Original Article

IMMEDIATE IMPLANT PLACEMENT IN FRESH EXTRACTION SOCKETS USING THE OPEN HEALING TECHNIQUE AND TISSUE LEVEL IMPLANTS

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ABSTRACT

Introduction: Correctly managed, immediate implant placement into fresh extraction socket is a favorable treatment option in order to reduce the overall treatment time and to increase the patient's comfort and satisfaction.
Methodology: Atraumatic extractions (N = 42) with socket preservation were performed in n = 40 patients (0.74 sex ratio) followed by immediate placement of tissue level implants. Post extraction sockets were filled with either platelet-rich growth factors (PRGF) clots, or deproteinized bovine bone granules, or both; then covered by collagen resorbable membrane or cyanoacrylate and left exposed during healing. The pre-loading need for additional augmentation was assessed clinically and radiologically, using CBCT scans at t = 6 months. The success and survival rate were evaluated by control CBCT scans at a 4 year follow-up.
Results: This analysis showed that "open healing" technique allowed uneventful healing and sufficient bone formation in combination with immediate placement of soft tissue level implants, a survival rate of 100% and a success rate of 95.2% at a 4 yr follow-up. There were no significant differences regarding crestal bone level stability around the implants with the different augmentation materials.
Conclusion: Immediate placement of tissue level implants in fresh post extraction sockets using "open healing" approach can be favorable from both a clinical and radiological point of view considering the results at 4 years. In addition, soft-tissue problems associated with extensive flap mobilization and tension may be avoided and the 3D architecture of hard and soft tissues surrounding the implant may be maintained due to the tissue level implants design in accordance with the biological width when restored.
Keywords: Immediate implant placement; open healing; flapless; biological width.

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1. Introduction

Nowadays the first choice treatment option after extraction of failing teeth is represented either by immediate implant placement or by a socket preservation procedure [1,2]. Correctly managed, immediate implant placement into fresh extraction socket is a favorable treatment option in order to reduce the overall treatment time and to increase the patient's comfort and satisfaction [3]. Oral implantology has been intensively researched in basic as well as in clinical grounds [4]. In order to improve and accelerate healing of both hard and soft tissues after immediate implant placement, substitutes including growth factors and biomaterials have been traditionally employed and membranes were introduced to separate tissues [5]. It has been previously reported [6] that immediate implantation will not prevent resorption of the alveolar ridge. A recent systematic review analyzed the three-dimensional changes in bone tissue after immediate installation of a single implant in a fresh extraction socket, reaching a clear conclusion that bone remodeling occurs after tooth extraction even with immediate implant insertion [7]. One other recent systematic review described the effects of implants with different connections on the crestal bone level in relation with the surgical procedure after at least 12 months of functional loading. The conclusion was that platform-switched implants showed greater crestal bone preservation than non-platform-switched implants. There was no significant difference in the crestal bone loss with one- versus two-stage placement or the use of immediate versus delayed loading. Although there were statistically significant differences favoring immediate implant placement, as well as

favorable outcomes for crestal bone level changes, the small differences may not be clinically relevant because of high heterogeneity among studies [8].

However, the use of immediate implantation techniques without raising a muco-periosteal flap, combined with a bone graft in the gap left between the implant and the post extraction socket walls, led to osseointegration accompanied by high stability of bone and the resulted soft tissue [7-9]. On the other hand, the use of tissue level implants is beneficial for the surrounding soft and hard tissues, especially when inserted with a flapless approach. Furthermore, the "open healing" technique used as an alternative ridge augmentation procedure, maintains a high stability of the crestal bone level as well as the architecture of the soft tissue after the healing period, with a good outcome even when resorptions of the buccal bone were present prior to extraction [10].

According to the literature, a classification system for management of molar extraction sockets is based upon the morphology of the septal bone and its influence on the implant's primary stability. Implants may be placed predictably into molar sockets when initial stability can be obtained within the septal bone, either entirely (Type A socket) or partially (Type B socket), or by engaging the walls at the periphery of the socket (Type C socket). Otherwise, a delayed protocol should be utilized [11].

When it comes to monoradicular sites, especially in the esthetic zone, a simplified socket classification and repair technique was described: Type 1 - labial bone plate and associated soft tissues are completely intact; Type 2 - soft tissue is present, but a dehiscence osseous defect exists that is indicative of the partial or complete absence of the labial bone plate; Type 3 - midfacial recession defect is present, representing the loss of the labial bone plate and soft tissues [12]. A further classification of Type 2 socket defects where the soft tissue is present but a dehiscence osseous defect was later used to quantify the absence of the labial bone plate: Type 2A - absence of the coronal one-third of labial bone plate of the extraction socket 5 to 6 mm from the free gingival margin; Type 2B - absence of the middle to coronal two-thirds of the labial bone plate of the extraction socket approximately 7 to 9 mm from the free gingival margin; Type 2C - absence of the apical one-third of the labial bone plate of the extraction socket 10 mm or more from the free gingival margin [13].

This study shows the rationale behind immediate placement of a tissue level implant in the fresh extraction socket in conjunction with the "open healing" technique, showing not only the advantages of tooth extraction with minimal damage to the surrounding anatomic structures, but also how to maintain the implant surrounding hard and soft tissues three-dimensional architecture, following the guidelines previously reported in the literature [14].

The aim of this retrospective analysis is to validate the protocol of immediate implant placement into fresh extraction sockets using open-healing approach and non-submerged (tissue-level) implants and to evaluate the outcome of the surrounding bone at 12 and 24 month after loading.

Table 1. Surgical site position.

A.

Bone site	Number of Sites
Maxilla	23 (54.8%)
Mandible	19 (45.2%)

B.

Site region	Number of Sites
Anterior	22 (52.4%)
Lateral	20 (47.6%)

2. Materials and Methods

This retrospective study evaluated patients treated between 2014-2018 in a private dental practice. The study protocol is in accordance with the Helsinki Declaration of 1975, revised in 2000 and was approved by the Ethics Committee. Every person involved in the study signed an informed consent. Patients with hopeless teeth with indication for extraction and implant therapy were recommended for the study. If primary stability could not be achieved or if the buccal bone plate was missing, such as there were no conditions to stabilize the implant in the healing phase, a delayed protocol was followed. The sites with indication for two stage approach were excluded from this study. There were 40 patients (sex ratio 0.74), with 42 surgical sites that met the conditions for immediate implant placement. After the teeth were extracted atraumatically, the extraction sockets were cleaned, and all granulation tissue was removed carefully.

We included surgical sites from the anterior and lateral regions of both maxilla and mandible (location frequency is detailed in Table 1 - A, B). Both smokers (23.8%) and non-smokers (76.2%) were included in the study. Surgical interventions were performed according to our standard procedures. Tooth extraction was performed atraumatically, the roots where separated and extracted one by one in order to preserve the surrounding walls and interradicular septum. Of all the surgical sites, there were 2 sites that had two surrounding walls, 3 sites with three surrounding walls, the rest of the alveoli having all 4 surrounding walls. A tissue level implant was inserted into the neoalveolus created in the post extraction socket according to the initial 3D planning. Tissue level implants with similar Titanium alloy composition were used in all cases, 40 sites received standard 4.8 mm diameter platform conical implants (TRI Octa, TRI Dental Implants AG, Hünenberg, Switzerland) and 2 sites received wide neck 6.5 mm diameter platform cylindrical implants TissueLevel StandardPlus WN® (Straumann AG, Basel, Switzerland).

Both implant types had a 1.8 mm high polished collar. The implants were placed having the polished collar at the same level with the cement-enamel junction (CEJ) level of adjacent teeth, with respect to the biological

Table 2. Grafting material.

Grafting Material	Number of Sites
Bio-Oss	31 (73.8%)
Copios	7 (16.7%)
Bio-Oss + PRGF	3 (7.1%)
No grafting material	1 (2.4%)

Table 3. Membrane type.

Membrane type	Number of Sites
Histoacryl	19 (45.2%)
Bio-Gide	18 (42.9)
PRGF	3 (7.1%)
No membrane	2 (4.8%)

width protocol. The implant was installed in the septum in 4 sites, in other 3 sites the neoalveolus were created along the socket walls and in 35 sites new alveolae were created in another axis than the roots axis. In 2 of the sites in the molar region of the maxilla, internal lifting of the sinus membrane was performed in the same stage with implant insertion in the septum. No flap or deperiostation were performed in any of the 42 sites. The gaps of the alveolae where fulfilled either with deproteinized bovine bone granules (DBBO), with plasma rich in growth factors (PRGF) clots (Endoret - PRGF®, BTI Biotechnology Institute, Vitoria-Gasteiz, Spain) mixed with DBBO or PRGF clots alone. The gaps were covered with a resorbable collagen membrane (RCM) or with a PRGF fibrine membrane. The membranes were stabilized with a PTFE continuous suture (Coreflon®, Implacore Sp. z o.o. Poznań, Poland) that was applied to the free gingival margins. In caset the gap between the implant neck and the gingival margin was less than 4 mm, a layer of cyanoacrylate was applied instead of the membrane and no suture was applied. There was one single site that neither received a graft material nor a membrane.

We used the following biomaterials: DBBO: Bio-Oss® (Geistlich Pharma, Wolhusen, Switzerland), Copios® (Zimmer Biomet Dental, Palm Beach Gardens, FL-USA) and RCM: Bio-Gide® (Geistlich Pharma, Wolhusen, Switzerland), Socket Repair Membrane® (Zimmer Biomet Dental, Palm Beach Gardens, FL-USA), Histoacryl® (B. Braun Medical, Melsungen, Germany) (Tables 2 and 3).

The patients received a specific scheme for control and follow up appointments. Clinical observations were made at 24 h, 48 h, 7 days and 14 days. The suture was removed after 21 days. Antibiotics were prescribed for prophylactic reason. Indications for cleaning and special care of the clinical sites were given. Painkillers and non-steroidal anti-inflammatories were recommended just when needed. The suture removal took place after three weeks. In order to allow maturation of the bone and soft tissue, the sites were allowed to heal for at least six months before loading. We have chosen this aspect of the protocol based on previously success rate reported in the literature [15]. The case where no grafting material or membrane were used was planned to be loaded after three months, but the patient postponed the appointment until after six months due to personal reasons.

The CBCT scans were performed with the same investigation unit Cranex 3D (Soredex, Helsinki, Finland/ KaVo Dental Gmbh, Biberach, Germany) and analyzed with the OnDemand 3D software (CyberMed, Yuseong-gu, Daejeon, Korea).

3. Results

During the observation period, a total of 41 patients with 43 surgical areas were treated with immediate implant placement in the post extraction site using the open-healing technique. One patient did not show up for prosthetic treatment, so we excluded him from the study. Therefore, the analysis included 42 surgical areas in 40 patients (42.5% male and 57.5% female). The nean patient age was 50.2 ± 16.0 years (aged 28-81 years).

The clinical outcome was observed, checking parameters such as inflammation, swelling, pain and soft tissue secondary healing. The patients were scheduled at the specified time frame, 6 months before loading, for the CBCT scan in order to analyze the bone volume, crestal bone loss and the possibility of scheduling the implant loading procedures. All implants were loaded, using fixed single unit or multiunit cemented restorations, respecting the biological width protocol [16]. CBCT control scans were performed at 24 and 48 months follow-up. Success and survival rates were analyzed using the Buser criteria: (1) Absence of persistent subjective complaints, such as pain, foreign body sensation, and/or dysesthesia; (2) Absence of periimplant infection with suppuration; (3) Absence of mobility; (4) Absence of continuous radiolucency around the implant [17]. From the 42 sites, only 2 (two) cases needed additional surgery after clinical and CBCT observation at 6 months. Both sites were in the premolar area, one in the maxilla and one in the mandible, underwent the same procedure, using the exact same biomaterials (BioOss and BioGide). Both patients were suffering from the same systemic disease, Hepatitis, Type C Virus. There was no relevant correlation with other factors. Of these 2 cases, one required additional bone augmentation procedure and the second one just a soft tissue remodeling procedure, yielding a survival rate of 100% and a success rate of 95.2% at the control time of 6 months after initial surgery. The CBCT scans showed a stable bone dimensions at 24 and 48 months follow-up intervals with a bone preservation of 98.9 ± 0.7% and 98.1 ± 0.9% compared with initial measurements. The results were analyzed and interpreted by the same clinician, in order to eliminate deviations. The bone parameters measured on CBCT scans showed stable results for all three bone levels mean values (buccal and oral bone plate height, and crest width – Table 4).

To sum up, the atraumatic extraction (Fig. 1) was followed by the tissue level implant insertion in the septum (Fig. 2). The "Open healing" technique is shown at one day, two days and three weeks in Fig. 3. Follow-ups at one and three years (Fig. 4), as well as 4 years

Table 4. CBCT bone level measured parameters.

		Mean	Std. Deviation	Minimum	Maximum
Initial	BP-height	13.55	2.90	4.08	17.71
	OP-height	14.34	2.90	3.03	20.70
After loading	BP-height	13.73	1.74	10.70	17.17
	OP-height	14.26	1.87	8.97	18.99
1 year after loading	BP-height	13.61	1.78	10.68	17.03
	OP-height	14.07	1.82	8.94	18.87
4 years after loading	BP-height	13.26	1.85	10.59	16.43
	OP-height	14.02	1.71	8.89	16.13

BP = buccal bone plate, OP = oral bone plate. All measurements in mm.

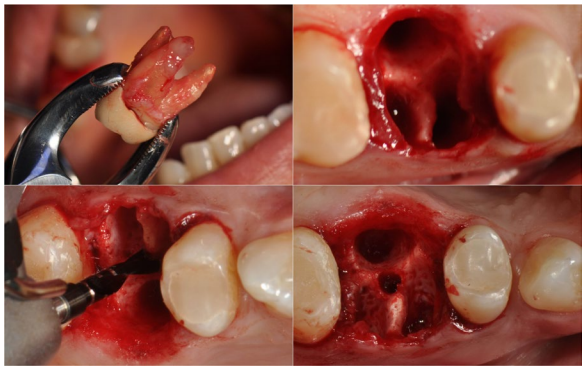

Figure 1. Atraumatic extraction (a,b). Neoalveolus preparation in the septum (c,d).

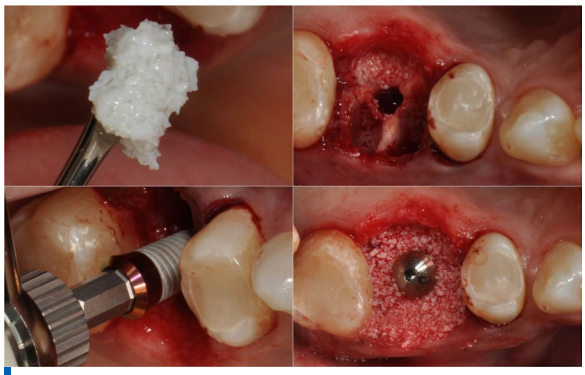

Figure 2. Bovine bone granules filling the alveolae (a,b). Tissue level implant inserted in the septum (c,d).

(Fig. 5) shape the picture of one of the cases that were successfully addressed using the protocol described in this study.

In our study, all implants obtained a good primary stability. The treatment was judged to be successful if implant loading was possible with no additional augmentation needed and implants were in place at the follow-up intervals, thus a success rate of 95.2%. The survival rate after criteria described by Buser et al in 1997 was 100% [18].

4. Discussions

In order to facilitate the implant therapy, ridge resorption caused by tooth extraction should be limited or even eliminated. The evaluation of bone quality during treatment planning is mandatory

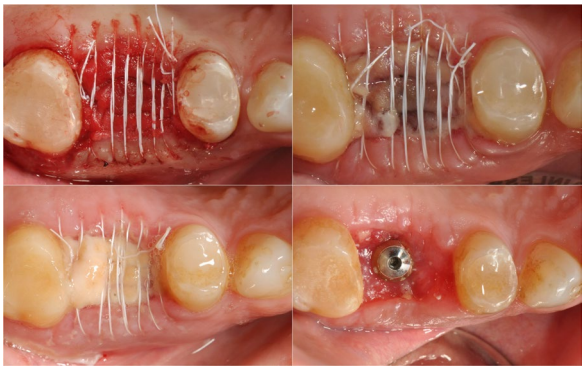

Figure 3. Open healing. Resorbable collagen membrane stabilized by PTFE continuous suture (a). Healing at 24h (b), 48h (c) and 3 weeks (d).

Figure 4. Follow-up at 12 months (clinical – a,b and radiological – c) and at 36 months (clinical – d,e and radiological – f).

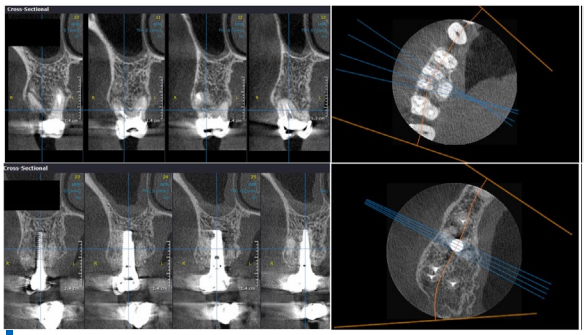

Figure 5. CBCT scan before surgery (up) and at 4 years follow up (down), showing implant position in the septum.

especially when immediate loading is intended. Positive results regarding the possible implant stability can lead to immediate implant insertion as the first choice clinical procedure instead of a delayed two-stage approach. Such a delayed-approach treatment sequence encompasses several steps over an extended period of time and appointments, not only for the practitioner, but also for the patient. Barone et al. [19] showed that regenerative techniques

(GBR) were able to limit resorption of the alveolar crest after implant placement in a fresh extraction socket. On the contrary, Hsu et al. [20] demonstrated in an experimental study that the placement of implants and deproteinized bovine bone granules into fresh extraction sockets generates significant buccal bone loss as well as low osseointegration. Other clinical studies [21–23] used GBR techniques to fill the gap between bone and implant.

Our study showed that placing a bone graft into the residual gap around a post-extraction socket is helpful for limiting the amount of facial-palatal contour change from the FGM to more apical reference points. In a retrospective cohort study conducted by Tarnow et al. the conclusion stated was that all post-extraction implant placement without flap elevation demonstrated some negative contour change (facial collapse) relative to the adjacent contralateral control tooth. However, the change was minimal compared to previous studies where full periosteal flaps were elevated for ridge augmentation after teeth extraction. According to these authors, the key elements in preserving ridge contour are protection, containment and maintenance of the bone graft during the healing phase of treatment, which can extend from 4 to 6 months. A contoured healing abutment or provisional restoration were used to close the gap and keep the graft in place [24]. Alternatively, our concept is based on the tissue level emergency profile design that can seal the gap similarly to the contoured healing abutment. The advantage of our technique compared to the above-mentioned ones is that having the tissue level in place after the osseointegration period, there will be no trauma of the peri-implant tissues generated by the dismounting of the healing abutment or provisional crown and mounting the final prosthesis. When the tissue level implant's neck was not wide enough to close the space left, cyanoacrylate tissue glue was used to protect the bone graft [14]. In gaps that are larger than 4 mm, a collagen resorbable membrane was placed over and stabilised with a continuous PTFE suture, according to the described "open healing" protocol. Although various studies have shown controversial results regarding the effect of secondary wound dehiscence occurring during healing when using suitable membrane materials, the protocol allows uneventful healing and sufficient bone formation. Also, soft-tissue problems associated with extensive flap mobilisation and tension may thus be avoided.

5. Conclusion

This retrospective study indicates that immediate implant placement into fresh extraction sockets using tissue level implants, suitable grafting materials and membranes with the "open healing" protocol allows uneventful healing, predictable aesthetic results and lower surgical trauma compared with conventional methods using flap techniques. Furthermore, the soft-tissue problems associated with flap mobilization and consecutive tension due to the wound closure are avoided. The clinical significance of the combination of the "open healing" technique, with immediate implant placement of a tissue level implant into a fresh extraction socket with partial or complete loss of the buccal bone plate has significant benefits for both the clinician and the patient: treatment procedures are reduced to fewer appointments, the overall time of the treatment is reduced and the tridimensional architecture of the soft and hard tissues is maintained, including the possibility of regenerating the buccal bone plate when missing. Further scientific studies need to be conducted to reinforce our clinical results.

Author contributions

All the authors participated in establishing the concept and protocol. AI, AD, VP performed the surgical procedures. MIN, AM, GT participated in data gathering, analysis and interpretation. All the authors participated in critically revising the manuscript.

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Questions

1. In which situation is immediate implant placement possible?

❑a. When primary stability can be obtained;
❑b. In type A socket;
❑c. In all socket types;
❑d. After all granulation tissue is removed and the alveolae are cleaned.

2. Buser criteria for survival and success are:

❑a. Absence of any postoperative edema;
❑b. Absence of mobility;
❑c. Absence of continuous radiolucency around the implant;
❑d. Absence of periimplant infection with suppuration.

3. The following is true about immediate implantation:

❑a. It reduces the overall treatment plan;
❑b. It stops the postextractional bone loss;
❑c. It can be done in conjunction with the open healing technique;
❑d. The polished collar must be placed at the same level as the cement-enamel junction.

4. To facilitate implant placement:

❑a. Tooth extraction must be atraumatic;
❑b. Postextractional bone loss must be minimized;
❑c. A mucoperiosteal flap should be raised;
❑d. Additional augmentation should be performed.