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Dimensional changes of the post extraction alveolar ridge, preserved with Leukocyte- and Platelet Rich Fibrin: A clinical pilot study

Andreas Anwandter[a], Stephanie Bohmann[b], Mauricio Nally[c], Ana B. Castro[d,*], Marc Quirynen[d], Nelson Pinto[c,d]

[a] Periodontology and Oral Implantology, University of the Andes, Chile
[b] Oral Prosthetic and Surgical Implantology, University of the Andes, Chile
[c] Graduate School of Periodontology and Implant Dentistry, Faculty of Dentistry, University of the Andes, Chile
[d] Department of Oral Health Sciences, KU Leuven & Dentistry, University Hospitals Leuven, Periodontology, Belgium

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ABSTRACT

Objectives: This clinical trial explored the clinical and radiographic dimensional changes of the alveolar ridge in the first 4 months after tooth extraction in combination with the application of Leukocyte- and Platelet Rich Fibrin (L-PRF).
Methods: Eighteen single rooted maxillary and mandibular sockets were filled with L-PRF without soft tissue closure. Clinical measurements (bone sounding) were performed using a customized acrylic stent and radiographic measurements were accomplished using Cone Beam Computed Tomography (CBCT), immediately after tooth extraction and after 4 months.
Results: The clinical observations indicated a mean horizontal resorption of 1.18 ± 2.4 mm ($p = 0.8$) at the crest, 1.25 ± 2.0 mm ($p = 0.57$) and 0.83 ± 2.0 mm ($p = 0.78$) at 2 mm and 4 mm apical to the crest, respectively. The buccal plate demonstrated a mean vertical loss of 0.44 ± 3.5 mm ($p = 0.9$), the centre of the socket had a significant filling of 5.72 ± 3.6 mm ($p = 0.0001$) and the oral cortical plate had a mean vertical gain of 0.09 mm ± 1.57 mm ($p = 0.9$). The radiographic analysis demonstrated a mean vertical bone loss of 0.27 ± 2.5 mm ($p = 0.9$) on the buccal and of 0.03 ± 1.6 mm ($p = 0.9$) at the oral crest. The width of the alveolar ridge had a mean loss of 1.33 mm ± 1.43 mm.
Conclusions: Within the limitations of this pilot study, it can be concluded that L-PRF might show clinical benefits for ridge preservation.

1. Introduction

The preservation of the alveolar ridge dimensions is fundamental for the optimal installation of an oral implant, which permits the completion of a functional and aesthetic rehabilitation [1].

Tooth extractions are one of the most common procedures, due to un-restorable caries lesions and advanced periodontal disease [2]. After tooth extraction, the alveolar bone suffers an atrophy process. Together with the loss of bundle bone, dimensional changes of the alveolar bone can be observed, as well as soft tissue re-modulation. The most relevant volumetric alterations take place in the first three months after tooth extraction and have a greater magnitude in the vestibular aspect of the socket where the vestibular bone plate is generally thinner [1–3]. Tan et al. [2] in their systematic review, reported for human extraction sockets where no preservation technique was used, a mean horizontal bone resorption of 3.8 mm, and a vertical resorption of 1.2 mm, within the first 6 months after tooth extraction. This corresponds to 29–63% of horizontal and 11–22% of vertical bone dimension loss. These volumetric changes often require complementary surgical techniques for the optimal installation of oral implants [4].

To avoid or limit this ridge modification, several preservation techniques have been described, including the filling of the socket with auto-grafts, allografts, xenografts or alloplastic materials, combined with resorbable or non-resorbable membranes [4]. In a recent systematic review [5], xenografts were found to perform the best, followed by allografts and alloplastic materials when compared to natural healing. The amount of remaining graft material at the time of observation was higher for allografts, followed by xenografts, and alloplastic materials. Even if these materials can diminish alveolar bone resorption, their remodelling can have unfavourable results due to their avascular nature. Also

* Corresponding author at: Department of Oral Health Sciences, Periodontology, Kapucijnenvoer 7, blok a, bus 7001, 3000, Leuven, Belgium.
E-mail address: anabelen.castrosarda@kuleuven.be (A.B. Castro).

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the exposure of membranes often used in combination with these bone substitutes, can jeopardise the final outcome [6]. The high concentration of remaining substitute particles may also decrease the final bone to implant contact (BIC) [7] and their high cost may also be a limiting factor for their use. Auto-grafts are an alternative, but they often involve donor site morbidity and/or a limited availability [8].

With the actual advancements in biotechnology and increase knowledge in bone regeneration, new biologically active methods have been developed to outweigh the disadvantages of non-vital materials and autografts [9]. The latter includes first and second generation platelet concentrates [10]. The first group involves Platelet Rich Plasma gel (PRP). During its preparation artificial additives are used to manipulate the coagulation process (e.g. anticoagulants, thrombin and/or calcium chloride). PRPs have a high content of platelets and a fine fibrin mesh [11,12]. They are unfortunately characterized by a short duration of platelet degranulation, which might explain their impaired regenerative power. The second-generation platelet concentrates comprises Leukocyte and Platelet Rich Fibrin (L-PRF), described for the first time in France by Dohan et al. [11]. This auto-graft is obtained by a centrifugation process of blood obtained from the patient itself, without the addition of any anticoagulants or coagulation activators. The naturally produced coagulation leads to a fibrin clot with a 97% and 50% of circulating platelets and leucocytes, respectively [12]. Once the clot is separated from the supernatant and the red element phase, it can be compressed into a membrane or a plug [13]. L-PRF membranes are composed of a dense high cross-linked fibrin mesh with tri-molecular unions that entraps viable platelets and leucocytes. This biological scaffold releases growth factors, adhesion molecules and pro- and anti-inflammatory cytokines, for up to 7 days [14,15]. As such it can (i) modulate the reparative inflammatory response, (ii) increase the efficacy of tissue regeneration, angiogenesis, and neovascularization, and (iii) diminish postoperative pain and edema [16]. These characteristics makes L-PRF a biologically suitable graft for alveolar ridge preservation, especially considering the low costs and the simple and atraumatic harvesting. Its application in the alveolar sockets might enhance alveolar tissue regeneration in comparison with non-bioactive materials.

The clinical effectiveness of L-PRF in the maintenance of alveolar ridge volume has not yet been clearly established. The aim of this study was to describe the clinical and radiographic dimensional changes 4 months after tooth extraction in combination with an L-PRF application.

2. Material and methods

The present study was designed as an un-controlled clinical trial. The protocol was approved by the Ethical Committee of University of the Andes, Santiago, Chile. Patients were enrolled after informed consent was obtained, and the protocol was conforming to the ethical guidelines of the 1975 Declaration of Helsinki. During this pilot phase the treatment was offered for free.

2.1. Patient selection

Twenty patients, with 1 extraction socket each, were enrolled and treated in the Odontology Health Care Centre of University of the Andes (San Bernardo, Chile), during the period 2011–2015. All patients consulted with the need of being rehabilitated with oral implants. The inclusion criteria included: ≥18 years of age, ASA (Physical Status Classification System, American Society of Anesthesiologist) I (normal healthy patient) or II (patient with mild systemic disease), the indication of single rooted tooth extraction with the persistence of 50% or more of bone support (previously evaluated with a periapical radiograph).

The exclusion criteria were: ASA III (patient with severe systemic disease) or IV (patient with severe systemic disease with constant threat to life) patients, uncontrolled diabetes, smokers (≥ than 20 cigarettes/day), use of immunosuppressant medication, pregnancy, a removable prostheses over the treated site, adjacent tooth extractions, or a diffuse infectious process next to the site to be intervened.

2.2. Study protocol

Prior to surgery an alginate impression of the mandible or maxilla was taken and a cast was obtained for the preparation of an acrylic stent that was used for both the clinical and radiographic recordings (Fig. 1).

2.2.1. Surgical technique

Two days before the tooth extraction, the subjects started the use of 0.12% chlorhexidine (Oralgene®, Maver Pharma®) twice a day. Before tooth extraction, venous blood was drawn (antecubital vein) with a 21 G needle to fill 4–8 tubes of 10 mL each (vaccutainers: Intra-Spin®, Intra-lock International Inc.®, USA). The tubes did not contain any additive or anticoagulant. They were centrifuged for 12 min at 2700 rpm (centrifuge: Process PCO2 PC-02®, Process Ltd.®, Nice, France). After spinning, L-PRF clots were collected and stored in a closed sterile box; some of them were slightly compressed into membranes (by gravitation via a glass plate, circa 5 min). The tooth was extracted in the most atraumatic way as possible (local anaesthesia 2% Lidocaine), the alveolus was curetted profoundly and finally rinsed rigorously with saline (Fig. 1).

2.2.2. Clinical measurements

Prior to the application of the L-PRF, clinical data were recorded with the help of an acrylic stent. It was prepared based on a preoperative cast where the teeth to be extracted were removed. Gutta-percha markers were placed in the buccal, occlusal and oral side of the future extraction site. These markers will ensure that the future CBCT measurements are recorded at the same location and position (pre- and postoperative).

At each of the 3 planes of the stent (buccal, occlusal and oral), 3 openings were made with a 1 mm diameter burr, corresponding to specific landmarks of the alveolar bone: buccally and orally at the position of the crest, and at 2 mm and 4 mm apically; occlusally at the buccal and oral crest, and at the deepest point of socket. For details see Fig. 2. The distance bone-stent was measured with a 40# endodontic file with rubber ring immediately after extraction and after 4 months.

2.2.3. Leukocyte- and platelet rich fibrin (L-PRF) application

First the bony borders (alveolar socket walls) around the alveolus, buccally and orally were uncovered (full thickness flap) over a distance of ±2 mm, creating an envelope. After the socket was completely filled with several L-PRF clots, the latter was condensed with a gauze. Finally L-PRF membranes were positioned over the clots, inside the socket, with its borders slipped in the envelope between the bony border and soft-tissue (buccally and orally). The soft tissues were gently sutured (3.0 silk suture with a 20 mm needle) at the mesial and distal ends and in the centre of the socket, without an attempt for closure.

2.2.4. Radiographic examination on CBCTs

Three gutta-percha markers (2 mm fragments of endodontic cones) were attached onto the acrylic stent in standardized positions. They served as radiopaque markers in order to