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Complications and Treatment Methods of the Lateral Sinus Lift Technique: A Literature Review

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ABSTRACT

Maxillary sinus lift procedures are common surgical interventions that increase bone volume for successful dental implant operations. These procedures serve to correct the loss of alveolar bone and the enlargement of the sinus cavity that typically occur following the loss of a tooth. The lateral sinus lift technique, developed by Boyne and James, provides access to the maxillary sinus cavity. This method preserves the Schneiderian membrane and fills the space between the sinus floor and the membrane with graft material. Complications that may arise intraoperatively during sinus lift procedures include bleeding and perforation of the Schneiderian membrane. The use of compresses and vasoconstrictors can effectively control bleeding; however, membrane perforation can frequently result in graft loss and implant failure. Postoperative complications include sinusitis, infections, and implant migration into the sinus. Rapid diagnosis and appropriate treatment can manage these complications. To minimize the risk of complications, it is important to conduct a detailed radiographic examination before the procedure. During implant procedures, anatomical variations and additional accessory structures should also be considered. The success of a sinus lift depends on the correct use of surgical equipment and appropriate treatment planning. Consequently, surgeons should carefully evaluate patient characteristics and select appropriate surgical techniques.

Lateral Sinüs Lift Tekniği Komplikasyonları ve Tedavi Yöntemleri: Literatür Derlemesi

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ÖZET

Maksiller sinüs lift prosedürleri, dental implant operasyonlarının başarılı bir şekilde gerçekleştirilmesi için kemik hacmini artırmak amacıyla sıkça tercih edilen cerrahi girişimlerdir. Bu prosedürler, diş eksikliği sonrası oluşan alveolar kemik kaybı ve sinüs boşluğunun genişlemesini düzelten işlemlerdir. Lateral sinüs lift tekniği, Boyne ve James tarafından geliştirilen bir yöntemdir ve maksiller sinüs boşluğuna erişimi sağlar. Bu yöntemde, Schneiderian membranı korunur ve sinüs tabanı ile membran arasındaki boşluk greft malzemesi ile doldurulur. Sinüs lift operasyonlarında intraoperatif komplikasyonlar arasında kanama ve membran perforasyonu yer alır. Kanama kompres, vazokonstrüktör kullanımıyla kontrol altına alınabilirken, membran perforasyonu genellikle greft kaybı ve implant başarısızlığına yol açabilir. Postoperatif komplikasyonlar arasında ise sinüzit, enfeksiyonlar ve implantın sinüse migrasyonu gibi durumlar yer alır. Bu komplikasyonların yönetimi, zamanında tanı ve uygun tedavi ile mümkündür. İşlemden önce detaylı bir radyografik inceleme yapılması, komplikasyon riskini azaltmada önemli bir rol oynar. Anatomik varyasyonlar ve ek aksesuar yapılar da implantoloji prosedürleri sırasında dikkate alınmalıdır. Sinüs lift operasyonlarının başarısı, cerrahi ekipmanların doğru kullanımı ve uygun tedavi planlaması ile yakından ilişkilidir. Bu nedenle, cerrahların hasta özelliklerini dikkatlice değerlendirmesi ve uygun teknikleri seçmesi önemlidir.

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INTRODUCTION

Maxillary sinus lift describes a surgical procedure often used to increase bone volume for successful dental implant surgery.[1] These procedures correct alveolar bone loss and pneumatization of the sinus cavity after tooth loss. A reduction in alveolar bone height and the enlargement of the sinus are common complications following the loss of a tooth. Sinus enlargement can make implant placement difficult and in some cases impossible.[2] Currently, two main sinus lift techniques are commonly used: lateral sinus lift and crestal sinus lift.[3] The sinus lift technique, which uses the lateral window approach developed by Boyne and James (1980), enables access to the maxillary sinus cavity while preserving Schneiderian membrane, and involves filling the cavity between the maxillary sinus floor and Schneiderian membrane with autogenous bone graft or biomaterials.[4] Crestal sinus lift is performed through the implant cavity, with or without placing a bone graft directly into the maxillary sinus during the implant placement phase. The choice between these two techniques is dependent on various factors, including the patient's anatomical characteristics, the condition of the sinus cavity, and the specifics of the implant treatment strategy.[3]

The maxillary sinus has the largest volume among the paranasal sinuses.[5] Following tooth loss, bone resorption occurs in two ways: central resorption, which is a natural consequence of the bone remodeling process, or resorption resulting from pneumatization of the sinus cavity to the alveolar crest. Such resorption frequently results in decreased bone volume, which might not be adequately suitable for the placement of dental implants, therefore necessitating a maxillary sinus lift for implant placement.[6] Implant treatment in the atrophic maxilla can be challenging when faced with reduced bone height, particularly when the remaining height of the alveolar bone is below 6 mm. In such cases, maxillary sinus augmentation is recommended before implant placement. The implant can be placed simultaneously with the sinus lift procedure, or can be placed after completing bone formation.[3]

It is imperative to consider the potential for anatomical variations and the presence of additional accessory structures when undertaking implant procedures in the maxilla. Failure to accurately pre-diagnose these anatomical variations can result in a higher occurrence of surgical complications. Therefore, radiographic diagnosis and planning are crucial in reducing the likelihood of intraoperative complications during surgical procedures. As such, cone beam computed tomography examination is recommended before performing a sinus lift.[7,8] The most common complications of maxillary sinus lift surgery are Schneiderian membrane perforation and hemorrhage.[9] Intraoperative complications of maxillary sinus lift surgery include hemorrhage, membrane perforation, buccal flap perforation, and infraorbital nerve injury, although rare. Postoperative complications include graft infections, sinus infections, postoperative sinusitis, flap dehiscence, oroantral fistula formation, insufficient graft volume for implant placement, exfoliation of graft material through the window due to rupture of the sinus membrane, displacement of dental implants into the sinus cavity, and dental implant failure.[10] In addition to summarizing the techniques and management strategies, we also aimed to provide a concise overview of complication frequencies reported in the literature, which is presented in Table 1.

Table 1. Summary of complication frequencies and outcomes reported in clinical studies on lateral sinus lift procedures

Author (Year)	Study Type	Sample Size	Technique / Topic	Complication (%)	Main Findings
Al-Dajani (2016)	Meta-analysis	12 studies	Lateral sinus lift	Membrane perforation 23.5%	Incidence of perforation and associated risk factors identified
Stacchi et al. (2017)	Systematic review	32 studies	Lateral sinus lift	Membrane perforation 15.7%	Intraoperative complications analyzed
Schwarz et al. (2015)	Retrospective	407 augmentations	Lateral sinus lift	Membrane perforation 8.6%	Presence of septa and smoking identified as significant risk factors
Hernández-Alfaro et al. (2008)	Clinical study	474 sinus lifts	Lateral sinus lift	Implant success 97% in small perforations	Size of perforation directly affects implant success
Toscano et al. (2010)	Retrospective	56 cases	Sinus lift with piezoelectric device	Perforation 3.6%	Piezoelectric device reduced complication rates
Nolan et al. (2014)	Retrospective	359 sinus lifts	Lateral window	Perforation 41%	Perforation significantly increased complication risk
Vázquez et al. (2014)	Retrospective	202 sinus lifts	Lateral window	Perforation 25.7%	Reported complication rates; guidelines for prevention and treatment provided
Díaz-Olivares et al. (2021)	Systematic review + Meta-analysis	7 studies	Lateral sinus lift	High implant survival in small perforations	Different membrane repair methods and survival outcomes evaluated
de Almeida Ferreira et al. (2017)	Retrospective	745 sinus lifts	Sinus membrane perforation cases	Perforation 30.6%; implant survival 97.68%	Implant survival assessed in cases with membrane perforation
Park et al. (2019)	Clinical study	65 sinus lifts	Sinus lift without membrane repair	Membrane perforation 39%	Even without repair, implant success rates were acceptable
Guo et al. (2016)	Prospective cohort	53 sinus lifts	Sinus floor elevation	4 perforations observed	Long-term evaluation of membrane thickness and ostium patency

The aim of this review is to investigate the complications associated with lateral sinus lift surgery and the management and treatment of these complications.

Intraoperative complications

1. Bleeding

The maxillary sinus is primarily supplied by three main arteries: the posterior superior alveolar artery, infraorbital artery, and posterior lateral nasal artery.[11] There is also an alveolar antral artery known as an anastomosis of the posterior alveolar artery and the infraorbital artery. This artery also provides an arterial supply to the maxillary sinus and adjacent teeth. The alveolar antral artery has clinical importance as it reduces the risk of severe bleeding during surgical procedures, but restricts the surgeon's field of vision and increases the risk of membrane perforation, and can destabilize the graft in patients undergoing grafting.[12,13] A diameter of greater than 1 mm for the alveolar antral artery can result in severe hemorrhage.[14] It is important to exercise caution when performing procedures in the posterior region of the maxilla, as the posterior superior alveolar artery passes approximately 19 mm

above the alveolar crest. The first molar tooth region is the closest area to the alveolar crest.[15] In a study of CT scans, it was found that 10.5% of people had vessels wider than 0.5 mm in the lower two-thirds of the anterolateral sinus wall. The average thickness of these vessels was 1.2 mm with diameters ranging from 0.5–2.5 mm.[16-18] Preserving the integrity of these arteries is crucial not only for visualization and to avoid complications during the operation, but also to support neoangiogenesis of the graft.[19]

Severe bleeding can prevent clear visualization of the surgical field and must be controlled to complete the operation. The use of electrocautery or bone wax is an effective method of hemostasis. It is essential that bleeding is appropriately stopped and that the potential for haemosinus formation—a complication that can arise following the procedure—is excluded.[20,21] Pieri et al. reported the successful use of a diode laser to stop bleeding during a lateral sinus lift.[22] To stop bleeding, either electrocautery or bone wax can be used. It is important to ensure that bleeding is stopped effectively and to eliminate the possibility of haemosinus, which may develop after the procedure.[10]

2. Membrane perforation

The lateral sinus lift technique entails meticulous dissection of the pseudostratified ciliated columnar epithelium, known as Schneiderian membrane, that covers the maxillary sinus. This membrane is carefully lifted away from the sinus walls.[23] The most common complication of this technique is membrane perforation.[24] In a meta-analysis conducted by Al-Dajani et al.,[25] the incidence of membrane perforation was reported as 23.5%. This complication can lead to graft loss, impaired sinus function, and implant failure. It is important to note that the sinus membrane has osteogenic properties. Therefore, lifting the sinus membrane without bone grafting can result in new bone regeneration.[24] As such, the sinus membrane serves two functions as it stabilizes the graft and also supports new bone formation.

Lum et al.[23] report that sinus membrane perforation is affected by the thinness of the Schneiderian membrane and the decrease in the amount of residual alveolar bone. The study also investigates the potential relationship between smoking and membrane perforation, but no correlation was identified. Schwarz et al.[26] found a significant relationship between sinus membrane perforation and the presence of residual alveolar bone, the presence of sinus septa, and smoking. Hernandez et al.[27] investigated implant success according to perforation size. The success rate was 97.14% for perforations smaller than 5 mm, 91.89% for perforations of 5–10 mm, and 74.14% for perforations larger than 10 mm. Therefore, enlargement of the membrane perforation reduces the implant success rate. Moreover, the presence of antral septa increases the risk of membrane perforation in patients.[28] Performing the sinus lift operation with a piezoelectric device instead of traditional methods also reduces the possibility of complications.[29] Other factors that increase the risk of membrane perforation are uncontrolled application of force on the sinus membrane, not using the appropriate instrument, and higher than normal adhesion of the membrane to the bone.[30]

Although the literature does not clearly describe the treatment of membrane perforations, it is recommended to use suturing or fibrin glue. Small perforations do not require treatment, while large perforations can be managed with the help of a membrane. In cases of large perforations, cancellous block graft can be used instead of particle graft or the operation can be abandoned.[27] A meta-analysis reported that a variety of techniques are used for the treatment of membrane perforations, including clotting, suturing, collagen membranes, platelet-rich fibrin, hemostatic agents, and laminar bone and block bone grafts.[27,30-35] Furthermore, the meta-analysis reported that perforations smaller than 5 mm can be managed by folding the membrane itself or with resorbable sutures, perforations between 5–10 mm can be treated with resorbable collagen

membrane, and platelet-rich fibrin can be used as adjuvant treatment for these perforations.[30] For perforations of 10 mm or smaller, the operation can be continued and the implant can be placed at the same time.[27] If perforations are larger than 10 mm, the combined use of laminar bone and resorbable collagen membrane is recommended and implantation is delayed to the next stage.[30]

3. Other intraoperative complications

Rare intraoperative complications, such as injury to the buccal flap or injury to the infraorbital nerve, can result from failed surgery. Injuries observed in the buccal flap can result from interventions that release the flap for primary closure. It is possible to damage the infraorbital nerve because of incisions made during flap retraction and flap release. Therefore, it is important to know the anatomy of the infraorbital nerve.[10,36,37] Furthermore, surgeons should consider that in cases of an excessively resorbed maxilla, the infraorbital nerve can come into close proximity with the alveolar crest. Any resulting neurosensory changes typically resolve spontaneously within 6 months.[36]

Postoperative complications

1. Postoperative infection and sinusitis

Postoperative surgical site infections are rare, however, sinusitis is the most common complication following sinus lift procedures.[10,36] Sinusitis is a temporary reaction of the airway defense mechanism. Sinusitis has been reported in 3–20% of cases. If the patient exhibits symptoms, such as headache, pain, or tenderness in the maxillary sinus area, and runny nose after the operation, sinusitis should be suspected.[38] Sinusitis often occurs in patients predisposed to sinusitis, such as those with hypertrophic turbinates, deviated septum, or allergies.[39,40] It is not possible to distinguish between sinus infection and graft infection. When signs of infection are observed, treatment should be started without delay. If there is a delay in treatment, the infection developing only in the maxillary sinus can progress to pansinusitis.[10] Postoperative acute sinusitis can develop due to the occlusion of the maxillary ostium as a result of mucosal inflammation, hematoma, tissue fluid, or overfilling of the graft.[36] Additionally, smokers have a higher risk of developing sinusitis.[41] Nolan et al.[42] reported that the risk of developing sinusitis in patients with membrane perforation was six times higher than in those without membrane perforation.

To prevent postoperative infection, the use of prophylactic antibiotics and 0.12% chlorhexidine gluconate mouthwash before the procedure is recommended.[43] Preoperative use of chlorhexidine reduces infectious complications.[44] For the treatment of patients who develop sinus infections, amoxicillin and clavulanic acid can be used as antibiotics and fluticasone can be used as nasal anti-inflammatory. It is recommended to use these medications every 12 hours for 1 week.[41]

2. Migration of the implant into the sinus

Implant migration into the sinus cavity is an uncommon complication. Inadequate examination of the bone type before the operation and a lack of proper planning can cause this complication.[45] Inadequately shortening the treatment period can cause the implant to migrate into the sinus.[46] Implant migration tends to occur with greater frequency when cylindrical implants are placed in the posterior maxillary region.[46,47] Patients presenting with this complication frequently show inadequate primary stability during implantation. Furthermore, bone resorption resulting from infection is also a contributing factor.[26] Migration into the sinus has been reported more frequently in smokers and narrow implant diameters.[46] In order to avoid this complication, it is recommended to use implant designs that are narrower apically and wider coronally. Furthermore, it has been proposed that a case-specific methodology for drilling could prove advantageous in sinus lift

operations. This approach involves avoiding the final drill to increase primary stability.[48]

It is recommended that implants that migrate into the sinus be removed immediately. If removal is postponed, sinusitis must be controlled.[45] Three methods can be used to remove the migrated implant: via the transnasal route, the transoral route by entering through the fossa canina, or direct flap removal. The initial two methods are endoscopic surgical techniques and are considered conservative approaches. Oroantral fistula is a potential consequence of implant migration at the surgical site and is typically managed using local flap operations.[48-50]

4. Ostium blockage

The sinus ostium provides a pathway between the maxillary sinus and the nasal cavity and is situated in an inferior position on the medial wall of the maxillary sinus. The ostium allows for drainage of mucosal secretions and ventilation of the sinus.[48] Edema that develops after the procedure causes mucosal thickening, increased membrane thickness, and the development of ostium obstruction.[51] Additionally, excessive filling of the sinus with a graft can cause obstruction of the ostium. Bone size of 15 mm or more is rarely required in the sinus lift procedure. Considering that the average height of the maxillary sinus is 35 mm, half of the sinus is filled with 15–16 mm of grafting and the inflammation that develops in the overfilled sinus thickens the membrane causing obstruction of the ostium.[38] As a result of ostium obstruction, sinusitis usually occurs. If an infection develops immediately before initial recovery, it can be useful to reopen the operation area, remove a portion of the graft, and modify the antibiotic treatment.[2,38]

5. Dehiscence of the incision line

Dehiscence of the incision line is a rare condition and usually occurs in the first week after surgery.[36,38] Therefore, the operating area is at least 5 mm away from the flap line. In addition, primary closure of the flap by making a relaxing incision while closing the flap should be practiced routinely. While small dehiscences are generally regarded as insignificant, openings of 2–3 cm require re-suturing. If the incision line does not heal for 2 months, surgery should be performed again and the tissues must be relaxed and re-sutured.[36,38]

CONCLUSION

The lateral sinus lift technique represents a successful method that is applied prior to implant placement in pneumatized sinuses and atrophic posterior maxilla. However, the technique is not without complications. It is essential to have comprehensive knowledge of the potential complications that might arise following the procedure, and the appropriate treatment options. Most complications that arise after the procedure are readily treatable. To minimize the incidence of complications, it is essential that a comprehensive radiographic examination is conducted prior to the procedure.

Ethical Approval

Ethical committee approval was not required for our study. An ethics declaration form has been completed.

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: BEY, Data collection or access: BEY, Analysis and comments: BEY, Literature search: BEY, Writing: BEY.

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