Gore®) were placed with particular care to obtain good flap repositioning (Fig. 6). Subsequently, chlorhexidine gluconate gel 0.2% twice daily for 15-20 days was prescribed, and post-operative instructions were given to the patient. Periodic clinical and radiographic checks were scheduled (Fig. 7), and the implants were loaded after 4 months.

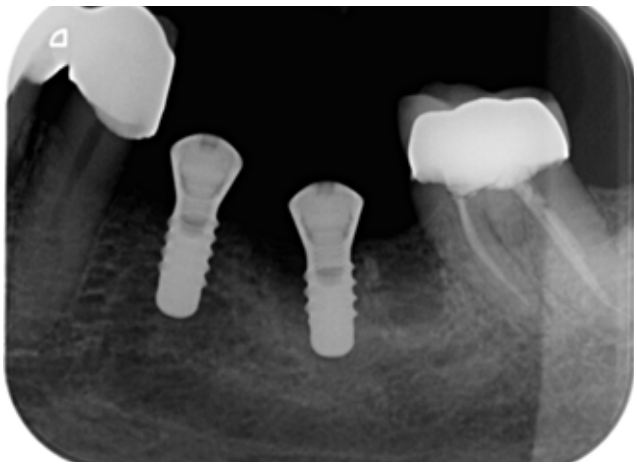

Figure 7 Postoperative x-ray

Results

During the follow-up visit, we did not observe any complications, such as implant loss, peri-implantitis, or loss of the peri-implant bone. Implants achieved a good primary stability (>35 N/cm). Prosthetic

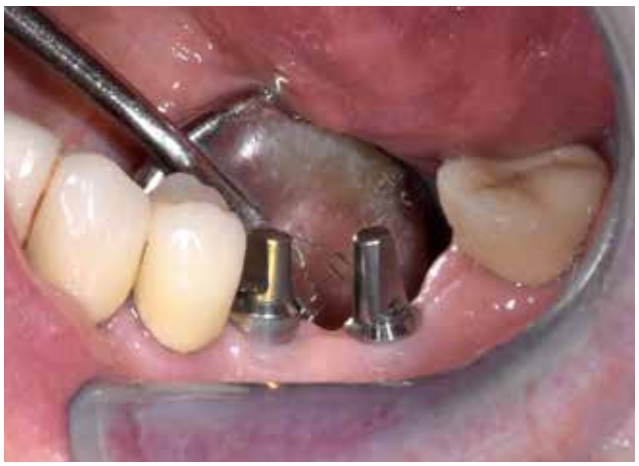

Figure 8 Tissue healing and prosthetic step

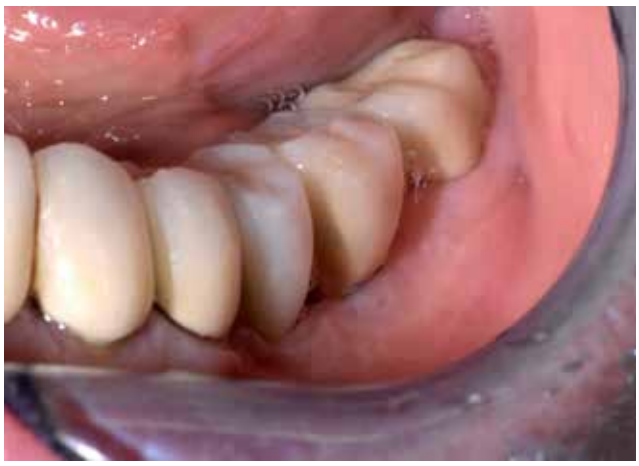

Figure 9 Definitive prosthesis

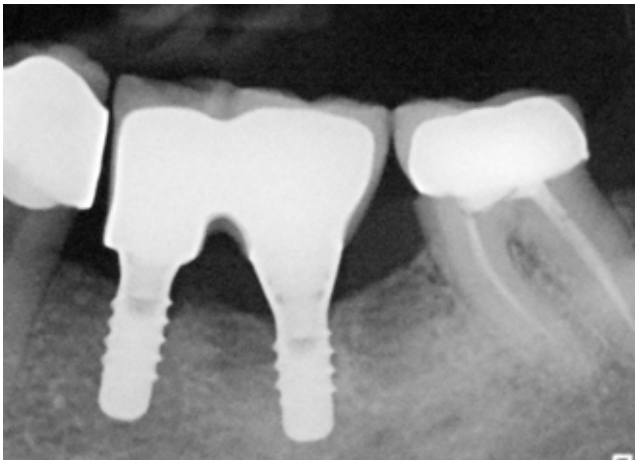

Figure 10 6 months-follow-up

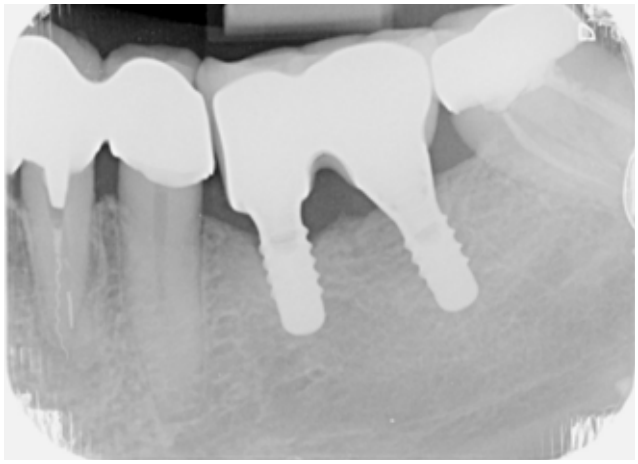

Figure 11 3-years follow-up

rehabilitation after the surgical phase allowed us to obtain satisfactory function and esthetics (Fig. 8, 9). The success of implant therapy is highlighted by clinical and radiographic controls (Fig. 10, 11). Similar successful cases have been reported in other studies, with follow-ups of up to 5 years (20). The technique is repeatable and predictable, and this case describes the salient steps; however, candidate selection is very important for the success of this protocol.

According to the authors' experience, some rules must be considered.

- The patient must be healthy, a non-smoker, and must not have untreated periodontitis. The patient must be co-operative and adhere to the dentist's instructions.
- The clinical case must be carefully assessed in advance: the cause of tooth extraction, the possible presence of recurrent infections, the type of bone, etc. Therefore, evaluation of radiographs (and CBCT if appropriate) is also necessary.
- Prophylaxis for surgery involves antibiotic therapy and chlorhexidine gel 0.2%.
- The extraction must be completed atraumatically to preserve the residual bone.
- Among the various types of lasers, Er,Cr:YSGG is recommended for the best decontamination capacity.
- The use of biomaterials is often necessary to cope with bone defects.

There are several types of lasers available on the market. The authors report settings for the correct use of the Er,Cr:YSGG laser in different substrates (Table 1). It is important to follow the programs of the device to avoid adverse effects to the hard and soft tissues. Operators must comply with all regulations for their own safety and for that of the patient, such as wearing special protective glasses.

Discussion

The laser (light amplification by stimulated emission of radiation) was introduced into dental practice by

Er,Cr:YSGG Laser	TIP	LENGTH	POWER	FREQUENCY	AIR	WATER
Soft tissue	MC-3	9 mm	3.5 W	50 Hz	20%	80%
Hard tissue	MZ-8	6 mm	3.5 W	20 Hz	40%	60%
Decontamination	MZ-6	9 mm	2.0 W	50 Hz	20%	80%

Table 1 Laser parameters

Miaman in the 1960s. Since then, its use has steadily increased and many devices have been developed specifically for different oral conditions. Two categories of lasers can be distinguished. Hard lasers, such as Carbon dioxide (CO2), Neodymium Yttrium Aluminum Garnet (Nd:YAG), Er:YAG and Er,Cr:YSGG, offer both hard tissue and soft tissue applications. Cold or soft lasers, based on the semiconductor diode devices, are broadly termed as low-level laser therapy (LLLT) or "biostimulation" (21). Lasers in the first category are generally more expensive, bulky, and more complex than the latter.

The erbium "family" of lasers has two distinct wavelengths, Er,Cr: YSGG (yttrium scandium gallium garnet) lasers and Er:YAG (yttrium aluminum garnet) lasers. The wavelength of erbium has a high affinity for hydroxyapatite and water. Consequently, it is the most suitable for both hard tissue and soft tissue surgery. The high affinity for water results in a low penetration depth, which allows good surface ablation without compromising deep tissues. Erbium lasers can cut both soft and hard tissues with minimal thermal damage to the surrounding epithelial tissue, resulting in a low incidence of inflammatory reactions and more rapid healing (22). The utilization of Er,Cr:YSGG lasers in dentistry has been studied extensively and in several applications. For example, their use adjunctive to conventional periodontal therapy is reported to be more effective in bacterial reduction, compared with conventional periodontal therapy. Additionally, Er,Cr:YSGG lasers are also successful in coagulation of open blood vessels and deepithelization of the gingival pocket as reported by Dereci et al. Other studies affirm that laser-assisted treatment is a better treatment modality, compared with conventional non-surgical periodontal treatment (23). It has also been reported that ER,Cr, and YSGG lasers enhance cell attachment and migration on root surfaces (24). The Er,Cr:YSGG laser, operating at a wavelength of 2780 nm, has been demonstrated to be a valuable tool in endodontic treatment. Martins et al. demonstrated how a laser-assisted protocol can achieve predictable endodontic outcomes, comparable to conventional strategies (25). Therefore, the photoacoustic effect exerted by this type of laser has proven to be effective against many pathogens. Recent studies have highlighted that laser technology is capable of eliminating bacteria more effectively than chemical products (16).

Regardless of the proven laser decontamination effect, several studies have shown that immediate implants can also be placed in infected sites if certain precautions are taken. In a systematic review, Waasdorp et al. affirm that sites must be thoroughly debrided prior to placement and guided bone regeneration is usually performed to fill the bone-implant gap and/or socket deficiencies (26). From the point of view of bacterial contamination, this reassures clinicians that the infected site would not represent an obstacle regardless of the type of decontamination carried out. However, this article highlights the multiple benefits of laser therapy, such as proven efficacy on pathogens, minimal invasiveness, reduced intraoperative bleeding, increased visualization of the operative field, and good prognosis for tissue healing (27). Certainly, the technique involves a learning curve and requires experience in implantology. There are also some disadvantages, such as the cost of the device. The studies presented by a review on the subject show how immediate placement into infected sites does not lead to an increased rate of complications and does not compromise tissue integration, provided that appropriate clinical procedures are followed to achieve good socket decontamination (20). Therefore, the drawbacks of this technique are comparable to those of type 1 implants positioned in non-infected sites. The main etiology of periodontitis is plaque accumulation, and the evolution from periodontitis to peri-implantitis occurs in the absence of supportive maintenance care.

Periodontal infections are mixed infections caused by different species of aerobic and anaerobic bacteria (28). Dent et al. reported a reduction in implant failures when antibiotics are used pre-operatively (29). Nevertheless, a systematic review suggests that the benefits of antibiotic prophylaxis for non-infected sites are unclear and may not be needed (30,31). It is also important to consider that the presence of some independent systemic (i.e., smoking) and local risk factors (i.e., residual cement, dimensions of the keratinized tissue, and surface roughness) may increase the probability of occurrence of periodontitis (32).

In this clinical protocol, the ErCr:YSGG laser was used

in association with antibiotics and chlorhexidine gel 0.2%. Therefore, it is not possible to determine a clear causal effect of the laser alone in decontamination and good osseointegration of the implants. For this reason, further clinical studies are needed to clarify certain aspects. In any case, the technique is based on current scientific evidence and on clinical experience that promotes immediate placement of implants, even in infected sites.

Conclusion

The protocol for placement of type 1 implants in infected sites performed with Er,Cr:YSGG laser decontamination includes several precautions to avoid complications, but it has several advantages such as the reduction of operating time and patient comfort. This technique does not appear to increase the risk of failure; however, it is necessary to follow a certain set of protocols and procedures to prevent peri-implantitis and infective complications, as outlined in the principles of modern implantology. It would be interesting and useful to deepen the topic with further studies.

Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions

M.P., MA.P., R.C. and F.A. have given substantial contributions to the conception or the design of the manuscript, R.A. and M.D. to acquisition, analysis and interpretation of the data. All authors contributed equally to the manuscript and read and approved the final version of the manuscript.

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