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Implant Placement in Fresh Extraction Socket with Simultaneous Bone Regeneration

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Authors' contributions

This work was carried out in collaboration between all authors. Author AL designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author FS managed the timing of the surgery protocol, author FF managed the literature searches, analyses of the study and author ML revised entire manuacript. All authors read and approved the final manuscript.

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Case Study

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ABSTRACT

The aim of this manuscript is to describe a case of immediate implant placement with simultaneous bone regeneration. A brief review of the literature and the biological rationale is also described in the manuscript.
Presentation of Case: A 42 years old woman Affected by a crown-root fracture referred to our Department. After careful extraction, an implant was inserted immediately as well as a simultaneous bone grafting to reduce post-extractional socket-shrinking. After osseointegration (4 months) the implant was loaded and the clinical and radiographic follow-up is presented. A Cone beam computed tomography was also made to show the integrity and the preservation of buccal bone plate one year after loading.

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Discussion: A traumatic extraction, three-dimensionally positioning of the fixture, the simultaneous bone graft insertion and a tension free wound closure has allowed us to achieve healing without complications and a good clinical result.
Conclusion: The use of bone regeneration around immediate implant can help us to obtain good functional and esthetic outcomes.

Keywords: Biomaterials; extraction socket; immediate implant; grafting; Deproteinized Bovine Bone Mineral (DBBM); bone regeneration.

1. INTRODUCTION

Over the past 25 years new treatment protocols have been proposed such as immediate and early implant placement [1-4] that differ from those described in the 80's from Branemark, which included a late implant placement 6-12 months after healing [5]. The proponents of this therapeutic concept claimed reduced exposure of patients to surgery, limited physiological bone resorption after extraction and hence better esthetic outcomes [6,7]. Although osseointegration was demonstrated with experimental study in animals [8,9] and confirmed by human histology [10], no clear clinical and histological evidence was available about the possible influence of immediate implant placement on the process of bone modeling and remodeling [11].

After tooth extraction, in fact, there is a reduction of bone volume [12-14]. According to a recent literature review, mean horizontal and vertical bone resorption is 3.79 mm and 1.24 mm respectively after 6 months of healing in humans [15]. This bone shrinkage is greater from the buccal side and two thirds of this reduction occurs in the first 3 months of healing [16]. It is now believed that this process of resorption is the result of the interruption of blood supply that affects part of the vascular plexus in the periodontal lamina dura delimiting the socket which, as noted, has a stronger presence in the buccal bone [17]. Implant positioning immediately after tooth extraction does not counteracted this physiological phenomena [12]. Sanz et al. [18] in a randomized controlled clinical trial showed that implant placement into extraction sockets will result in significant bone reduction of the alveolar ridge.

Studies show that the integrity and thickness of the buccal bone [19-20] positively influences the outcomes of immediate implants.

In a clinical trial, mean vertical bone resorption of approximately 1 mm of the buccal bone was reported 4 months after immediate implant insertion. This osseous shrinkage was greater when buccal bone was thinner (1.2±2.1 mm) [21].

In order to reduce these changes in the post-extraction site and preserve tissue volumes bone regeneration techniques are used at the time of implant placement [22-25].

Many studies have evaluated the placement of different grafting material with or without membranes to fill the marginal defects that often occur after the insertion of implants into fresh extraction sockets. Caneva et al. [26] evaluated the use of a resorbable collagen membrane over immediate implants in dogs. The amount of bone resorbed was smaller in the test sites compared with control sites without membrane (1.7 vs 2.2 mm). Araujo e Lindhe [27] showed that the use of xenogenic graft in the buccal gap between immediate implants and buccal and lingual bone plates reduced horizontal and vertical bone loss compared with non grafted controls. Similar results were reported by Barone et al. [28] in another study using cancellous bone and collagen membrane in a submerged healing environment. However, while adequate osseointegration is achieved with or without bone regeneration no evidence was available to support the superiority of one technique or biomaterial over another [29].

In this study, we present a case of implant placement in fresh extraction socket and simultaneous bone regeneration. The step-by-step surgical procedure is described in the text and the clinical and radiographic outcome at one year of follow-up is presented. The aim of the paper is to demonstrate that the use of deproteinized bovine bone mineral (DBBM) in the buccal gap at immediate implants can be effective in limiting ridge alterations in post-extraction sites and contribute to the preservation of the alveolar process.

2. CASE REPORT

2.1 Diagnosis and Treatment Planning

A 42 years old female affected by a crown-root fracture of #24 (Fig. 1a-b-c) referred to our Department. The patient did not show systemic contraindication to surgery. After careful clinical and radiographic examination (Fig. 1 and Fig. 2a) we listed the fixed prosthetic treatment options:

- Extraction of #24 and abutment preparation of #23 and #25 to run a bridge of three elements.
- Extraction of #24 and immediate implant placement with simultaneous GBR at the fracture site with the possibility of reducing surgeries.
- Endodontic treatment of 24, orthodontic extrusion, abutment reconstruction with endodontic post and metal-ceramic crown.

The ability not to sacrifice healthy teeth and the complexity of the third treatment together with the unfavorable crown-root ratio convince us and the patient to the second therapeutic choice.

We performed initial periodontal therapy (scaling and root planning) and evaluated the patient after 4 weeks. No signs of active periodontal infection were present. The scientific literature and clinical experience show that before any rehabilitative intervention, periodontal treatment must be carried out in all cases where it is necessary and leads to a higher probability of implant success [30]. We subsequently prescribed a CT dentalscan for the analysis of the maxillary bone volume available at post-extraction site.

Although the buccal bone and the periodontal biotype was thin, CT analysis showed adequate bone volume and no socket defect compatible with type 1 implant placement (Fig. 2b). In a recent consensus meeting researchers declared that for immediate implant placement the residual socket must be intact and with no buccal defects [31]. In presence of buccal bone defect is preferable differ the implant insertion to improve the predictability of the treatment.

Prior the surgery an informed consent was taken.

2.2 Surgical Procedure

2.2.1 Tooth extraction

Antibiotic prophilaxys was prescribed with amoxicillin and clavulanic acid 1 day before surgery and 4 day after surgery.

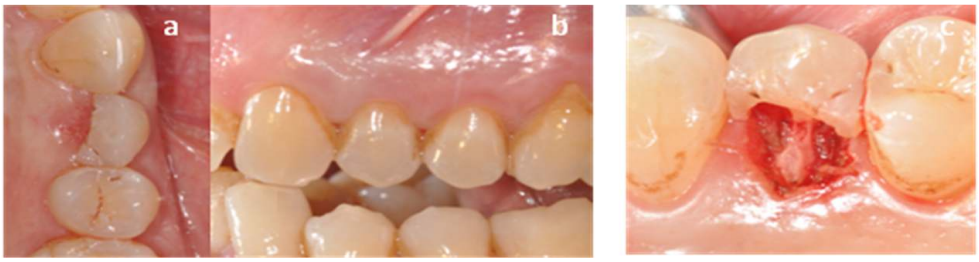

Fig. 1. Initial clinical situation. (A) Occlusal view. (B) Lateral view. (C) Palatal view after gingivectomy performed to highlight the extension of tooth fracture

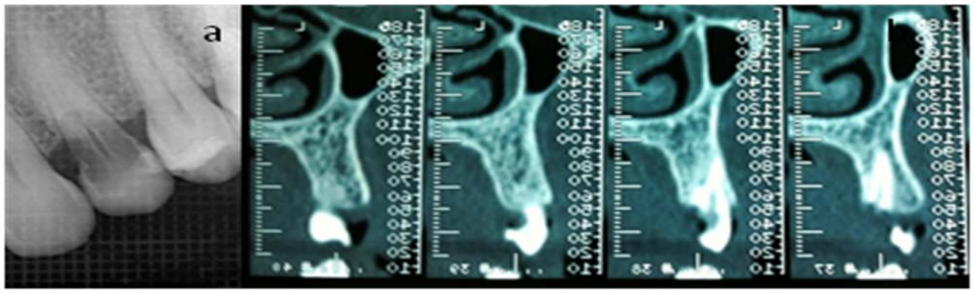

Fig. 2. Radiographic control before surgery. (A) Periaphical radiograph. (B) TC dental scan

Extraction and implant surgery was performed under local anestesia using 4% articaine solution combined with a vasoconstrictor (Ubistesin forte, 3M ESPE). A sulcular incision is employed buccaly and palatally. The mesial and the distal extents of the buccal and palatal flaps were carried to the mesial angle of the adjacent canine tooth and the distal line angle of the adjacent maxillary second premolar tooth, respectively. No vertical incision were performed to improve tissue healing. We extracted the tooth reducing trauma in order to preserve the thin buccal wall. Care is taken not to compress or damage the residual interradicular bone (Fig. 3a). Following debridement of the extraction socket, the interradicular bone is removed to its most apical extent utilizing a rongeur forceps as described by Fugazzotto et al. [32]. Removal of this interradicular bone provides a broader, more stable base for ideal site preparation.

The fresh socket remained intact with no bone defect.

2.2.2 Implant insertion and management of implant-to-socket wall space

The primary objective of implant insertion into a fresh extraction socket is to reduce treatment time. Primary implant stability in a three-dimensional prosthetic guided position is the prerequisite for the success of this treatment protocol. To achieve this you have to anchor to the palatal cortical bone extending more than 1 mm beyond the apex of the tooth extracted [20,33].

Implant bed preparation started with spear-shaped bur and spiral drills of increasing diameter. The palatal aspect of the socket was arraneged to engage native bone to preserve buccal bone and to improve implant stability. The implant, cylindrical 3.5/11 mm ((OsseoSpeed ™ Astra Tech AB, Mölndal, Sweden), was placed apically in native bone and more palatally (Fig. 3b). The insertion torque was 25 N/cm².

A residual gap from the shoulder of the implant to the buccal crest was present and was filled with granules of deproteinized bovine bone mineral (DBBM; Bio-Oss, Geistlich Biomaterials, Wolhusen Switzerland) of small particle size (Fig. 3c). Bone grafting was performed because bone to implant distance was more than 3 mm as recommended by a recent studies [34-37]. Within 2 mm, in fact, the horizontal defect is filled by newly formed bone starting from the coagulum through a mechanism of intramembranous ossification [11].

Xenograft was not covered with a collagen membrane (Bio-Gide, Geistlich Biomaterials, Wolhusen Switzerland) because the buccal bone was intact according to previously published selection criteria and technical execution [32,38-39]. The mucoperiostal flaps are sutured against the healing abutment with non resorbable e-PTFE suture (expanded polytetrafluorethylene, Gore-Tex, W. L. Gore Associates Inc, Flagstaff, Az) (Fig. 3d).

2.2.3 Postoperative management

For plaque control, the patient rinsed with 0.2% chlorhexidine dicuglonate 3 times a day for two week and performed a roll-stroke brushing technique avoiding in the early days of healing the surgical site.

We carried out weekly checks in the first month and monthly up to 4 months.

2.3 Prosthetic Phase

The healing process took place without complications. After 4 months we proceeded maintenance to the prosthetic phase (Fig. 4). A polyether precision material was used (Impregum Penta Duosoft, 3M ESPE). In Figs. 4 b-c are observable the conditioning of the soft tissue and individualized abutments tightened and inserted at 25 N cm. No implant movement was noted during abutment insertion.

After conditioning of soft tissue we proceed to the final restoration to 4 weeks (Fig. 4d). Implant was restored with a cemented porcelain fused to metal crown.

3. RESULTS

One year after the delivery of the prosthesis no signs of complication such as perimplant infection or mucosal recession was observed (Fig. 5a). The radiographic control showed stable bone crest levels (Fig. 5b). The CBCT (Cone beam computed tomography) scans show the preservation of the buccal bone wall after 12 months from loading (Fig. 6a). The buccal wall was present, however a crestal palatobuccal bone loss there was irrespectively of biomaterial graft as confirmed by comparing the initial CT scans (Fig. 6b) with the CBCT in Fig. 6a.

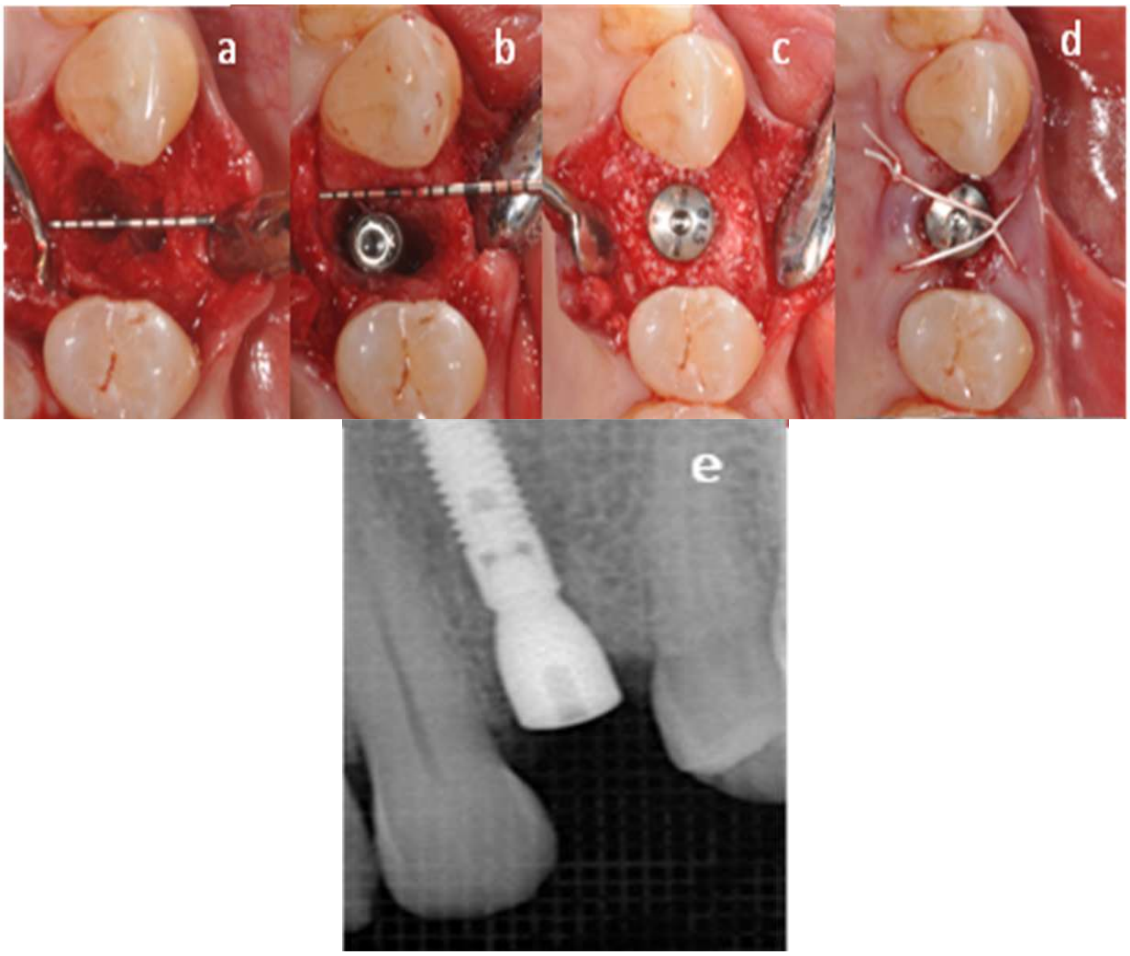

Fig. 3. Implant surgery. (A) Fresh extraction socket. The apical part of the interradicular septum is remove to facilitate implant insertion. (B) Correct 3D positioning of the implant. Note the gap between cortical bone walls and the implant surface. (C) The gap is filled with xenograft and a transmucosal healing abutment is placed. (D) The flaps sutured against the healing abutment with e-PTFE suture. (E) Periaphical radiographic after implant placement

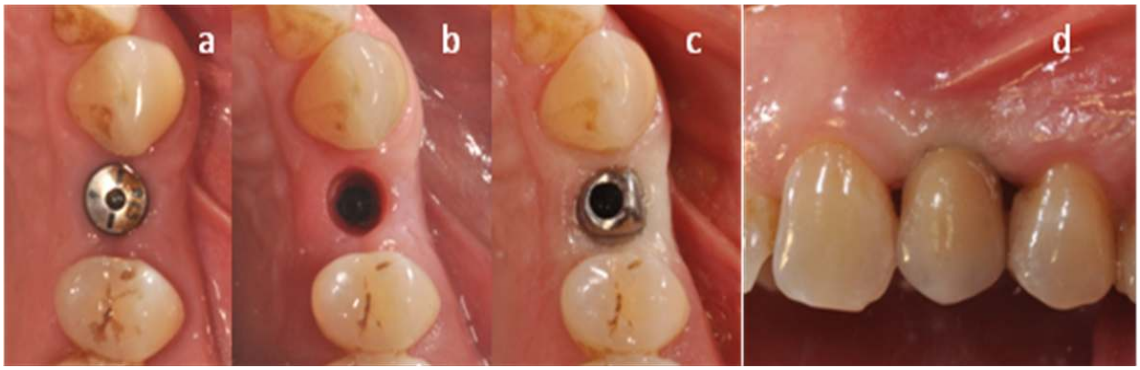

Fig. 4. Prosthetic phase. (A) Clinical aspect after 4 months of healing. (B) Soft tissue healing after osseointegration period. (C) Individualized abutment. (D) Clinical aspect after the delivery of the porcelain fused to metal crown

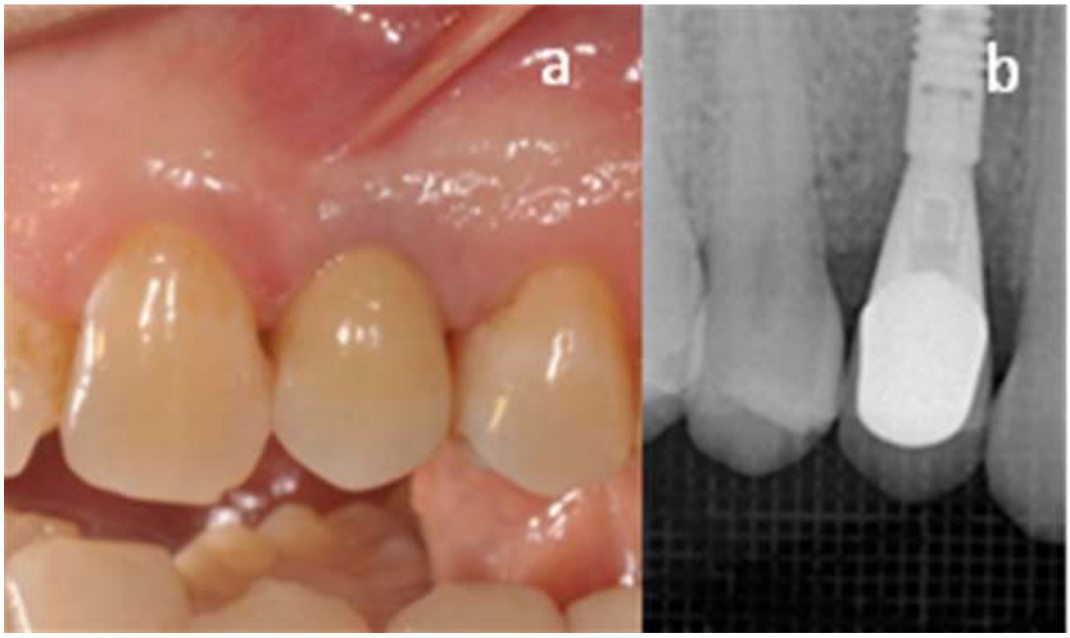

Fig. 5. Clinical control at one year of follow-up. (A) Clinical aspect. (B) Radiographic control. No bone loss was observation period of one year. The interdental papillae appeared to fill more of the embrasure spaces than at baseline (see Fig. 4)

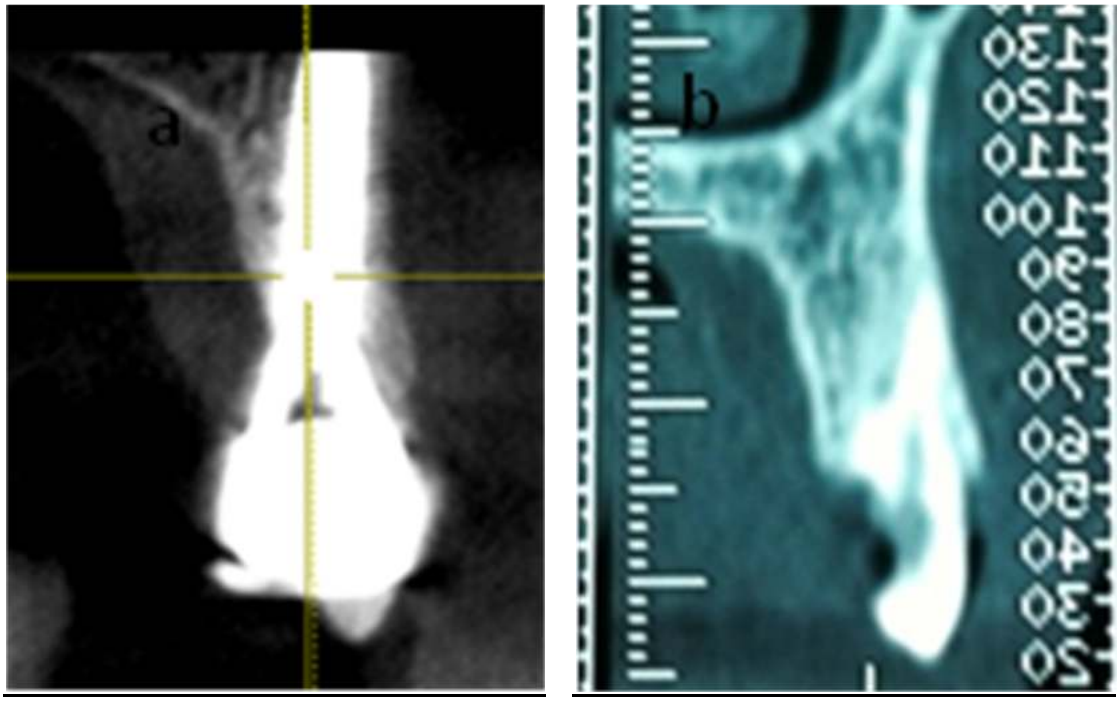

Fig. 6. (A). CBCT (Cone Beam Computed Thomography) control 12 months after loading. Buccal bone around the implant is preserved although there has been an alveolar bone resorption secondary to tooth extraction. (B). shows to dental scan and alveolar bone volume prior to the dental avulsion

4. DISCUSSION

The need to reduce the treatment times and the number of surgeries in implantology has led operators to new therapeutic protocols. The use of post-extraction implants is one of them and it is a common situation in everyday clinical practice [40-43]. When you opt for an immediate implant you must consider some factors to increase the predictability of treatment [21]. Among these, the available bone volume and buccal wall thickness, periodontal biotype, the site of the extraction and the correct three-dimensional positioning of the implant [44].

Just the correct three-dimensional positioning system plays a fundamental role in the success of the procedure. Hence, when using the immediate implant placement protocol, the buccal positioning of the implant should be avoided [20,45]. Implant placement must therefore be guided by the ideal prosthetic position as well as by the assurance of primary stability in the apical portion of the socket and the creation of an adequate gap dimension (> 2 mm) between implant surface and the inner buccal bone plate in the coronal portion, to allow for adequate bone healing [46,29]. In a vertical dimension, it is important that the final position of the implant rim is placed at least 1 mm apical to the buccal ridge, in order to compensate for the expected vertical resorption. In order to compensate for the expected horizontal bone resorption of the buccal bone plate, the use of bone substitutes, with a low resorption rate, to fill the gap has been shown to reduce this resorption significantly and therefore their use should be advocated when the esthetic demands are high.

In the specific case we used a xenogenic graft to fill the void between the implant and the walls of the fresh extraction socket to counteract the irreversible process of bone modeling after tooth extraction and maintaining ridge volume as described by Pagni et al. in a review article [47]. When one or more walls of the socket are missing, concomitant augmentation procedures with combinations of barrier membranes and bone graft are required [48].

We opted for an immediate implant with simultaneous grafting technique for 2 specific reasons.

The first was represented by the anatomical site and the availability of residual bone with intact buccal wall. A recent consensus conference defined premolar site as ideal post-extraction socket for the bone availability and for minor aesthetic demands [31]. When the socket bone walls are not preserved, other implant timing protocols may be reccomended that have provided excellent outcomes regarding the preservation of both hard and soft tissues [49].

The second reason was represented by the possibility of getting in a 3D correct position the primary stability of the implant that is prerequisite for the success of the procedure [50].

We have opted for a transmucosal healing to avoid a second surgical stage, reducing time and because of the low amount of soft tissue.

Predictable healing may be achieved in cases of submerged and transmucosal healing of implants placed in healed or fresh extraction sockets. [51,52].

Minimally invasive extraction, three-dimensionally positioning of the fixture, the simultaneous bone graft insertion and a tension free wound closure has allowed us to achieve healing without complications and an implant-supported rehabilitation that meets the requirements of aesthetics and function as confirmed by clinical and radiographic control at one year of follow-up (Fig. 5a-b).

We did not record recession of the gingival margin although the literature cites this issue as the most frequent in the case of immediate implant placement [53]. Among the risk factors for soft tissue shrinkage, the authors cite a buccal positioning of implant shoulder, a thin periodontal biotype and a compromised buccal bone wall at the time of implant placement [50,54-55]. Peri-implant papillae have to be developed during the soft tissue conditioning phase using provisional crown (Fig. 5a). When the interdental bone level is not reduced and the distance between the bone crest and the contact point is ≤ 5 mm, the tissue will shape within at few weeks following the delivery of the implant-supported crown [56-58].

After 12 months from loading a CBCT study of the postextraction site show that the buccal bone was preserved around the immediate implant treated with xenogenic graft although there was a palatobuccal bone loss (Fig. 6).

5. CONCLUSION

The use of a bone grafting technique at immediate implants can preserve buccal bone but this does not completely prevent the physiological bone remodeling after tooth extraction.

However, this case report may not be useful to draw firm conclusions about the predictability of the treatment but only to present the clinical procedure and its biological rationale.

ETHICAL APPROVAL

For this study all the authors have obtained all necessary ethical approval from suitable Institutional or State or National or International Committee. This confirms either that this study is not against the public interest, or that the release of information is allowed by legislation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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