Lateral Sinus Augmentation Vol 3.

Use of barriers to close lateral window

1. **AK** Starch-Jensen T, Deluiz D, Duch K, Tinoco EMB. Maxillary Sinus Floor Augmentation With or Without Barrier Membrane Coverage of the Lateral Window: a Systematic Review and Meta-Analysis. J Oral Maxillofac Res. 2019 Dec 30;10(4):e1. doi: 10.5037/jomr.2019.10401.
2. **TV** Ohayon L, Taschieri S, Friedmann A, Del Fabbro M. Bone Graft Displacement After Maxillary Sinus Floor Augmentation With or Without Covering Barrier Membrane: A Retrospective Computed Tomographic Image Evaluation. Int J Oral Maxillofac Implants. 2019 May/June;34(3):681–691
3. **DL** Molnár B, Jung AK, Papp Z, Martin A, Orbán K, Pröhl A, Jung O, Barbeck M, Windisch Comparative analysis of lateral maxillary sinus augmentation with a xenogeneic bone substitute material in combination with piezosurgical preparation and bony wall repositioning or rotary instrumentation and membrane coverage: a prospective randomized clinical and histological study.Clin Oral Investig. 2022 Aug;26(8):5261-5272.
4. **CM** Wang Z, Zhang J, Ren L, Yang G. Repositioning of the bone window in lateral sinus floor elevation with simultaneous implant placement: A retrospective radiographic study. Clin Oral Implants Res. 2022 Aug;33(8):816-833.

Sinus augmentation healing

5. **VX** Jungner M, Cricchio G, Salata LA, Sennerby L, Lundqvist C, Hultcrantz M, Lundgren S. On the Early Mechanisms of Bone Formation after Maxillary Sinus Membrane Elevation: An Experimental Histological and Immunohistochemical Study. Clin Implant Dent Relat Res. 2015 Dec;17(6):1092-102.
6. **RH** Dragonas P, Katsaros T, Schiavo J, Galindo-Moreno P, Avila-Ortiz G. Osteogenic capacity of the sinus membrane following maxillary sinus augmentation procedures: A systematic review. Int J Oral Implantol (Berl). 2020;13(3):213-232.
7. **NL** Stacchi C, Rapani A, Lombardi T, Bernardello F, Nicolin V, Berton F. Does new bone formation vary in different sites within the same maxillary sinus after lateral augmentation? A prospective histomorphometric study. Clin Oral Implants Res. 2022 Mar;33(3):322-332.

Post-operative infections

8. **MS** Testori T, Drago L , Wallace SS, et al. Prevention and treatment of postoperative infections after maxillary sinus elevation surgery: clinical consensus and recommendations. Int J Dent . 2012 ; 2012 : 365809 .
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Implant survival in grafted maxillary sinus

11. **DL** Raghoebar GM et al. Long-term effectiveness of maxillary sinus floor augmentation: A systematic review and meta-analysis. J Clin Periodontol. 2019 Jun;46 suppl 21:307-318.
12. **CM** Park WB, Kang L, Han JY. Factors influencing long-term survival rates of implants placed simultaneously with lateral maxillary sinus floor augmentation: a 6-20 year retrospective study. Clin Oral Implants Res 2019 Oct;30(10):977-988.

Crestal sinus augmentation

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14. **RH** Bjarni E Pjetursson, Niklaus P Lang Sinus floor elevation utilizing the transalveolar approach Periodontol 2000 2014 Oct;66(1):59-71. doi: 10.1111/prd.12043.
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20. **CM** Gargallo-Albiol J, Sinjab KH, Barootchi S, Chan HL, Wang HL. Microscope and micro-camera assessment of Schneiderian membrane perforation via transcrestal sinus floor elevation: A randomized ex vivo study. Clin Oral Implants Res. 2019 Jul;30(7):682-690.
21. **VX** Puterman I, Weinstein B, Walton P, Fien M The Modified Osseodensification Visco-Elastic (MOVE) Sinus Protocol: A Case Series to Illustrate the Combination of Osseodensification with Viscoelastic Bone Replacement Material. Clin Adv Periodontics. 2022 Sep;12(3):180-185.
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Use of barriers to close lateral window

Topic: barrier membrane coverage of lateral window
Authors: Starch-Jensen T, Deluiz D, Duch K, Tinoco EMB.

Title: Maxillary Sinus Floor Augmentation With or Without Barrier Membrane Coverage of the Lateral Window: a Systematic Review and Meta-Analysis
Source: J Oral Maxillofac Res. 2019 Dec 30;10(4):e1. doi: 10.5037/jomr.2019.10401.
DOI: 10.5037/jomr.2019.10401
Reviewer: Amber Kreko
Type: systematic review
Keywords: alveolar ridge augmentation, dental implants, oral surgical procedures, review, sinus floor augmentation.

Purpose: To test the hypothesis of no difference in implant treatment outcomes after MSFA with or without barrier membrane coverage of the lateral window.

Material and methods:
- Systematic review of RCTs and controlled trials on humans up to July 2019.
- Focus question: Are there any differences in implant treatment outcomes after MSFA with or without barrier membrane coverage of the lateral window?"
- Primary outcomes: survival of suprastructures and survival of implants
- Secondary outcomes: ISQ, MBL, bone regeneration, patient reported outcome measures, and biologic and mechanical complications

Results:
- 7 studies were included
- Survival of implants: MSFA with or without barrier membrane does not seem to significantly influence survival rate. Higher percentage of implant failures without barrier membrane coverage and immediate implant placement.
- Bone regeneration: NSD with or without barrier membrane. Higher percentage of newly formed bone and diminished non-mineralized tissue with barrier coverage compared to no barrier.
- Biologic and mechanical complications: infrequent and not severe. Sinus perforation most frequent. Mucosal tears and wound dehiscence was comparable between methods. Displacement of grafting material into subcutaneous space only reported without barrier membrane.

Conclusions:
- NSSD in treatment outcomes with or without barrier membrane coverage of the lateral window. Membrane increases percentage of newly formed bone, diminish proliferation of non-mineralized tissue, and prevent displacement of grafting material. Barrier membrane coverage of the lateral window seems to be beneficial and improve implant treatment outcomes.

Topic: Barrier Membrane in Lateral Window Sinus Augmentation
Authors: Ohayon L, Taschieri S, Friedmann A, Del Fabbro M
Title: Bone Graft Displacement After Maxillary Sinus Floor Augmentation With or Without Covering Barrier Membrane: A Retrospective Computed Tomographic Image Evaluation.
Source: Int J Oral Maxillofac Implants. 2019 May/June;34(3):681–691
DOI:10.11607/jomi.6940
Reviewer: Tam Vu
Type: Retrospective Study
Keywords: barrier membranes, bone substitute, computed tomography, sinus floor elevation, sinus membrane

Purpose: to assess the stability of bone graft material after maxillary sinus floor augmentation with and without barrier membrane.

Material and methods:

- 41 pts
    - Control: barrier membrane covering lateral window
    - Test: no membrane
- Surgery performed
    - Sinus elevation and grafted with anorganic bovine bone (Cerabone, Straumann)
    - Control: collagen barrier membrane (Collprotect, Straumann) to cover lateral window
- Radiographic assessment, CBCTs taken:
    - Diagnostic preop (baseline)
    - Immediate post sx
    - 7 days post sx -- evaluate sinus membrane swelling and bone graft stability
    - 6 mo postop – eval sinus membrane thickness and measure bone graft dislodgement out of sinus cavity
- Post op morbidity evaluation based on pt report

Results:

- Post op swelling of sinus membrane seen at 7 days at 100% (Graft dislodgement seen)
- 6 mo post op CBCT measurements:
    - Test group had sig higher bone graft dislodgement, mean of 3.8 mm (range 0 – 12.2 mm)
    - Control (membrane): mean graft dislodgement of 0.46 mm
- Postop morbidity – pain and swelling complaints sig greater in test group
- Sig reduction of postop morbidity at 7 days in control (membrane) group
- Post op edema of sinus membrane applies pressure to top of graft which appears disorganized on CBCT → this causes bone particles to migrate to buccal mucosa through lateral window

Conclusion:

- Post op membrane swelling is a major risk factor for bone graft dislodgement into the buccal mucosa
    - Other factors: antrostomy size, graft volume, swelling/hemorrhage
- Use of barrier membrane was helpful in preventing dislodgement of bone graft material through sinus antrostomy into the buccal mucosa, thereby reducing postop morbidity

BL: no barrier membrane to cover lateral window = bone graft stability is unpredictable for early healing period

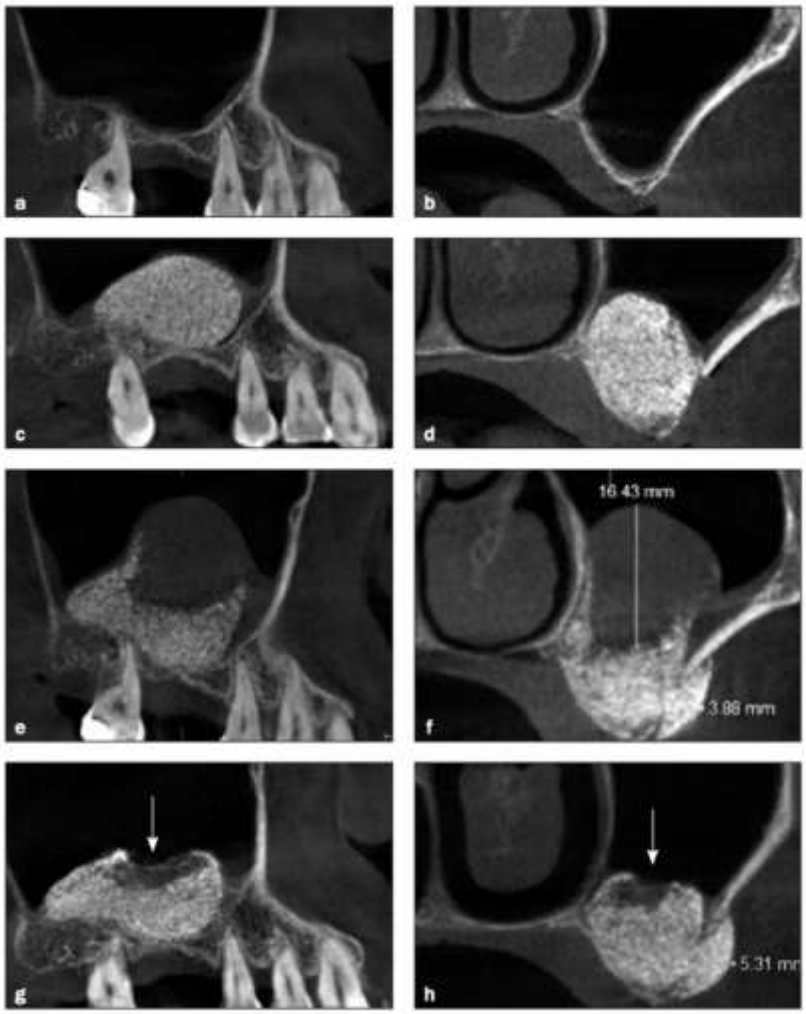


Fig 2 Test group clinical case with small postoperative bone graft displacement. *(a)* Preoperative CBCT coronal view. *(b)* Preoperative CBCT cross-sectional view: the sinus membrane is healthy and not identifiable. *(c)* Immediate postoperative CBCT coronal view. *(d)* Immediate postoperative CBCT cross-sectional view: the bone graft contours are well delimited. *(e)* 7-day postoperative CBCT coronal view. *(f)* 7-day postoperative CBCT cross-sectional view: the sinus membrane edema, measured at 16.4 mm, was significant and pushed away the biomaterial particles, which moved away at the level of the upper area of the bone graft and migrated through the lateral bone window within the buccal mucosa. The bone graft dislodgment length was 3.9 mm. *(g)* 6-month postoperative CBCT coronal view. *(h)* 6-month postoperative CBCT cross-sectional view: the upper part of the bone graft still had a disorganized aspect *(white arrow)*, showing a jeopardized new bone formation in this area, due to the postoperative swelling or hematoma of the sinus membrane. The bone graft dislodgment length was 5.3 mm.

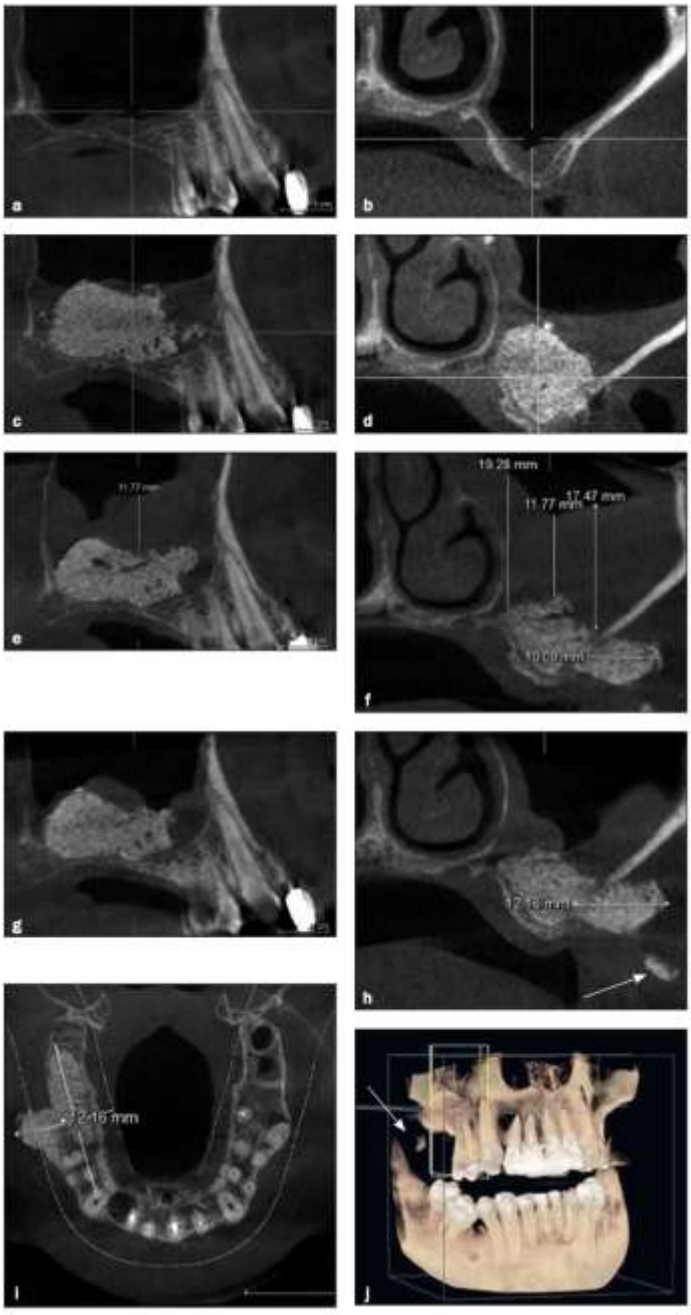


Fig 3 Test group clinical case with significant postoperative bone graft displacement. *(a)* Preoperative CBCT coronal view. *(b)* Preoperative CBCT cross-sectional view; the preoperative thickness of the membrane was clearly identifiable. *(c)* Immediate postoperative CBCT coronal view. *(d)* Immediate postoperative CBCT cross-sectional view: the bone substitute particles showed well-delimited contours. *(e)* 7-day postoperative CBCT coronal view. *(f)* 7-day postoperative CBCT cross-sectional view. The postoperative sinus membrane swelling occupied a large part of the sinus cavity and was measured along its vertical axis from 11.8 to 19.9 mm. The bone substitute particles migrated through the lateral window and were measured at 10.1 mm along its horizontal axis. Isolated biomaterial agglomerate was localized into the connective tissue. *(g)* 6-month postoperative CBCT coronal view. *(h)* 6-month postoperative CBCT cross-sectional view. *(i)* 6-month postoperative CBCT axial view. *(j)* 6-month postoperative 3D CBCT image. The bone graft dislodgment was significant, and the measurement of its length was 12.2 mm. The bone substitute particles, which detached from the bone graft, deeply migrated into the buccal connective tissue *(white arrow)*.

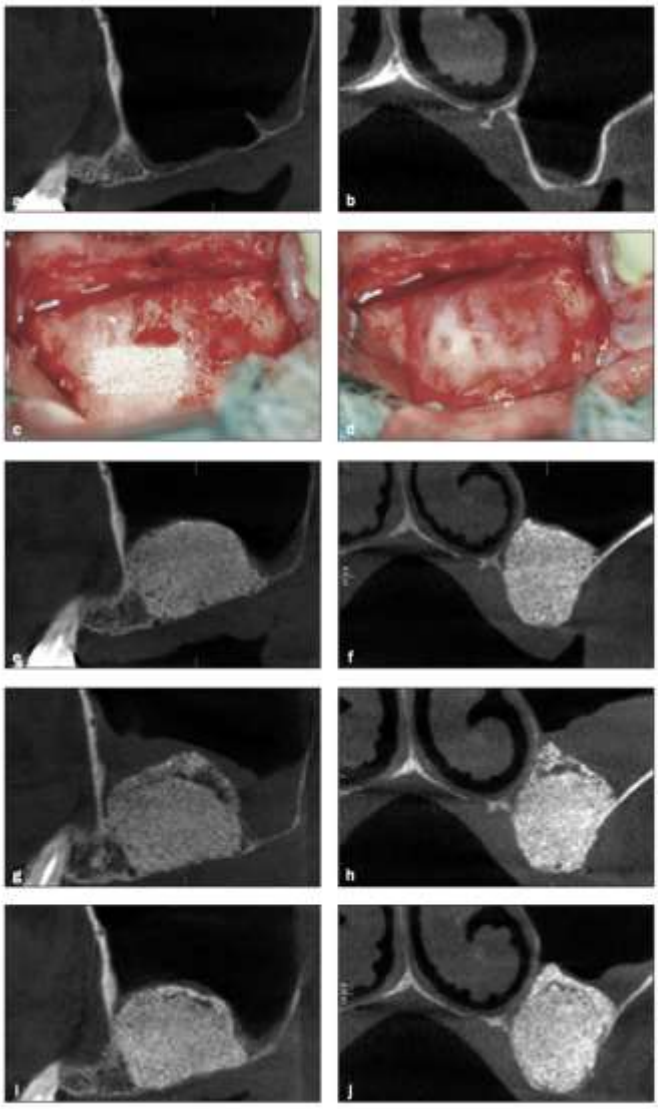


Fig 4 Control group clinical case. *(a)* Preoperative CBCT coronal view. *(b)* Preoperative CBCT cross-sectional view. *(c)* The space between the elevated sinus membrane and the alveolar ridge was filled with bone substitute. *(d)* The barrier membrane was placed over the lateral bone window to cover the biomaterial. *(e)* Immediate postoperative CBCT coronal view. *(f)* Immediate postoperative CBCT cross-sectional view: the biomaterial showed a dense and homogenous aspect. *(g)* 7-day postoperative CBCT coronal view. *(h)* 7-day postoperative CBCT cross-sectional view: the postoperative swelling of the sinus membrane caused radiolucency areas into the biomaterial. *(i)* 6-month postoperative CBCT coronal view. *(j)* 6-month postoperative CBCT cross-sectional view. The radiolucency areas are still identifiable inside the bone graft, showing a poor mineralized bone quality at this level. The bone substitute particles all remained inside the sinus cavity.

Topic: Barriers-Closure
Authors: Molnár B, Jung AK, Papp Z, Martin A, Orbán K, Pröhl A, Jung O, Barbeck M, Windisch P.
Title: Comparative analysis of lateral maxillary sinus augmentation with a xenogeneic bone substitute material in combination with piezosurgical preparation and bony wall repositioning or rotary instrumentation and membrane coverage: a prospective randomized clinical and histological study.
Source: Clin Oral Investig. 2022 Aug;26(8):5261-5272.
DOI: 10.1007/s00784-022-04494-x.
Reviewer: Daeoo Lee
Type: RCT
Keywords: Window, membrane, coverage

Purpose: To investigate if, in lateral maxillary sinus augmentation, the repositioned bony wall or the application of a collagen membrane results in more preferable new hard tissue formation.

Material and methods:

- 40 pts recruited
    - Bony wall repositioning group (n=20): Using Piezoelectric device used
    - Collagen membrane group (n=20): rotary
        - Resorbable collagen membrane (collprotect membrane, botiss biomaterials GmbH, Zossen, Germany)
- Lateral sinus floor augmentation with BSM (cerabone, botiss biomaterials GmbH, Zossen, Germany)
- Surgery for bony wall (BW)
    - Piezoelectric window preparation (3d guided stent): 7x7mm window
    - Cerabone insertion
    - Bony wall repositioning
    - Periosteal sutures
    - Mucosal sutures
    - 6 months reentry
    - Guided biopsy harvesting
    - Core biopsy
    - Implant insertion
- Surgeyr for Collagen membrane group (CM)
    - Rotary window preparation (3mm diameter rotary diamond bur 400RPM)
    - Sinus mucosa elevation
    - Cerabone insertion
    - Collprotect membrane coverage
    - Periosteal sutures
    - Mucosal sutures
    - 6 months reentry
    - Core biopsy
    - implant insertion
- Statistical and histological analysis

Results:

- BW vs CM (NSSD, $p>0.05$ for all)
    - Duration surgery (45.8 vs. 49.2 min)
    - Perforation (6/20 vs. 7/20)
    - Discomfort-VAS (Day0 30.9 vs. 44.5; Day1 19.8 vs. 29.6; Day3 12.9 vs. 24.8; Day4 9.5 vs. 17.6)
    - Hematoma (Day3 0.7 vs. 1.3)
    - Edema (Day3 1.9 vs. 1.8)
- Histological results
    - 29/40 biopsy were able to be analyzed
    - Similar tissue reactions and integration pattern of the xenogeneic BSM were observable in both the BW and CM groups
- Histomorphometric (BW vs. CM)
    - Newly formed bone (27.8% vs. 30.3%)

- Residual bone (32.9% vs. 31.8%)
- CT (39.2% vs. 37.9%)

Conclusions:
The closure of the access window by means of the piezosurgically harvested autologous bony wall or the collagen membrane led to comparable bone augmentation results in combination with the BSM without any statistically significant clinical or histological differences between groups.

Topic: Window repositioning
Authors: Wang Z., Zhang J., Ren L., Yang G.
Title: Repositioning of the bone window in lateral sinus floor elevation with simultaneous implant placement: A retrospective radiographic study
Source: Clin Oral Impl Res. 2022;33:816–833.
DOI: 10.1111/clr.13963
Reviewer: Cyrus J Mansouri
Type: Retrospective study
Keywords: clinical research, cone-beam computed tomography, sinus floor augmentation, sinus floor elevation, surgical procedures

Purpose:
To evaluate whether repositioning (vs removing) the bone window leads to better stability of the graft material during sinus augmentation with simultaneous implant placement.

Material and methods:
34 patients received 40 implants simultaneous to lateral sinus augmentation.
- test/repositioned window =14 implants
- control/removed window = 26 implants

Test / repositioned window protocol:
- Piezoelectric saw used to segment lateral bone, which was lifted and preserved for closure later.
- BioGide placed half in and half out the maxillary sinus.
- BioOss Collagen bone graft placed.
- Implant placed.
- Preserved bony window repositioned in place.
- BioGide covered lateral wall defect.

Control / removed window protocol:
- Rotary diamond bur used to grind lateral bone wall away.
- Otherwise same protocol without repositioning of the preserved bony window.

CBCTs were made prior, immediately after, and 6-months after surgery. Sinus anatomical parameters were measured. Apical bone height (ABH), endo-sinus bone gain (ESBG) and palatal/buccal bone height (PBH/BBH) were measured 2-dimensionally, and augmentation volume (AV) and palatal/buccal augmentation volume (PAV/BAV) were also measured in 3-dimensions. Lateral defect length (LDL) and lateral window length (LWL) were also measured to evaluate antrostomy recovery.

Results:
Patient factors and sinus anatomical features were similar between tx groups. Membrane perforation was 3/12 (25%) in the test group and 0/22 in the control group. Perforations were small and managed to complete the surgical procedure.

Most two- and three-dimensional measurements were similar between groups. However, buccal bone height was significantly higher for the test than control group. Similarly, buccal augmentation volume

reduction was significantly lower for the test group. LDL/LWL was significantly lower in the test group demonstrating repositioning of the window was advantageous for recovery of the antrostomy.

Conclusion:
Repositioning of the window could contribute to superior dimensional outcomes at the buccal side of the window and facilitate recovery of the antrostomy defect.

Sinus augmentation healing

Topic: Bone formation after Sinus Elevation
Author: Jungner M, Cricchio G, Salata LA, Sennerby L, Lundqvist C, Hultcrantz M, Lundgren S.
Title: On the Early Mechanisms of Bone Formation after Maxillary Sinus Membrane Elevation: An Experimental Histological and Immunohistochemical Study.
Source: Clin Implant Dent Relat Res. 2015 Dec;17(6):1092-102.
DOI: 10.1111/cid.12218.
Type: Animal Study
Reviewer: Veronica Xia
Keywords: sinus floor elevation, bone grafting, animal study, bone formation, sinus membrane

Purpose:

- Histologically and immunohistochemically (IHC) study early bone formation events in max sinus of primates 10 to 45 days after membrane elevation

Materials and Methods:

- 9 adult male primates (8 subject to experimental sx and 1 used as positive control) were subjected to bilateral maxillary sinus membrane elevation using a lateral replaceable bone window technique.
- One oxidized dental implant was placed into the maxillary sinus cavity on both sides.
- In four animals, one sinus was left without any additional treatment, whereas the contralateral sinus was filled with autologous bone grafts from the tibia.
- In two animals, the implants were inserted under the elevated sinus membrane on both sides.
- In two animals, the sinus membrane was totally removed.

TABLE 1 Surgical Protocol in Relation to Time, Fixation Procedure, and Experimental Animal

Primate	Time (days)	Left Sinus		Right Sinus	
		Fixation Procedure	Surgical Protocol	Fixation Procedure	Surgical Protocol
1	10	Immunohisto	Elevation and bone graft	Immunohisto	Elevation
2	10	Histology	Elevation and bone graft	Histology	Elevation
3	10	Immunohisto	Elevation	Histology	Elevation
4	10	Immunohisto	Removal of membrane	Histology	Removal of membrane
5	45	Immunohisto	Elevation and bone graft	Immunohisto	Elevation
6	45	Histology	Elevation and bone graft	Histology	Elevation
7	45	Immunohisto	Elevation	Histology	Elevation
8	45	Immunohisto	Removal of membrane	Histology	Removal of membrane

- All animals subject to bilateral sinus membrane lifting using lateral sinus access technique
- Animals sacrificed and specimens were collects for histological and IHC examination

Results:

- Histology
    - Sinus elevation
        - 10 day specimen:
            - Successful elevation of sinus membrane, forming secluded area filled mainly with granulation tissue and bone fragments
            - Bone formation close to endosteal surface near implant sprouting into granulation tissue
                - Osteoblasts forming mineralized tissue at existing bone/bone fragments near vessels as solitary islets

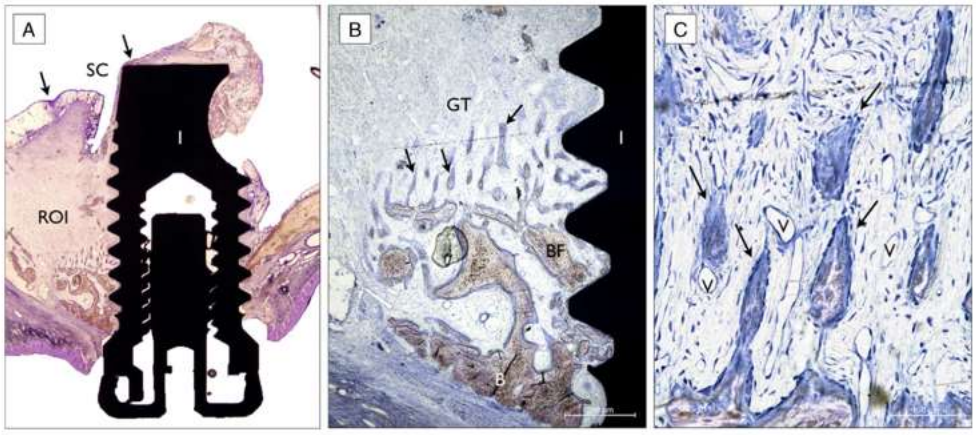


Figure 1 *A–C*, Light micrograph of a specimen 10 days after membrane elevation. *A*, The implant (i) is penetrating marginal bone and protruding into the sinus cavity (SC). The region of interest (ROI) of the study is bordered by the implant, sinus membrane, and marginal bone. Sinus membrane (*arrows*). *B*, Close up of Figure 1A, new bone formation (dark blue) is seen at existing bone (B), bone fragments (BF), and as solitary islets (*arrows* pointing to some) into the granulation tissue (GT). Bone is formed at the implant (I) surface. *C*, Higher magnification of Figure 1B, showing islets of osteoblasts and bone formation (*arrows*) near vessels (V).

- No bone forming activity at elevated sinus near apical portion of implant
- Osteoblastic activity at denuded endosteal bone surface and new bone directly on implant surface (in/just above marginal bone)

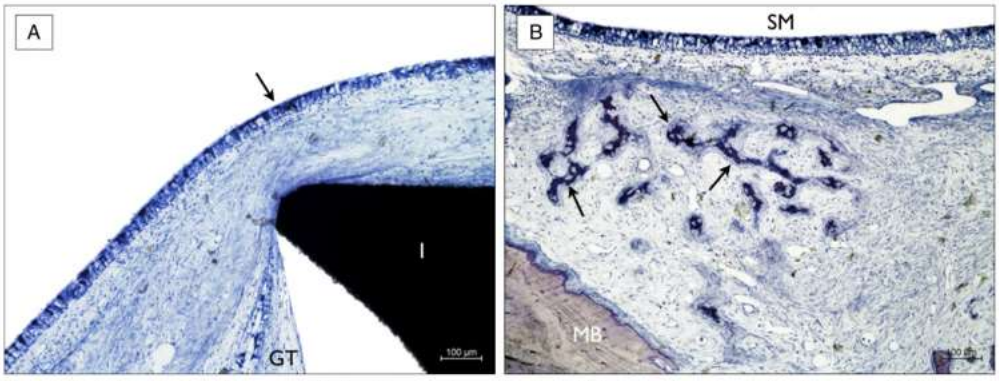


Figure 2 *A–B*, Details of specimen taken 10 days after membrane elevation. *A*, Sinus membrane (*arrow*) at the most apical implant thread (i). There are no signs of bone formation neither near the membrane nor in the granulation tissue (GT). *B*, Solitary bone formation (*arrows*) between the elevated sinus membrane (SM) and the marginal bone (MB). New bone formation (dark blue) is seen on the endosteal surface of the marginal bone.

        - 45 day specimen:
            - Well-developed bone/marrow tissues in elevated space
            - Center of specimen showed slender bone trabeculae, loose CT, and fat cells

        - Newly formed bone lining sinus membrane
        - BIC at apical area
        - Tip of implant contacting dense fibrous tissue/sinus membrane
    - Membrane removal
        - 10 day specimen: similar to sinus elevation specimens
            - Granulation tissue lateral to implant, with bone at endosteal bone and implant surface
        - 45 day specimen: new sinus membrane line implant
            - Small area near endosteal surface/coronal threads filled with new bone
                - Sinus membrane touched tip of more apical threads; tip of implant

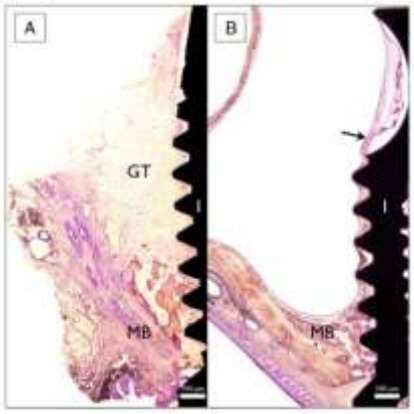


Figure 4 *A–B*, Light micrographs 10 days (A) and 45 days (B) after removal of the membrane. *A*, The region of interest is filled with granulation tissue (*GT*). Bone formation is seen near and at the implant (I). *B*, A new membrane has been formed and is following the contour of the implants (*arrows*). New bone is seen in the first two implant threads (I). MB = marginal bone.

    - Sinus membrane elevation and bone graft
        - 10 day specimen: bone graft particles in granulation tissue to fill area beneath elevated membrane
            - Bone formation at endosteal bone/implant surface
            - No bone forming/resorptive activities at graft particles
        - 45 day specimen: similar to membrane elevation group
            - More dense fibrous tissue near/at apical part of implant
            - Marginal bone resorption had occurred
- Immunohistochemical observations
    - Osteocalcin (OC) clearly expressed in 10/45 day
        - Seen in endothelial cells in superficial part of lamina propria
        - Presence stronger in 46 day
    - Osteopontin (OP) strong expression in all 10 day specimens
        - Increase close to where implant placed
        - Stronger in 45 day
    - Macrophages
        - Interspersed in 10 day specimen, no detection in 45 day
    - CD68
        - Few cells of lamina propria in 10 day and in residual bone in 45 day

Conclusion:

- Bone formation was observed to start from the sinus floor close to the implant
- At 10 days, woven bone trabeculae seen to project into granulation tissue (occupying space secluded by elevated sinus, implant surface, and cortical bone)
- At 45 days, well-developed bone and marrow tissue filled the elevated space, and newly formed one present lining the sinus membrane and contacting implant
- No evidence that sinus membrane induced bone formation
- Removal of sinus membrane results in less bone formation

Topic: Osteogenic capacity
Author: Dragonas P, et al.
Title: Osteogenic capacity of the sinus membrane following maxillary sinus augmentation procedures: A systematic review
Source: Int J Oral Implantol (Berl). 2020;13(3):213-232.
DOI: N/A **PMID**: 32879927
Reviewer: Ryan Higgins
Type: Systematic Review
Keywords: Osteogenic, sinus elevation/graft, sinus membrane, systematic review

Purpose:
- To analyze the current evidence on osteogenic capacity of the sinus membrane following maxillary sinus augmentation procedures

Materials and Methods:
- 6 databases used to identify studies reporting new bone formation in close proximity to sinus membrane after maxillary sinus augmentation
    - No clinical studies identified, 26 preclinical studies included in review
- 7 studies were not included in qualitative synthesis, 29 were included in qualitative synthesis

Results:
- 9 studies supported osteogenic potential of the sinus membrane
- 8 studies reported no evidence of osteogenicity from the sinus membrane
- 9 remaining studies reported on the local effects of rhBMPs
    - Majority reported enhanced new bone formation in sinus membrane region

Conclusions:
- New bone formation capacity of pluripotent mesenchymal cells in sinus membrane is known
- Systematic review of the studies does not consistently support significant contribution of sinus membrane to new bone formation follow maxillary sinus augmentation procedures

Topic: Sinus augmentation
Authors: Stacchi, C et al.
Title: Does new bone formation vary in different sites within the same maxillary sinus after lateral augmentation? A prospective histomorphometric study
Source: Clin Oral Impl Res. 2022;33:322–332
DOI: 10.1111/clr.13891
Reviewer: Nicolas Iobo
Type: Prospective

Keywords: bone regeneration, bone substitutes, guided tissue regeneration, maxillary sinus, sinus floor elevation
Purpose: to assess the histomorphometric outcomes of lateral maxillary sinus augmentation and to examine the relationship between these results and the bucco-palatal sinus width (SW) as well as the residual bone height (RBH).

Materials and methods:

22 patients needing sinus floor elevation for dental implants were selected. Specific inclusion criteria were set, such as RBH <5mm and ≥6mm SW. Sinus lift was performed using ultrasonic instruments. A composite graft (50%/50% mix cortico-cancellous porcine graft and synthetic nano-hydroxyapatite) was placed, and the site was covered with a bovine collagen membrane. Postoperative care included antibiotics, anti-inflammatory drugs, and specific sinus surgery instructions. Radiographic measurements were performed to evaluate bone height and sinus width. Samples processed for histological and hystomorphometric analysis. The study tested differences in new bone formation based on SW and RBH. Primary and secondary outcomes included the amount of newly formed mineralized tissue (NFMT), residual graft (RG), and any complications after 6 months of healing.

RESULTS:
In this study,18 patients were included, with 36 bone-core biopsies and implants inserted. No complications or adverse events were reported, and all implants were functional with follow-ups ranging from 7 to 31 months after prosthetic loading.

Radiographic Measurements: RBH ranged from 2.0 to 4.9 mm, with mesial sites showing significantly higher RBH than distal sites. SW ranged from 7.3 to 23.4 mm, with significantly higher SW in distal sites compared to mesial sites.

Histological and Histomorphometric Analyses: After 6 months, RG particles were still present, surrounded by NFMT. The mean %NFMT was higher in mesial sites (17.5 ± 4.7 %) compared to distal sites (11.6 ± 4.7%), while non-mineralized tissue (NFNMT) was higher in distal sites. SW showed a significant negative association with %NFMT, while RBH showed no correlation. The study confirmed that mesial sites had higher NFMT, while distal sites had more NFNMT, with SW being a key factor in these differences.

Conclusions:
The study found that the percentage of newly formed mineralized tissue (%NFMT) 6 months after lateral sinus floor elevation varies across different areas of the same maxillary sinus. There is a strong negative correlation between %NFMT and SW, while RBH showed no significant impact. Clinicians should consider SW when selecting grafting materials and determining the healing period. The use of SW as a key predictor variable should be considered when comparing the histomorphometric outcomes of different biomaterials in maxillary sinus studies.

Post-operative infections

Topic: infections after sinus elevation
Authors: Testori T, et al.

Title: Prevention and treatment of postoperative infections after maxillary sinus elevation surgery: clinical consensus and recommendations
Source: Int J Dent. 2012; 2012: 365809
DOI: 10.1155/2012/365809
Reviewer: Mahya Sabour
Type: Clinical consensus and recommendation
Keywords: infections, maxillary sinus, elevation, sinus augmentation

Purpose: to report the results of a clinical consensus of experts (periodontists, implantologists, OMFS, ENT, and microbiologists) on clinical questions and provide recommendation on how to prevent, diagnose, and treat post-operative infections.

Discussion:

- -What is the normal postop patient response to sinus surgery?
  - Swelling, ecchymosis, mild-mod discomfort, minor nose bleeds
  - Symptoms usually resolve within three weeks. Acute spontaneous pain is a warning sign and should be investigated
- What is the correct preop and postop pharmacological treatment after sinus surgery?

	Prophylaxis	Post-op therapy
No penicillin allergy	Amoxicillin/clavulanic acid 1g BID p.o. starting 24h prior to surgery	Amoxicillin/clavulanic acid 1g TID p.o. for 7d
Penicillin allergy	Clarithromycin 250mg BID + Metronidazole 500mg TID p.o. starting 24h prior to surgery	Clarithromycin 250mg BID + Metronidazole 500mg TID p.o. for 7d

  - Common consensus reached regarding corticosteroid therapy, but not on the dosage due to the heterogeneity of the regimens used by different experts
- In case of persistence of signs and symptoms beyond 3 weeks, what are the proper clinical recommendations?
  - CT to evaluate sinuses, and nasal and sinus endoscopy as needed
- What is the difference between early and delayed complication?
  - Early: within 21d after surgery
  - Delayed: more than 21d
- Which postop infection can be managed only with pharmacological treatment?
  - Graft infection that is well contained under the sinus membrane (verified via scan) and has only a clean serum exudate from the surgical incision – must monitor until resolution

No penicillin allergy	Amoxicillin/clavulanic acid 1g TID + Metronidazole 500mg TID p.o. for 7-10d
Penicillin allergy	Levofloxacin 400mg BID p.o. until 72h to symptom remission

- Which post-op infections require a combined pharmacological and surgical approach?
  - If graft is well contained under the Schneiderian membrane (seen on CT) but signs and symptoms persist beyond 3w + additional symptoms (tenderness, nasal obstruction, pain, fistula, pus from nose and throat, flap dehiscence, and suppuration) --> partial or total graft removal combined with pharmacological therapy
  - If graft is not contained under the SM and graft material is lost inside the sinus --> multidisciplinary approach with functional endoscopic sinus surgery and removal of graft and implants from an oral approach.
- What are the clinical indications for a microbiologic assay?
  - Always suggested but decide based on days vs. recovery speed, seriousness of complication, and general patient condition

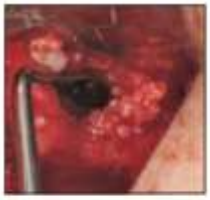
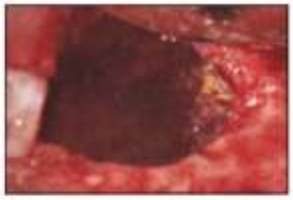
    - Negative result (bacterial absence) does not mean absence of infection since during antibiotic therapy, cultures are usually negative. Second test is recommended a few days after the end of antibiotic therapy
- In case of surgical management of postop infection, is a re-entry possible and how long should the surgeon wait?
    - Re-entry is possible after CT evaluation and ENT re-eval to confirm complete sinus healing (avg 6-9m)
- What are the most appropriate clinical recommendations to reduce the incidence of postop complications?
    - Careful med history and proper pt selection with healthy maxillary sinus
    - Pre-op CT to evaluate sinus anatomy and identify pathology
    - Recommend smoking cessation, especially in heavy smokers (>=15 cig/d)
    - Resolution of perio and endo diseases
    - Antibiotic prophylaxis
    - Achieve full mouth plaque score and full mouth bleeding score <15%. Advisable to remove provisional crowns and disinfect the abutments with antiseptic solution
    - Pre-op skin disinfection with an antiseptic solution and CHX
    - Sterile draping and infection control
    - Keep incision distant from antrostomy
    - Prevent salivary contamination for graft and/or other biomaterials
    - Prevent bone overheating
    - Two sets of instruments: one for flap elevation and one for grafting phase
    - Rinse surgical site with sterile saline and keep surgical time as short as possible
    - Post-op CHX and correct post-op pharmacotherapy
    - Preplanned pt controls: weekly follow ups for 1st month and monthly for the following 3m

Conclusion:
- Excellent results after sinus elevation are because complications are minimal and prevented through proper case selection, good surgical technique, and proper and prompt handling of complications.
- Implant survival rates are in the high 90th percentile with textured implant surfaces, xenografts (highest survival), and placement of barrier membrane over the window.
- Complications are infrequent, often localized and readily resolved.

Topic: infected sinus graft
Authors: Khouly I , Phelan J , Munoz C , Froum SJ
Title: Human histologic and radiographic evidence of bone formation in a previously infected maxillary sinus graft following debridement without re-grafting; a case report
Source: Int J Perio Restorative Dent . 2016 ; 36 : 723 - 729
DOI: 10.11607/prd.2409
Reviewer: Amber Kreko
Type: case report
Keywords: sinus augmentation, infection, reentry, implants

Purpose: To evaluate the histologic and radiographic new bone formation following maxillary sinus reentry surgery without a bone graft.

Case Report:
- 61 year old nonsmoking woman with a failed sinus augmentation procedure that was performed in the maxillary left sinus. Re-entry procedure was required to retreat sinus complication
- Initial procedure: Bio-Oss 1-2mm used to fill sinus cavity, Bio-Gide used to cover lateral window.

- One week after initial procedure – infection of sinus was diagnosed with signs of graft contamination. Planned treatment – removal of graft material via re-entry then sinus aug after a 6 month healing period and implant surgery 5 months later.
- Reentry done 3 weeks after 1st operation – removal of bone graft and debridement of sinus.
    - Flexible nature of membrane changed to nonflexible with fibrotic thickening. Some graft particles close to membrane remained intact with hard consistency. These particles were left to avoid membrane perforation. Membrane lost its ability to fold.
    - 
      Fig 2a *Intraoperative view at the time of sinus reentry with removal of the bone graft.*
      
      Fig 2b *Intraoperative view after removal of the bone graft. Note the consistency of the sinus membrane with some bone particles.*
- Healing uneventful and new pano and CBCT taken. Bone formation in area of previous sinus procedure was detected. Implant procedure was preformed with no further augmentation. Bone core was taken. Implants were placed, uncovered, then restored with successful integration at 18 months.
- Histologic analysis: new bone formation was detected in all sections.

Conclusions: This case report showed that sinus reentry without regrafting was sufficient to induce formation of bone. More cases needed to confirm results.

Topic: Sinus graft infection
Authors: Urban, Istvan A et al
Title: Incidence, diagnosis, and treatment of sinus graft infection after sinus floor elevation: a clinical study
Source: The International journal of oral & maxillofacial implants vol. 27,2 (2012): 449-57
DOI: n/a
Reviewer: Tam Vu
Type: Clinical
Keywords: postoperative infection, sinus elevation, sinus graft, sinusitis

Purpose: to evaluate the occurrence of sinus graft infection and a surgical and pharmacologic treatment regimen
Material and methods:

- Pts were treated for sinus floor elevation
- If clinical dx of sinus graft infx → CT performed to diagnose involved sinus cavity

<u>Treatment of Infected Sinus Graft</u>

- FTF of original sinus lift sx to expose lateral site of bone graft
- All loose membrane pieces removed
    - Grayish-looking bone graft particles were irrigated with sterile saline

- More confined, intact, immobile, immature, healthy-looking graft gently curetted until all loose graft particles removed
    - Impossible to determine which graft zone was infected
    - Local abx used to treat remaining sinus graft
        - Doxycycline putty [100 – 200 mg doxy diluted in 0.1 – 0.2 mL of saline]
        - Placed on graft for 2 min and flushed with sterile saline
- Defect gently curetted again to reestablish bleeding – formation of blood clot
- No further tx for defect – five-wall defect allowed to heal/fill with newly formed bone (deficiencies treated at time of implant placement)
- Flap reapproximated with primary closure
- Systemic abx – Augmentin 1 g BID for 7 days
    - NSAIDs and nasal decongestants (oxymetazoline hydrochloride, Nasivine 0.05%) as needed

Results:

- Btn 2001 and 2010, 198 pts treated, 274 sinus lifts
- 8 (2.3%) patients experiences one or more clinical symptoms of sinus graft infx 1 – 3 weeks after sinus augmentation
    - Severe pain
    - Fistulous tract extending into oral cavity
    - Recurrent facial swelling at 2 – 3 wks
    - Abscess
    - Elevated body temp
    - Loss of bone graft particles through fistula/border of flap (“popcorn sign”)
- CT scans may show
    - Thickening of sinus membrane
    - Complete opacification of sinus cavity

<u>Results of Surgical Intervention</u>

- Breakdown of collagen membrane + loose bone graft particles floating in purulent exudate
- Infx not yet involved with entire graft
    - Marked diff in loose particles floating in pus and stable immature graft zone
- Re-entry did not reveal detectable communication btn remaining defect and sinus cavity

<u>Results of Systemic Abx</u>

- 2 pts had concomitant sinusitis treated with nasal spray
- Acute symptoms disappeared within 48 hrs
- All pts healed uneventfully, infx was eliminated in all cases
- Average total healing time prior to implant placement: 10.6 mo
    - All defects had bone fill, but greatly reduced in size
    - Mainly implant fenestrations
- 100% implant survival rate

Conclusion: With the limitations of the 8 pts studied, the surgical and pharmacologic approach used in this study (removal of loose, infected graft particles, local abx, and systemic abx) successfully treated sinus graft infection, achieve optimal graft volume without subsequent sinus elevation, and resulted in long-term implant survival. Still need multicenter study with larger pt population.

Figs 3c and 3d Panoramic view and cross-sectional CT scan images demonstrate loss of integrity of the bone graft at the central part, a suspected internal fistulous tract into the sinus cavity, and complete sinusitis that obliterated the sinus cavity *(arrow)*.

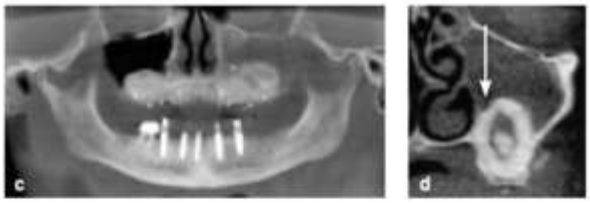
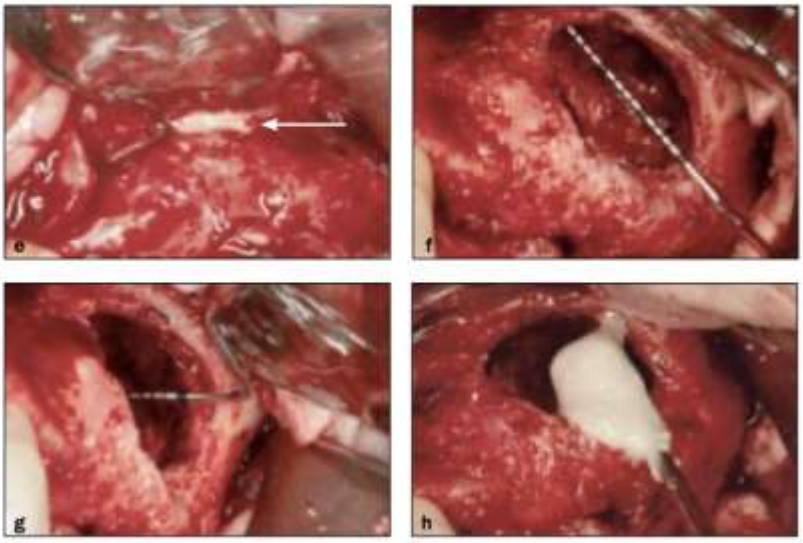


Fig 3e The patient was treated for sinus graft infection at 6 weeks after sinus grafting on the basis of the CT scan and consultation with an otolaryngologist. After flap elevation, purulent exudate *(arrow)* and loose grayish particles were visible, confirming infection of the graft.

Figs 3f and 3g The mesiodistal and buccolingual dimensions of the defect were measured after the cleansing procedure.

Fig 3h Application of the doxycycline putty.



Figs 3i and 3j Postoperative CT scans confirm complete healing of the sinusitis at 4 weeks after emergency treatment of the sinus graft and infection. Note the large five-wall defect. Remnants of the internal suspected fistulous tract are still identifiable *(arrow)*.

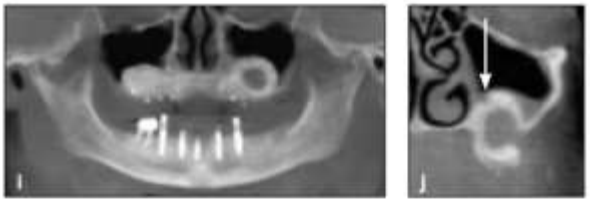
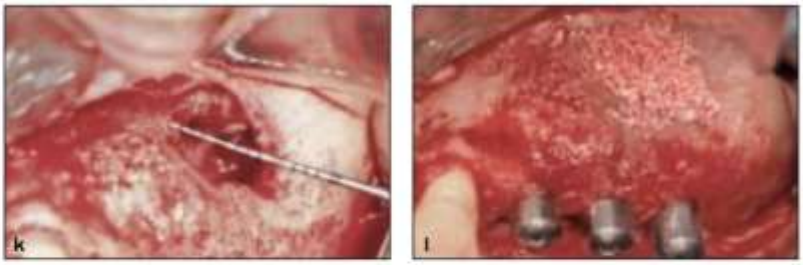


Fig 3k The defect has been reduced 1 year after sinus infection treatment and subsequent uneventful healing. Note that the majority of the defect is filled in with bone, but a moderate defect remains. In the eight patients treated, this was the largest remaining defect.

Fig 3l The defect is covered with a bone graft.



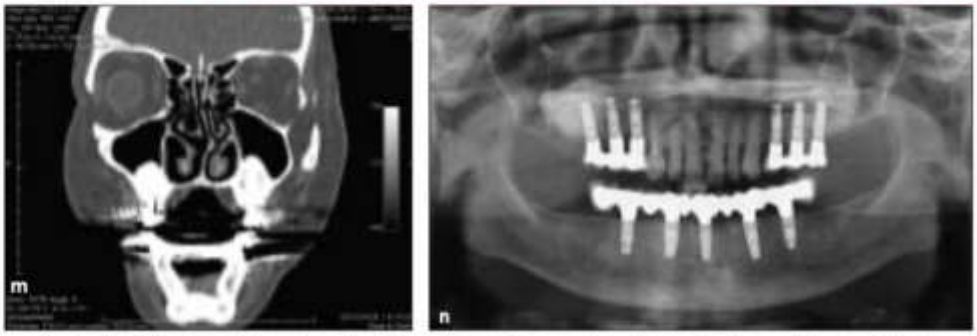


Fig 3m Follow-up CT scan after implant loading (18 months after the infection was treated) demonstrates complete healing of the sinusitis and good bone graft incorporation. Note the healthy and open ostium complex.

Fig 3n Panoramic radiograph demonstrates stable bone after 10 months of loading.

Implant survival in grafted maxillary sinus

Topic: maxillary sinus floor augmentation, implant success
Authors: Raghoebar GM, Onclin P, Boven GC, Vissink A, Meijer HJA.
Title: Long-term effectiveness of maxillary sinus floor augmentation: A systematic review and meta-analysis.
Source: J Clin Periodontol. 2019 Jun;46 Suppl 21:307-318.
DOI: 10.1111/jcpe.13055
Reviewer: Daeoo Lee
Type: Meta-Analysis
Keywords: biological complications, bone augmentation, dental implants, lateral approach, maxillary sinus floor elevation, sinus lift

Purpose: To assess the long-term effectiveness (≥5 years) of maxillary sinus floor augmentation (MSFA) procedures applying the lateral window technique and to determine possible differences in outcome between simultaneous and delayed implant placement, partially and fully edentulous patients and grafting procedures.

Material and methods:

- Electronic search (Medline, Embase and The Cochrane Central Register of Controlled Trials)
- Statistical analysis

Results:

- 11 studies included final analysis
- 383 pts (615 MSFA and 1517 implants)
- Outcome
    - 5 yr implant range (88.6% to 100%)
        - Implant loss was significantly higher when a mix of AB and BS was used
    - NSSD in terms of implant survival b/t fully and partially edentulous pt. nor b/t one and two stage surgery
    - PRP to AB did not result in less resorption of the grafting material.
    - Intra- and postoperative complications after MSFA were minor and unrelated to the grafting material used
    - Perforation (0% to 31.5%)
- Meta-Analysis
    - High heterogeneity (I^2= 90%)
    - 5-years implant survival rate of 97.8%
    - Annual implant loss was higher when implants were placed in a mixture of AB and BS compared with placement of implants in AB or BS alone (0.81 versus 0.23, $p < 0.001$)
    - Implant loss per year was independent of
        - simultaneous or delayed implant placement in relation to MSFA (0.38 versus 0.39, $p > 0.05$)
        - dental status (partial or fully edentulous) at time of implant placement (0.13 versus 0.23, $p > 0.05$).

Conclusions: MSFA is a safe and predictable procedure as part of oral rehabilitation of severely atrophic maxillae with dental implants. The survival of implants is high, with no difference in simultaneous or

delayed implant placement, dental status being partially or fully edentulous, or using AB or BS as augmentation material.

Topic: Survival of simultaneous implant placement
Authors: Park WB., Kang KL., Han JY.
Title: Factors influencing long-term survival rates of implants placed simultaneously with lateral maxillary sinus floor augmentation: A 6- to 20-year retrospective study
Source: Clin Oral Impl Res. 2019;30:977–988.
DOI: 10.1111/clr.13505
Reviewer: Cyrus J Mansouri
Type: Retrospective study
Keywords: bone regeneration, bone substitutes, guided tissue regeneration, sinus floor elevation, smoking

Purpose:
To evaluate the influence of residual bone height, membrane perforation, and presence of voids on implant survival during simultaneous lateral sinus augmentation.

Material and methods:
218 patients (631 implants) who underwent lateral sinus augmentation and simultaneous implant placement in private practice (from 1999-2003). Radiographs were made preop, immediately after sinus elevation with implant placement, after prosthesis delivery, and at follow-up visits. PA radiographs made immediately after final prosthesis delivery and at follow-up visits. Residual bone height and marginal bone loss were calculated with panoramic and periapical radiographs, respectively. Presence of voids were followed up by CBCTs at 2-3 years.

Results:
A total of 207 patients (613) implants were included in the study.

- 98 smokers with a mean follow-up of 12 years
- Membrane perforation occurred in 73 patients (245 implants)
- Voids in 11 patients (28 implants)
- Residual bone height of non-perforated membranes vs perforation was 2.69 mm vs 2.48 mm (significant according to study)
- Residual bone height for survived vs failed implants was 2.64 mm vs 2.19 mm (SSD)
- Overall survival was 95%
- Survival was higher in:
    - Females than males (98% vs 81%).
    - Non-smokers than smokers (90% vs 77%).
        - Hazard ratio 2.75 for implant failure.
    - Residual bone ≥ 3 mm than < 3 mm (92.4% vs 78.8%).
        - Hazard ratio 2.73 for implant failure.
    - No significant difference between non-perforated and perforated (91% vs 77.7%).
- Non-perforated sinuses had a higher incidence of voids. Voids did not have a significant influence on implant survival. 2 cases of voids associated with peri-implantitis.

Conclusion:
Smoking significantly influenced survival. RBH < 3 mm also had a significant influence on survival rate which authors deems clinically acceptable. Neither perforation nor voids had a significant impact on implant survival.

Crestal sinus augmentation

Topic: Osteotome
Author: Summers RB.
Title: A new concept in maxillary implant surgery: the osteotome technique
Source: Compend Contin Educ Dent 1994; 15 p 152.
DOI:
Type: Clinical Study
Reviewer: Veronica Xia
Keywords: osteotome, osteotomy, sinus floor elevation, implant placement

Purpose:

- Review limitations of drilling into soft bone and the osteotome technique

Discussion:

- Mandible (type I/II bone) vs maxilla (type III/IV bone)

Osteotome technique

- Osteotomy preparation without bone removal
- Maintain existing maxillary bone by pushing bone aside with minimal trauma, while developing osteotomy
    - Compact osseous later around osteotomy (denser bone interface with implant)
- Can widen ridge (ridge expansion osteotomy—REO)
- Some osteotomes have concave tips to collect/hold bone and push material in front of advancing osteotome
- Osteotome sinus floor elevation (OSFE) is simpler and less traumatic

Materials and Methods:

- 143 implants placed into sites developed with osteotomes

Results:

- Two implants failed due to mobility, and 16 implants could not be tested due to cemented final prosthesis
- All other implants were determined to be successful

Conclusion:

- Press-fit implants are best suited to the osteotome technique
- Osteotome superior to drilling when:
    - Soft/spongy bone
    - Spiny ridge less than 4mm width
    - Sites with less than 10mm bone height to sinus
- Osteotome technique is useful and predictable in soft maxillary bone

Topic: Transalveolar Sinus Elevation
Author: Pjetursson, et al.

Title: Sinus floor elevation utilizing the transalveolar approach
Source: Periodontology 2000, Vol. 66, 2014, 59–71
DOI: 10.1111/prd.12043
Reviewer: Ryan Higgins
Type: Narrative Review
Keywords: Transalveolar, sinus floor, elevation

Purpose:

- To describe technique of sinus floor elevation via Transalveolar approach

Discussion:

- Anatomy of maxillary sinus:
  - Local contraindications = Inadequate residual bone height (<4-5mm)
  - Septa : 26.5-31% incidence
  - Layers of SM-
    - pseudostratified ciliated columnar epithelium
    - loose, highly vascular connective tissue
    - periosteum
- Surgical technique:
  - Small round bur → 3 different sizes with #3 being .5mm smaller than implant diameter
  - Small osteotome used to create greenstick fracture
    - Second tapered osteotome with rounded tip can be used to increase fracture size
  - Third straight osteotome with diameter 1-1.5mm smaller than implant or piezoelectric surgery can be used for final elevation
  - Test for perforation via Valsalva maneuver
  - Can complete surgery with or without grafting
    - If grafting place 0.2-0.3g of grafting material
    - Autogenous, allogenic, or xenogenic grafting material can be used
  - Place implant using specific implant protocol
- Postsurgical care:
  - Rinse twice daily for first 3 weeks using .1/.2% CHX
  - Antibiotics = 750 mg of amoxicillin, 3x daily for 1 week
- Complications:
  - Tan 2008 = Systematic review finding perforation rate 0-21.4% with avg 3.8%
  - Small perforations can be treated with tissue fibrin glue
  - Larger perforations access must be accomplished via lateral window
    - Repair using barrier membranes, lamellar bone plates, suturing
  - Re-entry can be completed 6-9 months later
- Grafting Materials:
  - Controversial whether or not it is necessary to apply grafting material to maintain space
  - Pjetursson 2009 = Prospective study finding 4.1mm mean bone gain when grafting material used compared to 1.7mm when no grafting material used
- Success and implant survival:
  - Tan 2008 = Systematic review and meta-analysis found mean implant survival rate of 92.8% over 3 years
- Residual bone height:
  - Consensus Conference 1996 = Statistical difference in implant survival when residual bone height was ≤ 4mm compared to ≥ 5mm

- Patient-centered outcomes:
    - Pjetursson et al. = Mean visual analog scale score was 91± 17 of undergoing a similar treatment again

Conclusions:

- In posterior maxilla with residual bone height 5-8mm and relatively flat sinus floor elevation via Transalveolar technique indicated

Topic: Sinus Augmentation
Authors: Nedir et al.
Title: Osteotome sinus floor elevation technique without grafting: a 5-year prospective study
Source: Journal of Clinical Periodontology 2010; 37: 1023–1028
DOI: 10.1111/j.1600-051X.2010.01610.x
Reviewer: Nicolas Lobo
Type: Prospective cohort
Keywords: atrophic maxilla; bone grafting; bone regeneration; crestal bone loss; dental implants; long-term study; posterior maxilla; sinus lift; sinus osteotome

Purpose: To assess the long-term stability of bone formation around implants placed in the resorbed posterior maxilla without grafting.

Materials and Methods:
This study focused on patients needing implant treatment in the posterior maxilla using the OSFE technique without grafting. Inclusion criteria: residual bone height (RBH) of ≤8mm, plan for 10mm implants, and achieve primary implant stability. The study included 17 patients. The OSFE procedure involved careful sinus floor elevation without bone grafts, and all implants achieved primary stability. Clinical and radiographic evaluations aimed to confirm bone formation around the implants without grafting and to assess implant stability over 5 years. Success was measured by criteria such as implant stability, absence of pain or infection, and stable bone levels, assessed through periodic radiographs. Radiographic measurements were analyzed digitally to assess parameters like RBH, sinus bone levels, and implant protrusion, with precision enhanced through image processing.

Results:
The study evaluated 25 dental implants (15 standard and 10 standard esthetic) placed in molar and premolar regions, with most implants being 10mm long. A few implants required shorter lengths due to membrane perforation. The implants were stable, with a 100% survival rate over 5 years. Bone gain around the implants averaged 3.2 ± 1.3mm, with some implants showing significant bone gain. The length of implant protrusion into the sinus decreased over time, 4.9 ± 1.9mm after surgery to 1.5 ± 0.9mm and crestal bone loss was minimal (0.8 ± 0.8mm) and stabilized after 5 years. No patients experienced pain or sinus-related issues, even those with membrane perforation, and the bone gain continued to increase slightly after the first year, stabilizing between years 3 and 5. Statistical analysis showed significant

differences in bone formation and protrusion length between various time points.

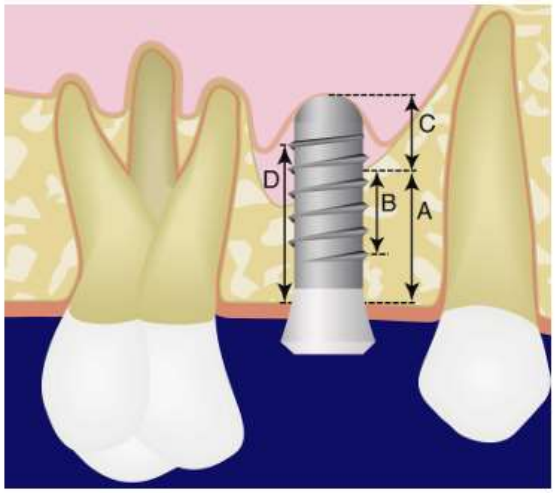


Fig. 1. Schematic drawing of the parameters measured on radiographs (Nedir et al. 2006, 2009): (A) residual bone height under the sinus, (B) distance from the most coronal implant thread to the most apical implant–bone contact. An increase in B distance corresponds to endo-sinus bone gain, (C) implant length protruding in the sinus, (D) distance from the most coronal bone–implant contact to the most apical implant thread. A decrease in D distance corresponds to crestal bone loss.

Conclusions:
The study suggests that implant rehabilitation in edentulous atrophied posterior maxilla can be effectively achieved using implants that are 10mm or shorter, along with the OSFE technique, without the need for grafting. Peri-implant bone increased over time, reaching 3.2mm after 5 years. The findings confirm that bone formation in the posterior maxilla beneath the sinus membrane can occur without grafting, making the procedure predictable and reliable for long-term success in treating compromised posterior maxilla.

Topic: Osteotome sinus floor elevation technique
Authors: Pjetursson BE, et al.
Title: Maxillary sinus floor elevation using the osteotome technique with or without grafting material. Part I–Implant survival and patient's perception.
Source: Clin Oral Implants Res2009:20:667–676.
DOI: 10.1111/j.1600-0501.2009.01704.x
Reviewer: Mahya Sabour
Type: Cohort study
Keywords: sinus augmentation, bone grafting, complications, implants, failure, osteotome technique, survival

Purpose: to analyze the survival and success rates of implants placed via the osteotome technique, compare peri-implant soft tissue parameters and marginal bone levels of osteotome-installed and conventionally placed implants and to evaluate patients' treatment perception

Material and Methods:
- 252 implants placed in 181 medically healthy patients with a mean age of 54.9
- 2 groups were studied over 6 years:
  - Test: implants placed in conjunction with sinus augmentation via osteotome technique
  - Control: implants placed using standard surgical procedures
- Evaluated:
  - Survival of implants and incidence of biological complications in the test group

    - Peri-implant ST conditions and marginal bone levels between the 2 groups – assessed PPD, PAL, BOP, and the distance between the implant shoulder and mucosal margin (DIM)
    - Patient perception on implant therapy assessed using a visual analogue scale

Results:

- Cumulative survival rate of the test group after a mean follow-up of 3.2 years was 97.4% (95% CI: 94.4-98.8%)
- Failure rate of test group implants increased in correlation to reduced residual bone height and implant length.
    - survival rates were 100% for 12mm implants, 98.7% for 10mm and 8mm, and 47.6% for short implants.
    - 100% for residual bone heights >5mm, 91.3% for <=4mm and 90% for 4-5mm
    - Transalveolar sinus floor elevation technique is most predictable with residual alveolar bone height of >=5mm and implants of >=8mm
- NSD in the PPD, PAL, % sites with BOP, marginal bone levels, and incidence of peri-implantitis between test and control groups

Conclusion:

- The transalveolar osteotome technique is a reliable and predictable method for implant placement at sites with >=5mm residual bone height and relatively flat sinus floor.
- Soft tissue parameters such as PPD, PAL, BOP, and marginal bone levels did not differ between osteotome-installed implants and conventionally placed implants.
- >90% patients were satisfied with the treatment and would be willing to redo if necessary and considered the costs as justified.

Topic: osteotome technique
Authors: Pjetursson BE, Ignjatovic D, Matuliene G, Bragger U, Schmidlin K, Lang NP.
Title: Maxillary sinus floor elevation using the osteotome technique with or without grafting material. Part II–Radiographic tissue remodeling.
Source: Clin Oral ImplantsRes2009:20: 677–683.24.
DOI: 10.1111/j.1600-0501.2009.01721.x
Reviewer: Amber Kreko
Type: clinical study
Keywords: biological complications, bone augmentation, bone grafting, complications, crestal, dental implants, failures, longitudinal, osteotome technique, patients' satisfaction, peri-implantitis, sinus augmentation, sinus floor elevation, sinus grafting, success, survival, transalveolar technique

Purpose: To evaluate the pattern of tissue remodeling after maxillary sinus floor elevation using the transalveolar osteotome technique with or without utilizing grafting materials

Material and methods:

- 252 implants placed in 181 patients – 65% placed without grafting material and 35% placed with grafting (BioOss).
- Radiographs were taken and measurements included pre-surgical residual bone height, implant penetration into the sinus, height of graft apically, height of graft mesially and distally, and maturation of the grafting material.

Results:

- Mean residual bone height was 7.5mm

    - Implants placed with grafting material: 6.4mm
    - Implants placed without grafting material: 8.1mm
- Implants penetrated on avg. 3.1mm into sinus cavity
    - With grafting: 3.6mm
    - Without grafting: 2.8mm
- Membrane perforation was detected in 10.8% of sites
- Survival rate of 97.4% after a follow-up of 3 years.
    - Residual bone height of ≤4 mm – 91.3%
    - Residual bone height 4-5 – 90%
    - Residual bone height above 5 – 100%
- Mean radiographic bone gain
    - Without grafting: 1.7mm
    - With grafting: 4.1mm
- Probability of gaining 2mm or new bone was 39.1% when no grafting material was used and increased to 77.9% when grafting material was used.

Conclusions: When transalveolar sinus floor elevation was done without grafting material, only a moderate gain of bone could be detected mesially and distally. When grating was used, a substantial gain of new bone was seen.

Topic: benign paroxysmal positional vertigo
Authors: Vernamonte, S et al.
Title: An unusual complication of osteotome sinus floor elevation: benign paroxysmal positional vertigo
Source: Int J Oral Maxillofac Surg2011:40: 216–218
DOI: 10.1016/j.ijom.2010.07.010
Reviewer: Tam Vu
Type: Case Report
Keywords: osteotome, sinus floor elevation, benign paroxysmal positional vertigo, nausea, implant, mallet

Definition: Cupulolithiasis: deposit, presumably composed of mineral, on the cupula of the posterior semicircular canal which renders this organ sensitive to gravitational force and, therefore, subject to stimulation with changes in head position

Purpose: to present case of intense benign paroxysmal positional vertigo (BPPV) during osteotome sinus floor elevation (OSFE), and discuss available tx options, diagnostic strategies, and pathophysiology of this complication

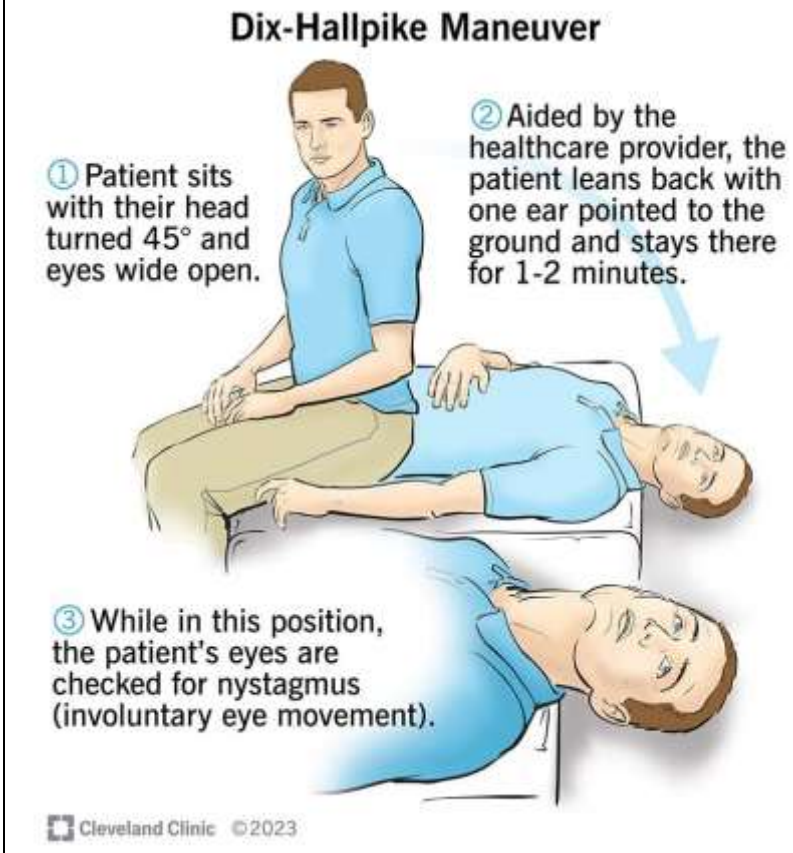
Case Report:

- 50 yo male, no sig med hx, partially edentulous scheduled for OSFE with simultaneous implant placement
- Osteotomy with piezo, then 2 mm twist drill 1 mm short of sinus floor
- Percussion w/lesser diameter osteotome until cortical sinus floor fracture
- Light malleting
- 3.5 x 11 mm placed

- Immediately after anesthetic wore off, pt experienced intense vertigo + nausea (no hx of dizziness)
- Anti-vertigo drug (betahistine 8 mg BID for 2 days) prescribed
- Symptoms persisted on day after sx → referred to ENT
- Dx: BPPV assoc w/Cupulolithiasis of right posterior semicircular canal
    - Tx: Epley's maneuver [successful]
- Pt reported complete resolution of vertigo + nausea
- Dix-Hall-pike test performed, observed no nystagmus → determined no signs of vertigo/nausea
- Pt evaluated weekly for 1 mo – reports complete resolution of all symptoms

Discussion:

- Dix-Hallpike maneuver used to diagnose BPPV
- Incidence of OSFE-related BPPV is <3%
- Symptoms of BPPV:
    - Brief attacks of vertigo + nausea, provoked by angular position changes of head
    - Resolves within several days to weeks, may persist chronically
- Theory of BPPV
    - Cupulolithiasis: triggered by debris from degenerating otoconia of the utricular macula and settling on the cupula of the posterior semicircular canal
- Tx of BPPV
    - Drugs
    - Surgery
    - Vestibular rehab exercises
- Primary management:
    - Maneuver to reposition debris [no symptoms when head change position)
    - Epley's maneuver
    - After canalith repositioning – pt is advised not to lie back, bend over, or tilt head for 2 days.
        - Sleep slightly elevated and avoid turning towards affect ear during sleep
- Conditions associated with BPPV
    - Head and neck trauma
    - Post surgery (stapedectomy, cochlear implant, OSFE, molar teeth extraction, vestibular neuronitis, prolonged bed rest, infx, tumors)
- Considerations
    - Pt's with hx of vertigo – use of PSFE is not recommended
        - Pt's advised to get up slowly after sx, and excessive tapping with mallet should be avoided
    - BPPV is self-limiting, symptoms often subside or disappear within 6 mo of onset
    - Usually age of onset of BPPV is 50 – 60 years, incidence increasing with age



Epley, J M. "The **canalith repositioning procedure**: for treatment of benign paroxysmal positional vertigo." *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* vol. 107,3 (1992): 399-404. doi:10.1177/019459989210700310

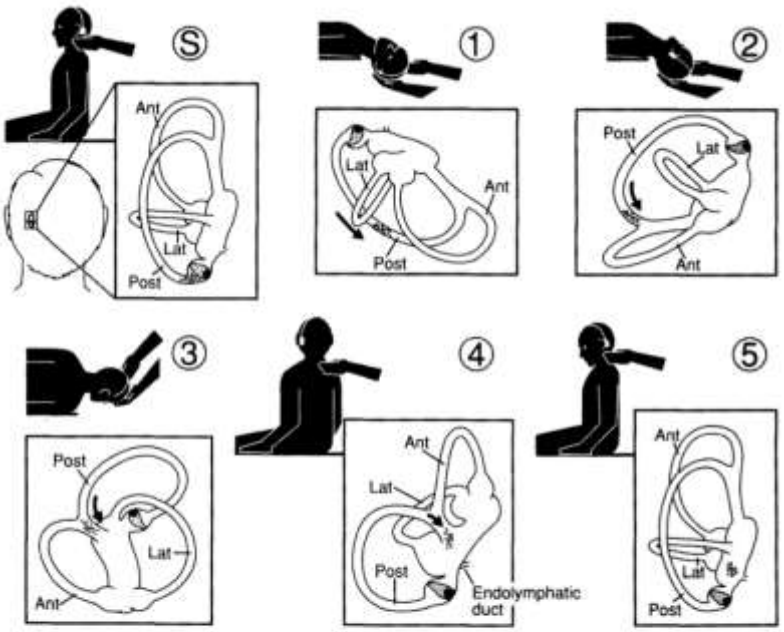


Fig. 1. Positions for CRP, targeting left PSC. *Dark figure, side view; boxes,* operator's exposed view of left labyrinth, showing gravitating canaliths. Semicircular canals are labeled. **S (Start),** Patient is seated, operator behind, oscillator applied. **1,** Head is placed over the end of the table, 45 degrees to the left (canaliths gravitate to center of PSC). **2,** While head is kept tilted downward, it is rotated to 45 degrees right (canaliths reach common crus). **3,** Head and body are rotated until facing downward 135 degrees from supine position (canaliths traverse common crus). **4,** While head is kept turned right, patient is brought to sitting position (canaliths enter utricle). **5,** Head is turned forward, chin down 20 degrees. General: Pause at each position until induced nystagmus approaches termination, or T sec (latency + duration) if no nystagmus. Keep repeating entire series (1 through 5) until no nystagmus any position.

Topic: crestal sinus grafting, perforation
Authors: Boyacıgil DU, Er N, Karaca Ç, Koç O.
Title: The effect of residual bone height and membrane thickness on sinus membrane perforation in crestal sinus grafting: A prospective clinical study.
Source: Int J Oral Maxillofac Surg. 2021 Feb;50(2):251-257.
DOI: 10.1016/j.ijom.2020.05.018
Reviewer: Daeoo Lee
Type: Prospective
Keywords: Sinus grafting; Sinus augmentation, Crestal, Transalveolar, Osteotome sinus floor elevation; Sinus membrane perforation.

Purpose: To determine the rate of sinus membrane perforation in patients undergoing **crestal sinus grafting**, as well as the effect of Schneiderian membrane thickness and residual bone height (RBH) on membrane perforation, using CBCT

Material and methods:

- 25 pts (44 crestal sinus grafting procedures)
- CBCT scans
    - Initial exam, immediately post-op, 3 mo post-op for perforation
- Group based on RBH

    - Control (RBH >=5mm)
    - Test (RBH < 5mm)
- Group based on thickness regardless of RBH
    - Group A (<1mm)
    - Group B (1-2mm)
    - Group C (>=2mm)
- Surgery
    - Midcrestal incision
    - Osteome technique
    - Control group
        - Twist drills in the implant system were used to create the implant bed to a depth of 23 mm below the sinus floor
    - Test group
        - Osteotomes were used to prepare the implant bed
- Membrane perforation evaluation
    - Valsalva manoeuvre and by CBCT
- Statistical analysis

Results:

- 44 crestal sinus grafting on 25 pt.
- 18.2% (8/44) perforation (NSSD)
    - Test group: 26.3%
    - Control group: 12%
- Median Membrane thickness (NSSD)
    - Perforation: 1.27mm
    - Without perforation: 1.35mm
    - 38.6% were in group A (23.5% perforation)
    - 31.8% in group B (7.1% perforation)
    - 29.6% in group C (23.1% perforation)
- In all patients with membrane perforation, an increased density in the maxillary sinus was observed (CBCT)

Conclusions:

A high perforation rate after using a modified osteotome technique was found using CBCT. Although there is no statistical association between membrane perforation with smaller RBH and thinner sinus membrane, clinically there is a tendency for the membrane perforation rate to increase in the presence of RBH of <5mm and a thickness of <1mm.

Topic: Perforation rate
Authors: Gargallo-Albiol J., Sinjab KH., Barootchi S., Chan HL., Wang HL
Title: Microscope and micro-camera assessment of Schneiderian membrane perforation via transcrestal sinus floor elevation: A randomized ex vivo study
Source: Clin Oral Impl Res. 2019;30:682–690.
DOI: 10.1111/clr.13453
Reviewer: Cyrus J Mansouri
Type: Cadaver study
Keywords: clinical assessment, diagnosis, sinus floor elevation

Purpose:
To evaluate effectiveness of microscope and non-invasive camera to assess Schneiderian membrane perforation and to evaluate how membrane elevation height (MEH) and residual ridge height (RRH) influences the incidence of perforations during crestal lift.

Material and methods:
5 fresh human cadaver heads fully or partially edentulous in maxillary arch. CBCT scans were made at baseline and analyzed for implant placement, RRH, membrane thickness. Preparation depth was determined based on RRH in CBCT images. Sinus crest approach drills were used for osteotomies. Elevation height was randomly determined between 3 or 6 mm (group 1 or 2). After elevation, integrity of membrane was examined by microscope and a micro-camera. Intra-surgical images were obtained and viewed. After elevation, a lateral window was prepared apical to the crestal preparation and sinus membrane was assessed with liquid communication assessment.

Results:
A total of 26 sites were analyzed with a mean membrane thickness of 0.64 mm, mean ridge height and width of 5.03 mm and 8.62 mm, respectively.
Incidence of membrane perforation:

- Mean incidence of perforation was 40.62%.
- 23.07% for 3 mm of membrane elevation height.
- 76.92% for 6 mm of membrane elevation height.
- OR of 9.88 for perforation at 6mm.
- No significant correlation was found between incidence of perforation and residual ridge height or width or membrane thickness.

Microscope and micro-camera coincided with post-op CBCT and liquid assessment in 87.5% of sites.

Conclusion:
Microscope and micro-camera may be used to detect perforation intra-op with high accuracy in the cadaver model. Membrane elevation height has a significant influence on perforation rate.

Topic: MOVE Protocol
Author: Puterman I, Weinstein B, Walton P, Fien M
Title: The Modified Osseodensification Visco-Elastic (MOVE) Sinus Protocol: A Case Series to Illustrate the Combination of Osseodensification with Viscoelastic Bone Replacement Material.
Source: Clin Adv Periodontics. 2022 Sep;12(3):180-185
DOI: 10.1002/cap.10188.
Type: Case Series
Reviewer: Veronica Xia
Keywords: osseodensification drills, sinus elevation, bone graft

Background:

- Osseodensification drills used to relocate native bone to floor of max sinus and minimize membrane perf

Purpose:

- Case series to describe surgical approach to crestal sinus membrane elevation (combining benefits of osseodensification sinus lift with viscoelastic colloidal biomaterial to gain greater membrane elevation)
    - Modified osseodensification visco-elastic (MOVE) protocol

        - Use osseodensification drills to generate hydrostatic pressure necessary to elevate/spread the colloidal biomaterial
            - Use largest twist drill before infracture, apply biomaterial with cannula, distributing hydrocolloid with slow-revolution reverse drilling

Cases:

- All cases used MOVE protocol
    - Twist drill at 800 RPM to within 1-2mm of sinus floor
    - Series of drills counterclockwise at 800RPM to widen osteotomy
        - Infracture of sinus floor with final osteotomy drill (until haptic feedback)
    - Then, viscoelastic graft material injected into osteotomy
    - Final osteotomy drill at 100RPM counterclockwise without irrigation to direct graft apically to lift membrane
    - Implant placed
    - 500mg amoxicillin 3xday for 7 days and NSAIDS

Case 1

- ASA I 68 yo male missing #14 with 3-4mm of native bone apical to sinus floor
- MOVE protocol, implant placement, uneventful healing

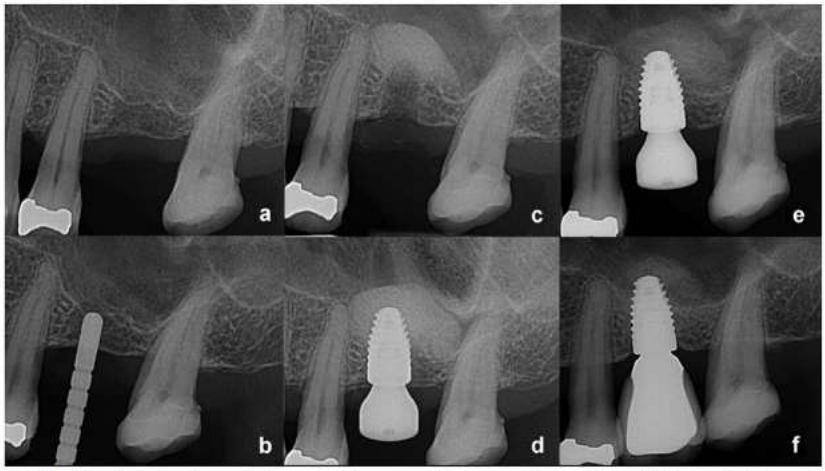


FIGURE 4 Periapical radiographs demonstrating case 1 (a) preoperative condition, (b) direction indicator pin prior to sinus infracture, (c) after membrane elevation, (d) immediately after implant insertion, (e) 10 weeks post implant insertion, and (f) 10 months post implant insertion

Case 2

- ASA I 62 yo female missing #2 and 3 with 4mm of ridge height
- MOVE protocol, implant placement
- CBCT at 15 months showed bone surrounding implants

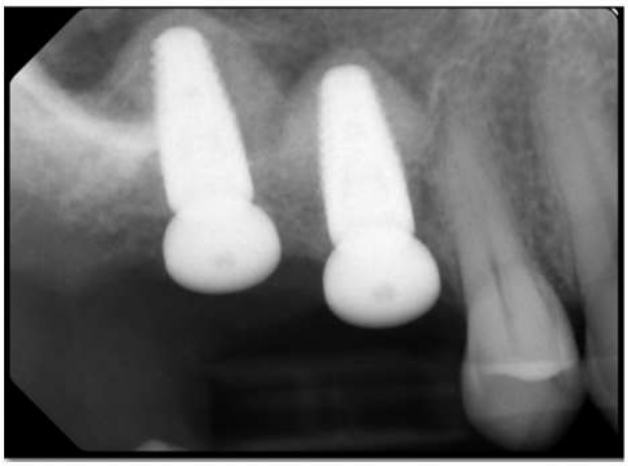


FIGURE 6 Case 2 immediately post implant insertion

Case 3

- ASA I 44 yo female with hopeless #4
- MOVE protocol, implant placed (torqued to 30Ncm)
- Xenograft condensed in space around implant
- Post-surgical CBCT verified containment of graft material around implant apex

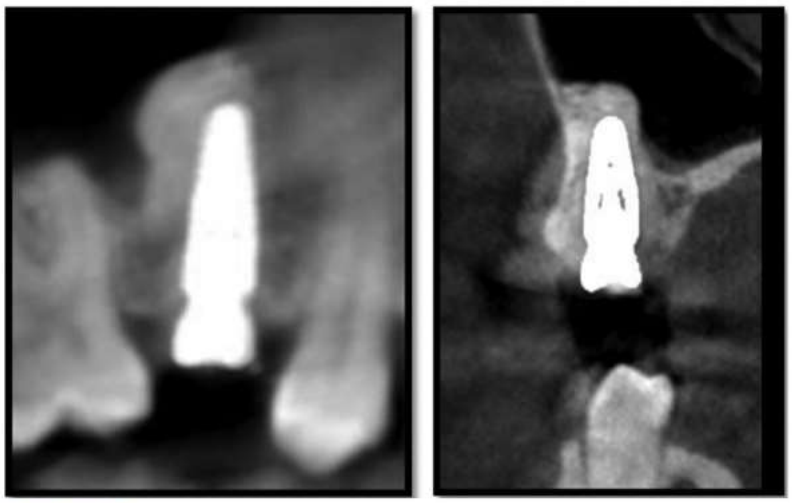


FIGURE 9 Case 3 immediately postoperative CBCT

Discussion:

- MOVE protocol shortens procedure time (when compared to osteotome) due to delivery system for the viscoelastic graft material → direct application of graft to apex of osteotomy
- Distinct feedback with osseodensification drills to confirm sinus infracture
- Putty graft material is easily distributed and allows membrane to remain intact
- Rotary instrument for sinus elevation reduces trauma
- Widest possible drill good to visualize membrane through osteotomy and reduces risk of perforation (increased force distribution)
- Bone gain 4-6mm

Conclusion:

- MOVE protocol allows for greater sinus membrane elevation through crestal lift, reduced procedure time, and less traumatic membrane elevation

Topic: Crestal Sinus Augmenation
Author: Salgar, et al.
Title: Osseodensified Crestal Sinus Window Augmentation: An Alternative Procedure to the Lateral Window Technique
Source: J Oral Implantol. 2021 Feb 1;47(1):45-55
DOI: 10.1563/aaid-joi-D-19-00288
Reviewer: Ryan Higgins
Type: Clinical
Keywords: dental implant, sinus graft, osseodensification, transcrestal, residual bone height, lateral window

Purpose:
- Investigate clinical efficacy of osseodensifying burs for crestal maxillary sinus bone augmentation

Materials and Methods:
- 3 patients = All with less than 1.5mm radiographic bone height
- Osseodensifying burs used for sinus augmentation
    - Densify alveolar bone by rotating in the noncutting counterclockwise direction 800-1200 RPM
        - Purchase points made with high-speed round diamond bur
        - 3.0mm Densah bur at 1100 RPM advancing in 1mm increments up to 3mm
            - 4.0, 5.0, and 5.3mm Densa burs used successively in same manor
        - Cortical allograft placed into site and final Densah bur used at 150 RPM with no irrigation to propel allograft into sinus
            - Step repeated 10-15 more times with each repeat pushing graft material vertically 1mm
    - Irrigation + pressure wave induces autografting of bone particles along the inner surface walls and apex
        - Autogenous bone chips create the gentle hydraulic detachment and elevation of the Schneiderian membrane
- Cases 1 and 2 also had horizontal ridge augmentation completed with collagen membrane and Mineralized cortical allograft bone (MTF Symbios)

Results:
- Mean initial (pre-op) bone height = 1.1±0.4mm
- Mena final (post-op) bone height = 11.9±1.3mm
- No perforations of Schneiderian membrane

Conclusions:
- The osseodensified crestal sinus window technique may be a possible alternative procedure for the lateral sinus window technique in cases of maxillary sinus bone augmentation

    - Technique can be used even when pre-op radiographic bone height is <1.5mm
- Limitations = Small sample size (3 cases), short follow up (1 year)