Received: 23rd April 2015 Accepted: 20th July 2015 Conflicts of Interest: None

Source of Support: Nil

Review Article

Open Sinus Lift Surgery and the Importance of Preoperative Cone-Beam Computed Tomography Scan: A Review

Amin Rahpeyma[1], Saeedeh Khajehahmadi[2]

Contributors:

[1]Associate Professor of Oral and Maxillofacial Surgery, Oral and Maxillofacial Diseases Research Center, School of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran; [2]Assistant Professor of Oral and Maxillofacial Pathology, Dental Research Center, School of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran.

Correspondence:

Dr. Saeedeh Khajehahmadi. Dental Research Center of Mashhad University of Medical Sciences, P.O. Box: 91735-984, Vakilabad Blvd, Mashhad, Iran. Tel.: +98(51)38829501. Email: khajehahmadis@mums.ac.ir

How to cite the article:

Rahpeyma A, Khajehahmadi S. Open sinus lift surgery and the importance of preoperative cone-beam computed tomography scan: A review. J Int Oral Health 2015;7(9): 127-133.

Abstract:

Open sinus lift surgery is a form of pre-prosthetic surgery for increasing the quality and quantity of bone in the posterior region of the maxilla. Pre-operative assessment of the maxillary sinus is essential for the success of this surgery. PubMed search was carried out in English language literature for open sinus lift surgery and cone-beam computed tomography (CBCT). The results focused on anatomic variants, vascular anatomy, complications, osteotomy/ostectomy window dimensions and thickness of the Schneiderian Membrane. 59 articles were included in this review. Features other than the height and the width of the residual alveolar ridge that should be evaluated in preoperative CBCT scan include the thickness of the lateral maxillary sinus wall, the presence of the alveolar antral artery and its diameter, the maxillary sinus floor width and angulation, irregularity of sinus floor, intimate relation of Schneiderian membrane with the roots of the adjacent teeth, sinus septum, and the quality of subantral bone. Other conditions that occasionally may be observed in special situations are also explained. More than ten parameters should be checked in evaluating CBCT images of paranasal sinuses other than the width and the length of the residual ridge in the posterior region of the maxilla. Each of them may have a significant impact on the results of the open sinus lift surgery.

Key Words: Cone-beam computed tomography scan, maxilla, open sinus lift

Introduction

In the posterior region of the upper jaw, tooth replacement in the edentulous ridge with dental implants requires sinus lifting surgery when the maxillary sinus is pneumatized, extending toward the alveolar process.[1] This surgery is a form of pre-prosthetic surgery for increasing the quality and quantity of bone in the posterior region of the maxilla. Pre-operative assessment of the maxillary sinus is essential for the success of this surgery.

If the amount of bone, between the ridge crest and the maxillary sinus floor is inadequate, (<5 mm) then open sinus lift procedure is indicated.[2] Pre-operative cone-beam computed tomography scan (CBCT) before open sinus lift surgery has been recommended by Dobele *et al.* and Nunes *et al.*[3,4] Much more information can be obtained from CBCT other than the width and length of subantral bone as explained in this article. The CBCT is not the sole tool for this purpose. Comprehensive intraoral examination and carefully taken medical and dental histories are very important tools in this respect. However, when CBCT is used for pre-operative evaluation of the maxillary sinus and the edentulous region, as much information as possible should be obtained from this radiographic technique.

Sinus Lift Surgery and CBCT Scan

PubMed search was carried out in English language literature for open sinus lift surgery and CBCT. The results focused on anatomic variants, vascular anatomy, complications, osteotomy/ostectomy window dimensions, and thickness of the Schneiderian membrane.

Fifty-nine articles were included in this review. Features other than the height and the width of the residual alveolar ridge that should be evaluated in preoperative CBCT scan include the thickness of the lateral maxillary sinus wall, the presence of the alveolar antral artery and its diameter, the maxillary sinus floor width and angulation, irregularity of sinus floor, intimate relation of Schneiderian membrane with the roots of the adjacent teeth, sinus septum, and the quality of subantral bone. Other conditions that occasionally may be observed in special situations are also explained.

Features other than the height and the width of residual alveolar ridge that can commonly be observed in CBCT are:

a) Thickness of the lateral maxillary sinus wall.
b) Presence of alveolar antral artery and its diameter.
c) Maxillary sinus floor width.
d) Irregularity of sinus floor.
e) Intimate relation of Schneiderian membrane with the roots of the adjacent teeth.
f) Maxillary sinus septum.

g) Estimation of the bone/biomaterial volume needed for sinus lifting.
h) Evaluation of the quality of subantral bone.

Thickness of the Lateral Maxillary Sinus Wall

If the lateral maxillary wall is thick, then the open sinus lift procedure becomes harder and takes more time.[5] If the trapdoor technique is designed to be used, then reducing the thickness of bone is necessary to minimize complications.

Excessive convexity of this wall compels the surgeon to choose the ostectomy technique for lateral antrostomy instead of the lateral inverted window.[6]

Presence of Alveolar Antral Artery and its Diameter

A large-diameter artery in the osteotomy/ostectomy window can provoke profuse bleeding, resulting in obscuring the vision in the surgical field. This will increase the possibility of Schneiderian membrane perforation.[7] If the whole artery is enclosed by the bone, management by electrocautery is all that is needed but when this artery is in close contact with Schneiderian membrane, use of electrocautery will lead to membrane perforation. It has been suggested that it is possible to prevent injury to this artery with the use of a piezosurgery device, or careful bone removal and changing the osteotomy window from oval or round shape to longitudinal trough above/below this artery.[8,9]

Alveolar antral arteries with a diameter more than 0.5 mm can be observed on CBCT images and profuse bleeding should be expected if the artery has a diameter more than 3 mm.[10] This artery is responsible for intra-operative hemorrhage which is the second frequent complication of sinus lift procedure after membrane perforation (Figure 1).[11]

Maxillary Sinus Floor Width

The distance between the lateral maxillary sinus wall and the medial maxillary sinus wall (lateral nasal cavity boundary) and the formed angle are also important. In very narrow and very wide sinuses and sharp angulation between these two structures, the open sinus lift surgery becomes difficult.[12] In narrow sinuses, the trapdoor technique is contraindicated.[13]

Irregularity of Sinus Floor

Irregularities of the maxillary sinus floor make the surgery more difficult in comparison with the flat-surface bone (Figure 2).[14]

Intimate Relation of Schneiderian Membrane with the Roots of the Adjacent Teeth

If Schneiderian membrane comes in contact with the root(s) of the teeth adjacent to the edentulous space the risk of membrane perforation during sinus lift procedure increases. This is the reason why this procedure is more difficult in single-tooth edentulous spaces.[15] Restricted surgical access and irregular nature of the overlying bone, located between the root apices,

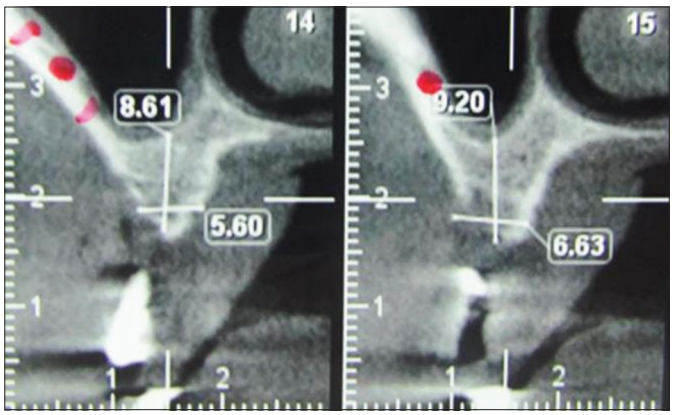

Figure 1: Alveolar antral artery in in close proximity to the Schneiderian membrane.

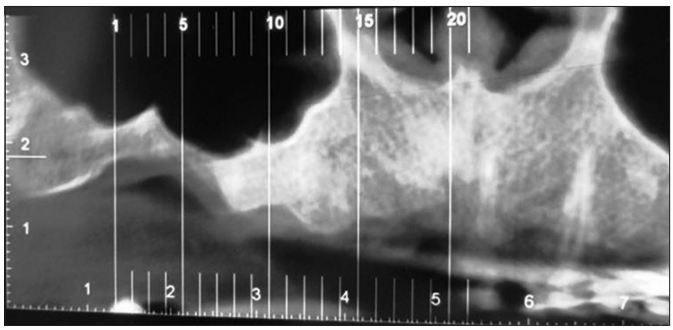

Figure 2: Irregularities and spurs on the floor of the maxillary sinus.

are the other reasons for high rate of maxillary sinus membrane perforation during local sinus lift for single-tooth implants.

Maxillary Sinus Septum

Maxillary septa: Approximately, 22.5-33% of CBCTs shows the presence of septa in the maxillary sinus.[16,17] A septum on the floor of the maxillary sinus influences the design of the osteotomy window and changes the one-window technique to two smaller windows on either side of the maxillary sinus floor septum or the w-shaped trapdoor.[18,19] Closed sinus lift below the sinus floor septum is also a difficult procedure.

Estimation of the Bone/Biomaterial Volume Needed for Sinus Lifting

If the estimated volume of the bone for open sinus lift is large and the autogenous bone is the choice, then the iliac crest and tibia should be selected as the donor site.[20] Chin bone is considered when a small amount of bone is needed or when composite graft (mixture of autogenous bone and biomaterial) is to be used.

Evaluation of the Quality of Subantral Bone

Quality of subantral bone can be estimated through the CBCT.[21-23]

Other conditions that occasionally may be observed in special situations are:
1) Mucous membrane thickening.

2) Pathologic lesions of the sinus.
3) Previous Caldwell-Luc surgery.
4) Previous maxillary or zygomatic fracture.

Sinusitis of the maxillary sinus should be treated before sinus lift surgery.[24] This can be medical or in advanced stages can be managed with endoscopic sinus surgery.

Normal maxillary mucous membrane thickness is 0.3-0.9 mm[25,26] or simply speaking <1 mm.[27] Mucosal swelling more than 2 mm is considered as pathologic thickening. There is a significant correlation between perforation rate and membrane thickness. The perforation rate is lowest when the thickness is 1.5-2 mm.[28]

Pathologic lesions of the maxillary sinus such as cysts and tumors should be treated surgically before open sinus lift surgery. The exception is maxillary mucous retention cyst that can be drained or aspirated simultaneously with sinus augmentation.[29,30]

Previous Caldwell-Luc surgery

If the maxillary sinus has undergone a previous Caldwell-Luc surgery, especially if oroantral fistula has occurred following tooth extraction, the current open sinus lift surgery is not indicated. Because of surgical scar, fibrosis and adherence of the tissue, this procedure will probably fail. In this situation bone graft strategies with special techniques, such as press-fit and triple layer closure, are indicated.[31,32] If Caldwell-Luc surgery is used for removal of a foreign body or pathologic lesions, fibrous tissue, and osteoneogenesis fills some part of the maxillary sinus (auto-obliteration).[33]

Maxillary and zygomatic fracture

Zygomatic process of the maxilla is a thick bone and acts as one of the vertical buttresses of the face; therefore, it is used for internal fixation in Lefort I, II, and zygomaticomaxillary complex fractures.[34]

If the edentulous space present with internal fixation devices is visible on CBCT images, then their removal should be considered concomitant with the sinus lift procedure.

Usually, the length of the screws is more than the thickness of the maxillary buttresses and their tip is in the maxillary sinus; as a result, under the best conditions the surgeon confronts with perforated Schneiderian membrane.[35]

Finally, there is a situation that is not pathologic but may have an influence on the open sinus lift surgery: "Extension of the maxillary sinus into the nasal floor" (palatonasal recess) (Figure 3).[36] It is ectopic pneumatization of maxillary sinus toward the palatal processes of maxillary bone, which is called, by some authors, the palatal recess.[37,38] Elevating thin Schneiderian membrane from this recess is difficult.

Figure 3: Palatonasal recess*; pneumatization of the maxillary palatal process.

Influence of preoperative CBCT scan findings in the design of sinus lift surgery. The design of the osteotomy window for open sinus lift surgery depends on the anterior and inferior limit of the maxillary sinus. The posterior boundary of the ostectomy window depends on the posterior extension of the desired augmentation rather than on the posterior extent of the maxillary sinus.[39] The surgeon should elevate the sinus membrane to the anterior and medial walls of the sinus and as far posteriorly as necessary for implant placement.[40]

Osteotomy/ostectomy window should extend 2-3 mm from the anterior limit of the maxillary sinus and 2-3 mm above the maxillary sinus floor in circular, oval or rectangular designs with rounded corners.[41,42] The superior limit of this window depends on the desired length of the implant. This dimension is always reported as the distance from the alveolar crest. Thirteen or fifteen millimeters is the advised length.[43,44] Boyne and James recommended ostectomy window with a 1-cm diameter.[45] A wide window, up to 1.5 cm in diameter, has been recommended for difficult surgical cases.[46] Whenever the surgeon confronts with a difficult situation it is wise to enlarge the lateral wall ostectomy window.

Ignoring the anterior limit of the maxillary sinus in edentulous patients leads to uneven new maxillary sinus floor with the lost chance of implant insertion in the neglected anterior part of the maxillary sinus (Figure 4).

Placing the inferior limit of the ostectomy/osteotomy window flush with the maxillary sinus floor, especially when the maxillary sinus is severely pneumatized into the alveolar process, decreases the buttress effect and prevents the maxillary sinus from retaining the grafting material inside. Correct dimensions of the osteotomy window in relation to the maxillary sinus are illustrated in Figure 5. In alveolar ridges with less resorbed bone, the location of the ostectomy window falls much higher on the lateral maxillary sinus wall

than in more severely resorbed ridges. In such a situation, the superior boundary of the ostectomy window approaches the infraorbital nerve and special care should be taken during the surgery to avoid iatrogenic injury to the infraorbital structures.

Lateral window interferes with the alveolar antral artery (which is an intraosseous anastomosis between the infraorbital artery and the posterior superior alveolar artery) in the lateral maxillary sinus wall in 10-30% of the cases.[47,48]

It should be pointed out that the more resorbed the bone crest, the higher the risk of injuring such a vessel during the sinus augmentation procedure.[49]

The position of the maxillary ostium is the other factor that should be checked before any sinus surgery.[50] In routine open sinus lift surgery, it is recommended that the medial maxillary mucous membrane should be elevated to better nourish the graft, especially if a biomaterial alone (without adding autogenous bone) is used as the sole graft material for maxillary sinus augmentation.[51,52]

Elevation of this membrane very widely may result in the obstruction of the draining route of the maxillary sinus, the maxillary ostium. The altered anatomy of the maxillary sinus and subsequent changes in the function is the result as well as the need for ample biomaterial to fill the created biologic box.

Another importance of this structure is when the buccal fat pad is used as the last resource for the management of large perforations in the Schneiderian membrane.[53] This pedicled flap, which is fixed to the medial maxillary sinus should not interfere with the maxillary sinus draining route.

In narrow-field CBCT images, some important information will be missed, including the deviated nasal septum and hypertrophied inferior turbinate (Figure 6). Correction of the deviated septum with septoplasty and inferior partial turbinectomy for alleviating the problem of hypertrophied inferior turbinate is indicated to prevent recurrence of sinusitis.[54]

There are some important factors in open sinus lift surgery and other tools other than CBCT should be used for evaluating them. Limitations of CBCT in preoperative evaluation of maxillary sinus before open sinus lift surgery are the following:

The depth of the vestibule may be observed in CBCT of some edentulous posterior maxilla in the form of air bubbles, but it is better determined through comprehensive intraoral examination. In shallow vestibules, the sinus lift procedure is more frustrating. The transverse relation of the jaws, interocclusal distance, and anterior-posterior arch relationship,

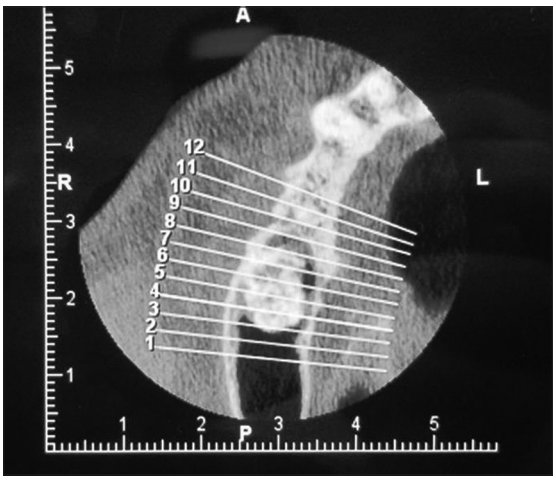

Figure 4: Forgotten anterior boundary of the maxillary sinus in open sinus lift surgery leads to slit formation between the bone graft and the maxilla.

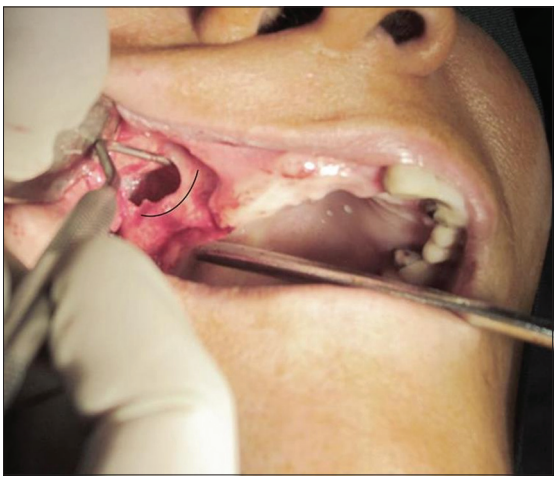

Figure 5: The inferior limit of the osteotomy window should be 2-3 mm above the sinus floor.

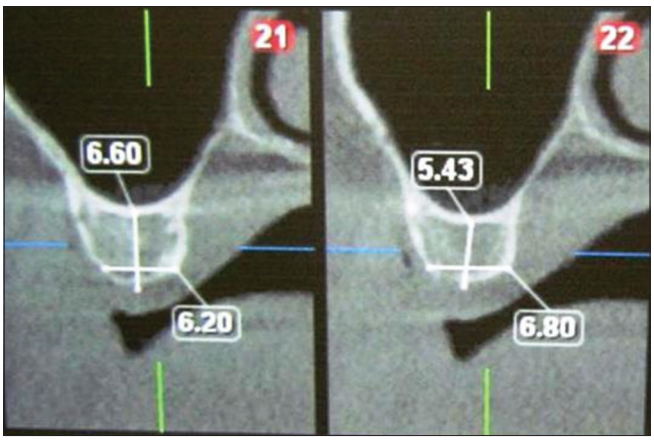

Figure 6: Narrow-field cone-beam computed tomography. Valuable information about the nasal septum, inferior turbinate, upper limit of the osteotomy window and condition of the osteomeatal complex is missed.

which have a great influence on decision-making and treatment planning are best determined after thorough intraoral physical examination.

CBCT cannot outline the normal sinus mucosa. Schneiderian membrane perforation is the most prevalent complication of open sinus lift surgery.[55] The mean thickness of the membrane is less than 1 mm, while the CBCT with 2-mm slices can just show mucosal thickening of more than 2 mm.[56] Very thin maxillary sinus mucous membrane is susceptible to perforation even in the hands of the most experienced surgeons.[57]

Panoramic views can reveal sinus septa but with false positive and false negative results.[58] Oblique septa may not appear on panoramic views. The length of the subantral bone is less accurate in panoramic views than the in CBCT images, so relying only on this radiographic technique for deciding about open sinus lifting will overestimate the need for sinus augmentation.[59]

Conclusion

More than ten parameters should be checked in evaluating CBCT images of paranasal sinuses other than the width and the length of the residual ridge in the posterior region of the maxilla. Each of them may have a significant impact on the results of the open sinus lift surgery.

References

1. Chiapasco M, Zaniboni M. Methods to treat the edentulous posterior maxilla: Implants with sinus grafting. J Oral Maxillofac Surg 2009;67(4):867-71.
2. Peleg M, Garg AK, Misch CM, Mazor Z. Maxillary sinus and ridge augmentations using a surface-derived autogenous bone graft. J Oral Maxillofac Surg 2004;62(12):1535-44.
3. Dobele I, Kise L, Apse P, Kragis G, Bigestans A. Radiographic assessment of findings in the maxillary sinus using cone-beam computed tomography. Stomatologija 2013;15(4):119-22.
4. Nunes LS, Bornstein MM, Sendi P, Buser D. Anatomical characteristics and dimensions of edentulous sites in the posterior maxillae of patients referred for implant therapy. Int J Periodontics Restorative Dent 2013;33(3):337-45.
5. Khajehahmadi S, Rahpeyma A, Hoseini Zarch SH. Association between the lateral wall thickness of the maxillary sinus and the dental status: Cone beam computed tomography evaluation. Iran J Radiol 2014;11(1):e6675.
6. van den Bergh JP, ten Bruggenkate CM, Disch FJ, Tuinzing DB. Anatomical aspects of sinus floor elevations. Clin Oral Implants Res 2000;11(3):256-65.
7. Apostolakis D, Bissoon AK. Radiographic evaluation of the superior alveolar canal: Measurements of its diameter and of its position in relation to the maxillary sinus floor: A cone beam computerized tomography study. Clin Oral Implants Res 2014;25(5):553-9.
8. Greenstein G, Cavallaro J, Tarnow D. Practical application of anatomy for the dental implant surgeon. J Periodontol 2008;79(10):1833-46.
9. Ewers R. Maxilla sinus grafting with marine algae derived bone forming material: A clinical report of long-term results. J Oral Maxillofac Surg 2005;63(12):1712-23.
10. Ella B, Sédarat C, Noble Rda C, Normand E, Lauverjat Y, Siberchicot F, *et al.* Vascular connections of the lateral wall of the sinus: Surgical effect in sinus augmentation. Int J Oral Maxillofac Implants 2008;23(6):1047-52.
11. Kaufman E. Maxillary sinus elevation surgery: An overview. J Esthet Restor Dent 2003;15(5):272-82.
12. Velloso GR, Vidigal GM Jr, de Freitas MM, Garcia de Brito OF, Manso MC, Groisman M. Tridimensional analysis of maxillary sinus anatomy related to sinus lift procedure. Implant Dent 2006;15(2):192-6.
13. Chan HL, Suarez F, Monje A, Benavides E, Wang HL. Evaluation of maxillary sinus width on cone-beam computed tomography for sinus augmentation and new sinus classification based on sinus width. Clin Oral Implants Res 2014;25(6):647-52.
14. Mazor Z, Peleg M, Gross M. Sinus augmentation for single-tooth replacement in the posterior maxilla: A 3-year follow-up clinical report. Int J Oral Maxillofac Implants 1999;14(1):55-60.
15. Kahnberg KE, Wallström M, Rasmusson L. Local sinus lift for single-tooth implant. I: Clinical and radiographic follow-up. Clin Implant Dent Relat Res 2011;13(3):231-7.
16. Kim MJ, Jung UW, Kim CS, Kim KD, Choi SH, Kim CK, *et al.* Maxillary sinus septa: Prevalence, height, location, and morphology. A reformatted computed tomography scan analysis. J Periodontol 2006;77(5):903-8.
17. Neugebauer J, Ritter L, Mischkowski RA, Dreiseidler T, Scherer P, Ketterle M, *et al.* Evaluation of maxillary sinus anatomy by cone-beam CT prior to sinus floor elevation. Int J Oral Maxillofac Implants 2010;25(2):258-65.
18. Zijderveld SA, van den Bergh JP, Schulten EA, ten Bruggenkate CM. Anatomical and surgical findings and complications in 100 consecutive maxillary sinus floor elevation procedures. J Oral Maxillofac Surg 2008;66(7):1426-38.
19. Krennmair G, Ulm C, Lugmayr H. Maxillary sinus septa: Incidence, morphology and clinical implications. J Craniomaxillofac Surg 1997;25(5):261-5.
20. Gaggl A, Schultes G, Santler G, Kärcher H. Treatment planning for sinus lift augmentations through use of 3-dimensional milled models derived from computed tomography scans: A report of 3 cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;86:388-92.
21. Geurs NC, Wang IC, Shulman LB, Jeffcoat MK. Retrospective radiographic analysis of sinus graft and implant placement procedures from the Academy of Osseointegration Consensus Conference on Sinus Grafts. Int J Periodontics Restorative Dent 2001;21(5):517-23.
22. Duckmanton NA, Austin BW, Lechner SK, Klineberg IJ. Imaging for predictable maxillary implants. Int J Prosthodont 1994;7(1):77-80.
23. Marchand-Libouban H, Guillaume B, Bellaiche N, Chappard D. Texture analysis of computed tomographic images in osteoporotic patients with sinus lift bone graft reconstruction. Clin Oral Investig 2013;17(4):1267-72.

24. Pignataro L, Mantovani M, Torretta S, Felisati G, Sambataro G. ENT assessment in the integrated management of candidate for (maxillary) sinus lift. Acta Otorhinolaryngol Ital 2008;28(3):110-9.
25. Tos M, Mogensen C. Mucus production in the nasal sinuses. Acta Otolaryngol Suppl 1979;360:131-4.
26. Pommer B, Unger E, Sütö D, Hack N, Watzek G. Mechanical properties of the Schneiderian membrane *in vitro*. Clin Oral Implants Res 2009;20(6):633-7.
27. Waite DE. Maxillary sinus. Dent Clin North Am 1971;15(2):349-68.
28. Wen SC, Lin YH, Yang YC, Wang HL. The influence of sinus membrane thickness upon membrane perforation during transcrestal sinus lift procedure. Clin Oral Implants Res 2014.
29. Kara IM, Küçük D, Polat S. Experience of maxillary sinus floor augmentation in the presence of antral pseudocysts. J Oral Maxillofac Surg 2010;68(8):1646-50.
30. Mardinger O, Manor I, Mijiritsky E, Hirshberg A. Maxillary sinus augmentation in the presence of antral pseudocyst: A clinical approach. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103(2):180-4.
31. Scattarella A, Ballini A, Grassi FR, Carbonara A, Ciccolella F, Dituri A, *et al.* Treatment of oroantral fistula with autologous bone graft and application of a non-reabsorbable membrane. Int J Med Sci 2010;7(5):267-71.
32. Watzak G, Tepper G, Zechner W, Monov G, Busenlechner D, Watzek G. Bony press-fit closure of oro-antral fistulas: A technique for pre-sinus lift repair and secondary closure. J Oral Maxillofac Surg 2005;63(9):1288-94.
33. Lawson W, Patel ZM, Lin FY. The development and pathologic processes that influence maxillary sinus pneumatization. Anat Rec (Hoboken) 2008;291(11):1554-63.
34. Rahpeyma A, Khajehahmadi S. Reconstruction of the maxilla by submental flap. ANZ J Surg 2014.
35. Rahpeyma A, Khajehahmadi S. Alveolar Antral Artery: Review of Surgical Techniques Involving this Anatomic Structure. Iran J Otorhinolaryngol 2014;26(75):73-8.
36. Chan HL, Monje A, Suarez F, Benavides E, Wang HL. Palatonasal recess on medial wall of the maxillary sinus and clinical implications for sinus augmentation via lateral window approach. J Periodontol 2013;84(8):1087-93.
37. Komori E, Sugisaki M. Ectopic pneumosinus maxillaris dilatans. A case report. J Craniomaxillofac Surg 1988;16(5):240-2.
38. Alberti PW. Applied surgical anatomy of the maxillary sinus. Otolaryngol Clin North Am 1976;9(1):3-20.
39. Woo I, Le BT. Maxillary sinus floor elevation: Review of anatomy and two techniques. Implant Dent 2004;13(1):28-32.
40. Tidwell JK, Blijdorp PA, Stoelinga PJ, Brouns JB, Hinderks F. Composite grafting of the maxillary sinus for placement of endosteal implants. A preliminary report of 48 patients. Int J Oral Maxillofac Surg 1992;21(4):204-9.
41. Vercellotti T, De Paoli S, Nevins M. The piezoelectric bony window osteotomy and sinus membrane elevation: Introduction of a new technique for simplification of the sinus augmentation procedure. Int J Periodontics Restorative Dent 2001;21(6):561-7.
42. Avera SP, Stampley WA, McAllister BS. Histologic and clinical observations of resorbable and nonresorbable barrier membranes used in maxillary sinus graft containment. Int J Oral Maxillofac Implants 1997;12(1):88-94.
43. Bensaha T. Evaluation of the capability of a new water lift system to reduce the risk of Schneiderian membrane perforation during sinus elevation. Int J Oral Maxillofac Surg 2011;40(8):815-20.
44. Wallace SS, Tarnow DP, Froum SJ, Cho SC, Zadeh HH, Stoupel J, *et al.* Maxillary sinus elevation by lateral window approach: Evolution of technology and technique. J Evid Based Dent Pract 2012;12 3 Suppl:161-71.
45. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. J Oral Surg 1980;38(8):613-6.
46. Ozyuvaci H, Aktas I, Yerit K, Aydin K, Firatli E. Radiological evaluation of sinus lift operation: What the general radiologist needs to know. Dentomaxillofac Radiol 2005;34:199-204.
47. Rysz M, Ciszek B, Rogowska M, Krajewski R. Arteries of the anterior wall of the maxilla in sinus lift surgery. Int J Oral Maxillofac Surg 2014;43(9):1127-30.
48. Kang SJ, Shin SI, Herr Y, Kwon YH, Kim GT, Chung JH. Anatomical structures in the maxillary sinus related to lateral sinus elevation: A cone beam computed tomographic analysis. Clin Oral Implants Res 2013;24 Suppl A100:75-81.
49. Rosano G, Taschieri S, Gaudy JF, Weinstein T, Del Fabbro M. Maxillary sinus vascular anatomy and its relation to sinus lift surgery. Clin Oral Implants Res 2011;22(7):711-5.
50. Shanbhag S, Karnik P, Shirke P, Shanbhag V. Cone-beam computed tomographic analysis of sinus membrane thickness, ostium patency, and residual ridge heights in the posterior maxilla: Implications for sinus floor elevation. Clin Oral Implants Res 2014;25(6):755-60.
51. Jang HY, Kim HC, Lee SC, Lee JY. Choice of graft material in relation to maxillary sinus width in internal sinus floor augmentation. J Oral Maxillofac Surg 2010;68(8):1859-68.
52. Wallace SS. Maxillary sinus augmentation: Evidence-based decision making with a biological surgical approach. Compend Contin Educ Dent 2006;27:662-8.
53. Kim YK, Hwang JW, Yun PY. Closure of large perforation of sinus membrane using pedicled buccal fat pad graft: A case report. Int J Oral Maxillofac Implants 2008;23(6):1139-42.
54. Timmenga NM, Raghoebar GM, Boering G, van Weissenbruch R. Maxillary sinus function after sinus lifts for the insertion of dental implants. J Oral Maxillofac Surg 1997;55:936-9.
55. Hernández-Alfaro F, Torradeflot MM, Marti C. Prevalence and management of Schneiderian membrane perforations during sinus-lift procedures. Clin Oral Implants Res 2008;19(9):91-8.
56. Cagici CA, Yilmazer C, Hurcan C, Ozer C, Ozer F. Appropriate interslice gap for screening coronal paranasal

sinus tomography for mucosal thickening. Eur Arch Otorhinolaryngol 2009;266(4):519-25.
57. Becker ST, Terheyden H, Steinriede A, Behrens E, Springer I, Wiltfang J. Prospective observation of 41 perforations of the Schneiderian membrane during sinus floor elevation. Clin Oral Implants Res 2008;19(12):1285-9.
58. Maestre-Ferrín L, Carrillo-García C, Galán-Gil S, Peñarrocha-Diago M, Peñarrocha-Diago M. Prevalence, location, and size of maxillary sinus septa: Panoramic radiograph versus computed tomography scan. J Oral Maxillofac Surg 2011;69(2):507-11.
59. Fortin T, Camby E, Alik M, Isidori M, Bouchet H. Panoramic images versus three-dimensional planning software for oral implant planning in atrophied posterior maxillary: A clinical radiological study. Clin Implant Dent Relat Res 2013;15(2):198-204.