

# Resonance Frequency Analysis for Immediately Placed Dental Implants Replacing Periapically Infected Teeth

Mohammed Majid Abdulmunem

## ABSTRACT

**Aims:** There is a controversy regarding the indication of implant insertion into the sockets of infected teeth. This study aimed to evaluate the outcome of immediate implants replacing periapically infected teeth utilizing Resonance Frequency Analysis (RFA) method.

**Materials and Methods:** Preoperatively, clinical, and radiographic examination accomplished for the patients. After anesthetizing the surgical area, the accused tooth extracted, and the socket curetted by surgical curette to remove the periapical lesion then irrigated by normal saline solution. The implant inserted into its prepared site. Beta-tricalcium phosphate ( $\beta$ -TCP) (combined by collagen membrane) used to fill gaps  $\geq 2$  mm and to repair bone defects. Implant stability quotient (ISQ) values were measured for the implants during surgery and after 16 weeks. Postoperative clinical and radiographic evaluation were conducted for each patient.

**Results:** Fourteen implants out of 41 immediate implants (34.1%) had been inserted in the extraction sockets of teeth have chronic periapical lesions (infected sites), T-test showed no significant difference in implant stability (ISQ value) between implant placed in infected and non-infected sites neither at baseline nor at 16-weeks. Paired t-test showed highly significant increase in implant stability (ISQ value) of implants placed in infected sites while in the other implants the mean ISQ value increased with no significant difference during the healing period. The success rate was 100% after 4 years of implantation.

**Conclusions:** Presence of periapical lesion is not a contraindication to place immediate implant when properly managed and can provide similar survival rate to that of implants inserted into healthy sockets.

**Keywords:** Dental implant, immediate implant placement, infected sites, Resonance Frequency Analysis.

**Published Online:** October 23, 2022

**ISSN:** 2684-4443

**DOI :** 10.24018/ejdent.2022.3.4.214

**M. M. Abdulmunem\***

Department of Oral Surgery and  
Periodontology, Mustansiriya  
University/Dentistry College, Iraq.  
(e-mail:

mohammed.m.abdulmunem@  
uomustansiriyah.edu.iq)

*\*Corresponding Author*

## I. INTRODUCTION

Many experimental and human studies investigated the outcome of immediate implant placement into infected sites “a term that is used inclusively for sites with periodontal, periapical, or combined lesions” [1]. The classification of infection was frequently vague and varied among the studies. Additionally, the outcome measures were often unrelated to the infection type [2].

Animal experiments with fluorescence microscopy and histological studies have shown that implants placed in sites previously infected by induced periapical lesions and intentionally produced periodontitis can osseointegrate as well as implants placed in healthy sites [3]-[7]. Reference [3] were the first to study the immediate placement of implants in surgically induced periapical lesions in four dogs, and concluded that chronic infection, such as periapical lesion, may not contraindicate immediate implant placement if particular clinical management were taken.

Reference [8] published a clinical study, in which mandibular anterior teeth with unrecoverable periodontitis

and periapical lesions were included. After extraction, the lesions curetted, and the implant sites irrigated with an antibiotic solution. 100 % survival rate observed with no implant failure at a total follow-up period of 44 months.

Reference [9] published the first prospective, randomized clinical study evaluating implants placed immediately into infected sites, where 50 implants divided into two equal groups, an immediate placement group replacing teeth with a periapical lesion and the other group placed after 3-months of healing. After extraction, the sockets were thoroughly degranulated and the lesions collected for microbial analysis. After healing of 6 months, immediate implants in the infected sites observed a 92% survival rate, while 100% survival rate was calculated for the other group.

In this study, the measurement of implant stability by the principle of resonance frequency analysis (RFA), accompanied by clinical and radiographic evaluation used to assess immediate implants replaced teeth with periapical lesions and compare it with that placed in healthy sites.

## II. MATERIALS AND METHODS

This randomized clinical trial conducted in Dental College Teaching Hospital, Department of Oral and Maxillofacial Surgery / Dentistry College Baghdad University. All patients given a clear detailed explanation about the study and were asked to sign a consent form.

### A. Inclusion Criteria

- Patient's age more than 18 years old.
- Patients have maxillary and mandibular incisors, canines, and premolars to be extracted and replaced by dental implant.
- Teeth involved with chronic periapical infection, which indicated for extraction and replacement by dental implants.
- Presence of adequate available bone to attain primary implant stability.

### B. Exclusion Criteria

- Patients with local, systemic diseases, drugs, and habits that may jeopardize implant success, or that have systemic diseases that contraindicate surgical intervention.
- Pregnancy.
- Close proximity of vital structures (less than 2 mm) such as maxillary sinus, mental foramen and inferior alveolar nerve.
- Signs of acute infection and presence of purulent exudates.
- Patients with bad oral hygiene.

### C. Preoperative Assessment

All the patients subjected carefully to clinical examination to show the signs of acute and chronic infection and pus discharge as well as overall general examination for the oral health and the planned implant site to show its candidate for dental implant treatment.

The patients asked for panoramic radiograph and periapical radiograph for the tooth that planned for extraction, in order to examine the anatomy and direction of the root, the health of the periapical tissue, proximity to the vital structures, size and extension of the periapical lesion if present. In some cases, CT scan gives better evaluation to the size and extension of the periapical lesion.

### D. Surgical Procedure

At first, the patients were prepared to provide aseptic environment for the surgical procedure, and this done by covering the patients with a surgical set towel, the patients instructed to rinse their mouth with 0.12 % chlorhexidine mouthwash for thirty seconds preoperatively, and the skin around the mouth disinfected with povidone-iodine solution.

Local anesthesia (lidocaine 2%, adrenalin 1:100000, 2.2 ml cartridge, Septodont, France) injected to the surgical area. The compromised tooth extracted carefully as atraumatic as possible to avoid destruction of the alveolar bone. The reflection of three-sided mucoperiosteal flap may be performed before extraction to facilitate atraumatic procedure. The periapical lesion curetted through the socket by surgical curette or the lesion removed directly from the periapical area in cases with bone destruction that involved

the buccal plate, then the socket irrigated with normal saline solution.

The implant site preparation performed by sequential drilling through the extraction socket with apical extension of at least 2 mm beyond the socket or the periapical cavity that developed from periapical infection, in order to provide adequate amount of bone to engage the implant. The choice of drilling depth planned to depend on the measurements provided by the panoramic radiograph and that provided directly from the extracted root, taken in mind that implant diameter at the crestal part not exceeding 4 mm in order to provide appropriate emergence profile. In the maxillary anterior sites, the drilling directed toward the palatal side to engage the palatal bone for better implant stability, with special attention to achieve a correct implant angulation for the final prosthesis.

The implant fixture (Dentium Co., Korea) inserted to the prepared site according to the diameter of the final drill or with a larger one (utilizing undersized drilling technique for better engagement), the decision was depended on the density of the bone that clinically observed during drilling.

### E. ISQ Value (Implant Stability)

The measurement of implant stability performed using the Osstell™ ISQ (Goteborg, Sweden, 4th generation) with magnetic RFA measurements. A Smart peg was introduced into the implant body. The transducer probe was directed at the top of the Smart peg with a distance of approximately 2 mm and held stable until the device beeped and displayed the ISQ value. The measurements were taken twice in the buccolingual and mesio-distal directions, the mean of the two measurements represented the ISQ value for each implant at base line record which represent primary implant stability. The cover screw was then inserted inside the implant body.

### F. Augmentation

In cases with implant-bone gap more than 2 mm or presence of bone defect,  $\beta$ -tricalcium phosphate (Zizine laboratoire, France) and autogenous bone (if available) gathered from the implant preparation site were mixed to fill these gaps and to compensate lost bone. The surgical area covered by collagen membrane (Genoss co., Korea), then the flap closed by simple interrupted suture using 3/0 non-resorbable black silk suture (Dyneke, Australia).

The patient received the post-operative instructions that involving the placement of extra oral cold pack especially at the first 8 hours, avoid warm diets and mouth rinsing at the first day. Amoxicillin 500 mg capsule three times daily, metronidazole 500mg three times daily were prescribed for each patient at least 5 days after surgery. With the instruction for the patient to maintain the oral hygiene by rinsing with chlorhexidine mouth wash two times daily for 2 weeks.

### G. Follow-up and Data Analysis

All the cases followed at two, eight, sixteen weeks and evaluated clinically for the signs of infection (pus discharge, pain, and swelling). The detection of implant mobility performed during second stage surgery at 16-weeks and subsequent follow up visits. The radiographic assessment made in parallel with the clinical evaluation to show bone changes and periimplant radiolucency, and implemented by periapical and panoramic radiographs.

At 16 weeks, in the second stage surgery, all the implants uncovered using soft tissue punch (Dentium Co., Korea), the smart peg No. 6 fixed to the implant body and ISQ value calculated by Osstell devise in the same way as recorded during surgery with both buccolingual and mesiodistal directions, the record documented as secondary implant stability at 16 weeks. A suitable healing abutment (gingival former) placed at the implant top. After two weeks, the patients referred for final prosthesis construction. All the patients followed for 4 years with clinical and radiographic examination.

T-test and paired t-test used to analyze the data. The level of significance tested according to the P-value, were  $P > 0.05$  (Not Significant),  $P < 0.05$  (Significant),  $P < 0.01$  (Highly significant).

The analyses were accomplished using two computer software programs: Statistical Package for Social Sciences (SPSS version 18) and Microsoft Office Excel 2007.

### III. RESULTS

Twenty two patients (10 males and 12 females) with age ranged from 23-66 years (mean 42.51) received 41 immediate implants, 14 implants (34.1%) of all cases (5 males and 6 females) had been inserted in the extraction sockets of maxillary and mandibular teeth with chronic periapical lesions (infected sites) Table I, and all the implants were survived (100 % success rate). Implant length used in the study was (12 and 14), implant diameter used was (3.4, 3.8, and 4.3) (Fig. 1).

TABLE I: DISTRIBUTION OF IMPLANTS ACCORDING TO THE JAW

	Incisors	Canines	Premolars	Total
Maxillary	4	1	7	12
Mandibular		1	1	2

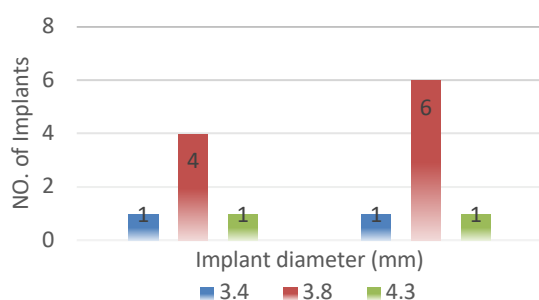


Fig. 1. Distribution of implant length and diameter.

Comparison was made between implants replaced teeth with chronic periapical lesions and implants replaced teeth that hadn't periapical lesions regarding mean ISQ value at base line and at 16 weeks follow up visit. The results showed no statistical significant difference ( $P > 0.05$ ) between the two groups neither at baseline nor at 16 weeks (Table II, Fig. 2).

Statistical analysis was made to study the change in implant stability during the healing period. The results showed that the mean ISQ value in cases of implants placed in infected sites had increased with a high significant difference ( $P < 0.01$ ) from baseline to 16 weeks, while in cases of implants placed in non-infected sites had increased with no significant difference ( $P > 0.05$ ) (Table III, Fig. 3).

TABLE II: COMPARISON BETWEEN INFECTED AND NON-INFECTED SITES ACCORDING TO ISQ VALUE

Stability at baseline					T-test	P value
Category	No.	Mean	$\pm$ SD	SE		
Non-infected sites	27	66.07	9.19	1.77	0.70	0.49 [NS]
Infected sites	14	63.86	10.24	2.74		
Stability at 16 weeks					T-test	P value
Category	No.	Mean	$\pm$ SD	SE		
Non-infected sites	27	68.69	7.64	1.47	1.38	0.18 [NS]
Infected sites	14	71.89	5.75	1.54		

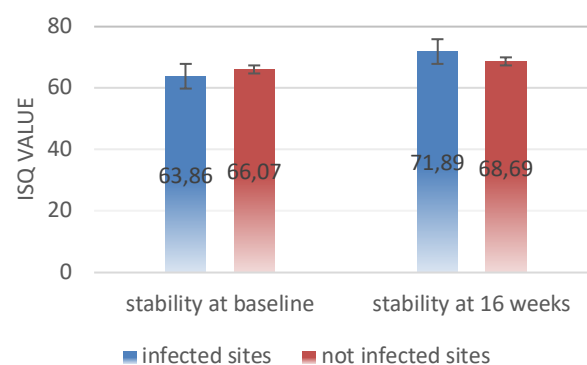


Fig. 2. Comparison between infected and non-infected sites according to ISQ value.

TABLE III: CHANGE IN IMPLANT STABILITY (ISQ VALUE) IN INFECTED AND NON-INFECTED SITES

Variables	Stability	No.	Mean	$\pm$ SD	Paired T-test	P value
Non-infected sites	Stability at baseline	27	66.07	9.19	1.82	0.080 [NS]
	Stability at 16 weeks	27	68.69	7.64		
Infected sites	Stability at baseline	14	63.86	10.24	3.18	0.007 [S]
	Stability at 16 weeks	14	71.89	5.75		

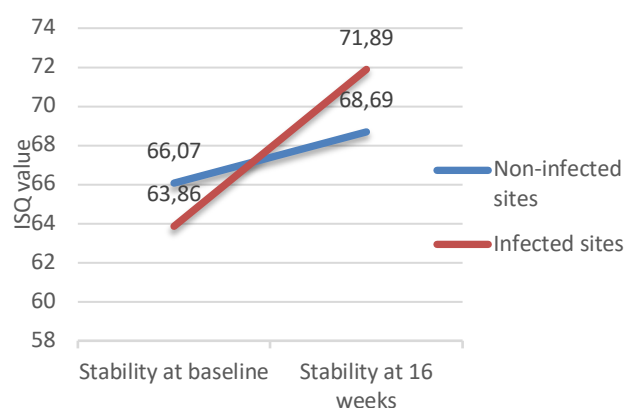


Fig. 3. Change in implant stability during the healing period in infected and non-infected sites.

## IV. DISCUSSION

All the implants survived without complications. This result is in line with previous studies that had 100% survival rate of implants placed in extraction sites of teeth that have periapical lesions [8], [11].

Reference [9] attributed success of implants in such cases to the behaviour of endodontic infection, which composed from mixed microorganisms dominated by anaerobic bacteria of species that are commonly restricted inside the infected root canal, and eradicated by the extraction of the involved tooth.

It is difficult to confirm this opinion as in this study no histologic examination was made to investigate the removed periapical lesions and the type of dominant bacteria could not verified. However, the high success rate may be attributed to the treatment protocol, where appropriate degranulation by surgical curette was made for the periapical lesion, followed by normal saline irrigation to eradicate the remaining granulation tissue, combined with postoperative antibiotic prescribed for all patients regardless of the presence or absence of periapical infection.

Complete and thorough debridement of the extraction socket prior to implant placement in teeth with periapical lesion is an essential step to remove any inflammatory periapical soft tissue in order to permit blood clot formation around the implant, which subsequently will lead to angiogenesis, fibrogenesis, and osteogenesis in the site [2], [12]. Local irrigation with antimicrobials performed in some papers [11]. Others suggested limited value concerning any clinical benefit of its application, as the infected tissue in the pulp itself considered the media for endodontic pathogens, while the periapical lesion is the inflammatory response to the infected intra radicular tissue. Therefore, thorough degranulation may be a critical step in immediate implant placement in sites with periapical lesion; however, the clinical advantage of antimicrobial irrigation considered disputable [1].

In this study the mean value of primary stability of implants placed in cases with periapical lesion was (63.86 ISQ) with no statistically significant difference with implants placed in other sockets neither at baseline nor at 16 weeks. However, the mean ISQ value of implants placed at sites of chronic periapical lesion increased significantly from baseline to 16 weeks and measure (71.89 ISQ).

The secondary stability recorded was slightly higher than previous study by [9] who also found that there is no significant difference regarding the biological (secondary) stability of immediate implants placed in sockets of teeth have chronic periapical lesions and implants placed in healed sites.

Reference [14] suggested that the loss of bone was compensated for by an increased interfacial stiffness resulting from bone formation and remodelling, and this may explain the significant increase in the mean ISQ values of implants inserted into infected sockets during the healing period rather than others that placed in healthy sites.

As observed from the clinical work, the presence of small periapical destruction inside the alveolar bone had minimal effect on the primary stability. However, in some cases attaining implant stability represented the main challenge especially when there was large bone destruction that resulted

from large periapical lesion and this confirmed the previous point of view of [11] where the authors concluded that the primary implant stability represent a difficult goal in cases with periapical pathology especially when large bone destruction occur, but when primary implant stability is achieved the immediate placement into sites with periapical lesion have no difference than that placed in healthy sockets, with equal type of tissue integration of the implants if suitable clinical protocol was employed.

## V. CONCLUSIONS

Within the limit of the available data and the follow up of this study, the conclusion can be produced that immediate implant, inserted into sockets of extracted teeth have chronically infected sites, osseointegrated and provide high survival rate when properly managed.

## ACKNOWLEDGMENT

I offer my appreciation and deepest gratitude to Dr. Jamal Abid Mohammed and Dr. Thair Abdul Lateef for their scientific help, support, and advice.

## REFERENCES

- [1] Lee CT, Chuang SK, Stoupel J. Survival analysis and other clinical outcomes of immediate implant placement in sites with periapical lesions: systematic review. *Int J Oral Maxillofac Implants*. 2015; 30(2).
- [2] Waasdorp JA, Evian CI, Mandracchia M. Immediate placement of implants into infected sites: a systematic review of the literature. *J Periodontol*. 2010; 81(6): 801-8.
- [3] Novaes Jr AB, Vidigal Jr GM, Novaes AB, Grisi MF, Polloni S, Rosa A. Immediate implants placed into infected sites: a histomorphometric study in dogs. *Int J Oral Maxillofac Implants*. 1998; 13(3): 422-8.
- [4] Novaes Jr AB, Marcaccini AM, Souza SL, Taba Jr M, Grisi MF. Immediate placement of implants into periodontally infected sites in dogs: a histomorphometric study of bone-implant contact. *Int J Oral Maxillofac Implants*. 2003; 18(3).
- [5] Marcaccini AM, Novaes Jr AB, Souza SL, Taba Jr M, Grisi MF. Immediate placement of implants into periodontally infected sites in dogs. Part 2: A fluorescence microscopy study. *Int J Oral Maxillofac Implants*. 2003; 18(6).
- [6] Papalexiou V, Novaes AB, Grisi MF, Souza SS, Taba M, Kajiwar JK. Influence of implant microstructure on the dynamics of bone healing around immediate implants placed into periodontally infected sites. *Clin Oral Implants Res*. 2004; 15(1): 44-53.
- [7] Chang SW, Shin SY, Hong JR, Yang SM, Yoo HM, Park DS, et al. Immediate implant placement into infected and noninfected extraction sockets: a pilot study. *Oral Surgery, Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2009; 107(2): 197-203.
- [8] Villa R, Rangert B. Early loading of interforaminal implants immediately installed after extraction of teeth presenting endodontic and periodontal lesions. *Clin Implant Dent Relat Res*. 2005; 7(s1): s28-35.
- [9] Lindeboom JA, Tjiook Y, Kroon FH. Immediate placement of implants in periapical infected sites: a prospective randomized study in 50 patients. *Oral Surgery, Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2006; 101(6): 705-10.
- [10] Crespi R, Capparè P, Gherlone E. Immediate loading of dental implants placed in periodontally infected and non-infected sites: a 4-year follow-up clinical study. *J Periodontol*. 2010; 81(8): 1140-6.
- [11] Siegenthaler DW, Jung RE, Holderegger C, Roos M, Hämmerle CH. Replacement of teeth exhibiting periapical pathology by immediate implants. A prospective, controlled clinical trial. *Clin Oral Implants Res*. 2007; 18(6): 727-37.
- [12] Farina R, Trombelli L. Wound healing of extraction sockets. *Endodontic Topics*. 2012; 25(1): 16-43.

- [13] Villa R, Rangert B. Immediate and early function of implants placed in extraction sockets of maxillary infected teeth: a pilot study. *J Prosthet Dent.* 2007; 97(6): S96-108.
- [14] Turkyilmaz I, Sennerby L, Tumer C, Yenigul M, Avci M. Stability and marginal bone level measurements of unsplinted implants used for mandibular overdentures: a 1-year randomized prospective clinical study comparing early and conventional loading protocols. *Clin Oral Implants Res.* 2006; 17(5): 501-5.



**M. M. Abdulmunem.** An oral surgeon specialist born in Baghdad, Iraq, in 1987, graduated with a bachelor's degree (B.D.S.) in 2009 from Al-Mustansiriyah University/Dentistry College. Complete the (M.Sc.) degree in oral and maxillofacial surgery in 2016 from Baghdad University/Dentistry College. Lecturer at Al-Mustansiriyah University in the Oral Surgery and Periodontology Department.

ORCID: <https://orcid.org/0000-0001-9327-813X>

E mail: [mohammed.m.abdulmunem@uomustansiriyah.edu.iq](mailto:mohammed.m.abdulmunem@uomustansiriyah.edu.iq)