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Original Research Article

Lateral and crestal sinus lift complications: a retrospective comparative study

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ABSTRACT

Background: To explore the relationship between the operative methods for sinus lifting and related intra-and postoperative complications.
Methods: 47 cases of sinus lift were traced, with 118 implants placed. 83 of them after lateral sinus lifting and 35 with a crestal approach. Presence of bone septum, thickness of the sinus membrane, bone density, and the height of residual bone were tracked out preoperatively, as prerequisites of complications during and after implant placement in the distal parts of the maxilla.
Results: In eight cases (17.02%), sinus membrane perforations occurred. The most common location of the tearing was close to the lower medial edge of the bone window. After fixing perforation, a total of 37 implants were placed under these conditions. In three of them (5.41%), poor osseointegration was found after six mounts. Statistically significant impact of the thickness of the sinus membrane in cases of membrane tearing was found.
Conclusions: Increasing the height of the available bone in the distal areas of the maxilla by elevating the maxillary sinus floor is a safe and predictable procedure. Both the crestal and lateral approaches have a high success rate. All possible complications during the operation need to be analyzed in advance, and when they occur, it is mandatory to fix them adequately. Therefore, a careful consideration of the local and systemic conditions affecting implant survival is essential for successful implant treatment.

Keywords: Lateral sinus lift, Impaired osseointegration, Sinus lift complications, Sinus membrane perforation

INTRODUCTION

Implant dentistry is a specialized field of dentistry that involves the surgical placement of dental implants into the jawbone to replace missing teeth or provide support for dental prostheses.[1] Dental implants are artificial tooth roots that are made of titanium or other materials and are surgically implanted into the jawbone. Once the implant is placed, it osteointegrates with the surrounding bone tissue, creating a stable foundation for implant-supported prostheses.[2] This method offers several benefits over conventional tooth replacement options such as dentures and bridges. Dental implants are more durable and long lasting than other options.[3] They are also more comfortable and provide better chewing ability, speech and oral health. Moreover, dental implants prevent bone loss in the edentulous jaw and maintain the natural shape of the face.[4] Recently, implant-supported restorations have become a popular choice for many patients due to their high success rate and long-term benefits.[5]

Unfortunately, more frequently, the available bone volume in the distal parts of the maxilla is insufficient, especially in terms of bone height. In these conditions, it is necessary to increase bone volume using an elevation of the maxillary sinus floor. The sinus lift is an important procedure in implant dentistry that involves placing a bone substitute material under the Schneiderian membrane in the edentulous region of the molars and premolars. This is necessary because the maxillary sinus

starts to enlarge its volume after tooth extraction.[6] Other causes, such as earlier tooth loss, periodontal disease, and alveolar bone resorption, lead to insufficient bone height.[7] During a sinus lift, the sinus membrane is elevated, and bone graft material is placed in the space created, which helps to promote bone augmentation in the area.[8] The procedure for a sinus lift involves making an incision in middle of alveolar ridge to expose the bone, creating a bone window on lateral wall of maxillary sinus, followed by lifting Schneiderian membrane and placing the bone graft material in space created. After the bone graft material is placed and covered with a resorbable collagen membrane, the incision is closed. The bone recovery period after sinus lift typically takes several months, during which the bone graft material integrates with the existing bone in jaw, creating a more stable foundation for dental implants.[9,10] Although complications such as infection, sinusitis, membrane perforation, and graft displacement may occur during the procedure, the success rate of the sinus lift is generally high, with implant survival rates ranging from 92.6% to 98.6%.[11,12]

METHODS

Retrospectively, 47 patients with lateral and crestal sinus lifts were tracked out, and 118 dental implants were placed. The operations were performed from September 2018 to March 2020. Patients with one or more missing teeth in the posterior maxilla and a decreased height of the alveolar bone were included in this study. Patients with systemic diseases, preexisting inflammatory processes in the maxillary sinus, or poor oral hygiene were not included. The minimal follow-up period was two years after functional loading of the dental implants. The exact implantation sites, bone volume measurement, and bone density evaluation were performed on the basis of cone-beam computed tomography (CBCT). Software used Simplant Pro 15 (Materialise, Louvain, Belgium).

Study included only cases with a minimum height of residual bone in the implant area of 3 mm. When height of available bone was more than 6 mm and relative bone mineral density was over 300 HU, the placement of the implants was performed simultaneously with lateral sinus lift. In other cases, 2-stage closed implantation was applied no earlier than eight months after the operation, when the bone graft was completely integrated. Preoperative antibiotic therapy with 875 mg amoxicillin and 125 mg of clavulanic acid twice daily for 10 days was prescribed. Along with this, non-steroid anti-inflammatory drugs prescribed, and nasal decongestants.

Conventional surgical protocols were used to lift the floor of the maxillary sinus. Local anesthesia was applied, including a superior posterior alveolar nerve block, terminal infiltration in the area of the upper premolars, a superior anterior alveolar nerve block, and a greater palatal nerve block. The incision involves the shaping of a vestibular trapezoidal flap, starting with an incision of the attached gingiva at the middle of the alveolar crest and continuing with two vertical incisions at both ends. The exact positions of the vertical incisions were determined according to the size of the implantation area and the location of the bone window. Their minimum distance was not less than 6 mm from the future bone window. Then, the full-thickness muco-periosteal flap was elevated, and the lateral wall of the maxillary sinus was exposed. A bone window with an oval or trapezoidal shape was formed with a lower border located parallel to the alveolar ridge, a few millimeters above the floor of the maxillary sinus. An ultrasonic surgical device (NSK-nakanishi international, Vario Surge 3, Tokio, Japan) was used together with the following tips: for the shaping of the bone window: SG6D, SG7D, and SCL1; for the separation of the Schneiderian membrane: SG9, SG10. The final elevation of the sinus membrane was performed using manual, specialized periosteal elevators. Under the sinus membrane, a slow-resorbable collagen membrane (Evolution Std., Tecnoss, Italy) was placed. In the formed space, bone substitute material (Gen-Os, Tecnoss, Italy) was inserted. The lateral bone window was covered with a second absorbable collagen membrane (Evolution Thin, Tecnoss, Italy) and if necessary was fixed.

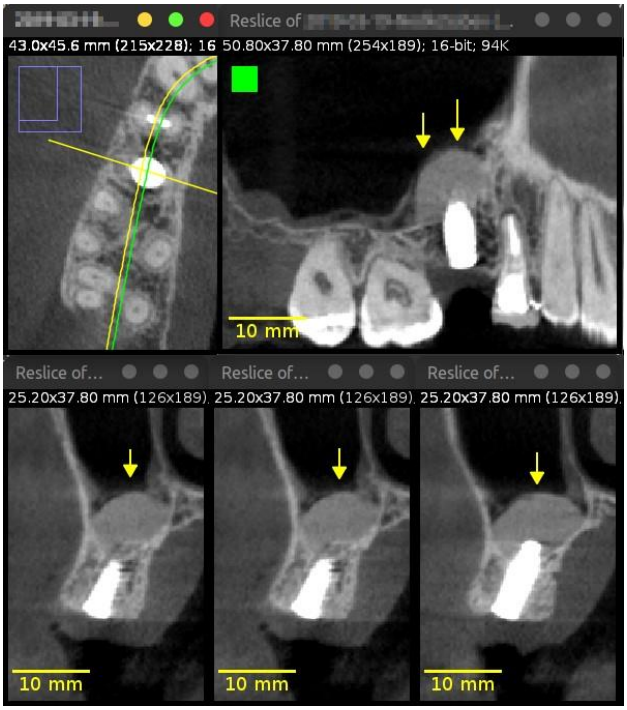

Figure 1: Postoperative CBCT. Axial slices, panoramic reconstructions, and para-axial reslices after CSL and implantation in area of upper second premolar (tooth 15) sinus membrane integrity is not impaired (yellow arrows), and the exact location of the graft is shown. Implant apex is fully covered by bone substitute in all directions.

The crestal sinus lift was performed by hydraulic separation with the crestal approach sinus kit (CAS Kit, Hiossen-Ostem, Seoul, South Korea), following the

manufacturer's surgical procedure. A postoperative CBCT was administered to monitor the integrity of the sinus membrane, the exact location of the graft, and its coverage over the implant (Figure 1). Additionally, the achieved bone height was measured.

The following indicators were traced: the available bone height, the mineral density of residual bone, and the incidences of complications during and after the operation: tearing of the sinus membrane, inflammation of maxillary sinus, impaired osseointegration of dental implants, insufficient bone volume achieved, and graft displacement. The statistical processing was conducted using SPSS statistic 25 (Armonk, NY, 10504-1722, USA).

RESULTS

Maxillary sinus lifting was conducted in 47 patients to increase the available bone height, followed by implant-supported restoration of the edentulous area. Of them, 25 were men and 22 were women, aged between 28 and 70 years old. A total of 118 implants were placed.: 83 after lateral sinus lifting and 35 with a crestal approach. 60 implants were inserted unilaterally: 34 after lateral sinus lift and 26 after crestal sinus lift.

At the same time, 58 implants were placed on both sides: 49 after the lateral approach and 9 with the crestal approach. The case distribution is shown in Table 1 by type of operation, site of implantation, and the patient's sex.

The presence of bone arterial anasthomosis between the alveolar and infraorbital arteries was found preoperatively in 57.5% (n=47). Profuse bleeding during the operation was detected in 10 cases, or 21.3%. The presence of the bone septum and irregularities of the sinus floor were detected in 48.9% of the cases.

Table 1: The Distribution of the implant placed according to area of implantation and the patient's sex.

Sex			Area of implantation		Total
			Upper premolars	Upper molars	
Male	Type of operation	Crestal sinus lifting	10	10	20
		Lateral sinus lifting	16	28	44
	Total		26	38	64
Female	Type of operation	Crestal sinus lifting	5	10	15
		Lateral sinus lifting	18	21	39
	Total		23	31	54
Total	Type of operation	Crestal sinus lifting	15	20	35
		Lateral sinus lifting	34	49	83
	Total		49	69	118

In eight cases (17.02%), sinus membrane perforations occurred. The most common location of the tearing was close to the lower medial edge of the bone window. The Schneiderian membrane was fixed by suturing in three cases and in the other five by means of double layer coverage with absorbable oxidized cellulose gauze (Gelita-Cel Standard, Gelita medical GmbH, Eberbach, Germany) and resorbable collagen membrane evolution fine (Technoss, Italy). A total of 37 implants were placed under these conditions. In three of them (5.41%), impaired osseointegration was found after six mounts.

To verify the hypothesis that thickness of Schneiderian membrane affects occurrence of perforation, the Mann-Whitney U test was conducted. The results obtained showed a statistically significant impact of the thickness of sinus membrane in cases of membrane tearing: mean rank 74.14 in cases of perforation and 55.88 without: U=934.00, p=0.039, r=0.19. However, in monitored cases, the effect was observed to be smaller than typical influence of this effect.

Partial displacement of the bone substitute after surgery was detected in four implants (3.4%, n=118), placed at the same time as the lateral sinus lift. In the hydraulic lifting of Schneiderian membrane using crestal approach, no displacement of the graft or tearing of the membrane was found.

The average height of residual bone measured is 6.27 mm (St.Dev 1.55, n=118), and the mineral bone density in these areas is 422.24 HU (with a range from 209 to 756, n=118).

Impaired osseointegration and implant loss were found in 3.4% (n=118), three of them in the region of the second upper molar (after lateral sinus lift) and one in the first upper premolar (after crestal sinus lift). In the cases above, the bone density was lower than the average: 330,33 HU. No statistically significant correlation was found between these indicators. The mean rank of bone density in cases of implant failure was 64.38; in the other successful cases, it was 59.33, U=208.50, p=0.772 (Mann-Whitney U test).

Acute maxillary sinusitis occurred in one case after crestal sinus lift. Despite the lack of X-ray evidence of spreading the graft in the maxillary sinus, the implant and bone substitute were removed three weeks after surgery.

DISCUSSION

Sinus lift surgery has been associated with intra- and postoperative complications, reaching 5.64%.[13] Tearing of the sinus membrane is the most common complication during surgery.[14-16] The main prerequisites are the presence of irregularities in the maxillary sinus floor and the presence of a bone septum or mucocele. Although some studies have described a relationship between sinus membrane thickness as a factor of possible perforation, data analysis shows that this effect has a smaller than typical magnitude (r=0.19).[17-19] Nevertheless, a careful preoperative evaluation of cases and the selection of an appropriate surgical technique are necessary. Clinically undiagnosed sinus membrane tearing often leads to infection of the bone graft and possible dispersal into the maxillary sinus. In these conditions, the probability of the appearance of acute maxillary sinuitis with subsequent loss of bone-substitute material and implant failure is almost certain. Even the fixed perforation of the Schneiderian membrane during sinus lift surgery can affect the implant survival rate, but studies have shown that the success rate for implants placed in these conditions is still high, ranging from 96.2% to 97.96%.[8,13]

Implant displacement in the maxillary sinus is a significant complication that can occur during and after implantation. It occurs in cases with severe pneumatization and poor bone density.[14] Inadequate residual bone height has been reported as a possible cause of implant displacement.[7] Migration into the maxillary sinus has been reported in various studies.[8,9,15] Prevention of implant displacement involves various approaches, including careful planning of implant placement and usage of appropriate surgical techniques. To minimize the risk of implant displacement, it is crucial to work with a skilled and experienced implant surgeon who can properly evaluate and plan the implant placement procedure.[9] However, the implant survival rate after such incidents is still high, ranging from 90% to 96.9%.[8,15] In the current study, there were no cases of displaced implants in the maxillary sinus. This can be explained by the careful selection of the cases preoperatively. Simultaneous sinus lifting and dental implant placement were performed only in conditions of appropriate bone mineral density and a minimum height of the available bone above 6 mm. The success of implantation in conjunction with sinus lifting depends on various local and systemic factors, including the primary stability achieved during implant placement. Studies have shown that the survival rate of implants placed after maxillary sinus augmentation with bone grafts is 95.8%.[11] The aggregated results in this study of lateral and crestal sinus lift are in agreement with published data (96.61%). Despite the difficulties of the intraoperative diagnosis of possible perforation of the sinus membrane related to the crestal approach, successful osseointegration rates in the studied group were high - 99.8%). These data have a higher success rate than those published by Xia et al, Jamcoski et al, and Dragonas et al where the survival rate reported is slightly lower: from 94.1 to 98.05%.[7,8,11] The possible reason for this higher success rate may be explained by the use of hydraulic elevation of the sinus mucosa, which is more atraumatic than other conventional methods.[20] On the other hand, the lateral approach to sinus membrane elevation has wider indications and provides better visibility in the operative field. The success rate of implants placed in conjunction with lateral sinus lifts is very high, with studies reporting survival rates of up to 98.3%.[8] The results of the study provided are close: 96.39%. In these conditions, it is necessary to consider not only the type of sinus lift performed but also the fact that implantation is conducted in the distal parts of the maxilla, where the bone mineral density and quality are lower compared to other areas of the jaw.[21] These factors are relevant to the reported lower survival rate of dental implants in this area.[6,12,20,21]

The current study has some limitations because of the relatively small number of tracked cases and the many anatomical and clinical factors that could influence the operative outcome. Therefore, no definitive conclusions can be drawn on the basis of these observations, and further studies are required.

CONCLUSION

Increasing the height of the available bone in the distal areas of the maxilla by elevating the maxillary sinus floor is a safe and predictable procedure. Both the crestal and lateral approaches have a high success rate. All possible complications during the operation need to be analyzed in advance, and when they occur, it is mandatory to fix them adequately. Therefore, a careful consideration of the local and systemic conditions affecting implant survival is essential for successful implant treatment.

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