Maxillary Sinus Lateral Wall Thickness and Morphologic Patterns in the Atrophic Posterior Maxilla

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Background: The aim of the present study is to examine the sinus lateral wall thickness (LWT) of atrophic posterior maxilla (<10 mm) of patients with complete and partial edentulism and determine the influence of residual ridge height (RH), sex, and age on maxillary LWT.

Methods: Four hundred fourteen measures were taken from 140 consecutive patients that met the inclusion criteria. On the selected sagittal section, a built-in digital caliper recorded in millimeters the RH and LWT (a perpendicular line at 3, 5, 7, 10, 13, and 15 mm from the lowest point of the sinus floor). Edentulous spans were further classified as complete edentulous atrophic maxilla (CEM) and partial edentulous atrophic maxilla (PEM). The mixed linear model was used to test the effects of sex, type of edentulism, edentulous span, and RH on the measurement of the LWT of the sinus.

Results: Mean LWT for PEM was 1.71 ± 0.12 mm, and for CEM, 1.57 ± 0.07 mm ($P = 0.01$). The mixed model yielded significant effect of edentulous span ($P = 0.048$) and interactions among type of edentulism and edentulous span ($P < 0.001$) and edentulous span by RH ($P < 0.01$). Age and RH were positively associated with LWT; however, they did not interact with RH, sex, or type of edentulism. RH has been shown to correlate with edentulous span ($P < 0.001$) and type of edentulism ($P = 0.01$). The longer the edentulous span, the thinner the LWT. Similarly, RH was larger for PEM (6.85 ± 0.34 mm) than CEM (5.69 ± 0.26 mm).

Conclusions: The maxillary sinus lateral wall tends to increase in thickness from the second premolar to the second molar and from 5 mm up to 15 mm. In addition, RH, presence of teeth adjacent to the edentulous atrophic ridge, and age were shown to influence maxillary sinus LWT. *J Periodontol 2014;85:676-682.*

KEY WORDS

Anatomy and histology; bone regeneration; dental implants; maxillary sinus; oral surgical procedures; sinus floor augmentation.

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Oral rehabilitation in the posterior maxilla often presents a challenge owing to ridge resorption after tooth extraction and subsequent sinus pneumatization.[1,2] Several techniques have been used to overcome this challenge: bone augmentation,[3] short implants,[4] or tilted implants;[5,6] however, shorter and tilted implants may not have long-term stability due to strong occlusal forces exerted in this area.[7] In addition, the atrophic posterior maxilla has lower bone density[8] than the non-atrophic posterior maxilla, and this may lead to other potential complications such as implant migration to the maxillary sinus.[9] To avoid these potential complications, sinus augmentation with a variety of bone grafts has been regarded as a gold standard in reconstructing deficient posterior reabsorbed maxilla.[10]

Two main approaches for sinus augmentation have been proposed: lateral window approach[11] and crestal approach using primarily osteotomies.[12] Both have shown acceptable results;[10] however, the lateral window approach is still considered more predictable in terms of outcome and safety, especially for cases with minimal bone height.[13] Despite this predictability, complications do occur, most related to sinus anatomy.[14] Extensive bleeding, implant migration, and sinus infection should be considered when performing sinus augmentation, and clinicians should learn how to prevent

doi: 10.1902/jop.2013.130392

and manage these problems.[15] Sinus membrane perforation (19.8%)[16] remains the most common complication during sinus augmentation. To avoid this, preoperative assessment of anatomy variations by radiographic assessments are essential.[14] The presence of septum, sinus shape/morphology, and a sharp angulation between the lateral and medial wall have all been shown to increase the chance of membrane perforation and indirectly lead to sinus complications.[14] In addition, osteotomy of the lateral wall may tear the Schneiderian membrane.[17] Knowledge of the sinus anatomy, including lateral wall thickness (LWT), is key to minimizing these potential complications.

Cone-beam computed tomography (CBCT) offers a three-dimensional reliable diagnostic image for detecting anatomic variations of the maxillofacial region and enables us to report more precise data. Only two studies have evaluated sinus LWT by radiographic assessment;[18,19] these data on Korean patients cannot be extrapolated to a white population. In addition, neither of the current studies examined the influence of residual ridge height (RH) on LWT. Hence, the present study aims to investigate: 1) posterior atrophic maxilla (<10 mm) sinus LWT in patients with complete and partial edentulism; and 2) the influence of RH, sex, and age on LWT.

MATERIALS AND METHODS

This study used a retrospective clinical database that included patients treated as part of routine periodontal care using accepted therapy for each patient's specific clinical needs. Because this study involved a retrospective analysis of preexisting data, and current data do not include any identifiable private information, approval by an institutional ethics board was not required.

Patient Selection

Overall, 414 measures were taken from 140 consecutive white patients fulfilling the inclusion criteria (144 males and 270 females; mean age: 67.2 ± 18.8 years) (2:1 female:male ratio).

Image Acquisition

The scans used were selected from the CBCT database. All images were obtained with a CBCT machine‖ in the Center of Implantology, Oral and Maxillofacial Surgery (CICOM), Badajoz, Spain, by an experienced radiologist (VC) between 2010 and 2013. The imaging parameters were set at 120 kVp, 18.66 mAs, scan time 20 seconds, resolution 0.4 mm, and field of view that varied based on the scanned region. The CBCT scans of each individual were transferred to a desktop computer equipped with implant planning software.¶ Data were saved in the digital imaging and communications in medicine (DICOM) format.

Inclusion and Exclusion Criteria

One examiner (AM) conducted image screening using the following inclusion/exclusion criteria.

Images were included if: 1) maxillary sinuses were located between premolars and molars as a result of missing single or multiple teeth; 2) RH was <10 mm; 3) teeth were present adjacent to or opposing the edentulous area so that the location of the edentulous ridges corresponding to the tooth site could be identified; and 4) the maxillary sinus to be measured was visible from its floor to ≥15 mm from the alveolar crest of the edentulous ridge.

Images were excluded if: 1) unclear or incomplete due to scattering or other reasons; 2) edentulous ridge height was <10 mm; 3) the location of the edentulous ridge could not be determined; 4) sinus pathology was present that made the measurement impossible; 5) the outline of the edentulous ridge could not be identified, e.g., extraction sockets; or 6) the sinus had been grafted or implants had been placed.

Image Analysis

On the selected sagittal section, a built-in digital caliper made the following measurements in millimeters: RH (the distance from the alveolar crest up to the lowest point of the sinus floor) and LWT (a perpendicular line at 3, 5, 7, 10, 13, and 15 mm from the lowest point of the sinus floor) (Fig. 1). The 15-mm level was chosen to be the level where the lateral window augmentation ends.[20] The edentulous areas were further classified as complete edentulous atrophic maxilla (CEM) and partial edentulous atrophic maxilla (PEM) in an attempt to determine the influence of the presence of teeth on LWT.

Statistical Analyses

The mixed linear model as implemented in software# was used to test the effects of sex, type of edentulism, edentulous span (within patients: first molar [1M], second molar [2M] and second premolar [2PM]), and RH of the measurement (within patients: 3, 5, 7, 10, 13, and 15 mm) on the LWT of the sinus. RH and patient age served as covariates for the analysis. The mixed model was also used to test the effects of sex, type of edentulism, and edentulous span on RH, with patient age serving as a covariate. The type of covariance matrix was selected using the Schwarz–Bayesian criterion. A *P* level of 0.05 was set for significance level. When needed, the Sidak correction for post hoc comparison was used.

RESULTS

The average thickness in millimeters and the 95% confidence intervals for the LWT as a function of

‖ i-CAT, Imaging Sciences International, Hatfield, PA.
¶ InvivoDent, Anatomage, San Jose, CA.
# SPSS, v.17.0, IBM, Chicago, IL.

edentulous span and height of the measurement are presented in Table 1. Figure 2 displays the interaction between edentulous span and measured height for LWT. Additionally, Table 2 lists the percentiles according to edentulous span, type of edentulism, and height of edentulism.

Using a compound symmetry covariance matrix, the mixed model yielded main effect of edentulous span (Table 3), $F(1; 1{,}520) = 3.03$, $P = 0.048$), and the interactions among type of edentulous and edentulous span (Fig. 3) $F(2; 1{,}013) = 9.37$, $P<0.001$, and edentulous span by RH, $F(10; 1{,}394) = 2.56$, $P<0.01$. Age and RH were positively associated with LWT (slope = 0.017 mm/year, $P = 0.033$, and slope = 0.15 mm/year, $P = 0.044$, respectively), but they did not interact with RH of the measure, sex, or type of edentulism (all $P > 0.30$). However, RH did interact with edentulous span ($P < 0.001$), which indicated that slopes between RH and the LWT were different for each edentulous span.

Regarding the influence of RH on LWT, the mixed model yielded only main effect of type of edentulism, $F(1,141) = 6.82$, $P = 0.01$, and edentulous span, $F(2,213) = 9.56$, $P < 0.001$. RH was larger for PEM (6.85 ± 0.34 mm) than CEM (5.69 ± 0.26 mm). In addition, RH was found to be smaller for 1M and 2M (5.96 ± 0.23, 5.89 ± 0.30 mm) than for 2PM (6.96 ± 0.27 mm) edentulous spans.

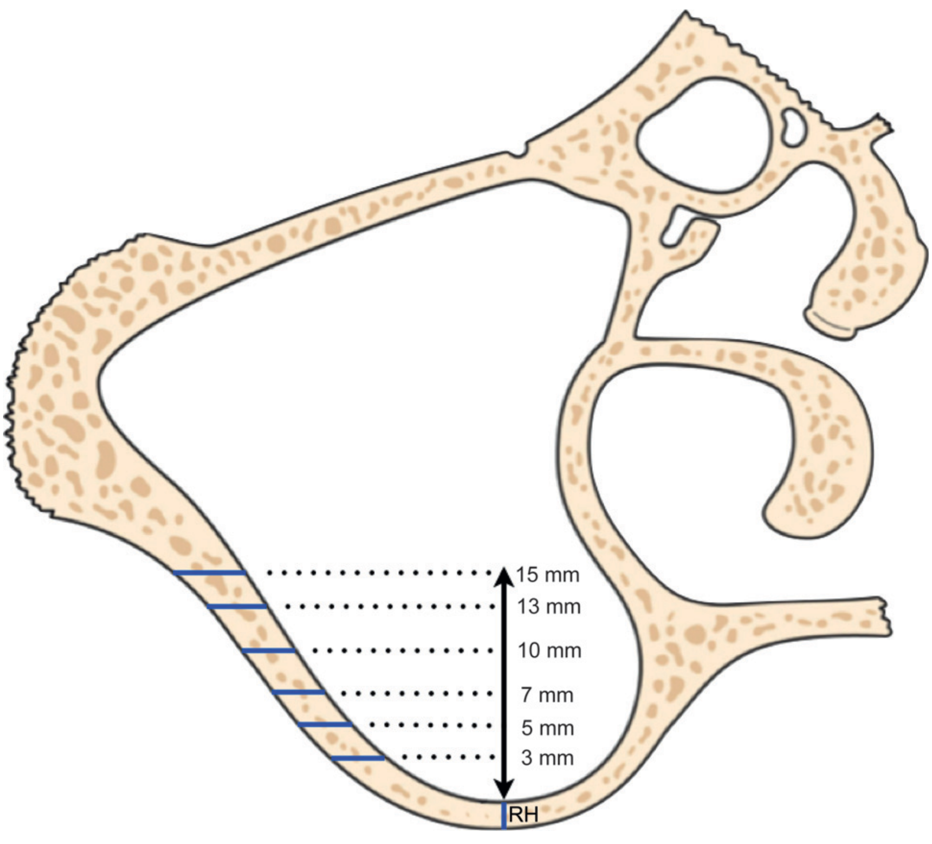

Figure 1.
Depiction of RH and LWT at all the measured levels.

DISCUSSION

Maxillary sinus augmentation via lateral approach presents complexity for dissection and elevation of sinus membrane, often due to the irregular anatomy associated with the sinus.[21] This irregular anatomy may result in a tear of the Schneiderian membrane during surgery. To successfully perform this procedure, a thorough understanding of the anatomy of the maxillary sinus is imperative. Although the influence of membrane perforation on implant success remains to be determined,[22] the factors that influence it must be thoroughly assessed to avoid surgical and post-surgical complications. The presence of septum, sinus shape/morphology, and a sharp

Table 1.

Thickness in mm (average [95% confidence interval]) for the LWT as Function of Edentulous Span and Measured Height

Edentulous span	3 mm	5 mm	7 mm	10 mm	13 mm	15 mm
2PM	1.37 (1.20 to 1.54)	1.18 (1.01 to 1.35)	1.22 (1.05 to 1.39)	1.27 (1.10 to 1.44)	1.36 (1.19 to 1.53)	1.44 (1.28 to 1.61)
1M	1.70 (1.55 to 1.84)	1.57 (1.43 to 1.71)	1.61 (1.46 to 1.75)	1.76 (1.61 to 1.9)	1.93 (1.78 to 2.07)	2.09 (1.94 to 2.23)
2M	1.72 (1.54 to 1.89)	1.56 (1.39 to 1.74)	1.67 (1.49 to 1.84)	1.86 (1.69 to 2.03)	2.07 (1.90 to 2.25)	2.21 (2.04 to 2.39)

angulation between the lateral and medial wall have all been shown to increase the incidence of membrane perforation.[14] These findings are in agreement with the data reported from this study, which showed that RH, age, and the type of edentulism (PEM or CEM) impact LWT. On the contrary, sex did not seem to affect LWT. Because of these factors, each case must be evaluated independently to reduce the number of membrane perforations and consequent complications. The findings from the present study might help the clinician overcome the pitfalls during maxillary sinus augmentation by illustrating the anatomic patterns of the lateral wall.

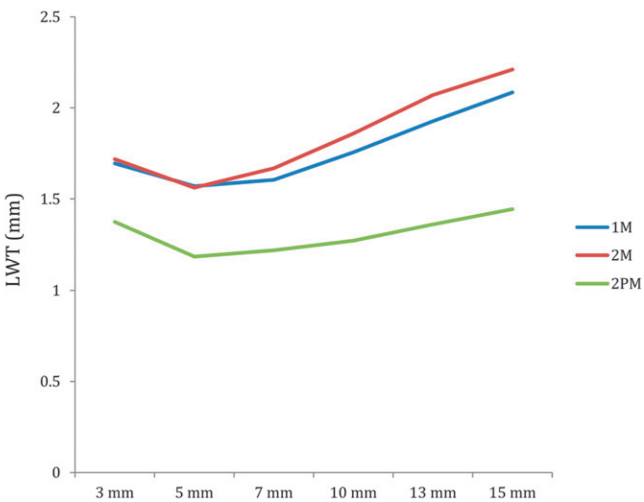

Figure 2.
Interaction between edentulous span and measured height for LWT.

The management of the lateral wall during sinus augmentation via lateral approach has been emphasized because its thickness may influence the integrity of the Schneiderian membrane.[2] Results from this study demonstrate that mean LWT for PEM was 1.71 ± 0.12 mm, and for CEM, 1.57 ± 0.07 mm ($P = 0.01$). Yang et al.[18] found thicker mean LWT in patients with complete edentulism (1.75 ± 0.80 mm) than PEM. This difference might be attributed to either the measuring reference used to determine LWT (i.e., anatomic landmarks or inclination of the line following the lateral wall anatomy) or the race of the patients.[18] On the other hand, Neiva et al.[23] showed, in white skulls, that mean LWT was thinner than that found in the present study (0.91 ± 0.43 mm). Again, instruments used to record the data might be the cause of this disparity.[23] Furthermore, it is noteworthy that these findings demonstrated that the presence of teeth adjacent to the edentulous span is related to mean LWT.

In this study, it was found that the maxillary sinus lateral wall tends to increase in thickness from the second premolar to the second molar area from 5 mm up to 15 mm. In addition, RH, presence of teeth adjacent to the edentulous atrophic ridge, and age have all been shown to influence maxillary sinus LWT. This is in agreement with a recent study that reported that LWT tended to increase from the

Table 2.

Percentiles According to Edentulous Span, Type of Edentulism, and RH

Edentulous span	Type of Edentulism	Percentile	3 mm	5 mm	7 mm	10 mm	13 mm	15 mm	RH
2PM	PEM	25	1.25	1.00	1.00	1.00	1.00	1.00	5.24
		50	1.25	1.03	1.25	1.26	1.5	1.50	7.68
		75	1.60	1.50	1.56	1.75	1.81	2.06	8.82
	CEM	25	1.14	1.00	0.90	0.85	1.00	1.00	4.56
		50	1.25	1.20	1.20	1.23	1.25	1.25	6.25
		75	1.58	1.50	1.50	1.58	1.75	1.74	7.94
1M	PEM	25	1.33	1.25	1.25	1.31	1.50	1.50	5.06
		50	1.75	1.59	1.54	1.75	2.00	2.00	6.63
		75	2.00	2.00	2.00	2.25	2.29	2.71	8.19
	CEM	25	1.03	1.00	1.00	1.00	1.06	1.25	3.75
		50	1.50	1.25	1.25	1.46	1.75	2.00	5.00
		75	2.00	1.75	1.75	2.00	2.00	2.25	6.8
2M	PEM	25	1.26	1.25	1.10	1.25	1.25	1.25	3.75
		50	1.50	1.50	1.75	1.75	1.75	1.66	7.00
		75	2.00	1.88	2.00	2.00	2.00	2.58	8.2
	CEM	25	1.20	1.00	1.00	1.20	1.27	1.50	3.25
		50	1.27	1.25	1.50	1.60	1.77	2.00	5.56
		75	2.00	1.60	1.75	2.15	2.5	2.80	7.75

Table 3.

Thickness in mm (average [SE]) for the LWT as Function of Type of Edentulism and Edentulous Span

Edentulous Span	PEM	CEM
1M	1.94 (0.09)	1.61 (0.07)
2M	1.93 (0.12)	1.77 (0.07)
2PM	1.27 (0.11)	1.35 (0.07)

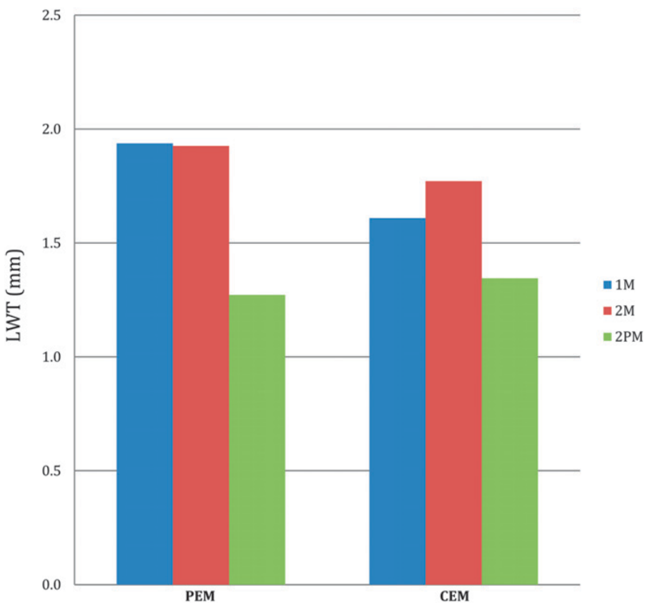

Figure 3.
Interaction between type of edentulism and edentulous span for LWT.

second premolar to the second molar.[18] These data are also in agreement with Neiva et al.,[23] who conducted a study on white skulls and reported that LWT varies depending on each individual and on the region measured; however, these differences were not significant.[23] Similar results were also obtained by Yang et al.[24] in non-embalmed Korean hemifaces. They reported that LWT was thinner in the second molar region than in the first molar region. In addition, it was pointed out that structures such as the zygomatic buttress or the maxillary tuberosity may influence LWT. However, in a CBCT study on Korean patients, Kang et al.,[19] found that the more anterior the region, the thicker the LWT. The differences noted in these studies might be due to ethnicity or the methods used to determine LWT. Additionally, it is important to remember that research using CBCT has an intrinsic risk of bias due to the distortion of this device; and that differences might be attributable to this as well.[25]

Regarding the vertical height where LWT was measured, significant differences were found at 10 mm from the sinus floor of the edentulous region between the first molar and second premolar and between the second molar and second premolar, as well as at 15 mm between the first and second molar. These results showed similarities to previous studies[18,19,23,24] but cannot be compared due to the disparity in methodology, ethnicity, and inclusion criteria carried out in other research. It was found that in the second premolar area, at all the measured points, LTW was thinner than the rest of the plotted regions. Furthermore, it was observed that there was a tendency to increase LWT when it increases from 5 mm and that at 3 mm in all measurements LWT was thicker than at 5-mm measurements. One interesting finding was that in the PEM group, the first and second premolar regions were similar but both differed at second premolar. On the other hand, for the CEM group, the first molar region differed from the second molar region but again, both differed from the second premolar region.

In addition, previous studies have assessed the influence of sex and age on the maxillary sinus anatomy;[18,23,26-28] however, only one[18] focused on LWT. The present study found a significant difference in mean LWT between sexes only in the premolar region. However, no correlation was found between sex and LWT in this study. Therefore, the present study is in agreement with previous studies in which significant differences in the maxillary sinus anatomy were not observed between sexes.[27,28]

With respect to aging, it is hypothesized that aging causes the pneumatization of the maxillary sinus and, consequently, younger individuals would have thicker LWT. The present findings showed that LWT is positively correlated with RH and age. In other words, the higher the RH, the greater the LWT is expected to be, with a slope of 0.15 mm/year. Furthermore, the older the patient, the thicker LWT should be, with a presumed slope of 0.017 mm/year. This study corresponds with findings from previous studies[18,19,24,27] that lateral pneumatization does not increase with age. This might be explained by the different populations that were included in all these studies (white[23] versus Korean[18,19,24]).

Results from this study imply that the less RH, the thinner the lateral maxillary sinus wall. As reported by Monje et al.,[8] who showed that bone density in maxillary sinus region is influenced by the remaining bone height, a thinner LWT suggests a lower bone density. This may suggest that when performing a maxillary sinus augmentation via lateral approach in severely reabsorbed maxilla, increased care is required because LWT might be more soft and friable.

CONCLUSIONS

The maxillary sinus lateral wall tends to increase in thickness from the second premolar to the second molar and from 5 mm up to 15 mm. In addition, RH, presence of teeth adjacent to the edentulous atrophic ridge, and age have all been shown to influence maxillary sinus LWT. Nonetheless, each case must be individualized to foresee possible complications owing to anatomic variations.

ACKNOWLEDGMENTS

The authors thank FEDICOM Foundation (Foundation for the Study of Implantology, Oral and Maxillofacial Surgery), Badajoz, Spain, for financial support. Also, they thank Ms. Purification Barragán, CICOM, Badajoz, Spain, for her valuable help to collect and organize the data included in this study. Moreover, the authors thank Dr. Miguel Velasco-Torres, Department of Oral Surgery and Implant Dentistry, University of Granada, Spain, for his valuable help in developing this research and Dr. Ivan E. Rudek, Department of Periodontics and Oral Medicine, University of Michigan, Ann Arbor, Michigan, for providing the depiction of the maxillary sinus to explain the methodology carried out to obtain the measurements of the LWT. Additionally, the authors are grateful for the assistance of Dr. Alexandra B. Plonka, Department of Periodontics and Oral Medicine, University of Michigan, for editing this manuscript. The authors report no conflicts of interest related to this study.

REFERENCES

1. Pietrokovski J, Massler M. Alveolar ridge resorption following tooth extraction. *J Prosthet Dent* 1967;17: 21-27.
2. van den Bergh JP, ten Bruggenkate CM, Disch FJ, Tuinzing DB. Anatomical aspects of sinus floor elevations. *Clin Oral Implants Res* 2000;11:256-265.
3. Chiapasco M, Casentini P, Zaniboni M. Bone augmentation procedures in implant dentistry. *Int J Oral Maxillofac Implants* 2009;24(Suppl.):237-259.
4. Monje A, Chan HL, Fu JH, Suarez F, Galindo-Moreno P, Wang HL. Are short dental implants (<10 mm) effective? A meta-analysis on prospective clinical trials. *J Periodontol* 2013;84:895-904.
5. Monje A, Chan HL, Suarez F, Galindo-Moreno P, Wang HL. Marginal bone loss around tilted implants in comparison to straight implants: A meta-analysis. *Int J Oral Maxillofac Implants* 2012;27:1576-1583.
6. Del Fabbro M, Bellini CM, Romeo D, Francetti L. Tilted implants for the rehabilitation of edentulous jaws: A systematic review. *Clin Implant Dent Relat Res* 2010; 14:612-621.
7. Friberg B, Jemt T, Lekholm U. Early failures in 4,641 consecutively placed Brånemark dental implants: A study from stage 1 surgery to the connection of completed prostheses. *Int J Oral Maxillofac Implants* 1991;6:142-146.
8. Monje A, Monje F, González-García R, et al. Influence of atrophic posterior maxilla ridge height on bone density and microarchitecture [published online ahead of print April 22, 2013]. *Clin Implant Dent Relat Res.* doi: 10.1111/cid.12075.
9. Galindo-Moreno P, Padial-Molina M, Avila G, Rios HF, Hernández-Cortés P, Wang HL. Complications associated with implant migration into the maxillary sinus cavity. *Clin Oral Implants Res* 2012;23:1152-1160.
10. Wallace SS, Froum SJ. Effect of maxillary sinus augmentation on the survival of endosseous dental implants. A systematic review. *Ann Periodontol* 2003; 8:328-343.
11. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. *J Oral Surg* 1980;38:613-616.
12. Summers RB. A new concept in maxillary implant surgery: the osteotome technique. *Compendium* 1994;15: 152, 154-156, 158 passim; quiz 162.
13. Misch CE. Maxillary sinus augmentation for endosteal implants: Organized alternative treatment plans. *Int J Oral Implantol* 1987;4:49-58.
14. Chan HL, Monje A, Suarez F, Benavides E, Wang HL. Palatonasal recess on medial wall of maxillary sinus and clinical implications for sinus augmentation via lateral window approach. *J Periodontol* 2012;84:1087-1093.
15. Chan HL, Wang HL. Sinus pathology and anatomy in relation to complications in lateral window sinus augmentation. *Implant Dent* 2011;20:406-412.
16. Pjetursson BE, Tan WC, Zwahlen M, Lang NP. A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. *J Clin Periodontol* 2008;35 (Suppl. 8):216-240.
17. Hernández-Alfaro F, Torradeflot MM, Marti C. Prevalence and management of Schneiderian membrane perforations during sinus-lift procedures. *Clin Oral Implants Res* 2008;19:91-98.
18. Yang SM, Park SI, Kye SB, Shin SY. Computed tomographic assessment of maxillary sinus wall thickness in edentulous patients. *J Oral Rehabil* 2012;39: 421-428.
19. 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* 2011; 24(Suppl. A100):75-81.
20. Wang HL, Katranji A. ABC sinus augmentation classification. *Int J Periodontics Restorative Dent* 2008;28: 383-389.
21. 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;15:192-196.
22. Ardekian L, Oved-Peleg E, Mactei EE, Peled M. The clinical significance of sinus membrane perforation during augmentation of the maxillary sinus. *J Oral Maxillofac Surg* 2006;64:277-282.
23. Neiva RF, Gapski R, Wang HL. Morphometric analysis of implant-related anatomy in Caucasian skulls. *J Periodontol* 2004;75:1061-1067.
24. Yang HM, Bae HE, Won SY, et al. The buccofacial wall of maxillary sinus: An anatomical consideration for sinus augmentation. *Clin Implant Dent Relat Res* 2009;11(Suppl. 1):e2-e6.
25. Baumgaertel S, Palomo JM, Palomo L, Hans MG. Reliability and accuracy of cone-beam computed

tomography dental measurements. *Am J Orthod Dentofacial Orthop* 2009;136:19-25; discussion 25-18.

26. Sharan A, Madjar D. Maxillary sinus pneumatization following extractions: A radiographic study. *Int J Oral Maxillofac Implants* 2008;23:48-56.
27. Güler AU, Sumer M, Sumer P, Biçer I. The evaluation of vertical heights of maxillary and mandibular bones and the location of anatomic landmarks in panoramic radiographs of edentulous patients for implant dentistry. *J Oral Rehabil* 2005;32:741-746.
28. Neugebauer J, Ritter L, Mischkowski RA, et al. Evaluation of maxillary sinus anatomy by cone-beam CT prior to sinus floor elevation. *Int J Oral Maxillofac Implants* 2010;25:258-265.

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Submitted June 17, 2013; accepted for publication July 24, 2013.