Masterclass in Clinical Practice

Implant Dentistry

with

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Lateral window Sinus Floor Elevation technique

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Introduction

Insufficient bone below the maxillary sinuses in the posterior maxilla is a common finding in dental implant treatment. Reasons for loss of available bone in the posterior maxilla can be from traumatic extractions, pneumatisized sinuses and loss of alveolar bone due to periodontitis.

Over the past five decades sinus floor elevation procedures to increase this available bone have evolved from being an extreme procedure performed by a select few specialists, to a reliable procedure being performed daily by specialists and experienced dentists alike.

The original procedure to establish bone within the sinus floor for implant placement was described and published by Boyne and James as well as Tatum.[1,2] Since then it has been refined and made easier by the introduction of specialized instruments and grafting materials.

It must be stressed though that sinus floor elevation (SFE) procedures should only be done by clinicians with surgical training as well as experience in performing these procedures. Knowledge of the sinus anatomy, nerve and arterial supply as well as using CBCT technology is essential in performing successful SFE procedures. The reader is referred to our Masterclass in International Dentistry - African Edition, Vol 12 No 6, *Maxillary Sinus Anatomy: Essential knowledge for sinus floor elevation (SFE).*[3]

One stage versus two stage placement protocol

Today's patients demand surgical procedures with less trauma, shorter treatment time and possibly without compromising the success rate. Having this in mind, a one stage (simultaneous) approach would be a preferred one (see video). The procedure implies that both sinus floor elevation and implant placement is done during the same session. It can be considered only if the primary implant stability is achievable. It is well known that primary implant stability is influenced by several factors – residual alveolar ridge dimensions, bone quality (density), implant macro-design and the site preparation technique. However, sufficient sub-antral residual alveolar ridge height is the most important criterion and the threshold of ≥5 mm was traditionally declared for considering a simultaneous implant placement (ITI Treatment Guide, Volume 5). However, implant success has been reported in residual alveolar bone height as low as 3 mm.[4,5] Also, we are aware that quality of bone in the posterior maxilla is poor and might be enhanced by certain techniques, such as bone condensing, either by application of osteotomes or under-preparation of implant sites. Additionally, primary implant stability could be improved by using tapered macro-designed implants.

Whenever it is anticipated that adequate primary implant stability cannot be attained, a decision for staged approach should be made. Depending on the maxillary sinus anatomy, extent of augmentation and choice of grafting material, the healing period can vary from 3 – 12 months. For single-tooth gaps with favourable narrow sinus anatomy and predominantly autologous bone graft using a 3–4 months healing time should be sufficient. In cases with so-called "eggshell" sinus floor, augmented with bone substitute only, a total healing period of 9-12 months is needed before implant installation.

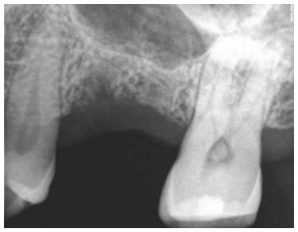

Figure 1: Pre-operative view of the bone volume in 26 position

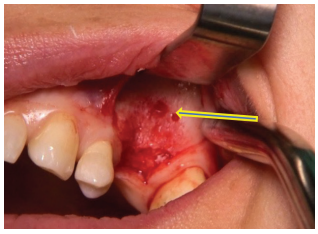

Figure 2: Red bone and white bone visible with arrow indicating floor of sinus. Window would be prepared above the red bone in white bone

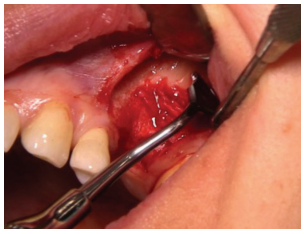

Figure 3: Instead of drilling bone away, harvesting over the site of window is done with a bone scraper. This creates a large surface to volume bone graft that can be mixed with the bone filler

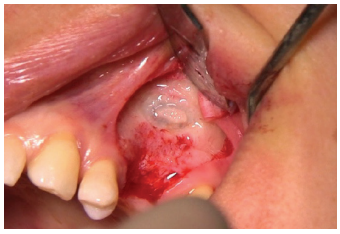

Figure 4: Once bone has been harvested, a small window is prepared for access with specialized sinus floor elevation instruments. This is prepared in the "white" bone. As soon as the dark shadow of sinus is visible, the depth of the groove is slowly increased to prevent perforating through the Schneiderian membrane

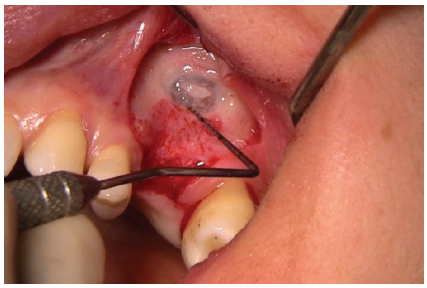

Figure 5: The groove is checked easily with a light scraping of a periodontal probe which will identify where the bone is not yet fully removed. Light pressure on the central bone disc will also show movement inward if bone is fully prepared (see video)

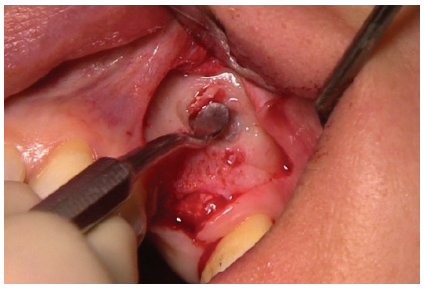

Figure 6: After removing the bone over window, the initial release of Schneiderian membrane around window margin is often best done with a universal scaler

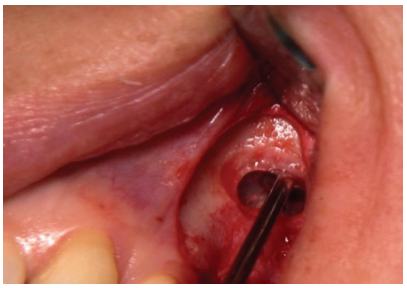

Figure 7: Specialized SFE instruments are then used to lift the Schneiderian membrane to the desired level

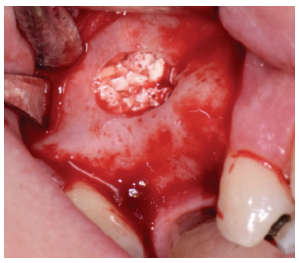

Figure 8: A sinus graft packed with clearly visible larger particles (1-2mm) which allows for more angiogenesis than small particles

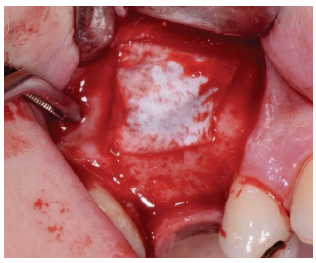

Figure 9: Once the graft material has been placed, a membrane is placed over the window.

Over the years, several systematic and meta-analysis studies have revealed an average success rate of 92–98% on the efficacy of the lateral window SFE procedures and simultaneous and/or delayed implant placement.[6-9]

Incision design

The planned position and size of the lateral window mainly determines the flap design. Other factors include a dentate versus edentulous area, restorations on neighbouring teeth, the amount of attached keratinized tissue, additional need for horizontal and/or vertical augmentation and simultaneous versus delayed implant placement.

Incisions should be placed in such a way which allow good access and visibility to perform the procedure. Incorrect flap design could lead to increased post-operative discomfort for the patient and operator fatigue due to excessive and prolonged retraction of the vestibular tissues.[10]

A full-thickness mucoperiosteal flap is elevated, by making a mid-crestal incision and two vertical releasing incisions. In the case of a one-staged approach with an inadequate amount of attached gingiva, the crestal incision can be placed slightly more towards palatal. This will ensure a wider band of attached keratinized mucosa buccal of the placed dental implant. The vertical incisions should extend deep enough into the vestibulum to allow elevation of the flap past the superior border of the planned lateral window. The anterior and posterior releasing incisions should not be over the anterior and posterior border of the lateral window, as this could lead to poor wound healing and dehiscence formation. A safe distance is at least 3-4 mm away from the proposed window, allowing for closure of the flap over

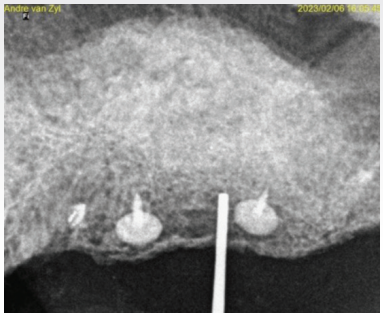

Figure 10: The superior border of a sinus graft showing a solid margin indicating intact Schneiderian membrane after SF

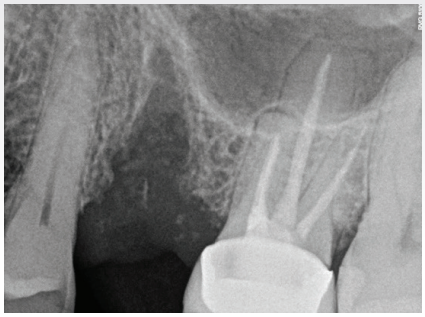

Figure 11: Tooth removed and bone below sinus inadequate depth towards distal for implant placement.

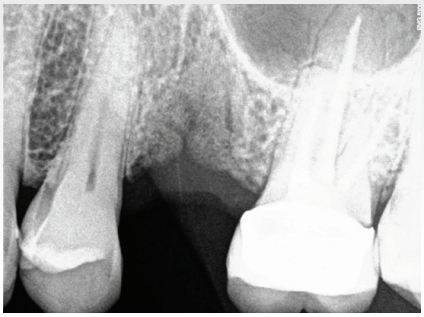

Figure 12: Bone healing after 4 months

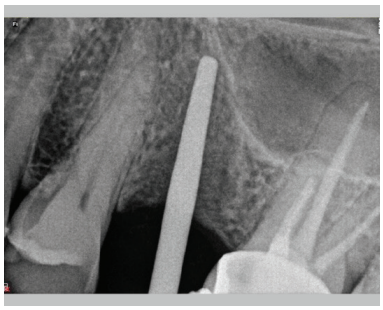

Figure 13: To avoid a sinus floor elevation, the implant can be angled to utilize the bone mesial of anterior sinus wall and still emerge in the occlusal surface for screw retention. Osteotomes are used to prevent perforation

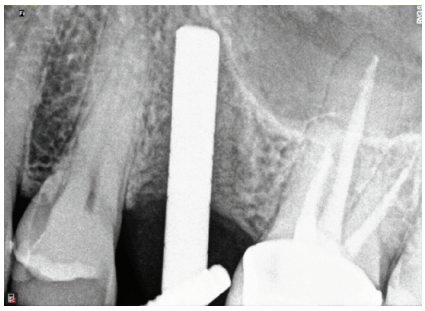

Figure 14: Careful drilling is done to prevent perforation in the anterior wall

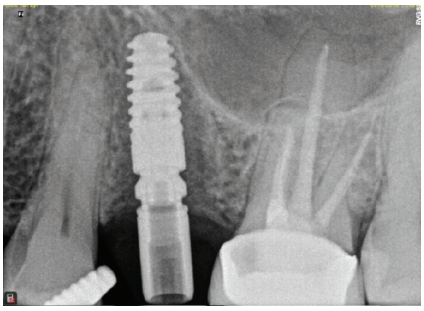

Figure 15: Implant placed without involving sinus

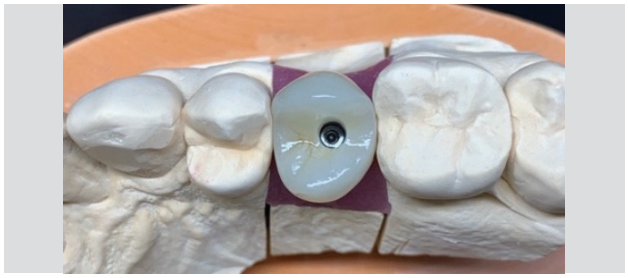

Figure 16: Although the access is slightly towards distal aspect of crown, it has avoided the involvement of sinus or SFE

healthy bone (Figures 1-9).

Some patients may experience post-operative numbness on the side where the lateral window sinus augmentation was performed. This is due to cutting the terminal branches of the infra-orbital nerve when making the anterior vertical releasing incision. This complication could be avoided by making a superficial anterior vertical incision in the alveolar mucosa and then spreading the edges with a Metzenbaum scissor.[11]

Alternative incision designs for lateral window sinus augmentation include a single horizontal vestibular incision and a triangular flap design.

Grafting materials and technique

Over the past few decades different grafting materials for SFE have been investigated. The first question one must answer is whether a grafting material should be used at all, or if it would be sufficient to just elevate the sinus membrane and leave the space for coagulum formation using an implant as a supporting pilar. Two to three millimetres of bone height can be gained with this technique, but where more than 3 mm of vertical bone dimension is required to accommodate an implant, a grafting procedure is recommended.

For many years autologous bone was considered the gold standard for grafting due to its high osteoinductive potential and desirable biological response. However, some shortcomings related to autologous bone grafts, such as high resorption rate, morbidity of donor site and volume limitations has changed the research focus toward non-autologous bone substitutes. These biomaterials, mainly xenografts, allografts and some alloplastic materials have been shown to be suitable for grafting procedures, especially in sinus augmentation.[11] These materials have shown high osteoconductive and low resorption rates. A recent consensus report revealed that characteristics of biomaterial scaffolds are comparable to autologous bone

in augmentation procedures, especially when combined with osteo-inductive cells when it has shown an additional effect in sinus augmentation.[12] It is well known that such bone substitutes lack osteogenic and osteoinductive properties. To overcome these shortcomings, some materials with osteoinductive properties, such as platelet-rich-fibrin (PRF), were introduced as an addition in bone augmentation protocols. The positive effects of PRF-xenograft combination in reducing inflammatory reaction, promoting angiogenesis of newly bone formations, and improving scaffold mechanics have been reported[13,14] More research is needed to propose clear guidelines on this topic.

To obtain good bone quality and avoid gaps in the augmented sinus, it is important to pack grafting material in a way that provides maximum contact with adjacent native bone. For this purpose, a sterile insulin injector with bevelled tip can be used to deliver grafting material directly against both the medial and the anterior maxillary sinus wall.[11]

However, a high graft packing density through excessive compaction of grafting particles should be avoided to optimise the macrostructural environment for bone regeneration.[15] This is demonstrated in the video. When packing the graft into the sinus, small increments should be packed using specialized instruments. In the author's experience, packing should be started in the furthest corners of the augmentation to avoid leaving spaces in those difficult to reach areas. Making sure the Schneiderian membrane is mobilised sufficiently will help in this regard and retracting the membrane with a small periosteal elevator to gain access to the deep corners during graft packing may also help. The palato-nasal recess may be too far away from the lateral window to allow for effective membrane lifting and this area is often one where either the membrane is not lifted sufficiently or under packing of the graft material may leave voids.

During packing a "bounce-back" of the Schneiderian membrane will be noticed and this indicates an intact membrane and that the grafting material is not too densely packed (see video).

Membrane to cover window

There is still controversy on whether a resorbable or non-resorbable membrane should be placed over the lateral window SFE following sinus augmentation (Fig.9). Studies have found that the presence of a barrier membrane over the window does not influence the amount of vital bone formation after sinus augmentation.[16]

Placement of a barrier membrane does however provide graft stability and prevents lateral graft displacement through the sinus antrostomy, which can occur due to baro-trauma such as flying, nose blowing, sneezing, diving, etc.[17] The membrane can be placed over the sinus wall osteotomy or between the graft and inner surface of the sinus wall. To ensure additional stability of the graft, the membrane should be secured with bone tacks/bone pins, if the sinus wall thickness allow for this (See video).[11] Patients should be advised prior to the SFE procedure that they will have to avoid activities as mentioned above. A nasal decongestant may have to be used to prevent the nasal passages from becoming blocked to prevent the need for blowing the nose. This may be necessary for up to 2 weeks post-surgery. Patients must be instructed to sneeze through the mouth.

Underwood's septa

The prevalence of sinus septa was found to be as high as 69%.[18] Sinus septa are mostly present in the premolar/first molar region and are more commonly found in edentulous atrophic maxillae than in dentate maxillae.[11]

Schneiderian membrane perforation is significantly associated with the presence of sinus septa. Therefore, the use of CBCT imaging is an invaluable tool in studying the anatomy of the maxillary sinus to determine the presence, location, number, morphology, and height of sinus septa.

Sinuses with a single prominent medio-lateral septum, requires the creation of two separate window osteotomies to successfully perform sinus augmentation, leaving the septum in between intact.[11]

In rare cases where an anterior-posterior septa is present; it might be required to perform a "window within a window". A larger window osteotomy is created in the lateral wall of the lateral compartment. Thereafter the Schneiderian membrane is lifted to expose the lateral wall of the medial compartment. A smaller window osteotomy is created in the lateral wall of the medial compartment to allow lifting of the Schneiderian membrane in the medial compartment. Both medial and lateral compartments are then grafted.[11] These cases should only be managed by highly skilled and trained surgeons.

Many clinicians perform sinus augmentation without the benefit of CBCT technology and this should be avoided as septa, amongst other anatomical challenges such as roots within the sinus, may be missed. The anatomy including pathology of the maxillary sinus is covered in a previous Masterclass in Implantology.[3]

Conclusion

Performing SFE to enable dental implant reconstruction in the posterior maxilla is an essential part of rehabilitation in edentulous or partly edentulous situations. It requires post-graduate training in not only surgical procedures, but specifically maxillary sinus augmentation. It should not be attempted after a superficial training course as dealing with complications may be difficult and may lead to unnecessary litigation. Indemnity insurance should also be comprehensive

and include sinus augmentation procedures. Successful augmentation in cases where sinus pathology is present may require treatment beforehand by an Ear Nose and Throat specialist.

Radiography should be used immediately after SFE surgery to verify that the graft is contained and that the Schneiderian membrane was not torn during the packing process. Should the filler graft material be shown to have spilled into the sinus through such a tear, the graft may have to be removed immediately to avoid the morbidity of a second operation later. A successful graft will show a smooth superior border with "egg" shape (Fig. 10).

It should also be stressed that alternative techniques are available to prevent performing a lateral window SFE, such as a vertical sinus floor elevation using Summers' technique, or sometimes using what bone is available by angling the implant (Figures 11-16) to prevent perforating the sinus floor. This can be used especially if a patient does not wish to go through a lateral window SFE procedure or does not have the finances for it.

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