CASE REPORT

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# Intra-sinus rigid fixation of a resorbable barrier membrane to repair a large perforation of the sinus membrane: a technical note

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**Abstract** (J Korean Assoc Oral Maxillofac Surg 2023;49:297-303)

A resorbable barrier membrane is commonly used for the repair of perforated sinus membranes during sinus lifting surgeries. However, repairing large-scale perforations poses challenges for clinicians as the protection and isolation of graft material remain uncertain. With this technique, we aimed to prevent graft material loss and subsequent sinus-related complications using intra-sinus rigid fixation of the resorbable barrier membrane in cases with a large perforation of the sinus membrane.

**Key words:** Bone substitutes, Dental implants, Maxillary sinus, Membranes, Sinus floor augmentation

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## I. Introduction

Sinus lifting procedures are generally safe. However, certain intraoperative and postoperative complications have been reported. The most prevalent complication is sinus membrane perforation[1]. This perforation may cause the loss of graft material, subsequent infection, early implant failure, and disruption of normal sinus physiologic function[2]. Various materials and techniques have been proposed to repair sinus membrane perforations[1-9], with the most common approach being application of a resorbable barrier membrane to cover the perforated area[1-7].

Although the clinical significance of sinus perforations is controversial[2-4,6,7], many studies have shown that it is not necessary to abort a sinus lifting procedure if the graft material is completely protected and isolated from the maxillary sinus environment by a resorbable barrier membrane[2,4-7]. However, repairing large-scale perforations poses challenges for clinicians as they cannot determine whether the graft material remains protected and isolated by the resorbable barrier membrane. This is because the intra-sinus resorbable barrier membrane, which directly covers the perforated area, is concealed by the overlying graft material, and the maintenance of its proper position becomes questionable as graft material is gradually packed into the sinus cavity. Specifically, a barrier membrane can shift away from the perforation during graft placement, resulting in subsequent loss of graft material containment[4].

In this technical note, we describe a simple technique to maintain coverage of a large perforated area using a resorbable barrier membrane during the repair of a large sinus membrane perforation. We placed a resorbable barrier membrane against the large perforated area and performed intra-sinus rigid fixation on the medial bony surface of the sinus with a titanium screw to prevent the loss of graft material and subsequent sinus complications.

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## II. Case Report

A 58-year-old male patient with no significant medical history presented with a desire for rehabilitation of the maxillary right molar area. He was transferred from a local dental clinic to our hospital because the remaining bone volume was very small, requiring a substantial amount of bone grafting with sinus lifting surgery. Preoperative clinical and radiologic examinations, including cone-beam computed tomography (CBCT), revealed several issues in the maxillary right posterior area, including insufficient bone volume for routine implant placement due to sinus pneumatization.(Fig. 1) Implant restoration of the maxillary right area was lost, and the implants in the maxillary right second premolar and second molar regions were affected by severe peri-implantitis. Additionally, the implant in the maxillary right first molar region exhibited osseointegration failure and was displaced into the maxillary sinus.

The two implants in the maxillary right second premolar and second molar regions were surgically removed due to peri-implantitis. Subsequently, a plan was created to remove the displaced implant in the maxillary sinus using a lateral window approach.

After incision and flap reflection, an oval-shaped bony window was created and separated on the lateral wall of the maxillary sinus using an outfracture or "off-the-wall" osteotomy technique[10]. The two ailing implants affected by peri-implantitis were removed, and the sinus membrane was elevated and intentionally perforated. The implant in the sinus cavity was removed through the perforation. Finally, the size of the perforation was measured as approximately 1.5 cm at the largest diameter.(Fig. 2)

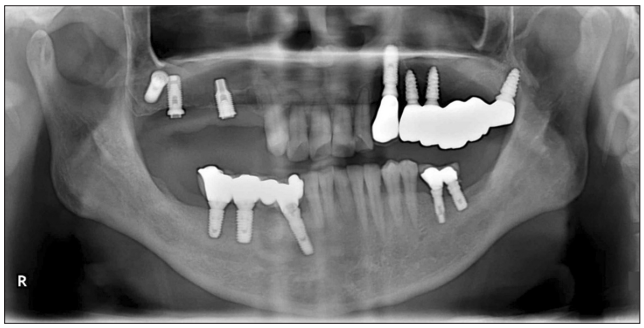


**Fig. 1.** Preoperative panoramic radiograph. The implants in the maxillary right second premolar and second molar regions were affected with severe peri-implantitis, and the implant in the maxillary right first molar region exhibited osseointegration failure and was displaced into the maxillary sinus cavity.
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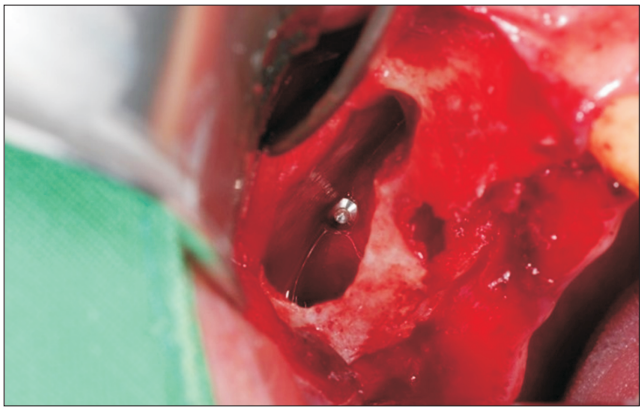

**Fig. 3.** Intraoperative clinical photo showing the repair of a large perforation using intra-sinus rigid fixation and stabilization of a resorbable barrier membrane with a titanium screw.
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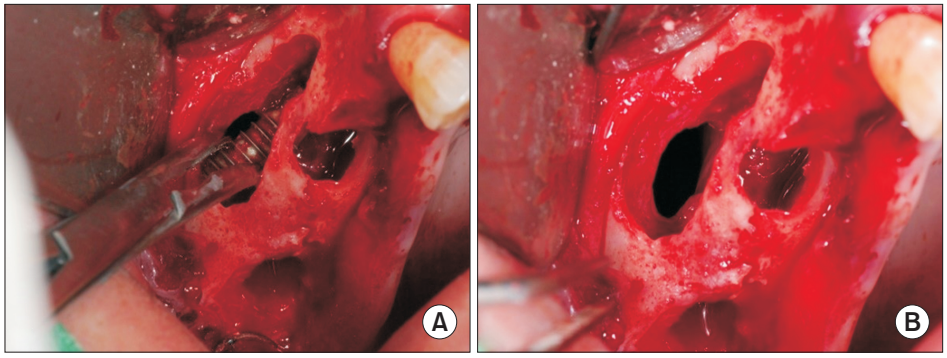


**Fig. 2.** Intraoperative clinical photos. A. The implant, which was displaced into the sinus cavity, was removed using hemostats through the perforated sinus membrane. B. A large perforation on the sinus membrane was identified and was measured to be approximately 1.5 cm at the largest diameter.
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A 3.0 cm×4.0 cm semi-rigid resorbable collagen barrier membrane (OssMem Hard; Osstem) was asymmetrically designed so that the longer portion could be placed and folded into the inner sinus cavity.

A titanium screw (Bone Screw; Osstem) was used to internally fix and stabilize the collagen membrane on the medial or palatal bony surface of the sinus cavity, ensuring coverage of the perforated area. For bone grafting, a mixture of freeze-dried bone allograft (FDBA, SureOss; HansBiomed) and deproteinized bovine bone mineral (DBBM, A-Oss; Osstem) in a 1:1 ratio was hydrated with saline. The hydrated bone graft material was then gently packed beneath the collagen membrane until the entire sinus cavity was filled and the collagen membrane was extended beyond the upper boundary of the bony window osteotomy to confirm complete sealing of the graft material.(Fig. 3, 4)

Dental implants (TS III SOI; Osstem) with a sandblasted and acid-etched surface, which was coated with a pH-buffering agent to introduce hydrophilic properties, promote osseointegration during the early healing period, and accelerate new bone formation, were placed[11]. Bone graft material was then supplementally placed, and the separated bony window was repositioned over the bone graft and covered by the outer portion of the collagen membrane.(Fig. 5. A) Due to the low initial stability of the implants (<10 Ncm), cover screws were connected and the implants were submerged. The flap was sutured without any tension (Fig. 5. B), and postoperative radiographs were obtained immediately to confirm the proper

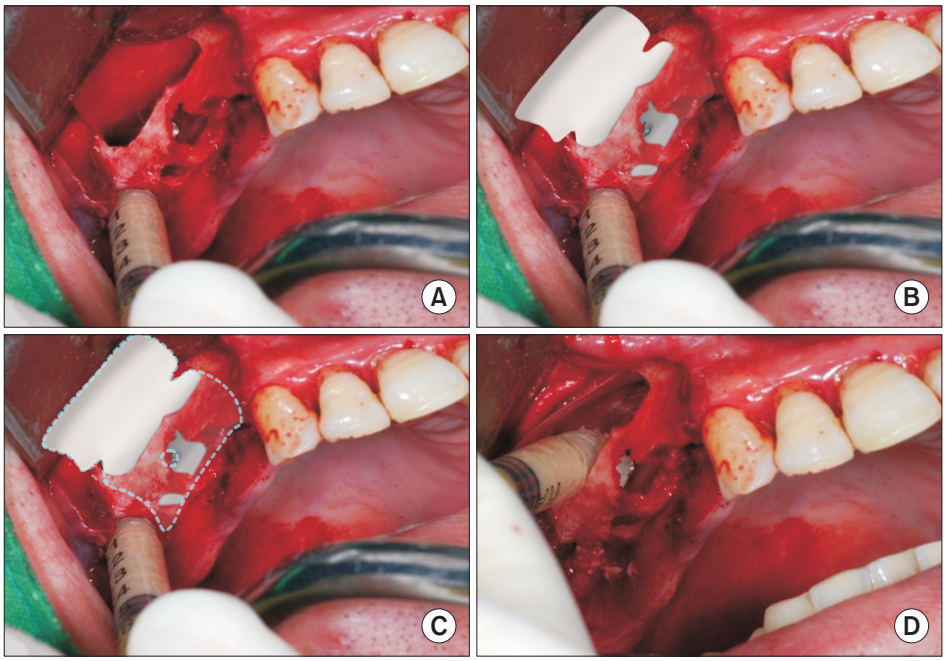


**Fig. 4.** After fixation of the resorbable barrier membrane, bone graft materials were inserted into the sinus cavity. A. Bone grafting through the implant drilling site. B, C. Schematic drawings of the design of the resorbable barrier membrane and its intra-sinus rigid fixation with a titanium screw. D. Bone grafting through the lateral window.
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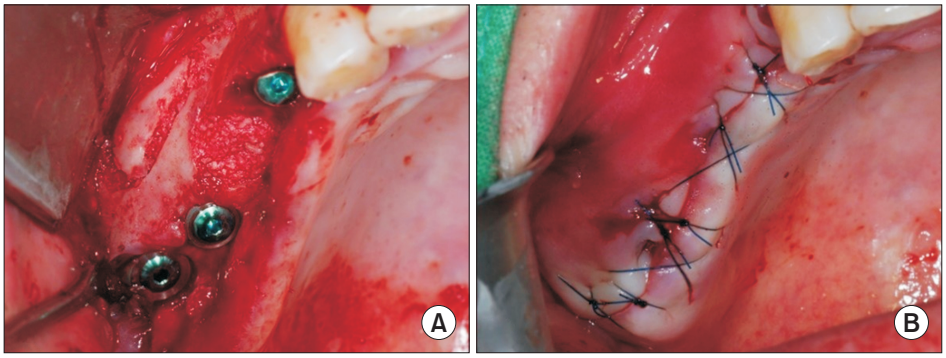


**Fig. 5.** Dental implant placement after bone grafting. A. A resorbable barrier membrane extended beyond the upper boundaries of the lateral window osteotomy. Additional bone grafting was performed and the detached lateral bony window was repositioned. B. A tension-free suture was placed.
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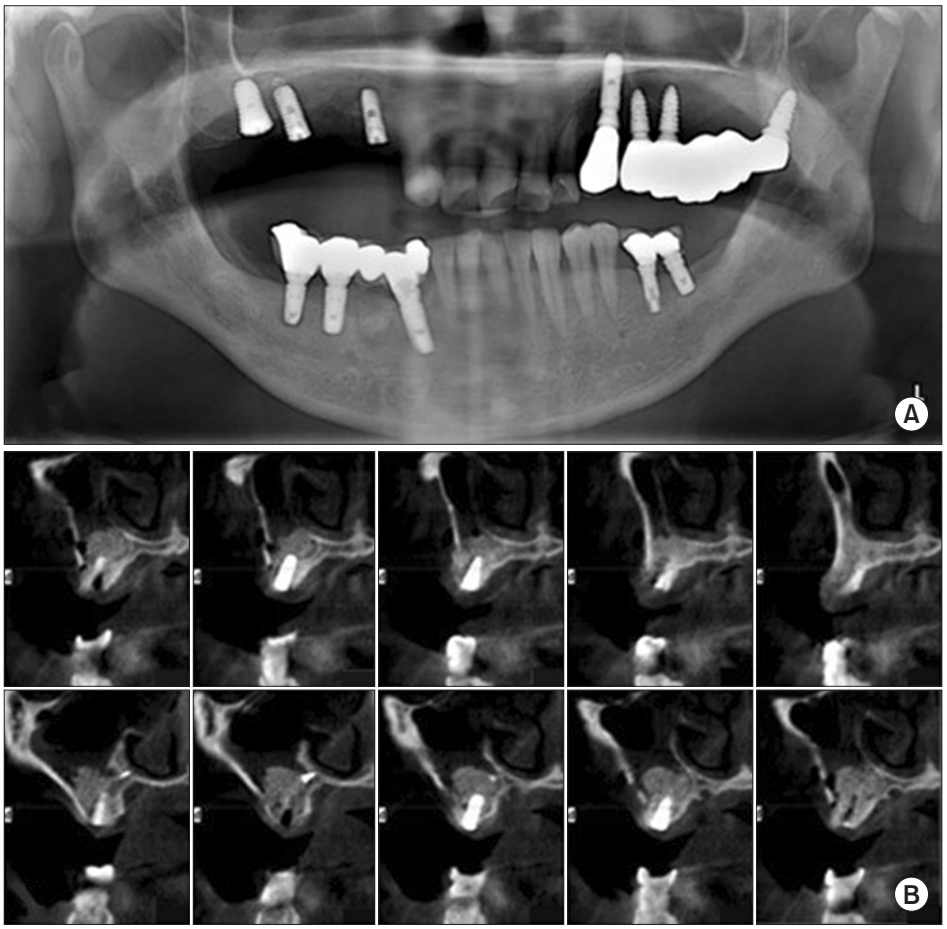


**Fig. 6.** Postoperative radiographs showing that the resorbable barrier membrane, which was internally fixed and stabilized by a titanium screw, maintained its proper position and prevented the loss of graft material into the sinus cavity. Panoramic radiograph (A) and cone-beam computed tomography (B) images showing the titanium fixation screw at the medial bony wall of the sinus.
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protection and isolation of the bone graft material by the collagen membrane.(Fig. 6) The patient received painkillers and antibiotics for 10 days, and a 0.2% chlorhexidine mouthwash was also prescribed three times a day. The sutures were removed 10 days after the surgery. The patient reported no sinus symptoms associated with complications during the entire healing period.

After 6 months, the implants were uncovered, and healing abutments were placed. The patient received temporary restorations following the progressive loading protocol. Finally, 12 months after the initial implant placement and sinus lifting procedures, the final restorations were delivered and the patient expressed satisfaction with the outcome.(Fig. 7)

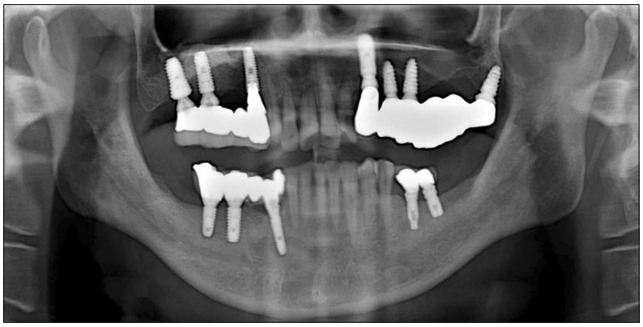

**Fig. 7.** Panoramic radiograph obtained after delivery of the final restoration.
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## III. Discussion

The classification and subsequent management of membrane perforations vary depending on the location and size of the perforation[12], and the clinical significance of sinus perforations remain controversial[2-4,6,7]. Several studies have shown no relationship among membrane perforations, postoperative complications, and implant survival[2,4,6,7]. However, it has been reported that the size of the perforation correlates with implant failure, particularly in cases of large perforations[3]. Hernández-Alfaro et al.[3] classified membrane perforation size as either small to moderate (<10 mm) or large (≥10 mm) and demonstrated that implant survival rate was significantly lower in cases of large perforations.

Various materials and techniques have been proposed to repair sinus membrane perforations including direct suturing, cyanoacrylate adhesives or autologous fibrin glue, lamellar bone sheets, buccal fat pads, and block bone grafts[1-9]. However, the most commonly used approach is the diverse application of a resorbable barrier membrane to cover the perforated area[1-7]. When a large perforation occurs and a bone graft is simultaneously indicated, immediate repair using a resorbable barrier membrane is essential to complete the procedure. The main purpose of using a resorbable barrier membrane is to seal the perforated area, cover the graft material, and prevent the loss of graft material into the sinus cavity, which can lead to various sinus complications and implant failure[1-7].

In techniques that utilize a resorbable barrier membrane, it is typically fixed and stabilized on the outer surface of the sinus[1-7]. Therefore, it becomes challenging to confirm whether the graft material remains protected and isolated by the resorbable barrier membrane during grafting, especially in cases of large perforations. Since the sinus cavity cannot be visualized as the graft material is gradually packed beneath the inner portion of the resorbable barrier membrane that covers the perforated area, there is a potential risk of displacement and subsequent loss of graft material into the sinus cavity. Moreover, postoperative stimulation of the sinus can alter the original position of the resorbable barrier membrane. To address these risks, a change in the routine concept of fixing a resorbable barrier membrane was attempted in this technique from an external to internal perspective.

Given that a screw is left in the medial wall of the sinus with this technique, a foreign body reaction or loosening and displacement of the screw may occur. However, since no higher incidence of postoperative complications was reported in the screw "tent poles" grafting technique[13], sterilized titanium screws typically cause no complications such as foreign body reactions or infection. The maxillary sinus reactions were examined through an endoscope in 14 patients with machined surface implants exposed to the inside of the maxillary sinus. No signs of inflammatory reactions, infection, or increased secretion inside the maxillary sinus were observed[14]. It was also revealed that when the mucosa of the sinus floor is penetrated less than 2 mm by an implant, a newly formed membrane can voluntarily cover the penetration, acting as a natural barrier in the sinus cavity[15]. Therefore, it can be assumed that the screw remaining on the sinus bony wall would not contribute to the development of sinus complications. However, it is important to consider the possibility of loosening or displacement of the titanium screw, as it is almost impossible to remove titanium screws with this technique. By accurately measuring medial or palatal bone thickness in preoperative CBCT scans and selecting the location and length of the titanium screws, they can be positioned rigidly while minimizing their exposed surfaces. Otherwise, resorbable screws offer a viable alternative.

DBBMs have been widely used as an osteoconductive material for sinus lift surgeries, ridge preservation, immediate implant placement after tooth extraction, and guided bone regeneration[16-18]. The unique advantage of DBBMs is their ability to maintain volume with slow substitution by new bone compared to autogenous and allogeneic bone grafting materials[17,18]. A-Oss, which was adopted in this technical note, is a recently introduced DBBM produced by chemical treatment with an aromatic and strong alkali solvent, followed by a low-temperature annealing process below 400°C. In contrast to the DBBMs for volume maintenance, FDBAs, whether decalcified or not, exhibit robust bone formation with islands of new bone, indicating evidence of bone induction and a more active state of turnover and replacement. However, FDBAs tend to be resorbed more rapidly than DBBMs. As observed in this technical note, a mixing or layering technique using different grafting materials is commonly applied to augment deficient alveolar bone around dental implants[18].

This technique aims to enhance the predictability of clinical outcomes by ensuring the protection and isolation of graft material during a sinus bone graft procedure by maintaining the proper position of the resorbable barrier membrane. Compared to previous techniques[1-7,12], this technique may reduce the size of the resorbable barrier membrane or the number of fixation tacks or screws. More titanium screws can be added to the inner wall of the sinus cavity for definitive fixation and stabilization of the resorbable barrier membrane. A semi-rigid resorbable barrier membrane is recommended for easy manipulation and versatile application with this technique[5]. However, in sinuses with a broad base, it may be difficult to insert a titanium screw and fix a resorbable barrier membrane medially under direct visualization. If the titanium screw is accidentally displaced into the sinus cavity, locating and removing the missing screw could prove difficult.

In conclusion, our technique may offer superior protection and isolation of the graft material during sinus bone grafting procedures, especially when a large perforation has occurred. Further investigations assessing implant survival and histomorphometric analysis through long-term follow-ups are necessary to validate this technique.

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## Authors' Contributions

W.J.J. and S.H.Y. participated in resources investigation and wrote the manuscript. Y.K. participated in the surgery. Y.S.C. conceptualized the study and participated in the surgery. W.W.L. and J.W.S. participated in the resources investigation. M.T. and K.G.H. reviewed and revised the manuscript. C.J.P. designed the study and coordinated and carefully reviewed and revised the manuscript. All authors have read and agreed to the published version of the manuscript.

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## Ethics Approval and Consent to Participate

The study was conducted according to the guidelines of the Declaration of Helsinki (2013) and approved by the Institutional Review Board (No. 2021-04-014) of Hanyang University Hospital.

## Consent for Publishing Photographs

Written informed consent was obtained from the patient for publication of this article and accompanying images.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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