Bilateral direct sinus lift with platelet rich fibrin (PRF) in combination with DFDBA and FDBA: a case report

Yogesh Khadtare[1,*], Abdul Aziz[2], Shekhar Prashant[3]

[1]Associate Professor, Bharati Dental College, Pune, [2]PG Student, [3]Associate Professor, Hazaribagh College of Dental Science, Jharkhand

***Corresponding Author:**
Email: dentechpune@gmail.com

Abstract

Platelet rich fibrin (PRF), developed in France by Choukroun et al(2001), is a second generation platelet concentrate widely used to accelerate soft and hard tissue healing. It's advantages over the better known platelet rich plasma (PRP) include ease of preparation & application, minimal expense and no need of biochemical blood handling (no bovine thrombin or anticoagulants required). This article describes the use of PRF in bilateral direct sinus lift case. Around 20 ml of blood is collected from the patient for each side procedure in the vacutainer tubes and then placed immediately before the coagulation cascade begins in a centrifugal machineat 3000 rpm for 10 min and the middle fraction containing the fibrin clot is then collected to obtain the PRF. Sinus cavities after lifting the membrane was filled with PRF in combination with DFDBA and FDBA. The post-operative radiograph showed faster healing as compared to physiologic healing. However, the preparation being strictly autologus, the amount of PRF obtained is limited.

Keywords: Bilateral direct sinus lift, Platelet rich fibrin, Platelet rich plasma, Healing.

Introduction

The main purpose of clinical research has been the development of bioactive surgical additives, which help in faster healing process.(1) The healing of hard and soft tissues both, is mediated by a wide range of intra and extra cellular events, which in turn are regulated by various signalling proteins.(2) However, it is known that platelets play a crucial role in haemostasis as well as wound healing process.(3) The development of technologies to obtain platelet concentrates led to formation of Platelet rich plasma (PRP). However, because of legal restrictions on blood handling procedures another family of platelet concentrate appeared in France-Platelet rich fibrin (PRF).(4) Regardless of the choice of graft material or membrane selection predictable bone regeneration is dependant upon 4 major biological principles: primary wound closure, blood supply, space maintenance and wound stability.(5) Bone Grafting is more successful when it occurs in a contained and well vascularised environment. Blood supply provides the necessary cells, growth factors to initiate the osteogenic bio-mineralization. Injury to blood vessels during oral surgical procedures causes blood extravasation, subsequent platelet aggregation and fibrin clot formation. The major role of fibrin in wound repair is haemostasis and fibrin also provides a matrix for the migration of fibroblasts and endothelial cells that are involved in angiogenesis and responsible for remodelling of new tissue. Platelet activation in response to tissue damage and vascular exposure results in the formation of platelet plug and blood clot as well as the secretion of biologically active proteins like growth factors (GF)-platelet derived growth factors (PDGF), transforming growth factors-β (TGF-β), vascular endothelial growth factor (VEGF) and insulin like growth factor (IGF).(6,7) These growth factors can exert chemotactic effects towards human osteoblasts.(8) Release of active proteins results in expression of gene sequence that directs cellular proliferation, collagen synthesis and osteoid production.(9)

PRF obtained from autologous blood which is simply centrifuged blood without any addition contains 95% of platelets and is used to deliver growth factors in higher concentration to the site of bone defect or a region requiring augmentation.

In this case report bilateral direct sinus lift with trapdoor design is done using PRF in combination with DFDBA and FDBA. Post op-radiographic results reveal that healing and bone formation is much faster compared to physiological bone formation. This case gives us unique bio-additive combination to fill the sinus lift cavity for better and faster results.

Case History

A male 54 year old patient had come to Bharati Vidyapeeth Deemed University dental college and hospital, Pune with the chief complaint of replacement of missing teeth in upper posterior region(Fig. 1). Patient had no significant family and medical history, dental history of extractions done 5 years back.

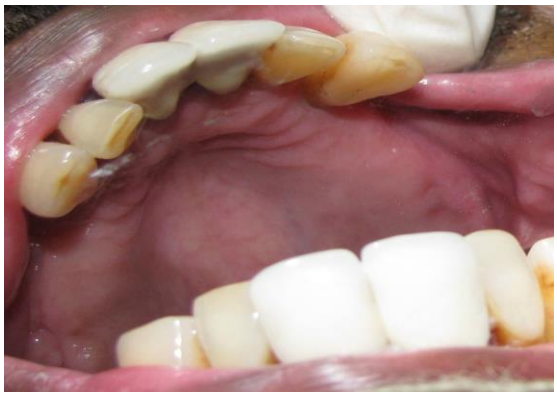

Fig. 1: Bilateral edentulous region in maxillary posterior region

Investigations done:
Blood investigations and CBCT.
Radiographic findings: atrophic maxilla bilaterally.
Right side: average bone height from sinus floor to alveolar crest was 3.6 mm approximately (Fig. 2).

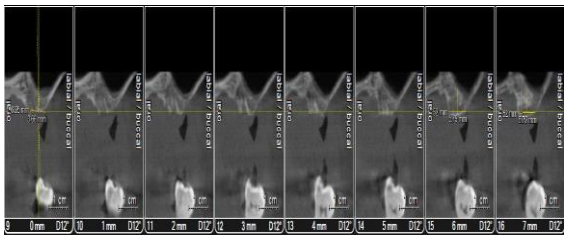

Fig. 2: Right side dimensions

Left side: Average bone height from sinus floor to alveolar crest was 3.2 mm approximately (Fig. 3).

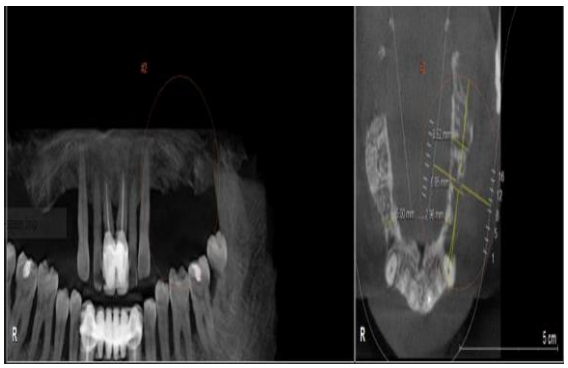

Fig. 3: Left side dimensions

Treatment advised: bilateral direct sinus lift with the use of PRF in combination with DFDBA and FDBA followed by implant placement.

Surgical technique: Full thickness mucoperiosteal flap was raised to sufficiently access the lateral wall of sinus with two releasing vertical incisions (Fig. 4).

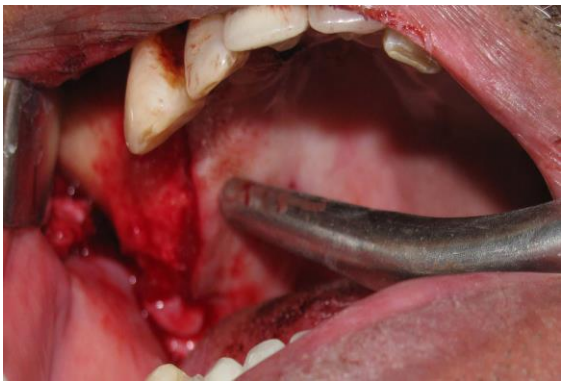

Fig. 4: Flap reflection

The window outline was made on the lateral aspect at 6 mm height from alveolar crest. Window dimensions were 1.5 cm inferio-superiorly and 2.5 cm antero-posteriorly(Fig. 5).

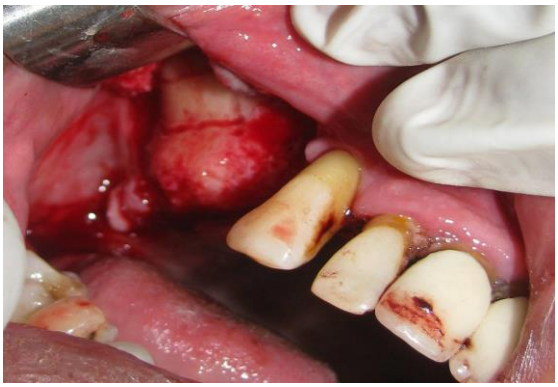

Fig. 5: Outline of window

The trapdoor design window was prepared with round diamond bur (Fig. 6).

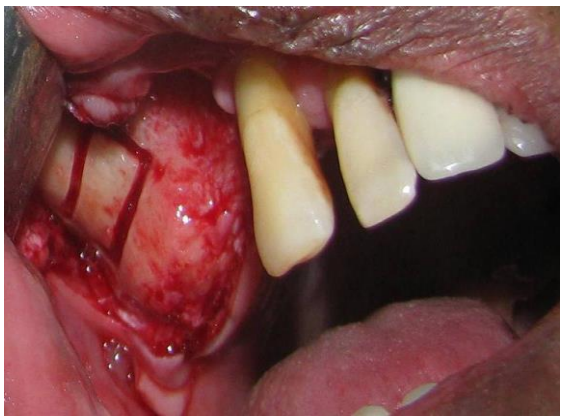

Fig. 6: Trap door design

Reflection of the sinus membrane was done beginning at the sinus floor and then releasing the sinus membrane circumferentially around the window opening. The sinus membrane was then thoroughly elevated posteriorly as far as the tuberosity and across the entire floor of thesinus to reach the medial wall.

Platelet rich fibrin preparation:[10] Around 20 ml of venous blood was collected in the vacutainer tube without anticoagulant (Fig. 7).

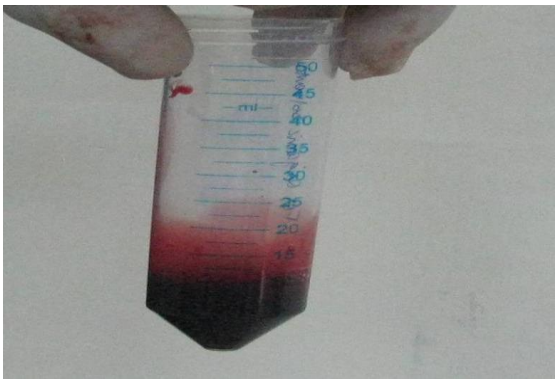

Fig. 7: 20 ml of blood

The vacutainer tube was then placed in a centrifugal machine at 3000 revolutions per minute (rpm) for 10 min after centrifugation 3 distinct layers were seen (Fig. 8).

Fig. 8: Centrifuge machine

The top layer was straw coloured but mostly clear liquid which is the plasma, middle fraction containing the fibrin clot and the lower fraction containing red blood cells (Fig. 9).

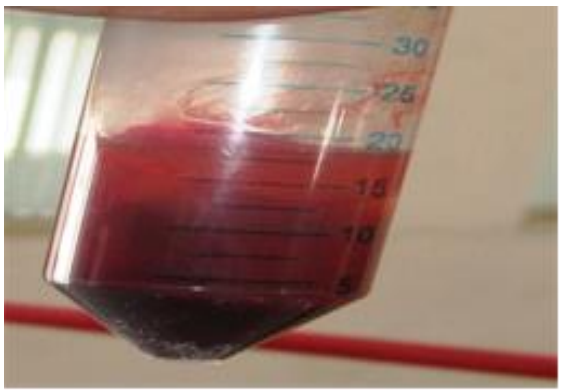

Fig. 9: Post centrifugation

The upper straw coloured layer was then removed and middle fraction was collected 2mm below lower dividing line which is the PRF(Fig. 10).

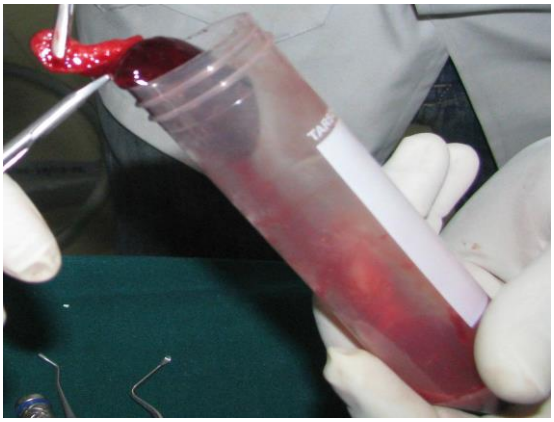

Fig. 10: PRF membrane

Mechanism which is followed here is that, fibrinogen which is initially concentrated in the high part of the tube combines with the circulating thrombin due to centrifugation to form fibrin. A fibrin clot is then obtained in the middle of the tube just between the red corpuscles at the bottom and acellular plasma at top. Platelets are trapped massively in the fibrin meshes.

Platelet rich fibrin handling: The success of this technique entirely depends on the speed of blood collection and transfer to the centrifuge. Without anticoagulant the blood sample starts to coagulate almost immediately upon contact with the tube and it does take a minimum of few minutes of centrifugation to concentrate fibrinogen in the middle and upper part of the tube. Quick handling is the only way of obtaining a clinically usable PRF clot. Clinician can obtain very resistant autologus fibrin membranes by driving out the fluid trapped in the fibrin matrix.

PRF grafting in sinus cavity: When 100% allogenic bone (DFDBA/FDBA) is used in a sinus lift graft, bone regeneration occurs only via osteoconduction.[11] Therefore when allogenic bone is used in combination with PRF it allows the growth factors in PRF to act on the endosteal osteoblasts and marrow stem cells of the bony sinus walls, while the fibrin, fibronectin and vitronectin adhere collectively to the allogenic bone particles. This results in enhanced cellular migration and regenerative bone deposition on the allogenic bone. In addition the clotted nature of PRF will improve the handling properties of the allogenic bone particles and make them easier to place. Thus to gain all these benefits PRF with FDBA and DFDBA was used to fill the sinus cavity (Fig. 11, 12).

Fig. 11: PRF+DFDBA

Fig. 12: PRF+FDBA

Lateral window was pushed inside the sinus cavity below the sinus floor as part of trap door design. This will prevent sinus membrane to descend down and will also provide thick cortical bone at the floor of the sinus. The sinus cavity was densely packed with PRF and FDBA and DFDBA combination(Fig. 13).

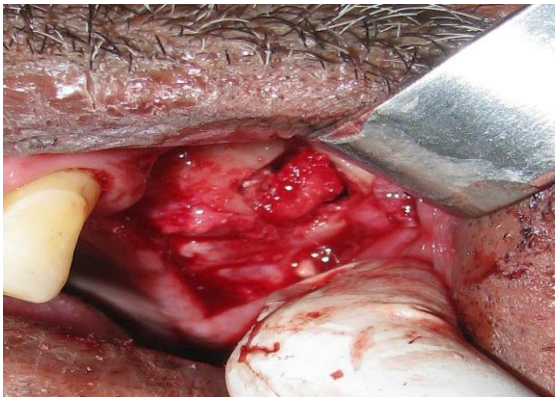

Fig. 13: PRF+FDBA+DFDBA packed into sinus cavity

Window was covered with bio-gen collagen membrane, flap was repositioned and suturing was done(Fig. 14).

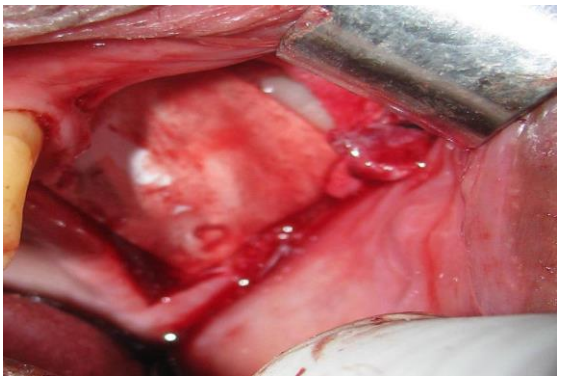

Fig. 14: Sinus cavity covered with membrane

Post-operative instructions and medications were given and patient was recalled after 7 days. The same procedure was done on the other side also after 15 days.

Results

Studies have demonstrated that bone graft cells do indeed possess membrane receptors for nearly all of the growth factors contained within platelets. Carl E. Misch has mentioned that the materials in the sinus graft affect the rate of bone formation and the bone formation is fastest with autogenous bone graft (4 -6 months), DFDBA/FDBA (6-10 months) and alloplast (up to 24 months) in normal physiologic condition.

1 month follow up: After 1 month of the procedure OPG was taken and significant increase in bone height from alveolar crest to floor of the sinus was seen. However, bone in the sinus cavity was not completely radioopaque and radiolucent patches were seen. This indicates faster healing and bone regeneration in sinus cavity compared to normal physiological healing when PRF is used in combination with DFDBA and FDBA.

3 months follow up: After 3 months of procedure again CBCT was taken and significant increase in bone height and radioopacity was seen on both sides in maxillary posterior region with little radiolucency indicating an increase in bone mineral density. Post-operative CBCT show that bone height in upper premolar region after sinus lift from the inferior border of the sinus to the crest of the alveolar bone has increased to approximately 8 mm and buccolingual width is 7 mm and in molar region superior-inferior height has increased to 8 mm and width has increased to 6.85mm(Fig. 15).

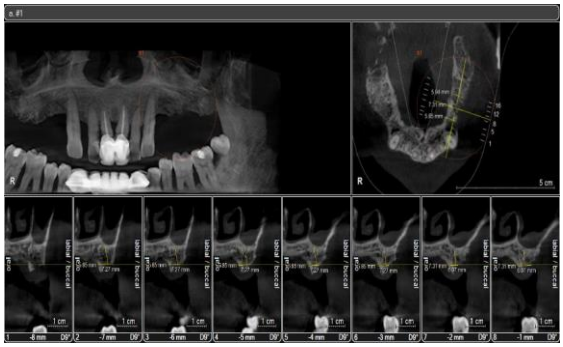

Fig. 15: Post 3 months dimensions

Increase indicates a clinically more rapid formation and earlier maturation of the bone grafts that were stimulated by PRF.

Discussion

PRF was first used by Choukroun et al. in France and belongs to a new generation of platelet concentrate which is a simplified processing technique not requiring biochemical blood handling. According to Simonpieri et al. the use of platelet concentrate during bone grafting offers the following four advantages: First, the fibrin clot plays an important mechanical role with the PRF membrane maintaining and protecting the grafted biomaterials and PRF fragments serving as biological connectors between bone particles. Second, the integration of this fibrin network into the regenerative site facilitates cellular migration, particularly for endothelial cells necessary for the neo-angiogenesis, vascularisation and survival of the graft. Third, the platelet cytokines(PDGF, TFG-β, IGF-1) are gradually released as the fibrin matrix is resolved, thus creating a perpetual process of healing. Fourth, the presence of leucocytes and cytokines in the fibrin network can play a significant role in the self-regulation of inflammatory and infectious phenomena within the grafted material.[12]

In-vitro release of growth factors from PRF and the results of *in-vivo* studies have now put forward a proposal to optimize the clinical application of PRF.[7] In-vitro studies have shown better results of PRF over PRP.[13] The findings by Wiltfang et al from series of clinical trials showed encouraging results. Dohan et al proved a slower release of growth factors from PRf than PRP and observed better healing properties with PRF. In a study by Bensaid et al it was observed that the cells are able to migrate from the fibrin scaffold; while Kawamura and Urist demonstrated that PRF may act as a supportive matrix for bone morphogenic protein as well.

Conclusion

With this article we can conclude that the new and recent generation of platelet concentrates-PRF can be considered healing biomaterial, as it features all the necessary parameters permitting optimum healing.[13] Thus, PRF can be very useful bio-additive in combination with bone graft material in sinus lift procedures. Despite the fact that cytokines trapped in PRF'S are gradually released and able to accelerate the cellular phenomena, it was structure of the fibrin network is the key element of all improved PRF healing process.[10] Finally from a clinical standpoint, this biomaterial appears to accelerate physiologic healing and the numerous perspectives of PRF have still to be clinically tested. However, it cannot be ignored that since it is obtained from an autologous blood sample, the quantity of PRF produced is limited.

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