

Ethoss versus Mineralized Plasmatic Matrix for Maxillary Lateral Sinus Lifting with Simultaneous Implant Placement

Abdullwahab A. Al Khadher¹, Sally E. Abdelsameaa², Wael M. Ahmed³

Abstract:

Objective: The aim of this study was to compare the effect of Ethoss and Mineralized Plasmatic Matrix (sticky bone) for maxillary lateral sinus lifting with simultaneous implant placement. **Patients and methods:** This study included 20 patients with missed maxillary posterior teeth and they were treated by lateral maxillary sinus lift with Simultaneous Implant Placement. The patients were equally and randomly classified into two equal groups. Group I used Ethoss for bone grafting (n=10) while group II used Mineralized Plasmatic Matrix (MBM) (n=10). All patient was evaluated clinically (the stability of the dental implant, the depth of pocket around the implant, and the gingival bleeding index) while radiographically with CBCT after implant placement (T0), 6 months (T6) and 9 months(T9) after collecting the evaluation data, they were entered and analyzed statistically. **Results:** There was no statistically significant difference between both groups clinically in an interval evaluation period with the Modified sulcus bleeding Index and Peri-implant pocket depth except in Implant Stability Assessment in T9 with group I has high significant difference (P=0.015) when comparing with group II, also was no statistically significant difference between both groups radiologically in bone gain in an interval evaluation period. **Conclusion:** Both Ethoss and MBM can be used for maxillary sinus augmentation, with no difference between them clinically and radiographically, and using Ethoss grafting material is preferable due to the easy handling properties, fast hardening, time-saving and good stability after 9 months.

Introduction:

Variable causes of alveolar ridge atrophy have been reported including periodontal disease, developmental anomalies, and trauma. Bone remodeling involving both internal and external changes begins to affect the residual alveolar ridge immediately following the extraction of teeth.¹ Certain pattern of bone resorption after tooth loss has been shown in alveolar bone. Bone resorption has primary impact on the labial aspect of alveolus in which width reduction occurs first followed by reduction in its height.^{2,3}

When planning implant supported prosthesis in the posterior maxillary region, grafting techniques are often required as a result of poor bone quality and quantity that frequently limit the rehabilitation of fully or partially edentulous patients.^{4,5} to reestablish the bone height of these regions, bone substitutes accompanied with maxillary sinus augmentation has been used as an alternative.⁶

Many studies have described various grafting procedures to enable the placement of endosseous implants in the posterior maxilla after re-establishment of adequate bone volume. The most commonly maxillary sinus floor augmentation technique is a technique introduced by Tatum⁷ and modified by Boyne and James⁸ and by Wood and Moore.⁹ This technique involves the creation of a window in the lateral sinus wall with the use of a small round bur. Then elevation of the sinus membrane is performed with great care to avoid any membrane perforations during the elevation procedure.⁷

The Mineralized Plasmatic Matrix (MPM) is an autologous blood product highly concentrated in platelets and fibrin in a liquid state combined with a bone substitute. Bonding between the fibrin and bone particles could be created. A PRF-type membrane is also created from the filler material, which is easy to form.¹⁰ The simplicity of the PRF protocol is apparent during MPM preparation, however, yields a liquid platelet/fibrin concentrate with high possibility of bounding to bone particles. Also, creation of a dense fibrin network woven around the mineral blocks is revealed by Scanning electron microscopy. As a result, bone grafts can be readily conformed and the surgical site is fortified by the various contained products.¹¹

Ethoss is a novel bone graft made up of 65 percent -TCP and 35 percent CS (35 percent). When CS is added to -TCP, it forms Ethoss, a compound alloplastic biomaterial that hardens in situ and attaches directly to the host bone, helping to retain the space and shape of the grafted site while also acting as a sturdy scaffold.^{12,13} The graft's greater mechanical stability is critical for bone repair and the transformation of mesenchymal cells into osteoblasts.¹⁴ As a result, better regeneration of high-quality hard tissue is possible.^{15,16}

Both CS and -TCP are totally resorbable bone substitutes, resulting in the regeneration of high-quality essential host bone without the existence of graft leftovers for an extended period of time. Depending on the patient's physiology, CS element resorption takes three to six weeks, resulting in vascular porosity in the -TCP scaffold, allowing for improved vascular ingrowth and angiogenesis. Hydrolysis, enzymatic, and phagocytic processes are used to resorb the -TCP element.^{17,18}

To the best of our knowledge, no reports have compared between Ethoss and MBM material in human trial especially as augmented materials after lateral sinus lifting, so the aim of study was to compare the effect of Ethoss and Mineralized Plasmatic Matrix (sticky bone) for

¹Postgraduate MSc student, Department of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University, Mansoura, Egypt. abdullwaha2011@gmail.com

²Associate Professor, Department of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University, Mansoura, Egypt.

³Associate Professor, Department of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University, Mansoura, Egypt.

maxillary lateral sinus lifting with simultaneous implant placement.

Materials and Methods:

This study involved twenty patients who seeking implant-prosthetic rehabilitation of missing maxillary posterior teeth and needed lateral maxillary sinus lift. The patients were selected from the Outpatient Clinic of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University, according to the following: inclusion criteria; missing one or more maxillary posterior teeth, residual bone height (3-5) mm, adequate inter-arch space and co-operative patients, while exclusion criteria; local or systemic diseases that contraindicate implant insertion or surgery, smokers and alcoholism and parafunctional habits such as bruxism and clenching. Written informed consents were taken from all patients. The patients were informed about the benefits, risks, complications and follow up times before treatment. This study was approved by the Ethical Committee of the Faculty of Dentistry, Mansoura University with No. (M02030320).

Methods

The patients were randomly assigned to one of two equal groups:

Group I: lateral sinus lifting augmented by Ethoss with simultaneous implant placement.

Group II: lateral sinus lifting augmented by MPM with simultaneous implant placement.

The surgical protocol:

The sinus lift was performed according to Tatum's instructions⁷. Before local anesthesia, the surgical site was properly swabbed with betadine, then topical anesthesia was applied for 1 to 2 minutes.

A full thickness rectangular mucoperiosteal flap was used to expose the lateral wall of the maxillary sinus.

After flap elevation, the lateral wall of the maxillary sinus was thinned down with DASK (Dentium, South Korea) Drill #4 or #5 at a 45-degree angle until the shadow of the schneiderian membrane could be seen. Depending on the window size required, the DASK Drill #4 or #5 was then gently moved mesio-distally till the required window was established.

A dome-shaped sinus (XSE1L) curette was used to gently separate the membrane from the bony window's edge. Following that, using a series of sinus elevation curettes, the membrane was elevated to separate it from the sinus walls until it reached the appropriate height.

After that, the drilling was done with the implant motor unit and a low-speed-reduction, high-torque coolant contra-angle hand-piece (Implant X-cube, Saeshin America, China). Drilling was done at 600-800rpm in a precise direction. Depending on the implant width, sequential drilling with abundant irrigation was performed until the necessary dimensions were obtained. The implant (NucleOSS®, Turkey) was installed 1 mm below the alveolar crest bone using a coupling wrench with ratchet, then the surgical cover screw was applied into the implant.

For group I: The space created by sinus lifting was filled with Ethoss bone grafting material (Figure 1A), which was delivered in a sterile syringe ready to be mixed with sterile saline. Once the Ethoss was mixed, it was quickly applied to the graft site and positioned as needed. Sterile gauze was then placed over the material for 3-5 minutes until it began to harden and show resistance to pressure.

For group II: the space created by sinus lifting was filled with MBM. (Figure 2A)

MBM preparation: The MPM was prepared using two tubes filled with 9 mL of the patient's blood. The venous blood was centrifuged for eight minutes at 2700 RPM to separate the red blood cells from the platelets. After centrifugation, the outcome was two layers: a yellow plasma liquid on top of the tube separated from the red blood cells at the bottom. A syringe was used to collect the yellow component, which was then placed in a cup containing the Onexeno bone grafting material. To obtain MBM, the entire mixture was mixed for a few seconds.

For both groups: primary stability was recorded for all fixtures using osstell ISQ (Integrate Diagnostic AB, Gothenburg, Sweden), no membrane was used and finally the flap was sutured in its position, using 4/0 polypropylene, interrupted sutures.

Clinical follow-up

Sutures were removed after 2 weeks, healing was assessed, and any symptoms of infection or dehiscence were detected. The patient were evaluated at immediately after fixture installation (T0), at 6 months (T6) and at 9 months (T9) post surgically for clinical and radiographic evaluation.

Second stage surgery

Local anaesthetic was performed after 6 months, and the cover screw was exposed through a minor crestal incision, stability was recorded for all fixtures using osstell ISQ and placed of healing abutment for 10-14 days.

Prosthetic phase

The healing abutment was replaced by the functional abutment, and the impression was taken with the help of an impression post and a laboratory analogue before fabricating the working cast. The final porcelain fused to metal crown restoration was temporary cemented for 3 months.

Clinical Evaluation

Implant Stability Assessment: the ISQ levels measured by the ostell ISQ instrument were used to assess implant stability in all patients¹⁹, at T0, T6, and T9.

Modified sulcus bleeding Index (mBI): 20 clinical signs and symptoms of inflammation of peri-implant mucosa were evaluated at T6 and T9 at 4 sites around each implant (buccally, mesially, distally and palatally).

Peri-implant pocket depth: at T6 and T9, the pocket depth was measured at four locations around each implant (mesial, buccal, distal, and palatal). The measurements were taken to the nearest 0.5mm accuracy.

Radiographic Evaluation

CBCT was taken for each patient at preoperative surgery (Figure 1&2 B), T0 (Figure 1&2 C), T6 and T9 (Figure 1&2 D).

Residual bone height: the residual bone height (RBH) of the alveolar ridge was measured at preoperative surgery as the distance from the alveolar crest to the floor of the maxillary sinus at the intended implant placement site.

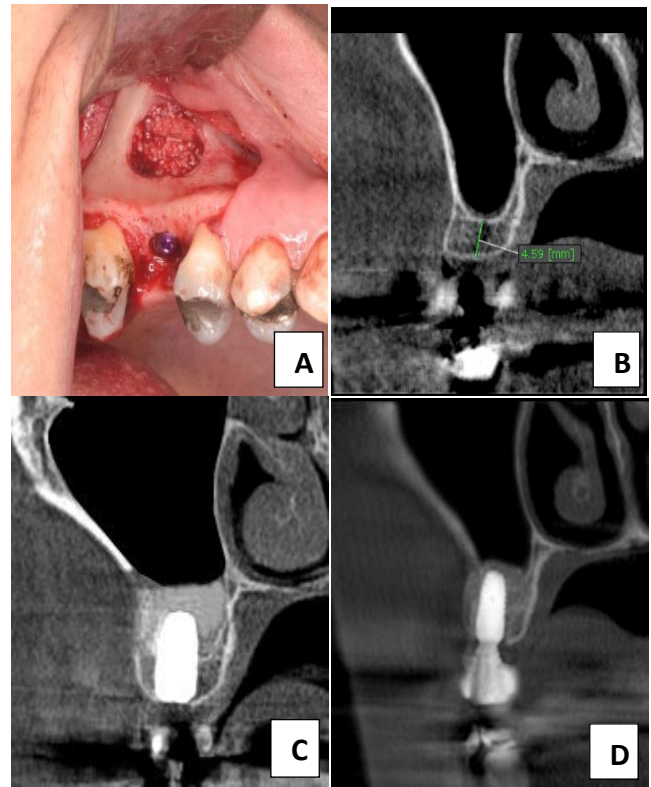
Implant protrusion length: implant protrusion length (IPL) inside the maxillary sinus was measured as the distance from the sinus floor to the implant apex at T0.

Apical bone height: the Apical bone height (APH) represented the bone above the implant and was measured. It was calculated as the distance from apical implant apex level to the most apical level of radiopaque area at T0, T6 and T9.

The bone gain: the bone gain resulted from sum of IPL at T0 plus APH at T0, T6 or T9. (Bone gain = IPL + APH)

Statistical Analysis

Data were fed to the computer and analyzed using IBM SPSS Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. Qualitative data were described using number and percent. Quantitative data were described using median (minimum and maximum) and mean, standard deviation for parametric data after testing normality using Shapiro-Wilk test. Significance of the obtained results was judged at the (0.05) level.



MBM Case:
45 years old female patient (right first molar).

Figure 2: A photograph showing MBM and implant in place after placement of cover screw (A). Cross sectional view showing amount of vertical height (B). Immediate postoperative CBCT (cross-sectional view) (C). Cross-sectional view of implant after porcelain fused to metal crown insertion at T9 (D).

Results:

A total of twenty patients received 24 dental implant were included in the study for replacement of teeth in posterior maxilla placed simultaneous with lateral maxillary sinus floor elevation with Ethoss (Group I) or with MBM (Group II)

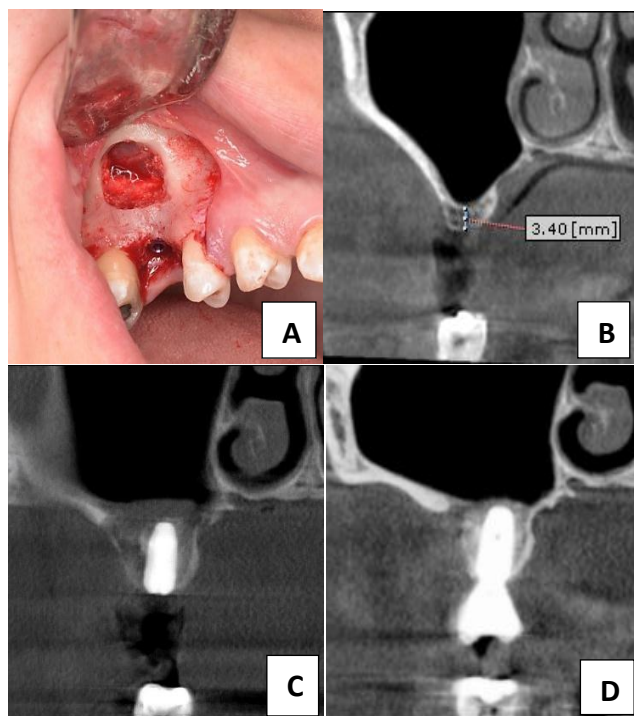
Clinical assessment

□ Implant stability assessment (chart 1):

- In group I: implant stability increased from 67.75 at (T0) to 73.75 at (T6) and then to 76.90 at T9 with the highest percent of change is detected between T0 and T9 (13.5%) followed by percent of change from baseline to after 6 months (8.9%) and the least was detected between at 6 and 9 months (4.3%).
- In group II: implant stability increased from 66.8 at T0 to 70.55 at T6 and then to 73 at T9 with the highest percent of change was detected between T0 and T6 (5.6%) followed by percent of change from T6 and T9 (3.5%) and the least was detected between at T0 and T9 (0.29%).
- There was no statistically significant difference between group I and group II at T0 and T6 while there was a statistically significant higher mean implant stability at T9 among group I than group II (P=0.015).

□ Modified sulcus bleeding index (mBI):

- In group I: between 6 months after prosthesis and follow up at 9 months and illustrates non statistically significant change of bleeding index.



Ethoss Case:
35 years old female patient (right first molar).

Figure1: A photograph showing Ethoss and implant in place after placement of cover screw (A). Cross sectional view showing amount of vertical height (B). Immediate postoperative CBCT (cross-sectional view) (C). Cross-sectional view of implant after porcelain fused to metal crown insertion at T9 (D).



- In group II: between 6 months after prosthesis and follow up at 9 months and illustrates non statistically significant change of bleeding index.

- There was no statistically significant difference between both groups at T6 & T9 as regarding modified bleeding index (P>0.05)

□ **Peri-implant probing depth:**

- In group I: between 6 months after prosthesis and follow up at 9 months and illustrates non statistically significant change of peri-implant probing depth.

- In group II: between 6 months after prosthesis and follow up at 9 months and illustrates non statistically significant change of peri-implant probing depth.

- There was no statistically significant difference between both groups at T6 & T9 as regarding peri-implant probing depth (P>0.05).

Radiographic assessment

• **Bone height gain (IPL + ABH) (Table 1):**

- In group I: bone height gain decreased from 8.98 at T0 to 8.09 at T6 and then to 7.6 at T9 with the highest percent of change was detected between T0 and T9 (15.5%) followed by percent of change from T0 to T6 (9.9%) and the least was detected between at T6 and T9 (6.1%).

- In group II; bone height gain decreased from 9.54 at T0 to 8.41 at T6 and then to 7.84 at T9 with the highest percent of change was detected between T0 and T9 (17.8%) followed by percent of change from T0 and T6 (11.8%) and the least was detected between at T6 and T9 (6.8 %).

- Between both groups: there was a non- statistically significant difference of mean bone height gain at T0, T6 and T9 between groups I and II (p>0.05).

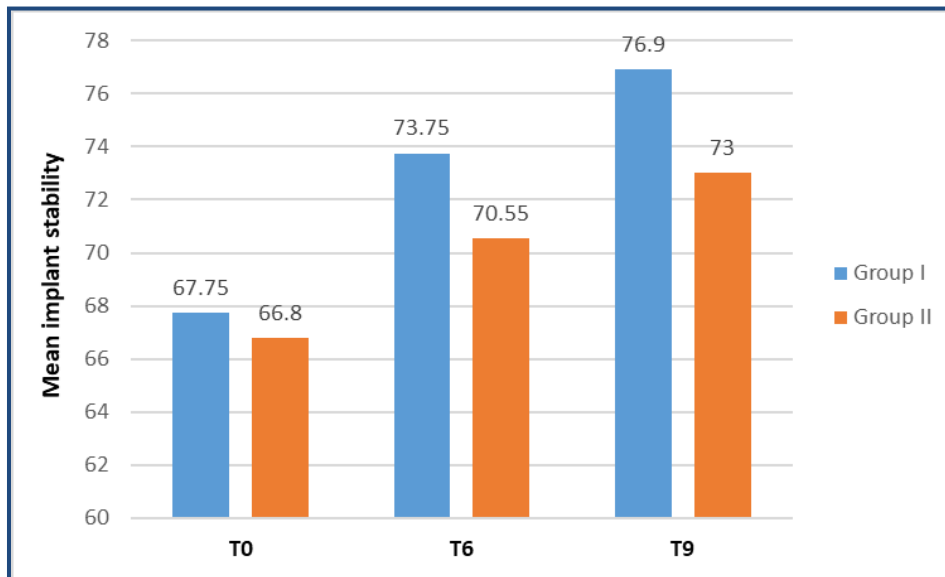


Chart (1) showing: implant stability assessment

Table (1): Comparison of Bone height gain between studied groups.

Bone height gain (IPL+ABH)	Group I ETHOSS n=10	Group II MBM n=10	test of significance
T0	8.98±1.21	9.54±1.46	t=0.913 p=0.373
T6	8.09±0.70	8.41±1.22	t=0.722 p=0.480
T9	7.60±0.70	7.84±1.10	t=0.576 p=0.572
Paired t test	P1=0.001* P2<0.001* P3<0.001*	P1=0.001* P2<0.001* P3<0.001*	
mean difference ± SD			
D1	0.897±0.628	1.123±0.68	
D2	1.39±0.603	1.698±0.75	
D3	0.491±0.155	0.575±0.197	
%1	9.9%	11.8%	
%2	15.5%	17.8%	
%3	6.1%	6.8%	

T0 at baseline or immediate, T6 at 6 month, T9 at 9 month, P1, %1,

D1: difference between T0 & T6, P2, %2, D2: difference between T0&T9, P3, %3, D3: difference between T6&9

Discussion:

The present study designed to compare between Ethoss and MBM in vertical ridge augmentation with dental implant placement. Ethoss is a synthetic fully resorbable grafting material consisting of β -TCP (65 %) and CS (35 %) and is in order to preserve the alveolar ridge and enhance the regeneration of bone, as shown in preclinical and clinical studies published by the authors.²¹

Ethoss bone graft is pyrogen-free and bacteriostatic, forming a nano porosity cell-occlusive membrane that inhibits undesirable soft tissue cells from invading at an early stage, eliminating the requirement for a barrier membrane.²²

MPM is an autologous blood product highly concentrated with platelets and fibrin mixed with the mineral phase of bone graft forming a homogeneous single component, which is compact and stable, containing the graft, the dense fibrin network where the fibrin can become bound to bone particles, and the growth factors promoting healing. This procedure allows linking all the particulates together in one product. During manipulation, the retention in the fibrin mesh of the bone fragments or the grafting material conserves its cohesion and avoids its departure away from the recipient bed which may contribute to the increased bone volume gained and allow us to avoid the use of membranes.^{23,24}

Regarding implant stability, this study reported that there was no significant difference between the two groups. In group I and II, ISQ increased along the evaluation intervals which is in agreement with P Fairbairn et al.²⁵ This is may be attributed to two factors, the increased degree of osseointegration of the implant and increased maturation of the surrounding bone.

In our study, there was a statistically significant higher mean implant stability at T9 among group I than group II ($P=0.015$). This was explained by Ozyuvaci et al,²⁶ along with other authors,^{27,28} that Ethoss can be reabsorbed and replaced by bone within a short interval of time like six months. The CS element will resorb over a three-to-six-week period, thus creating a vascular porosity in the β -TCP scaffold for improved vascular ingrowth and angiogenesis.²⁹ Xenograft reported that a healing period of more than 8 months seemed not to improve xenograft substantially.³⁰

The resorption rate and the ability of a given grafting material to assist bone reconstruction seem to affect the bone healing mechanism and the geometry of the newly-formed tissue. Such differences might affect the overall quality of the newly-formed bone.³¹

In our study, there was a non- statistically significant difference of mean bone height gain at T0, T6 and T9 between groups I and II ($p>0.05$). Ethoss is hardens in situ when mixed with sterile saline and bind directly to the host bone, helping maintain the space and shape of the grafted site, and act as a stable scaffold.^{25,32} The improved mechanical stability of the graft is a crucial factor for bone healing and differentiation of mesenchymal cells to osteoblasts. Thus contributing to enhanced regeneration of high quality hard tissue.³³

Agreement with this study by P Fairbairn and M Leventis,³⁴ the periosteum, which contains multipotent mesenchymal stem cells capable of converting into bone and cartilage and offers a source of blood vessels and growth factors, plays a significant role in bone transplant integration, healing, and remodelling, according to the study.

MPM is an evolution of PRP which is an autologous modification of fibrin glue and is used to deliver the growth factors in high concentration to the bone site. These growth factors (PDGF and TGF- β) accelerate post-surgical healing, bone augmentation, and improve soft tissue texture. One of the highest concentrations of PDGF and TGF- β in in the body is found within the blood platelets. This advantage may allow MPM obtained from allogenic bone or xenograft to obtain osteoinductive properties of autogenous bone and save future patients from donor site complications.³⁵

To the best of our knowledge, Ethoss bone graft application is easier than MBM because the Ethoss grafting material's CS component hardens in minutes when mixed with sterile saline and binds directly with the host site, resulting in a more stable and pressure resistant mixture that maintains the space and shape of the grafted site.^{22,36}

The limitation of our study was needed to larger sample sizes should be used to confirm study results and histological evaluation of the formed bone to prove that it is fully formed and free of defects.

Conclusion:

1. Both Ethoss and MBM can be used for maxillary sinus augmentation, with no difference between them clinically and radiographically.
2. Using Ethoss grafting material is more preferable due to the easy handling properties, fast hardening, time saving and good stability after 9 months.

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