Videoscope-assisted lateral maxillary sinus floor elevation: evaluation of the Schneiderian membrane for micro-perforations

Sarah Ohnander,[*] Anastasia Kelekis-Cholakis,[*] Chrysi Stavropoulou,[*] Stephen Harrel[†]

Correspondence

Sarah Ohnander, Graduate Periodontics Resident, University of Manitoba, Winnipeg, Canada.

E-mail: ohnandes@myumanitoba.ca

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[*]Department of Dental Diagnostic and Surgical Sciences, Division of Periodontics, Dr. Gerald Niznick College of Dentistry, University of Manitoba, Winnipeg, Manitoba, Canada

[†] Department of Periodontics, Texas A&M College of Dentistry, Dallas, Texas

Summary: No incidence of micro-perforations of the Schneiderian membrane were detected during lateral sinus lift procedures when observed with a videoscope.

Abstract:

Introduction: Sinus floor elevation procedures are of a moderate to high complexity, entailing a significant risk of complications. The most frequent and common intra-operative complication is perforation of the sinus membrane. For the lateral window technique, perforation rates of 10% to 20% have been documented. Several studies have reported a correlation between perforation of the membrane and failure of the graft, as well as post-operative infection. In order to help identify perforations early, the authors evaluated the Schneiderian membrane for micro-perforations. The purpose of this case series was to identify the incidence of micro-perforations during lateral maxillary sinus elevation surgery.

Case Series: Lateral maxillary sinus floor elevation was performed on 8 patients. A surfactant solution was applied topically to the exposed Schneiderian membrane. The presence of micro-perforations was assessed by observing for a bubbling effect after slight positive pressure. Evaluations were recorded using a videoscope, which provided magnification and additional lighting at the surgical site. Data was collected after evaluation of the membrane intra-operatively; post-operatively, the recordings of the procedure were randomised and evaluated by three periodontists.

Conclusion: Use of a surfactant solution and videoscope evaluation did not reveal any incidence of micro-perforations on the Schneiderian membrane during lateral sinus lift.

Key words: sinus floor augmentation; maxillary sinus

Background

First described by Tatum in 1986, lateral maxillary sinus floor elevation has become a reliable and predictable procedure to overcome ridge deficiencies in the posterior maxillary region [1]. The mucosal lining of the maxillary sinus, the Schneiderian membrane, is a pseudostratified, ciliated columnar epithelium with underlying connective tissue [2]. There are a number of anatomical factors that may increase the risk of damage to the Schneiderian membrane during surgical elevation. These include but are not limited to the presence of septa, the angulation of the sinus walls at the apical sinus region, the width of the sinus, residual height, and membrane thickness [3].

Sinus floor elevation procedures are of moderate to high complexity, entailing a significant risk of complications. The most frequent and common intra-operative complication is perforation of the sinus membrane [3,4]. For the lateral window technique, perforation rates of 10% to 20% have been documented [4–6]; they typically occur with burs during the osteotomy, or manual elevators during separation of the membrane [7]. Nolan et al reported a correlation between perforation of the membrane and failure of the graft [8].

The most common post-operative complication is sinus infection, often a sequala of membrane perforation [3]. Perforation of the membrane and contamination with saliva creates an ideal environment for sinus infection [3]. Graft loss or failure due to membrane perforation has been reported to occur at an incidence of 1.9% (0-17.9%) [6] or 1% (0-20%) [4]. Clinicians must focus on

early detection of membrane perforation during surgery to avoid unnecessary complications [9,10].

In order to help identify perforations early, two novel diagnostic tools were utilized. The use of an endoscope during sinus elevation has been previously described[11], but not the use of a videoscope for assistance in visualization. The authors suggest a novel technique using a videoscope[‡] to aid in the diagnosis of membrane perforations, allowing for better visualization and ability to record for later evaluation. Additionally, a surfactant solution was administered: 1% baby shampoo[§] in normal saline. This solution has been safely used on the Schneiderian membrane in medical procedures with no adverse effects [12–14]. The solution was applied topically to the surgically exposed membrane when there were no visible perforations detected. The patient then lightly blew their nose, which would create a bubbling effect if any micro-perforations were present.

To the best of the authors' knowledge, no previous studies have evaluated Schneiderian membrane micro-perforations, and none have concomitantly used a videoscope or surfactant solution. The purpose of this study was to identify the incidence of micro-perforations during lateral maxillary sinus elevation surgery.

Clinical Presentation and Case Management

[‡] MicroSight; Q-Optics; Duncanville, TX.
[§] Johnson and Johnson; New Brunswick, NJ.

Ethics approval was obtained from the Biomedical Research Ethics Board, Bannatyne Campus, at the University of Manitoba (HS24052, B2020:072). The study was registered on clinicaltrials.gov (NCT04510701). Patients of the Dr. Sam Borden Graduate Periodontics Clinic who required lateral sinus floor elevation surgery were presented with the informed consent form. Recruitment took place from August 2020 to December 2021, with eight patients (Table 1) fulfilling the inclusion and exclusion criteria (Table 2).

The maxillary lateral sinus lifts were performed by periodontics residents. Membrane evaluation was completed at a minimum of 3 points during surgery: immediately after removal of the bony window, at the start of membrane elevation, and mid-way through membrane elevation. The surfactant solution was applied topically to the membrane, the patient was asked to lightly blow their nose, and the area was observed for bubbling. The process was recorded with the videoscope by one operator (SO). Any membrane perforation noted was recorded following Fugazzotto's classification [3]. All patients received the same post-operative instructions (Table 3) and prescriptions (Table 4). A limited FOV CBCT scan was taken immediately post-operatively to confirm adequate elevation of the membrane and graft placement [15]. All patients were followed-up at 1 and 2 week post-operative appointments, and as necessary thereafter. A visual analog scale (VAS) questionnaire evaluating post-operative pain experienced by the patient was completed at the 1-week follow-up appointment.

Videoscope recordings were evaluated post-surgically by three periodontists. Recordings were randomized and each periodontist individually evaluated them for membrane perforations,

micro-perforations, or bubbling visible on the membrane. Evaluators were masked to the results noted by the surgeon who performed the surgery, and blinded to the patient's information.

Clinical Outcomes

During the surgeries, grossly visible membrane perforation was noted once (1/25, or 4%). Bubbling present on the membrane due to micro-perforations was not noted (0%).

When considering the post-operative video evaluations at three observation times, the results are outlined in Table 5. 25 videos were evaluated. Rater evaluations were compared to the findings noted intra-surgically and correlated for agreement. Perforation agreement by rater was 96% (24/25), 88% (22/25), and 100% (25/25). The total agreement for perforations was 94.67%. Bubbling agreement by rater was 96% (24/25), 84% (21/25), and 92% (23/25). The total agreement for bubbling was 90.67%.

No complications were reported by the patients or practitioners, including post-operative infections, sinusitis, or other complications. VAS questionnaire results are presented in Table 6.

Discussion

There are several limitations to consider. This is a case series with a small number of subjects, with different practitioners performing the surgical procedures. COVID-19 also played a role in recruitment, as a number of patients did not wish to proceed with surgery during the

pandemic. Regarding the videos themselves, video quality was not always ideal. Some of the included videos were out of focus, and landmarks may have been difficult to identify by the raters. Additionally, bubbling was intermittently present on the membrane by way of the dropper/syringe used to apply the surfactant solution: drawing the solution into the dropper incorporated air, which at times created bubbles that were then deposited onto the membrane.

Conclusion

Use of a surfactant solution and videoscope evaluation did not reveal any incidence of micro-perforations on the Schneiderian membrane during lateral sinus lift.

Summary

- Why are these cases new information?
    - This case series evaluates maxillary sinus lifts in a novel manner, with the use of a surfactant solution and videoscope.
- What are the keys to successful management of these cases?
    - Comprehensive treatment planning considering sinus anatomical factors, as well as careful membrane elevation, are necessary for avoiding intra-operative membrane perforation.
- What are the primary limitations to success in these cases?

- Although no micro-perforations were noted during this case series, a larger sample size would be of benefit.

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Conflict of Interest

Dr. Harrel is a patent holder of the Microsight Videoscope. The other authors have no conflicts of interest to disclose.

References

1. Tükel HC, Tatli U. Risk factors and clinical outcomes of sinus membrane perforation during lateral window sinus lifting: analysis of 120 patients. Int J Oral Maxillofac Surg. 2018;47(9):1189–94.
2. Insua A, Monje A, Urban I, Kruger L, Garaicoa-Pazmiño C, Sugai J, et al. The Sinus Membrane–Maxillary Lateral Wall Complex: Histologic Description and Clinical Implications for Maxillary Sinus Floor Elevation. Int J Periodontics Restorative Dent. 2017;37(6):e328–36.

3. Fugazzotto P, Melnick PR, Al-Sabbagh M. Complications when augmenting the posterior maxilla. Dent Clin North Am. 2015;59(1):97–130.
4. Chiapasco M, Casentini P, Zaniboni M. Bone augmentation procedures in implant dentistry. Int J Oral Maxillofac Implants [Internet]. 2009;24 Suppl(1):237–59. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19885448
5. Jensen SS, Terheyden H. Bone augmentation procedures in localized defects in the alveolar ridge: clinical results with different bone grafts and bone-substitute materials. Int J Oral Maxillofac Implants [Internet]. 2009;24 Suppl:218–36. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19885447
6. Pjetursson BE, Tan WC, Zwahlen M, Lang NP. A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation: Part I: Lateral approach. J Clin Periodontol. 2008;35(SUPPL. 8):216–40.
7. Labanca M, Azzola F, Vinci R, Rodella LF. Piezoelectric surgery: Twenty years of use. Br J Oral Maxillofac Surg. 2008;46(4):265–9.
8. Nolan PJ, Freeman K, Kraut RA. Correlation between schneiderian membrane perforation and sinus lift graft outcome: A retrospective evaluation of 359 augmented sinus. J Oral Maxillofac Surg [Internet]. 2014;72(1):47–52. Available from: http://dx.doi.org/10.1016/j.joms.2013.07.020
9. Kim YK, Lee JY, Park JW, Kim SG, Oh JS. Sinus Membrane Elevation by the Crestal Approach Using a Novel Drilling System. Implant Dent. 2017;26(3):351–6.
10. 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;30(7):682–90.

11. Elian S, Barakat K. Crestal endoscopic approach for evaluating sinus membrane elevation technique. Int J Implant Dent. 2018;4(1):6–11.

12. Rosen PL, Palmer JN, O'Malley BW, Cohen NA. Surfactants in the management of rhinopathologies. Am J Rhinol Allergy. 2013;27(3):177–80.

13. Chiu AG, Palmer JN, Woodworth BA, Doghramji L, Cohen MB, Prince A, et al. Baby shampoo nasal irrigations for the symptomatic post-functional endoscopic sinus surgery patient. Am J Rhinol. 2008;22(1):34–7.

14. Isaacs S, Fakhri S, Luong A, Whited C, Citardi MJ. The effect of dilute baby shampoo on nasal mucociliary clearance in healthy subjects. Am J Rhinol Allergy. 2011;25(1):27–9.

15. Rapani M, Rapani C, Ricci L. Schneider membrane thickness classification evaluated by cone-beam computed tomography and its importance in the predictability of perforation. Retrospective analysis of 200 patients. Br J Oral Maxillofac Surg [Internet]. 2016;54(10):1106–10. Available from: http://dx.doi.org/10.1016/j.bjoms.2016.08.003

Tables

Table 1 Study population

Participant ID	Age	Sex	Right or Left Sinus
340	74	F	Left
342	72	F	Right
542	48	F	Right
442	62	F	Left
540	58	M	Right
343	40	F	Right
440	60	F	Right
543	64	F	Left

Table 2 Inclusion and exclusion criteria

Inclusion Criteria:
• Patients requiring maxillary sinus floor elevation (lateral approach), with current subantral bone height 5 mm or less • Male or female patient, 18 years of age or older • Patients who exhibit adequate ability to comply with postoperative instructions, research protocols and methods • Patients who have read, understand, and have signed the informed consent form • Patients with an adequate level of oral hygiene, defined as Full Mouth Plaque Score (FMPS) and Full • Mouth Bleeding Score (FMBS) less than 20% (after periodontal therapy, if necessary)

Exclusion Criteria:	
Absolute contraindications:	**Relative contraindications:**
• Patients on IV bisphosphonates • Patients undergoing chemotherapy • Patients who have undergone head and neck radiotherapy where the field of irradiation included the maxilla • Patients whose membrane thickness is increased due to an existing sinus pathology (sinusitis or mucosal cysts) • Diabetic patients with uncontrolled diabetes and poor glycemic control • Patients who are undergoing long-term immunosuppressive therapy, or have been taking corticosteroids long-term • Patients with active or untreated periodontitis	• Patients who have been receiving long term oral bisphosphonate therapy (3 years duration or more) • Patients who smoke > 10 cigarettes per day • Patients who are alcohol abusers • Patients who are on antithrombotic medications should be treated with extra caution during surgery, as well as patients with blood disorders that may affect hemostasis

Table 3 Post-operative instructions

For the first few days following the surgery:	For the first weeks following the surgery:
• Avoid smoking • Avoid alcohol • Avoid excessive exercise • Avoid hot food and beverages • Avoid hard and crunchy foods • Avoid foods with seeds	• Avoid blowing the nose • Avoid drinking with a straw

Table 4 Post-operative prescriptions

Post-operative prescriptions:
• Augmentin (875 mg twice a day for 10 days; amoxicillin 750 mg with clavulanic acid 125 mg) • Patients allergic to Augmentin can receive Levofloxacin, 750 mg once a day for 10 days • Ibuprofen 400 mg (Q6H x 2 days, then PRN pain) • Acetaminophen 500 mg (Q6H staggered with ibuprofen, PRN pain) • Chlorhexidine gluconate (0.12%) for 2 weeks BID

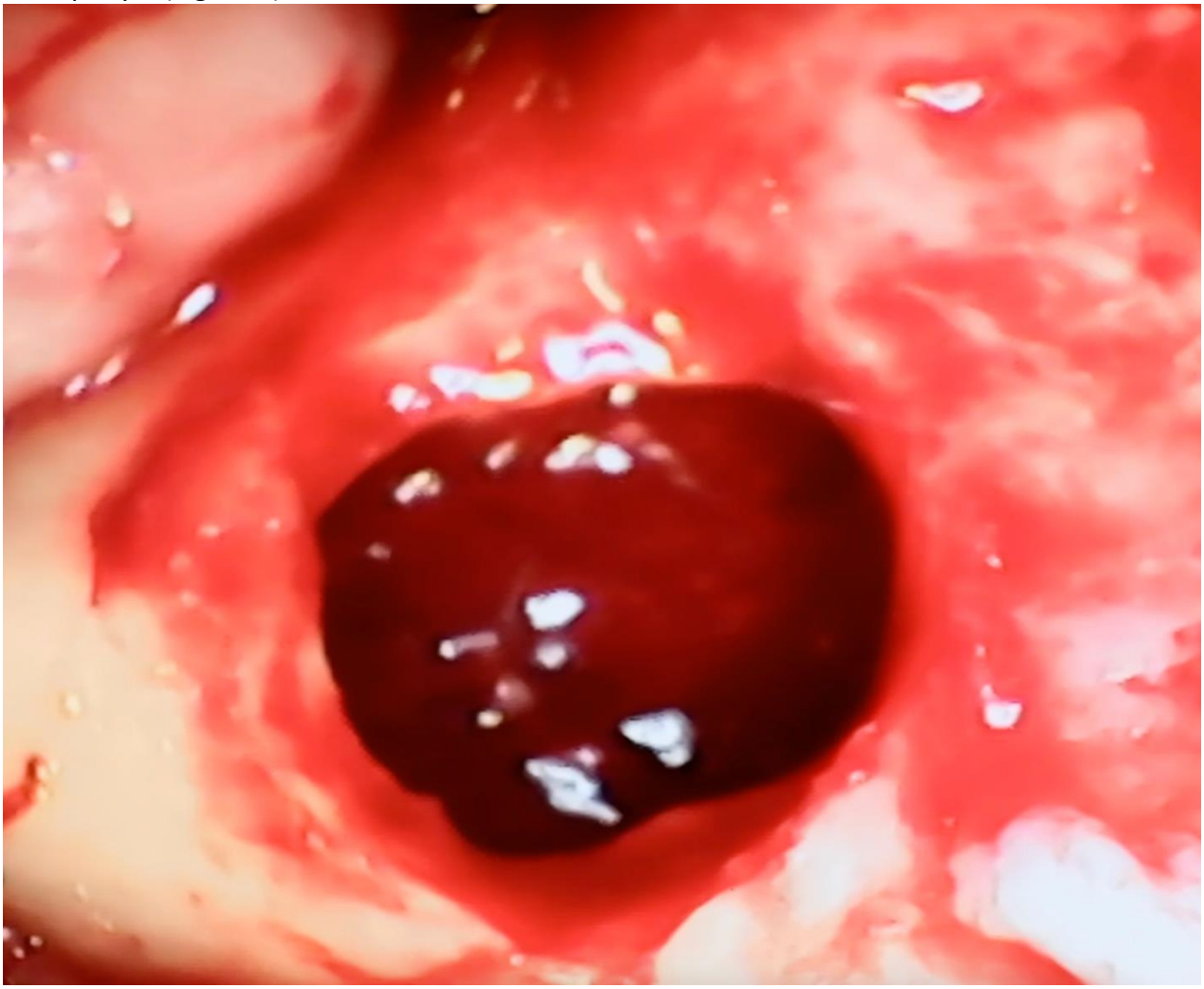
Table 5 Rater perforation and bubbling agreements, as compared to intra-surgical results

Rater	**Perforation Agreement**	**Bubbling Agreement**
1	24/25 (96%)	24/25 (96%)
2	22/25 (88%)	21/25 (84%)
3	25/25 (100%)	23/25 (92%)
Total	94.67%	90.67%

Table 6 Results from Visual Analogue Scale (VAS) post-operative form

Participant ID	Pain experienced during the first two post-operative days	Pain experienced overall during the first post-operative week
542	Mild	No pain
442	Mild	Mild – no pain
540	Mild	Mild
343	Moderate	Moderate
440	Mild	Mild
543	Moderate	Moderate

Exemplary 1 (Figure 1):



Exemplary 2 (Figure 2):

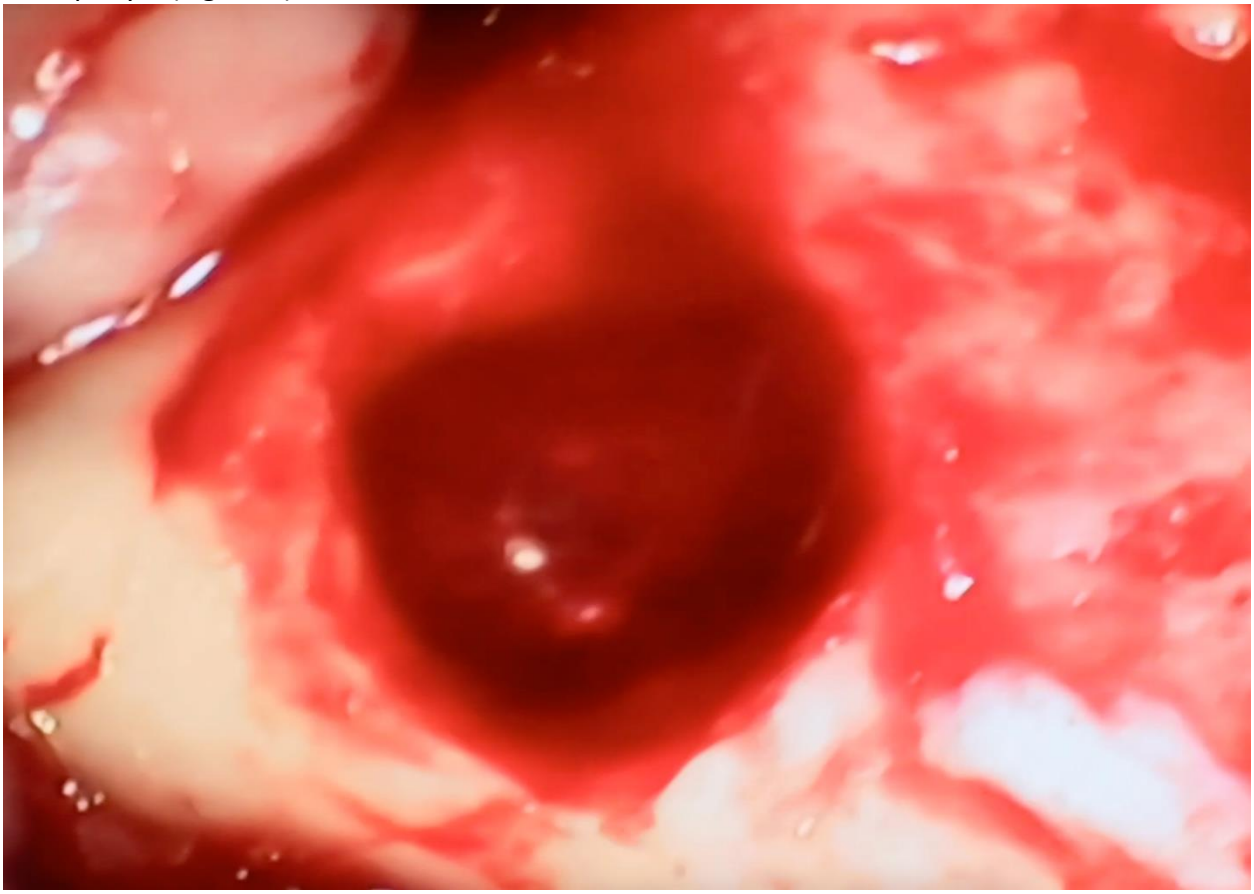


Figure 1:
Osteotomy preparation with surfactant solution applied to membrane, with patient breathing in

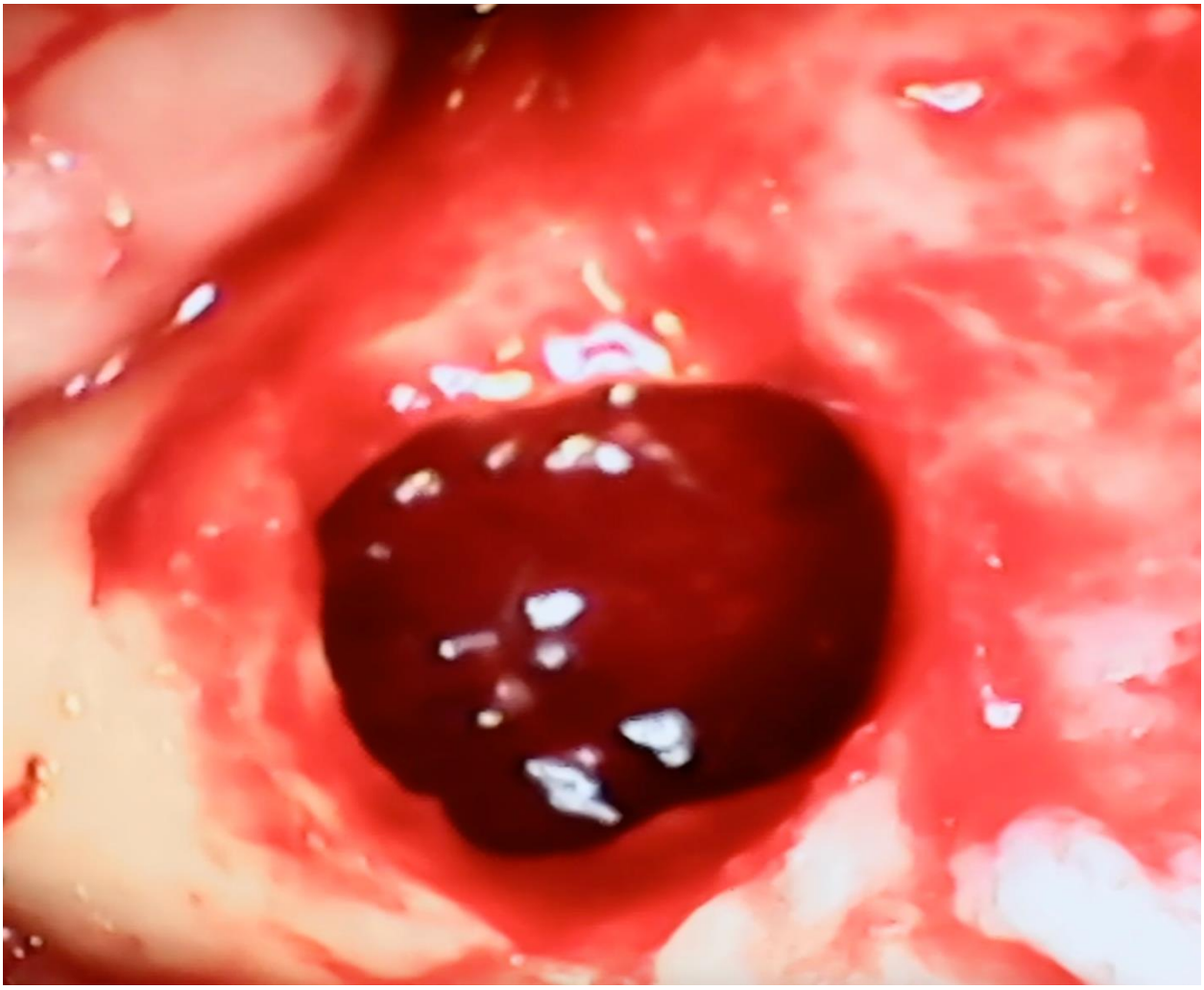


Figure 2: Osteotomy preparation with surfactant solution applied to membrane, patient breathing out with solution visible over window

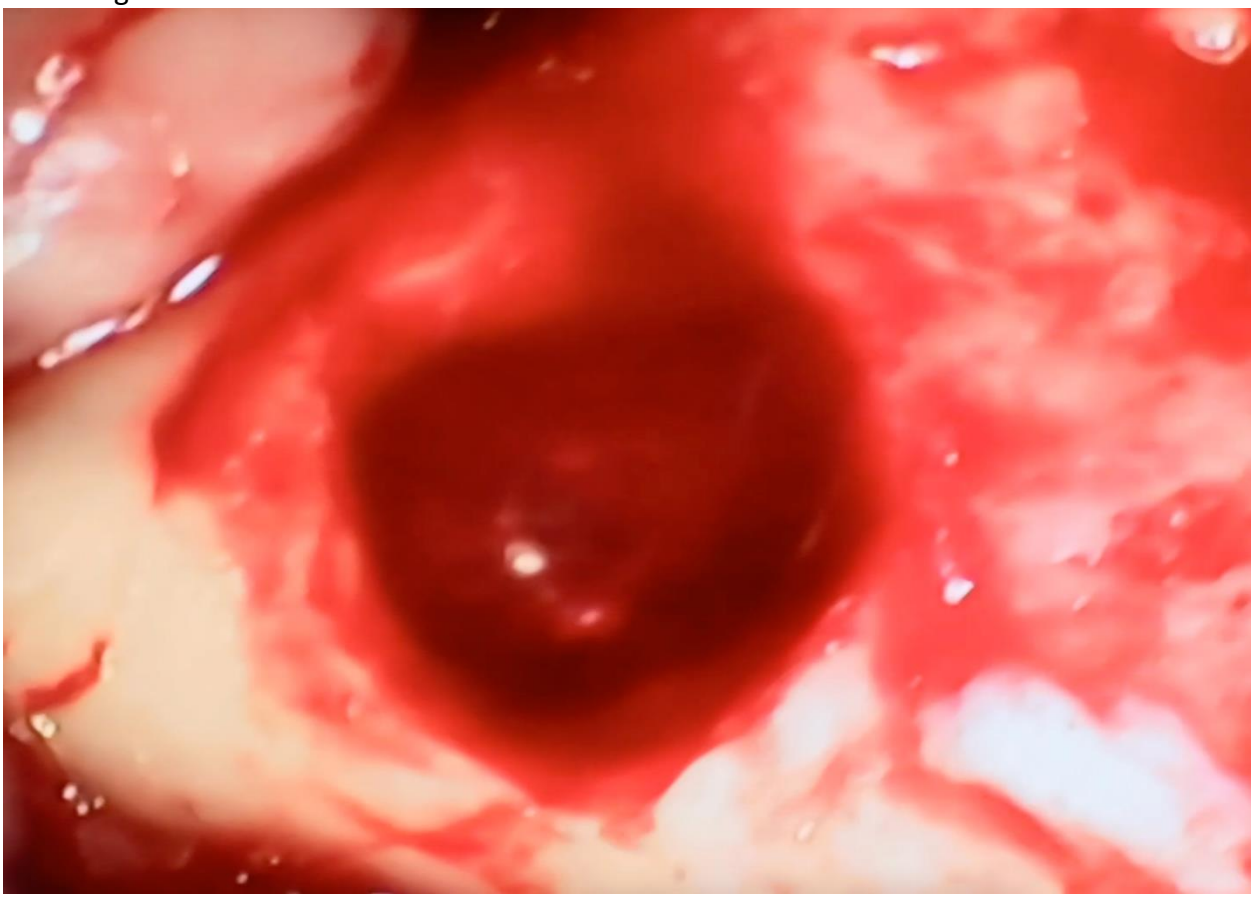


Figure 3: Bubbling already present on the membrane due to bubbles being incorporated into the dropper/syringe prior to placing solution on membrane

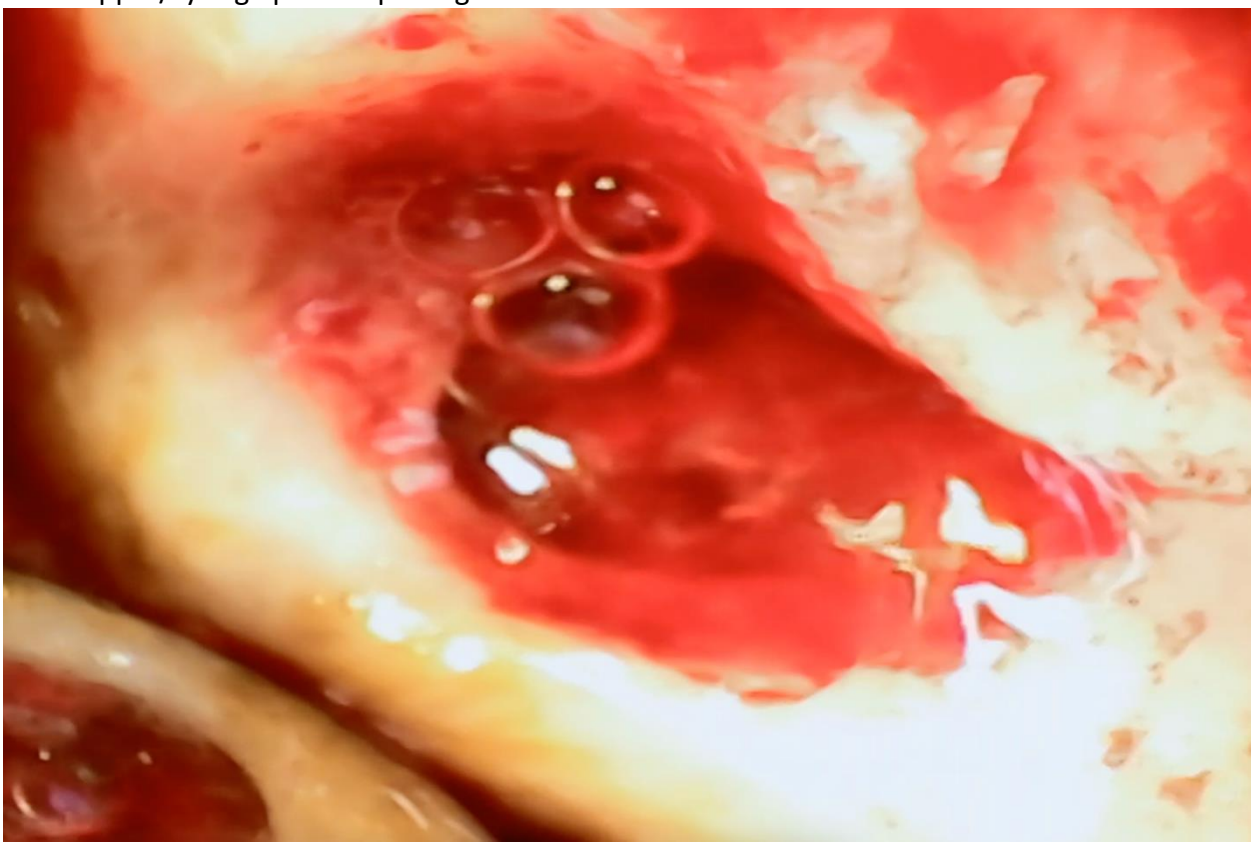


Figure 4: Membrane perforation visible

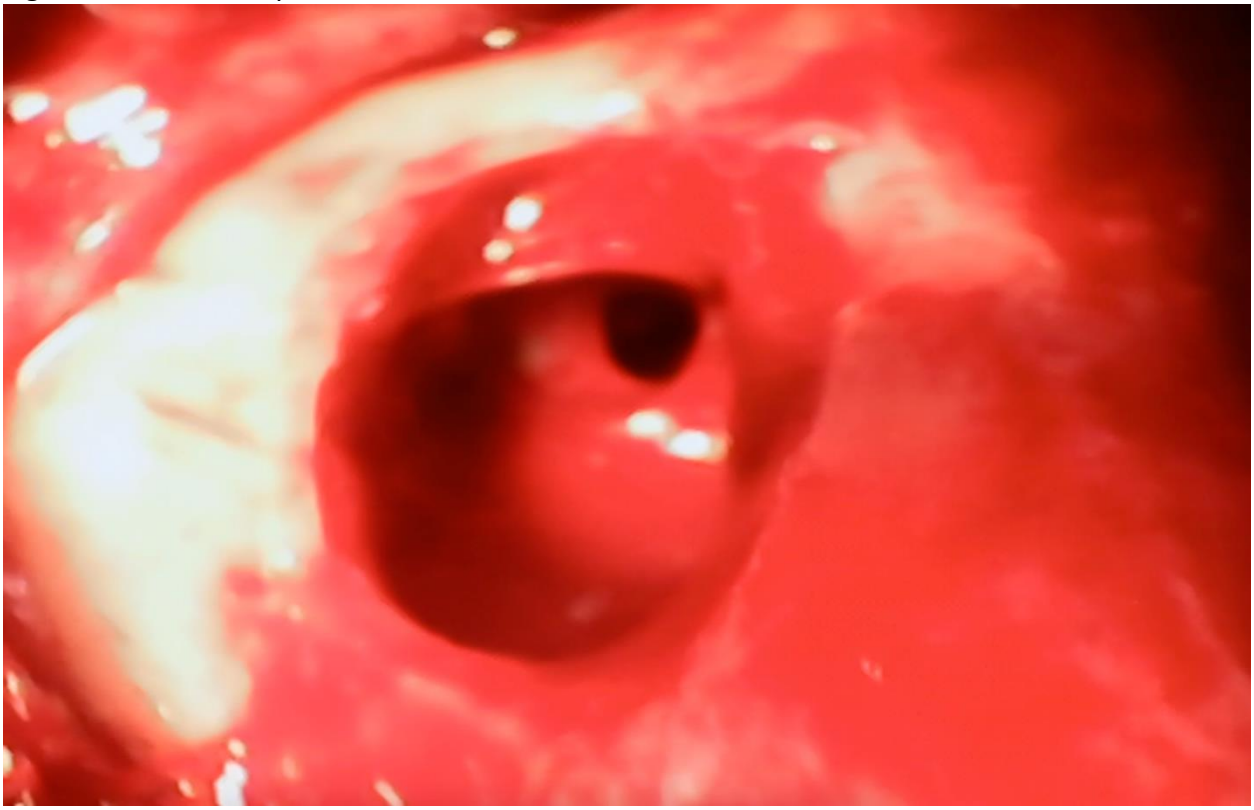
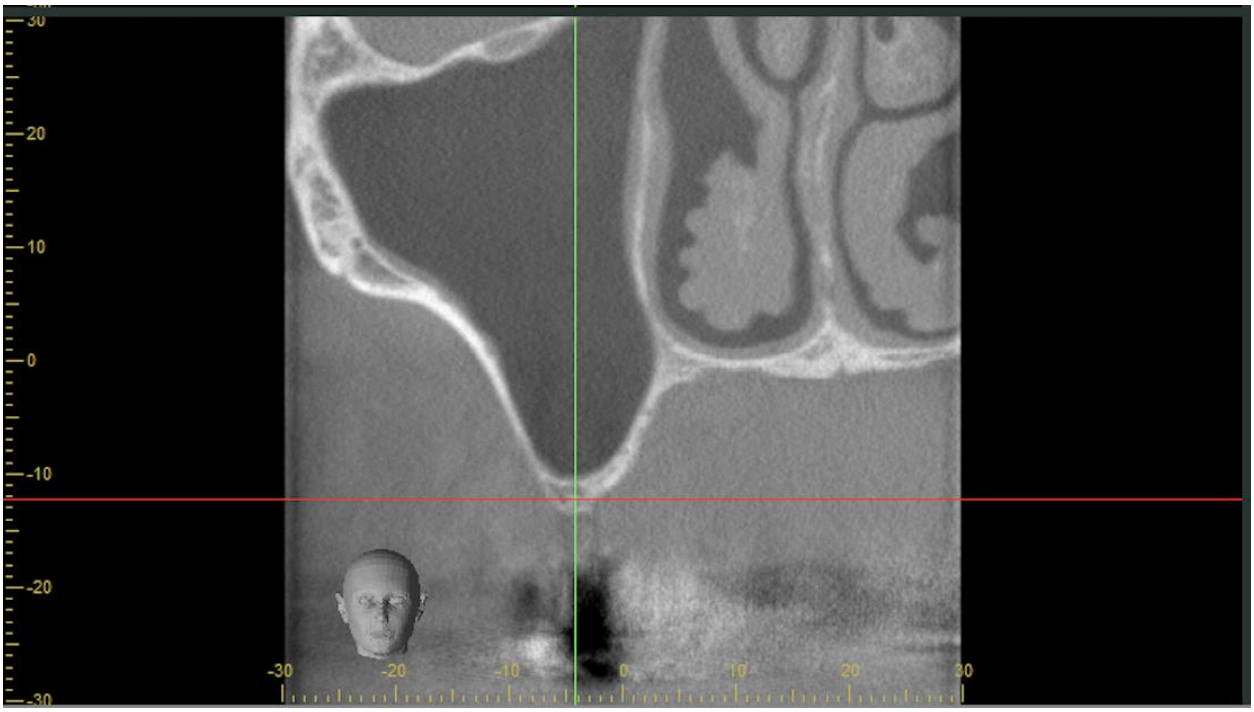


Figure 5: Pre-operative cone-beam computed tomography (CBCT) images
5a Coronal View:



5b Sagittal View:

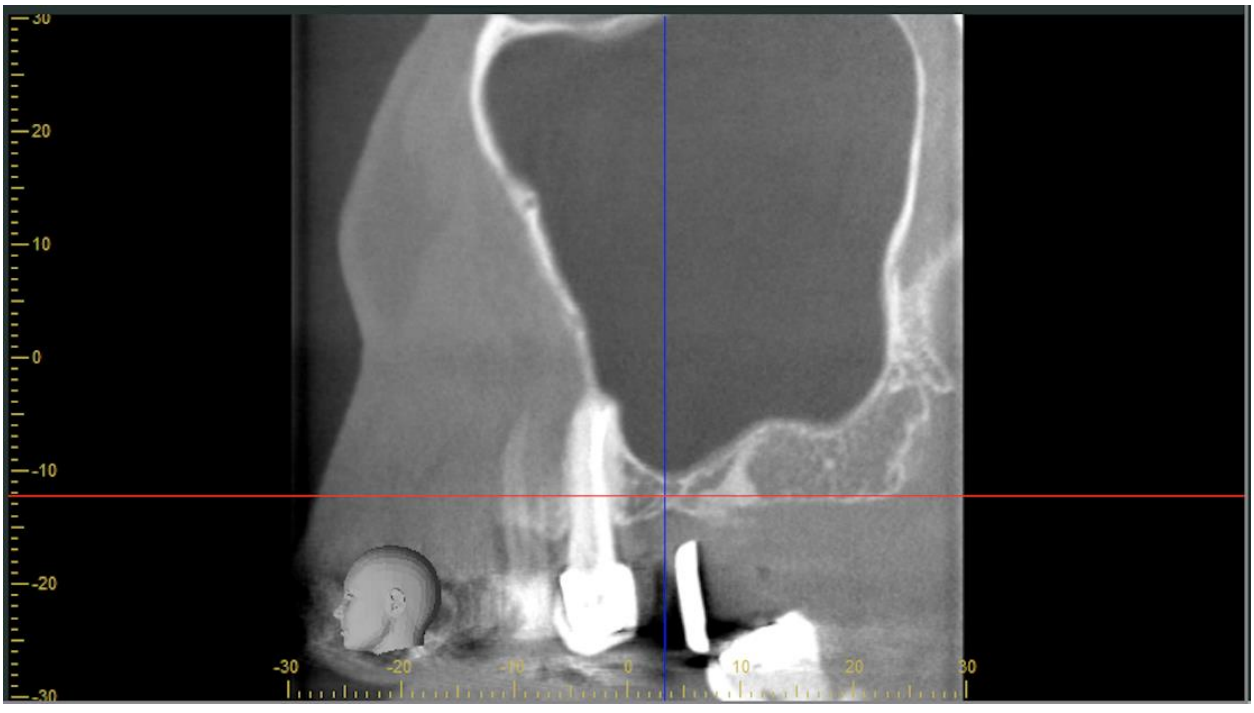
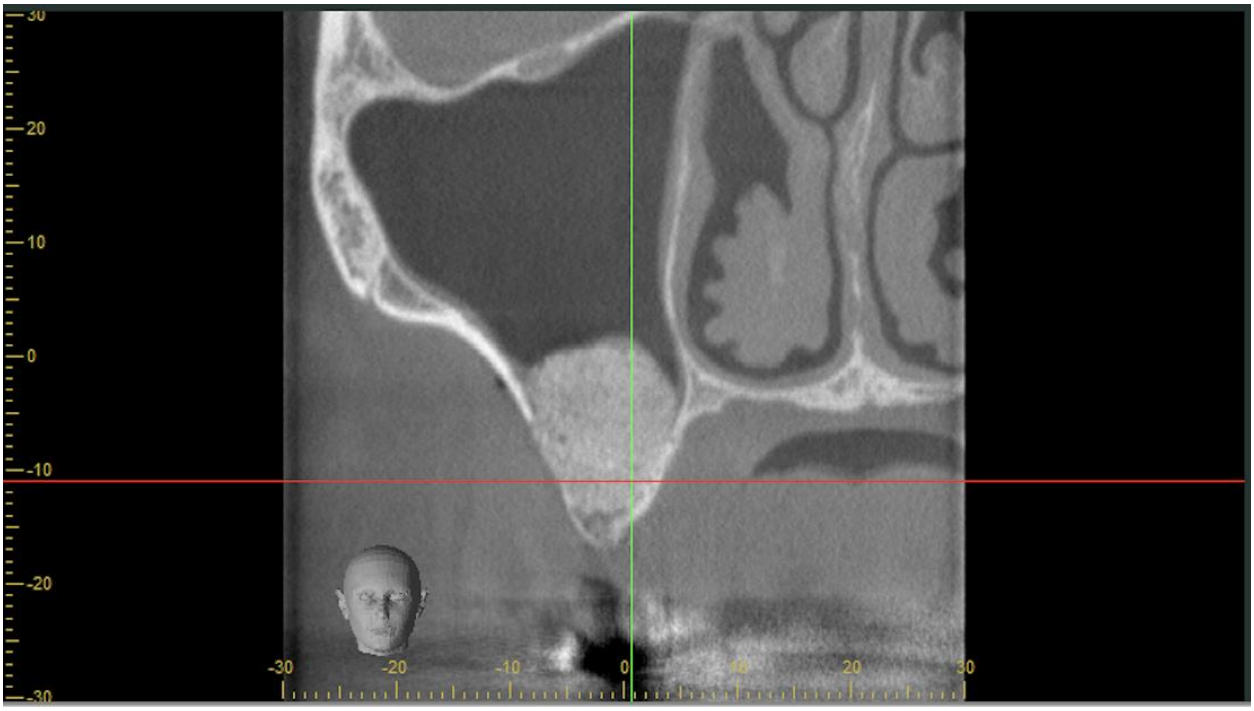
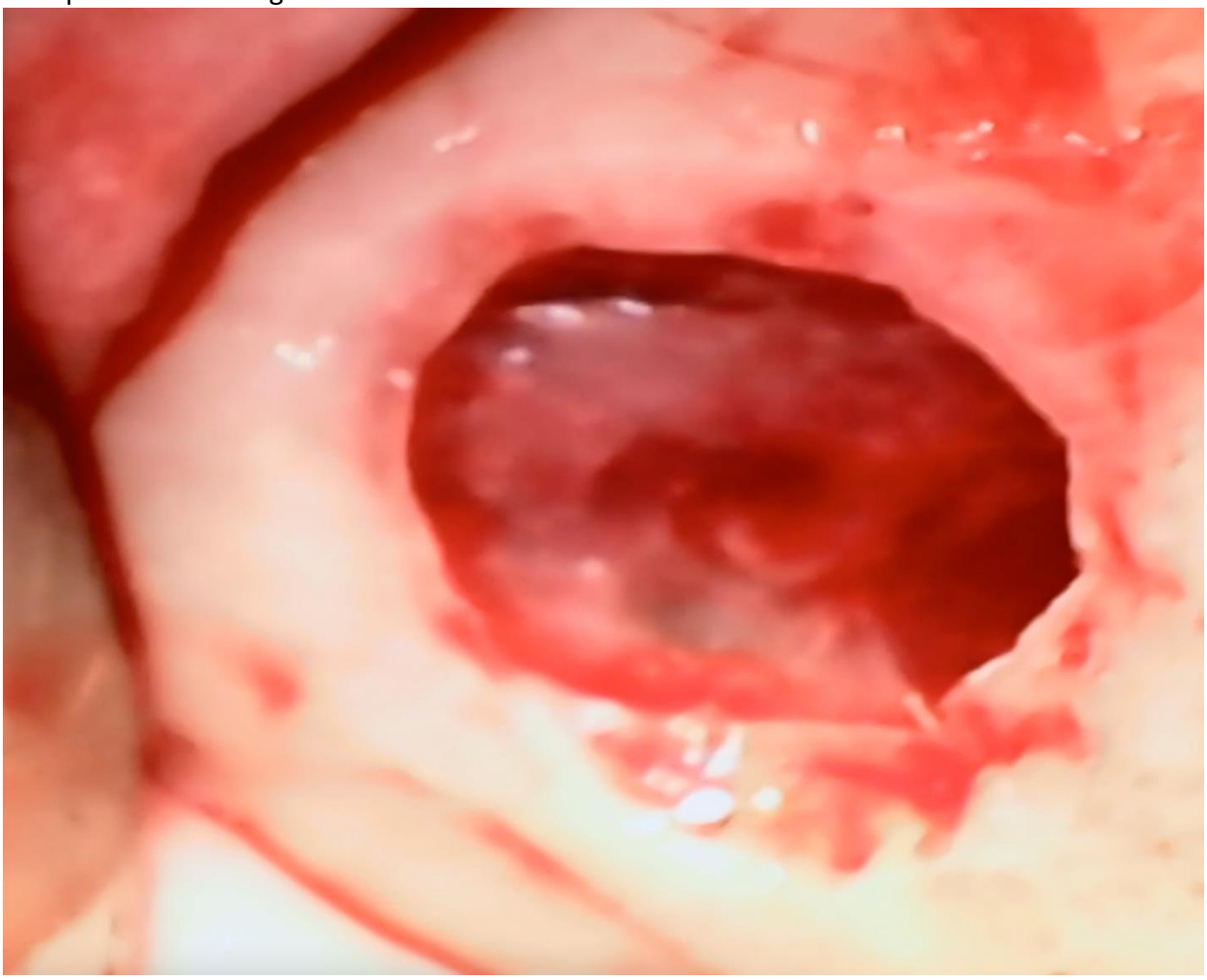


Figure 6: Post-operative cone beam computed tomography (CBCT) images
6a Coronal view:



6b Sagittal view:

Supplementary Figure 1: osteotomy preparation with surfactant solution applied to membrane, with patient breathing in



Supplementary Figure 2: osteotomy preparation with surfactant solution applied to membrane, with patient breathing out