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Computer Guided Versus Conventional Maxillary Sinus Augmentation Using Allogenic Bone Blocks with Simultaneous Implant Placement in Severely Pneumatized Sinuses

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ABSTRACT

Background: Maxillary sinus lifting is a complex procedure with reported complications in the literature where the presence of sinus septa further complicates the procedure, they including membrane perforation, bleeding. Aim: The aim of this study is to decrease the incidence of membrane perforation which is the most common reported complication, and to determine whether the use of surgical guides could decrease the incidence of membrane perforation. Materials and methods: A total of 12 cases where blindly divided into 2 groups; Group (A) computer guided maxillary sinus lifting and Group (B) conventional sinus lifting, both groups received allogenic bone blocks for sinus augmentation with simultaneous implant placement. Cone beam CT was performed pre operatively for planning the number and position of implants to be placed and for fabrication of the surgical guide. Results: In all cases the Schneiderian membrane was successfully elevated except for one case in Group (A) where membrane perforation occurred and 2 cases in Group (B) Conclusion: The use of surgical guide in sinus lifting procedures decreases the incidence of membrane perforation working time and improve implant positioning.

1. INTRODUCTION

Maxillary sinus floor elevation was first described by Boyne[(1)] in 1980 utilizing lateral window approach to access the sinus cavity and elevate the Schneiderian membrane creating a space for placement of grafting material. The Consensus Conference on Maxillary Sinus Elevation in 1996[(2)] placed recommendations for different degrees of pneumatization regarding grafting and implant placement which entails that in case of category D cases with 1-3 mm of residual alveolar ridge (RBH) grafting and delayed implant placement after 6 months is recommended.

The most common complication that was encountered during sinus lifting procedures is but not limited to perforation during opening the lateral window or during manipulation of membrane with sinus elevators, bleeding, and presence of sinus septa which further complicates the dissection of the Schneiderian membrane.[(3)(4)(5)]

Schneiderian membrane perforation was classified by Valassis and Fugazzotto[(4)] into 5 classes according to the location of the perforation into (Figure 1):

Class I: perforation is adjacent to the osteotomy site

Class II: perforation is located in the mid superior aspect of the osteotomy

Class III : A class III perforation is located at the inferior border of the osteotomy

Class IV : A class IV perforation is located in the central two thirds of the inferior border of the osteotomy site

Class V : A class V perforation is a preexisting area of exposure of the sinus membrane.

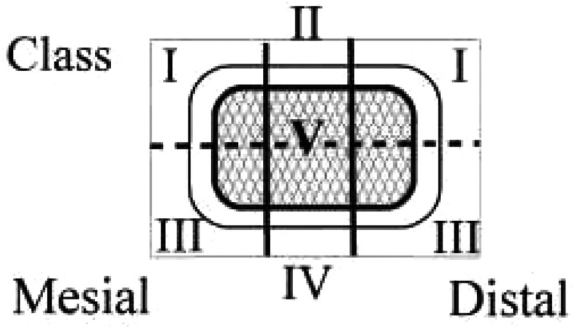

Figure (1) — Classification of Schneiderian membrane perforation according to Valassis and Fugazzotto[(5)]

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Computer guided antral wall elevation was first introduced by Manderales and Rosenfeld[6] in 2008. They proposed the use of CAD/CAM surgical stent to greatly enhance the quality and the results of sinus floor elevation technique especially on the incidence of Schneiderian membrane perforations.[7]

The purpose of this study was to determine the accuracy of computer guided sinus lifting in aiding in reduction of incidence of membrane perforation against the conventional means.

2. MATERIAL AND METHODS

The current study was approved by the research ethics committee of the Future University and conducted on patients selected from the outpatient clinic of the oral and maxillofacial surgery department, Future University in Egypt.

A total of 12 patients with total 14 sinuses where the remaining alveolar bone is less than 3mm where blindly divided into 2 groups; Group (A) sinus elevation and augmentation with simultaneous implant placement were performed using computer guided surgical stent and Group (B) sinus elevation and augmentation with implant placement were performed using the conventional sinus lifting technique without surgical guide. C.B.C.T was performed pre operatively to determine the amount of remaining alveolar bone of severely pneumatized sinuses and the number and angulation of the placed implants. the C.B.C.T used for fabrication of the surgical guide (Figure 2)

Inclusion criteria; all patients included in this study had a residual alveolar bone height ranging from 1 to 3 mm. The patients were medically free and had no systemic illness or under any medication that could impair or interfere with osteogenesis of the augmented bone.

Exclusion criteria; patients suffering from active systemic disease, have a pathosis in maxillary posterior region, or patients treated with irradiation in head and neck region or with bisphosphonate medication.

Surgical guides were fabricated using CBCT scan and conventional impression of the maxillary arch. The cast was then scanned with optical scanner (open technique) which was imported to software (3 diagnosys v 4.2, 3 Diemme, Italy) and the guide was 3D printed (form labs, USA)

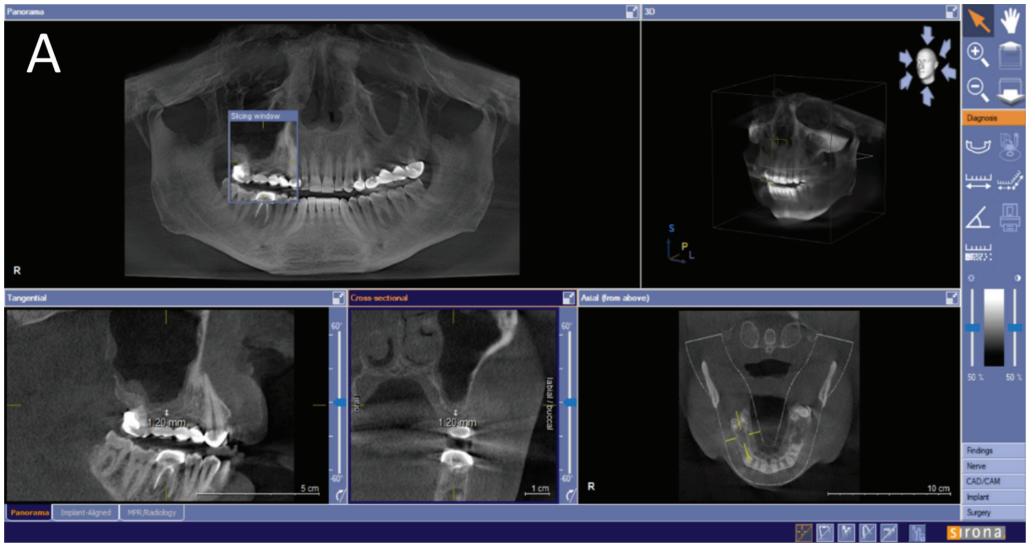

Figure (2A) — Preoperative CBCT of Group A

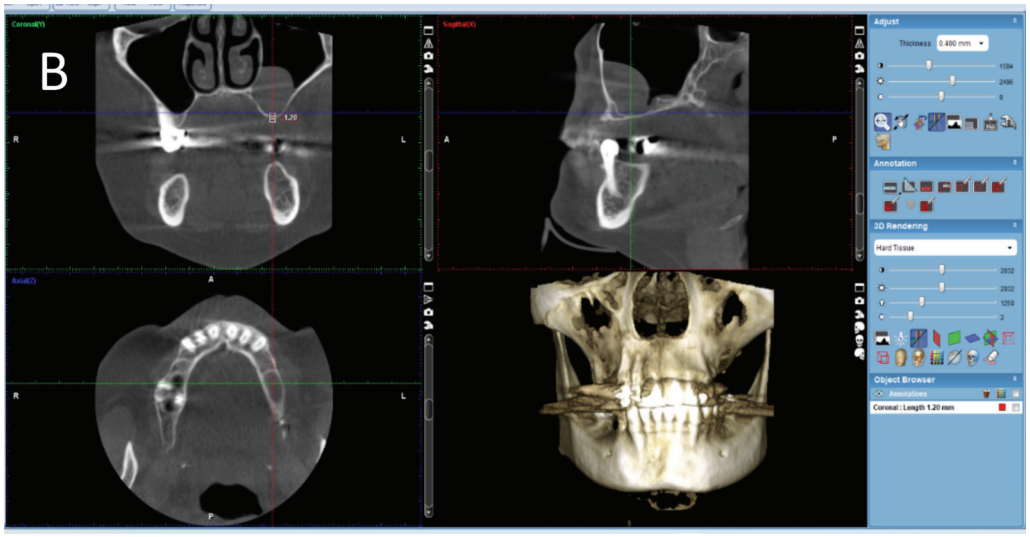

Figure (2B) — Preoperative CBCT of Group B

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All patients underwent surgery under local anesthesia (LA) except those receiving bilateral sinus lift procedures, who were admitted to operation theater to undergo general anesthesia (GA). The whole procedure was done under full aseptic atraumatic technique, in which the patients rinsed with chlorohexidine 0.125%, skin was disinfected with povidone-iodine (Betadine). Patients undergoing surgery under LA received topical anesthesia at the vestibular and palatal desired sites of injection. Local anesthetic solution in the form articaine HCL 4% with epinephrine 1/100,000 as a vasoconstrictor (Artinibsa 4%; Inibsa, Barcelona, Spain) was injected for hemostatic purposes utilizing the infiltration technique in multiple sites from the canine region to the molar region buccally and palataly.

After conforming the subjective and objective signs and symptoms of anesthesia, crestal incision was performed by Bard-Parker blade #15 extending from the most posterior region to the most posterior tooth. An oblique curvilinear incision was performed in the form of c-shaped incision to allow maximum reflection of the flap. A mucoperiosteal elevator was used to elevate a full thickness mucoperiosteal flap exposing the lateral bony wall covering the maxillary sinus. The palatal mucoperiosteal flap was also resealed to avoid tension from retraction on soft tissue.

In Group (A) the surgical guide was then positioned in place to mark the preplanned position of the bony window of the sinus and the proper position and angulation of the pre-planned implants. (Figures 3A, 3B, 3C).

Figure (3A) — Two-line incisions along the crest or the ridge and another oblique Cshape incision on the buccal aspect of the maxilla

Figure (3B) — Reflection of palatal mucoperiosteal flap;

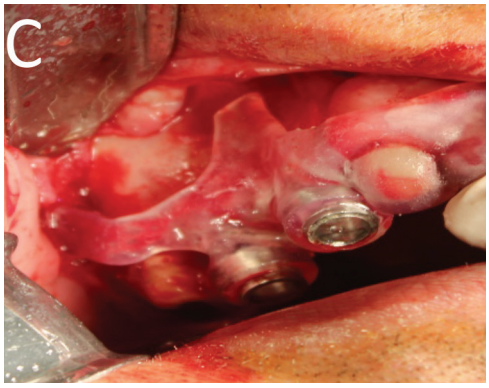

Figure (3C) — Surgical guide seated in place

The sinus cavity was then accessed by means of a bony window performed in the lateral wall using a round diamond stone (Meisinger, Hager & Meisinger GmbH, Germany) mounted on a 1:1 straight surgical hand piece with 25,000 rpm until the shadow of the of the Schneiderian membrane was visible and slight movement was seen while applying minimal pressure on the bone window. (Figure 4).

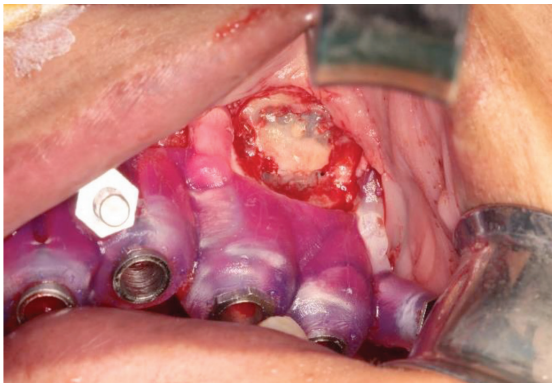

Figure (4) — Surgical Guide in place, and lateral window cut using surgical diamond bur

Careful elevation of the Schneiderian membrane was carried out using open sinus lift elevators, and the bony trap door elevated within the maxillary sinus. (Figure 5).

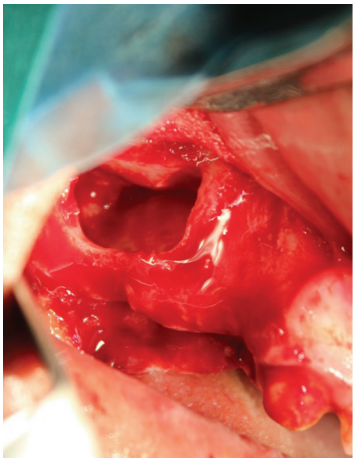

Figure (5) — Elevation of the membrane after removal of the guide in group A

In Group (B), a bony window was prepared conventionally without using a surgical guide , the bony window was predetermined using CBCT according to the dimensions of the allogenic bone block, the inferior cut was planned to be 2-3mm above the sinus floor (Figure 6A and 6B)

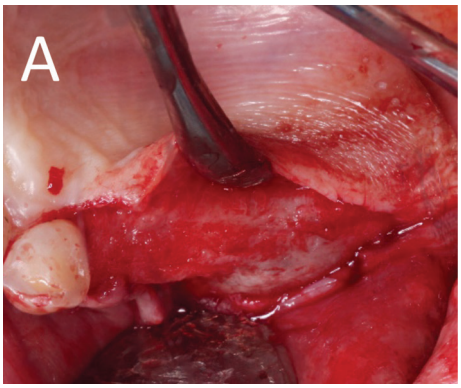

Figure (6A) — Group (B) flap reflection

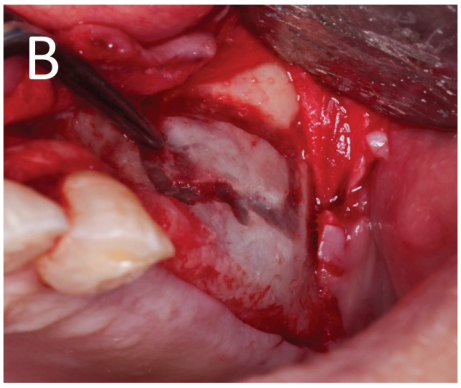

Figure (6B) — Group (B) window preparation

In both groups unicortical allogenic bone blocks were used, they had the following dimensions (0.9 x 1.2 x 0.8cm) (Maxxeus Dental, USA). (Figure 7).

The blocks were first seated with in the maxillary sinus below the elevated Schneiderian membrane with the trap door elevated to present the new floor of the sinus cavity. Excess size of the block protruding outside the sinus and sharp edges were carefully trimmed.

Figure (7) — The Maxxeus allogenic bone block used in the Study group

Sequential implant drilling was then commenced using the implant system kit (B&B, Bologna, Italy) to the preplanned implant length and width using 800RPM and torque 10Ncm with copious irrigation and implant is placed. (Figure 8A, 8B and 8C)

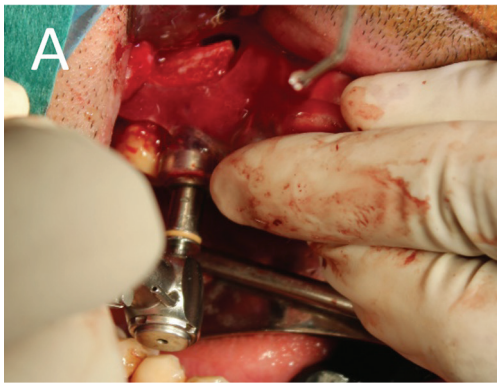

Figure (8A) — Sequential implant drilling Group A

Figure (8B) — Sequential implant drilling Group B

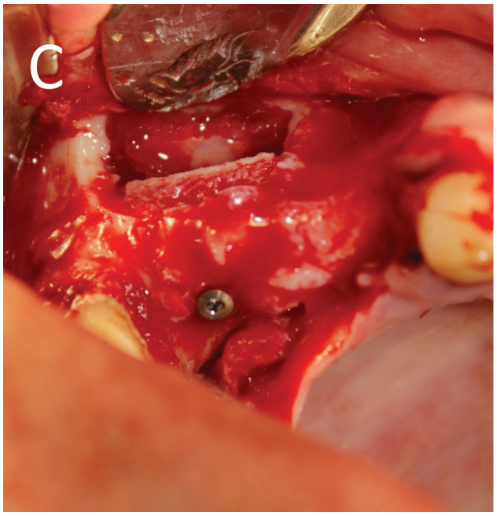

Figure (8C) — Implant in place

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3. RESULTS

Total of 12 cases with a total of 14 sinuses were blindly divided into to groups, Group A utilizing computer guided sinus elevation and Group B utilizing conventional method. In all cases the Schneiderian membrane was successfully elevated except for one case in Group (A)where membrane perforation occurred and 2 cases in Group (B) with a total percentage of 14% in Group (A) and 28% in Group (B). (Figure 9)

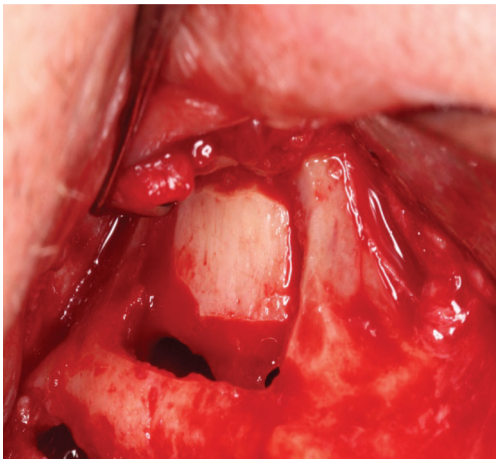

Figure (9) — Schneiderian membrane perforation

One case of group A and one in group B where minor perforation occurred it was not addressed and the procedure was continued normally, the other perforation that occurred in group B was large and had a PRF synthesized and placed as a resorbable autogenous membrane.(Figure 10)

The guided group utilizing the surgical guide shows high adaptation of the guide for both sinus osteotomy and implant placement in addition to application of the allogenic bone blocks and the conventional one without the guide the osteotomies were done 2 or 3mm higher than the sinus floor and application of the bone blocks after the membrane elevation with simultaneous implant placement .

In both groups the patients have uneventful healing despite the occurrence of membrane perforation, another CBCT was performed 4 month post operatively prior to loading of the implant. (Figure 11)

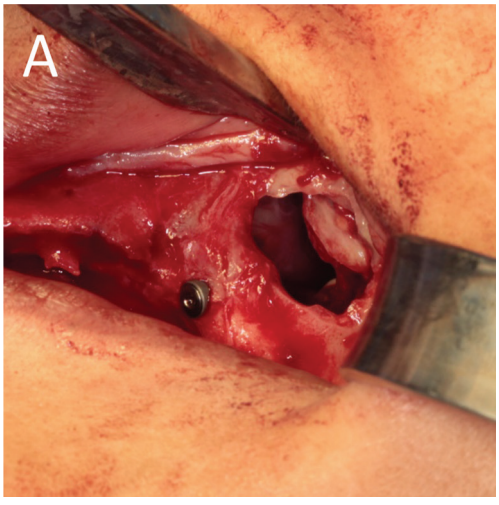

Figure (10A) — Large perforation occurred during elevation of the Schneiderian membrane,

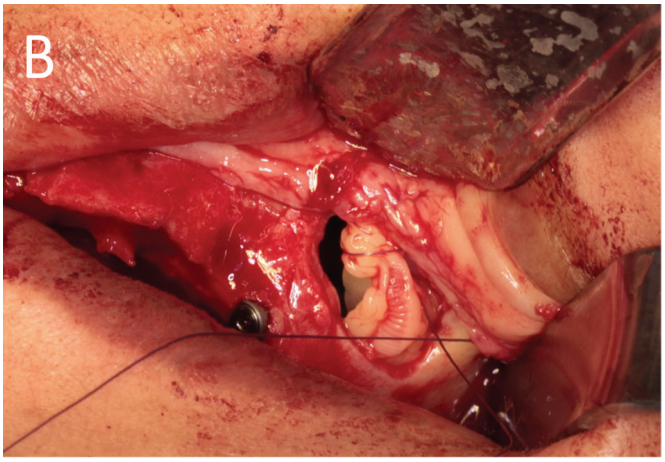

Figure (10B) — Management of the perforation using PRF as an autogenous membrane.

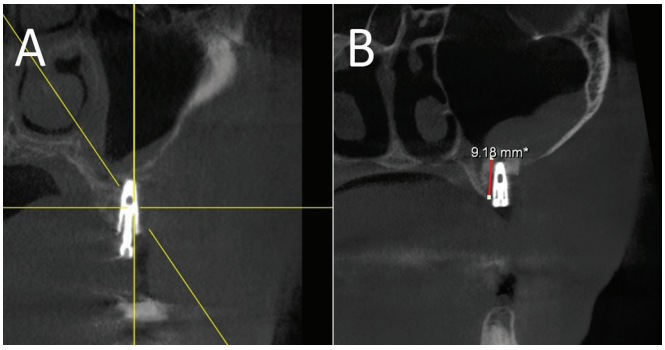

Figure (11) — CBCT 4 month post operative
A: Group A
B: Group B

4. DISCUSSION

In severely pneumatized sinus the process of sinus lift and sinus augmentation is a complex procedure which requires proper planning and meticulous application of the surgical procedure.

One of the most reported complication of sinus floor elevation is perforation of the Schneiderian membrane attributed to the complex anatomy of the maxillary sinus which could be misleading to the surgeon in identification of the proper position of the lateral window.[8][9] likewise lack of experience and reduced tactile sensitivity may increase the risk of accidental membrane perforation.[10]

Cone beam CT (CBCT) can provide accurate identification of the sinus anatomy, presence of sinus septa, thickness of the lateral sinus wall, accurate dimensions of the residual alveolar ridge height, but transferring this information during surgical procedure is difficult and time consuming. With aid of CBCT and 3D printers this information can be transferred to the patient mouth by the aid of a surgical guide fabricated according to the patient anatomy.[11]

In previous studies the surgical guide was fabricated after importing the scanned cast and radiographic image into 3d surgical planning software

(Mimics or simplant) which is then milled using computer aided design (CAD) computer aided manufacture (CAM) with only demarcation of the initial drilling position of the implants. The role of the guide in these studies shows decreased incidence of membrane perforation and reduction of time of operative procedure [7][9]

In this study the computer guides was fabricated using CBCT and cast produced from the patients impression which is scanned using an oral scanner which is imported to planning software (3 diagnosis- Italy) and 3d printed (form labs – USA). This fabricated guides used to demarcate the accurate position inferior, mesial, and distal osteotomies, as for the superior osteotomy is determined according to the height of the allogenic bone block used (Maxxess- Italy) and allow determination of position, angulation and sequential drilling for the implants to be placed in a prosthetically driven manner.

Proper stabilization of the surgical guide is crucial for accuracy of the osteotomy and implant drilling to reduce difficulties encountered in the prosthetic phase.

In this study the use of computer guides reduces the incidence of membrane perforation where only one case (14%) in Group (A) compared to 2 cases (28%) in Group (B), this can be explained by accurate allocation of the inferior cut which is the most common site of membrane perforation avoiding too high or too low osteotomy.[4]

Schneiderian membrane perforation if occurred it should be managed either with a collagen membrane or a lamellar bone sheet if large, or it will heal spontaneously if it is located in an area where the elevated mucosa is folded together. [4][5] [12]

This is because if the sinus cavity is augmented without addressing the membrane perforation the graft material will protrude inside the sinus cavity causing foreign body reaction and graft rejection specially when the graft is in a granular form.[12]

The membrane perforations that occurred in this study was not addressed except for the one that was too large in size, this is due to the augmented material that was used was in the form of a blocks that was fixed to the residual alveolar ridge by the implant and hence it will not be displaced as what occurs in case of the use of granules form.[13]

5. CONCLUSION

Within the limitation of current study using prefabricated patient specific surgical guide improves the surgical procedure tailored for each case and reduces the incidence of membrane perforation.

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