



REVIEW ARTICLE

**PREVENTION AND MANAGEMENT OF INTRA-OPERATIVE COMPLICATIONS IN
MAXILLARY SINUS AUGMENTATION USING THE LATERAL APPROACH? A REVIEW**

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Abstract

The lateral approach for maxillary sinus grafting has become a routine technique with an implant survival rate over 96% in the maxillary posterior region. However, this technique may be associated with some complications that may occur at different time points and influence short and long-term implant survival rate. This article is dedicated to intra operative complications which are mainly due to anatomical variations such as the shape of the sinus, the presence of septa and other particularities such as the intraosseous passage of the antral alveolar artery which may interfere with the position of the vestibular window.

In order to identify the risk and prevent the complications, a perfect knowledge of the anatomy is therefore essential. If a complication does occur, it must be treated in an efficient manner to prevent the postoperative complications that may follow, in the form of chronic or acute sinusitis. The prevalence of intra operative complications is conversely proportional to the surgeon's skill and experience without an influence on implant survival if they are properly managed.

Keywords: Bone graft, complications, management, maxillary sinus augmentation, prévention

Introduction

Maxillary sinus augmentation via the lateral approach technique, has been recognized for many years as a reliable, effective and well documented technique for bone augmentation in the posterior maxilla.^{1,2,3} This technique is reported to induce more complications being more invasive than the crestal approach.^{4,5}

In medicine, as in everyday life, each time a complication occurs, two questions must be asked: why did I get this complication, and how could I have avoided it? According to Pjetursson et al,⁶ there is a learning curve in implant dentistry, represented in higher survival rates and lower complication rates reported in more recent clinical studies. This is particularly true for maxillary sinus augmentation

using the lateral approach. Comparing studies from the early 2000s^{7,8} with those published 20 years^{9,10} later the 5y implant survival rate is 92% and 95% respectively. the purpose of this article is to identify, through the literature and the author's experience, the ways to achieve this by preventing and treating complications in the most predictable way.

Intra operative complications:

In order to prevent and to anticipate them a pre-operative CBCT is absolutely mandatory.^{11,12}

Neurosensory disturbance:

This complication is rarely mentioned. Sometimes after the surgery the patient can feel some numbness on the same side the graft has been performed. This is

due to the presence of terminal branches of the infra orbital nerve which are cut at the moment the anterior vertical releasing incision is made.¹³ The prevention of this complication consists of making a partial incision, instead a full thickness one, in the alveolar mucosa and spreading the edges with Metzenbaum scissors, which stretches the nerve fibers rather than cutting them (Figure 1).

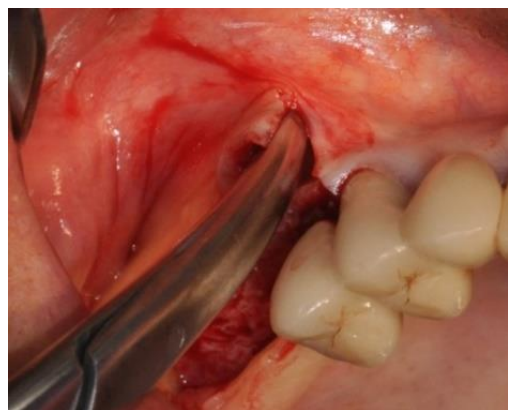


Figure 1. Metzenbaum scissors are inserted under the split thickness incision and opened to stretch the nerve branches without cutting them

Vascular damage

This complication is only observed if the lateral approach is used. A significant bleeding may complicate the procedure. It is due to a damage of the alveolar antral artery when making the vestibular osteotomy when its passage is intra osseous within the buccal wall. This artery is an anastomosis between the infraorbital artery and the postero-superior alveolar artery, its passage being extraosseous in 44% of cases.¹⁴ Its course can be very variable so it should be checked systematically on cross sectional cuts 15 with a pre op CBCT. The likelihood for an intraoperative bleeding with a vessel of 0.5-1mm in diameter will be 10% and 57% for a diameter of 1-2 mm.¹⁵ The higher risk corresponds with a diameter more than 2mm.¹⁶

Intra operative bleeding can be managed with various methods. By crushing the bleeding point with a hemostat,¹⁷ applying pressure with a gauze impregnated with tranexamic acid 13 or bone wax.¹⁷ The risk is the recurrence of bleeding post operatively.¹³ Electro coagulation with a bipolar device can also be employed 15 with the risk of sinus membrane damage.

The absence of a suture at the distal releasing incision may favour the drainage of the clot.¹⁸

Avoiding bleeding remains the best approach. To do this, it will be necessary to proceed with the isolation of the alveolo antral artery using piezo surgery (Figure 2).^{13,19} Another option, if technically possible, is to make the window as small as possible and to move it lower.¹⁷



Figure 2. The alveolo antral artery has been isolated using piezo surgery

Membrane perforation:

It is the most common complication with a prevalence between 0 and 58% and an average of 19.5%.²⁰ This complication is not considered as a negative factor for bone formation and implant survival^{21,22} even contrary opinions on the quality of new-bone formation²³ and survival have been expressed.^{24,25}

Risk factors and prevention:

The prevention of this type of complication is essential and for that it is necessary to be able to detect the risk factors of tearing in the most comprehensive manner.²⁶

Considering the membrane thickness, there is a controversy. According to Aimetti et al²⁷ the sinus membrane in patients with a thick gingival phenotype is thicker. Lum et al²⁸ in their retrospective study, concluded that patients who experienced membrane perforation had a thinner membrane compared with patients without membrane perforation. But Insua et al,²⁹ after testing mechanically sinus membranes harvested from fresh cadavers, found that a thick membrane is not prevented to tear, as its resistance under elastic forces is not higher than a thinner one. Similarly, Lin et al³⁰ showed that membranes with a thickness of 1 to 1.5 mm were the most resistant while those that are thinner or thicker are more prone to tearing.

It is therefore impossible to appreciate the real thickness relying solely on radiographic examination, especially since it is over-evaluated on the CBCT.³¹

Another risk factor that must be considered is the presence of septa. In case of complex internal anatomy, a 3D reconstruction is essential³² to have an exact idea of the number of septa, their orientation, and their size.

The prevalence of perforation is less with medio lateral septa compared with antero-posterior²⁶ and an appropriate surgical approach must be implemented according to these criteria.³³ For instance, when the sinus is divided in 3 cavities because of the presence of 2 medio-lateral septa it is preferable to consider 3

different sinuses³⁴ to be grafted or by removing surgically the septa when it is antero-posterior.¹³ The width of the sinus cavity is also a risk factor.³⁵ This parameter is appreciated by measuring the angle between the buccal wall and the palatal component of the nasal wall. When this angle is acute the perforation rate is more than 60%³⁶ and it decreases moving in a more posterior direction, making the anterior region the most dangerous regarding the risk of perforation, especially in the presence of a particularly narrow anterior recess (Figure 3). Consequently, the window should be placed as close as possible to the anterior wall¹³ in order to dissect the membrane under direct vision, which will allow the detection and treatment of any tears.

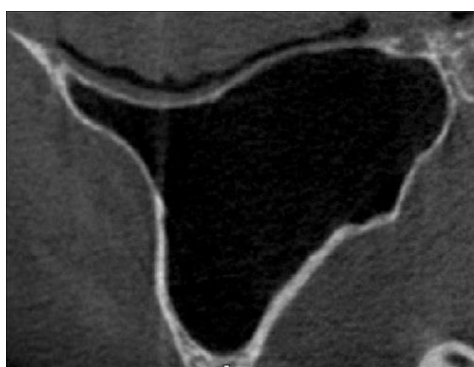


Figure 3. The anterior part of the sinus is very narrow (axial cut)

The thickness of the lateral wall is also mentioned as a risk factor.³⁷ If the buccal wall is thin, it is recommended to erode it until the membrane is visible in order to lift it.¹⁹ When the buccal wall is thick the lateral osteotomy by erosion using the piezo surgery would be time consuming and therefore it is recommended to cut the window and to lift it out. The risk of perforation being very high, in some cases, because of its strong adhesion to the bone. This degree of adhesion can't be detectable on the CBCT. To prevent this drawback, it is recommended to split the thick window in small pieces in order to detach each of them with a lower pulling force (Figure 4. a, b).¹³ Regarding the grafting technique, when the implants are placed simultaneously if the sinus is entirely filled with the grafting material, the risk is to tear the membrane apically while inserting the implants is very high by creating an increased pressure internally.

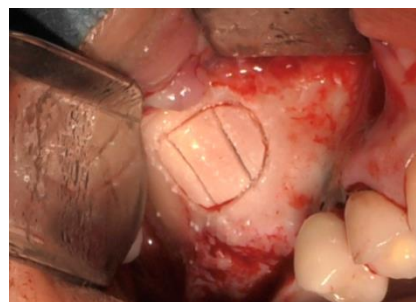


Figure 4a. The window is divided in 3 small pieces



Figure 4b. All pieces are removed successively

To avoid this undetectable perforation, it is preferable to fill the sinus cavity two-thirds of the way and then place the implants before completing the graft. Smoking has been recently identified as a risk factor.³⁸

How to detect the perforation?

The Vaslava maneuver might have certain limitations,³⁹ thus, a more preferable approach would be to detect perforation and to manage it more efficiently by direct view. An alternative way is to inject saline into the sinus cavity and to ask the patient if he/she feels liquid flowing into the nose.

Management of perforations

According to Nolan et al,²⁴ the use of antibiotics to treat post-operative sinusitis and graft failure was higher in sinuses with perforation. This means that the size of the perforation must be as small as possible and that perfect hermeticity must be ensured to grafting material penetration in the sinus. Among the treatments reported, the most widely used technique in the studies reviewed was collagen membrane repair although this was managed in different ways.⁴⁰ Often the perforation occurs when the window is made and is tangent to the osteotomy line (Figure 5a), so that it is not completely visible. In this case, the shape of the window must be modified so that it can be seen in its entirety (Figure 5b). The next step is to initiate the detachment on the opposite side (Figure 5c) of the perforation to take advantage of the membrane's own elasticity, which will lead to a reduction of its size and to its partial closure (Figure 5d).

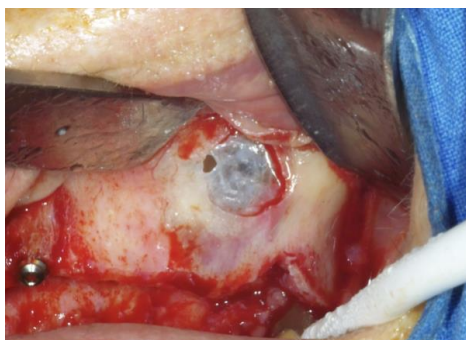


Figure 5a. The perforation is tangent to the osteotomy line

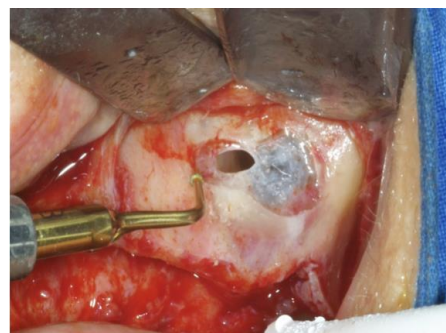


Figure 5b. The shape of the window is modified to see the perforation in its entirety



Figure 5c. The detachment is initiated opposite to the perforation



Figure 5d. The perforation size is reduced

Then, it will be necessary to seal it with a collagen membrane to ensure its hermeticity.⁴¹ But, despite the use of a collagen, membrane perforation and repair of the Schneiderian membrane can compromise new bone formation and implant survival rate.⁴² They explain this by saying that during the condensation of the graft the surgeon cannot know if the membrane resists the pressure or not. To prevent this, it is preferable to pack the grafting material always against a bony wall and not upwards or backwards because of the risk of an undetected perforation.

In the same way it was reported⁴³ a higher prevalence for sinusitis in cases of membrane perforation (31.4%) despite intraoperative closure with resorbable membranes. In this report, as the way in which the collagen membrane was used was not specified, it can be assumed that the stability of this membrane above the perforation was not ensured and that it shifted during the placement of the graft.⁴⁴ It is therefore necessary to ensure its stability at the time of grafting. For this purpose, the Pouch Technique has been advocated.⁴⁵

The disadvantage of this technique is that there may be a gap between the medial wall and the graft which may alter the quality of the newly formed bone. The way to prevent this could be the use of the Tattone Technique⁴⁶, which consists of stabilizing part of the collagen membrane with titanium pins on the medial

wall, allowing this type of perforation to be hermetically sealed (Figure 6. a, b).

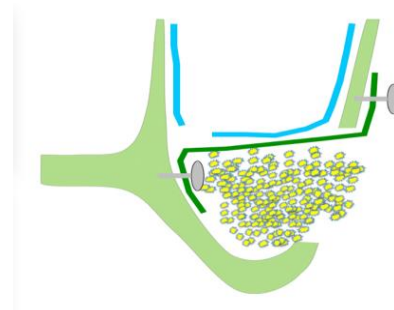


Figure 6a. The membrane is pinned in the medial wall and the buccal wall

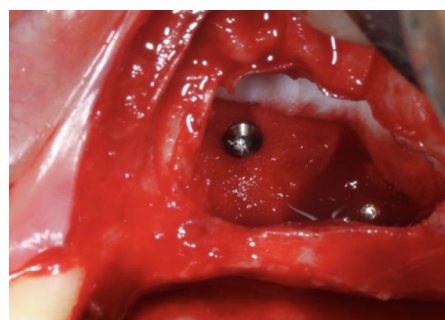


Figure 6b. Clinical view: the titanium tacks in the medial wall

This technique is particularly indicated in case of presence of a para-nasal recess of less than 30° which can result in a tear adjacent to the medial wall.^{24,47}

De Oliveira et al⁴⁸ assert that the resorbable membrane influences the intensity of inflammatory responses producing a reduction in bone formation. Another option is to use a resorbable suture⁴⁹ with the risk with of enlarging the perforation or PRF membranes.⁴⁷ This last possibility needs to be further documented.

According to other authors^{39,49} the implant failure rate increases as the perforation size. In only two studies^{50,51} the treatment of both small and large defects has been described. Small defects have been managed with resorbable collagen membrane in both studies.

Large defects with resorbable sutures and adsorbable membranes⁴⁹ with no differences for the implant failure, conversely to Hernandez-Alfaro et al⁵² who treated large defects with lamellar bone and a lower implant success compared to small defects.

The impact of membrane perforation on graft quality and implant survival remains controversial. Moreno Vazquez et al⁵³ and Sakkas et al⁵⁴ assert there is no impact of membrane perforation on the graft failure rate conversely to others.⁴² In a recent systematic review,⁴⁰ it was concluded that a negative impact on the bone graft itself or on remodeling processes could not have been shown. Another option to avoid the complications related to granules loss trough the perforation could be the use of PRF^{55,56} alone as grafting material or without any grafting material⁵⁷ with an implant survival of 100% and 98.7% respectively, but evidence is still lacking.

Delamination

At the time of the osteotomy or during its dissection, the schneiderian membrane may be partially damaged due to the tearing of its periosteal part (Figure 7). Although not perforated because the pseudostratified respiratory epithelium will remain, it will be very fragile. This type of lesion should be treated in the same way as a perforation.

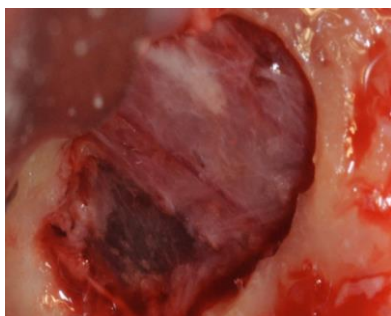


Figure 7. The delamination (dark area) in the lower left

For large perforations, a better option would be to abort the surgery and to insert a collagen sponge in the sinus cavity and to wait 3-6 weeks.⁵⁸ This time frame allows the membrane to heal, making the re-entry much easier using a split thickness approach.

Implant migration

When the implant placement is performed simultaneously to the graft it is necessary to achieve a perfect implant stability to prevent the implant from falling into the sinus and its migration in sensitive areas (Figure 7).⁵⁹ The implant can migrate for two reasons: If the sinus floor is not dense, the osseodensification technique can be used.⁶⁰

The second reason is when the bone height under the sinus is reduced and there is an indication to place implants at the same time as the graft, it will be necessary to undersize the drilling and to use a tapered implant which may cause a fracture of the vestibular wall when the implant is inserted using a high torque.

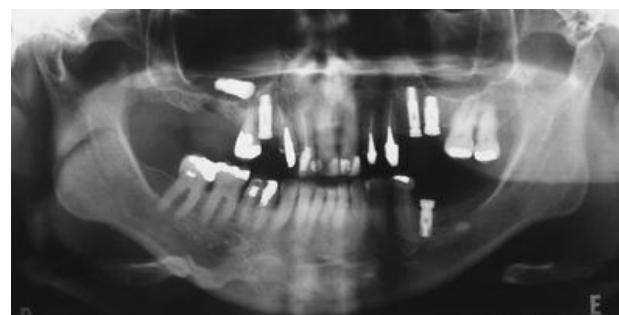


Figure 7. The Implant migration in the sinus

The solution is to shift the window apically 8-10 mm (Figure 8. a, b, c).¹³



Figure 8a. The implant is the sinus floor



Figure 8b. The implant is removed with a surgical aspirator

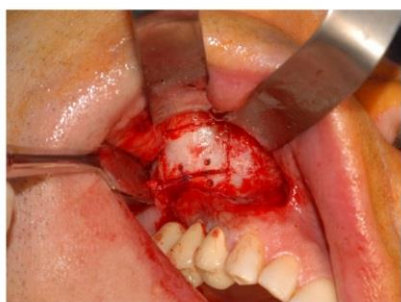


Figure 8c. The bony segment is repositioned and secured with absorbable sutures.

Conclusion

In addition to the risk factors mentioned above the frequency of intra operative complications is also inversely proportional to the surgeon's skill and experience. They can be considered to have no influence on graft and implant post operative survival, if they are properly managed thanks to a perfect knowledge of the anatomy and its variations. If not, they may cause acute or chronic infectious post-operative complications.

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ԿՈՂԱՅԻՆ ՄՈՏԵՑՄԱՍԲ ՎԵՐԾՆՈՏԱՅԻՆ ԾՈՑԵՐԻ ՄԵԾԱՑՄԱՆ ՆԵՐՎԻՐԱՀԱՏԱԿԱՆ ԲԱՐԴՈՒԹՅՈՒՆՆԵՐԻ ԿԱՆԽԱՐԳԵԼՈՒՄ ԵՎ ԿԱՌԱՎԱՐՈՒՄ: ԱԿՆԱՐԿ

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Ամփոփում

Վերծնոտային ծոցերի մեծացման կողային մեթոդը դարձել է սովորական տեխնիկա, իմպլանտների գոյատևման մակարդակը գերազանցում է 96%-ը վերծնոտային ծոցերի հատվածում: Այնուամենայնիվ, այս տեխնիկան կարող է կապված լինել որոշ բարդությունների հետ, որոնք կարող են առաջանալ տարբեր ժամանակներում և ազդել իմպլանտների կարճաժամկետ և երկարաժամկետ գոյատևման մակարդակի վրա: Այս հոդվածը նվիրված է ներվիրահատական բարդություններին, որոնք հիմնականում պայմանավորված են անատոմիական փոփոխություններով, ինչպիսիք են վերծնոտային ծոցերի ձևը, միջնապատերի առկայությունը և այլ առանձնահատկություններ, ինչպիսիք են անտրալ ավելույին զարկերակի ներոսկրային անցումը, որը կարող է խանգարել վեստիբուլյարի պատուհանի դիրքին: Ռիսկը բացահայտելու և բարդությունները կանխելու համար անհրաժեշտ է անատոմիայի կատարյալ իմացությունը: Եթե բարդություն առաջանա, այն պետք է արդյունավետ կերպով բուժել՝ կանխելու հետվիրահատական բարդությունները, որոնք կարող են հետևել՝ քրոնիկ կամ սուր սինուսիտի տեսքով: Ներվիրահատական բարդությունների տարածվածությունը հակառակը համեմատական է վիրաբույժի հմտությանը և փորձին՝ առանց իմպլանտների գոյատևման վրա ազդեցության, եթե դրանք պատշաճ կերպով կառավարվեն:

**ПРОФИЛАКТИКА И ЛЕЧЕНИЕ ИНТРАОПЕРАЦИОННЫХ ОСЛОЖНЕНИЙ ПРИ УВЕЛИЧЕНИИ
ВЕРХНЕЧЕЛЮСТНОЙ ПАЗУХИ ЛАТЕРАЛЬНЫМ ДОСТУПОМ? ОБЗОР**

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Абстракт

Латеральный доступ при увеличении верхнечелюстной пазухи стал рутинной техникой с коэффициентом приживаемости имплантата более 96% в задней области верхней челюсти. Однако этот метод может быть связан с некоторыми осложнениями, которые могут возникать в разные моменты времени и влиять на краткосрочную и долгосрочную приживаемость имплантатов. Эта статья посвящена интраоперационным осложнениям, которые в основном связаны с анатомическими вариациями, такими как форма пазухи, наличие перегородок и другими особенностями, такими как внутрикостное прохождение антральной альвеолярной артерии, которое может мешать положению вестибулярного окна.

Поэтому для выявления риска и предотвращения осложнений необходимо идеальное знание анатомии. Если возникнет осложнение, его необходимо лечить эффективным образом, чтобы предотвратить возможные послеоперационные осложнения в виде хронического или острого синусита. Распространенность интраоперационных осложнений обратно пропорциональна навыкам и опыту хирурга и не влияет на приживаемость имплантата при правильном лечении.