Clinical study of osseointegration of immediate implant in dentoalveolar socket with and without periapical pathosis

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ABSTRACT
Objective: Today, one of the most challenging aspects of esthetic implant modalities is to obtain a predictable immediate implant placement in post-extraction sites, without waiting for the site to heal. This is a treatment modality that has received much attention. Also implants can be successfully placed in human post-extraction infected sites. This prospective study investigates a comparison between osseointegration of immediate implant placement in fresh and infected dentoalveolar sockets.

Materials and Methods: Ten patients (six males and four females) with a different mandibular tooth indicated for extraction were included in this study. Their ages ranged between twenty to fifty two years. Teeth extraction was done as a traumatically as possible; the ten patients were divided into two groups: where there was no periapical pathosis after radiographical examination was referred to as group I, while those who had periapical pathosis identified on radiographical examination were referred to as group II. Each patient was evaluated clinically and radiographically immediately after operation, and 1.5, 3 and 6 months post-operatively.

Results: There was no statistically significant difference in the changes which occurred in both group I and group II. The percentages of changes were calculated in relation to the baseline at postoperative records. However the percentage of changes between the two groups at different follow up periods were steady immediately after operation, six weeks and twelve weeks, and it significantly decreased at the last follow up after six months.

Conclusion: Immediate implant placement in a fresh socket and also infected socket proved to be of great benefit to both the dentist and the patient as it eliminates the need for second stage surgery and an additional healing period, decreases the total time, better preserves soft tissue contours and height in esthetic zones, reduces overall cost and results in better osseointegration.

Key words: osseointegration, periapical pathosis, immediate implant

INTRODUCTION
Endosseous dental implant therapy has rapidly became the prosthetic standard of care for a vast array of clinical applications, and we are faced with the challenge of developing dynamic treatment planning protocols. With increased prevalence of edentulous individuals over sixty-five years of age, dental professionals are actively seeking to increase public utilization of endosseous dental implants. Immediate implants have become widely accepted despite controversial beginnings, and the available literature consistently cites high levels of success (ranging from 94-100 percent on an average). Yet there is no universally agreed upon case selection criteria.

The success rates of endodontic treatment for vital and non-vital teeth have been reported to be 82.8% and 78.9% respectively. Periradicular surgery is essential when nonsurgical endodontic treatment fails. Although periradicular surgery has a high success rate, there are still teeth with problems that cannot be solved by periradicular surgery and require extraction. In these cases, the placement of implant after tooth extraction is a good option for re-establishing the function and esthetics.

The immediate implant placement in post-extraction sites, without waiting for the site to heal, is a treatment modality that has received much attention. Also
implants can be successfully placed in human and animals post extraction infected sites. The immediate placement of an endosseous implant after tooth extraction as several advantages: it maintains the horizontal and vertical dimensions of the osseous tissues, keeps the implant in the same angulations as the pre-existing natural tooth, reducing treatment time and decreasing patient discomfort, while achieving high predictability and an excellent esthetic outcome.6

MATERIALS AND METHODS

This study included ten patients (six males and four females) with a different mandibular tooth indicated for extraction. Their ages ranged between twenty and fifty two years, with a mean age of thirty six years. The patients were selected from the out-patient clinic of Oral & Maxillofacial Surgery department at the Faculty of Dentistry, Suez Canal University. The patients were free of systemic conditions as confirmed using the printed medical questionnaire scored by each patient. The ten patients were divided into two groups: Group I (control group) no periapical pathosis identified after radiographical examination (fresh socket). Group II – periapical pathosis identified after radiographical examination (infected tooth socket).

Implant system used in the study

TUT implant system (TUT Dental Implant Co., Cairo, Egypt) was used in the present study. It is fabricated from commercially pure medical titanium grade III. This implant is cylindrical and threaded with tapered vented end. The implants of this system are available in several lengths 9, 11, 13 and 15 mm, and diameters of 2.9, 3.4, 3.9, 4.4, and 4.9mm.

The surgical and prosthetic procedures were explained to each patient in detail. Also the complications of surgery (risk of damage to inferior alveolar nerve, sinus perforation, post-operative bleeding, pain and swelling) were mentioned. The need for intra-operative and post-operative photographs as well as exposure to X-ray for at least four times after surgery during the follow up were also mentioned.

Pre-operative panoramic or periapical X-ray was requested in order to reveal periapical and periodontal conditions, relationship between the teeth to be extracted and the roots of adjacent teeth, length and mesiodistal dimensions of the socket (Figures 1 and 2).

All surgical procedures were performed under aseptic conditions. This was achieved by asking the patient to rinse with 15 ml of 0.1% Chlorhexidine (Antiseptol mouthwash, Kahirapharmaan Chem Industry Co. Cairo, Egypt), immediately before surgery to reduce the oral microbial count. A perioral facial preparation of the patient using Providene-Iodine 10% [Betadine, Nile Co. for Pharma, Cairo, Egypt (under license from Mundipharma AG, Basel Switzerland)] antiseptic solution was done. The field was then isolated with sterile towels.
Implant Osteotomy
Preparation of the extraction area and the apical bone for the placement of the implant was done.

Points to note
- The osteotomy started with a round bur or pilot drill. Once the osteotomy is complete to the desired depth with at least 3 to 5 mm of intimate implant-to-bone contact, an implant is placed.
- The implant must be stable within the osteotomy with no mobility. A small round bur or a position marker is used at the beginning of the procedure to determine the center of the osteotomy. Alternatively, a pilot drill may be used. This will provide an indication of the density of the bone. The diameter of the osteotomy is enlarged to reach the last drill according to implant diameter, i.e. 3mm drill for 3.4 implant, 3.5 mm for 3.9 implant and 4mm for 4.4 implant.

Palpation of the ridge buccally and lingually is performed to give an early indication for any inadvertent perforation by a misdirected drilling. The depth to which the implant is inserted should be sufficient to allow the creation of an emergence profile that is aesthetically acceptable.

The Implant to Socket Wall Space
The space between the implant and socket wall was sealed with the bone chips that resulted from drilling and put it between the implant and the socket wall as possible.

Implant insertion
The implant was inserted in the socket and turned until resistance encountered. The plastic mount was removed with slight mesiodistal and upward movement, the implant driver and ratchet wrench applied and the implant was turned to be at the proposed position (Figures 5, 6 and 7).

Anesthesia: 2% Mepivacaine with 1/20000 Levnordefrin (Mepecaine, Alexandria Pharmaceuticals, Alexandria, Egypt) inferior alveolar nerve block was carried out in the lower jaw.

Tooth Extraction
Every attempt was made to minimize trauma to the alveolus during the extraction. The use of a periotome to make the initial sulcular incision around the tooth was done to facilitate separating the soft tissues from the root and cutting the periodontal ligaments (Figures 1 and 2). Curettage was done after tooth extraction to remove any granulomatous tissue or remaining periodontal fibers and to confirm buccal and lingual plate integrity (Figures 3 and 4).

Implant Selection
Implant length was selected to extend beyond the apex and assure primary stability. The size of the final drill for implant placement was determined according to the diameter of the socket as the final drill is larger by one size than the largest drill that can be inserted in the socket with friction.
Radiographic evaluation
Standardized digital periapical radiographs were carried out, immediately post-operative, six weeks, 12 weeks and 24 weeks after implant placement. The postoperative periapical film was saved as a base record. (Figures 8, 9, 10 & 11)

Soft Tissue Management
Undermining the buccal and lingual mucoperiosteum to be stretched in order to cover the implant was performed. Primary closure was done with horizontal mattress technique using black silk suture material.

Clinical Evaluation
Patients were followed-up one week, six weeks, twelve weeks and twenty four weeks post operatively to evaluate for any swelling, infection, implant exposure, and pain.

Standardized periapical radiographs was obtained by use of XCP (Rinnorporation, XCP instrument for extension cone paralleling, IL.,USA.) film holding device and film positioning stent. Radiographs
for all subjects were done using the same exposure parameters; 65 Kilovolts and 10 milliamper for 0.06 sec. using the same calibrated Orix (Orix-Aet, ARDET,s.r.1.Milano,Italy) x-ray machine. The x-ray films were developed and fixed manually using fresh chemicals. Computer scanning for periapical radiographs was obtained, image readout was displayed on the computer screen, then the readout image was stored to be analyzed by Digora software (Digora software provided by Orion Corp.Soredek medical system Helsinki, Finland).

**Radiodensometric analysis**
The optical density of the alveolar bone surrounding the implant site was measured for mesial and distal area, as a tangential line to the implant thread with width of 0.5mm from implant thread. the density of apical area calibrated according to a line connect the two mesial and distal lines. The density measurements are calibrated by quantifying the image on gray scale and the records are standardized according to implant density.

**Radiometric analysis**
Linear measurements were carried out to assess the crestal bone loss. The implant length was measured from the apex of the implant to the top of the cover screw, and the bone length was considered the tangential line to the implant thread from the level of implant apex to the bone crest. Linear measurements were calibrated and standardized according to the predetermined implant length.

**Follow up**
**Clinical follow up**
Clinical evaluation was performed weekly for each patient for the first three weeks postoperatively for any signs of postoperative infections.

**Radiographic follow up**
Periapical radiographic films were used in this study to determine the changes of bone density and interproximal crestal bone height. These periapical radiographs were taken over 24 weeks postoperative at six, twelve and twenty four weeks’ intervals with the immediate postoperative radiograph as a baseline value for the measurements.

**RESULTS**
In Group I (control group, immediate implants in fresh socket), bone density decreased minimally from the immediate postoperative 77.8±9.99 to 76.2±6.83 after 6 weeks, then increased to reach 77.53±5.91 after 12 weeks, till 90.27±5.3 after 24 weeks, showing no statistically significant difference at the 0.05 level in the three records (Table 1).

In Group II (test group, immediate implants in infected socket), Bone density decreased minimally from the immediate postoperative 72±6.77 to 71.73±6.38 after six weeks to reach 72.93±6.364 after 12 weeks till 89.33±17.340 after 24 weeks showing no statistical significant difference at the 0.05 level in the three records.

In group I crestal bone loss increased steadily from 0.8mm after 6 weeks to reach 1.5mm after 12 weeks till 1.9 mm after 24 weeks postoperatively (Table 2). While in group II crestal bone loss increased steadily from 0.8 after 6 weeks to reach 1.5 mm after 12 weeks till 1.9mm after 24 weeks postoperatively. There was no statistically significant difference in crestal bone loss in Group I in comparison to Group II as recorded in the follow up after 6 weeks, 12 weeks and 24 weeks.

**DISCUSSION**
Dental therapy primarily aims to maintain teeth in a state of health, function and appropriate aesthetics. However, extraction of teeth is still needed when the teeth cannot be saved by periodontal and restorative measures and the dentist is faced with no replacement options. Therefore, endosseous dental implant therapy rapidly becomes the prosthetic standard of care for a vast array of clinical applications. The primary focus of
The implant survival rate was 100%, and hard and soft tissue integration was similar and favorable in both the fresh and the infected groups.

The aim of the present study was to compare osseointegration following immediate implant placement in fresh dentoalveolar socket with infected dentoalveolar socket. In group I, the patients selected had teeth indicated for extraction with no periapical pathosis, while in group II, the patients had teeth with periapical pathosis.

In the present study, the immediate post-extraction implant placement led to excellent clinical outcomes. The attention in implant dentistry has shifted from the achievement of osseointegration, to creating aesthetic implant-supported restorations which mimic the tooth being replaced.

Block and Kent achieved good clinical results with immediate implants when the site was free from periodontal and periapical diseases. According to these authors, increased failure rates resulted when immediate implantation was carried out after extracting teeth due to periodontal or periapical diseases.

The present study supports David et al's confirmation that immediate implantation performed into extraction sockets of teeth exhibiting periapical pathology did not lead to an increase in biological complications. The implant survival rate was 100%, and hard and soft tissue integration was similar and favorable in both the fresh and the infected groups.

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<table>
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<th>Group</th>
<th>Site</th>
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<th>3m</th>
<th>6m</th>
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*No statistical significant difference at the 0.05 level.
Statistical significant difference at the 0.05 level.
Highly statistical significant difference at the 0.01 level.

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<td>0.036</td>
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*No statistical significant difference at the 0.05 level.
relative success rate, preservation of hard and soft tissues, and general high patient satisfaction with the esthetic and functional outcomes show that this clinical procedure can be considered a safe, effective, and predictable treatment option for the immediate rehabilitation of post-extraction fresh and infected sockets.

In the current study, long cone paralleling technique with XCP film holder was used for periapical radiographs for standardized technique. This is in agreement with Hermann et al,\textsuperscript{9} who evaluated crestal bone changes around 59 unloaded non-submerged and submerged titanium implants. Standardized radiographs were taken at monthly intervals for 6 months. Evaluation of bone density changes was done by using computer image analysis. In the present study, in order to determine the bone density and interproximal crestal bone height the implant was used as reference point from the digitalized radiographs. These reference points were chosen because they were permanently visible and easy to locate on all radiographs.

We followed certain measures which were in agreement with Wang et al.\textsuperscript{10} who reported that in immediate implant placement for replacement of teeth with periapical lesions, success can be achieved if preoperative and postoperative measures, such as antibiotic administration, meticulous cleaning, and alveolar debridement are followed. Others have shown that immediate implant placement in infected socket is possible under the controlled use of antibiotics\textsuperscript{11-14}. In the current study, tooth extraction was done as atraumatically as possible, and this is in agreement with Rouck\textsuperscript{16}, who confirmed that atraumatic extraction technique is very important for the success of immediate implants and facilitated maintenance of the maximum amount of bone. Atraumatic extraction will allow for the preservation of buccal plate bone (preventing perforations or alveolar bone fracture), without which an immediate implant might be contraindicated. Atraumatic extraction may be prevented by ankylosis, which is a relative contraindication to immediate implant therapy. Gross iatrogenic expansion of the alveolus during extraction is likewise a relative contraindication\textsuperscript{15}.

In present study tooth was extracted atraumatically, and without the need for flap elevation. According to Campelo and Camara\textsuperscript{17}, flapless implant placement is considered to be a blind surgical technique. Care must be taken to avoid perforation of the cortical plates during drilling. However, this need not be of concern if the patient has been appropriately selected and an appropriate width of bone is available for implant placement. The procedure used was in agreement with Cardaropali et al,\textsuperscript{18} who reported that the surgical trauma caused by flap elevation induces remodeling of surface layer of alveolar bone.

Seok\textsuperscript{19} concludes that an osteotomy might have positive and negative effects on the prognosis of an immediate implant. It helps in the thorough debridement of the hard and soft inflamed tissue but a buccal fenestration defect can have adverse effects on bone regeneration. Cases with buccal fenestration were excluded from our study.

Another critical aspect which we faced during this study is the diameter of the periapical lesion. If it exceeded the diameter of the planned implant, then there would have been a need to obtain implant stabilization more apically. To deal with this problem we extended the osteotomy 3-4 mm apically to gain initial stability as far as possible. If the implant diameter is larger than the diameter of the periapical lesion, initial stability may be sufficient without extending 3–5mm apically to the extraction socket. This is in accordance with Becker\textsuperscript{20} who suggested that initial stability may be sufficient when apical extension was 3–5mm. The defect morphology after implant placement exhibited no statistically significant difference.
Our study agreed with Saadon\textsuperscript{21} who stated that drilling only 3-4 mm beyond the root apex protected the bone from excessive heat generation as compared to drilling in healed sites as the latter required more preparation. He also demonstrated that a temperature over 47 C for 1 min may induce heat necrosis in the bone.

The results of this study support the hypothesis that augmentation of defects with autogenous bone has a beneficial impact on the long-term hard and soft tissue stability, which agrees with the findings of Gökçen B\textsuperscript{22}, who confirmed that placement of an implant in an extraction socket resulted in a gap between the extraction socket wall and the surface of the implant. These defects were augmented with autogenous bone collected during drilling. Various techniques and materials have been introduced for the reconstruction of bony defects of alveolar bone, such as autogenous, allogeneic, or alloplastic bone grafts. Alloplastic and allogeneic materials and guided tissue regeneration techniques have demonstrated promising results but they lack predictability. From a theoretical standpoint, use of autogenous bone as a filling material in marginal defects and dehiscence preserves the buccal bony structures and has predictable results. The autogenous graft reduces the resorption of alveolar crest after extraction.

A potential disadvantage with immediate implants could be the mismatch between the implant surface and the socket wall. Gaps could be present after implantation because the dental roots do not have a regular circular diameter.

However the present study agreed with Boticelli\textsuperscript{23,24}, who stated that marginal gaps occurring between the implant surface and socket wall may predictably heal with bone formation. This hypothesis is supported by many studies.

In the current study in Group I (control group, immediate implants in fresh socket), bone density decreased minimally from the immediate postoperative 77.8±9.99 to 76.2±6.83 at six 6 weeks and then increased to 77.53±5.91 after 12 weeks and reached 90.27±5.3 at 24 weeks showing no statistical significant difference at the 0.05 level.

In group II (test group, immediate implants in infected socket), bone density decreased minimally from the immediate postoperative 72±6.77 to 71.73 ± 6.38 till six weeks and then increased to reach 72.93±6.364 after 12 weeks till 89.33±17.340 after 24 weeks showing no statistical significant difference at the 0.05 level.

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In group I crestal bone loss increased steadily from the immediate postoperative 0.8mm after 6 weeks to reach 1.5mm after 12 weeks till 1.9 mm after 24 weeks, while in group II crestal bone loss increased steadily from the immediate postoperative 0.8 after 6 weeks to reach 1.5 mm after 12 weeks till 1.9mm after 24 weeks.

There was no statistical significant difference in crestal bone loss in group I in comparison to group II as recorded in the follow up after 6 weeks, 12 weeks and 24 weeks.

These results were in agreement those of with Noveas et al\textsuperscript{25} who concluded that the percentage of osseointegration for experimental implants was not significantly different from that in the control implants. In the present study, no statistical significant differences were found at the follow-up period between immediate placement of implants in sockets with and in those without chronic periapical infected lesions.

The results of present study are also supported by Barone et al\textsuperscript{26} who evaluated bone density around immediately loaded oral implant, and reported that all implants used showed increased bone density after loading. Abrahamsson\textsuperscript{27} reported that the bone density measured in adjacent and distant areas from the
implant surface, although the differences were not statistically significant, the type of surface can influence the adjacent bone healing. These differences indicate that the characteristics of the implant surfaces may influence the reaction of bone tissue during the healing, mainly in areas adjacent to the implants.

In the study crestal bone loss was in accordance with the observations of Siegenthaler and the vertical bone loss at the implant site associated with implant placement and tissue integration resulted in mean values of 1.6 and 1.9mm in the test and control groups respectively. The vertical bone loss observed at the implant sites is a result of the vertical implant position and the changes due to the biological process of tissue integration. Also Covani et al. and Krennmair concluded that the radiographic evaluation of bone levels during the first year of evaluation showed no differences between the both implant groups.

Mobility indicates the absence of complete osseointegration and is a definite sign of implant failure and its absence is a very important criteria for implant success. In the present study, there was no mobility during the whole evaluation period. Our study agreed with Arastasios in which 43 patients were treated using different types of implants, with immediate non-functional loadings. All implants were successfully osseointegrated showing no mobility and good esthetics.

These results corroborate previous clinical studies and meet the success criteria defined for implant treatment proposed in the consensus report of the 1st European Workshop on Periodontology.

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