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EFFECT OF MINERALIZED PLASMATIC MATRIX AND TITANIUM GRANULES AS GRAFT MATERIALS FOR IMMEDIATE IMPLANT PLACEMENT

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ABSTRACT

Objectives: This study was conducted to compare and assess the effect of mineralized plasmatic matrix (MPM) versus titanium granules (Tigrans) as bone regenerative materials during immediate implant placement.

Material and Methods: A total of 12 patients with 12 implants have been included in this study, patients were divided into 2 groups. Group I received Mineralized Plasmatic Matrix (MPM), and group II received Titanium granules (Tigran) as bone regenerative materials for immediate implant placement. Clinical and radiographic outcomes of the treatment were assessed at 3 and 6 months of implant placement. As for bone height and bone density, they were both measured radiographically immediate post operatively, at 3 and 6 months postoperatively and statistically analyzed.

Results: Statistical analysis of the two groups bone densities showed a significant increase ($P \leq 0.05$) at 3 months postoperatively (Group I=105.17±18.88. Group II=101.07±10.81), and at 6 months postoperatively (Group I=713.83 ±28.52HU. Group II=658.83±37.16HU) in comparison to the immediate implant placement data (Group I=84.43 ±8.63. Group II=85.48±8.61. Also the bone densities increased significantly ($P \leq 0.05$) from 3 months to 6 months after implant insertion in both groups. Comparing the two groups, no significant difference was present between them at any of the time intervals ($P \geq 0.05$) . Bone height was evaluated immediate postoperatively, at 3 and 6 months after implant placement. Comparing the Mean of bone height between the two groups there was no statistically significant difference ($P \geq 0.05$) between them at any of the time intervals. Regarding the changes in bone height in both group I and group II, there was a statistical significant ($P \leq 0.05$) decrease in changes of bone height at 3 months and 6 months respectively in comparison with the immediate post-operative data.

Conclusion: The use of MPM and Tigran was successful as bone regenerative material for immediate implant placement regarding bone height and bone density.

KEYWORDS: Immediate implant,Titanium granules, Tigran, MPM, bone regeneration, osteointegration, growth factors, and platelet concentrates.

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INTRODUCTION

Dental implants are the best choice to replace a missing tooth. Branemark was the first surgeon who studied the different aspects of implant design, including biological, physiological, mechanical, and functional phenomena relative to endosteal implant success. [1]

For implant placement, a certain quantity of surrounding bone is needed. The degree of bone loss varies between different individuals according to the anatomic area. Within the first 6 months after extraction more than 60% of alveolar bone width and 50% of alveolar bone height could be lost. Immediate implant solves this problem, as it preserve the width and height of alveolar bone, reduce treatment time and enhance esthetics.[2]

However, some complicating factors have been reported, among which are; the socket shape that does not allow the intimate contact between the bone and fixture which can compromise primary stability, presence of residual infection at the extraction site which endangers osseointegration.[3]

Guided bone regeneration is used in implant treatment to promote the esthetic and function in an inadequate bone volume and area where it can increase the height and width of alveolar bone. Attempts for bone regeneration around an implant involve the usage of natural or synthetic graft materials.

One of these synthetic graft materials is porous titanium granules. It acts as an effective scaffold that has osteo-conductive property. It allows good bone integration due to granules structure. Titanium granules was used as a bone substitute material for sinus floor augmentation, contour enhancement of the alveolar process around delayed dental implant, treatment of a large cystic cavity, and in treatment of peri-implantitis.[4,5]

Titanium granules consist of irregular and porous granules of commercially pure titanium. When implanted into a certain defect, the granules theoretically could interlock with each other, creating an uninterrupted structure. The porous properties of titanium granules may lead to in-growth of newly formed bone. [4,5] It is a biocompatible material, easy to handle, has good aesthetic and functional results. It is also non resorbable, therefore would able to maintain the graft volume.[6]

In 2000, Turner et al.[7] used titanium granules in fixation of femoral hip stem and found that the granules maintain stability for 6 months in vivo. In 2007 he evaluated the use of porous titanium granules for cementless fixation of a hip replacement femoral stem. [5]

In 2009, Jonssan et al.[8] evaluated porous titanium granules (Tigran) in a pilot study of four cases of lateral tibial depression fracture to support the elevated articular surface and found that; titanium granules are not resorbed, and can be easily handled during surgery. Moreover Bystedt, [9] in 2009 used titanium granules as a non resorbable augmentation material in sinus floor augmentation and the results were successful.

In 2011 Wahlfahrt et al.[10,11] used titanium granules in surgical treatment of peri-implant osseous defects. They found no adverse effect from titanium granules usage as it can be integrated into human alveolar bone and supports implant osseous defects. Also, researches were done on the use of titanium granules (Tigran) in critical size defect adjacent to titanium implant in rabbit tibia, and in critical size periodontal defect previously made in mini pegs respectively. They demonstrated that; titanium granules are osteoconductive graft material suitable for regeneration of bone in critical size defect. The inherent stability of the granules provide a scaffolding effect strong enough to withstand external forces that can influence wound healing, and thus provides primary wound stability important for a successful treatment outcome. [10]

The Mineralized Plasmatic Matrix (MPM) is an

autologous blood product with high concentrations of fibrin and platelets in a liquid state integrated with a bone graft that can be autogenous, xenogenic, allogenic bone or a bone substitute like synthetic bone. [12] It is a modification of PRF and PRP presented by Perisse [13] followed by El Moheb [14].

The integration of grafts bone particles inside the fibrin network is a major advantage of MPM over the autologous growth factors membranes in PRM or PRF. Actually, the bone grafting materials are mixed with the autologous growth factors for MPM production. This gives the MPM appropriate positional stability [15,16] by stabilizing the bone particles, maintaining its shape inside the defect. Also entrapment of leucocytes and platelets in its fibrin network causes acceleration of tissue healing and minimization of bone loss during healing period and prevent soft tissues ingrowth inside the graft. [17]

Several authors have documented the efficiency of MPM in the implant dentistry field, through improvement of implants osseointegration, stability and minimum bone loss results. [18-22]

This article focuses on comparing the effect of MPM versus Tigran in immediate implant placement in anterior maxillary zone.

PATIENTS AND METHODS

This study was conducted on 12 submerged immediately placed implants for replacement of single root maxillary tooth. A total number of 12 patients (six females and six males) were included in this study. The age ranged from 22 to 50 years old with mean value of 35.5. Patients involved in this study were selected from the Department of Oral and Maxillofacial Surgery, Faculty of Oral and Dental Medicine, Cairo University.

The inclusion criterion was; presence of one or more single rooted hopeless teeth at the upper jaw. The teeth were indicated for extraction as they were diagnosed as un-restorable. The exclusion criteria were ; presence of any local or systemic condition interfering with soft or hard tissue healing, inadequate oral hygiene and severe periodontitis.

Patients Grouping:

Patients were randomly divided into two equal groups:

Group I (six candidates 6 implants): the gap between the implant and the socket wall was grafted with MPM.

Group II (six candidates 6 implants): the gap between the implant and the socket wall was grafted with Tigran.

Study Design:

The study design included two stages:-

Stage I: This stage included extraction of the hopeless tooth simultaneously with immediate implant placement. In addition to the augmentation of the resulting bony defect between socket walls and the placed implant.

Stage II: This stage started six months after stage I. It included delayed loading and fabrication of the final restoration.

Strict oral hygiene measures were advised to each patient before surgery. It include tooth brushing 3times daily followed by Mouth wash containing chlorhexidine hydrochloride (Hexitol, Adco) solution was prescribed t.i.d for 2 weeks post-operative along with analgesic anti-inflammatory drugs (ibuprofen) and Augmentin antibiotic (amoxycillin + clavulanate potassium, GSK) 1gm b.i.d for 5 days.

Stage I:

Surgical technique:

Hopeless teeth were extracted atraumatically with the aid of periotome followed by adequate socket debridement and irrigation. Fig (1)

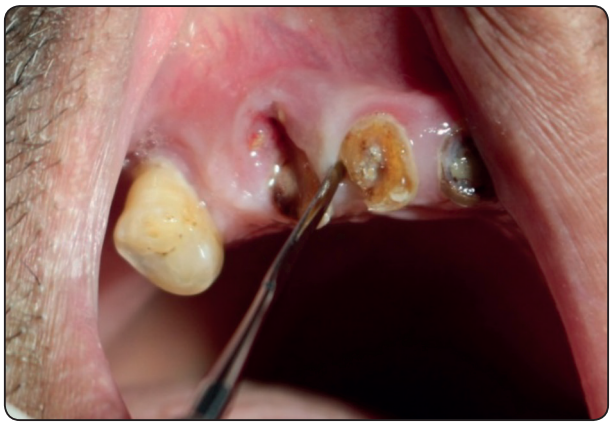

Fig (1): atraumatic extraction of single rooted tooth using periotome.

The osteotomy site was prepared with sequential drilling to receive the equivalent implant size.

Implant System used:

Microdent* dental implant system was used in this study

Preparation of MPM:

MPM preparation was carried out according to Dohan et al [23] protocol. Venous blood was collected from the antecubital vein. The collected sample was transferred into (10ml) sterile test tubes without any anticoagulant. The tubes were placed in a centrifuge machine that was operated to run at 3,000 rpm for 10 minutes. After centrifugation, blood was separated into three distinctive layers: an upper layer of platelet poor plasma, middle layer of platelet rich plasma layer and the bottom layer of red blood cells. The plasma rich layer containing fibrin, plasma leukocytes and mesenchymal cells is collected. Then it was mixed with particulate bone graft (Beta tri calcium phosphate β-TCP) and drop from the patient blood. The mixture was left to set for few minutes for polymerization and formation of sticky bone. Fig (2) MPM mixture was used to fill the gap around the immediate implant. Fig (3) The buccal flap was then advanced and sutured over the implants.

Tigrans granules:

Tigran** granules are pure porous titanium granules (80% air and 20% titanium) with particle diameter ranges between 500-1,000 microns. The granules are non resorbable and maintain their volume. (Fig 4).

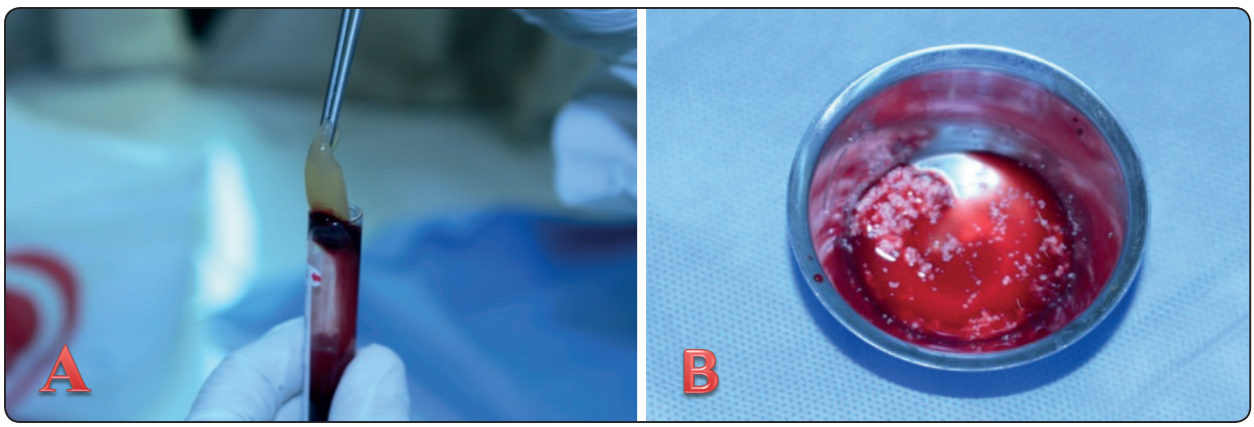

Fig (2): A) Platelet rich fibrin clot ready to be separated from red blood cells coagulum. B) Mixing of platelet rich fibrin layer with particulate bone graft for MPM preparation

*Implant Microdent System, S.L, Barcelona, Spain.
** Tigran technologies AB, Elos Medical AB, P.O, Sweden

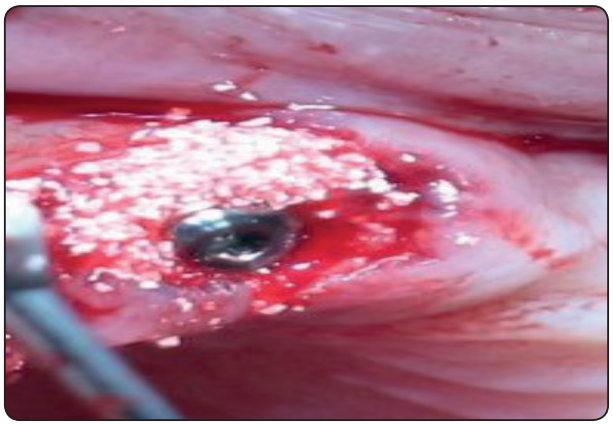

Fig (3): placement of MPM in the extracted tooth socket after implants insertion.

Fig.(5): Insertion of titanium granules (Tigran) around dental implant.

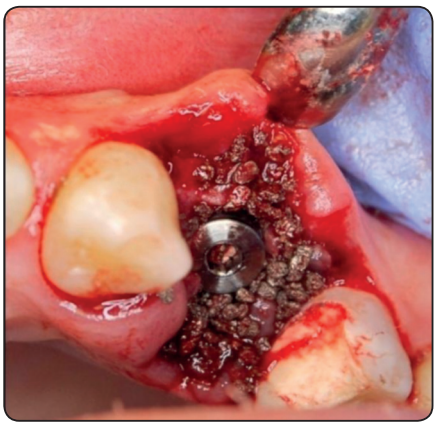

Fig.(4): Titanium granules (Tigran) graft material.

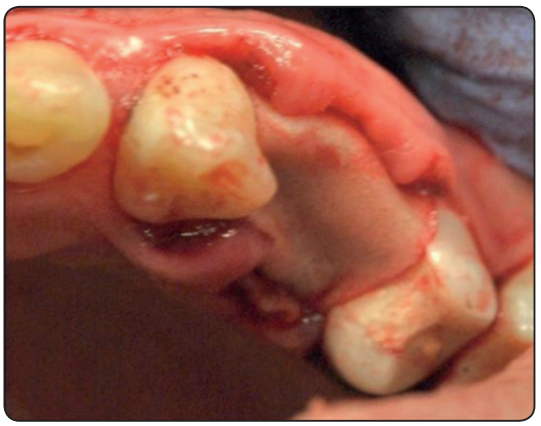

Fig.(6): Collagen membrane placement over the covering screw before suturing.

Titanium granules were mixed with blood collected from the socket of the extracted tooth and physiological saline solution.* The granules were then packed around implant using an amalgam condenser (Fig 5).

Before flap closure, a synthetic collagen membrane** was placed on the top of implant and adapted to the buccal and palatal bone (Fig 6). The flap was then sutured with 3-0 black silk suture material.

Postoperative care:

After surgery patients were instructed to apply cold packs to minimize post-operative edema. Mouth wash containing chlorhexidine solution was prescribed 3 times a day for 2 weeks post- operative along with analgesics, anti-inflammatory drugs and antibiotics. After one week patients are recalled for suture removal.

* Sodium chloride 0.9%, El Nasr pharmaceutical chemicals Co., Egypt.
**Collagen membrane, Bioteck SpA, Italy.

Follow up:

Patients were recalled on weekly bases at the first month then on monthly bases for clinical and radiographic evaluation. The surgical site was inspected to evaluate the soft tissue healing and implant and the surrounding bone was examined radiographically.

Implant stability measurement:

The implant stability was measured at six month visit before implant loading. It was measured using the resonance frequency analysis via the Osstell ISQ system. A transducer (Smartpeg) is connected to the implant to be assessed with the Osstell device to measure the stability. The stability was evaluated on palatal, buccal, mesial and distal side of the implant and the mean values of implant stability quotients ISQs were calculated

Statistical analysis

The collected data were statistically analysed. The significance of the difference between the preoperative and postoperative data regarding bone height and bone density at the same group was assessed using the Student T test (paired and unpaired). The two groups were compared to each other using also the Student T test (paired and unpaired). The statistical analysis was carried out using SPSS ver. 22 software (statistical package for social science on windows 2013). A probability value $p \leq 0.05$.

Radiographic evaluation:

Serial radiographic examination of the implants' sites was made to assess peri-implant bone changes. (Immediate postoperative, 3 month and 6 month) Standardized direct digital periapical radiographs were taken at the baseline and follow-up periods by the Digora system* using a periapical x-ray

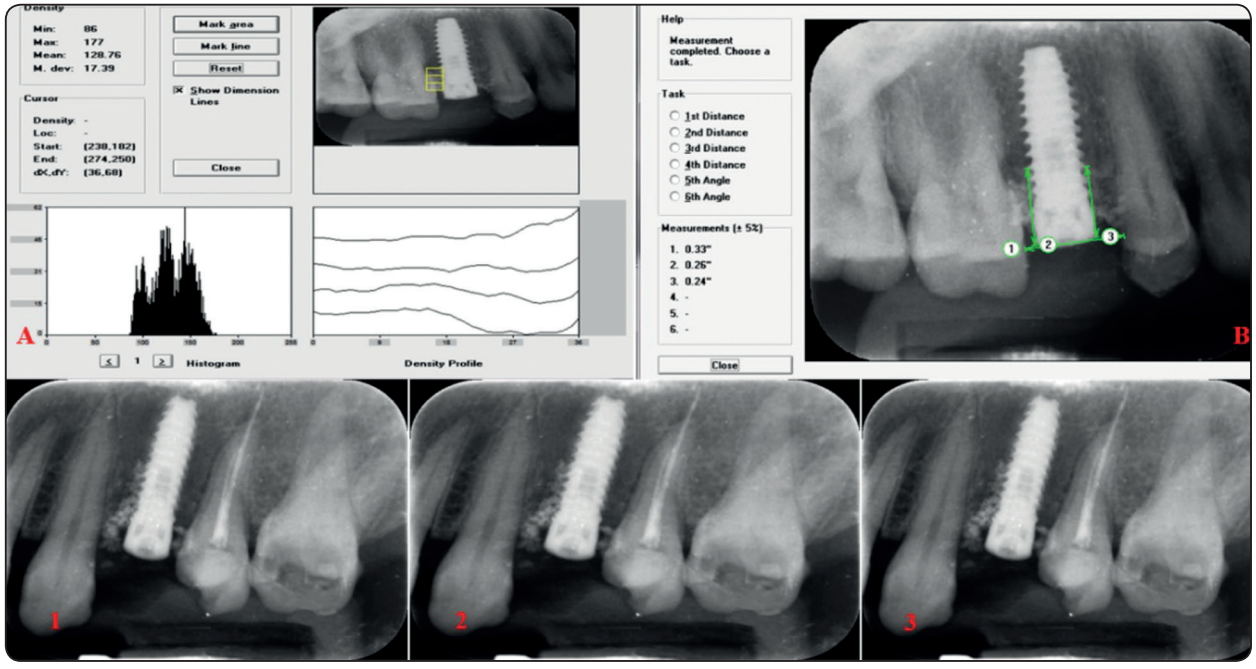

Fig (7) A. Digora software using the area density measurements method. B. Marginal bone height analysis by the Digora software. Periapical x-ray showing 1.Immediate postoperative radiograph. 2.Three months postoperative radiograph. 3.Six months postoperative radiograph.

* Orion Corporation, Soredex, Medical system, Helsinki, Finland.

machine. The machine was set at the same exposure parameters throughout the study period as follows; 70kVp, 7mA and 0.08 exposure time.The standardized long cone paralleling technique was used to perform all images using Rinn XCP film holder which consists of interchangeable plastic bite blocks, a plastic aiming ring and a metallic indicator arm. For standardization and reproducibility of geometric parameters during radiographic exposure, for every patient the specially designed occlusal stent was used. The Digora imaging plate was held parallel to the long axis of the implant using Rim XCP periapical film holder while the acrylic radiographic stent was held in place inside patient's mouth. The plates were then exposed to the pre-set x-ray beam. All plates were scanned using the Digora scanner. Images were then displayed on a monitor and stored on the computer unit for further investigation.

Image Analysis

Images were manipulated using the specially designed software of the Digora system; by this software radiometric and linear measurements were performed. All images were assessed by one observer twice at two different sessions to eliminate any intra-observer variations. The mean of the two trials was calculated and included into further statistical analysis.

The baseline radiographs were then compared to the follow-up radiographs to detect the relative radiographic bone density and bone height changes by time.

- Measurement of bone density changes (densitometric analysis)

As an attempt to assess the bone density changes around each of the studied implants, a rectangular-shaped area was drawn to cover the "Region of Interest" (ROI) which presented the investigated material. The mean density of the ROI was calculated.

- Measurement of marginal bone height changes (linear measurements)

The used software allows measurements be performed to the nearest tenth of a millimeter. In this study, linear measurements were taken from the top of the implant to the first bone to implant contact (mm) along the mesial and distal aspects of each of the studied implants.

RESULTS

Mean Implant Stability Quotients (ISQs) of the MPM group I was 70 ±10HU, while that of the Tigran group II was 69 ±11HU after 6 months of implant placement. No statistical significant difference ($P \geq 0.05$) between implants stability of both groups at this follow up interval. Fig (8)

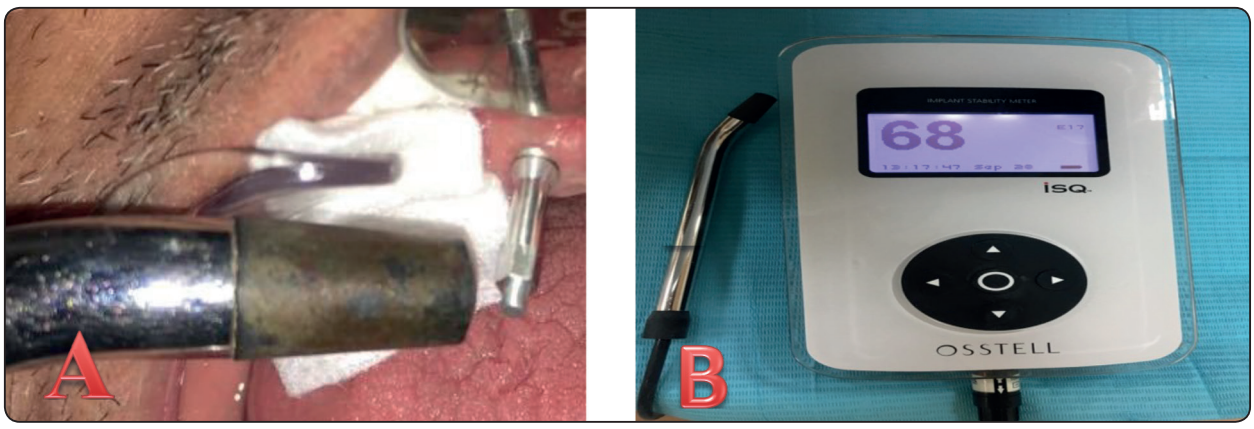

Fig (8): (A,B) ISQ measurement of implant stability using OSSTELL.

Bone Density:

The two groups bone densities showed a significant increase ($P \leq 0.05$) at 3 months postoperatively (Group I=105.17±18.88. Group II=101.07±10.81), and at 6 months postoperatively (Group I=713.83 ±28.52HU.

Group II=658.83±37.16HU) in comparison to the immediate implant placement data (Group I=84.43±8.63. Group II=85.48±8.61). Also the bone densities increased significantly ($P \leq 0.05$) from 3 months to 6 months after implant insertion in both groups..(Table 1,2)

Comparing the two groups, no significant difference was present between them at any of the time intervals ($P \geq 0.05$) . Group I had higher bone density scores than Group II. Fig (9)

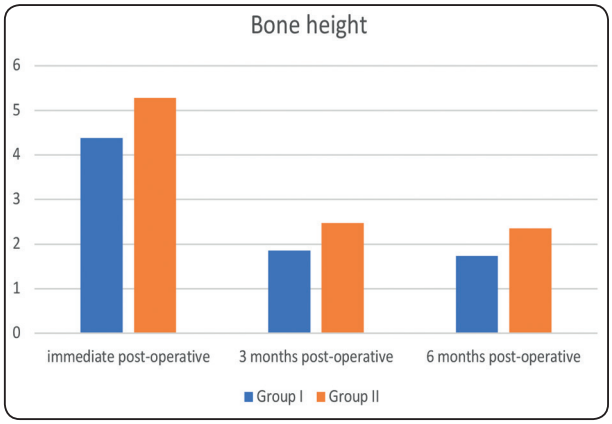

Fig. (9) Line Chart showing the bone density scores of the two groups immediate postoperative, 3, 6 months intervals.

Table (1): Average Bone density of MPM group (group I)

	Immediate post-operative	3 months post-operative	6 months post-operative
Mean ± SD (Min – Max)	84.43 ± 8.63 (74.30 – 99.30)	105.17 ± 18.88 (84 – 133.6)	118.42 ± 16.28 (99 – 142)
Comparison between Immediate post operative and 3month (P value)	0.016		
Comparison between Immediate post operative and 6month (P value)	0.013		
Comparison between 3month and 6month (P value)	0.010		

Table (2): Average Bone density of Tigran group (group II)

	Immediate post-operative	3 months post-operative	6 months post-operative
Mean ± SD (Min – Max)	85.48 ± 8.61 (74.30 = 97.70)	101. 07 ± 10.81 (86.40 – 119.00)	110.70 ± 10.95 (97.20 – 126.00)
Comparison between Immediate post operative and 3month (P value)	0.006		
Comparison between Immediate post operative and 6month (P value)	0.002		
Comparison between 3month and 6month (P value)	0.009		

Bone Height:

Bone height was evaluated immediate postoperatively, at 3 and 6 months after implant placement. Comparing the Mean of bone height between the two groups there was no statistically significant difference ($P \geq 0.05$) between them at any of the time intervals. Regarding the changes in bone height in both group I and group II, there was a statistical significant ($P \leq 0.05$) decrease in changes of bone height at 3 months and 6 months respectively in comparison with the immediate post-operative data. (Table 3,4) Fig (10)

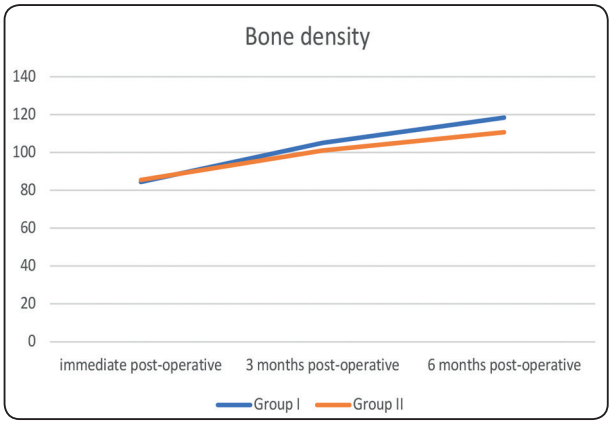

Fig. (10) : Showing a comparison between the mean decreases in Bone height of the two groups at the different follow up intervals. (GI=MPM, GII=Tigran)

TABLE (3): Average Radiographic defect height at deepest site (mm) MPM group (group I)

	Immediate post-operative	3 months post-operative	6 months post-operative
Mean ± SD (Min - Max)	4.38 ± 0.97 (2.90 – 5.60)	1.85 ± 0.60 (0.90 – 2.70)	1.73 ± 0.65 (0.70 – 2.60)
Comparison between Immediate post operative and 3month (P value)	0.004		
Comparison between Immediate post operative and 6month (P value)	0.002		
Comparison between 3m and 6month (P value)	0.010		

Table (4): Average Radiographic defect height at deepest site (mm) Tigran group (group II)

	Immediate post-operative	3 months post-operative	6 months post-operative
Mean ± SD (Min - Max)	5.28 ± 1.32 (3.20 – 6.80)	2.47 ± 0.90 (1.10 – 3.60)	2.35 ± 1.01 (0.70 – 3.50)
Comparison between Immediate and 3 month	0.001		
Comparison between Immediate and 6 month	0.001		
Comparison between 3month and 6 month	0.003		

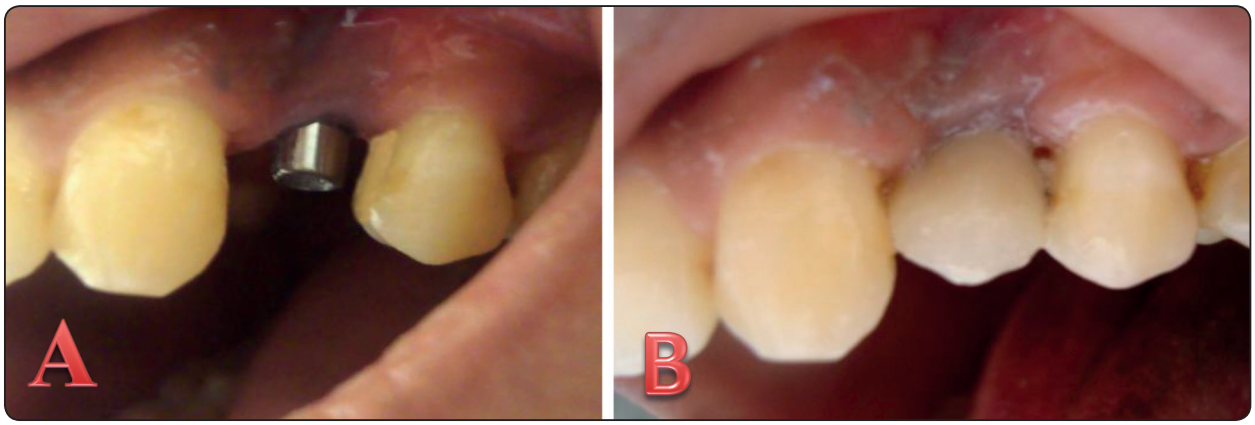

Fig (11): A: Placement of the reduced abutment. B: The final crown restoration.

Stage II:

Six months post implant-fixtures placement, delayed loading and fabrication of the final restoration was performed.

DISCUSION

The present study was designed to evaluate osseointegration around dental implants placed immediately in fresh extraction sockets with the addition of MPM or titanium granules to compensate for any bony wall loss around the implant. Assessment was done clinically and radiographically.

The implant placement method chosen in this study was the one stage surgery which offers many advantages over the two-stage surgery including: reducing the treatment time, decreasing the amount of crestal bone loss and eliminating the risk of second stage implant uncover and this goes with El Askary in 2007.[24]

Herman et al,[25] stated that standardized radiographs are very important in evaluating bone changes around dental implant. In 2011, Corpas et al. [26] found that any minute bone changes during a short time could be assessed and followed by digital intraoral radiograph.

Absence of wound dehiscence or any adverse soft tissue reaction indicated that the titanium granules are a biocompatible material. In agreement with this finding, Steveling et al.[6] 2011 who referred to the biocompatibility and absence of soft tissue adverse reaction to titanium granules when used as a graft material. Regarding the soft tissue dark color around the implant at the site corresponding to titanium granules placement. The dark shadow may be due to the grayish color of graft material and its nature. In contrast with this Bystedt 2009 [9] didn't notice dark discoloration of the soft tissue.

In this study at the Tigran group statistical significant increase in bone density between immediate post operatively, 3 and 6 months follow up period was also reported and this may be attributed to osteo-conductive property of the graft material. In agreement with this findings Steiner et al. 2008[27] who reported a proliferation of cellular, connective tissue elements and islands of new bone with an osteoid seam surrounded by osteoblasts within connective tissue at 6 to 8 weeks. While from 8 to 12 weeks there was a maturation of bone trabecule and increase in bone volume.

Mineralized plasmatic protein achieved the benefits of hard scaffold material, represented in bone graft material and tissue engineering represented in the PRF which is a source of fibrin network. [28,29]

The MPM is a cost effective source of growth factors also it is easy to prepare.it is used as an alternative to block bone procedure. Stability of grafted bone is granted against any motion, so the volume of augmentation is maintained during the healing period therefore the need of block bone is minimized. As for the fibrin networks, it entraps platelets and leucocytes to release growth factors so bone regeneration and soft tissue healing is hurried.[28,29]

In an experimental study conducted by El Moheb et al [30] for comparing between PRF and MPM was done prior to implants placement at sheep heads .They found at the MPM group, since it is a sticky and homogenous mixture. So, once the bone graft or the bone particles were placed on the site, they sticked to the site.

The MPM as a natural and autogenous product, it can offer bone particles stability. In the current study, the mean Implant Stability Quotients (ISQs) of the MPM group I was 70 ±10HU, while that of the Tigran group II was 69 ±11HU after 6 months of implant placement. There was no statistical significant difference ($P \geq 0.05$) between implants stability in both groups at the follow up intervals. Our results concluded that adding tigran or MPM at immediately placed implants favour their stabilities at the follow up intervals.

In the current study, there was a statistical increase ($p \leq 0.05$) in the bone density of the MPM group at the follow up intervals.These finding are in agreement with those of Arafat et al [31] who used MPM in cases of implants accompanied with sinus lift procedure, and also with other clinical studies.[32-34]

CONCLUSION

Based on our findings, we conclude that the MPM and the Tigran granules both have satisfactory results as graft material for immediate implant placement regarding bone height and bone density.

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