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THE EFFECT OF PLATELET RICH FIBRIN (PRF) VERSUS XENOGRAFT IN CLOSED SINUS LIFT WITH IMPLANT PLACEMENT ON IMPLANT STABILITY IN MAXILLARY POSTERIOR AREA

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ABSTRACT

Aim of the study: The aim of this study was to compare the effect of PRF versus xenograft on implant primary stability after closed sinus elevation in the maxillary posterior area.

Material and methods: Sixteen male and female patients were selected from the Outpatient Clinic, faculty of Oral and Dental Medicine Cairo University. All patients fulfilled the following criteria: Presence of edntulous area in posterior maxilla and bone height at least 5-6 mm below the maxillary sinus at maxillary posterior area. Patient's age ranged from 25 to 45 and they all had good oral hygiene.

Results: The study results showed that there was no statistically significant difference between (PRF) and (Xenograft) groups in ISQ reading.

Conclusions: Maxillary sinus elevation by osteotome technique and using PRF or xenograft as a grafting material is a predictable and effective procedure for correcting limited bone resorption in posterior areas of the maxilla. Both xenograft and PRF can be used to increase primary stability of simultaneous implant placement with closed maxillary sinus elevation. Further studies are needed with more follow up periods to evaluate healing capacity.

INTRODUCTION

Nowadays dental implants are widely used to replace both the form and the function of missing teeth.

After extraction of the natural tooth, bone remodeling occurs that causes pressure threshold-regulated bone atrophy. In the maxilla, apart from the resorption of the buccal plate of the residual ridge after tooth extraction, increased osteoclastic activity of the periosteum of the maxillary sinus floor leads to the enlargement of the sinus. This pneumatization occurs at the expense of alveolar ridge height beneath the maxillary sinus. Inadequate height, width, and density of the alveolar process are considered some of the common limiting factors for

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dental implant placements in the posterior maxillary regions and poor quality and quantity of alveolar bone may limit implant placement.

Several sinus lifting procedures for implant placement have been introduced since the 1980s. The techniques provide space between the alveolar process of the maxilla and the elevated Schneiderian membrane, and filled space with any graft materials such as autogenous bone, xenograft, allograft, alloplastic bone, or Platelet rich fibrin.

Autogenous graft is still considered the gold standard. However ,it is taken from the chin, mandibular ramus or symphysis and this can make it impractical to clinical practice. Other grafting materials, such as xenogenic, allogenic, alloplastic materials or combinations of different graft materials, have been also introduced.

Platelet-rich fibrin (PRF) was reported in 2001 by Choukroun et al. Several studies have recently reported the application of PRF in sinus augmentation. The application of PRF for sinus augmentation is a cheap, safe, easy surgical procedure and the clinical and radiological findings have been shown to have a good effect regarding new bone formation.

Recently, the use of PRF as a sole graft material for sinus augmentations with simultaneous implant placement has shown good results. In 2008, Diss et al. first published the one-year results of implant placement with the osteotome technique using PRF as the only graft material.

The closed sinus lifting procedure with PRF as grafting material presents the following advantages: There is no need for a donor site involving a more or less invasive surgical approach, no need for a xenograft or an alloplastic material, a limited perforation of the sinus membrane can be treated because of the healing capacity of fibrin matrix, in case of penetration of the grafting material in the sinus there is no risk of sinus infection, the procedure is more affordable without compromising implant predictability, the use of a filling material permits a larger distension of the membrane and preparation of a larger grafted volume and the material protects the membrane from perforation by direct contact with the metallic osteotomes. Sinus floor elevation using PRF as the sole graft material has been recently introduced. Simonpieri et al. followed up a case of dental implant treatment combined with simultaneous sinus lift with PRF as the sole filling material and demonstrated that stable new bone formation occurred around the dental implants.

The aim of this study was to compare the effect of PRF versus xenograft on implant primary stability after closed sinus elevation in the maxillary posterior area. The null hypothesis was that there would be no difference between both grafting materials.

MATERIAL AND METHODS

Sixteen male and female patients were selected from the Outpatient Clinic, faculty of Oral and Dental Medicine Cairo University**.** The patients fulfilled the following criteria: Edentulous area in posterior maxilla and bone height at least 5-6 mm below the maxillary sinus. Patients' age ranged from 25-45 years. Only patients with good oral hygiene were selected. Selected patients were also free from acute or chronic sinus diseases, or allergic reactions that might affect the health integrity of the sinus lining and interfere with lining elevation. Exclusion criteria included patients with bad oral hygiene, or patients with systemic disease that may affect normal healing. Pregnant patients and heavy smokers (more than 20 cigarettes per day) were also excluded.

Patient examination

A) ***Medical History:*** Full medical history of the patients was recorded, including previous and recent illnesses, hospitalization, surgeries and complications. Patients with contraindication to surgical intervention have been excluded.

B) Dental history: The patients were asked about the actual cause of losing the teeth whether it was due to dental caries or periodontal problem. They were also asked about the date of the last tooth extraction and about any pain or clicking in the tempromandibular joint.

C) Radiographic examination: Panoramic radiograph for initial screening was done.

D) Diagnostic mounting and setup: Impressions for upper and lower arches were done for each patient to fabricate dental casts. Face bow and interocclusal records were made and casts were mounted on a semiadjustable articulator to evaluate the interarch distance. Prosthetic wax-up corresponding to the exact replica of the definitive prosthesis was done and accepted by the patient. A pre-surgical stent was then performed for evaluation of implant placement.

E) Patient imaging: Cone-beam computed tomography (CBCT) was taken for accurate estimation of the height and width of the bone.

Virtual Planning

The DICOM file was imported by blue Sky Bio software (Grayslake, Illinois, USA) for planning of potential implant site and measurements of the bone quantity (the occlusocervical height, mesiodistal width and buccolingual depth) were made. **(Fig. 1)**

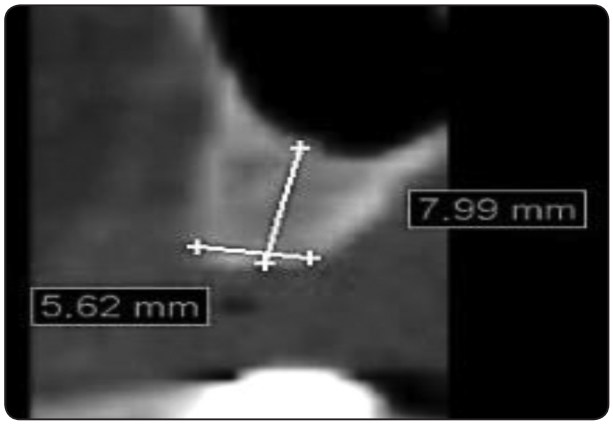

Fig. (1) Cross sectional CBCT image view measuring of bone quantity

Proper localization of the maxillary sinus in the proposed site for implant placement was done. Then a virtual implant of the proper dimensions was selected for the proposed implant site in which at least 2 mm of the implant was inside the maxillary sinus and at least 1 mm of bone was present facially, lingually, mesially and distally. **(Fig. 2)**

Surgical procedure

Injection of Local anesthesia* at site of the edentulous area was done. Crestal incision down to bone by lancet 15 c was done and reflection of the flap bucally and lingually with mucoperiosteal elevator was done to expose the bone. **(Fig. 3)**

Initial Preparation of osteotomy site was done using classical drilling sequence (pilot, intermediate and final drills)** until the maximum limited length of bone available was reached. Osteotomy preparation was done under saline irrigation to avoid heat generation.

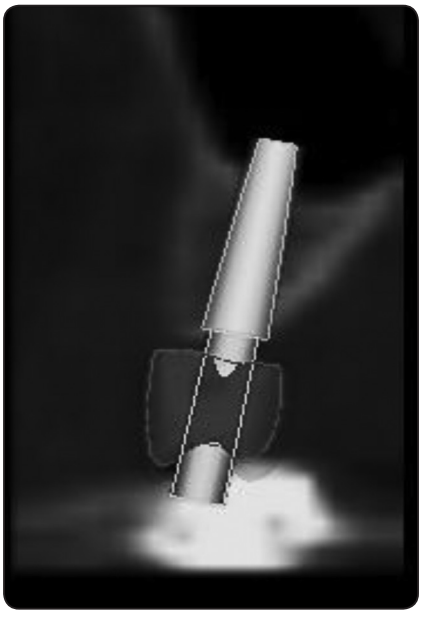

Fig. (2) Cross sectional CBCT images view illustrate virtual planning of single implant

* ArtPharmaDent Articaine HCL 4%
** Implant: One Q (Dentis)

Fig. (3) reflection of the flap bucally and lingually to expose the bone

A 2.5 mm osteotome was inserted into the osteotomy and advanced with light malleting to a depth of 1 mm from the sinus floor. Gentle tapping using the mallet was done in which 2 strokes were done then a 3rd harder one after. A wait time of 5 seconds elapsed between each tapping. A 3 mm osteotome was then tapped gently to fracture up the sinus floor. Elevation of the maxillary sinus was done using the suitable concave osteotomes by malleting the ostotome with the surgical mallet. A 3.5 mm osteotome was then tapped gently to elevate the sinus floor to the desired depth of the implant in the maxillary sinus. This was repeated several times until the desired depth marked on the osteotome was achieved. **(Fig. 4)**

Fig. (4) The osteotome reaches the desired depth

In the control group

After preparation of the osteotomy, condensations of the xenograft by the osteotome in the osteotomy were done. **(Fig. 5)** Implants were inserted after checking that there is no perforation**.**

Fig. (5) Xenograft condensation in the osteotomy

In the study group

A sample of 10 C.C of venous blood was withdrawn from the patient and centrifuged without delay at 3000 rpm for 13 minutes to obtain PRF. **(Fig. 6)**. The PRF was removed from the tube and squeezed by gauze, then it was applied with

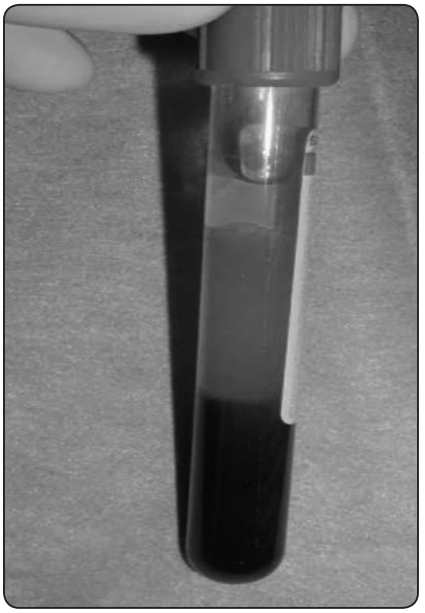

Fig. (6) PRF

condensation in the osteotomy site by the osteotome. **(Fig. 7)** Implants were inserted after checking that there was no perforation.

For both groups:

Sinus membrane was examined for air leaks using the Valsava maneuver by blocking the patient's nostrils and asking the patient to blow through his or her nose. Air leak at the implant site is an indication of sinus membrane perforation.

For both groups, implants (4-mm wide and 10 mm long) were placed in the prepared osteotomy sites using a hand ratchet.

Implant stability Measurements

Smart peg was placed on the implant and the Ostell* was used to record the implant stability quotient (ISQ) **(Fig. 8).** The Measurement probe of the ostell was held close to the top of the smart peg without touching it. When the instrument senses the smart peg, the ISQ value becomes displayed on the screen. Measurements for all surfaces was done (buccal, lingual, mesial and distal). Three readings were taken for each surface and an average was calculated.

The healing collar was placed to allow measuring of implant stability every two weeks for ten weeks, then closure of the flap around the healing collar by interrupted suture was done using 4/0 resorbable sutures. **(Fig. 9)**

Postoperative Follow-up and prosthetic procedure

Each patient was scheduled for follow up visits every two weeks for ten weeks. Implant stability was recorded at 0 (time of implant placement) and 2, 4, 6 and 10 weeks after surgery.

After four months, all the patients were recalled for another x-ray to examine whether there was continued radiolucency around the implant body.

Fig. (7) PRF condensation in the osteotomy

Fig. (8) Showing primary stability measurement by ostell.

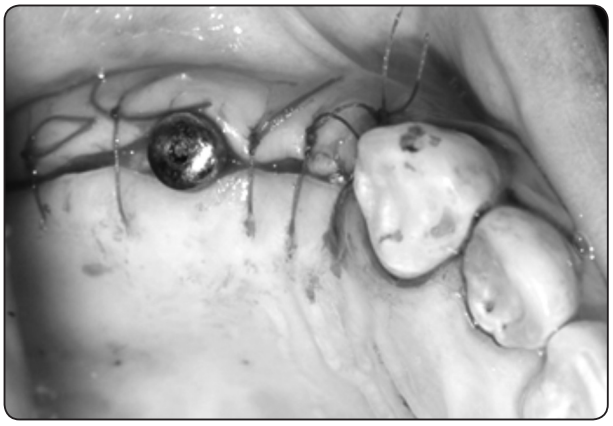

Fig. (9) Healing collar was inserted and the wound closed by 4/0 resorbable suture

* Ostell : MegaGen

When implants were stable, prosthetic procedure was performed.

At the prosthetic phase, implant level impression (closed tray technique) was done using condensation silicone rubber** base impression material and sent to the lab. Metal try in of the prosthesis was done. After stock abutment was tightened with a 35Ncm torque, the porcelain fused- to-metal prosthesis was cemented to the stock abutment after 7–10 days. Periodical x-ray was taken to check proper seating of prosthesis. **(Fig. 10)**

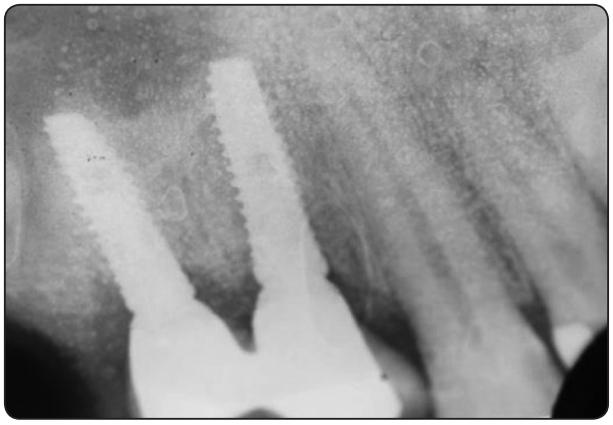

Fig. (10) Periapical x-ray was taken to check proper seating of prosthesis

RESULTS

Independent sample t-test was used to compare between two groups in non-related samples. Repeated measure ANOVA was used to compare between more than two groups in related samples. Paired sample t-test was used to compare between two groups in related samples.

Two-way ANOVA was used to test the interaction between variables.

The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

1. Effect of time

For both groups, the highest mean implant stability was recorded immediately after implant placement followed by 10 weeks, 8 weeks, 6 weeks and 2 weeks after implant placement while the least mean implant stability was recorded 4 weeks after implant placement.

A) PRF (Group A) :

There was a statistically significant difference was found between (0w), (2w), (4w), (6w), (8w) and (10w) groups where (P=0.026) The mean and standard deviation values were calculated for each group in each test. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests, data showed parametric (normal) distribution.

B) Xenograft (Group B) :

There was a statistically significant difference between (0w) and each of (2w), (4w), (6w), (8w) and (10w) groups where (p=0.010)

2. Effect of groups

Implant stability was slightly higher in the PRF group after 2 and 4 weeks, however statistical analysis revealed insignificant differences between (PRF) and (Xenograft) groups at all time intervals. **(Fig.11)**

** Zhermack Zetaplus C-Silicone

TABLE (1) The mean, standard deviation (SD) values of implant stability (ISQ) of the two groups at all time intervals.

Variables	Stability				
	PRF		Xenograft		p-value
	Mean	SD	Mean	SD	
0 weeks (at implant placement)	69.85	6.74	75.38	5.28	**0.186ns**
After 2 weeks	63.30	4.58	61.55	10.62	**0.744ns**
After 4 weeks	62.55	4.49	59.20	3.29	**0.216ns**
After 6 weeks	64.65	0.82	64.40	1.83	**0.787ns**
After 8 weeks	66.60	0.74	67.45	1.35	**0.252ns**
After 10 weeks	73.20	1.29	72.80	1.39	**0.649ns**
p-value	**0.026***		**0.010***		

;significant (p<0.05)** **ns; non-significant (p>0.05)

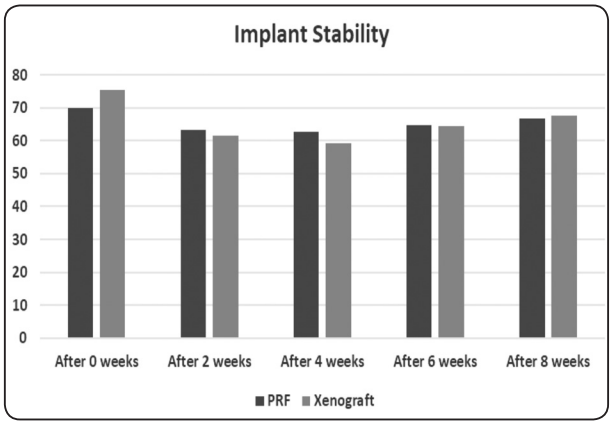

Fig. (11) Bar chart representing implant stability (ISQ) for the two groups

DISCUSSION

Discussion of Methodology

This study was planned on the assumption that performing closed maxillary sinus and placement of implants with good primary stability and osseointegration accompanied by health of remaining structures is of paramount importance.

All factors that could affect osseointegration either systemically or locally were considered. All selected patients were generally healthy with no medical history of debilitating diseases to avoid the adverse effect of systemic disorders on the healing process and osseointegration. Hwang et al., 2006 [6] enumerated general contraindications for implant insertion as metabolic, collagen and hematological disorders, cardiac circulatory diseases, osseous metabolic disturbances and patients under current medications as corticosteroids, immune suppressive and long-antibiotic therapy.

Van den Bergh et al., 2000 [7] found that in cases of chronic sinusitis, the sinus lining becomes thick and spongy with chronic reactive mucosal changes that make its elevation difficult. Therefore, the selected patients were free from acute or chronic sinus diseases, or allergic reactions that might affect the health integrity of the sinus lining and interfere with lining elevation.

Patients with heavy smoking habits were excluded from the study, as it affects the Schneiderian membrane rendering it atrophic, thin and fragile. Maintenance of good oral hygiene in non-smokers is very important for healing process, prognosis and results of the study.[8]

CBCT was done to all patients for three-dimensional treatment planning, especially prior

to sinus floor elevation for evaluating both residual alveolar ridge and sinus conditions.[9]

The advantage of closed technique over the open technique in sinus lift is that it is a less invasive technique that enables placement of implants of 10 mm or longer simultaneously with reduction in operative time. It provides better postoperative comfort and preservation of the sinus cavity integrity compared with open technique.[10]

In our study, we selected cases that had at least 5-6 millimeter of remaining alveolar bone height between the floor of the sinus and the crest of alveolar ridge as the length of the bone is an important factor for proper engagement and initial stabilization of implant in cases of closed sinus lift technique with simultaneous implant, which is in agreement with what was explained by Komarnyckyj et al.,1998.[11]

A set of concave osteotomes of varying dimensions were used in the study during implant bed preparation for sinus lifting, some authors reported that the concave osteotomes are suitable with the poor bone quality of maxilla as osteotomes compresses the bone horizontally and vertically creating a denser area for implant placement with no dehiscence or heat generation, in addition to the great tactile sensitivity with the use of osteotome.[12]

Recently, the application of autologous platelet concentrates to enhance bone regeneration has increased in maxillofacial surgery.[13] In our study, we elevated the sinus membrane by osteotomes from 2 to 4mm with addition of a graft material (PRF or xenograft). This allows new bone formation at the apical part of implant through the osteogenic potential of the Schneiderian membrane that is composed of a few layers including the epithelial lining, the lamina propria, and osteogenic layer toward the maxillary bone.

Discussion of results

From the results of the current study, the null hypothesis could be accepted as implant stability values were comparable in both groups with no statistically significant difference between them.

The results of this study showed that all the implants had ISQ values of over 65 at the first measurement immediately after implant placement in both groups, indicating that both xenograft and PRF procedures provided good primary stability, which is the most important basis for implant success.[8] Implant stability however decreased after 2 weeks and then increased gradually after 8 weeks post-operative to reach a level comparable to that at implant placement in both groups.

ISQ values decreased after 2 and 4 weeks in both groups, this could be due to the bone remodeling that happens through the advanced deformation of old bone and initiation of new bone formation, which is in agreement with the histological process of osseointegration that is explained by Barewal et al., 2003.[14,15]

It was concluded in this study that PRF application increased implant stability during the early healing period, as evidenced by higher ISQ values. Simple application of this material seems to provide faster osseointegration. Achieving accelerated implant osseointegration could make immediate or early loading of implants more predictable. This can be attributed to the fact that the activated platelets in PRF release growth factors, resulting in cellular proliferation, collagen synthesis, and osteoid production.[16,17]

Joost Brouwers et al., 2019 reported increased implant stability in patients treated with PRF. 10 days after implantation with PRF they found high ISQ values 55-80 representing highly stable implantation. [18]

Various studies have demonstrated the efficacy of and support the exclusive use of xenogenic materials for sinus floor augmentation. The use of this material decreases the morbidity associated with surgical procedures to collect autogenous bone. When autograft or demineralized allografts

are utilized there is a tendency for both a volumetric resorption in the order of 25% and a transformation of the graft density towards that which would normally be found in the posterior maxilla. The result would then be an implant receptor site with a typical low bone density. The osteoconductive properties of xenografts as a grafting material in human sinus augmentation have been well documented.[19, 20]

CONCLUSION

Maxillary sinus elevation by osteotome technique and using PRF or xenograft as a grafting material is a predictable and effective procedure for correcting limited bone resorption in posterior areas of the maxilla.

Both xenograft and PRF can be used to increase primary stability of simultaneous implant placement with closed maxillary sinus elevation.

Further studies however are needed with more follow up periods to evaluate healing capacity.

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