Alveolar Ridge Augmentation with Titanium Mesh Adapted On 3D Model with Bone graft versus Using of Autogenous bone graft Stabilized by PRF Membrane in The Atrophic Mandible

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Abstract

Objective: The aim was to evaluate alveolar ridge augmentation using an autogenous bone graft with PRF versus associated with a titanium mesh (Ti-Mesh). Subjects and Methods: 28 patients were selected and divided into two groups, in group (A) a 3D model was created after that titanium mesh was adapted to the model before the surgical procedure. While in group(B) autograft and PRF membrane were used bone width, bone height and bone density were measured. Results: PRF/ Bone graft showed a significantly higher bone width than Titanium Mesh / Bone graft. PRF/ Bone graft showed a significantly higher bone height than Titanium Mesh / Bone graft. PRF/ Bone graft showed a significantly higher bone density than Titanium Mesh / Bone graft. Conclusion: Auto graft covered by PRF membrane is considered a superior solution for ridge augmentation and preservation which promotes bone healing without any side effects. The PRF membrane obtained from the same patient is better than the 3D model of titanium mesh and cheaper, faster, and easier to prepare.

KeyWords:Alveolar ridge augmentation, Titanium mesh, PRF.

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Introduction.

At alveolar ridge defects, bone augmentation is required for implant placement, especially in cases of extensive horizontal and vertical bone resorption. When implant stability or right positioning cannot occur. Such as being placed in unfavorable anatomical positions. This leads to implant failure. So, alveolar ridge augmentation is required. Many techniques of bone augmentation have been improved "[1-3].

The best way to increase the bone volume in the alveolar ridge is to use the patient's own bone graft, which has the ability to stimulate, support, and produce new bone. [4, 5] The patient's bone graft has three advantages: it can induce new bone formation by releasing growth factors, it can act as a scaffold for new bone to grow on, and it can contain cells that behave like osteoblasts, which are the cells that makes bone. These osteoblast-like cells are often used in laboratory studies to create new bone and to engineer bone tissue, but there are few clinical cases that use these cells directly. This case series shows a new technique that uses the principles of bone tissue engineering on the site where the bone graft is placed, to grow the osteoblast-like cells in the body, and to use a titanium mesh as a scaffold. The new bone that is formed can reach a sufficient volume and density in four months of growing in the body. The titanium mesh technique is another option, which uses a solid titanium membrane to cover the bone grafts that are taken from the patient's own body before placing the implants. Roccuzzo and colleagues[6] have described a surgical protocol for increasing the bone height by using this technique.

A biomaterial and a source of autologous growth factors is platelet rich fibrin (PRF). On bone regeneration, it has a good effect. To decrease graft resorption and promote graft maturation, the use of PRF and a barrier membrane aims. With PRF and a resorbable membrane, the block graft used is protected to aid in ridge augmentation. Being definitely autogenous in nature, easy and low cost with specific three-dimensional architecture of the fibrin is PRF. High levels of healing and inflammatory cytokines are proved by PRF.[7, 8]

SUBJECTS AND METHODS

Patient selection: twenty-eight patients were selected. All patients had deficiencies in vertical height and horizontal width at mandibular alveolar ridges. "In accordance with the Declaration of Helsinki, written informed consent was taken from all patients, and the local ethics review committee of the Faculty of Dental Medicine at Al Azhar Universityfor Boys approved the study".

Surgical protocol:

Preoperative "CBCT scan onDemand3D software" was performed to all patients to evaluate alveolar residual bone anatomy and dimensions and 3D reformatted scan of the deficient ridge is fabricated in the first group while, in the second group the suggested treatment involved reconstruction of the mandibular alveolar ridge defects through block graft and PRF membrane.

PRF preparation

10ml of the patient's venous blood was drawn. Venous blood was centrifuged at 3000 (rpm) for 15 minutes using glass tube without anticoagulant. [7]Collected PRF was compressed between two perforated sterile plates to form the membrane**.**

Surgical procedures:

At recipient site: Sterile conditions were maintained for all procedures. Local anesthetic ARTINIBSA[1] was used. A pyramidal flap was made to expose the deficient bone area. A crestal incision and a vertical incision on the buccal side were made at the recipient site. The recipient site was prepared by using diamond round bur (3mm) for decortication and increasing the vascularity of recipient site to add bone graft.

At group (A):

The defect augmented with applied bone graft (xenograft, Hypro Oss[2]) and titanium mesh stabilized with micro screws with diameter (1.5mm)[3]. Using blade no.15 at the buccalperiosteum allows tension free closure of the wound with maintenance of the periosteal cover of the graft. Fig (1) the flaps were repositioned and sutured passively with 4-0 Vicryl suture.

[1]Inibisa Dental, Spain
[2]natural collagenated bovine bone graft, Giessen, Germany
[3]titanium, micro system, Biomaterial Korea

Fig (1): Titanium mesh adapted on the 3D model

At group (B):

At donor site: Anesthesia was induced in the symphysis region and the block graft was lined with a fissure bur. The block harvested bone was freed with mallet and chisels. The bone block graft was stabilized at the recipient site with one or two screws of diameter 1.5 mm[4]. The block graft was covered with the PRF membrane. The flaps were passively repositioned and sutured with 4-0 Vicryl suture (Fig 2-5).

Fig (2): lining the block graft 5 mm from the apices of the lower anterior teeth

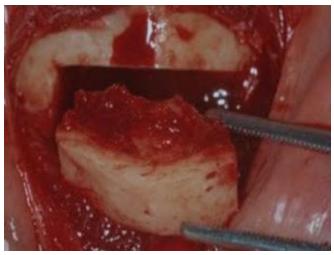

Fig (3): Symphysis area was free from harvested block

Fig (4): defect restored with platelet rich fibrin (PRF) membrane and autogenous bone graft.

Fig (5): autogenous bone graft from symphysis area.

Postoperative care:

Post-operative instructions for each patient included:

1-Postoperative medications which included: antibiotic and anti-inflammatory regimen.

2-Soft diet for first week postoperative surgical procedure.

3-Good oral hygiene instructions.

Radiographic evaluation:

"CBCT onDemand3D software was used to evaluate horizontal width, vertical height and bone density of mandibular ridge in mm after bone augmentation" after 4 months postoperatively.

Statistical analysis: This study was used paired t-test to compare bone height, bone width and density before and after 4 months of augmentation.

RESULTS:

Regarding bone width, both groups showed a significantly higher bone width after treatment. (p=0.001*). PRF/ Bone graft showed a significantly higher bone width than Titanium Mesh / Bone graft.

Regarding bone height, both groups showed a significantly higher bone height after treatment. (p=0.001*). PRF/ Bone graft showed a significantly higher bone height than Titanium Mesh / Bone graft.

Regarding bone density, both groups showed a significantly higher bone density after treatment. (p=0.001*). PRF/ Bone graft showed a significantly higher bone density than Titanium Mesh / Bone graft.

[4]1.5 mm × 8 mm, titanium, Orthomax

Table (1): Titanium Mesh / Bone graft before and after treatment

Titanium Mesh / Bone graft	Before	After	After Treatment
Bone width	2.14±1.05	4.06±0.67	0.001*
%of changes	48.06%		
bone height	7.87±0.60	9.03±0.01	0.001*
%of changes	13.80%		
Bone density	1073.00±51.27	1038.00±37.07	0.001*
%of changes	13.2%		

Table (2): PRF/ Bone graft before and after treatment

PRF/ Bone graft	Before	After	After Treatment
Bone width	4.33±1.50	7.02±0.90	0.001*
%of changes	61.20%		
bone height	9.99±0.89	10.87±0.20	0.001*
%of changes	15.99%		
Bone density	1296.00±64.47	1136.00±40.20	0.001*
%of changes	14.6%		

Table (3): Comparison between Titanium Mesh / Bone graft and PRF/ Bone graft before and after treatment

		Titanium Mesh / Bone graft	PRF/ Bone graft	After Treatment
Bone width	Before	2.14±1.05	4.33±1.50	
	After	4.06±0.67	7.02±0.90	Significant difference
bone height	Before	7.87±0.60	9.99±0.89	
	After	9.03±0.01	10.87±0.20	Significant difference
Bone density	Before	1073.00±51.27	1296.00±64.47	
	After	1038.00±37.07	1136.00±40.20	Significant difference

DISCUSSION

This study compares two methods of increasing the bone volume in the lower jaw: one method uses a titanium mesh that is shaped on a 3D model and a bone substitute material, and the other method uses the patient's own bone and a PRF membrane [(9)] to hold it in place. Twenty-eight patients were chosen to measure the changes in the height, width, and density of the back part of the lower jaw bone that was thin before and after the two methods, and to check for any infection in the area that could affect the bone healing. The data collected from the measurements of the height and width of the back part of the lower jaw bone after the methods were compared with the measurements before the methods for both groups. These measurements were taken from CBCT scans using on-demand3D software.

In our study, 3D models were used, which are cheaper and faster to produce than stereo lithography models, but may not be as realistic [(10)]. Also, titanium mesh was used which is a biocompatible material that can be adapted to the 3D models before surgery, to reconstruct the alveolar ridge defects [(11)]. Titanium mesh has pores that allow blood and nutrients to reach the grafted bone from the surrounding tissues [(12)]. It also prevents the collapse of the soft tissues by providing space and support for the grafted bone [(13).] However, titanium mesh is a non-resorb able membrane barrier that can cause infection if exposed in the oral cavity after GBR.

PRF membrane has several advantages which contain several elements: growth factors, cytokines, anti-inflammatory effects, cytokines released in high numbers from platelet alpha granules following clotting. They are active through specific cell receptors and play a prominent role in wound healing. In addition, releasing of growth factors plays a large role in immune defense and considers the key regulators controlling the ability of regenerated agents. Also, many studies have shown that patients receiving PRF reported less postoperative pain, less need for analgesics, more rapid wound closure, and reduced swelling. All these advantages explain by the clotting that occurs in PRF which traps cells and growth factors capable of regenerating tissue in a natural way. [(12)]

In the present study, regarding bone width, there was a statistically significant difference between the two groups. PRF/ Bone graft showed a significantly higher bone width than Titanium Mesh / Bone graft. Regarding bone height, there was a statistically significant difference between the two groups. PRF/ Bone graft showed a significantly higher bone height than Titanium Mesh / Bone graft. Regarding bone density, there was a statistically significant difference between the two groups. PRF/ Bone graft showed a significantly higher bone density than Titanium Mesh / Bone graft.

Using small pieces of bone with titanium meshes has been a successful way to grow new bone in the jaws where teeth are missing for many years [(13-14)]. Miyamoto et al. [(15)] reported that in 27 cases where both the height and width of the bone were increased, the average increase was 3.7 mm (SD: 2) in width and 5.4 mm (SD: 3.4) in height. The main problem with this method was that the mesh was exposed in 40.7% of the cases, and this led to some, or all of the new bone being lost in 33% of these cases. Briguglio et al. [(13)] did a systematic review and found that the mesh was exposed in 0% to 80% of the cases (average 34.8%), and that the mesh had to be removed early in 22.8% of the cases. Other studies also reported similar results [(14)]. The main challenge of this method seems to be that the mesh can be seen through the gums at different times after the surgery, and this can cause some of the new bone to shrink, as these data show.

Also, cutting, shaping, fitting and fixing these meshes can be difficult.

One of the reasons why using the patient's own bone grafts works well to increase the bone volume in the mouth is that they can induce new bone formation by releasing growth factors. The best source of bone grafts for this purpose is the patient's own bone from different parts of the mouth, such as the lower jaw, the chin, the angle of the jaw, the back of the upper jaw, and the bony bumps in the mouth.(16) Another factor that helps the bone grafts to grow well is the use of PRF, which is a material that helps the blood clot to stay in place and prevents other tissues from filling the space. PRF contains many growth factors, such as transforming growth factor-1, vascular endothelial growth factor, BMP-1, platelet-derived growth factors, and insulin-like growth factors.(17) These growth factors are important for making new blood vessels, and for making the cells that can turn into bone cells grow and change.

The use of titanium mesh for bone augmentation was investigated by Proussaefs et al., (18). They found that the mesh increased the bone height and width in the radiographic and histological analyses. The bone graft resorbed by 15.08% in the first 6 months but stabilized after implant insertion. The mesh exposure did not affect the outcome. Amaral et al., (19) reported on the bone gain from GBR procedures using membranes, bone grafts, and PRF. They used a combination of autogenous and xenogenous grafts and PRF for vertical and horizontal bone augmentation in the upper and lower jaws. They achieved sufficient bone gain for implant placement. Lee et al., (20) evaluated autogenous bone and PRF for alveolar ridge augmentation. They performed the augmentation and implant placement simultaneously. They observed that the technique increased the vertical alveolar ridge height and allowed for adequate osseointegration.

CONCLUSION

Autograft covered by PRF membrane is considered a superior solution for ridge augmentation and preservation which promotes bone healing without any side effects. The PRF membrane obtained from the same patient is better than the 3D model of titanium mesh and cheaper, faster, and easier to prepare.

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