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Platelet-rich Fibrin in Sinus Lift Procedures: A Systematic Review

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Review Article

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Abstract: The aim of this review was to evaluate literature on the efficacy of platelet-rich fibrin (PRF) as a sole grafting material in sinus floor augmentation. The main advantage of PRF is the avoidance of a second surgical site needed for the harvest of autologous bone. A PubMed search was carried out, limited to human studies for articles on PRF as a sole grafting material. 15 unique results were found. Out of 15, 5 results met our inclusion criteria. All the studies were non-comparative and were analyzed for sample size, case-selection criteria, surgical technique, evaluation criteria, success rates and follow-up period. PRF showed promising results as a grafting material and is a relevant biomaterial for natural bone regeneration. Further, clinical studies including control groups in the form of randomized controlled clinical trials are required to establish the efficiency of PRF as a grafting material in sinus lift procedures.

Keywords: Platelet-rich Fibrin, PRF, sinus lift, sinus augmentation, sinus grafting, dental implant.

INTRODUCTION

One of the most common surgical interventions for obtaining adequate bone height before implant placement in atrophic posterior maxilla is sinus lift procedure [1]. Bone grafts have been considered a prerequisite for the success of sinus augmentation. Various bone grafts, such as autografts, allografts, xenografts, alloplasts or combination of these, have been previously used [2-7].

Following the principles of guided tissue regeneration, the possibility of sinus augmentation procedures without any bone grafts seems justified. There have been studies in which sinus augmentation without bone grafts where successful osseointegration of implants has been reported [8-10]. Additionally, autologous blood products rich in platelets have been solely used as an alternative to bone grafts in sinus lift procedures [11,12].

Platelet rich fibrin (PRF), a second generation platelet aggregate has been widely used to accelerate soft and hard tissue healing because of the presence of various growth factors[13]. Studies have demonstrated that viable platelets in PRF release six growth factors which are platelet derived growth factor (PDGF), vascular endothelial growth factor (VEGF), transforming growth factor (TGF), insulin-like growth factor (IGF), epithelial growth factor (EGF) and recombinant human basic fibroblast growth factor (bFGF)[14]. In-vitro studies have shown that PRF induced a significant and continuous stimulation and proliferation of all cell types with a strong differentiation in the osteoblasts [15,16]. In this systematic review we aimed to investigate the role of PRF as a sole grafting agent in pre-implant sinus augmentation procedures.

MATERIALS AND METHODS

Study design

Studies which used platelet rich fibrin as the sole grafting material for sinus lift procedure in humans were included in this review. Studies comparing other materials with PRF as sole grafting materials were also included. Experiments which used PRF as an adjunct or along with other grafts were excluded. Additionally, knowledge reports and review articles were excluded.

Search strategy

An electronic search of literature in PubMed was carried out in December 2017, limited to English-language and human studies using a combination of following key words: platelet rich fibrin, platelet rich growth factor, autologous fibrin, sinus augmentation, sinus lift and dental implant. No publication year limitation was applied. A total of 15 search results were returned. Primary selection of titles and abstracts was based on inclusion criteria. Full texts of all eligible

studies were obtained and reviewed by the authors. Manual search of the references of the eligible articles was done to obtain articles which met the inclusion criteria.

RESULTS

Of the 15 articles obtained from the search engine, 7 studies used PRF along with other graft materials, 2 articles were reviews, 1 was a knowledge report and 1 was on PRF in sinus perforation. 4 articles met the inclusion criteria. Manual search of the references of the 4 eligible articles yielded another study which met the inclusion criteria. Finally 5 articles have been reviewed by the authors.

Comparison of study designs

All the studies were non-comparative & implant placement was simultaneous. Mean age of patients in most studies were in fifties except one study where mean age of the patient was in sixties [20]. Four of the studies used a lateral approach to lift the sinus membrane and one study used the bone added osteotome sinus elevation (BAOSE) method [1]. PRF was prepared using the Choukroun's method in three studies [18-20]. One study used fibrin rich block with concentrated growth factors prepared by Sacco's protocol [11] and the other study used platelet very rich in growth factors (PVRGF) using a modified Choukroun's method [1]. Three of the studies used computed tomography as evaluation criteria [13, 19,20] 1 study used plain radiography [1] and the other used 3D volumetric computed radiography [18]. Only two studies did histologic evaluation of bone formation at the grafted site [13]. Two studies additionally performed functional evaluation of the implant [21,19].

Table-1: Summary of the articles reviewed

Name of the study	No of cases	Evaluation criteria	Mean bone height achieved	Follow up period	Complications
Tascheiri *et al.* [1]	15 patients Mean age – 53.9+14.3	i. Clinical ii. Functional (QOL) iii. Radiographical	2.9+0.8 mm	35.6 months	Peri-implant bone loss (0.36+0.19mm) at 12 months 2 cases of dehiscence< 4mm requiring re-grafting
Sohn *et al.* [11]	53 patients, 61 sinus lifts, 111 implants Mean age – 31.3 years	1. Radiographs- Panoramic CBCT 2. Clinical 3.Histological scans	A Success rate of 98.2% was reported	10 Months	Membrane perforations in 10 cases, 5 requiring collagen repair and 2 implant failures
Simonpieri *et al.* [15]	20 Patients, 23 Sinus Lifts, 53 Implants Mean age (59.8± 11.1 Yrs.)	1.Clinical 2.Radiographs- (Panoramic, CBCT)	10.4±1.2 mm	2-6 Years	3 Membrane perforations repaired with PRF membrane
Tajima *et al.* [20]	6 Patients, 9 Sinus Lifts, 17 implants Mean age 7.8 yrs.	1.Clinical 2.Radiographs- (Panoramic, CBCT) 3. Functional ISQ	7.5 mm New bone volume 0.70±0.31 ml, Mean ISQ 66.5±6.15	6 months Mean Density 323±156.2 HU	Nil
Mazor *et al.* [18]	20 patients, 25 sinus Lifts, 41 Implants Mean age 54.1±5.2 yrs.	Radiographic • Panoramic • Volumetric Computed Tomography Histologic sections in 9 patients	10.1±0.9 mm A 100% success rate was reported	6 months	Nil USG for membrane evaluation

DISCUSSION

Platelet-rich fibrin (PRF) is a simple, natural, inexpensive autologous fibrin matrix that is rich in platelets, leukocytes and growth factors. Fibrin and fibrin clots, which are thought to be beneficial for bone regeneration, play an important role in wound healing. By protecting the denuded wound tissues and providing a scaffold for cell migration during the tissue repair process, they function as a temporary shield. Furthermore, fibrin also serves as a reservoir for cytokines and growth factors. PRF clots obtained with a simple centrifugation procedure, stimulate several

biological functions like chemotaxis, angiogenesis, proliferation, differentiation, modulation, thereby representing an effective therapeutic device for a more rapid and effective regeneration of hard and soft tissues. PRF has moderate strength, is easy to handle, and promotes healing of the sinus membrane and bone. PRF has many beneficial characteristics that make it suitable for application as a filling material for sinus floor augmentation.

Preparation of PRF

In the Choukroun method, venous blood is collected in glass-coated plastic tubes without anticoagulant and immediately centrifuged. The coagulation cascade starts during centrifugation, and blood is divided into three parts in the tube: serum as a supernatant in the upper layer, the red blood cell layer at the bottom, and the PRF clot between them. Clot is removed from the tube and separated from the red cell base using pliers and gently pressed in between 2 sterile compresses to obtain an autologous fibrin membrane. There is a slight difference in PRF preparation in the Sacco's protocol. In the study of Sohn *et al*. fibrin-rich blocks were prepared by this method. 20 to 60ml of patient's venous blood was divided into 2 to 8 glass-coated test tubes without anticoagulants which were centrifuged at 2400 to 2700 rpm using a specific centrifuge with a rotor turning at alternated and controlled speeds for 12 minutes. 2 to 6 pieces of fibrin-rich blocks were prepared and characterized by 4 phases. The uppermost layer comprised of serum and the second layer represented by a very large and dense polymerized fibrin block. The third layer was a liquid phase containing concentrated growth factors (CGF's), white line cells, and stem cells. The lowest red layer was represented by concentrated red and white blood cells, platelets and clotting factors. The second layer with the fibrin buffy coat and the third liquid phase was used as alternatives to bone substitutes for sinus augmentation.

All the studies we reviewed used stable speed during centrifugation except the study of Tajima *et al.* which used the following parameters: 30 seconds of acceleration, 2 minutes at 2700 rpm, 4 minutes at 2400rpm, 4 minutes at 2700 rpm, 3 minutes at 3000 rpm, and 36 seconds to decelerate and stop. It is unclear if the minor difference in the method of preparation of PRF had any role in the amount of bone formed in each of the study. To comment on the effect of PRF prepared by different protocols requires analysis of the physical and biological properties of the PRF prepared by each if the methods. This information is unavailable in the articles reviewed and is therefore unclear if there is any effect on the results obtained.

Techniques of sinus lift procedure

There are different techniques for sinus augmentation. a) Lateral antrostomy as a one or two step procedure as direct method. b) Osteotome technique with a crestal approach as indirect method. Currently, most simple cases of sinus lift can be treated with the osteotomy technique, which implies less pain and no waiting time between grafting and implantation. However, the lateral approach offers a better control of the surgical site, particularly in a severely resorbed maxilla or when extensive implantation is needed.

In all the studies we reviewed, sinus lift was performed using the lateral approach except one [11]. In the lateral technique, access to the buccal maxillary wall was achieved by a mucoperiosteal incision, anterior and posterior releasing vestibular incisions, and elevation of a full-thickness flap. A bone window was created in a medial position to preserve the buccal bone around the implant. Thereafter, the sinus membrane was carefully elevated without perforation. In the study of Taschieri et al, indirect method of sinus floor augmentation was used. The Schneiderian membrane was elevated using osteotomes, with minimal surgical trauma. This less invasive technique was an attempt to reduce the grafting volume to the minimum and generate only the required bone volume needed for the adequate osseointegration and anchorage of the implants. In this method, the PRF was gently condensed into the sinus floor. The authors have not mentioned any difficulties or differences in handling the delicate PRF membrane during condensation process. Also there is no literature/information available to understand the effect of forces of condensation on the biologic activity of PRF. Though both the techniques have shown similar results in literature, it would be worthwhile to study the effect of mechanical forces on the osteogenic activity of PRF.

The amount of bone height gained maybe dependant on the residual bone height at the surgical site[5] The residual bone heights at the implant sites were at least 7mm [1]; 3.9±2.1mm [13]; 1.8±0.5 [15]; 4.28±1.0mm (Tajima et al); and 2.9±0.9mm (Mazor et al). The final bone gain was significant in the studies of Mazor *et al*.[18] (10.1±0.9mm) and Simonpieri *et al.* (10.4±1.2). However, the studies of Taschieri *et al.* (2.9±0.8mm), Sohn *et al*. (9.53±2.64mm) and Tajima *et al.* (11.8±1.67mm) reported lower bone gain. The increased bone gain was attributed to the high residual bone height prior to surgery. None of the articles we reviewed have commented on the role of pre-operative alveolar bone height in the success of the sinus lift procedure. Neither have the studies included the preoperative alveolar height as a case selection criteria except Taschieri et al which mentions that the residual bone height had to be at least 7mm either mesial or distal to the implant site. This aspect needs to be addressed in future studies on the subject.

Moreover, all studies were case series with no control groups. Given that the lack of control groups is likely to reduce the accuracy of results, further clinical studies, preferably including well-designed randomized

controlled trials are needed to compare the results of PRF as a sole grafting material with those of autologous bone grafts in sinus floor augmentation.

CONCLUSION

Platelet-rich fibrin has shown promising results as the sole grafting material in sinus floor augmentation procedures. Further studies in this subject can include randomized controlled trials covering the aspect of defined case selection criteria and standard assessment technique.

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