Int. J. Oral Maxillofac. Surg. 2016; 45: 1570–1576
http://dx.doi.org/10.1016/j.ijom.2016.09.023, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Systematic Review
Dental Implants

Maxillary sinus lift surgery—with or without graft material? A systematic review

L. deF.Silva[1], V. N. de Lima[1], L. P. Faverani[1], M. R. de Mendonça[2], R. Okamoto[3], E. P. Pellizzer[4]

[1]Department of Surgery and Integrated Clinic, Araçatuba Dental School, Universidade Estadual Paulista (UNESP), Araçatuba, São Paulo, Brazil; [2]Department of Infant and Social Dentistry, Araçatuba Dental School, Universidade Estadual Paulista (UNESP), Araçatuba, São Paulo, Brazil; [3]Department of Basic Sciences, Araçatuba Dental School, Universidade Estadual Paulista (UNESP), Araçatuba, São Paulo, Brazil; [4]Department of Dental Materials and Prosthodontics, Araçatuba Dental School, Universidade Estadual Paulista (UNESP), Araçatuba, São Paulo, Brazil

L. deF. Silva, V.N. de Lima, L.P. Faverani, M.R. de Mendonça, R. Okamoto, E.P. Pellizzer: Maxillary sinus lift surgery—with or without graft material? A systematic review. Int. J. Oral Maxillofac. Surg. 2016; 45: 1570–1576.

Abstract. The purpose of this systematic review was to perform a comparative analysis of the use or not of graft material in maxillary sinus lift surgery. Relevant studies published in the last 10 years were identified through a search of the PubMed/MEDLINE, ScienceDirect, and Cochrane Library databases and were assessed against the study inclusion and exclusion criteria. The initial search resulted in 1037 articles. After applying the inclusion and exclusion criteria, 16 articles remained. Four hundred and thirty-six patients were followed up over a postoperative period ranging from 6 months to 11 years. In total, 868 implants were installed in 397 maxillary sinuses. The implant survival rate was 96.00% for surgeries performed without graft material and 99.60% for those in which biomaterial was used, within a follow-up period of 48 to 60 months. In conclusion, maxillary sinus lift surgery, with or without graft material, is a safe procedure with a low complication rate and predictable results.

Key words: sinus floor augmentation; dental implants; bone formation.

Accepted for publication 27 September 2016
Available online 17 October 2016

The loss of posterior teeth and subsequent maxillary sinus pneumatization results in atrophy of the alveolar bone and can affect the proper rehabilitation of patients with osseointegrated implants.[1] In this context, maxillary sinus lift surgery (also known as maxillary sinus floor augmentation surgery) has been considered a safe treatment modality with a low complication rate.[2] The use of this procedure in order to insert implants was introduced by Tatum and published as a clinical study by Boyne and James.[3,4] This procedure is suitable for the rehabilitation of both a posterior tooth and a completely edentulous maxilla in regions with loss of alveolar bone and sinus pneumatization.[5]

Traditionally, the success of the maxillary sinus lift procedure is determined by the amount of vital bone formation after maturation of the graft and the long-term survival rate of the implants placed in that region.[2] Two approaches are commonly used: the lateral window technique and the osteotome intrusion technique.[5,6] The latter is indicated when at least 5–6 mm of alveolar bone is present, showing a gain of 4–8 mm in bone height, and there is sufficient bone to stabilize the implant.[5,7] The lateral window technique is indicated when large bone gains are required in severely resorbed jaws; implants can be installed immediately if primary stability is obtained, or after bone healing.[8,9]

Various grafting materials have been used in maxillary sinus lift surgery, including autologous bone, xenogeneic bone, demineralized or mineralized allogeneic bone, and alloplasts.[10] These grafts

0901-5027/01201570 + 07

may have potential for osteogenesis, osteoconduction, or osteoinduction.[10] According to Chen et al., bone formation in the maxillary sinus does not require the presence of biomaterial.[11] The maintenance of space for blood clot formation accompanied by the resorption and deposition of bone cells derived from the sinus periosteum or cancellous bone of the maxilla would be responsible for bone formation in this region.[11]

The intraoperative complication most commonly associated with maxillary sinus lift surgery is perforation of the sinus membrane.[1,2,5,12] Other complications include postoperative infection, sinusitis, exposure of the graft, graft loss, oedema, seroma formation, bleeding, and exposure of the membrane.[1,5,9,12] The objective of this study was to conduct a systematic review through a comparative analysis of the use or not of graft material in maxillary sinus lift surgery using the lateral window technique.

Materials and methods

This systematic review was conducted in accordance with the guidelines of the PRISMA statement[13] and following the models proposed in the literature.[14,15] Scientific articles were selected by two authors, and there was no disagreement among them regarding the results found.

Search strategy

Relevant studies published during the last 10 years and written in English were identified through a search of the PubMed/MEDLINE, ScienceDirect, and Cochrane Library databases. Two pairs of key words were used in the search: ''dental implants'' AND ''sinus floor augmentation'', and ''bone formation'' AND ''sinus floor augmentation''. The articles were selected by title and abstract and in accordance with the inclusion and exclusion criteria.

Selection of studies

Clinical studies were chosen based on title and abstract. Prospective and retrospective studies were included. The participants, intervention, comparison, and outcomes (PICO) were determined to formulate a specific question. Participants were patients who underwent maxillary sinus lift surgery through the lateral window technique, concomitant with implant placement. The intervention was the maxillary sinus lift procedure and the comparison was that between sinus lift with the use of graft material and without the use of graft material. The outcomes analysed were the rate of new bone formation in the maxillary sinus and the survival rate of the implants installed in the region.

Inclusion and exclusion criteria

Inclusion criteria included articles written in the English language, clinical trials, maxillary sinus lift surgery by lateral window technique associated with the installation of implants, and a minimum follow-up period of 6 months. Exclusion criteria included animal studies, case reports, case series, and literature and systematic reviews.

Evaluation of the reliability and quality

The studies were analysed systematically to identify possible bias in the results and conclusions, and were classified into different levels of evidence following the hierarchy of evidence provided by the National Health and Medical Research Council (NHMRC, Australia).[16]

Data analysis

The following data were identified and extracted from each article: first author, level of evidence, number of patients and average age, number of implants placed in the sinus lift region, bone height before and 6 months after surgery, type of graft material used, implant geometry, period of osseointegration, follow-up period, survival rate of implants placed, and complications associated with the procedure. Data were processed for quantitative and qualitative analyses.

Statistical analysis

SigmaPlot 12.3 (Systat Software Inc., San Jose, CA, USA) was used for the analysis of the survival rate of implants between groups (with graft material vs. without graft material) according to the follow-up period (0–6 months, 6–12 months, 12–24 months, and 24–36 months). The Shapiro–Wilk homoscedasticity test was applied, which showed homogeneity of the data analysed ($P > 0.05$). Therefore, the two-way analysis of variance (ANOVA) test was used for comparisons among the sources of variation (experimental group, period, and group vs. period).

Results

Searches in the three databases yielded 1037 articles. After evaluation according to the inclusion and exclusion criteria and the elimination of duplicate references, 30 articles were selected (Fig. 1).[10,11,17–44] Fourteen of these articles were excluded because they presented sinus lift techniques other than the lateral window technique, or implants were placed at different times after the maxillary sinus surgery.[10,32–44] The remaining 16 articles were included in the qualitative and quantitative analyses.[11,17–31] Tables 1 and 2 provide a summary of the 16 selected articles.

Qualitative analysis

The selected studies were all classified as retrospective or prospective. The level of scientific evidence in these studies ranged from II to III-2 (Tables 1 and 2). In total, 868 implants were placed in 436 patients, and these patients were assessed over follow-up periods ranging from 6 months to 11 years. Implants were placed in premolar and molar regions of the maxillary sinus submitted to lift surgery, and long implants were predominantly used.

The diameter of the implants used varied from 3.3 mm to 6 mm. Only implants with appropriate primary stability were considered in this study. The minimum period for osseointegration was 3 months and the loss of implants was attributed to the absence of adequate primary stability, especially in the alveoli after tooth extraction.

Three hundred and two maxillary sinus lift surgeries were performed with the interposition of some type of graft material; the materials used ranged from autologous and allogeneic bone to absorbable gelatin sponge. Ninety-five maxillary sinus lift surgeries were performed without the interposition of any graft material, besides the clot. The residual bone height in the region where the implants would be installed ranged from 2 mm to 11 mm, and the implant survival rate ranged from 88% to 100%. Regarding complications related to the procedure, sinus membrane perforation was the most reported. No disturbances in the normal process of osseointegration of the implants were registered.

Quantitative analysis

Four hundred and thirty-six patients aged between 18 and 85 years underwent maxillary sinus lift surgery with the concomitant placement of dental implants. Of the 868 implants, 667 were installed in the maxillary sinuses with biomaterial and 201 with only the clot. There was no statistically significant difference between the groups in the implant survival rate. At

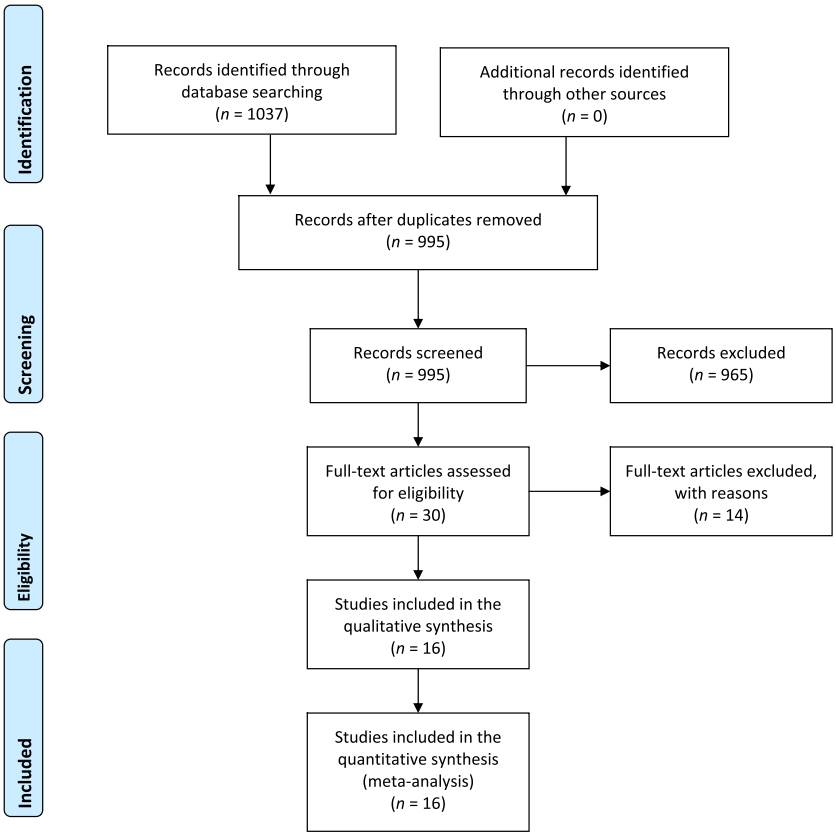

Fig. 1. Flow chart of the literature search strategy.

0–6 months of follow-up, the average survival rate of the implants placed in the maxillary sinus without graft material was 97.49% and with graft material was 96.88%. At 48–60 months of follow-up, however, the survival rate was 96.00% for implants in sinuses with no graft material and 99.60% for implants with graft material (Table 3).

The implant brands used are shown in Tables 4 and 5. Implants of 9 mm to 15 mm in length and 3.3 mm to 5 mm in diameter were used in the surgeries without graft material. For surgeries with biomaterials, the implants used were 8 mm to 18 mm in length and 3.3 mm to 6 mm in diameter.

The average bone height of sinuses in which no graft material was used was 5.55 mm preoperative and 12.08 mm at 6 months postoperative. In sinuses where graft materials were used, the average bone height was 4.65 mm preoperative and 12.82 mm at 6 months postoperative (Fig. 2). In the study by Altintas et al., the bone density measured at 6 months postoperative was significantly higher in the group of patients without a maxillary sinus graft than in the group of patients who received mineralized allogeneic bone.[24] However, bone formation was not observed in the implant apex region at 3 or 6 months in the group in which graft material was not used, whereas bone formation was observed in three of 12 implants at the same time points in the group of patients who received the graft.[24]

Membrane perforation was the most reported complication associated with the surgery in both groups, with 64 cases. This resulted in two cases of sinusitis in patients who underwent sinus lift with biomaterial. Other reported complications were one case of chronic oral fistula and one case of peri-implantitis in the group in which graft material was used (Fig. 3).

Statistical analysis

Comparisons between the groups after maxillary sinus lift with the placement of implants (with or without graft material), regardless of the period studied, showed no significant differences (interaction between the groups: with graft material vs. without graft material $P = 0.346$; periods analysed $P = 0.99$; groups vs. period $P = 0.729$).

Discussion

Maxillary sinus lift surgery is a procedure with predictable results and low morbidity

Table 1. Summary of data collected for sinus lifting without interpositional graft material.

Author	Year	Level of evidence	Type of study	Patients (*n*)	Operated maxillary sinuses (*n*)	Implants (*n*)	Average preoperative bone height (mm)	Average postoperative bone height (mm)	Follow-up (months)	Survival	Complications
Kaneko et al.[18]	2012	III-2	Prospective	11	11	21	4.7 ± 1.4	10.9 ± 2.2	24–46	95.20%	4 membrane perforation cases
Thor et al.[25]	2007	III-2	Prospective	20	27	44	4.6	Average gain of 6.5	14–45	97.72%	11 membrane perforation cases
Bassi et al.[28]	2015	III-1	Prospective	17	20	25	5.94	13.14	51	96%	None
Sohn et al.[31]	2008	III-1	Prospective	10	10	21	5	NR	6–12	100%	1 membrane perforation case
Moon et al.[21]	2011	III-2	Prospective	14	17	31	5	13.25	24	93.50%	2 membrane perforation cases
Altintas et al.[24]	2013	II	Prospective	7	10	12	NR	NR	6	100%	None
Chen et al.[11]	2007	III-2	Retrospective	33	NR	47	7.5 ± 2.1	Average gain of 4.5	24	100%	None

NR, not reported.

Table 2. Summary of data collected for sinus lifting with interpositional graft material.

Author	Year	Level of evidence	Type of study	Patients (*n*)	Operated maxillary sinuses (*n*)	Implants (*n*)	Average preoperative bone height (mm)	Average postoperative bone height (mm)	Biomaterial	Follow-up (months)	Survival	Complications
Silvestri et al.[30]	2013	II	Prospective	37	42	82	2–5	NR	Deproteinized bovine matrix; particulate swine cortical bone	6	96.34%	None
Merli et al.[29]	2013	II	Prospective	40	40	59	2.3; 2.0	11.1; 11.0	Deproteinized bovine matrix; autogenous bone	15	100%; 93.75%	2 cases of perforation of the membrane; 1 case of peri-implantitis
Johansson et al.[26]	2010	III-1	Prospective	61	NR	81	3–10	NR	Autogenous bone	12–60	98.80%	3 cases of membrane perforation
Sohn et al.[20]	2010	III-2	Prospective	7	9	18	5	NR	Absorbable gelatin sponge	6	88%	1 case of membrane perforation
Altintas et al.[24]	2013	II	Prospective	7	10	12	NR	NR	Allogeneic mineralized bone	6	100%	None
Trautvetter et al.[17]	2011	III-2	Retrospective	10	15	21	6.9	14.2	Polymer based on autogenous bone graft	60	100%	3 cases of membrane perforation and 1 case of sinusitis
Irinakis[19]	2011	III-2	Retrospective	49	49	49	5.09; 4.66	NR	Allograft	12–14	100%	2 cases of membrane perforation
Ardekian et al.[22]	2006	III-2	Retrospective	70	110	221	NR	NR	Deproteinized bovine matrix with autogenous bone	12–48	94%	35 cases of perforation of membrane, 1 case of sinusitis, and 1 case of fistula
Garlini et al.[23]	2010	III-2	Retrospective	26	27	47	7.4	15	Hydroxyapatite with collagen and glucosamine	48–132	100%	NR
Sakka and Krenkel[27]	2011	III-2	Retrospective	17	NR	77	1 to 11	NR	Autogenous bone	12	94.80%	NR

NR, not reported.

and has an expected success rate of >90% for medium- and long-term implants.[1] As noted in this study, the survival rate of the implants installed in sinuses with graft material was 96.00% and without graft material was 99.60%, at 48–60 months of follow-up. This difference between the groups is associated with the fact that a higher number of surgeries using graft materials were performed than surgeries without graft material, and the studies on surgeries using graft materials had longer follow-up periods than those in which no graft was used. Regarding the loss of implants, the most frequently reported reasons were instability during implant insertion[1,8,20,25,26] and the placement of implants after dental extraction in alveolar regions with less than 2 mm of height,[21] demonstrating the importance of primary stability in the rehabilitation of regions by sinus lift.

Regarding pre- and postoperative bone height, similar results were obtained for surgeries using and not using graft materials, with a slightly higher average gain for the group in which graft materials were used. Bassi et al. performed a study involving the installation of implants in regions of sinus lift with no graft material and observed a statistically significant difference in height between 3 and 51 months of follow-up, with an average loss of bone height of 1.57 mm.[28] According to the study by Garlini et al., an average bone loss of 1.8 mm in the region of the implant apex was registered for implants placed in maxillary sinuses with graft material over a follow-up period of 11 years.[23] Thus, a slight decrease in bone height obtained through sinus lift with or without graft material is observed over longer postoperative periods.

In the study by Altintas et al. comparing the maxillary sinus lift performed with or without graft material, new bone formation was not observed around the apex of the implants in sinuses with a clot within 6 months postoperative.[24] In the group in which biomaterial was used, three of the 12 installed implants showed bone formation around the apex within the same period, showing no statistically significant difference.[24] In the study by Sohn et al., in which graft material was used, new bone formation was observed around the surfaces of the implants placed.[20]

Kaneko et al. performed a study on the maxillary sinus lift without the use of graft material, in which the presence of new bone at the apex of the implants was not observed within 1 year.[18] In the study by Moon et al. using venous blood in the maxillary sinuses, the presence of newly

Table 3. Numbers of implants and survival rates.

Follow-up (months)	Maxillary sinus with graft material (*n*)	Maxillary sinus without graft material (*n*)	Survival rate with graft material	Survival rate without graft material
0–6	667	201	96.88%	97.49%
6–12	555	189	97.67%	97.07%
12–24	478	168	98.08%	96.48%
24–36	370	168	98.20%	96.48%
36–48	370	90	98.20%	96.31%
48–60	149	25	99.60%	96.00%

formed bone around the implants was observed at an average of 6.6 months.[21] These results may be explained by the maintenance of the space between the apex of the implant and the sinus membrane with the use of graft material or peripheral venous blood, assisting in bone formation in this region.

According to the study by Altintas et al., the density of newly formed bone in the group in which no graft was used was significantly higher than in the group in which graft material was used at 6 months of follow-up.[24] However, this result became statistically insignificant at periods of longer than 6 months.[24] Johansson et al. and Chen et al. suggested that a reduction in bone formation rate may occur, because any graft material has to be resorbed and replaced.[11,26] This fact could explain the difference in bone density at 6 months seen in the study by Altintas et al.[24]

Regarding the complications associated with the procedure, sinus membrane perforation was the most often observed, being reported for 61 out of 397 maxillary sinus lift surgeries. Ardekian et al.

Table 4. Brands and sizes of implants placed in the maxillary sinus without graft material.

Author	Year	Patient age, range (years)	Brand of implants	Implant length (mm)	Implant diameter (mm)	Implants (*n*)	Period of osseointegration (months)	Survival rate
Kaneko et al.[18]	2012	37–70 (Mean 57.00 ± 0.9)	Nobel Biocare	10–13	NR	21	6	95.20%
Thor et al.[25]	2007	19–78 (Mean 59)	Astra Tech	9, 11, 13, and 15	3.5, 4.5, and 5	44	3–8	97.72%
Bassi et al.[28]	2015	NR	Neodent	13	4.3	25	9	96%
Sohn et al.[31]	2008	Mean 50	MIS Implants Technologies and EBI Inc.	10–15	3.7–5	21	6	100%
Moon et al.[21]	2011	37–70 (Mean 56)	Sybron Implant Solutions	13	4.1	31	6	93.50%
Altintas et al.[24]	2013	23–80 (Mean 49.5)	Straumann	10–12	3.3–4.8	12	6	100%
Chen et al.[11]	2007	Mean 55	Straumann, Centerpulse Dental, Friadent GmbH	12, 13, and 15	NR	47	6	100%

NR, not reported.

Table 5. Brands and sizes of implants placed in the maxillary sinus with graft material.

Author	Year	Patient age, range (years)	Brand of implants	Implant length (mm)	Implant diameter (mm)	Implants (*n*)	Period of osseointegration (months)	Survival rate
Silvestri et al.[30]	2013	35–68	Thommen	9.5–11.5	4 and 4.5	82	6	96.34%
Merli et al.[29]	2013	38–66	Nobel Biocare	Average 10.6; 10.3	Average 4	59	8	100%; 93.75%
Johansson et al.[26]	2010	18–85	Straumann	8–12	3.3–4.8	81	5.2	98.80%
Sohn et al.[20]	2010	40–75 (Mean 56.1)	Sybron Implant Solution	13	4.1	18	6	88%
Altintas et al.[24]	2013	23–80 (Mean 49.5)	Straumann	10–12	3.3–4.8	12	6	100%
Trautvetter et al.[17]	2011	NR	Brånemark, Camlog	13, 15, 16, and 18	3.75, 4, 5, and 6	21	NR	100%
Irinakis[19]	2011	26–74	Nobel Biocare	Average 11.39; 12.82	Average 4.39; 4.8	49	6	100%
Ardekian et al.[22]	2006	NR	Medical Implant Systems	13–16	3.75–4.7	221	NR	94%
Garlini et al.[23]	2010	Mean 58	Dentsply, Friadent, Biomet	11–13	NR	47	10	100%
Sakka and Krenkel[27]	2011	Mean 62	Straumann, Nobel Biocare, Ankylos	NR	NR	77	9	94.80%

NR, not reported.

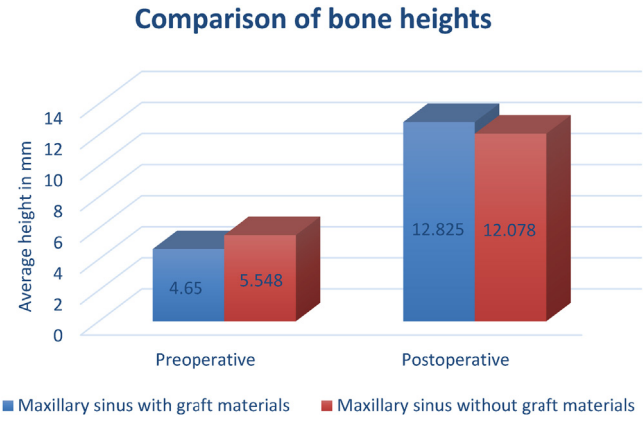

Fig. 2. Comparison of bone heights pre- and postoperative.

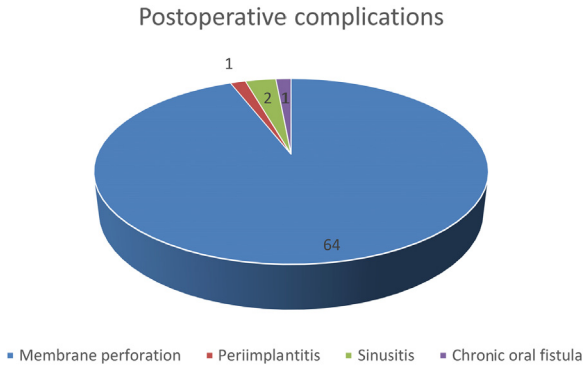

Fig. 3. Distribution of postoperative complications.

evaluated the incidence of membrane perforation in this type of procedure, concluding that this complication occurs more frequently in residual alveolar bone of a reduced height and that no statistical correlation exists between membrane perforation and the implant success rate.[22]

This review shows that maxillary sinus lift surgery is a safe procedure with a low complication rate and with predictable results. Although the successful use of graft materials is reported in the literature, this procedure is feasible without graft material and very similar results can be seen with and without the use of graft material. Furthermore, maxillary sinus lift surgery without the use of graft material results in a reduced surgical time and lower total costs compared to surgery with the use of grafts.

Funding

There are no sources or funding.

Competing interests

There are no conflicts of interest.

Ethical approval

Not required.

Patient consent

Not required.

References

1. Testori T, Weinstein RL, Taschieri S, Del Fabbro M. Risk factor analysis following maxillary sinus augmentation: a retrospective multicenter study. *Int J Oral Maxillofac Implants* 2012;**27**:1170–6.
2. Froum SJ, Khouly I, Favero G, Cho SC. Effect of maxillary sinus membrane perforation on vital bone formation and implant survival: a retrospective study. *J Periodontol* 2013;**84**: 1094–9.
3. Tatum Jr H. Maxillary and sinus implant reconstructions. *Dent Clin North Am* 1986;**30**:207–29.
4. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. *J Oral Surg* 1980;**38**:613–6.
5. Stern A, Green J. Sinus lift procedures: an overview of current techniques. *Dent Clin North Am* 2012;**56**:219–33. x.
6. Lee HW, Lin WS, Morton D. A retrospective study of complications associated with 100 consecutive maxillary sinus augmentations via the lateral window approach. *Int J Oral Maxillofac Implants* 2013;**28**:860–8.
7. Smiler D, Soltan M, Ghostine MS. *Contemporary sinus-lift subantral surgery and graft*. St Louis (MO): Saunders; 2009.
8. Zitzmann NU, Schärer P. Sinus elevation procedures in the resorbed posterior maxilla. Comparison of the crestal and lateral approaches. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1998;**85**:8–17.
9. Nolan PJ, Freeman K, Kraut RA. Correlation between Schneiderian membrane perforation and sinus lift graft outcome: a retrospective evaluation of 359 augmented sinus. *J Oral Maxillofac Surg* 2014;**72**:47–52.
10. 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**: 1859–68.
11. Chen TW, Chang HS, Leung KW, Lai YL, Kao SY. Implant placement immediately after the lateral approach of the trap door window procedure to create a maxillary sinus lift without bone grafting: a 2-year retrospective evaluation of 47 implants in 33 patients. *J Oral Maxillofac Surg* 2007;**65**:2324–8.
12. Moreno Vazquez JC, Gonzalez de Rivera AS, Gil HS, Mifsut RS. Complication rate in 200 consecutive sinus lift procedures: guidelines for prevention and treatment. *J Oral Maxillofac Surg* 2014;**72**:892–901.
13. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *J Clin Epidemiol* 2009;**62**:1006–12.
14. Lopes LF, da Silva VF, Santiago Jr JF, Panzarini SR, Pellizzer EP. Placement of dental implants in the maxillary tuberosity: a systematic review. *Int J Oral Maxillofac Surg* 2015;**44**:229–38.
15. Goiato MC, Dos Santos DM, Santiago Jr JF, Moreno A, Pellizzer EP. Longevity of dental implants in type IV bone: a systematic review. *Int J Oral Maxillofac Surg* 2014;**43**:1108–16.
16. National Health and Medical Research Council. *How to use the evidence: assessment and application of scientific evidence*. Australian Government NHMRC; 2000 . http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/cp69.pdf. [accessed 02.11.15].
17. Trautvetter W, Kaps C, Schmelzeisen R, Sauerbier S, Sittinger M. Tissue-engineered polymer-based periosteal bone grafts for maxillary sinus augmentation: five-year clinical results. *J Oral Maxillofac Surg* 2011;**69**:2753–62.
18. Kaneko T, Masuda I, Horie N, Shimoyama T. New bone formation in nongrafted sinus lifting with space-maintaining management: a novel technique using a titanium bone fixation device. *J Oral Maxillofac Surg* 2012;**70**:e217–24.

19. Irinakis T. Efficacy of injectable demineralized bone matrix as graft material during sinus elevation surgery with simultaneous implant placement in the posterior maxilla: clinical evaluation of 49 sinuses. *J Oral Maxillofac Surg* 2011;**69**:134–41.
20. Sohn DS, Moon JW, Moon KN, Cho SC, Kang PS. New bone formation in the maxillary sinus using only absorbable gelatin sponge. *J Oral Maxillofac Surg* 2010;**68**:1327–33.
21. Moon JW, Sohn DS, Heo JU, Shin HI, Jung JK. New bone formation in the maxillary sinus using peripheral venous blood alone. *J Oral Maxillofac Surg* 2011;**69**:2357–67.
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**:277–82.
23. Garlini G, Redemagni M, Donini M, Maiorana C. Maxillary sinus elevation with an alloplastic material and implants: 11 years of clinical and radiologic follow-up. *Oral Maxillofac Surg* 2010;**68**:1152–7.
24. Altintas NY, Senel FC, Kayıpmaz S, Taskesen F, Pampu AA. Comparative radiologic analyses of newly formed bone after maxillary sinus augmentation with and without bone grafting. *J Oral Maxillofac Surg* 2013;**71**:1520–30.
25. Thor A, Sennerby L, Hirsch JM, Rasmusson L. Bone formation at the maxillary sinus floor following simultaneous elevation of the mucosal lining and implant installation without graft material: an evaluation of 20 patients treated with 44 Astra Tech implants. *J Oral Maxillofac Surg* 2007;**65**(Suppl 1):64–72.
26. Johansson LA, Isaksson S, Lindh C, Becktor JP, Sennerby L. Maxillary sinus floor augmentation and simultaneous implant placement using locally harvested autogenous bone chips and bone debris: a prospective clinical study. *J Oral Maxillofac Surg* 2010;**68**:837–44.
27. Sakka S, Krenkel C. Simultaneous maxillary sinus lifting and implant placement with autogenous parietal bone graft: outcome of 17 cases. *J Craniomaxillofac Surg* 2011; **39**:187–91.
28. Bassi AP, Pioto R, Faverani LP, Canestraro D, Fontão FG. Maxillary sinus lift without grafting, and simultaneous implant placement: a prospective clinical study with a 51-month follow-up. *Int J Oral Maxillofac Surg* 2015;**44**:902–7.
29. Merli M, Moscatelli M, Mariotti G, Rotundo R, Nieri M. Autogenous bone versus deproteinised bovine bone matrix in 1-stage lateral sinus floor elevation in the severely atrophied maxilla: a randomised controlled trial. *Eur J Oral Implantol* 2013;**6**:27–37.
30. Silvestri M, Martegani P, D'Avenia F, Farneti M, Capri D, Paolantoni G, et al. Simultaneous sinus augmentation with implant placement: histomorphometric comparison of two different grafting materials. A multicenter double-blind prospective randomized controlled clinical trial. *Int J Oral Maxillofac Implants* 2013;**28**:543–9.
31. Sohn DS, Lee JS, Ahn MR, Shin HI. New bone formation in the maxillary sinus without bone grafts. *Implant Dent* 2008;**17**: 321–31.
32. Kim YK, Yun PY, Kim SG, Kim BS, Ong JL. Evaluation of sinus bone resorption and marginal bone loss after sinus bone grafting and implant placement. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009;**107**:e21–8.
33. Mardinger O, Chaushu G, Sigalov S, Herzberg R, Shlomi B, Schwartz-Arad D. Factors affecting changes in sinus graft height between and above the placed implants. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2011;**111**:e6–11.
34. Uckan S, Deniz K, Dayangac E, Araz K, Ozdemir BH. Early implant survival in posterior maxilla with or without beta-tricalcium phosphate sinus floor graft. *J Oral Maxillofac Surg* 2010;**68**:1642–5.
35. Voss P, Sauerbier S, Wiedmann-Al-Ahmad M, Zizelmann C, Stricker A, Schmelzeisen R, et al. Bone regeneration in sinus lifts: comparing tissue-engineered bone and iliac bone. *Br J Oral Maxillofac Surg* 2010;**48**:121–6.
36. Jurisic M, Markovic A, Radulovic M, Brkovic BM, Sándor GK. Maxillary sinus floor augmentation: comparing osteotome with lateral window immediate and delayed implant placements. An interim report. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;**106**:820–7.
37. López AM, del Pozo PP, Muela CM, Caicoya SO, Cuéllara CN, Escobar JI. Maxillary sinus augmentation with bovine hydroxyapatite alone: a safe technique with predictable outcomes in patients with severe maxillary atrophy. *Rev Esp Cir Oral Maxilof* 2015;**37**:87–92.
38. Felice P, Pistilli R, Piattelli M, Soardi E, Corvino V, Esposito M. Posterior atrophic jaws rehabilitated with prostheses supported by 5 × 5 mm implants with a novel nanostructured calcium-incorporated titanium surface or by longer implants in augmented bone. Preliminary results from a randomised controlled trial. *Eur J Oral Implantol* 2012;**5**:149–61.
39. Guljé FL, Raghoebar GM, Vissink A, Meijer HJ. Single crowns in the resorbed posterior maxilla supported by either 6-mm implants or by 11-mm implants combined with sinus floor elevation surgery: a 1-year randomised controlled trial. *Eur J Oral Implantol* 2014;**7**:247–55.
40. Felice P, Pistilli R, Piattelli M, Soardi E, Barausse C, Esposito M. 1-stage versus 2-stage lateral sinus lift procedures: 1-year post-loading results of a multicentre randomised controlled trial. *Eur J Oral Implantol* 2014;**7**:65–75.
41. Cannizzaro G, Felice P, Minciarelli AF, Leone M, Viola P, Esposito M. Early implant loading in the atrophic posterior maxilla: 1-stage lateral versus crestal sinus lift and 8 mm hydroxyapatite-coated implants. A 5-year randomised controlled trial. *Eur J Oral Implantol* 2013;**6**:13–25.
42. García-Denche JT, Wu X, Martinez PP, Eimar H, Ikbal DJ, Hernández G, et al. Membranes over the lateral window in sinus augmentation procedures: a two-arm and split-mouth randomized clinical trials. *J Clin Periodontol* 2013;**40**:1043–51.
43. Bae JH, Kim YK, Kim SG, Yun PY, Kim JS. Sinus bone graft using new alloplastic bone graft material (Osteon)—II: clinical evaluation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2010;**109**:e14–20.
44. de Vicente JC, Hernández-Vallejo G, Brañas-Abascal P, Peña I. Maxillary sinus augmentation with autologous bone harvested from the lateral maxillary wall combined with bovine-derived hydroxyapatite: clinical and histologic observations. *Clin Oral Implants Res* 2010;**21**:430–8.

Address:
Leonardo de Freitas Silva
José Bonifácio Street
1193
Vila Mendonça
Araçatuba
São Paulo 16015-050
Brazil
Tel: +55 18 3636 3270
E-mail: leonardofreitas86@gmail.com