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Case Report

Removal of Inflammatory Tissue/Product by Sinus Membrane Puncturing during Lateral Sinus Augmentation in Asymptomatic Patients with Severely Opacified Sinuses: A Case Series

Won-Bae Park [1], Jung Soo Park [2], Ji-Young Han [3], Seung-Il Shin [4] and Hyun-Chang Lim [4,*]

1 Private Practice in Periodontics and Implant Dentistry, Seoul 02771, Korea; njkysh@naver.com
2 Department of Periodontology, Korea University, Anam Hospital, Seoul 02841, Korea; freeme82@gmail.com
3 Department of Periodontology, Division of Dentistry, College of Medicine, Hanyang University, Seoul 04763, Korea; hjyperio@hanyang.ac.kr
4 Department of Periodontology, Periodontal-Implant Clinical Research Institute, School of Dentistry, Kyung Hee University, Seoul 02447, Korea; Shin.dmd@khu.ac.kr
* Correspondence: Hyun-Chang.Lim@khu.ac.kr; Tel.: +82-2-958-9382; Fax: +82-2-958-9387

Abstract: It is generally recommended that severe sinus membrane (SM) thickening should be treated prior to maxillary sinus augmentation (MSA), but during lateral MSA, inflammatory tissue/product may be removed by puncturing the SM. The present case report demonstrates surgical experience of lateral MSA with simultaneous inflammatory tissue/product removal for sinuses with severe opacification. In three patients requiring dental implant placement in the posterior maxilla, severe SM thickening was observed, but they were asymptomatic. The SM was gently elevated, followed by puncturing the SM, removing inflammatory tissue via the punctured site, draining, and thorough saline irrigation. Then, bone grafting and implant placement were performed with extra care not to spread bone substitute material into the punctured area. The postoperative pain following this procedure was more severe as compared to conventional MSA. Nasal bleeding was reported for 2–3 days. All implants were successfully integrated and demonstrated adequate function. Tissue samples retrieved during the surgery showed advanced inflammatory cell infiltration. The follow-up cone-beam computed tomographic scans revealed a significant reduction in SM thickening. In conclusion, inflammatory tissue/product removal by puncturing the SM can be applied during lateral MSA. However, more data should be needed due to the empirical nature of the present outcomes.

Keywords: case report; dental implant; maxillary sinus augmentation; sinus membrane thickening

Citation: Park, W.-B.; Park, J.S.; Han, J.-Y.; Shin, S.-I.; Lim, H.-C. Removal of Inflammatory Tissue/Product by Sinus Membrane Puncturing during Lateral Sinus Augmentation in Asymptomatic Patients with Severely Opacified Sinuses: A Case Series. *Appl. Sci.* **2021**, *11*, 11831. https://doi.org/10.3390/app112411831

Academic Editors: Paola Gandini and Andrea Scribante

Received: 6 November 2021
Accepted: 10 December 2021
Published: 13 December 2021

1. Introduction

Maxillary sinus pneumatization with alveolar bone loss limits the bone height for dental implants in proper lengths. To overcome such a situation, maxillary sinus augmentation (MSA) was introduced by pioneers, followed by a vast amount of clinical practice and research. Systematic reviews demonstrated long-term predictability of MSA, such as a high implant survival rate and a stable level of the peri-implant marginal bone [1–3].

Some risk factors are identified for MSA, of which sinus membrane (SM) thickening is the most frequently mentioned [4–6]. Several studies have addressed this issue and have demonstrated conflicting results, i.e., different thresholds for determining the pathologic condition [4,5,7,8]. Even though SM thickening is determined to pathologic status, it seems that a relatively low level of SM thickening is tolerable or minimally influential to MSA. However, it is generally accepted that advanced SM thickening should be managed before sinus augmentation employing medication and surgical intervention [9,10].

In retrospective studies, SM thickening is correlated with SM perforation during MSA [5,6]. SM perforation may impact negatively to clinical outcomes [11,12], but a recent

study demonstrated the spontaneous reduction of SM thickening in sinuses with perforated SMs compared to those without perforation [13]. Upon detecting SM perforation, extra care was given not to scatter bone substitute material into the sinus cavity. The exact mechanism behind the reduction of SM thickening is not known, but it can be assumed that a decrease in bacterial load by washing out the inflammatory products contributed to the reduction. Such might suggest that severely thickened SM can be managed by puncturing the SM and subsequent removal of inflammatory tissue/product simultaneously with MSA. However, this has not yet been reported.

The aim of this case report was to demonstrate the clinical and radiological outcomes following lateral MSA with simultaneous inflammatory tissue/product removal by puncturing the SM. The present case report was based on the clinical experience of one of the authors (W.-B.P.).

2. Case Report

This study included three patients who were treated in a private clinic. These patients required implant placement in the posterior maxillary region with reduced residual bone height (≤4 mm). Severe SM thickening was observed on the pre-operative panoramic radiographs and CBCT scans, but no patient reported any sinonasal symptoms. There was no specific medical condition contraindicating oral surgery in the patients. Three patients were light smokers. The detailed demographic information of the patients is presented in Table 1.

Table 1. Demographic and specific notes of the patients included in this study.

Patient No.	Sex/Age (years)	Smoking	Residual Bone Height (mm)	Implant Sites *	Implant Diameter and Length (mm)	Follow-Up after Final Prosthesis Insertion (Months)	Postoperative Sequelae	Sinus Membrane Thickening (Pre-Operative/at the Time of Final Prosthesis Insertion [mm])
1	Male/39	Yes	4.0	24	3.8 × 12.0	23	Pain, nasal bleeding, and wound dehiscence	41.7/9.1
			4.0	26	4.8 × 10.0			
			3.5	27	4.8 × 10.0			
2	Male/47	Yes	2.0	17	5.0 × 10.0	12	Pain, nasal bleeding, and wound dehiscence	32.5/8.5
			1.5	15	4.5 × 10.0			
3	Male/49	Yes	4.0	17	4.8 × 10.0	36	Pain, nasal bleeding	38.3/5.8
			0.8	16	6.0 × 10.0			
			3.1	14	3.8 × 10.0			

* Fédération Dentaire Internationale (FDI) tooth-numbering system.

2.1. Surgical and Clinical Procedures

All patients were administered 2.0 g of amoxicillin orally 1 h before the surgery. Following local anesthesia, a full-thickness flap was reflected to expose the lateral wall of the maxilla. A bony access window was prepared using a round bur. The SM was gently elevated using sinus curettes (Genoss, Suwon, Korea). The elevated SM was punctured using a 21-gauge aspiration needle (Figure 1a). The punctured area was slightly enlarged with a tweezer and a blade. Inflammatory tissue was removed via the punctured area as much as possible. The purulent exudate was then thoroughly drained using saline irrigation multiple times (Figure 1b–d). The removed inflammatory tissues were immersed in a 10% formalin solution for histological examination.

Implant placement and bone grafting were performed, as described in a previous study [11]. Briefly, a Prichard elevator to the sinus cavity along the upper border of the access window was placed, followed by making osteotomies for implant placement, grafting synthetic bone substitute material (Osteon III, Genoss, Suwon, Korea) in the space between the sinus floor and the elevator, and placing the implants (Implantium or Superline, Dentium, Suwon, Korea) (Figure 1e,f). During bone grafting, care was taken not to displace the material into the punctured area by inserting the material only in the space

below the Prichard elevator. After implant placement, bone substitute material was further grafted in the sinus to cover the implants completely. The bony window was covered with a collagen membrane (Genoss collagen membrane, Genoss, Suwon, Korea).

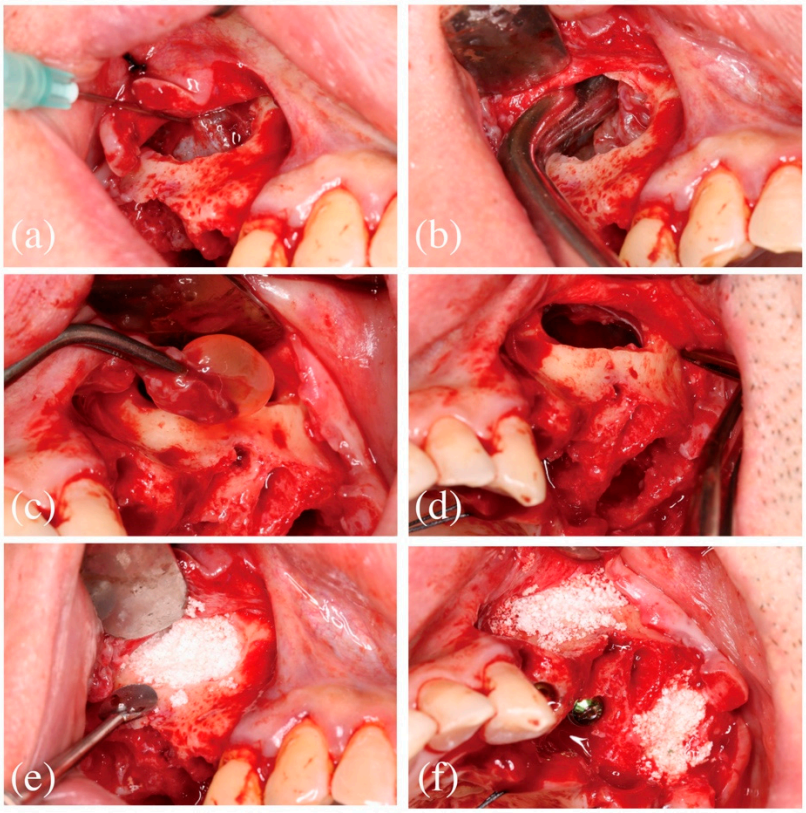

Figure 1. Clinical photographs of the surgery. (**a**) Intentional sinus membrane perforation using a 21-gauge needle (case 2); (**b**) Inflammatory tissue and exudate removal using suction (case 2); (**c**) Removal of inflammatory tissue and exudate following intentional sinus membrane perforation (case 1); (**d**) Immediately after drainage (case 1); (**e**,**f**) immediately after bone grafting.

A systemic antibiotic (Ciprofloxacin 500 mg, Ildong Pharmaceutical Co. Seoul, Korea) and a non-steroidal anti-inflammatory drug (Etodol® 200 mg; Micronized Etodolac, Yuhan Co. Seoul, Korea) were administered three times a day for 14 days. Patients were instructed to rinse the mouth with 0.12% chlorhexidine solution (Hexamedine, Bukwang Pharmaceutical, Seoul, Korea) twice a day for one week and were instructed not to blow their noses at least for one month. After 7–10 days, the sutures were removed. Uncovering for connecting healing abutments was performed after 4–6 months.

All patients were carefully monitored. The final prosthesis was inserted two months after the healing abutment connection. Panoramic radiographic images and CBCT scans were taken immediately after sinus augmentation, at the time of final prosthesis insertion, and during the follow-up visit.

2.2. Patients

2.2.1. Case 1

A 39-year-old man required tooth extraction and implant placement in the left maxillary posterior region. After the extraction of #24, #26, and #27, a bony access window was made, followed by elevating the SM, puncturing the membrane, and removing inflammatory tissue/exudate. Bone grafting (both in the sinus and the extraction socket) and implant placement were performed (Ø3.8 × 12.0 mm for #24 region, Ø4.8 × 10.0 mm for #26 region, and Ø4.8 × 10.0 mm for #27 region, Implantium, Dentium) (Figure 2a,b). The bony access window and the defect were covered using a collagen membrane.

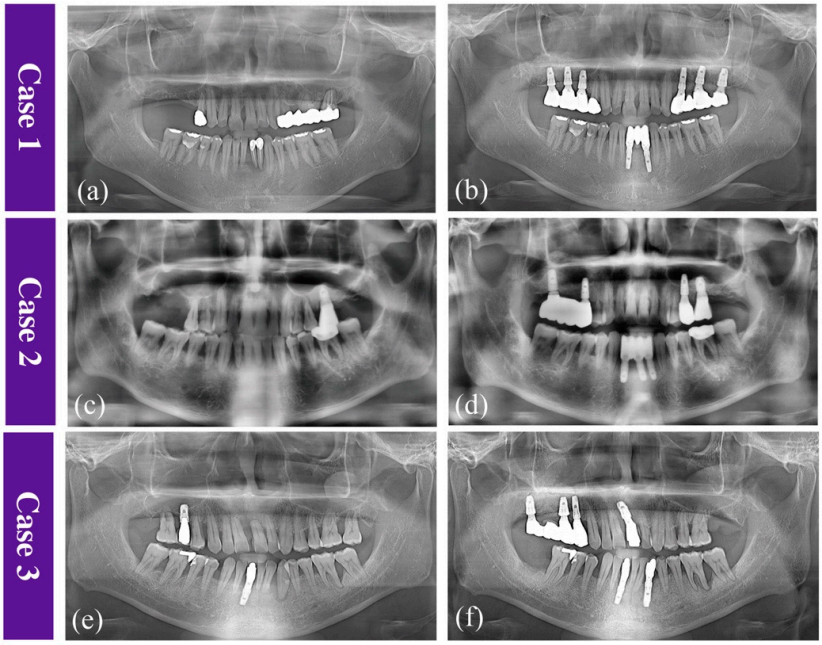

Figure 2. Panoramic radiographs of the patients. (**a**,**c**,**e**) Preoperative panoramic radiographs of the patients; (**b**,**d**,**f**) Follow-up panoramic radiographs of the patients (23, 12 and 36 months after final prosthesis insertion in the patient 1, 2 and 3, respectively).

2.2.2. Case 2

A 47-year-old man needed implant placement in the right maxillary molar region, where extraction was performed two months back. SM puncturing with the removal of inflammatory tissue/exudate was performed, followed by bone grafting and implant placement (Ø4.5 × 10.0 mm for #15 region and Ø5.0 × 10.0 mm for #17 region, Superline, Dentium) (Figure 2c,d).

2.2.3. Case 3

A 49-year-old man required implant placement in the right maxillary posterior region, with the simultaneous removal of the implant in the right maxillary second premolar region. This implant was removed using a trephine bur. A bony access window was made, followed by puncturing the SM and removing inflammatory tissue/exudate. Three implants were placed with bone grafting (Ø3.8 × 10.0 mm for #14 region, Implantium, Ø6.0 × 10 mm for #16 region, Superline, and Ø4.8 × 12.0 mm for #17 region, Implantium, Dentium) (Figure 2e,f).

2.3. Clinical Findings

All patients reported facial swelling and pain. The level of postoperative pain and discomfort was more severe as compared to conventional lateral sinus augmentation. Nasal bleeding occurred in all patients and continued for 2–3 days (Table 1).

At the time of suture removal, the pain and swelling were mostly subsided in all patients. The incision line away from the implant-placed area was slightly dehisced in cases 1 and 2, but secondary wound closure was achieved over time. No inflammatory exudate and pus were discharged via the dehisced area.

All patients were recalled every week in the first month and then every month until the healing abutment connection. All implants became integrated and functioned successfully for over 30.8 months after the final prosthesis insertion (case 1: 23 months, case 2: 12 months, case 3: 36 months) (Table 1). No patients reported any sinonasal symptoms during the follow-up period.

2.4. Histological Findings

The tissue samples comprised respiratory epithelium (ciliated pseudostratified columnar epithelium and basal cell layer), connective tissue area, and inflammatory exudate/mucus. In some parts of the epithelium, atrophied cilia and thickened basement membrane were observed. The connective tissue area was enlarged with increased inflammatory cell infiltration (Figure 3).

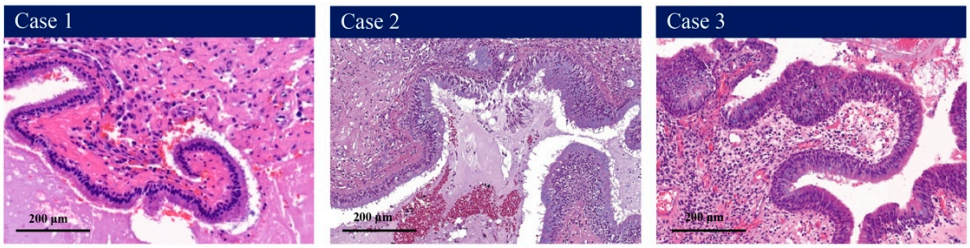

Figure 3. Histological observation of the retrieved tissues during intentional sinus membrane perforation procedure.

2.5. Radiological Findings

In the pre-operative CBCT scans, the maxillary sinuses exhibited severe SM thickening (Figure 4a,e,i). However, follow-up CBCT scans demonstrated a marked reduction in the thickening (Figure 4b–d,f–h,j–l). The mean thickening of the SM was 37.5 ± 4.7 mm pre-operatively and 7.8 ± 1.8 mm at the time of prosthesis delivery. No scattering or displacement of the bone substitute particles was observed. No recurrence of SM thickening was observed.

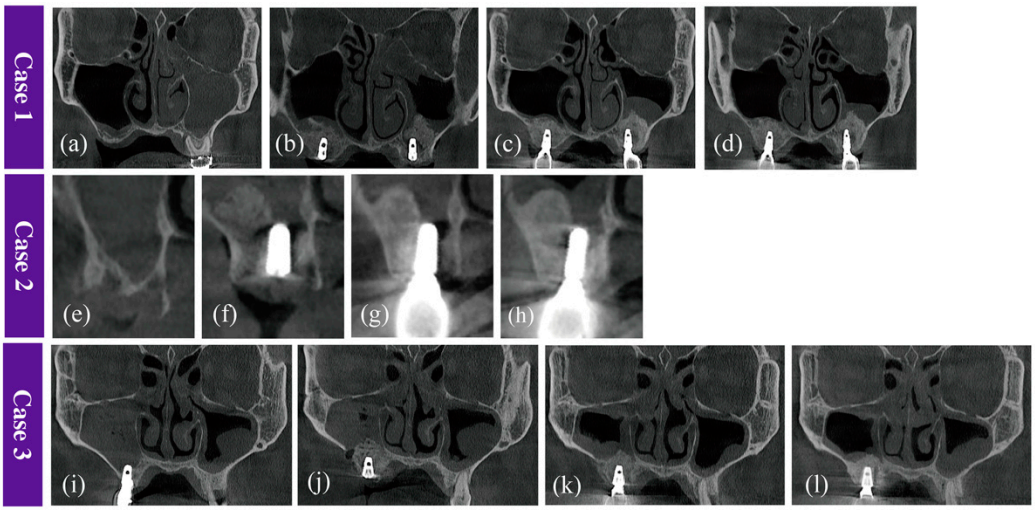

Figure 4. Cone-beam computed tomographic (CBCT) radiographs of the patients. (**a**–**d**) CBCT views of the patient 1; (**e**–**h**) CBCT views of the patient 2; (**i**–**l**) CBCT views of the patient 3; (**a**,**e**,**i**) Pre-operative CBCT view; (**b**,**f**,**j**) Immediate postoperative CBCT view; (**c**,**g**,**k**) CBCT view immediately after final prosthesis insertion; (**d**,**h**,**l**) CBCT at 23, 12 and 36 months after final prosthesis insertion in the patient 1, 2 and 3, respectively.

3. Discussion

This study reported the healing outcomes of lateral MSA and simultaneous removal of inflammatory tissue/product by puncturing the SM in asymptomatic patients with severe SM thickening. There was no implant failure reported over 23.7 ± 12.0 months after the final prosthesis insertion. The SM thickness was reduced with no recurrence; however, increased discomfort (pain, swelling, and nasal bleeding) was reported in the immediate postoperative period.

The development of sinonasal symptoms may not correspond to the degree of SM thickening. One study exhibited that most of the opacified maxillary sinuses were related to sinonasal inflammatory diseases [14]. However, another study demonstrated that various sinus pathologies in cone-beam computed tomographic (CBCT) scans were found even in asymptomatic patients, wherein SM thickening greater >3 mm was observed in 66% (838 out of 1406 sinuses) and complete or partial opacification in 7.8% (100 out of 1406) [15]. In line with those findings, all patients in the present case report did not present any sinonasal symptoms.

Despite the absence of the symptoms, SM thickening may carry a potential risk of complication in MSA. Especially, membrane thickening above a certain threshold could increase the risk due to the impaired clearance function of the maxillary sinus via the ostiomeatal complex [4]. Thus, until ostium patency and a decrease in mucosal thickening are achieved, MSA is generally contraindicated for the maxillary sinus with an ostial obstruction or severe opacification [16]. Some studies demonstrated simultaneous MSA and endoscopic sinus surgery under general anesthesia [16–18].

Therefore, the present approach could be debatable. There was no sure way to ensure that the inflammatory membrane thickening would resolve, and the grafted bone substitute material would consolidate. However, on an empirical basis of one of the authors (W-B. P), puncturing the SM was performed simultaneously with lateral MSA in the present study. A recent retrospective study partially supported the feasibility of the protocol in this study [13]. When the SM was accidentally perforated during lateral MSA, the amount of reduction in the SM thickening was more significant (from 6.14 mm to 2.39 mm) than that of cases with no membrane perforation (from 2.29 mm to 0.96 mm). The authors explained that cystic or inflammatory exudate could be discharged and washed out via the perforated site, reducing the inflammatory burden and preventing contamination of the grafted bone material [19]. In all the patients in this study, CBCT scans revealed a marked reduction of SM thickness, which indicates a decline in the pathologic status of the sinus [20].

Previously, puncturing the SM was predominantly used to manage antral pseudocyst simultaneously with MSA [21,22]. However, the aim of the procedure differed between that for antral pseudocyst and in the present cases. Antral pseudocyst generally does not require surgical removal upon detection [21,23]. However, for MSA, it was sometimes recommended to remove the antral pseudocyst to ease the SM elevation and prevent potential ostium blockage [8,22,24].

The current approach leaves room for safety issue. Even though all patients in the present study were asymptomatic preoperatively, this did not indicate a clinically acceptable state for MSA. Moreover, the cause of SM thickening was not revealed before MSA. Some of the causes, such as fungal infection, may lead to postoperative sinusitis. Empirically, a postoperative period of 10–14 days is essential for judging the success of the present surgical approach. Postoperative pain and nasal bleeding in the present patients were noteworthy compared to those with routine MSA, but these symptoms subsided by suture removal. Otherwise, other surgical and pharmacological interventions may have been needed. Another aspect is regarding the placement of graft material. Extra care should be needed not to push the material into the punctured area [13].

Further studies are warranted regarding the healing of the punctured SM and the bone-forming ability in the augmented sinus cavity with the damaged SM. A few studies were published on these issues [25–28], but investigations on the membrane to a cellular level or the quality of newly formed bone have yet to be made.

4. Conclusions

In conclusion, puncturing the SM might be considered for draining inflammatory products simultaneously with lateral MSA. Despite the obtained outcome in the present study, long-term monitoring is still required for validation and safety. Again, one should consider that the current approach was performed on an empirical basis, and more data needs to be collected.

Author Contributions: Conceptualization, W.-B.P.; methodology, W.-B.P.; validation, W.-B.P. and J.-Y.H.; formal analysis, W.-B.P. and J.S.P.; investigation, W.-B.P., J.-Y.H. and S.-I.S.; data curation, W.-B.P.; writing—original draft preparation, W.-B.P. and J.S.P.; writing—review and editing, H.-C.L.; visualization, S.-I.S.; supervision, H.-C.L.; project administration, W.-B.P. and J.-Y.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study.

Informed Consent Statement: All patients agreed to the publication. Informed consents were obtained from all patients.

Data Availability Statement: All data and material are presented in the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

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