Immediate Loaded Implants Placed in Fresh Extraction Sockets - Effect on Marginal Bone

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ABSTRACT
This study investigated the immediate implant placement in the maxillary aesthetic zone without flap elevation or enhancement of the hard tissue component with filler or membrane material. The aim of this paper is to study treatment outcome for immediate implant placement in fresh extraction socket in the maxillary anterior region regarding marginal bone level.

This retrospective cross-sectional study includes data on 41 patients, total of 54 implants (n = 54), treated for immediate placed implants without flap elevation. 30 patients, a total of 33 single immediate implants were placed in the anterior maxilla and immediately restored with a temporary crown. In another 11 patients, 21 implants were placed in fresh extraction sockets and temporalized with a provisional bridge engaging immediate implants and in some cases in combination with delayed implants.
No implants were lost during the follow-up period, mean radiographic follow up was 32 months. Analysis of the radiographs presented mean bone level of all sites 1.47 mm (SD 1.63) immediately after the installation and 0.85 mm (SD 0.75) at the follow up evaluation, resulting in a mean bone gain of 0.62 mm.
With careful patient selection immediate placement of implant in fresh extraction socket can be an attractive treatment modality in maxilla anterior region.
INTRODUCTION

A hopeless tooth scheduled for extraction is a common clinical problem facing dentists all over the world, caused by caries, periodontal disease, endodontic complication, tooth fracture, or trauma (Grandi et al., 2011). Screw shaped titanium implant has been an attractive alternative to rehabilitate missing teeth in failing dentition (Brånemark et al., 1977).

Traditionally clinicians have let the extraction alveolus heal for 2-3 months after the extraction before inserting an implant into the jaw bone (Quirynen et al., 2007). The implant has then been installed into the site after the healing period, using submerged two-stage method where the implant is covered with soft tissue and left to osseointegrate initially 6-8 months (Brånemark et al., 1977) later 6-12 weeks (Buser and Chen, 2009). Alternatively, a one-stage method has been used where a healing abutment is placed to the fixture at the primary implant surgery, and is kept out of masticatory powers for at least 3 months (Buser et al., 1990). Elevation of a flap contributes to bone resorption of the buccal wall because of the destruction of vascular supply (Araújo and Lindhe, 2005). Flapless surgery or minimal flap elevation is beneficial for preserving the crestal bone around the implant (Becker et al., 2005).

Osseointegration is defined as direct contact between living bone and implant. The primary stability is achieved by mechanical retention of the threads of implant to the tapped implant bed in jaw bone. Drilling procedure causes a wound around the implant in jaw bone and the process of osseointegration initiates and results in bone healing. The healing process follows the general wound healing stages of haemostasis, coagulation formation in the space between implant and alveolus, and formation of granulation tissue. During the first week, trabecular bone modelling starts and the bone tissue grows from the alveolar bone to the implant by apposition (increase in bone volume on existing bone). The secondary stability is gained by maturation of the newly formed bone tissue. Primary stability decreases over time while the secondary stability increases over time and after three to four weeks primary clinical stability is lost. Early functional loading can be reached if the implant is placed in bone with optimal balance.
between cortical and trabecular bone since the stability loss is less pronounced (Bosshardt et al., 2017; Araújo et al., 2006).

The time span from extraction of the tooth to the final restoration with traditional approach has been long and complicated for patients (Johannsen et al., 2012), and new treatment modalities has been under development, aiming to reduce the overall treatment time and number of surgical procedures (Quirynen et al., 2007). Trials has been done on placing implant to fresh extraction socket, treatment modality called in literature immediate implant. Temporary crown without any occlusal load can be connected to the fixture after the placement giving the patient a direct replacement of the extracted tooth (Laney, 2007). Survival rates for immediate implant placement into fresh extraction socket has been promising, 92.3-100 % (Polizzi et al., 2000; Lorenzoni et al., 2003; Consyn et al., 2011).

Upper jaw anterior region is a high aesthetic zone and can benefit from the ability to immediate rehabilitation after the extraction. Diversity of studies of immediate placement exist with different surgical approaches, both with or without flap elevation and placement of filler material to residual gaps or usage of membrane. Some of the authors have presented marginal bone gain around the implant between instalment and follow-up (Barone et al., 2004; Cooper et al., 2010) and some bone loss (Grandi et al., 2011; Kolerman et al., 2016; Soradi et al., 2012). Bone levels are of interest since the level of marginal bone determines soft tissue level (Grunder, 2005). In this study, we evaluate marginal bone healing of immediate implants without flap elevation or usage of filler or membrane, in order to determine their impact to the healing and treatment outcome.

The aim of this paper is to study treatment outcome for immediate implant placement in fresh extraction socket in the maxillary esthetical region regarding marginal bone level.
MATERIALS AND METHODS
This study consists of two parts; marginal bone height analysis using intra oral radiography and in addition a literature review on the topic of immediate placement of implants in fresh extraction sockets and immediate restored with a temporary crown. Appendix 1 illustrates a complete rehabilitation of a hopeless central incisor with the concept of immediate implant placement.

Literature review
The authors designed keywords to find relevant litterateur for immediate installed implants. The literature search was made in PubMed and were performed individually for each author. The titles for each search were read, if the title of the article addressed the purpose of the study, the abstract was read. If the abstract reported immediate implants installation effect on the marginal bone level with radiographic measurements, the article was read and analysed. The authors presented and discussed the relevant articles found. 12 of the total 610 articles were used as a reference list. Reference lists of the articles found during the literature search were carefully inspected and frequently cited original articles relevant to the subject of immediate implant placement complemented to our literature search (appendix 2).

Keywords: Immediate Dental Implant Loading, Maxilla, Dental Implants, Single-Tooth, Immediate single-tooth implants, hard tissue response, Single Implant, Comparison of bone level, extraction sockets, fresh extraction socket, bone-to-implant, relationship, Immediate loading, single-tooth implant, maxilla, partial implant and partial immediate implant.

Ethical consideration
Study material consisted of radiographs of patients which had already been treated in Palermo, Italy. All patients were informed of the study and they have given their consent to participate in this study. This study followed ethical principles of Department of Odontology, Umeå University and was ethical approved by the ethical board of the department. Authors of this paper didn’t have access to any medical records to ensure the privacy of participants. The sample consisted of coded radiographs and information
of follow-up time and installed implant size. A few patients were decoded during the quality control of the measurements, since the measurements of two measurers differentiated significantly from each other. Therefore, the treatment quality of these patients was controlled extra carefully.

**Patient selection**

This retrospective cross-sectional study includes data on 41 patients treated for immediate placed implants. Thirty-three implants in 30 patients were placed in the anterior maxilla by the concept of single immediate flapless placement in fresh extraction sockets and immediate restored with a temporary crown for non-functional loading. In another 11 patients, 21 implants were placed with the same concept of immediate placement of the implants in extraction sockets. These implants were used in implant-supported bridges. The same surgeon treated all the patients in a private practise in Palermo, Italy.

**The inclusion criteria were;** Patients with one or several hopeless teeth, which needed to be extracted in the anterior region of the maxilla. Teeth included were central or lateral incisors, canines or bicuspids in patients at least 18 years of age and in a good general health. Sufficient amount of bone apical or palatal to the alveolus of the extracted tooth in order to ensure primary insertion torque of at least 25 Ncm for splinted implants and 35 Ncm for single implant.

**The exclusion criteria were;** heavy smoking (more than 10 cigarettes a day), untreated or uncontrolled periodontal disease, poor oral hygiene, acute infection at the failing tooth site, soft and hard tissues defect that could impair the aesthetic outcomes of the treated site.

**Surgical protocol**

All patients who were subjected to implant surgery had a clinical and intraoral radiographic examination prior to the surgery. Evaluation was made if patient and the site was suitable for treatment, and patient was excluded from the study if high esthethetical or functional risk of site was present. Risk factors were not limited but included for example absence of sufficient keratinized mucosa, or a vertical and/or
horizontal soft tissue defect. These cases were treated with additional flap with or without graft, or by letting the alveolus heal before implant placement. Presence, absence or altered condition of post-extractive buccal or palatal bone has not been considered as a parameter requiring additional bone graft or socket preservation approach.

The surgeon together with patients, comparing the treating site to the contralateral tooth, clinically performed this evaluation. The implant surgery was performed under perioperative antibiotic treatment with Amoxicillin 1 g x 2 for 7 days, started 2 days before surgery and maintained 5 days postoperative. Patients allergic to penicillin received clarithromycin 250 mg x 2 for 7 days. Each patient received an individual oral hygiene regimen before surgery and for the postoperative follow up at least once a year.

The surgery was performed under local anaesthesia. An intrasulcular incision was performed around the tooth followed by an atraumatic extraction in order to maintain the walls of the alveolar socket intact. The extraction socket was examined for dehiscence and cleaned from granulation tissue. This was followed by a further evaluation if the implant could be placed without an additional flap. The site was prepared with maximal implant engagement with the apical and palatal residual bone to achieve optimal implant primary stability. Nobel Active implants (Nobel Biocare) were used, either with a diameter of 4.3 or 3.5 mm.

Implants were positioned to the dental arch using the neighbouring and opposite teeth as reference. Final insertion torque was measured after placement. Distance between the implant shoulder and neighbouring tooth was at least 1 mm in all cases. The implant shoulder was positioned at least 3 mm below the former buccal gingival margin or its most apical area in order to have enough peri-implant mucosa tunnel to compensate diameter discrepancy between implant and crown.

**Rehabilitation Protocol**

A temporary crown is used to seal the alveolus from the oral cavity and allow the support of the marginal soft tissue to maintain a good emerge profile. Prefabricated
acrylic temporary crown shell was intraorally relined and placed onto the temporary titanium abutment and the temporary crown was screw retained. Provisional restorations did not have any centric or eccentric occlusal contacts. The temporary crown was fabricated with a straight and/or light convex sub-marginal profile especially in the facial part, allowing to seal the gap between peri-implant mucosa margin and implant but avoiding soft tissue compression. The permanent crown was delivered 3-6 months after implant placement.

**Radiographic follow-up**

Digital periapical radiographs were taken using long-cone parallel technique. Radiographs were taken before extraction (figure 1), immediately after implant placements, before final restoration and after 15-61 month after functional loading (figure immediate implants 1). The distance between the mesial and distal alveolar bone crest to implant shoulder was measured (figure 1) using OsiriX Lite v.8.0 32-bit Pixmeo SARL, Bernex. The distortion of the radiographs was calculated by dividing the radiographic implant shoulder diameter by the actual one. Two independent groups performed measurements of the radiographic images.

**Statistical analysis**

Data analysis was performed in IBM SPSS 22 and Excel. The mean, median and standard deviation was calculated for measurements in respective sites. Standard deviation is a value that shows the mean standard deviation in a population of normal distribution. If the standard deviation is relatively large it implies a large difference between the samples (Björk, 2011). Intra-class correlation (ICC) was calculated of the two measurers in order to determine interrater reliability value. Interrater reliability test is a comparison between measurements of two or more observers that shows the agreement of the observers’ measurements (Björk, 2011).
RESULTS
Forty-one patients (26 women, 15 men) met the selection criteria and were treated with the concept of immediate implant placement with Nobel Active implant system with 54 implants in total. The mean duration between implant installation and the evaluation was 32 months (range 15-61 months). The measurements were done according to figure 1. No patients were excluded due to insufficient insertion torque, major flap elevation or damage of the alveolar bone due to extraction. The mean insertion torque was 43 Ncm. No implants were lost during the follow-up period. The implants were predominantly installed below the marginal bone level, and the temporary crown sealed the extraction alveolus from the oral cavity.

Analysis of the radiographs presented mean bone level of all sites 1,47 mm (SD 1,63) immediately after the installation and 0,85 mm (SD 0,75) at the follow up evaluation. Bone level gain was 0,62 mm. The average bone level before installation was for mesial site 1,66 mm (SD 1,85) and for distal site 1,29 mm (SD 1,34). At the follow up evaluation mean bone levels were 0,78 mm (SD 0,70) and 0,93 mm (0,80) for respective sites, resulting in mean bone level gain for mesial site 0,88 mm and mean bone level gain for distal site 0,36 mm. Mean bone gain for all sites was 0,62 mm (figure 2).

Intra-class correlation (ICC) was calculated in order to compare the measurements made by two independent groups. The ICC value for the mesial site was 0,92 and for distal site 0,88 after immediate installation. The follow-up ICC value for mesial site was 0,85 and distal site 0,92 (Figure 3).

DISCUSSION
This retrospective study evaluates marginal bone level around implants placed into fresh extraction sockets. The implant success rate in the present study was 100 %, which is in correspondence with Lorenzoni et al., (2003) while Bell and Bell (2014) and Cosyn et al., (2013) presented a lower success rate 92,9–93 %. A systematic review by Esposito, Grusovin and Worthington (2013) stated that prophylactic antibiotic treatment may reduce implant failure. The high success rate in the present study may be explained by
careful selection of patients. Comparison of different treatment modalities was difficult to make since the present study didn’t include a control group.

The marginal bone level modification was carefully analysed between the installation and follow-up. The gain in marginal bone level at mesial site was 0.88 mm between installation and follow-up, and at the distal site 0.36 mm. Some of the implants were installed on sites with no adjacent tooth distal to the implant, which might explain the difference of bone healing between the mesial and distal site. The mean bone level was 1.47 mm at the follow-up, which is in line with Cooper et al., (2010). Kolerman et al., (2016) and Cosyn et al., (2013) had similar results, though with usage of filler material in the residual gap between crestal bone and implant. Chu et al., (2015) placed implants in fresh extraction sockets and studied the effect of bone graft with/or provisional crown on facial-palatal ridge dimensional change. Their conclusion was that the group with immediate placement and bone graft combined with either a contoured healing abutment or custom-contoured provisional restoration yielded the smallest amount of change in facial-palatal contour. Further investigation is needed in terms of comparison of immediate placement of implant in fresh extraction socket with and without bone grafting material in order to determine the role of the bone formation enhancement material in the overall clinical outcome of this treatment modality. Different results in marginal bone gain/loss between authors might depend on several different factors. Implant design (diameter, macro and micro anatomy, prosthetic connection); implant positioning (apico-coronal and bucco-lingual); distance from surrounding teeth; prosthetic manufacturing represent just some samples of possible confounders. However, the most critical variable, to our opinion is the management of the prosthetic restoration, which can play a major role on marginal peri-implant bone and soft tissue stability.

The implant installation is considered successful if the radiographic bone loss is less than 1 mm in height and subsequently if annual marginal bone loss doesn't exceed average of 0,1 mm (Albrektson & Zarb, 1993). In this study radiographs were taken at implant installation and at a follow-up, which was between 15 and 61 months (mean 32 months). Different authors with similar studies have had different follow-up times
(Table 1) and therefore one has to be cautious when comparing these papers. Longer follow-up period and great success indicates good long term predictability of a treatment modality. A radiograph 12 months after the installation would had given a picture of the early healing process with immediate implant. Some difficulties occurred during the measurement of marginal bone levels from radiographs. Problems were related mostly to non-optimal projection of the area. This leads to overlapping of the adjacent tooth with the marginal bone of implant. In some cases both the buccal and palatinal border of crestal bone was present in radiograph, and it was therefore difficult to determine the marginal bone level. Eccentric projections made it difficult to calibrate the radiographic analysis software, since the implant shoulder wasn't pictured in an orthoradial way. Even though there were some difficulties with performing the measurements due to problems stated above, all the ICC values for different sites were over 0.8, which indicates a high accuracy of the measurements between two groups (Altman, 1991, in Björk, 2012).

The literature presents various factors that may affect bone healing and resorption around implants. Studies have attempted to find a correlation between the immediate implant survival and smoking, but the sample size has been too small for statistical verification (Bell and Bell, 2014). Greater bone loss and higher risk of implant failure among smokers have been presented by some authors (Soardi et al., 2012; Wilson & Nunn, 1999). Another factor presented in literature is plaque management. Ramanauskaite and Tervonen (2016) presented in their systematic review the importance of tailored peri-implant therapies and supportive oral hygiene treatment regimens as part of the overall treatment. When any studies regarding immediate implant instalment has excluded patients with poor oral hygiene, such as Kolerman et al., (2016) and Cooper et al., (2010), one might argue that patient sample doesn’t reflect the general population. Bell and Bell (2014) did not exclude patients with poor oral hygiene which may explain the slightly weaker success rate.

**Conclusions**

Despite the limitations of this study, the results are promising that immediate placement of implant in fresh extraction sockets can be a treatment modality to consider in the
anterior region of maxilla with careful selection of patients to be included. Longitudinal studies of this treatment alternative in comparison with the traditional implant treatment procedures is needed, as well as further research to determine if bone filler material in residual gap of implant and crestal bone is beneficial and gives reduced marginal bone loss. The outcome of the implant/soft tissue marginal aesthetic result needs to be further evaluated.

ACKNOWLEDGEMENTS
We would like to pay our gratitude’s to Stefan Lundgren for the opportunity to write our master thesis in the area of dental implants and for all guidance during the process. We would like to thank Giovanni Cricchio who provided the patient sample and relevant comments on our study, and Joakim Lundberg for measuring the sample and therefore providing data for ICC calculations.
REFERENCES


### TABLES

#### Table 1 Immediate implants in maxilla

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number of implants/patients</th>
<th>Follow-up time</th>
<th>Success rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barone <em>et al.</em>, (2006)</td>
<td>18 immediate implants</td>
<td>1 year</td>
<td>94,5 %</td>
</tr>
<tr>
<td>Bell and Bell (2014)</td>
<td>42 single unit immediate implants</td>
<td>1</td>
<td>92,9 %</td>
</tr>
<tr>
<td>Berberi <em>et al.</em>, (2014a)</td>
<td>20 immediate implants</td>
<td>3 years</td>
<td>100 %</td>
</tr>
<tr>
<td><em>Berberi et al.</em>, (2014b)</td>
<td>22 immediate implants</td>
<td>5 years</td>
<td>91 %</td>
</tr>
<tr>
<td>Cooper <em>et al.</em>, (2010)</td>
<td>58 immediate implants</td>
<td>1 year</td>
<td>94,5 %</td>
</tr>
<tr>
<td>Cosyn <em>et al.</em>, (2011)</td>
<td>30 immediate implants</td>
<td>3 years</td>
<td>96 %</td>
</tr>
<tr>
<td>Cosyn <em>et al.</em>, (2013)</td>
<td>28 immediate implants</td>
<td>3 years</td>
<td>93 %²</td>
</tr>
<tr>
<td>Grandi <em>et al.</em>, (2011)</td>
<td>36 immediate implants</td>
<td>1 year</td>
<td>97,2 %</td>
</tr>
<tr>
<td>Kolerman <em>et al.</em>, (2016)</td>
<td>39 immediate implants</td>
<td>Mean follow-up 44 months</td>
<td>94,7 %</td>
</tr>
<tr>
<td>Lorenzoni <em>et al.</em>, (2003)</td>
<td>9 immediate implants</td>
<td>1 year</td>
<td>100 %</td>
</tr>
<tr>
<td>Polizzi <em>et al.</em>, (2000)</td>
<td>130 immediate implants</td>
<td>5 years</td>
<td>92,3 %</td>
</tr>
<tr>
<td>Soardi <em>et al.</em>, (2012)</td>
<td>28 immediate implants</td>
<td>1 year</td>
<td>95,7 %³</td>
</tr>
</tbody>
</table>

¹Follow-up time unknown
²Mean follow-up for all study groups: 44 standard implant treatment (SIT), 28 immediate implant treatment (IIT), 18 implant treatment in conjunction with guided bone regeneration (GBR), implant treatment in grafted bone (BGR) harvested from the chin.
³Success rate for both maxilla and mandibular immediate implants, 48 in total.
**FIGURES**

**Figure 1.** A hopeless tooth scheduled for extraction (left radiograph). Implant inserted into a fresh extraction socket after an atraumatic flapless extraction (middle radiograph). Measurements were made from the first approximal crestal bone contact (marked with red arrows in the radiograph) perpendicular to the tangent of the implant shoulder (white arrow in the radiograph) for both mesial and distal aspects of the implant. Same measurements were made for the follow-up radiograph (in the right). Notice how the space between the extraction alveolar walls and implant is now filled by bone.
**Figure 2.** Mean radiographic distance between the reference point (implant shoulder) and first radiographic approximal crestal bone contact for mesial and distal site both after the instalment of the implant and at the follow-up. The measurements were performed with a computer program after calibration of the program with the given shoulder diameter. Both at the mesial and distal sites gain of crestal bone was seen between the instalment and follow-up. The standard error is marked for respective averages n=61.
**Figure 3.** Chart of intra-class correlation (ICC), presents the radiographic measurements agreement between the observers for respective site and a mean value of all measurements. Value of 1.0 means 100% agreement between the measurers in all measurements and 0.0 complete disagreement.
APPENDIX 2

PubMed search

- "Immediate dental implant loading" AND "Maxilla" AND "Dental implant, single tooth" (n = 81)
- "Tooth socket/surgery" AND "Immediate dental implant loading" AND "Dental implants" (n = 139)
- "Flapless" AND "Tooth extraction" AND "Implants" (n = 66)
- "Immediate single-tooth implants" AND "Hard tissue response" (n = 10)
- "Single implant" AND "Treatment" AND "Anterior maxilla" AND "Radiographic" (n = 64)
- "Single implant" AND "Comparison of bone level" AND "Extraction sockets" (n = 10)
- "Bone-to-implant" AND "Relationship" (n = 24)
- "Single-tooth" AND "Partial implant" AND "Fresh extraction socket" (n = 14)
- "Partial immediate implant" AND "Fresh extraction socket" (n = 29)
- "Immediate loading" AND "Single tooth implant" AND "Maxilla" (n = 171)

Titles screened (n = 610)

Titles excluded (not relevant) and duplicates removed (n = 535)

Potentially relevant articles, abstracts screened (n = 75)

Articles excluded (n = 63)

Full text read, articles included in reference list (n = 12)