

Sinus membrane Perforation

1. **AK** Hernández-Alfaro F , Toradeflot MM , Marti C
Prevalence and management of Schneiderian membrane perforations during sinus-lift procedures . Clin Oral Implants Res . 2008 ; 19 : 91 – 98
2. **TV** Fugazzotto PA , Vlassis JM . A simplified classification and re-
pair system for sinus membrane perforations . J Periodontol. 2003 ; 74 : 1534 - 1541
3. **DL** Pikos MA. Maxillary sinus membrane repair: update on technique for large and complete perforations. Implant Dent 2008 Mar;17(1):24-31.
4. **CM** 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 – 1099
5. **VX** Pizzini A, Basma HS, Li P, Geurs NC, Abou-Arraj RV. The impact of anatomic, patient and surgical factors on membrane perforation during lateral wall sinus floor elevation. Clin Oral Implants Res. 2021 Mar;32(3):274-284.
6. **RH** Krennmair S, Weinländer M, Forstner T, Malek M, Krennmair G, Postl L. The influence of different forms of sinus membrane perforation on the prevalence of postoperative complications in lateral window sinus floor elevation: A retrospective study. Clin Implant Dent Relat Res. 2022 Feb;24(1):13-23.
7. **NL** Krennmair S, Gugenberger A, Weinländer M, Krennmair G, Malek M, Postl L. Prevalence, risk factors, and repair mechanism of different forms of sinus membrane perforations in lateral window sinus lift procedure: A retrospective cohort study. Clin Implant Dent Relat Res. 2021 Dec;23(6):821-832.
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13. **VX** Basma HS, Abou-Arraj RV. Management of a Large Artery During Maxillary Sinus Bone Grafting: A Case Report. Clin Adv Periodontics. 2021 Mar;11(1):22-26.

Biomaterials

14. **RH** Khijmatgar S, Del Fabbro M, Tumedei M, Testori T, Cenzato N, Tartaglia GM. Residual Bone Height and New Bone Formation after Maxillary Sinus Augmentation Procedure Using Biomaterials: A Network Meta-Analysis of Clinical Trials. Materials (Basel). 2023 Feb 6;16(4):1376. doi: 10.3390/ma16041376.

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Sinus membrane Perforation

Topic: membrane perforation

Authors: Hernández-Alfaro F , Toradeflot MM , Marti C

Title: Prevalence and management of Schneiderian membrane perforations during sinus-lift procedures

Source: *Clin Oral Implants Res* . 2008 ; 19 : 91 – 98

DOI: 10.1111/j.1600-0501.2007.01372.x

Reviewer: Amber Kreko

Type: clinical study

Keywords: buccal fat pad, collagen membrane, complications, dental implants, inorganic bovine bone mineral, mandibular bone block, pneumatized maxillary sinuses, posterior maxilla, sinus floor elevation, sinus membrane perforation

Purpose: To evaluate retrospectively the prevalence of surgical complications of the sinus graft procedure proposing a protocol to repair sinus membrane perforations intraoperatively using a variety of techniques and materials

Material and methods:

- 474 sinus floor elevations on 383 patients were included. 1166 dental implants were simultaneously placed.
- Patients were clinically and radiographically examined for available bone volume, bone quality, anatomy, and any existing sinus pathology.
- Surgical technique: sinus augmentation described by Tatum. Full thickness flap, rectangular osteotomy, bony window was rotated medially and superiorly. Graft material was inorganic bovine bone mineral mixed with autologous bone.
- When perforation of membrane was found:

- Smaller than 5mm (group 1) – direct suturing with 6-0 vicryl or patching with collagen membrane (BioGide)
- Between 5mm and 10mm (group 2) – resorbable collagen membrane used and lamellar bone from sinus window was placed under it in order to reinforce reconstruction before insertion of graft material.
- Larger than 10mm (group 3) – treated in 3 ways: 1) covered with lamellar bone of lateral sinus window, 2) covered with pedicled buccal fat pad flap, 3) placement of bone block graft harvested from symphysis of mandible or retromolar area.

Results:

- 104 perforations of sinus membrane were observed; 19 bilateral and were the main intra-operative complication
 - Group 1 – 56 perforations: 44 treated with collagen membrane and 12 treated with sutures. 140 implants placed with a survival rate of 97.14%
 - Group 2 - 28 perforations. 74 implants placed with survival rate of 91.89%
 - Group 3 – 20 perforations: 10 treated with lamellar bone with buccal fat pad flap, 6 treated with block graft, and 4 treated with only lamellar bone. 58 implants placed with a survival rate of 74.14%
- 272 implants placed under repaired membrane perforations with a 90.81% survival rate.

Conclusions:

Perforation of Schneiderian membrane is the most prevalent intra-operative complication. They can be reconstructed and covered and not an absolute contraindication to the continuation of surgery provided that they do not allow the passage of graft material inside the maxillary sinus. Overall survival rate of implants after membrane perforation was 90.81%.

Topic: Sinus membrane perforations

Authors: Fugazzotto PA, Vlassis J.

Title: A simplified classification and repair system for sinus membrane perforations

Source: J Periodontol. 2003 Oct;74(10):1534-41

DOI: 10.1902/jop.2003.74.10.1534

Reviewer: Tam Vu

Type: Case Report

Keywords: maxillary sinus, membrane perforation, sinus augmentation, implant placement

Purpose: to discuss the classification and treatments of the maxillary sinus membrane perforations

Discussion:

Classification of Sinus Membrane Perforations

- **Class I**
 - Perforations at any point along the most apical wall of the prepared sinus window
- **Class II**
 - Perforations along the lateral/crestal aspects of the prepared sinus window (mesial/distal)
 - IIA – anywhere along lateral/coronal walls of prepared sinus window, sinus cavity extends 4-5 mm beyond perforation
 - IIB – perforation is at most mesial/distal extent, cannot uncover intact sinus membrane
- **Class III**
 - Anywhere within the body of the prepared sinus window

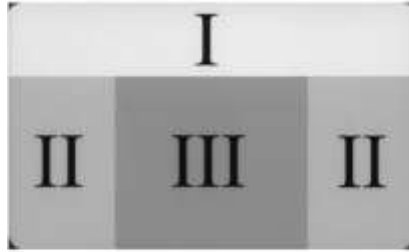


Figure 1.
A diagrammatic representation of the sinus membrane perforation classification system employed.

Treatment

- Class I
 - No concerns regarding therapy or final treatment results
 - Proper perforation management, do not apply pressure during reflection to maintain tear perforation dimensions
 - Apical displacement of sinus membrane after reflection will fold and seal the Class I perforation
 - Collagen tape can be used (to alleviate concerns about perforation after folding)
- Class II
 - IIA – extend osteotomy to expose intact sinus membrane, reflect membrane while bridging tear with curet.
 - ≤3 mm perforation still exist: collagen tape is placed before grafting
 - >3 mm: absorbable membrane is used
 - IIB – membrane is used and secured to surrounding alveolar bone with tacks
 - Proceed with grafting, no simultaneous implant placement
- Class III
 - Treated same as Class IIB
- Postop
 - Amoxicillin 500 mg TID for 10 days (Erythromycin 400 mg TID for 10 days if pcn-allergy)
 - No negative pressure (blowing nose) for 10 days
 - No removable prosthesis until suture removal
 - Prosthetic adjusted for cosmetics (not to be in function)

Conclusion: With proper diagnosis and treatment planning, sinus membrane perforations can be treated, and augmentation and implant placement can be done successfully.

Case 1:

Pt has Class IIA distal and Class IIB mesial sinus membrane perforation.



Figure 4.

Inadequate bone is present radiographically for implant placement in the maxillary left sinus area.

Bioabsorbable membrane secured with fixation tacks, bovine bone mixed with microfibrillar collagen placed into created sinus space. Hard tissue regeneration at 8 mo postop, implants placed and restored



Figure 5.

A Class IIA distal sinus membrane perforation and a Class IIB mesial sinus membrane perforation are evident.

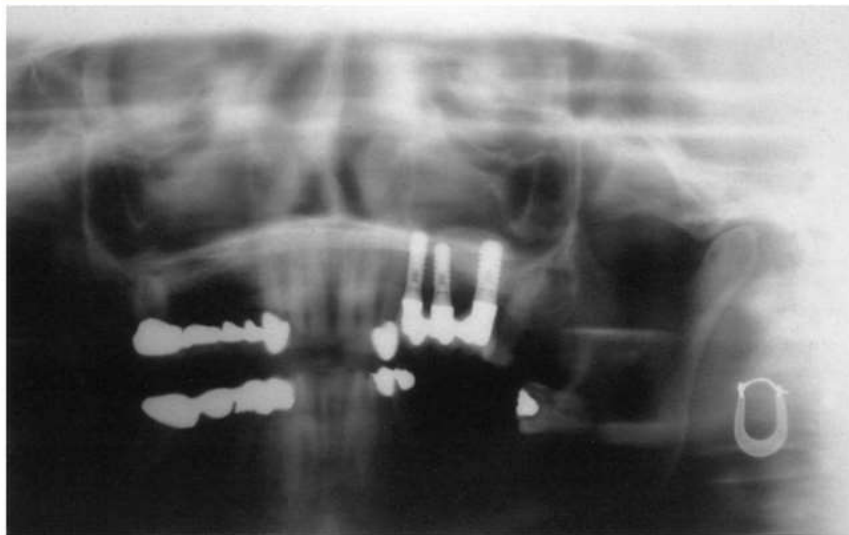


Figure 6.

Following appropriate management of the sinus membrane perforation, performance of augmentation therapy, and eventual implant placement, the maxillary left quadrant has been restored with a fixed prosthesis.

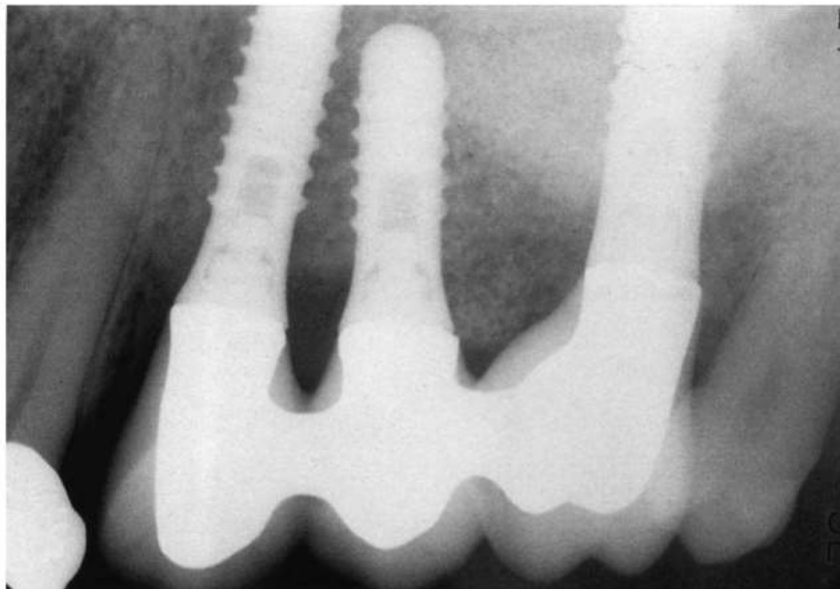


Figure 7.

A periapical radiograph demonstrates the successful augmentation therapy and restored implants.

Case 2:

Class IIB mesial perforation – absorbable membrane to create sinus space, secured with tacks, graft placed using bovine bone and DFDBA. Bone regen at 8 months, implants placed and restored.



Figure 8.

Inadequate bone is present for implant placement.



Figure 9.

A Class IIB sinus membrane perforation is noted mesially.



Figure 10.

Following membrane management, successful augmentation therapy has been carried out.



Figure 11.

An implant has been placed and restored in the previously augmented sinus.

Topic: Sinus membrane Perforation**Authors:** Pikos MA..**Title:** Maxillary Sinus Membrane Repair: Update on Technique for Large and Complete Perforations**Source:** Implant Dent. 2008 Mar;17(1):24-31.**DOI:** 10.1097/ID.0b013e318166d934**Reviewer:** Daeoo Lee**Type:** Case Report**Keywords:** repair, sinus membrane, collagen membrane, external fixation, technique**Purpose:** To describe technique for repairing large and complete sinus membrane perforation.**Discussion:**

- Anatomy:
 - (From CT 107 pts.)
 - Mean transverse dimension (mediolateral): 27 mm
 - Mean Width (anterioposterior): 35.6mm
 - (From CT 115 pts.)
 - Average volume of the maxillary sinus: 4.56 to 35.21 cm³(mean, 14.71 cm³)
 - 1 cm³ = 1ml
 - Maxillary sinus membrane: 0.3 to 0.8mm in thickness
- Maxillary Sinus membrane perforation and repair
 - MC complication: membrane perforation (10% to 56%)
 - Management:
 - (size of 2mm to 15mm) suturing, use of collagen membrane, fibrin sealants, freeze dried human lamellar bone sheets, oxidized regenerated cellulose
 - (Pikos >15mm) slow resorbing collagen membrane
- Surgical Technique for Large and Total Perforation
 - It includes the use of a slow resorbing collagen membrane with adequate structural integrity to adapt and maintain itself within the internal bony anatomy of the sinus
 - (e.g., Biomend collagen membrane)
 - See Fig. 1-4
- Case Reports
 - Fig. 5-12
 - 52M presents for replacement of failing dentition in the UL (to get 3 unit implant supported bridge)
 - Mucous retention cyst (2.5 x 2.0 cm²)
 - Complete membrane perforation to remove cyst
 - Biomend prepped and fixated externally using a tack.
 - Puros + Bio-oss + PRP placed
 - Another Biomend membrane placed to seal the lateral window.
- Discussion:
 - Most important to the success of **graft incorporation** is maintenance of the bony blood supply to the graft.
 - Critical not to cover the bony floor or the inferior 10+ mm of the anterior, posterior, medial, and lateral bony walls during the repair

Topic: Membrane perforation and vital bone

Authors: Froum SJ., Khouly I., Favero G., Cho SC.

Title: Effect of Maxillary Sinus Membrane Perforation on Vital Bone Formation and Implant Survival: A Retrospective Study

Source: J Periodontol. 2013 Aug;84(8):1094-9.

DOI: 10.1902/jop.2012.120458

Reviewer: Cyrus J Mansouri

Type: Retrospective study

Keywords: Bone grafting; dental implant; histology; sinus floor augmentation.

Purpose:

To evaluate the effect sinus membrane perforation has on percentage of vital bone and implant survival.

Material and methods:

Data was obtained retrospectively from the implant database at NYU. Records of interest were subjects who received bilateral sinus augmentation using the lateral wall technique. A total of 40 sinuses in 23 patients were selected.

Sinuses were grafted with either anorganic bovine bone matrix (ABBM), biphasic calcium phosphate (BCP) or mineralized cancellous bone allograft (MCBA). After an adequate healing period, a trephine drill was used to obtain a bone core biopsy for histomorphometry, and implants were placed. All perforations were reported < 10 mm in diameter and were repaired via a resorbable collagen membrane.

Results:

23 patients and 40 sinuses were included in the final analysis. Two implants were lost (97.5% survival rate). Perforation complications were reported in 15 sinuses (37%). Vital bone was 28.25% for MCBA, 12.44% for ABBM, and 30.6% for BCP. Implant success was 100% in perforated sinuses and 95.5% in non-perforated sinuses. A significant difference was found between perforated and non-perforated membranes in terms of vital bone percentage (26.3% vs 19.1%).

Summary Statistics for Percentage of Vital Bone in Perforated/Non-Perforated Sinus Membrane Groups

Group	Sinuses Observed (n)	Vital Bone			
		Mean (%)	Statistical Deviation (%)	Minimum (%)	Maximum (%)
Perforated	24	19.1	13.7	7	55
Non-perforated	16	26.3	6.3	13	37

Greater vital bone in the perforated group may be attributed to the additional barrier used which may prevent soft tissue migration and better contain the grafting material.

Conclusion:

Perforation of the Schneiderian membrane may result in increased vital bone formation. No difference in implant survival was found whether the membrane was perforated or not.

Topic: Factors in Sinus Membrane Perforation

Author: Pizzini A, Basma HS, Li P, Geurs NC, Abou-Arrej RV.

Title: The impact of anatomic, patient and surgical factors on membrane perforation during lateral wall sinus floor elevation.

Source: Clin Oral Implants Res. 2021 Mar;32(3):274-284.

DOI: 10.1111/clr.13698.

Type: Retrospective Study

Reviewer: Veronica Xia

Keywords: sinus floor elevation, membrane, perforation, anatomy, pathology

Purpose:

- Evaluate reported membrane perforation (MP) occurrence in lateral window (LWSFE), mean values for max sinus anatomic landmarks, and associated between anatomical/surgical/and patient factors in MP occurrence

Materials and Methods:

- Patients needing LWSFE were selected
- Evaluated: lateral wall thickness (LTW), angle of the lateral/medial walls in relation to the sinus floor (LFM), angle of the lateral/medial walls in relation to the anterior wall (LAM), distance between lateral/medial wall (LM-5), residual bone height, septa, and arterial anastomosis (PSA and IOA)

Results:

- 202 LWSFE included
- Overall:
 - LTW: 1.6mm
 - Residual bone height: 3.2mm
 - Sinus floor angle: 95 degrees
 - Angle at anterior wall (between medial/lateral): 75.5 degrees
- Septa identified in 20.8% of sinuses
- PSA/IOA anastomosis in 16.4% (14.6mm from crest of ridge)
- Breakdown of pathology:
 - 62.38% no pathology
 - 26.24% membrane thickening
 - 5.94% mucous retention cysts
 - 4/95% chronic sinusitis
- Association with MP
 - Lowest MP with LWT <1.5mm (14%)
 - Significantly higher when LST 1.5-2mm (39.3%) and >2mm (34.1%)
 - More MP with LFM angle <90 degrees (38%)
 - More MP with LAM angle <70 degrees
 - When MP, average sinus width (medial to lateral wall) was 11.4mm
 - Add of MP when LM-5 <10 was 3.29 times higher than LM-5 > 12mm
 - Larger average window surface area (WSA)—78.6mm²—associated with greater rate of MP (36.4%)
 - More MP when pathology presence
 - No association between septa and PSA/IOA and MP risk

Conclusion:

- Overall MP occurrence of 25.74%
 - Significantly more when:
 - Lateral wall thickness >1.5mm
 - Narrower maxillary sinus floor angle (LFM-- <90degrees) associate with greater perforation risk (37.9%)
 - Narrower LAM angle <70 degrees
 - At 5mm from sinus floor, MP more likely (45.5%) when lateral to medial width <10mm
 - At 5mm from sinus floor, majority of MP (45.4%) occurred with distance <10mm
 - This area correlated with narrower LAM

- Larger window surface area (average 78.6mm²)
- Presence of sinus pathology (membrane thickening, chronic sinusitis, or mucous retention cyst)
- No relationship to residual alveolar bone height, PSA/IOS

Topic: Sinus membrane perforation

Author: Krenmair, et al.

Title: The influence of different forms of sinus membrane perforation on the prevalence of postoperative complications in lateral window sinus floor elevation: A retrospective study.

Source: Clin Implant Dent Relat Res. 2022 Feb;24(1):13-23.

DOI: DOI: 10.1111/cid.13056

Type: Retrospective cohort study

Reviewer: Ryan Higgins

Keywords: lateral window, repair mechanism, sinus membrane perforation

Purpose:

- To evaluate the prevalence of postoperative complications (PC) after different forms of sinus membrane perforation (SMP) with lateral window sinus floor elevation (SFE)

Materials and Methods:

- 434 lateral window SFE (334 patients) including 331 SFE (241 patients) without and 103 SFE (93 patients) with SMP
- SMP subdivided into 4 categories
 - Small-moderate (<10mm), large (>10mm) and membrane biotype (BT) thin, thick
 - Thin = clear translucent membrane, cannot handle with tweezers (<1.5mm thick)
 - Thick = Measurable with perio probe, handle with surgical tweezers without further rupture (>1.5mm thick)
- Patient/surgery related risk factors affecting PC and the 1-year implant survival rate evaluated for SFE with/without SMP

Results:

- 261/331 SFEs had no SMP, 103 SFEs (94 patients) had SMP
- 27/331 SFEs (6.2%) had PCs
 - 14 = Maxillary sinusitis, 8 = Graft necrosis, 5 = Wound healing disturbances
 - SS increased rate of PCs with perforation group
 - Highest rate of PCs in perforation group found in patients with thin biotype and perforation ≥10mm

TABLE 3 Complication rate after sinus floor elevation procedure (SFE) with perforated and nonperforated sinus membrane

	Nonperforation Group A	Perforation Group B	Total	p Value		Nonperf. versus Group A versus	Perforation Group B
SFE	331	103	434		Odds ratio	95% CI	p Value
Sinusitis	4 (1.2%)	10 (9.7%)	14 (3.2%)	0.021	8.85	1.39–56.36	0.021
Wound	2 (0.6%)	3 (2.9%)	5 (1.1%)	0.209	5.43	0.39–75.88	0.209
Graft	1 (0.3%)	7 (6.8%)	8 (1.8%)	0.017	7.43	1.43–38.61	0.017
Total	7 (2.1%)	20 (19.4%)	27 (6.2%)	0.014	9.91	1.58–62.30	0.014

	SMP group I	group II	group III	group IV	Total	p Value
SFE	27	24	5	47	103	
Sinusitis	2 (7.4%)	0 (0%)	0 (0%)	8 (17.0%)	10 (9.7%)	0.118
Wound	1 (3.7%)	0 (0%)	0 (0%)	2 (4.2%)	3 (2.9%)	0.828
Graft	2 (7.4%)	0 (0%)	0 (0%)	5 (10.6%)	7 (6.8%)	0.449
Total	5 (18.5%)	0 (0%)	0 (0%)	15 (31.2%)	20 (19.4%)	0.005

Note: SMP I: thick biotype / <10 mm; SMP II: thin biotype / <10 mm; SMP III: thick biotype / >10 mm; SMP IV: thin biotype / >10 mm.

TABLE 4 Complication rate of sinus floor elevation procedure (SFE) with perforated sinus membrane in relation to SMP I-IV subgroups

- At 1-year evaluation 7/712 implant placed were lost
 - o 6/712 in non-perforation group
 - o 1/712 in the perforation group
 - o No difference in implant survival rate between groups (99.1% vs. 99.5%)

Conclusions:

- Prevalence of PC was SS influenced by forms of SMP
 - o PC more likely to occur when there is a perioperative (large) SMP and thin sinus membrane biotype than in SFE without or with small SMP in thick or thin biotype
- High implant survival rate may be explained by high percentage of staged implant placement procedure regardless of residual ridge height

Topic: Sinus perforations.

Authors: Krennmair, S et al.

Title: Prevalence, risk factors, and repair mechanism of different forms of sinus membrane perforations in lateral window sinus lift procedure: A retrospective cohort study

Source: Clinical implant dentistry and related research 2021;23:821–832.

DOI: 10.1111/cid.13016

Reviewer: Nicolas Lobo

Type: Retrospective cohort study

Keywords: lateral window, repair mechanism, sinus membrane perforation

Purpose: to understand the relationship between perforation size, sinus membrane thickness, and clinical implications.

Materials and methods:

355 patients who underwent sinus floor elevation (SFE) procedures using the lateral window technique (LWT). The study aimed to evaluate the prevalence and repair mechanisms of sinus membrane perforations (SMPs) and associated risk factors. 434 SFE procedures were performed, with radiographic examinations. LWT ovoid osteotomy, membrane reflection, and filled with a bone graft mixture.

SMPs were categorized by size, location, and membrane thickness. Four subgroups were established based on these factors, with different repair techniques applied for each.

Thick membranes (>1.5 mm) and thin membranes (<1.5 mm) were handled differently, with repairs including collagen membranes, sutures, or a combination of both.

- **Group P1 (Thick Biotype, Small–Moderate Perforations <10 mm):**
Central Location: Repaired using a collagen membrane and, if accessible, resorbable sutures.
Lateral Location: Membrane sutured at osteotomy sites with additional membrane coverage.
Implant Placement: One-stage or two-stage procedure depending on residual ridge height (RRH).
- **Group P2 (Thin Biotype, Small–Moderate Perforations <10 mm):**
Central Location: Repaired with a collagen membrane patch.
Lateral Location: Collagen membranes extended to the osteotomy border.
Implant Placement: One-stage or two-stage procedure based on RRH.
- **Group P3 (Thick Biotype, Large Perforations ≥10 mm):**
Central Location: Direct suturing of the membrane with additional collagen membrane patching.
Lateral Location: Membrane sutured to cranial osteotomy sites and patched with collagen.
Implant Placement: Based on alveolar crest dimensions.
- **Group P4 (Thin Biotype, Large Perforations ≥10 mm):**
Repairment: Attempt to reduce perforation size with sutures. Apply a double layer of collagen membrane, sutured and tacked.
Implant Placement: Typically performed in a two-stage procedure regardless of RRH.

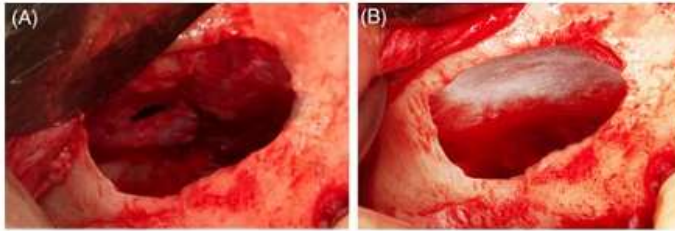


FIGURE 1 Small/moderate perforation (<10 mm) in thick sinus membrane biotype (A). Sinus membrane perforation covered with collagen membrane (B)

FIGURE 3 Large sinus membrane perforation (≥ 10 mm) in thick sinus membrane biotype (A). Direct closure with sutures (B)

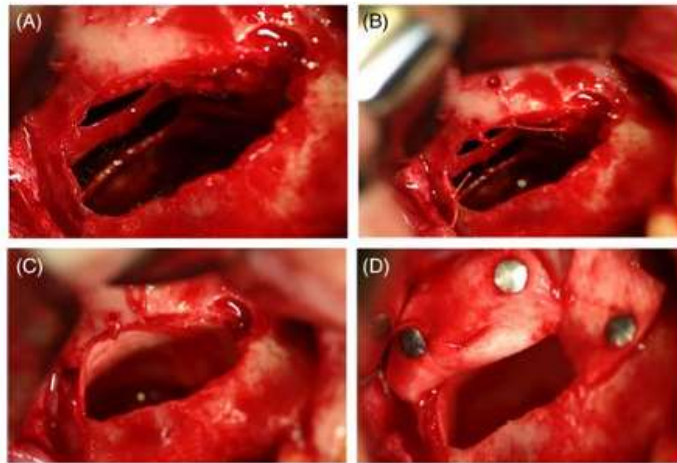
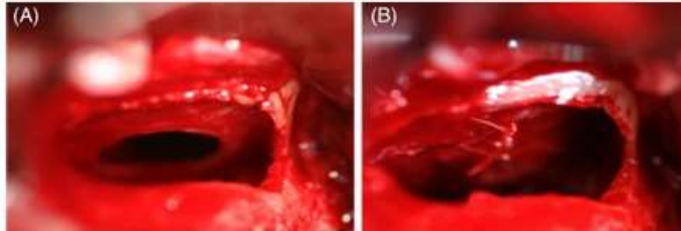


FIGURE 4 Large sinus membrane perforation (≥ 10 mm) in thin sinus membrane biotype (A). Smart sutures to stabilize cranial cavity (B). Sinus cavity veneered with collagen membrane (C). Tacked collagen membrane outside the sinus osteotomy (D). Sinus cavity grafting (E)

Results:

355 patients who underwent 434 SFE procedures, the overall incidence of SMPs was 23.8% at the procedure level and 26.5% at the patient level. SMPs were categorized into four subgroups:

1. P1 (Thick BT, <10 mm): 27 cases (26.6%), 53 implants.
2. P2 (Thin BT, <10 mm): 24 cases (23.3%), 47 implants.
3. P3 (Thick BT, ≥ 10 mm): 5 cases (4.8%), 11 implants.
4. P4 (Thin BT, ≥ 10 mm): 47 cases (45.6%), 90 implants.

P4 (Thin BT, ≥ 10 mm) was the most frequent and challenging type, with a significantly higher frequency of previous oral surgeries and 2-stage SFE procedures. Large perforations (≥ 10 mm) and thin sinus membranes were more common, with 68.9% occurring in thin membranes. Significant risk factors for SMPs included reduced residual ridge height, presence of maxillary sinus septa, and previous oral

surgeries. All SMPs were successfully repaired. The difficulty of repairs varied, with small to moderate perforations (P1, P2) being easier to repair, while large perforations in thin membranes (P4) were the most challenging, reflected in the highest scores for repair complexity.

Conclusions

Regarding SMPs during SFE procedures it is important to take into consideration the size and biotype. Specific anatomic and surgical risk factors, such as reduced residual ridge height and the surgical approach (1-stage vs. 2-stage), are associated with a higher risk of membrane perforation. Staged procedures are often more appropriate for large perforations in thin membranes to reduce the risk of complications. The general prevalence of membrane perforations may be overestimated in terms of clinical significance

Topic: Schneiderian membrane perforation treatment

Authors: de Almeida Malzoni CM, et al.

Title: The Effectiveness of L-PRF in the Treatment of Schneiderian Membrane Large Perforations: Long-Term Follow-Up of a Case Series

Source: J Oral Implantol. 2021 Feb 1;47(1):31-35.

DOI: 10.1563/aaid-joi-D-20-00044

Reviewer: Mahya Sabour

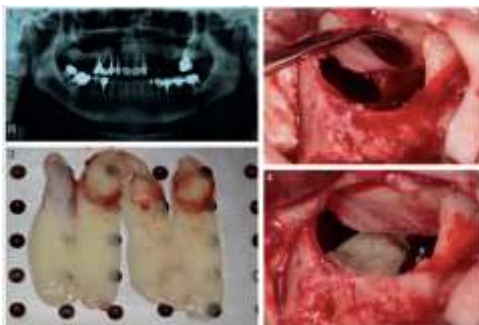
Type: Case series

Keywords: maxillary sinus, Schneiderian membrane, perforation, platelet-rich fibrin

Purpose: To assess the use of leukocyte and platelet-rich fibrin (L-PRF) in treating large Schneiderian membrane (SM) perforations in 9 clinical cases with a 2-5 year follow up.

Material and Methods:

- From January 2014 to 2017, 9 healthy patients with a mean age of 53.22 were selected for implant placement, requiring sinus floor augmentation (SFA).
- SFA was done through the lateral wall of the sinus, osteotomy done with a ball milling cutter until the SM could be seen. Membrane was detached with curettes, but a large disruption of the membrane integrity was seen in all patients. L-PRF membranes were interposed on the perforated region onto one another until the rupture could not be seen. Sinus cavity was filled with deproteinized bovine mineral bone (Bio-oss) and a collagen membrane, followed by primary closure



- CBCT or Pan taken after 8 months to assess bone graft gain and assess possible pathology. Implants were placed in all patients.
- Pts were evaluated after 3-5 years. CBCT or Pan were taken to assess the quality of the SM repair and osseointegration

Results:

- Adequate bone volume was seen at 8 months in all patients.
- No signs of infection or mucus were seen in the sinus cavity 3-5 years in all cases. No implants were lost.
- Correct osseointegration and effective repair of all SM perforations was seen.
- Promising results, but RCTs that involve control groups, perform bone formation analysis, and larger number of patients should be done in the future.

Conclusion:

Based on qualitative analysis of clinical results and radiographic/CBCT images, L-PRF membranes are effective for the treatment of large SM perforation repair, allowing osseointegration with no infection or mucus present after 3-5 years of follow-up.

Topic: membrane perforation

Authors: Wang D, Tian J, Wang Y, Wei D, Lin Y.1.

Title: Clinical and radiographic outcomes of reentry lateral sinus floor elevation after a complete membrane perforation

Source: Clin Implant Dent Relat Res. 2020 Oct;22(5):574-58

DOI: 10.1111/cid.12932

Reviewer: Amber Kreko

Type: clinical study

Keywords: complete membrane perforation, long-term outcome, membrane thickness, re-entry, sinus floor elevation

Purpose: To evaluate the long term clinical outcomes of reentry LSFE and the radiographic changes that occur following complete membrane perforation to elucidate the technical details of the reentry procedure and surgical outcome

Material and methods:

- 22 patients received reentry procedure with a history of discontinued therapy caused by complete sinus membrane perforations larger than 10mm.
- Radiographic measurements, demographic information, Cumulative survival rate of implants, marginal bone loss, and subsequent complications were recorded
- 3-6 months after perforation, new CBCT was done to identify maxillary sinus cavity conditions, sinus membrane continuity, and size and location of the buccal bone window from the first operation.
- Radiographic measurements included residual bone height, mean sinus membrane thickness, lateral bone thickness, height of the bone graft gained
- Re-entry:
 - o Scar tissue on window was dissected with a blade to raise mucoperiosteal flap and expose former window
 - o New larger window about 2mm from edge of original window was made.
 - o New window containing scar tissue was lifted into maxillary sinus.
 - o Sinus membrane was covered with PRF and collagen membrane (BioGide). Bone graft was placed in the space.

Results:

- Avg residual bone height was 3.83mm for 1st procedure and 3.73 at reentry. Avg thickness of lateral bone was 1.29mm. Thickness of sinus membrane was 1.03mm at 1st procedure and 1.91mm at reentry. Height of bone graft after reentry was 9.73mm.
- Membrane perforations occurred in 4/22 patients. 2 were suspended due to excessive perforation, other 2 were less than 5mm and repaired with BioGide.

- 34 total implants placed – 20 simultaneously and 13 delayed placement. Cumulative survival rate after an avg 5 year follow up was 97.1%. Marginal bone loss was 0.64mm after avg 5 year follow up.

Conclusions:

- Long term outcome of reentry LSFE is predictable and reentry LSFE is a reliable alternative following complete membrane perforation. Sinus membrane increased from 1.03mm to 1.91mm, cumulative survival rate of implants was 97.1% and marginal bone loss was 0.64.

Topic: Maxillary Sinus Augmentation Risk Assessment

Authors: Testori T, Yu SH, Tavelli L, Wang HL

Title: Perforation Risk Assessment in Maxillary Sinus Augmentation with Lateral Wall Technique

Source: Int J Periodontics Restorative Dent. 2020 May/Jun;40(3):373-380

DOI: 10.11607/prd.4179

Reviewer: Tam Vu

Type: Review

Keywords: maxillary sinus augmentation, risk assessment, risk factor, perforation rate

Purpose: review anatomical and pt-related factors that may affect risk of perforation during sx and propose a presurgical sinus assessment system

Material and methods: literature review of peer-reviewed journals using MEDLINE and Cochrane Library database

Discussion:

Perforation Risk Factors

Risk Factors Associated w/ Membrane Perforation during Lateral Sinus Augmentation			
Risk factors for perforation	Low risk	Moderate risk	High risk
Anatomic factors			

Sinus membrane thickness	1.5 – 2 mm	0.8 mm – 1.49 mm 2.01 mm – 2.99 mm	<0.8 mm >3 mm
Presence of sinus septa	Absence	One septum, Height <6 mm	Multiple Height ≥6 mm
Direction of sinus septa		Mediolateral (transverse)	Anteroposterior (sagittal)
Type of edentulism and root position relative to sinus cavity	Totally missing teeth (from 2 nd PM to 2 nd PM)	2 adjacent teeth missing (btn 1 st PM to 2 nd molar)	Single missing tooth (btn 2 nd PM to 2 nd molar); Presence of teeth at sinus elevation area and root into/near the sinus lift area
Residual bone height	>4 mm		<4 mm
Sinus width (angle btn lateral and medial sinus walls)	Wide (>60° angle)	30 - 60°	Narrow (<30°)
Palatonasal recess angle	Obtuse (≥90°)		Acute (<90°)
Alveolar antral artery	Diameters <1 mm	Diameter 1-2 mm	Diameter >2 mm
Patient-related factors			
Smoking habit	No		Yes
Preoperative chronic sinusitis	No		Yes
Gingival biotype	Thick (≥1 mm)		Thin (<1 mm)



Fig 5 A CBCT scan shows a wide maxillary sinus with an angle of approximately 44 degrees between the lateral and medial walls.



Fig 6 A CBCT scan shows the palatonasal recess, defined as the angle between the roof of the hard palate and the lateral wall of the nasal cavity.

Anatomy-Related Risk Factors

- Sinus Membrane Thickness

- Avg = 1 mm
 - Thicker = tolerate higher forces
 - Favorable membrane thickness = 1.5 – 2.0 mm
- Presence of Sinus Septa
 - Frequency found in Mx sinus: 28.4 – 44.8%
 - 1 study linked presence of septa with thin membrane → may have higher perforation rate
 - Septa affects osteotomy window design
- Direction of Sinus Septa
 - Majority are oriented in mediolateral direction (freq: 59.2 – 87.6%)
- Type of Edentulism and Root Position relative to sinus cavity
 - Mixed premolar-molar sites have higher perforation rate (41.2%) than PM sites (16.7%) and molar sites (26.2%)
 - Single tooth have higher risk of perf
 - Elevation area is closer to adjacent roots or thicker lateral sinus wall
- Residual Bone Height
 - Higher risk of perf when residual ridge height <4 mm
 - 7x high risk with residual bone height 3 – 6 mm (compared to <3 mm)
- Sinus Width
 - Narrow sinus = incr perf risk
 - Angle btn lateral and medial wall <30° → risk of membrane tear of 62.5%
 - Angle >30°, perf rate 0 – 28.6%
 - Narrow sinus morphology often found in 2nd PM area
- Palatonasal Recess Angle
 - Definition: angle btn **root of hard palate + lateral wall of nasal cavity**
 - Acute angle incr complexity and difficulty to do sinus augmentation
 - Limits the height of elevation
 - Acute palatonasal recess incidence:
 - 2nd PM: 15%
 - 1st molar: 8.2%
 - 2nd molar: 2.4%
- Alveolar Antral Artery (AAA)
 - Infra-osseous anastomosis of the posterior superior alveolar artery + infraorbital artery
 - Injury to the AAA during sinus augmentation may cause bleeding that may impair visualization → incr risk of membrane laceration
 - AAA patterns:
 - Completely intraosseous
 - Partial intraosseous
 - Under periosteum of lateral sinus wall
 - AAA in 2nd PM to 2nd molar commonly found adjacent to sinus membrane without bony layer interposed btn vessel and membrane
 - AAA diameter <1mm in 62.2% of cases
 - >1 mm in 37.8% of cases
 - Larger diameter have higher chance of bleeding

Patient-Related Factors

- Factors related to higher incidence of perforation and postop complications (i.e. sinusitis/wound dehiscence)
 - Smoking
 - Gingival phenotype
 - Chronic sinusitis

Perforation Risk Assessment

Perforation Risk Assessment (assessed using Risk Factors table above)	
Risk	Definition
Unlikely	All conditions meet low risk perforation <3 conditions at moderate risk
Possible	1 condition at high risk ≥3 conditions at moderate risk
Likely	≥2 conditions at high risk

Topic: Sinus membrane Perforation

Authors: Lum AG, Ogata Y, Pagni SE, Hur Y.

Title: Association Between Sinus Membrane Thickness and Membrane Perforation in Lateral Window Sinus Augmentation: A Retrospective Study.

Source: J Periodontol. 2017 Jun;88(6):543-549.

DOI: 10.1902/jop.2017.160694. Epub 2017 Feb 26.

Reviewer: Daeoo Lee

Type: Retrospective (CBCT based)

Keywords: membrane, thickness, perforation

Purpose: To assess association of Schneiderian membrane thickness on perforation during lateral window sinus augmentation

Material and methods:

- 551 pts treated with lateral window sinus augmentation (2006-2015) at Tuft University
- In the event of perforation ≥ 2 mm
 - Bioabsorbable membrane to seal and graft the area (BioGide)
 - Either DBBM (BioOss) or FDBA (MinerOss) used to bone augment
 - Surgical site was closed with horizontal mattress and simple interrupted sutures
 - Augmentin for 7-10 days and NSAID for 3 days post-op
- CBCT measurement
 - Image constructed using 0.3mm slices (pixel size: 0.3mm)
 - Single image chosen where the membrane was at its thinnest
- Statistical Analyses

Results:

- Perforation observed in 47 pt or 28.1% of the time
- Membrane thickness
 - Perforation Group: 0.84 mm
 - Non-Perforation Group: 2.65mm
 - SSD ($P < 0.001$)
- For every millimeter increase in membrane thickness, odds of membrane perforation decreased.
- Mean residual ridge thickness:
 - Perforation Group: 2.78 mm
 - Non-Perforation Group: 4.21 mm
 - SSD ($P < 0.001$)

Discussion:

- Risk factors for perforation
 - 1) membrane thickness; 2) residual ridge height; 3) excessive force on graft material; 4) septal bone; 5) smoking; 6) and gingival phenotype
- Background Literature: conflicting evidence regarding thickness and perforation

Conclusions:

Within the limitations of this study, there were associations between Schneiderian membrane perforation and both membrane thickness and residual bone height. Similarly, patients who experienced membrane perforation had smaller residual bone height.

Sinus artery

Topic: Alveolar Antral Artery

Authors: Valente NA

Title: Anatomical Considerations on the Alveolar Antral Artery as Related to the Sinus Augmentation Surgical Procedure

Source: Clin Implant Dent Relat Res. 2016 Oct;18(5):1042-1050

DOI: 10.1111/cid.12355

Reviewer: Cyrus J Mansouri

Type: Narrative review

Keywords: computerized tomography, cone beam CT, maxillary sinus, maxillary sinus floor elevation, sinus augmentation, sinus floor elevation

Purpose:

To summarize the results from studies analyzing the variability in anatomical position and dimension of the Alveolar Antral Artery (AAA) to aid clinicians when planning for sinus augmentation surgery.

Arterial supply of the maxillary sinus

Blood supply is provided by three branches of the maxillary artery (MA): the greater palatine artery, the infraorbital artery (IOA), and the posterior superior alveolar artery (PSAA).

The PSAA and IOA anastomose inside and outside the bony lateral antral wall that supplies the Schneiderian membrane. An extraosseous anastomosis is present 44% of the time, and an intraosseous anastomosis is always present. The intraosseous anastomosis is termed the alveolar antral artery (AAA) and passes through the area where bony windows are most frequently opened during sinus surgery.

Severing the AAA is not life threatening but can dramatically complicate the procedure. In more than 10% of cases there is a risk of bleeding due to artery diameter > 0.5 mm. In patients with artery diameter 1-2mm, probability of high-risk hemorrhage is about 57%. Integrity of the AAA may also optimize healing following augmentation.

Surgical strategies to prevent AAA resection

Piezoelectric surgical handpiece may be used to separate the artery from the bony window wall and leave it in space or be reflected together with the Schneiderian membrane. Identifying and leaving cortical bone covering the artery is another approach.

Anatomical considerations

AAA appears to have an intraosseous or intrawall position in 71.4% of cases and intrasinus position in 14.3% of cases.

Diameter of AAA has a mean size of 1.09 mm. Reported mean diameter ranges from 0.8 to 1.59 mm and can vary from 0.2-3.5 mm in size in individuals. Diameter is most often 1-2 mm.

Mean distance of AAA from the alveolar crest and sinus floor are 17.91 mm and 8.36 mm, respectively. Reported mean diameter ranges from 11.25 to 26.90 mm and 5.80- and 10.40-mm. Distances of 2.80 mm from crest and 0.00 mm from sinus floor have been reported. Edentulous patients tend to have shorter distances due to greater resorption of the alveolar crest.

Conclusion:

A thorough knowledge of artery anatomy, pre-operative assessment, and use of piezoelectric surgical handpieces allow risk of laceration of the AAA to be minimized.

Topic: Managing Large Artery

Author: Basma HS, Abou-Arraj RV.

Title: Management of a Large Artery During Maxillary Sinus Bone Grafting: A Case Report.

Source: Clin Adv Periodontics. 2021 Mar;11(1):22-26.

DOI: 10.1002/cap.10104

Type: Case Report

Reviewer: Veronica Xia

Keywords: lateral window, sinus augmentation, piezoelectric, PSAA, IOA, arterial anastomosis

Background:

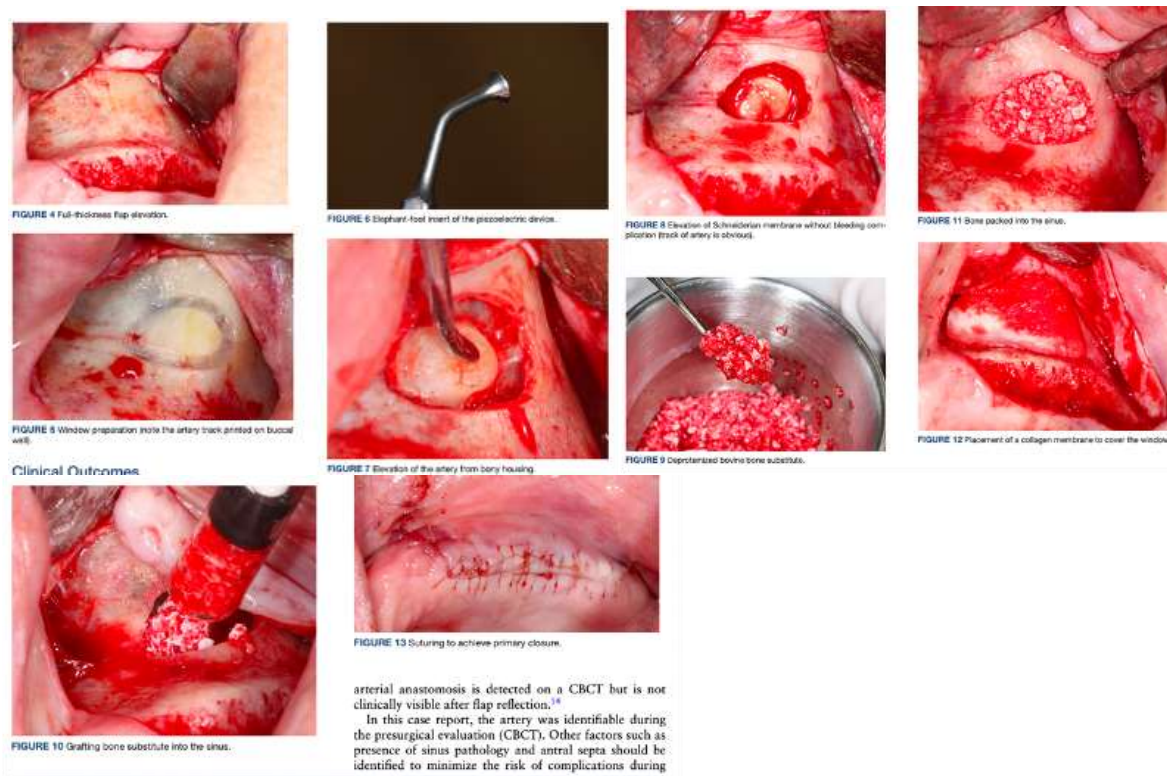
- Blood supply to anterolateral wall of max sinus and Schneiderian membrane from intraosseous anastomoses between posterior superior alveolar artery (PSAA) and infraorbital artery (IOA)
 - Usually, 18.9-19.6mm from alveolar margin

Purpose:

- To show a novel technique to elevate an unusually larger artery from its bony canal using piezo

Materials and Methods:

- Bilateral max sinus floor augmentation on a 58 yo female (receiving implant-supported prosthesis)
- Full thickness flap, and noted outline of artery on lateral wall of sinus
- Piezo used to cut oval window until intraosseous anastomoses between PSAA/IOA and Schneiderian membrane were visualized (no cuts made around the outline of the artery)
 - Piezo EL1 insert used to elevate artery from anal, in addition to elevation of the Schneiderian membrane



Results:

- No vessel ligation or injury occurred, deproteinized bovine bone substitute and collagen membrane placed, flap repositioned without tension

Conclusion:

- Using piezo to elevate artery and Schneiderian membrane is applicable when arterial anastomosis is not fully encased within the lateral sinus wall, and can overcome complications such as lacerating vessel
- LIMITATION: when artery fully encased in lateral sinus wall

Biomaterials

Topic: Residual Bone Height and Biomaterials

Author: Khijmatgar, et al.

Title: Residual Bone Height and New Bone Formation after Maxillary Sinus Augmentation Procedure Using Biomaterials: A Network Meta-Analysis of Clinical Trials

Source: Materials (Basel). 2023 Feb 6;16(4):1376

DOI: 10.3390/ma16041376.

Type: Meta-Analysis

Reviewer: Ryan Higgins

Keywords: biomaterials, bone substitutes, maxillary sinus augmentation, network meta-analysis, sinus floor elevation

Purpose:

- Determine influence of utilizing different biomaterials and residual bone height (RBH) on new bone formation after lateral sinus augmentation

Materials and Methods:

- 67 studies were included a
 - o 1955 patients, 2405 sinus augmentation procedures were performed
 - o Two groups were formed:
 - Radiographic bone height (RBH) <4mm of >4mm
- Biomaterials used were autogenous (Auto), xenografts (XG), allografts (AG), alloplasts (AP), bioactive agents (Bio), hyaluronic acid (HA), and combinations of these

Results:

- RBH ≤4 mm = XG + AG biomaterials ranked best
- RBH ≥4 mm = Auto, followed by Bio+XG and XG+Auto ranked best

Conclusions:

- No grafting biomaterial consistently performs better than others (quality of evidence was low with wide 95% CI)
 - o Combo of xenograft and autograft ranked best for <4mm RBH
 - o Combo of xenograft and bioactive agents ranked best for ≥4 mm
- The performance of materials in terms of new bone formation depends on RBH
- Findings confirm to ensure predictable bone formation, one should incorporate an osteogenic/osteoinductive material into an osteoconductive scaffold.

Topic: Sinus augmentation

Authors: Dragonas, P et al.

Title: Bone Regeneration in Maxillary Sinus Augmentation Using Advanced Platelet-Rich Fibrin (A-PRF) and Plasma Rich in Growth Factors (PRGF): A Pilot Randomized Controlled Trial

Source: International Journal of Periodontics and Restorative Dentistry 2023;43:319-327

DOI: 10.11607/prd.5491

Reviewer: Nicolas Lobo

Type: Pilot randomized controlled trial

Keywords: sinus augmentation, bone regeneration, PRF, PRGF

Purpose: to assess and compare the effects of advanced platelet-rich fibrin (A-PRF) and plasma rich in growth factors (PRGF), when combined with deproteinized bovine bone mineral (DBBM), on bone regeneration in maxillary sinus augmentation (MSA) procedures.

Materials and Methods: This pilot RCT, evaluated the effects of different treatments on MSA. The study included patients with delayed implant placement and residual crestal bone height of 6 mm or less. Participants were randomly assigned to one of three treatment groups:

- Control group: Deproteinized bovine bone mineral (DBBM, Bio-Oss) 1-2mm particle size, and a collagen membrane (Bio-Gide) over the lateral window.
- PRF group: Liquid A-PRF + DBBM to fill the maxillary sinus, over the lateral window Bio-Gide + A-PRF membranes.
- PRGF group: PRGF gel-like + DBBM as a filler of the maxillary sinus, over the lateral window Bio-Gide + PRGF membranes

Surgeries were performed using a lateral approach. Postoperative care included antibiotics, corticosteroids, and NSAIDs, with follow-ups conducted at 2 weeks and throughout a 6-month healing period. After 6 months, bone biopsy samples were collected during implant placement for histologic and histomorphometric analysis. The study's primary outcomes were the percentages of mineralized tissue (%MT), remaining bone graft material (%RBGM), and nonmineralized tissue (%NMT).

Results: 10 patients with 13 maxillary sinus grafts. The distribution was 5 sinuses in the PRF group, 5 in the PRGF group, and 3 in the control group. The participants were 6 women and 4 men, averaging 60.4 years old, with 2 smokers among them. Radiographic baseline bone height averaged 3.1 mm. 7 out of 13 sinuses (54%) experienced membrane perforations during surgery, all of which were repaired. Histomorphometric analysis of the bone biopsy samples showed mean %MT as 20.33% in the control group, 32.20% in the PRF group, and 34.80% in the PRGF group, with no statistically significant differences between the groups. The %RBGM was 24.00% in the control group, 26.00% in the PRF group, and 15.80% in the PRGF group, also without significant differences. %NMT was 55.66% in the control group, 41.40% in the PRF group, and 49.60% in the PRGF group, again with no significant differences.

Conclusions: The study concludes that adding A-PRF or PRGF to DBBM does not improve NBF outcomes in MSA procedures. Additionally, neither platelet concentrate showed any advantage over the other in the evaluated measures.

Topic: intraoral bone grafting with plasma rich in growth factors

Authors: Dragonas P, et al.

Title: Plasma rich in growth factors (PRGF) in intraoral bone grafting procedures: A systematic review

Source: J J Craniomaxillofac Surg. 2019 Mar;47(3):443-453.

DOI: 10.1016/j.jcms.2019.01.012

Reviewer: Mahya Sabour

Type: Systematic review

Keywords: bone graft, plasma rich growth factors, alveolar ridge augmentation, extraction, sinus floor augmentation

Purpose: to evaluate the effects of plasma rich growth factors (PRGF) in new bone formation, soft tissue healing, and post-operative pain and swelling following dental implant-related procedures such as ridge preservation, ridge augmentation, and maxillary sinus augmentation.

Material and Methods:

- 4 additional questions were asked regarding the use of PRGF in ridge preservation, augmentation and/or maxillary sinus augmentation procedures compared to surgical approaches that do not involve the use of PRGF:
 - o Can PRGF substitute bone grafting materials and/or barrier membranes?
 - o Does adding PRGF to bone grafting materials lead to enhanced bone quantity and quality outcomes?
 - o Does adding PRGF improve soft tissue healing?
 - o Does PRGF contribute to reducing post-op swelling and patient-reported pain?
- Variables assessed:
 - o % new bone (bone quality), alveolar ridge volume changes and socket fill (bone quantity) via histology, clinical measurements, and radiographs
 - o Soft tissue healing: color, response to palpation, presence/absence of granulation tissue, premature incision margin opening

- Post-op complications: swelling and pain (questionnaires and clinical eval)
- Selected RCTs and non-randomized controlled clinical trials that assessed therapy in healthy patients undergoing ridge preservation, augmentation and/or maxillary sinus augmentation with or without PRGF applied alone or combined with bone graft.

Results:

- 919 articles identified and 8 were finally selected after exclusion criteria
- Can PRGF substitute bone grafting materials and/or barrier membranes in ridge preservation, augmentation and/or sinus augmentations?
 - Bone grafting materials:
 - Two studies: significantly greater % of new bone volume and increased bone density when PRGF fibrin clot + PRGF membrane are used vs. natural healing
 - One study: no difference in early bone deposition when PRGF used vs. natural healing
 - No studies assessed ridge augmentation and sinus augmentation
 - No studies addressing barrier membranes
 - Does adding PRGF to bone grafting materials lead to enhanced bone quantity and quality outcomes in ridge preservation, augmentation and/or sinus augmentations?
 - No studies addressing ridge preservation and augmentation
 - Maxillary sinus augmentation:
 - One study: higher % new bone formation in PRGF + xenograft
 - Two studies: NSSD in % new bone in PRGF + xenograft or PRGF + β -TCP
 - No difference in graft resorption between 10d and 6 months after augmentation with β -TCP alone or combined with PRGF
- Does adding PRGF improve soft tissue healing in ridge preservation, augmentation and/or sinus augmentations?
 - Ridge preservation: PRGF resulted in significantly better soft tissue healing until the 15th day and increased KG at 10-12 weeks
 - Ridge augmentation: PRGF may prevent Ti-mech exposure by improving soft tissue healing
 - Maxillary sinus augmentation: no studies
- Does PRGF contribute to reducing post-operative swelling and patient-reported post-op pain in ridge preservation, augmentation and/or sinus augmentations?
 - Ridge preservation: Significantly less pain and inflammation at 3,7, and 15 days when PRGF was used
 - Ridge augmentation: no studies
 - Maxillary sinus augmentation: significant reduction in pain, less swelling and daily function limitations in PRGF + xenograft vs. xenograft alone
- There is a lack of controlled studies comparing bone grafts and PRGF in ridge preservation, therefore cannot extract any conclusions regarding the validity of substituting bone graft materials with PRGF
- Firm conclusions cannot be made on the use of PRGF as a sole grafting material in sinus augmentation, however it is a good potential alternative to grafting with an added benefit of repairing membrane perforations
- There is no evidence supporting the use of PRGF in sinus augmentation for enhancing bone quantity and/or quality outcomes
- Insufficient evidence to conclude clinical practice guideline regarding the use of PRGF for improved soft tissue healing

Conclusion:

There is limited evidence on the effect of PRGF in ridge preservation, augmentation, and maxillary sinus augmentation. Some studies report marginal benefits in soft tissue healing and post-op symptoms. However, its effects on bone regeneration when used alone or in combination with grafting materials in

ridge preservation and sinus augmentation is questionable. Further investigation in RCTs and larger population groups is needed.

Topic: L-PRF

Authors: Dragonas P, Katsaros T, Avila-Ortiz G, Chambrone L, Schiavo JH, Palaiologou A.

Title: Effects of leukocyte-platelet-rich fibrin (L-PRF) in different intraoral bone grafting procedures: a systematic review

Source: Int J Oral Maxillofac Surg. 2019 Feb;48(2):250-262.

DOI: 10.1016/j.ijom.2018.06.003

Reviewer: Amber Kreko

Type: systematic review

Keywords: leukocytes, platelet-rich fibrin, maxillary sinus, alveolar ridge augmentation, sinus floor augmentation, tooth extraction, growth factors

Purpose: To assess the effects of leukocyte-platelet-rich fibrin (L-PRF) on bone regeneration, soft tissue healing, and postoperative complications in patients undergoing ridge preservation, ridge augmentation, and maxillary sinus augmentation procedures

Material and methods:

- Systematic review up to December 2017.
- Research question: Does the addition of leukocyte-platelet rich fibrin enhance bone regeneration and soft tissue healing, and reduce postoperative complication in systemically healthy patients undergoing ridge preservation, ridge augmentation, and/or maxillary sinus augmentation procedures when compared to surgical approaches that do not involve the application of this blood derived product?

Results:

- 17 articles were included
- Can L-PRF be used as a substitute for bone grafting materials and barrier membranes in ridge preservation, ridge augmentation, and maxillary sinus augmentation procedures?
 - o Ridge preservation: more favorable outcomes with L-PRF than natural blood clot in post-extraction dimensional changes
 - o Maxillary sinus augmentation: no studies found when using L-PRF as sole bone grafting material. L-PRF had similar outcomes as a collagen membrane in terms of percentage of vital bone formation and residual graft material when used a membrane placed over the lateral window.
- Does the addition of L-PRF to bone grafting materials lead to enhanced bone quantity and bone quality outcomes in ridge preservation, ridge augmentation, and maxillary sinus augmentation procedures?
 - o Ridge preservation: only one paper that found that the addition of L-PRF to DFDBA had more favorable results to DFDBA in terms of horizontal bone loss following tooth extraction.
 - o Ridge augmentation: weak evidence. One study reported reduction in autogenous bone block resorption when covered by one L-PRF membrane.
 - o Maxillary sinus augmentation: most studies reported greater vital bone and lower residual bone graft with L-PRF added to graft however difference were not statistically significant. Currently no consistent evidence regarding improvement in bone quality when L-PRF added.

- Does the addition of L-PRF to bone grafting materials accelerate bone maturation in ridge preservation, ridge augmentation, and maxillary sinus augmentation procedures?
 - o Ridge preservation and ridge augmentation: no studies on the modalities were identified
 - o Maxillary sinus augmentation: only limited evidence on L-PRF when used in combination with bone grafts could accelerate wound healing and reduce duration of treatment
- Does the adjuvant use of L-PRF improve soft tissue healing in ridge preservation, ridge augmentation, and maxillary sinus augmentation procedures?
 - o L-PRF may enhance soft tissue healing, but the available evidence on extent and significance of these potential improvements is limited
- Does the use of L-PRF result in less postop swelling and patient reported post op pain?
 - o Apart from favorable outcomes in managing the symptoms that follow tooth extraction, there is no evidence to support similar outcomes of L-PRF in other augmentation procedures.

Conclusions: There is limited evidence on potential benefits of L-PRF in bone regeneration, soft tissue healing, and postoperative complications in systemically healthy patients undergoing ridge preservation, ridge augmentation, and maxillary sinus augmentation procedures.

- L-PRF have modest benefit with post extraction sockets by decreasing alveolar ridge remodeling and post op pain compared to natural healing
- L-PRF use in maxillary sinus augmentation does not seem to render more favorable outcomes and its use in ridge augmentation procedures is not adequately reported.

Topic: rhBMP-2 and bone augmentation

Authors: Dragonas P, Palin C, Khan S, Gajendrareddy PK, Weiner WD

Title: Complications Associated With the Use of Recombinant Human Bone Morphogenic Protein-2 in Ridge Augmentation: A Case Report

Source: J Oral Implantol. 2017 Oct;43(5):351-359

DOI: 10.1563/aaid-joi-D-17-00101

Reviewer: Tam Vu

Type: Case Report

Keywords: guided bone regeneration, sinus augmentation, rhBMP-2, dental implants, osteoinduction

Purpose: to describe a complication when using recombinant human bone morphogenic protein-2 (rhBMP-2) with allograft and xenograft in ridge augmentation and case management

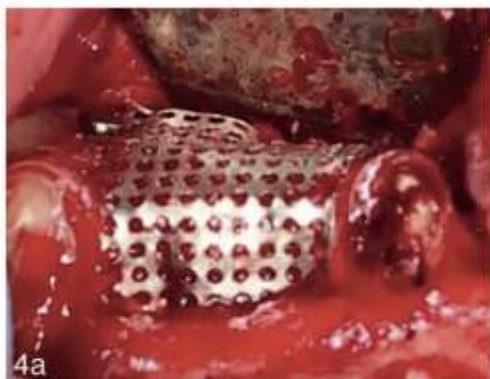
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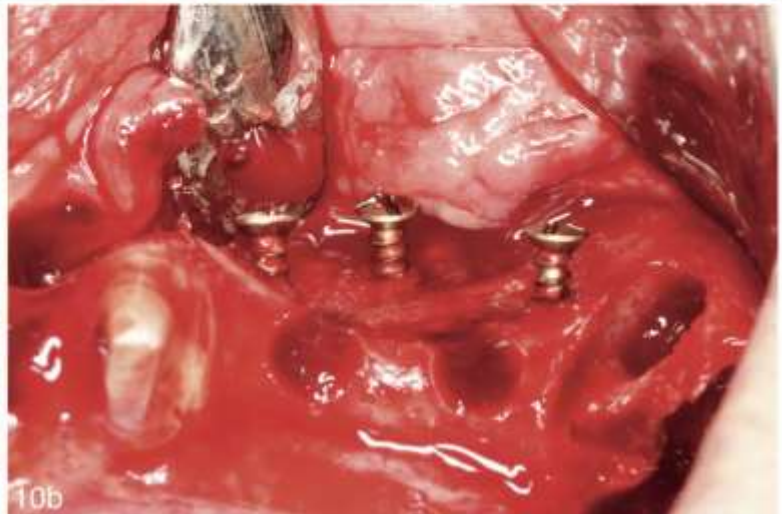
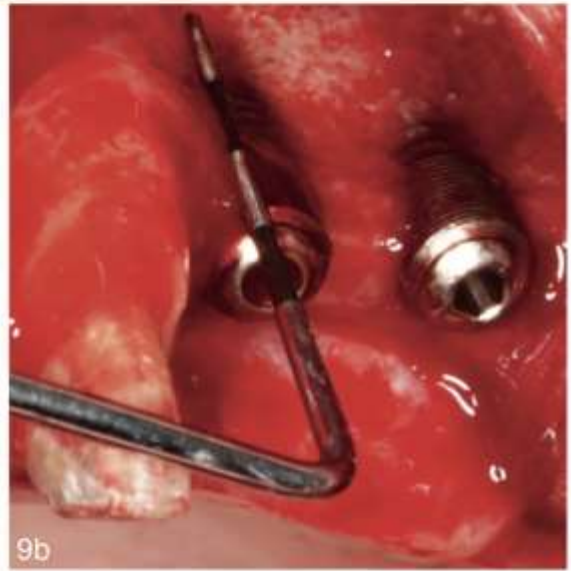
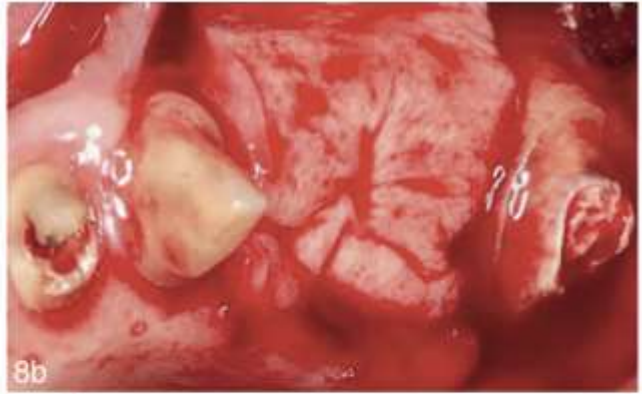
- 64 yo systemically healthy woman
- Simple extraction of #4, 5, 12, and 13 [no socket pres]
- CBCT at 10 wks post ext → requires simultaneous bilateral Mx sinus + ridge augmentation
- rhBMP-2 (Medtronic) + xenograft (BioOss, Geistlich) + allograft (MinerOss, Biohorizons)
 - rhBMP-2 soaked into collagen sponge for 15 min
 - xeno + allograft = 1:1 mix
- T-mesh + tacks to stabilize graft
- Healed uneventfully for 5 months (no early/late T-mesh exposure)
- CBCT at 5 mo
- 4 implants placed (Astra Osseospeed, Dentsply)
- Acellular Dermal Matrix (ADM) to thicken tissue
- Uncovery at 4 mo and Ext of #14 due to vertical root fracture
 - Dehiscence observed at all 4 osseointegrated implants
- 2 tx options presented
 - 1) GBR over exposed implant surfaces
 - 2) Explant + GBR and implants at 6 mo
- Option 2 was chosen
- GBR w/ 3 tenting screws + xenograft (BioOss) + non-cross-linked resorbable collagen membrane (Bio-Gide)
- 7 mo post op, CBCT done
- Straumann guided implants placed at 4, 5, 12, 13, 14
- Bilateral FGG completed
- Implants restored

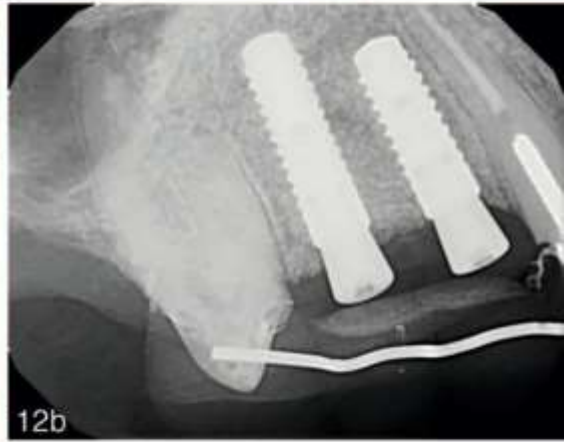
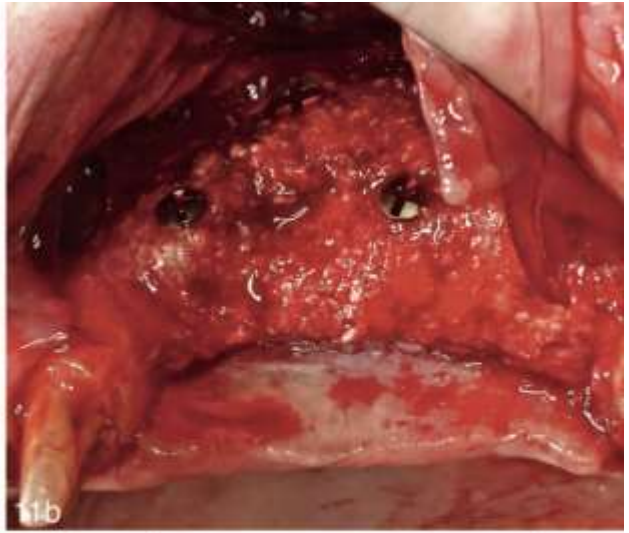
Discussion:

- Complication involving bone resorption and dehiscence was thought to be due to insufficient healing time (5 mo) – may need more time to mature, heal, and vascularize bone graft
- rhBMP-2 used due to its osteoinductive properties (off label use for ridge/sinus aug)
 - Limited histologic/histomorphometric evidence on regenerative potential of combination used in this study
- Addition of rhBMP to xenograft had negative effect on bone formation
 - Possibly due to increase in osteoclast differentiation via release of BMP-2
- Direct conclusion regarding effects of rhBMP-2 in bone aug cannot be made (no histo)
- GBR is effective and predictable procedure in peri-implant dehiscence and fenestrations when used at time of implant placement
 - No evidence for GBR at uncover/stage 2 surgery
 - Reduced vascular supply when grafting over dehiscence/fenestration at stage 2

Conclusion: Complication associated with rhBMP-2 in combo with allograft + xenograft following ridge augmentation includes rapid resorption. Limited evidence on bone maturation process of rhBMP-2 when combined with other biomaterials.









DL Topic: BMP-2 and Sinus Augmentation

Authors: Triplett RG, Nevins M, Marx RE, Spagnoli DB, Oates TW, Moy PK, Boyne PJ.

Title: Pivotal, randomized, parallel evaluation of recombinant human bone morphogenetic protein-2/absorbable collagen sponge and autogenous bone graft for maxillary sinus floor augmentation.

Source: J Oral Maxillofac Surg. 2009 Sep;67(9):1947-60.

DOI: 10.1016/j.joms.2009.04.085.

Reviewer: Daeoo Lee

Type: Prospective (RCT)

Keywords: Sinus Augmentation, BMP-2, Collagen sponge

Purpose: To compare rhBMP-2 + absorbable collagen sponge (ACS) to conventional graft for staged maxillary sinus floor augmentation

Material and methods:

- 160 pts. with less than 6mm bone height recruited for sinus augmentation.
- Compare rhBMP-2 + ACS VS. grafting + barrier membrane
 - Grafting materials:

- Either autogenous bone (iliac crest, tibia, oral cavity) or combination with allogeneic bone
- Parameters:
 - Effectiveness for function loading of implant at 6, 12, 18, and 24 month
 - Evaluate amount of new bone formation
 - Evaluate density of the newly induced and adjacent native bone at 6 mo.
- Bone Induction Analysis
 - CT scans taken 6 wks before and 6 month after graft implanation
 - Bone density analyzed from CT scan.
- Histologic examination
 - Collected at time of implant placement.
- Success
 - At patient level and implant level
- Statistical analysis

Results:

- 127 pt. completed study at 24 month.
- Bone Induction
 - rhBMP-2/ACS group: average change in bone height of 10.41 mm (baseline bone height of <4mm), 9.72 mm (<=6mm), and 5.25 mm (>6mm)
 - Bone graft group: average change in bone height of 12.74 mm (<=4mm), 12.11 mm (<=6mm), and 6.56 mm (>6mm)
 - Both had SS improvement but bone graft group was better
- Bone Density
 - At 6 mo after augmentation
 - in favor of the bone graft group (283 mg/cm³ vs. 200)
 - However, at 6mo after functional loading
 - In favor of rhBMP-2/ACS (358 vs. 298)
- Histologic
 - Bone graft group: 16% of the specimens had nonviable, fibrous-encapsulated graft material (**Quality**)
 - New bone comparable to the native bone in density and structure in both group
 - Most common observation remodeling of woven bone to lamellar bone.
- Success for implant
 - Pt. level (bone graft vs. rhBMP/ACS)
 - (6 mo) 91% vs. 79%
 - (12 mo) 91% vs. 79%
 - (18 mo) 91% vs 73%
 - (24 mo) 91% vs. 76%
 - Due to protocol violation for rhBMP/ACS
 - Implant level (bone graft vs. rhBMP/ACS)
 - (6 mo) 83% vs. 86%
 - (12 mo) 87% vs. 83%
 - (18 mo) 87% vs. 82%
 - (24 mo) 90% vs. 83%
- Safety
 - rhBMP-2/ACS group had significantly greater amount of facial edema

- Activity of the rhBMP-2 causing an influx of fluid and cells into the treatment area related to the chemotaxis and neovascularization at the site.

Conclusions:

rhBMP-2/ACS is an effective product for augmenting maxillary sinus.

Topic: Biologics

Authors: Monje A., del Amo FSL.

Title: Efficacy of biologics for alveolar ridge alveolar preservation/reconstruction and implant site development: An American Academy of Periodontology best evidence systematic review

Source: J Periodontol. 2022;93:1827–1847.

DOI: 10.1002/JPER.22-0069

Reviewer: Cyrus J Mansouri

Type: Systematic review

Keywords: alveolar ridge augmentation, dental implants, jaw, edentulous, sinus floor augmentation

Purpose:

To analyze the effect of autologous blood-derived products (ABPs), enamel matrix derivative (EMD), recombinant human platelet-derived growth factor-BB (rhPDGF-BB), and recombinant human bone morphogenetic protein-2 (rhBMP-2) on the outcomes of ARP/ARR and ISD therapy (alveolar ridge augmentation (ARA) and maxillary sinus floor augmentation (MSFA))

Material and methods:

An electronic database search was completed for RCTs evaluating ABPs, EMD, rhBMP-2, and rhPDGF-BB for ARP/ARR and ISD. Data on linear and volumetric Data on dimensional changes, histomorphometric findings, and a variety of secondary outcomes were extracted and analyzed.

PICO:

Population: Adult individuals

Intervention: Use of ABPs, EMD, rhBMP-2, or rhPDGF- BB in ARP/ARR, ARA, or MSFA.

Comparison: Conventional ARP/ARR and ISD modalities not involving the use of biologic mediators. All three treatments (ARP/ARR, ARA, and MSFA) were evaluated individually.

Outcomes: Bone changes (primary) and clinical implant-related, digital imaging, safety, and patient-reported outcome measures (PROMs).

Results:

A total of 39 articles were included in the qualitative synthesis (18 ARP/ARR, 9 in ARA, 12 in MSFA).

ARP:

- 18 studies (14 RCT, 4 split-mouth)
- 6 investigations on filling sockets with biologics vs unassisted socket healing, all using ABPs.
- Two studies on EMD + DBBM vs DBBM alone
- 3 studies on rhBMP-2 in combination with different materials compared to collagen sponge, β -tricalcium phosphate (β -TCP) + hydroxyapatite (HA), or demineralized bone matrix (DBM) gel.
- ABPs were the most studied biologic and included PRF, L-PRF, A-PRF, A-PRF+, PRGF, and CGF
- In general, investigations failed to demonstrate superior outcomes with additional use of biologics compared with conventional approaches. Attenuation of post-extraction resorption was found with the use of biologic.
- Two investigations reported no differences in socket closure/soft tissue wound healing.
- Increased mineralized bone tissue with use of biologics was supported by 5 studies.
- Regarding PROMS, two investigations demonstrated decreased postoperative pain with additional use of PRF.
- Reduced need for ancillary augmentation at the time of implant placement was found with the use of rhBMP-2.

- No adverse rxns were found with use of EMD or ABPs; use of rhBMP-2 resulted in adverse outcomes of erythema and edema in 12% of subjects.

ARA:

- 9 studies (RCTs)
- In general, test groups did not show superior outcomes of clinical, radiographic, or histologic parameters.
- One study demonstrated increased mineralized tissue formation and horizontal bone gain after 4 months with use of PRP.
- Another study demonstrated decreased incidence of wound dehiscence with additional use of PRP covering titanium-mesh in ARA.

MSFA:

- 12 articles (6 split-mouth, 6 parallel arm)
- One study showed accelerated bone healing with addition of L-PRF to bone graft (~14% increased newly formed bone).
- Another two studies showed ~10% increased mineralized tissue formation with use of PRP and rhPDGF-BB. Negligible differences were found at 7-9 months.

Clinical recommendations:

- ARP: Low level of certainty recommendation that additional use of ABPs, EMD, and rhBMP-2 fails to promote additional clinical benefits to conventional grafting. Addition may provide some benefits. Expert opinion supports use, but evidence is lacking.
- ARA: Low level of certainty recommendation stating uncertainty of additional clinical benefits. Expert opinion supports use of ABPs, rhPDGF-BB, and rhBMP-2 but evidence is lacking.
- MSFA: Low level of certainty recommendation stating uncertainty of additional clinical benefits. Expert opinion supports use of ABPs, rhPDGF-BB, and rhBMP-2 but evidence is lacking.

Conclusion:

Current evidence does not support use of ABPs, EMD, rhPDGF-BB, or rhBMP-2 to render superior clinical or radiographic outcomes. Histomorphometric results are favorably influenced by the use of these biologics. PROMs are underreported but seem to be minimally influenced by biologics. It is not currently possible to establish recommendations for their use in daily practice in these applications.