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Immediate Placement of Implants in Tooth Extraction Sockets in the Presence of Periapical Lesions with or without Er:YAG Laser Irradiation

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Abstract

Background and aims. Different clinical studies have reported high survival rates in immediate implant placement in extraction sockets with periapical lesions. The aim of this study was to investigate the effect of Er:YAG laser irradiation on success rate of immediate implant placement in tooth extraction sockets with chronic periapical lesions.

Materials and methods. Thirty patients requiring a single-root tooth extraction with chronic periapical lesions were included in this prospective, randomized, clinical trial and divided into control (n=15) and test (n=15) groups. After tooth extraction, the implant were placed with guided bone regeneration in the control group after periapical curettage and socket irrigation and in the test group, irrigation of the periapical region was accompanied with Er:YAG laser for 1 min at 100 mJ, 10 Hz, 12.73 J/cm^2. Radiographic (using standard long-cone parallel) and clinical parameters (plaque index [PI], modified bleeding index [mBI], probing depth [PD], keratinized mucosa [KM], Periotest values [PTV]) were assessed at baseline and 1, 3 and 6 months after implant placement. Data was analyzed with t-test and chi-squared test. The level of significance was set at 5%.

Results. A survival rate of 100% was observed for all the implants placed at the sixth-month follow-up, with no significant differences between clinical and radiographic parameters of the control and test groups at different time intervals (P>0.05).

Conclusion. At 6-month follow-up, there were no complications in soft and hard tissue healing processes after immediate placement of implants into fresh extraction sockets with chronic periapical lesions, regardless of Er:YAG laser irradiation.

Key words: **Dental implants, immediate placement, Er:YAG laser, chronic periapical lesion.**

Introduction

Replacing missing teeth by dental implants has been a great achievement in the history of dentistry. Nowadays, placement of implants immediately after tooth extraction has become a common and acceptable clinical method.[1-3] It seems that immediate implant placement preserves bony walls and prevents collapse of alveolar bone after extraction. Other advantages of this technique include a decrease in the number of surgical procedures, treatment time and costs, an increase in patient satisfaction, placement of implant in the same position as the extracted tooth and better axial placement and esthetic results.[3-6] Numerous clinical studies have reported immediate implant placement as a predictable procedure and long-term studies have shown its high success and survival rates.[7-9] Some of the authors have considered that immediate implant placement is contraindicated in the presence of infections such as periodontal and periapical lesions,[6,10] but several experimental and clinical studies have reported that immediate implant placement in the presence of periapical pathology does not have more complications and higher failure rates than those placed in a healed area.[5,11-15] According to these studies, immediate placement of dental implants into fresh extraction sockets with periapical endodontic lesions is not contraindicated if proper clinical approaches such as administration of antibiotics, cleaning of surgical site and alveolar debridement are followed.[5] Several microorganisms exist in inflammatory periapical lesions resistant to healing and form the bacterial plaque in the apical third of the root.[16] Microbial colonization has been claimed to be the primary etiologic factor for peri-implant infections causing early or late implant failures. Therefore, all authors suggest that the affected area must be carefully debrided and completely decontaminated before implant placement.[17-19] The goal of apical curettage is to eliminate periapical infected tissues, but it is difficult to determine whether all of the infected tissues and pathogenic microorganisms have been completely removed by curettage and rinsing the region or not.[16] Some studies have reported that apical lesions have radiographic signs of complete healing but histological studies have shown that have microorganisms remain in these lesions.[20-21] Furthermore, some other studies have reported that placing implants in tooth sockets with periapical lesions on x-ray films and after curettage and complete healing period of 3-4 months, periapical implant lesion (PIL) still developed.[22-24] Quirynen et al[22] have reported some cases with PIL as a result of remained infection in the apical area of infected teeth which were extracted a few months before implant placement. They attributed PIL to undiagnosed chronic inflammation in the alveolar bone. Therefore, laser irradiation as an adjunct to decontamination of infected area could be advised.

In the last few years, laser irradiation has been introduced as a useful method to achieve a sterile implant zone. Different laser systems such as diode and Erbium family (i.e. Er:YAG and Er:YSGG) have exhibited successful results in the decontamination of infected sites.[16,25] The Er:YAG laser at a wavelength of 2.94 μm has the highest absorption in water and is well absorbed by hydroxyapatite. Its first application for dental use was reported in 1992.[26-27] This laser can ablate both soft and hard tissues with minimal thermal effects.[28-29] Today, one of the most interesting indications is application of Er:YAG laser in peri-implantitis therapy.[30-31] Er:YAG laser is capable of removing granulation tissue and deep decontamination of the intrabony defects with a significant bactericidal effect on the implant surfaces, and it is also an efficient therapy leading to re-osseointegration in these clinical situations.[32] Therefore, Er:YAG laser-assisted decontamination of the infected areas can yield good results without any critical damage to the adjacent tissues.[33-34] The aim of this study was to investigate the effect of Er:YAG laser irradiation on the success rate of immediate implant placement in tooth extraction sockets with chronic periapical lesion.

Materials and Methods

Patient selection

In this prospective, randomized, clinical trial, thirty patients (16 women, 14 men) with an average age of 40.5 years (ranging from 23 to 58 years), referred to the Department of Periodontology of Isfahan Dental School and Torabinejad Dental Research Center, Isfahan University of Medical Sciences, were included. All the patients required an extraction of a single-rooted tooth (incisors, canines or premolars). The indications for tooth extraction were residual roots with untreatable carious lesion, endodontic treatment failures or tooth fractures. The patients were divided into two groups of control (CG, 15 patients) and test (TG, 15 patients). Inclusion criteria for patient selection were presence of periapical radiolucency ≥3 mm, presence of at least three bony walls of the alveolus, presence of ≥3 mm of intact bone beyond the root apex and presence of ≥3 mm of keratinized gingiva around the tooth. Exclusion criteria were presence of fistulae, suppuration, signs of acute infection, a sys-

temic disease, periodontitis, smoking, alcohol or drug abuse and inability to achieve primary stability during surgery. All the implants in this study were DIO-SM implant system (DIO Co, Busan City, Korea) with resorbable blast media (RBM) surface. All the treated teeth had radiographic signs of chronic periapical periodontitis. All the patients were treated by one operator based on standard clinical procedures. Preliminary diagnostic examinations included clinical examination and panoramic and periapical radiographs. All the patients were given information about the study protocol and asked to sign written consent forms.

Surgical procedure

One hour before surgery, all the patients received 1 g amoxicillin and 400 mg ibuprofen. In addition, the patients were given 0.2% chlorhexidine digluconate solution rinse for 1 minute.

Surgery was performed under local anesthesia (lidocaine 2% with epinephrine 1:100000). A sulcular incision was made at the tooth to be extracted. A vertical releasing incision was made at the distal adjacent tooth, if necessary, and the mucoperiosteal flap was reflected. The teeth were carefully extracted by using a periotom and forceps, so that the socket bony walls remained intact. In the control group all granulation tissues were removed carefully from the periapical area of the socket by curettage and washed with normal saline. While in the test group, the socket irradiation was also performed with Er:YAG laser device (Fidelish Plus, Fotona, Ljubljana, Slovenia, 2.94 μm Wavelength) using Ro7 handpiece and a fiber tip with a length of 16 mm and a diameter of 1 mm (Figure 1), accompanied with water irrigation, at 100 mJ, 10 Hz, 12.73 J/cm^2 for 1 min.

The implant osteotomy site preparation with standard drilling was performed using the protocol of Dio system and the apical portion of an implant site was placed at least 3 mm beyond the root apex. A screw-type Dio-SM implant was inserted with a minimal torque of 25 N/cm. Selection of implant diameter was based on obtaining primary stability and filling the socket. Since some portions of buccal plate might have been lost due to apical infection, guided bone regeneration (GBR) technique was applied to enhance bone fill of the gap between implant surface, bone walls and reconstruction of the buccal plate. Deproteinized bovine bone mineral (BIO-OSS® spongiosa particles, Geistlich-pharma, Wolhausen, Switzerland) was used and a resorbable collagen membrane (Bio-Gide®, Geistlich-pharma, Wolhausen, Switzerland) was placed to cover the defect. After obtaining tension-free mucoperiosteal flap closure, the flap was repositioned and then closed by 4-0 silk sutures.

Figure 1. Er:YAG laser device (Ro7 handpiece with fiber tip)

Postoperative management

After the surgical procedure, one dose of dexamethasone (8 mg/mL),[3] antibiotic (amoxicillin 500 mg, 3 times daily) for 7 days as well as an analgesic (Ibuprofen 400 mg, every 4-6 hours as needed) were prescribed. The patients were instructed not to brush the surgical site and 0.2% chlorhexidine mouthwash was prescribed twice daily for 2 week. A non-loaded healing period of six months was established for all the immediately placed implants.

Follow-up

All the evaluations and data collection were carried out by a clinician. Follow-up examinations were made at baseline and 1-, 3- and 6-month postoperative intervals. The following clinical parameters were assessed in the present study: plaque index (PI) and modified bleeding index (mBI) were determined on the all the surfaces except the occlusal surface.[35] Keratinized mucosa (KM) was recorded at the midbuccal sites. After a six-month healing period, second-stage surgical protocol was performed and the healing abutments were placed on the implants.

Implant stability was evaluated by a periotest (Medizintechnik Gulden, Esechenweg, Germany) and Perio Test Value (PTV) was recorded at baseline and after six months (at baseline, the healing abutment was placed on the implant body and after measurement of PTV, it was replaced with a cover screw). The periotest was maintained perpendicular to the healing abutment and data were registered. The optimal PTV should be in the range of -8 to 9.[36,37] Healing abutments were torqued to 35 N at the baseline

and six-month interval to standardize the PTV reading. In addition, after replacing the healing abutments on the implants, probing depth (PD) was measured around all surfaces of the implants with a periodontal probe (Hu-Friedy PGF-GFS, Hu- Friedy, Chicago, IL). Success criteria for implant survival included presence of implant stability, absence of peri-implant radiolucency, lack of signs and symptoms of infection, paresthesia, suppuration, pain and no more bone loss than the average bone loss criteria reported by Albrektsson et al.[38]

Radiographs

Intraoral periapical radiographs were taken with standardized long-cone paralleling technique using XCP holder (XCP Bite Blocks, Dentsply, Elgin, IL USA) with an inter-occlusal metal jig and template index. These radiographs were made at baseline and 1, 3 and 6 months after implant placement (Figures 2 and 3).

Statistical analysis

All the analyses in this study were performed with SPSS 11.5. For clinical parameters, data were registered and recorded as the mean ± standard deviation at baseline and at 1-, 3- and 6-month post-operative intervals. Differences between clinical parameters in the test and control groups at every time interval were statistically analyzed using independent t-test. Evidence of peri-implant radiolucency in the radiography was recorded as positive (+) or negative (-) in the third month. Differences between the presence or absence of peri-implant radiolucency in two groups were analyzed by using chi-squared test. The level of significance was set at P=0.05.

Results

After a 6-month follow-up, a survival rate of 100% was observed for all of the thirty implants. There was uneventful healing period around all the implants without any complications such as mucositis, wound dehiscence, pain, mobility, paresthesia and suppuration. Clinical parameter values are presented in Table 1. As a result, there were no statistically significant differences (P>0.05) between these parameters in the control and test groups from baseline to 6 months after implant placement. These findings indicated the health of soft tissues around implants over time in the two groups. Radiographic findings at 3-month follow-up demonstrated the presence of peri-implant radiolucency in some cases and absence of peri-implant radiolucency in some others with no statistically significant differences (P>0.05) between the

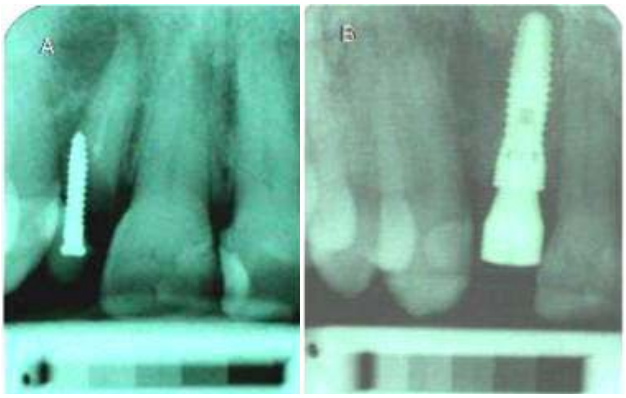

Figure 2. (A) Preoperative radiograph of tooth #12 in the control group at baseline. (B) Postoperative radiographs of implant in the control group after 6 months.

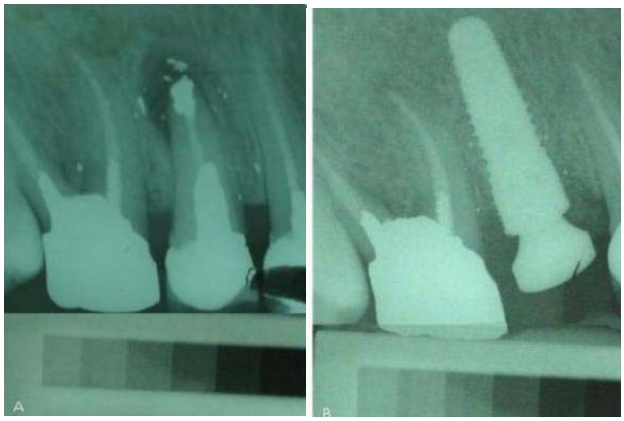

Figure 3. (A) Preoperative radiograph of tooth #15 in the laser group at baseline. (B) Postoperative radiographs of implant in laser group after 6months.

Table 1. Clinical parameters at different intervals of 6-month follow-up

	N=15		CG (No Laser)		*N=15*		TG (Laser)	
PI	19.06±9.13	16.00±4.19	14.86±5.23	17.20±7.80	15.73±12.42	14.26±4.33	15.53±5.11	17.46±6.94
mBI	13.20±4.47	9.66 ±3.61	7.46±3.90	10.60±4.48	13.00±7.79	8.53±5.24	7.26±3.84	12.53±4.79
KM (mm)	4.93±1.27	4.86 ±1.40	4.80±1.37	4.80±1.37	4.93±1.22	4.33±1.23	4.40±1.24	4.40±1.24
PD (mm)	-	-	-	3.73±0.59	-	-	-	3.62±0.79
PTV	0.40±1.21	-	-	-4.57±1.00	- 0.50±1.25	-	-	-4.68±1.55

Table 2. Evidence of periapical radiolucency at 3-month follow-up

	N= 15	CG(No Laser)	*N=15* TG(Laser)	Total
Radiolucency Periapical	+	8 (53.3%)	6 (40.0%)	14 (46.7%)
(3Months)	-	7 (46.7%)	9 (60.0%)	16 (53.3%)

control and test groups. Radiographic results are presented in Table 2. After a 6-month follow-up, there was no evidence of peri-implant radiolucency around any of the implants. These findings indicated resolution of periapical pathology around implants over time in both groups.

Discussion

In the present study, there were no complications in bone healing and osseointegration processes due to immediate placement of implants into fresh extraction sockets with chronic periapical lesion regardless of irradiation by Er:YAG laser. The implant survival rate was 100% after 6 months with desirable integration of soft and hard tissues. In addition, there were no signs of mucositis, wound dehiscence, pain, mobility, paresthesia, suppuration and there was no evidence of radiolucency around the implants. The first clinical application of immediate placement of implant was introduced by Schulte et al[39] in 1976. After an eight-year human follow-up study, this method was reported not to be associated with greater rate of complications.[1,39-42] Several clinical and experimental studies have been performed to investigate remodeling and osseointegration processes of residual alveolar bone, BIC percentage and success rate of fresh socket implants in the presence of periapical pathology.[5,11-15] Novaes et al,[11] in an animal study, placed implants immediately into fresh extraction sockets with periapical infections. They demonstrated that all the implants were osseointagrated after 12 weeks without any signs of inflammation and infection. In addition, histomorphometric analysis indicated no significant differences in BIC percentage in implants placed in this area compared to a healthy area.

Lindeboom et al,[4] in a human study, reported desirable bone regeneration after immediate implant placement following extraction of teeth with signs of chronic periapical periodontitis, pain, fistulae and suppuration.

According to Novaes et al,[5] immediate implant placement in tooth extraction socket with periapical lesion would not be necessarily contraindicated if appropriate preoperative and postoperative clinical procedures such as antibiotic administration, meticulous cleaning of surgical site and alveolar debridement were performed. On the other hand, some authors have reported that the presence of periapical lesion is a contraindication for placement of an implant immediately after tooth extraction.[6,10] Ayangco & Sheridan[23] carried out studies on teeth with a history of failed endodontics with periapical lesions and reported that after extraction, debridement, curettage, a healing period of 3−4 months, and implant placement, peri-implant lesion still developed. In another study, Nelson & Thomas reported that of 16 pre-implant extraction sockets, 69% were positive for the presence of bacteria (n=11). Of 56 osteotomies with a minimum of 3-month healing period, 21% revealed a positive culture at fixture placement (n=12). They concluded that bacteria can persist as a contaminant in apparently healed alveolar bone following extraction of teeth with apical or radicular pathosis.[21] In the present study, the same successful results as those reported in previous studies were achieved. Although the results of the present study were similar in both groups, they indicated success rate of immediate implant placement in fresh sockets with chronic periapical lesion, even with no interferential factor such as laser irradiation to guarantee removal of all remaining infected tissues and to create a very clean and decontaminated bed for implants. There were no significant differences in the mean values of the clinical parameters between the two groups ($P>0.05$), indicating the maintenance of peri-implant soft tissues over time. In addition, no significant difference was found between the mean of PTV in the group under laser irradiation compared to the control group. At the 3-month follow-up, in some cases the periapical lesion had completely been healed while in some others they were being healed.

The similar results of this study in both groups might be explained by the characteristics of the periapical endodontic lesions, since they are mixed infections including anaerobic bacteria (e.g. *Porphyromonas*, *Prevotella*, *Fusobacterium*, *Actinomyces* and *Peptostreptococcus*), and most often limited in the infected root canal systems.[43-44] Extraction of the involved tooth and degranulation of the socket possibly seems to eliminate the microbiological sources.[4]

Moreover, the periapical pathology may consist of a granuloma or a cyst. Nair et al,[45] in a clinical evaluation of 256 periapical lesions, found out that 50% of the lesions were granulomas and only 15% were cysts. Today, it is believed that a granuloma is a sterile lesion. Therefore, bone regeneration might occur following tooth extraction and degranulation of the area.[4] Nevertheless, the possibility exists for long-term residual cysts or infection in the healed alveolar ridge, which can negatively affect the prognosis of the implant.[47] In different studies, efficacy of laser application to resolve periapical pathology and persistent periapical lesions has been seen only when the tooth and root canals were the source of infections.[16] Most studies on laser application in implant dentistry were associated with the use of different laser sys-

tems in osteotomy site preparation, exploratory surgery and (in most recent years) in mucositis and peri-implantitis therapy.

Kesler et al,[48] in an animal study, reported a better osseointegration and faster bone healing in implants placed into osteotomy sites prepared by application of Er:YAG laser. They claimed that a possible reason for these results might be bactericidal effects of Er:YAG laser as well as a decreased bacterial count in tooth extraction sites. However, they reported the necessity of more clinical data and clinical investigations to substantiate this theory. On the other hand, at the end of the 6th month, both test and control groups of the present study demonstrated a great clinical success rate for immediate placement of implants into fresh sockets with chronic periapical lesions regardless the Er:YAG laser irradiation. Therefore, it seems the laser did not have any effect on the healing pattern of the apical lesions. However, based on the short-term follow-up and the limited number of participants in the present study, it cannot be concluded that the Er:YAG laser irradiation is not an effective method. In a recent study by Kusek,[49] the author showed reduced bacterial counts by performing bacterial cultures following laser treatment using Er:YSGG. Swabs were taken after extraction of the tooth and then after laser irradiation of the osteotomy site. The results showed a noticeable decrease in bacterial counts and no traces of virulent bacteria. Therefore, it is impossible to ignore the role of laser irradiation. More clinical studies and a long-term evaluation are recommended to investigate the real effect of laser irradiation, in particular Er:YAG, in this field.

Conclusion

According to the results of this study, at the 6-months follow-up, there were no complications in soft and hard tissue healing processes after immediate placement of implants into fresh extraction sockets with chronic periapical lesion regardless of Er:YAG laser irradiation.

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