EVALUATING THE OSSEOINTEGRATION OF IMMEDIATE DENTAL IMPLANT PLACED IN THE PRESENCE OF CHRONIC INFLAMMATORY PERIAPICAL LESIONS

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ABSTRACT

INTRODUCTION: Compromised teeth with periapical pathologies are removed before dental implant placement and sockets are left to heal. Some clinicians began to immediately place dental implants in fresh extraction sockets associated with chronic inflammatory periapical lesions and these studies revealed high success rates.
OBJECTIVES: To evaluate healing of dental implants placed in sockets with chronic inflammatory periapical lesions after socket debridement.
MATERIALS AND METHODS: 10 patients received 10 implants that were immediately inserted in sockets associated with chronic periapical granuloma. A variety of clinical and radiological parameters were assessed.
RESULTS: All implants were osseointegrated with satisfactory implant stability at the end of the 6-month follow-up period and with no signs of clinical mobility or infection. All periapical lesions healed with no radiographic signs of peri-implantitis or lesion recurrence.
CONCLUSIONS: Implants could osseointegrate successfully when their placement was done immediately after extraction of teeth with periapical lesions, assuming that proper clinical measures, such as careful cleaning, socket debridement and curettage are undertaken prior to the implant surgical placement.
KEYWORDS: Immediate Implant, Periapical Lesion, Fresh Tooth Socket.
SHORT RUNNING TITLE: Immediate Implant In Chronic Inflammatory Periapical Lesion

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INTRODUCTION

Immediate dental implant placement was first reported in 1989 by lazzara (1). Its major advantages are reduced treatment plan time, less procedure steps and placement of the implant fixture in an optimal axial position (2,3).
Compromised teeth were used to be removed before dental implants placement and their extraction sockets healing is left undisturbed (4). However removal of these teeth initiates the alveolar bone resorption that will affect the upcoming implant favorable position and the final restoration(5).
Fugazzotto et al.(6) compared immediate implant placement in infected sites with implant placement in uninfected sites of the same patient. For achieving more reliable outcomes, inter-patient variables were eliminated, and the results were the same.
Lindeboom et al.(7) placed immediate dental implants in teeth with chronic periapical lesions and reported that implant stability, success rate and one year follow-up assessment of bone level radiographically are not associated with the presence of periapical granuloma. The immediate implantation of single tooth implants to replace teeth with periapical lesions has proven to be a successful therapeutic option. The periapical microbial flora had no effect on implant success, mean Implant stability quotient, or radiographic bone level after one year of implant placement.
Crespi et al.(8) left the granulation tissue in teeth sockets and placed the implant 4 mm beyond the

apex with under-preparation of these implant sites. This Study concluded that immediate implants in periodontally infected sockets with good primary stability have a successful tissue integration to implants.

Panjali et al(9), supported the idea of atraumatic extraction of teeth having clinical or radiological infection signs followed by immediate implant without curettage nor debridement. Implant drilling sequence removed the granulation tissue without the need of intended removal or curettage. By this way, inflammatory response is diminished as well as bone resorption. This study concluded that implant survival rate was unaffected by immediate implant insertion in infected sites, whether with or without curettage so, implant placement is not hampered by infection. There is no substantial clinical difference between how the gap distance heals with bone around the implant and how a conventional socket heals.

According to some authors, it is required to have at least 3 to 5 millimeters of remaining apical bone in the vertical dimension. (10,11).

Thus the study's purpose is to assess a) the osseointegration of the implant within the bone; b) healing of the chronic periapical granuloma and wound healin Null hypothesis: Presence of chronic periapical granuloma will contaminate implants in the initial healing period.

MATERIALS AND METHODS

Ethical Approval

This was a clinical trial conducted on chosen patients from the Oral and Maxillofacial Surgery Department's outpatient clinic at Alexandria University's Faculty of Dentistry. and reported according to modified CONSORT guidelines (12). The Alexandria University Faculty of Dentistry's Ethical Committee validated the research protocol (IRB number: 00010556-IORG 0008839) and registered on ClinicalTrials.gov with registration number (NCT05101941). All of the patients fulfilled the inclusion criteria and signed an informed consent before going on surgical operations. The research was carried out in compliance with the Helsinki Declaration for Experimentation on Human subjects(13).

Sample size estimation

A total of 10 patients was needed to detect an assumed average proportional difference in the Implant Stability Quotient (ISQ) compared to the null hypothesis taking into consideration 95% confidence level and 80% power using Chi Square-test. Drop out estimate was calculated to avoid sampling errors according to oxford statistical standards to be +2 added to the estimated sample (about 20% of the overall estimated sample) (14,15) (PASS program version 20)

Patients

Ten patients have been included in this study with single rooted mandibular teeth suffering from chronic inflammatory periapical lesions that demands extraction and curettage with immediate implant placement.

Inclusion Criteria

a) Adult patients with age range of 18-45 years having no preference for one gender over the other and they agreed to a minimum follow up visits for 6 months, b) non-restorable single rooted mandibular teeth with chronic inflammatory periapical lesions represented as periapical radiolucency, pulp necrosis, sinus tract, failed RCT, c) Adequate bone beyond teeth apices without jeopardizing any anatomical structure, the accepted range was 3-5 mm of bone beyond the apex. We tried to avoid the inferior alveolar and mental nerve injury. d) maximum size of the periapical lesion was 5 mm.

Exclusion criteria

Patients were excluded if they were (a) Smokers and alcoholics, (b) Medically compromised patients having systemic disease interfering with bone healing, (c) Patients contraindicated for surgery, (d) Patients having Periodontitis, panoramic xrays were taken before selecting our patients as we excluded patients having periodontitis and bone loss according to World Workshop for Periodontology.(16).

Methods

Demographic data of the patients were collected, including name, age, sex, occupation, address, and telephone number. History of any medical condition like diabetes, hypertension, drug allergy or any medications was taken. History of periodontal disease, badly destructed teeth, swelling, trauma, failed restorations, any oral pathology and past dental experiences was recorded. The patient's chief complaint, desire and expectations were documented. Followed by soft tissue examination for any suppuration or discharge, swelling or tooth mobility.

Preoperative phase

Surgical assessment by Cone-Beam Computed Tomography (CBCT) was done to evaluate the dimension of the periapical lesion and the amount of sound bone beyond the apex as shown in Figure (1). 2 grams of antibiotic prophylaxis (amoxicillin+clavulanate, Augmentin, Glaxosmithkile, Middlesex, UK) was prescribed for controlling infection thirty to sixty minutes before operation, according to the Infectious Diseases Society of America guidelines (17).

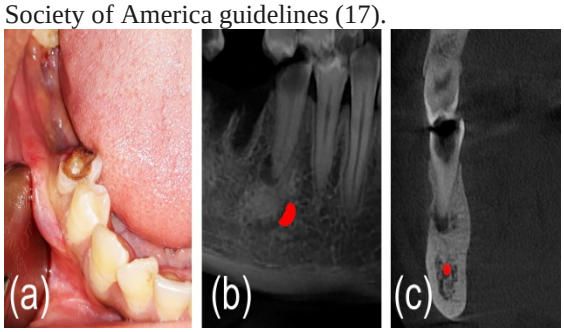

Figure 1: shows a presentation of a case with a periapical granuloma related to lower right second premolar preoperatively.

Surgical phase

Extraction of teeth

local anesthesia (Mepecaine-L) with 1:20000 adrenaline was used. Atraumatic extraction of compromised single rooted mandibular teeth was performed using lower premolar forceps and lower anterior forceps. Extraction of teeth was by rotation and traction "upward" movements without too much expansion of bone. Socket debridement and curettage were done using bone curette (figure 2). A sterilized gauze was placed between the periapical lesion and socket walls, and lateral pressure was applied on the gauze with the concave surface of the curette facing the bone. We repeated this until the gauze did not engage any tissue remnants.

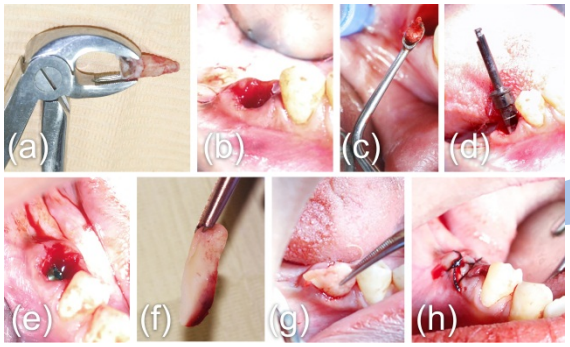

Figure 2: shows clinical phase. (a,b) extraction of a premolar. (c) socket curettage. (d,e) Implant placement. (f) prepared PRF. (g,h) PRF covering the extraction wound Implant placement

Implant site was prepared using conventional drills and the implant's apical part extended 4 mm beyond the apex. SuperLine implants (Dentium Co™) was used and implant collar was located at the same level of the crestal bone. Diameters used were 3.6, 4.0, 4.5, 5.0 and 6.0 mm. Lengths used were 8, 10, 12, and 14 mm. Insertion torque was at least 30 newton centimeter. Implant stability was checked by osstell(ISQ®) in a quotient scale (ISQ).

Use of platelet rich fibrin

15 ml of venous blood was aspirated from antecubital area to prepare platelet rich fibrin (PRF) in 3 sterile tubes. Each tube is 5 ml glass-coated test tube without anticoagulant. Centrifuge unit (E.T 80-1 Centrifuge) was set on 12 minutes and 2,700 rpm at room temperature. PRF was gently pressed into a membrane using glass slap and a sterile gauze. PRF was then placed over the surgical site and secured with Silk 3-0 non-resorbable suture in a figure of eight pattern to prevent its immediate displacement. (figure 2).

Postoperative phase

Patients were given comprehensive oral hygiene care and instructions, including; brushing twice daily, flossing once daily, cold fomentation for 5 minutes every 15 mins at the first hour, soft diet, high protein, high calorie diet and fluids for 2 weeks. They were advised to take the prescribed medications, which include: Augmentin 1 gm tablets (Amoxicillin 875 mg + Clavulanic acid 125 mg: GlaxoSmithKline, UK.) twice daily for 3 days, Flagyl 500 mg tablets (metronidazole 500mg: GlaxoSmithKline, UK.) every eight hours, Alphintern as anti-oedematous once daily (Amoun pharmaceutical, Egypt) , Cataflam 50 mg tablets (Novartis, Switzerland) as analgesic every eight hours and 0.12% chlorhexidine mouth wash (Arab drug company, ADCO) 3 times daily for 2 weeks. Sutures were removed 7 days after the surgery.

Patients were radiographically assessed using an immediate postoperative CBCT for further comparison of the periapical lesion dimensions with another CBCT done 6 months later to assess the healing of these lesions. Implant stability was re-tested by osstell after 6 months and compared to the readings taken at the surgical phase.

Patients were evaluated in terms of clinical and radiographic factors for six months.

Clinical Evaluation

a) Postoperative pain: It was recorded daily for 7 days through a 10-point Visual Analogue Scale (VAS) from zero to ten (0-1= None, 2-4= Mild, 5-7= Moderate, 8-10= Severe)(18).

b) Postoperative swelling: It was recorded daily for 7 days. Four parameters was used; none (no swelling), light (intraoral, localized to the treated area), moderate (extraoral swelling localized to the treated area), and severe (extraoral swelling extending beyond the treated area)(19).

c) Wound healing: Using Early Wound Healing Index (EHI), it was evaluated across weeks 2, 4 and 8. (EHI; 1: complete flap closure-no fibrin line; 2: complete flap closure-fine fibrin line; 3: complete flap closure-fibrin clot; 4: incomplete flap closure-partial necrosis; 5: incomplete flap closure-complete necrosis)(20) as shown in figure (3).

e) Implant stability

It was measured by implant stability meter Osstell™ (ISQ®) that uses Resonance Frequency Analysis (RFA) for calculating implant stability on a relative scale of implant stability quotients (ISQ) Immediate postoperative and while loading and prosthetic phase after 6 months(9,21) (figure 3).

Radiographic Evaluation

Immediate post-operative and after 6 months CBCT were requested in order to compare the dimension of the periapical lesion in millimeters using OnDemand system and image-j program (figure 3). Grey scale was measured by Image-J program. When a CBCT cut is inserted in Image-J program and the region of interest is selected, it calculates the Mean Gray Value which is average gray value within the selection. This is the sum of the gray values of all the pixels in the selection divided by the number of pixels. This readings correspond to the optical density of the area of interest.

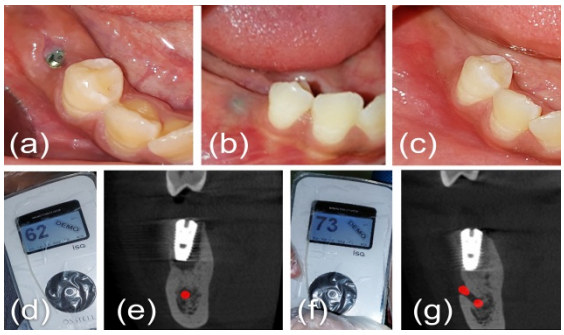

Figure 3: clinical and radiographic evaluation. (a,b,c) showing EHI at 2, 4 and 8 weeks. (d,e) showing ISQ values and a CBCT radiograph immediately postoperative. (f,g) showing ISQ values and a CBCT radiographic at 6 months follow up.

STATISTICAL ANALYSIS

Normality of quantitative data (implant stability and grey scale measurements) was checked using Shapiro Wilk test, box plots and descriptive. Data was presented using mainly Median, Inter Quartile Range (IQR) and Minimum and Maximum values in addition to Mean, Standard deviation (SD). Changes across time in pain scores, swelling, wound healing, and grey scale was assessed using Friedman test followed by post hoc test with Bonferroni adjustment when the results are significant. Pair t test was applied to assess changes in implant stability. Significance level was set at P value of 0.05. All tests were two tailed. SPSS for Windows, version 23, was used to analyse the data

RESULTS

The present study was a clinical trial reported according to modified consort guidelines conducted on 10 patients with an average age of 35±6.84 years where 10 implants were placed in fresh extracted mandibular single rooted teeth associated with chronic periapical granuloma. Patients were chosen from the Oral and Maxillofacial Surgery Department's clinic at Alexandria University's Faculty of Dentistry. Patients were selected upon the inclusion and exclusion criteria with no gender predilection, male/female ratio was 1:1 and they were followed up for 6 months (Table 1).

Table 1: Demographic data of the included patients

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Variables	Number of Patients (%)
Age (Mean ±SD)	35±6.84
Gender	
Males	5 (50)
Females	(50)

Table 2: Post-operative pain and edema scores across the different time points

Variable	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**
Pain (Mean±SD)	3.50 (0.85)	2.60 (0.97)	1.70 (0.82)	0.70 (0.82)	0.20 (0.42)	0.10 (0.32)	0.00 (0.00)
Swelling N=10, n(%)							
None	0 (0%)	0 (0%)	0 (0%)	6 (60%)	9 (90%)	9 (90%)	10 (100%)
Mild	10 100%)	1 10%)	7 (70%)	3 (30%)	1 (10%)	1 (10%)	0 0%)
Moderate	0 0%)	8 (80%)	3 30%)	1 10%)	0 (0%)	0 (0%)	0 0%)
Severe	0 (0%)	1 (10%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Friedman Test P value<0.0001*							

Table 3: Implant stability, dimension of periapical lesions and grey scale across time points

Variable	preoperative			Immediate postoperative			6 month follow up		
	Mean (SD)	Media n (IQR)	Min Max	Mean SD)	Media (IQR)	Min Max	Mean SD)	Medi n (IQR)	Min Max
Implant stability				65.00 (3.86)	66.00 (7.00)	59 - 71	75.50 (6.29)	75.00 (12)	65 - 84
Lesion Dimensions	71.70 38.01)	61.18 (22.36)	42.3 3 – 75.15	13.5 (23.41)	0.00 (34.0)	0 - 66	0.00 (0.0)	0.00 (0.0)	0 - 0
Grey scale	24.30 118.46)	-6.45 (168.5)	- 19.9 – 264.7	515.0 2 435.10)	367.9 (519.4)	121. 2 – 494.9	915.40 424.83)	756.7 5 783.6)	315. 0 – 501.0
*Statistically significant at p value ≤0.05									

Table 4: **Wound healing scores across time points**

Time intervals	**Mean (SD)**	**Median (IQR)**	**Min - Max**
2nd week	**2.80 (1.03)**	**2.00 (2.00)**	**2.00 – 4.00**
4th week	**1.00 (0.00)**	**1.00 (1.00)**	**1.00 – 1.00**
8th week	**1.00 (0.00)**	**1.00 (1.00)**	**1.00 – 1.00**
Friedman Test P value	**20.00 <0.0001***		

*Statistically significant at p value ≤0.05

Postoperative Pain

Pain was monitored for 7 days after surgery using a Visual Analogue Scale (VAS). There was mild pain on the first postsurgical days which completely subsided in all patients after 7 days. Mean values of the VAS scores was 3.50, 2.60, 1.70, 0.70, 0.20, 0.10, 0.00 starting from day 1 to day 7. (Table 2).

Post-operative swelling

Swelling was measured postoperatively for all patients during the 1st week. On the first day all of the cases experienced mild swelling which is intraoral and confined to the surgical field. On the second day most of the cases experienced moderate swelling which is extra-oral and confined to the surgical area. Swelling started to decrease from the 3rd day post operatively and vanished after one week (Table 2).

Implant stability

Implant stability was checked for all implants using the Osstell device, immediately postoperative and after 6 months. The mean ISQ value recorded postoperatively was 65.00 ± 3.86 where the minimum ISQ value was 59 and the maximum ISQ

value was 71. The mean ISQ recorded after 6 months was 75.50 ± 6.29 where the minimum ISQ value was 65 and the maximum recorded ISQ value was 84 (Table 3).

Dimensions of the periapical lesions

Mean lesion size preoperatively was 71.70 ± 38.01 then it decreased into 13.5 ± 23.41 immediately postoperative and vanished 6 months postoperatively (Table 3).

Grey scale

The mean grey scale of the periapical lesions recorded preoperatively was 24.30 ± 118.46 where minimum scale was -119.9 and maximum was 264.7. The mean grey scale recorded immediate postoperatively was 515.02 ± 435.10 where minimum scale was 121.2 and maximum was 1494.9. . The mean grey scale recorded 6 months postoperatively has increased into 915.40 ± 424.83 where minimum scale was 315.0 and maximum was 1501.0 due to bone deposition (Table 3).

Wound healing

Two weeks after surgery, mean EHI values was 2.80 ±1.03, 6 patients experienced complete flap closure with fine fibrin line and 4 patients experienced incomplete flap closure with partial necrosis. Four weeks after surgery, mean EHI values was 1.00, all patients experienced complete flap closure with no fibrin line (Table 4).

DISCUSSION

Immediate implants offer immediate predictable solution which restores function and reestablishes comparable esthetics(22). It has a beneficial psychological influence on the patient since the extracted tooth is replaced immediately without the patient having to wait for the socket to heal(7,23,24).

The study's main goal was to evaluate the osseointegration of immediate implant within the bone where chronic periapical granuloma exists and to assess the healing of these lesions.

Dental implants have succeeded when placed immediately into healthy extraction sockets(25,26) because neither peri-implantitis nor periapical radiolucency have been noticed. On the contrary, implant placement in infected sites was thought to be a relative contraindication because periapical lesions of these sites have been linked to implant failure in the literature(27–29). Some authors recommended placing implants immediately into extraction sockets to minimize alveolar bone resorption and treatment period(1,30).

Immediate implant placement provide various advantages, including alveolar ridge preservation owing to the avoidance of resorption after extracting teeth and allowing usage of implants that are longer and broader(31). Other advantages include shorter treatment time, lower risk of harm to anatomical landmarks, and less bone resorption due to lower heat production while drilling the osteotomy site(2,32).

This study shows that immediate implants have succeeded just like implants placed in healed sites, this is in accordance to a study that considered selection of immediate implants in chronic and acute lesions as a good treatment option with high chance to succeed(33). This may be clarified by the behavior of endodontic infections, which are mixed infections but anaerobic bacteria are dominating and it is usually limited in the infected root canal(34,35). Moreover, studies reported that immediate dental implant placement in an extraction site with a periapical infection did not result in a greater incidence of complication than the placement of a dental implant in an uninfected site(7,36).

If appropriate clinical procedures such as antibiotic administration, thorough cleaning, and alveolar debridement are undertaken before the surgical surgery, elimination of the cultured microorganisms as well as a reduction in the inflammatory response and bone resorption would occur and immediate placement of implants would result in a favorable type of tissue integration and this is in agreement with some authors (7,33,36–40). In contrast, Crepsi et.al. showed that granulomatous tissue fibroblasts from persistent inflammatory periodontal lesions and healing wounds responded similarly in vitro.

From the results of our study, the postoperative pain was mild and of short duration as it was a minimally invasive surgery and this results had a coincidence with other studies (37,41,42).

Postoperative edema was not severe and was confined to the surgical area and this was tested by some studies with the same findings (8,38,41) and to a study that revealed minor gingival swelling in the first days for the group that was scheduled for granulomatous tissue removal(43).

Healing of implants was free of complications and was generally uneventful. This was in accordance to another study (41); Since primary stability is the most critical factor affecting osseointegration, it is widely recognized as an important prerequisite for implant success. In a new extraction socket, there is little bone-to-implant contact at the time of implant insertion, which may result in lower primary implant stability. In this study, the mean ISQ value recorded immediately postoperative was 65.00 ± 3.86 which indicated moderate stability but it increased after 6 months with a mean of 75.50 ± 6.29, This was similar to other studies (7,44).

Meticulous debridement of the periapical lesions and extending implant site preparation beyond the root apex ≥ 4 mm was enough to promote the healing, to achieve a good primary stability and to reduce lesions size throughout the 6 months follow up period. This was in accordance to some studies (8,27,38,45)

Some studies supported application of PRF after immediate implant(46–48). One of the most critical

aspects of effective implant therapy is preserving peri-implant bone. By utilizing the regeneration ability of implant's surrounding tissue with the right stimulation, the quality as well as quantity of bone surrounding implant and soft tissue can be enhanced. Application of PRF or collagen membranes as an additional therapy will promote healing outcome of extraction sockets. This could also cover the implant and lower the chance of infection.

The limited number of patients and the different types of periapical pathologies necessitates further studies to be applied on a larger scale.

CONCLUSION

Implants could osseointegrate successfully when their placement was done immediately after extraction of teeth with periapical lesions, assuming that proper clinical measures, such as careful cleaning, socket debridement and curettage are undertaken prior to the implant surgical placement.

CONFLICT OF INTEREST: The authors state that they have no conflicts of interest.

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