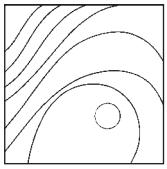
Two-Step Procedure for the Treatment of a Maxillary Sinus with Complex Sinus Septa: A Highly Predictive Method for Sinus Floor Augmentation After Perforation of the Maxillary Sinus Membrane



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A strategic surgical approach is necessary for patients who cannot undergo maxillary sinus augmentation due to a large perforation of the sinus membrane as a result of complex sinus septa. The technique includes partial cutting and removal of the sinus septum and graftless mucosal elevation of the concavity area. Six months after the procedure, bone growth was observed in the area where the septum had been partially removed. The sinus mucosa was slightly thicker because of scarring; consequently, maxillary sinus augmentation was safely achieved. This two-step procedure is effective for safe maxillary sinus augmentation in patients with complex sinus morphology. Int J Periodontics Restorative Dent 2019;39:e175–e180. doi: 10.11607/prd.3888

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The literature reports that extraction of the maxillary molars is often accompanied by simultaneous progressive pneumatization of the maxillary sinus. Sinus augmentation must be performed when an implant is placed in an atrophied maxillary molar region, and high success rates have been reported for this treatment.[1–3] To safely perform maxillary sinus augmentation, computed tomographic imaging is performed preoperatively to confirm the presence or absence of sinusitis or a mucocele, and to conduct an anatomical examination of the posterior superior alveolar artery and sinus septum.[4,5] Because sinus septa mainly run radially from the inner to the outer sinus wall, a number of methods have been reported to manage the presence of septa, including avoidance of sinus septa (a surgical method that comprises formation of several trap doors, depending on the heights of the septa) and a method based on the simultaneous removal of sinus septa, using tools such as chisels.[6–8]

However, the periphery of the septum is highly likely to cause mucosal perforation.[9] In cases of sinus membrane perforation, surgical repair methods have been used, mainly utilizing absorbable membranes, sutures, and laminate bones.[10–13] Many previous and recent reports have stated that if a repair is

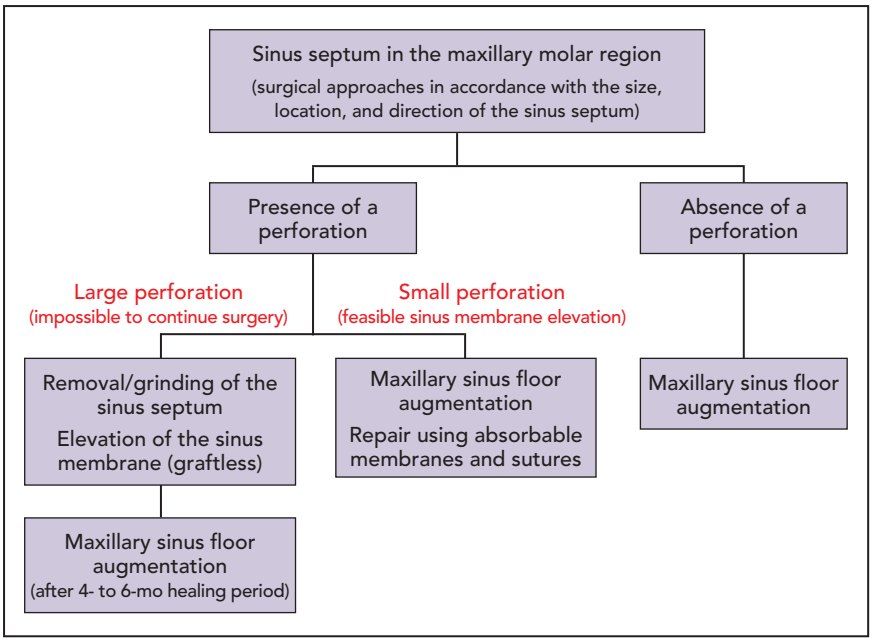

Fig 1 *Treatment protocol for the present study.*

performed, there are no differences in the histologic and implant survival rates of new bone formation at perforation sites as compared to nonperforated sites.[10–16] In the present study, the authors encountered cases in which it was not feasible to perform maxillary sinus augmentation during the first surgery due to complex sinus septa and a large perforation in the sinus membrane. Thus, the authors herein report a two-step augmentation method and demonstrate its safety, efficacy, and good predictability for managing complex maxillary sinus morphology.

Materials and Methods

Seven patients (two males, five females; mean age: 51.7 years; range: 32 to 67 years) who underwent the two-step procedure between 2007 and 2015 were selected for this retrospective study of the management of sinus morphology. The present study reports on two cases of sinus morphology management: one with grafting and one without. Prior to surgery, the patients received an explanation of the study and agreed to participate; written informed consent was obtained. The study was independently reviewed and approved by the Masaka Dental Clinic ethics committee.

Case 1

The patient was a 48-year-old woman with a chief complaint of difficult mastication resulting from missing teeth on the maxillary left side. Preoperative radiographic findings confirmed the presence of two sinus septa: one in the mesiodistal direction and one directed radially from the inner to the outer wall. The existing bone mass at the planned implant insertion site was 2 to 5 mm thick, and maxillary sinus augmentation was planned using a lateral window technique (Figs 1 and 2).

Surgical Methods

First Surgery

The sinus membrane was perforated during detachment; later, as the perforation site increased in size, the original surgical plan was cancelled. To avoid enlarging the perforation, mucosal elevation was performed to avoid the perforation site and expose the septum. In the mesiodistal direction, partial cutting and removal of the septum was performed. Most of the septum was removed from the base using a bone chisel, and the sharp edges were rounded using a diamond round bar and piezoelectric devices. Additionally, mucosal elevation was performed with a focus on the nasal cavity side of the septum. Finally, the surgical wound was sutured.

Second Surgery

Six months later, cone-beam computed tomography (CBCT; FineCube, Yoshida) findings showed bone growth in the sinus wall, where the septum had previously been; volume-rendered images showed that the septum had been removed.

In addition to the existing bone mass, there was natural bone growth of approximately 2 to 4 mm at the bottom of the sinus, which allowed for full initial placement of the implant; therefore, maxillary sinus floor augmentation (MSFA) with simultaneous implant insertion was performed.

The scar tissue (at the lateral window) from the previous surgery was split into different layers using a surgical knife and scissors, and space was secured on the maxillary sinus floor to allow the inner section of the scar tissue to drop into the maxillary sinus. After the sinus mucosa was lifted, the authors observed a slight increase in thickness because of scarring; as a result, elevation was achieved without concerns for perforation risk.

After MSFA, implant insertion was performed using the Brånemark System (Nobel Biocare) (3.75 or 4.0 × 11.5 mm), and beta-tricalcium phosphate (β-TCP; OSferion, Olympus Terumo Biomaterials) was used as bone grafting material (0.5- to 1.5-mm diameter).[17]

Case 2

The patient was a 32-year-old man who consulted the authors for treatment of a missing maxillary right first molar. Findings on preoperative CBCT scans showed that three sinus septa were present in a radial pattern from the inner to the outer sinus wall. There were also complex protuberances and concavities present. The existing bone mass was 3 mm thick at the planned implant insertion site and ≤ 1 mm thick at the mesial aspect (Fig 3).

Surgical Methods

First Surgery

Perforation occurred at the time of detachment of the sinus membrane; later, the perforation increased in size and the MSFA was

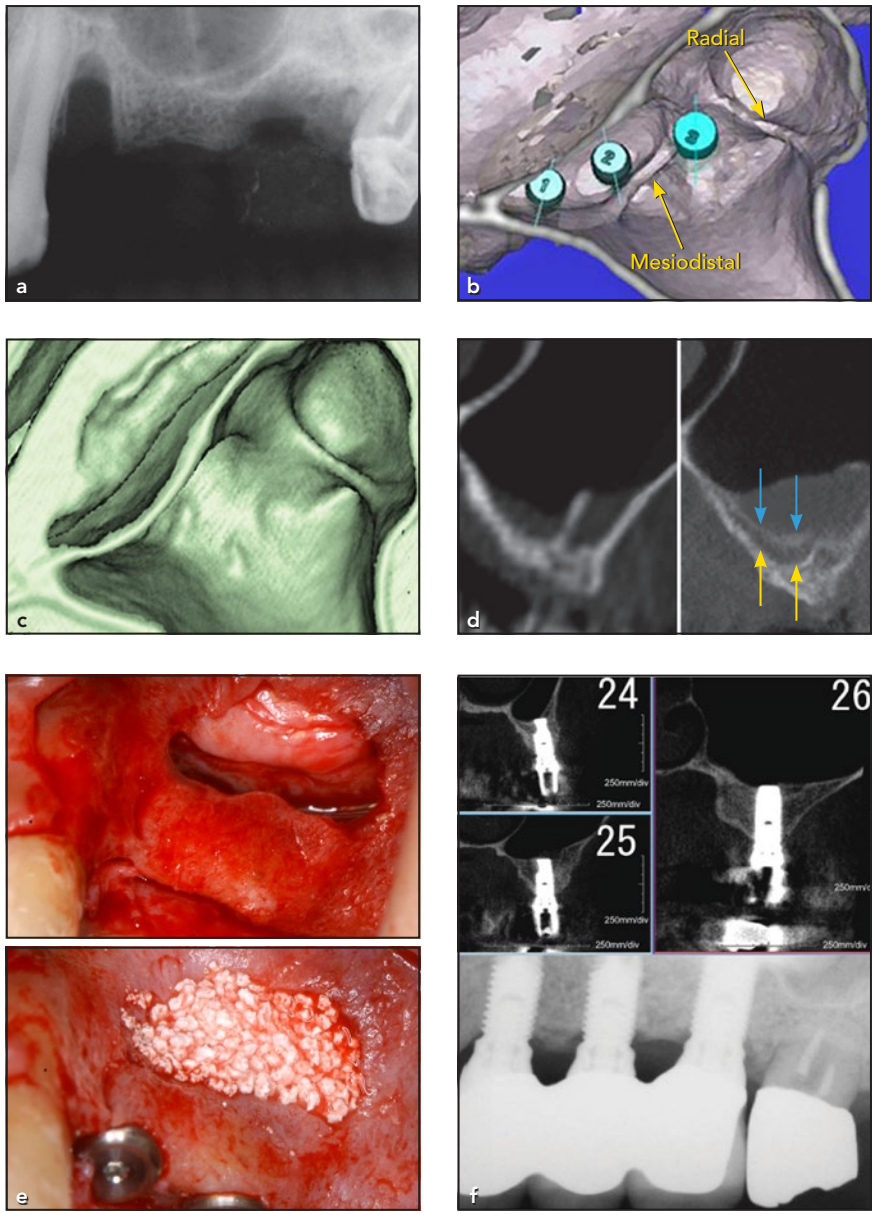

Fig 2 *Case 1.* (a) *Preoperative radiograph. The patient's maxillary left first and second premolars and first molar are not present.* (b) *Cone beam computed tomography (CBCT) scans and an implant insertion simulation using Simplant (Dentsply Sirona). In the implant treatment plan for this case, the sinus septum running in the mesiodistal direction created a considerable obstacle for inserting implants at the first and second premolars (septum height: 4.6 mm).* (c) *A Simplant image taken 6 months after the first surgery confirmed that the sinus septum was removed.* (d) *Pre- and postoperative coronal images at the second premolar site show the bone growth from the sinus septum to a portion of the inner wall* (yellow arrows: *maxillary sinus floor before surgery;* blue arrows: *maxillary sinus floor after surgery).* (e) *Findings at the time of the second surgery (maxillary sinus floor augmentation and simultaneous implant insertion). No bone healing was observed at the site used as a window during the first surgery; therefore, detachment using a partially layered flap was carried out exclusively at that site.* (f) *Radiographic and CBCT findings at the time of maintenance (10 years after treatment). The coronal radiograph and CBCT images of each implant obtained (sites 24, 25, and 26 [FDI system]) show progressed remodeling of the β-TCP.*

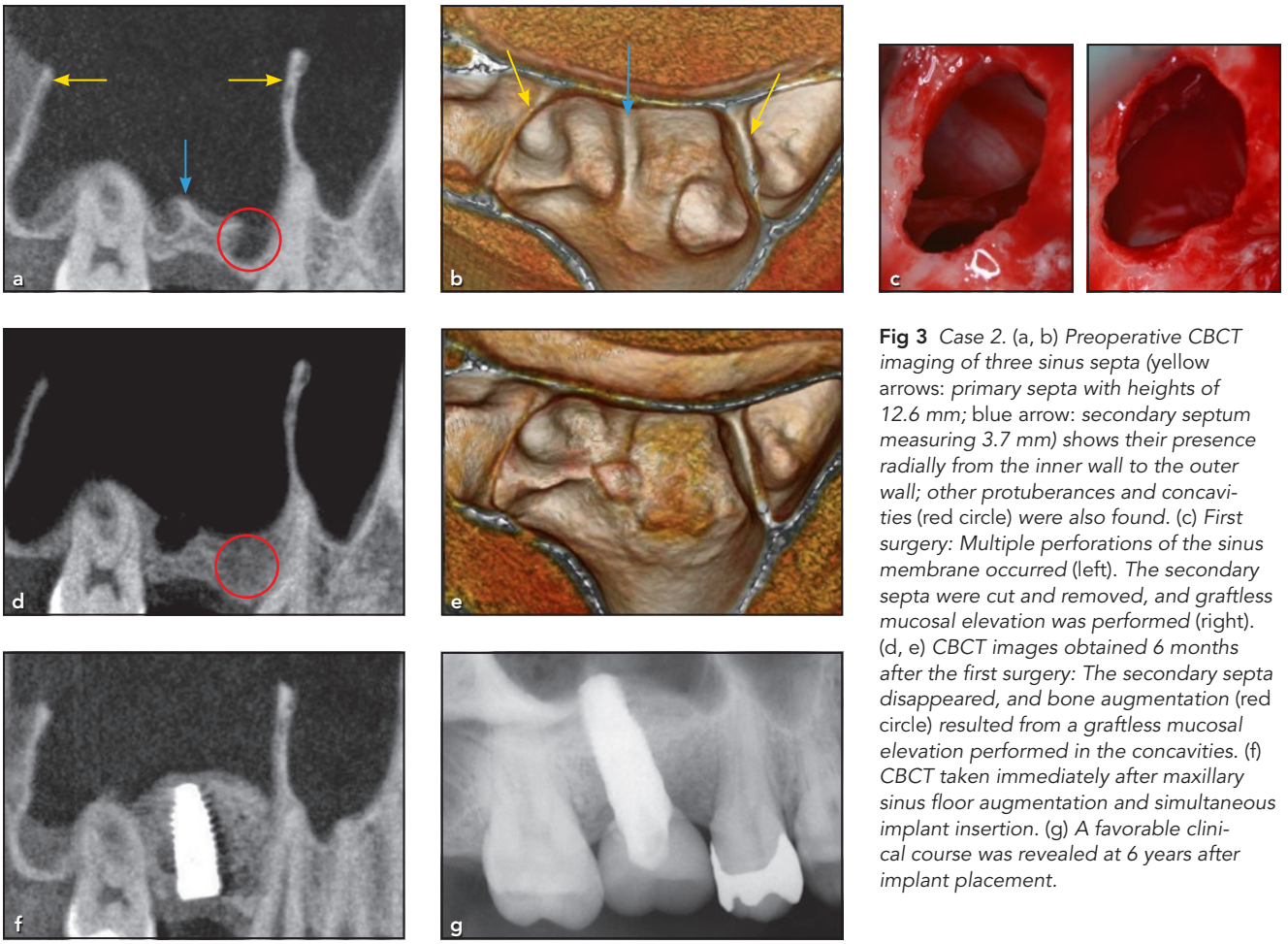

Fig 3 *Case 2.* (a, b) *Preoperative CBCT imaging of three sinus septa* (yellow arrows: *primary septa with heights of 12.6 mm;* blue arrow: *secondary septum measuring 3.7 mm) shows their presence radially from the inner wall to the outer wall; other protuberances and concavities* (red circle) *were also found.* (c) *First surgery: Multiple perforations of the sinus membrane occurred* (left). *The secondary septa were cut and removed, and graftless mucosal elevation was performed* (right). (d, e) *CBCT images obtained 6 months after the first surgery: The secondary septa disappeared, and bone augmentation* (red circle) *resulted from a graftless mucosal elevation performed in the concavities.* (f) *CBCT taken immediately after maxillary sinus floor augmentation and simultaneous implant insertion.* (g) *A favorable clinical course was revealed at 6 years after implant placement.*

discontinued. The secondary septa located at the planned implant insertion site were cut and removed, and graftless mucosal elevation was performed, focusing on the mesial concavity. Finally, the surgical wound was sutured.

Second Surgery

Six months later, CBCT imaging confirmed that the secondary septa had disappeared and that bone had developed in the concavities on the mesial side. MSFA and simultaneous implant insertion were performed using the XiVE implant system (4.5 × 11.0 mm; Dentsply Sirona) and OSferion β-TCP. In both cases, abutment connection surgery was performed 6 months after implant insertion.

Results

Simulation of implant insertion showed that the presence of septa and concavities would make implant insertion difficult. The sinus septa were then removed, and the sinus mucosa was slightly thicker because of scarring. Surgery was performed successfully and without complications, such as perforation of the sinus membrane. The implant survival rate was 100% in all seven cases.

Discussion

After sinus septa were first reported by Underwood in 1910,[18] studies on the incidence rate of septa presence have been carried out using various methods, including direct

observation of dried skulls or cadavers (Underwood[18]: 33.3%; Ulm et al[19]: 31.7%), clinical observation of cases during sinus lift procedures (Krennmair et al[20]: 27.7%), and radiographic observation using computed tomography (Kim et al[21]: 29.5%; Neugebauer et al[22]: 33.2%). The periphery of the septum is highly likely to cause mucosal perforation (odds ratio: 4.8).[9]

In the strategy reported here, perforated membranes were further elevated to expose the bone septa, which were then removed. No bone graft material was placed, eliminating concerns about the possibility of infection or graft material leakage. A systematic review and meta-analysis[23] of graft-free maxillary sinus floor elevation reported a 97.9% implant survival rate and 3.8-mm vertical bone gain with simultaneous insertion of an implant without bone grafting material, which has been reported to be a predictable method.[24] However, Ahn et al reported that there was almost no bone formation 6 months after maxillary sinus membrane elevation with collagen sponge[25]; this may be due to age, resorption of the collagen sponge, and intrasinus pressure that prevented securing of time and space sufficient for new bone formation. Bone regeneration in this patient was observed around the septa, possibly achieved by partial maintenance of the space; clots formed by blood from surrounding tissues and the septa themselves, may have functioned as a tent. Like the present cases, Dagba et al interrupted surgery on a case of sinus mucosal perforation and repaired the perforation with an absorptive membrane. Three to 6 weeks were allowed for mucosal healing before the second operation, which confirmed the thickened sinus membrane, and this technique was reported to be a safer surgical method.[26]

To summarize the benefits of the present two-step method, grinding of the septa and thickening of the maxillary sinus membrane lowers the likelihood of perforation of the maxillary sinus membrane during second surgery. This may be accompanied by bone regeneration of the graftless area, potentially simplifying the reoperation procedure and allowing simultaneous insertion of the implant.

Although the technique described here is advantageous for severely complex cases with septa, the surgical risk remains for secondary perforation of the thickened sinus membrane during the second stage of sinus augmentation. Performing the second elevation procedure within the thick scar tissue can reduce the risk of perforation. Gentle handling of the instruments is essential during every stage of the surgery.

Conclusions

The authors reported cases in which MSFA could not be performed because of an anatomically complex sinus septum causing a large perforation of the maxillary sinus membrane during surgery. Although such cases are extremely rare, the two-step procedure described herein is effective and provides options that enable safe performance of further MSFA reoperations.

Acknowledgments

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