Implant Placement Using Various Surgical Techniques: Case Report

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• Abstract

Implant placement is frequently complicated and challenging because of the poor quality and inadequate height of bone. Clinicians should consider various surgical procedures to overcome the problems. We report a case with various surgical procedures used such as inferior alveolar nerve repositioning, sinus bone graft, and autogenous block bone graft using the coronoid process and ramus to overcome severe vertical and horizontal alveolar bone atrophy.

• Key word : various surgical procedures, inferior alveolar nerve repositioning

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I. Introduction

Currently, implant placement is one of the most common procedures used in treating edentulous condition with proven high success rate. Its popularity notwithstanding, the procedure is often found to be infeasible in most clinical cases wherein patients show partial mandibular loss due to alveolar bone resorption and atrophy following tooth loss or diseases such as tumor or due to the presence of anatomical structures such as the maxillary sinus and inferior alveolar nerve canal. Other reasons for foregoing implant placement include various clinical conditions such as poor bone quality and insufficient vertical space between the damaged tooth and its antagonist, which prohibits prosthetic implant placement. In such cases, clinicians perform a wide range of surgical procedures to assess the patient's condition and to overcome the challenge via careful planning. They consider performing pre-procedure clinical tests, radiology tests, CT

examinations, diagnostic modeling, or other techniques to ensure treatment success. In this paper, we report a case along with literature review wherein a number of surgical procedures were performed in the course of implant placement and treatment to overcome multiple tooth loss as well as vertical and horizontal alveolar bone resorption.

II. Case Report

A healthy 20-year-old female patient visited our clinic in July 2005 requesting for implant restoration for multiple tooth loss. Our examination revealed that she was suffering from tooth loss (#12, 15, 22, 35, 36, 37, 44, 45, 46, 47) and over-retention of deciduous tooth (#65) as well as midface depression and mandibular prognathism. At the time of her visit, she was in the middle of corrective therapy that had been going on for 2 years. She refused orthognathic surgery and instead requested for implant restoration for the lost teeth. Thus, we carried out diagnostic model fabrication and orthopantomogram (OPG) and implant CT examinations. The clinical and radiological test results showed that the patient lacked a significant amount of remaining alveolar bone mass in the area spanning the edentulous space in the lower right first molar through the inferior alveolar canal. We also found that the width of her buccal alveolar ridge in the mandibular edentulous space on each side was less than 3mm, which was too narrow. As for the upper right second premolar area, residual alveolar bone up to the maxillary sinus floor was found to be less than 1mm high, which was practically nonexistent. We also found a depression in the labial bone in both upper lateral incisors as well as narrow buccal alveolar ridges (Fig. 1). We planned a treatment regimen that includes the following: maxillary sinus bone grafting and delayed implant placement (#15); autogenous block bone grafting and delayed implant placement (#12, 22); GBR and immediate implant placement (#35, 36, 37), and; inferior alveolar nerve repositioning and immediate implant placement (#45, 46, 47).

The procedures were performed in February 2006 under full anesthesia. Infiltration anesthesia was performed by applying 2% lidocaine (1:100,000 epinephrine) to the surgical areas. This was followed by crestal and releasing incisions in the upper right first premolar area, which were

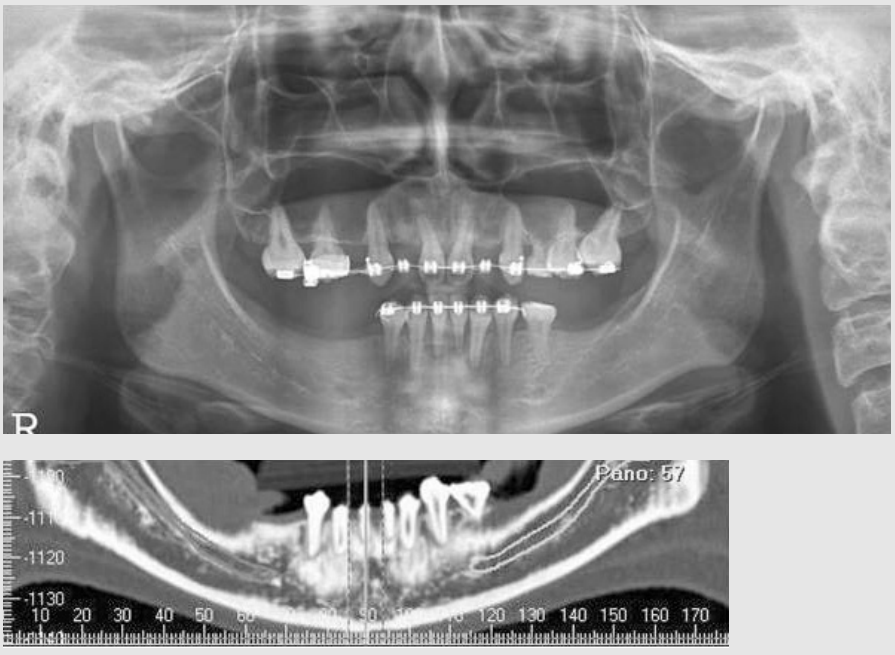

Fig. 1. Radiographic image at first visit.
A. Panoramic view.
B. CT imaging of Mandible - showing the poor crest height in the mandibular posterior sections.

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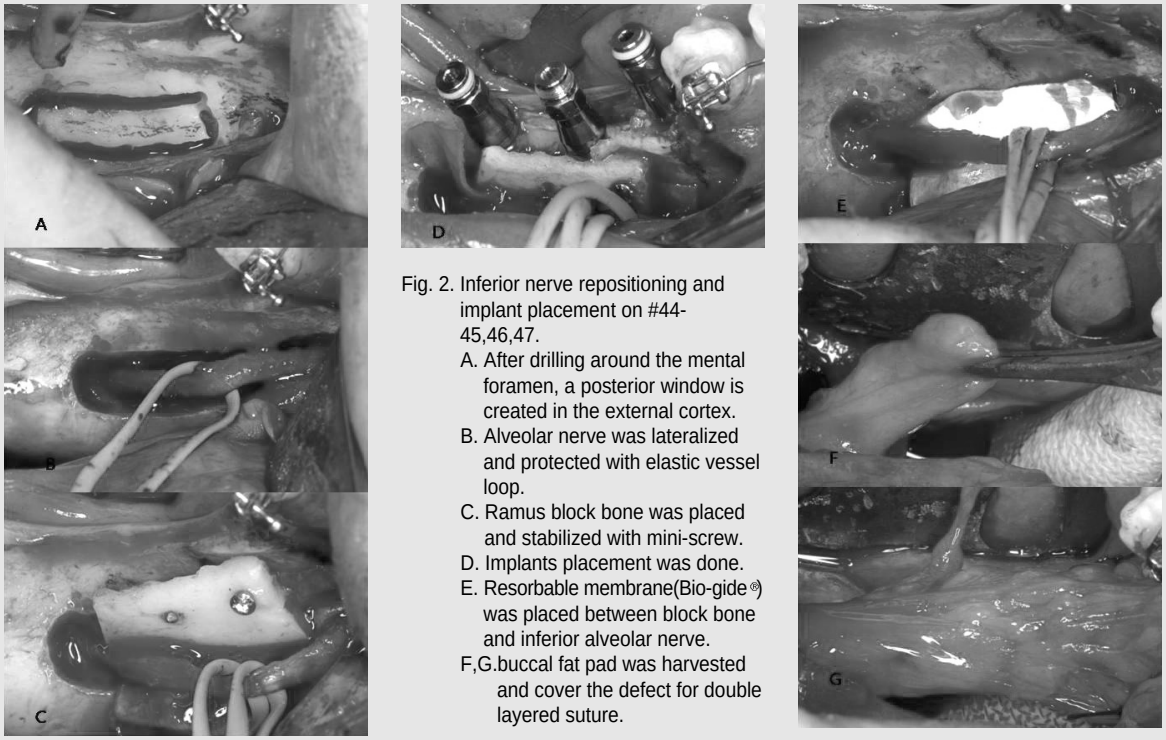

Fig. 2. Inferior nerve repositioning and implant placement on #44-45,46,47.
A. After drilling around the mental foramen, a posterior window is created in the external cortex.
B. Alveolar nerve was lateralized and protected with elastic vessel loop.
C. Ramus block bone was placed and stabilized with mini-screw.
D. Implants placement was done.
E. Resorbable membrane(Bio-gide®) was placed between block bone and inferior alveolar nerve.
F,G.buccal fat pad was harvested and cover the defect for double layered suture.

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made all the way to the retromolar area, and the full removal of the flap. Afterward, we harvested from the coronoid process and ascending ramus bone blocks that were subsequently wrapped in saline solution-soaked gauze and kept wet. Surgicel® (Ethicon, Auneau, France) was injected into the donor area to help stop the bleeding. Afterward, we lifted the flap to expose the hole and created a rectangular bone window 2.5 cm long and 5 mm high in the posterior site to remove it (Fig. 2-A). We went on to isolate the inferior alveolar nerve carefully, removed the bones surrounding the hole, separated the mental nerve, and performed lateral traction on the mental nerve as well as the inferior alveolar nerve in the posterior region using a nerve hook and an elastic loop (Fig. 2-B). With the surgical stent put in place, we carried out vertical marking in the buccal area of the implant placement site, aligned the bone blocks to the buccal alveolar bone, and fixed them firmly with two titanium screws (1.2D/10L) (Fig. 2-C). After conventional drilling, we placed three implants (Osstem US I, Korea) in the areas (#44-45, 46, 47) (Fig. 2-D), and then placed a Biogide® membrane (Osteohealth, Shirley, US) in between the bone blocks and the laterally transpositioned inferior alveolar nerve. This was followed by placing Orthoblast II® (IsoTis, Irvine, US) in the defect area near the implant and covering the anterior section with Ossix membrane® (OraPharma, Warminster, US) (Fig. 2-E). Afterward, we harvested the buccal fat pad for layer-by-layer suturing and sutured the wound in double layers (Fig. 2-F, G).

Next, we performed sulcular incision in the gingiva opening up from the upper right central incisor through the upper right first molar, and then lifted the entire buccal flap. Initially, we intended to perform sinus bone grafting (#15) by creating a circular bone window in the buccal area, removing the tissue, and lifting off an extremely thin layer of sinus mucosa. The attempt was not successful, however, resulting in tissue tear and full-bore opening onto the maxillary sinus (Fig. 3-A, B). Thus, we aligned the coronoid process block we harvested from the right onto the sinus floor (#15), and then fixed it firmly onto the crest with a small 10mm screw (Fig. 3-C). Afterward, we used the Loma Linda pouch technique to cover the large perforation in the sinus mucosa. We placed an Ossix membrane® in the upper area and closed the hole by applying Greenplast spray. We then covered the buccal bone window with an Ossix membrane® (Fig. 3-D). After that, remote palatal and crevicular incisions were made in

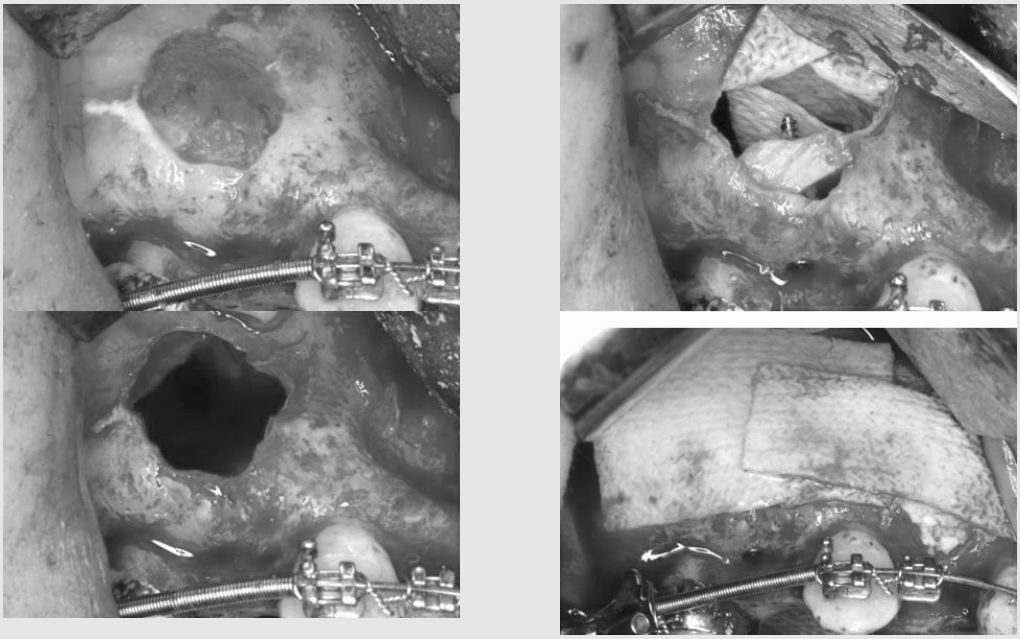

Fig. 3. Sinus membrane perforation and application of collagen membrane (Lomalinda pouch technique).
A. Lateral window was created and very thin membrane was observed.
B. Large perforation of the maxillary sinus membrane could be observed.
C. Resorbable membrane(Ossix membrane®) covered the internal sinus area and coronoid process block bone was stabilized with mini-screw.
D. Lateral window was covered with Ossix membrane®.

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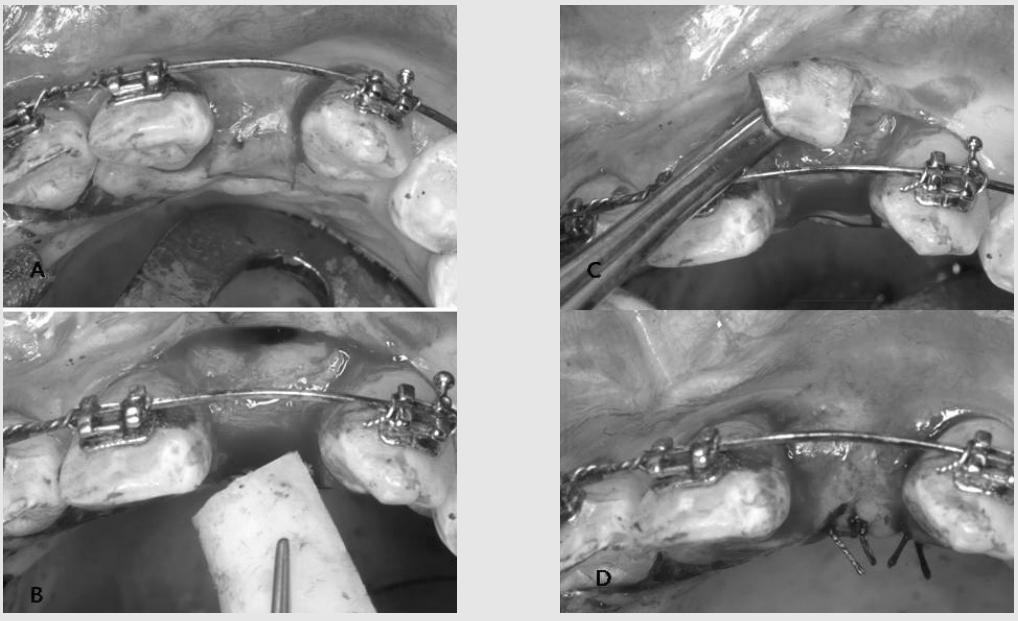

Fig. 4. Block bone graft on #22 area.
A.Remote palatal and crevicular incision was done.
B.Labial pouching was created.
C.Ramus block bone was placed.
D.Simple interrupted suture was done without tension.

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the upper left central incisor through the upper right first premolar, with the entire flap subsequently lifted. We placed in the labial depression (#12, 22) the lateral cortical bone we had removed during the inferior alveolar nerve repositioning as well as a chip of the coronoid process, added BioOss® (Osteohealth, Shirley, NY) in the area, covered the upper section with an Ossix membrane®, and completed the suture (Fig. 4).

What followed were crestal incision and releasing incision in the area beginning in the lower left second premolar and ending in the anterior border of the ascending ramus and full removal of the flap thereafter. We then harvested a bone block (10mm x 6mm) from the ascending ramus and wrapped the block in saline solution-soaked gauze and kept it wet. We went on to install a surgical stent and performed conventional drilling and tapping. A total of 3 implants (Osstem GS II, Korea) were placed in Nos. #35, 36, and 37. The buccal screw-thread of the #35 implant was exposed by about 3mm. We performed BioOss® grafting and covered the area with an Ossix membrane® (Fig. 5).

Following the procedures, the patient complained of lower-right-region ecchymosis and decreased sensitivity in her jaw and lips. After a month-long progress observation, we found that her lips fully recovered their sensitivity, but she continued to suffer a minor sensitivity abnormality in her right mandibular area. We allowed a 3-month healing period for the lower molar implants before carrying out secondary surgery and prosthetic treatment. Five months after the surgery, we placed implants (Osstem GS II) in Nos. 12 and 22, placed additional Biocera® (Oscotec, Seoul, Korea) to help maintain the labial volume, and inserted Permacol® (porcine acellular dermal collagen implant, Covidien, NY, US). We waited 5 months to allow healing before performing secondary operation and prosthetic therapy (Fig. 6).

Five months into post-surgical recovery, the patient complained of pressure in the right-hand side maxillary sinus, stuffiness in the right-hand side nostril, and minor pain on the right lateral side of her nose during palpation. Our diagnosis revealed acute inflammation of the maxillary sinus, and we accordingly put her on antibiotics, i.e., Augmentine® (500mg Amoxicillin and 125mg Clavulanate) for 5 days (Fig. 7). We delayed implant placement in No. 14 since corrective therapy for expanding the maxillary arch was still underway. Ten months after the surgery, we placed the implant (Osstem GS II) in the area (#14) and waited 7 months to allow healing before carrying out secondary operation and prosthetic treatment (Fig. 8).

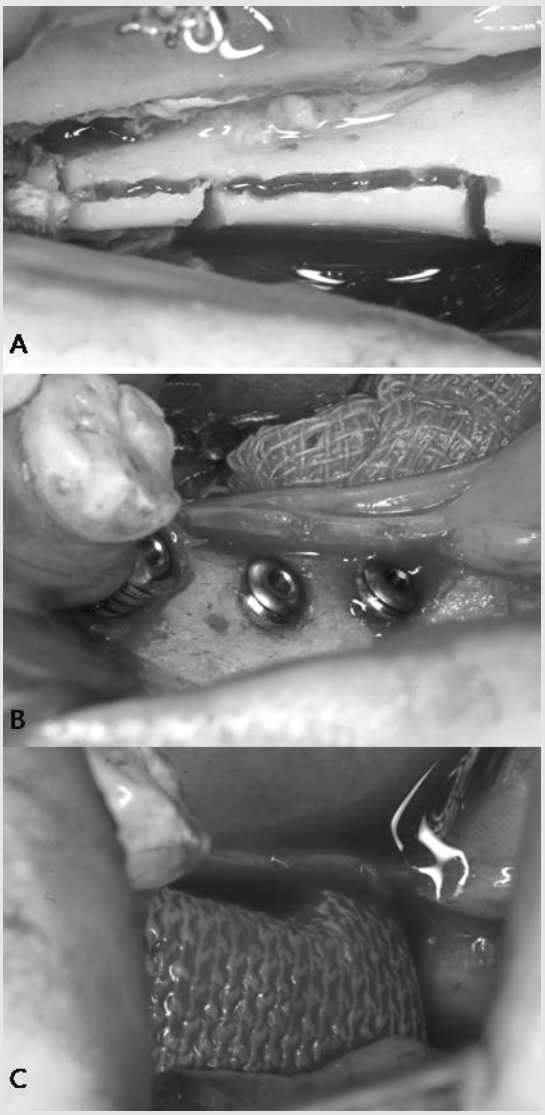

Fig. 5. Harvesting of Ramus Block bone and implant placement on #35,36,37.
A. Ramus block bone was harvested.
B. Implants were placed on #35,36,37 and thread was exposed.
C. Bone graft was done on exposed thread and covered with resorbable membrane. (Ossix membrane®)

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Upon completion of the upper-section prosthetic treatment, we performed maintenance work every 3 months. After 10 months, we observed in both lower molars marginal bone resorption and peri-implantitis. Thus, we performed curettage in the areas using laser (KEY Laser, KaVo, Biberach, Germany), rinsed them with chlorhexidine (CHG), injected Minocline dental ointment, and observed the progress. Pain and resorption continued in Implant No. 44, whereas resorption in other areas had ceased progressing (Fig. 9).

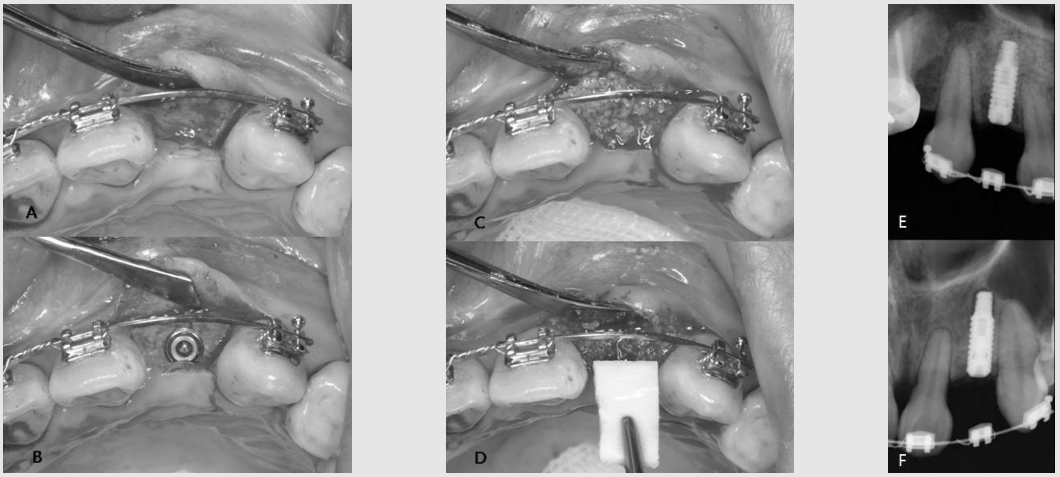

Fig. 6. Implant placement on #12,22.
A. Limited incision was done on #22 site.
B. Implant was placed on #22.
C. Bone graft with Biocera® was done for maintaining buccal volume.
D. Insertion of Permacol®.
E,F. Post operative periapical view.

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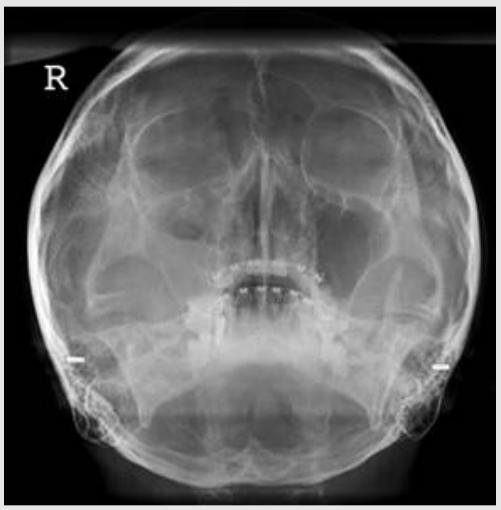

Fig. 7. Acute maxillary sinusitis on right.(Post OP 5 month)

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After 20 months, the implant (#44) was removed, and bone grafting was performed. Afterward, we waited 3 months to allow healing before performing re-placement and prosthetic therapy (Fig. 10). Other areas showed no particular adverse symptoms, continuing to function stably (Fig. 11).

III. Discussion

Vertical or horizontal alveolar bone atrophy of an edentulous space is a challenge that must be overcome to ensure successful implant placement. One solution to the atrophy problem is bone grafting performed prior to or during implant placement along which various procedures. Normally, horizontal augmentation using guided bone regeneration (GBR), horizontal veneer or onlay bone-block grafting, or alveolar ridge splitting is performed for horizontal alveolar bone atrophy. As for correcting vertical alveolar bone atrophy, procedures such as sinus bone grafting, bone grafting, supraplant, inferior alveolar nerve repositioning, and alveolar distraction could be performed.

In this case report, large perforation in the sinus mucosa occurred while maxillary sinus floor elevation was being performed. Perforation is one of the most common complications that occur during the procedure, with its morbidity rate ranging from 14 to 56% depending on the literature reviewed[1,2]. Sinus mucosa perforation is strongly associated with complications such as post-surgical infection, but its correlation with implant survival is reportedly low[3]. If the perforation has diameter of more

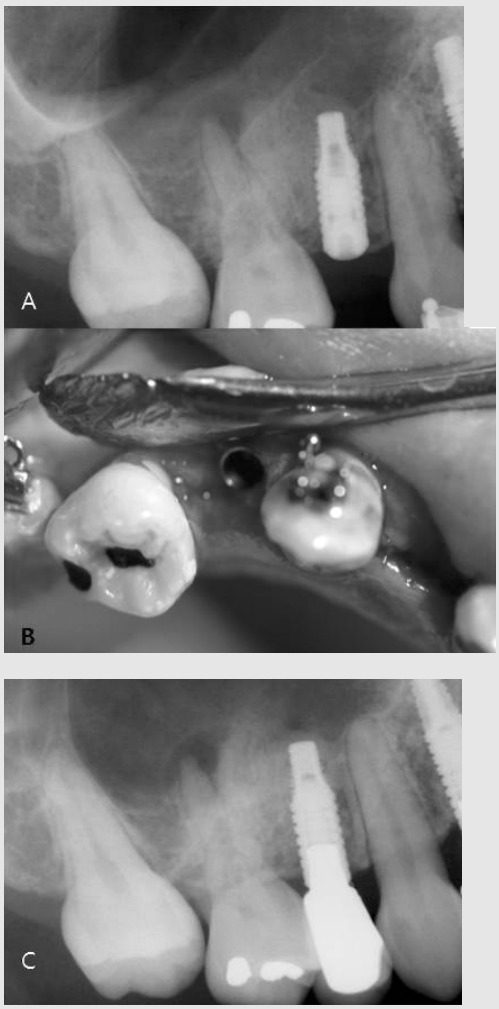

Fig. 8. #14 implant installation.
A. Periapical taking after implant installation.
B. Intraoral view on surgery.
C. Periapical view after prosthesis.

Fig. 9. Peri implantitis on both mandibular posterior implant prosthesis. (Panorama and periapical view)

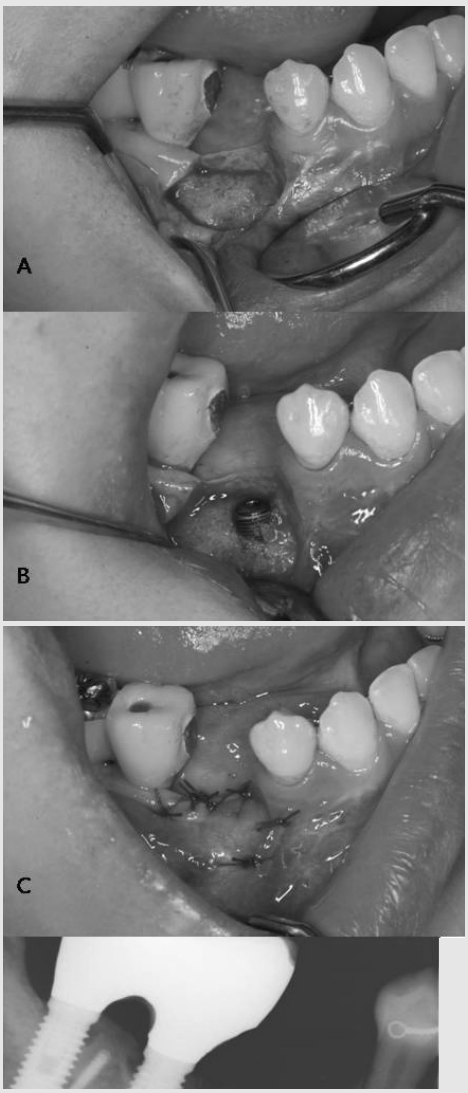

Fig. 10. Implant re-installation on #44.
A-C. Intraoral view on #44 area. Implant placement was done. (Osstem GS III, Korea)
D. Periapical view - Post OP 1 week.

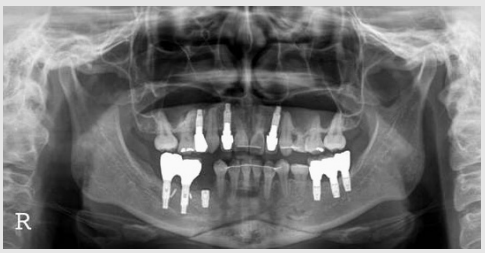

Fig. 11. Post operative panoramic radiography.(17month later)
Genioplasty was performed in this patient for cosmetic correction of chin protrusion.

than 5mm, the clinician should discontinue the surgery and resume only after a period of healing. Nonetheless, the surgeon may perform an alternative, such as autogenous tissue (buccal fat pad) grafting and bone grafting involving completely covering the perforated area in the maxillary mucosa with a barrier membrane. Kim, et al[13] reported a successful perforation correction case wherein the large perforation occurring during maxillary sinus floor elevation was covered with buccal fat pad and implant placement was carried out at the same time. The Loma Linda pouch technique used in this case report was introduced first in 2003. The technique involves surgeons inserting an absorption collagen membrane through the lateral window when large perforation occurs in the maxillary sinus mucosa. The perforated area and the sinus wall are then completely covered, and bone grafting is performed[4]. The strengths of the Loma Linda pouch technique include easy isolation and protection of the implant and minimum risk of the collagen membrane collapsing into the perforated area. The separated maxillary sinus bone wall could delay the bone's healing, however. Thus, we consider conducting a histological evaluation of the newly grown bone in the maxillary sinus following surgery to be necessary.

In our case, we only transplanted autogenous bone blocks in the large perforation that had occurred during maxillary sinus floor elevation, and then fixed them with screws and used the Loma Linda pouch technique to prevent foreign matter from entering into the maxillary sinus. Using autogenous grafts in sinus bone grafting helps blood vessels regenerate faster and allows instantaneous post-surgical Phase I bone formation as well. In such large perforation as the one reported in this case in particular, autogenous grafting can allow bone blocks to close off the damaged area and help increase the stability of bone grafts via screw-bolting. Five months after the surgery, we found acute inflammation of the maxillary sinus on the right-hand side maxillary sinus. Antibiotics were administered for 5 days, with the progress monitored. In most cases, maxillary sinus inflammation is treatable without serious complications if diagnosed early and treated properly. The implants we had placed in the upper molars were functioning successfully, with no adverse symptoms observed.

In the case of severe mandibular alveolar bone atrophy, clinicians may consider vertical augmentation via onlay grafting, segmental osteotomy, or interpositional bone grafting or alveolar distraction. However, these techniques have weaknesses such as the need for bone grafts and auxiliary devices, bone graft resorption, and extended periods of healing. In contrast, the inferior alveolar nerve repositioning we used in this case was found to secure early-phase stability effectively without bone grafting. Used in the case wherein alveolar atrophy is severe and the distance is not enough to perform bone grafting, the repositioning procedure allows lateral traction of the inferior alveolar nerve and the placement of a sufficiently long implant. The technique is also helpful in reducing resorption of the grafted bone and lowering the likelihood of failure due to infection or other factors. Still, it is not without risks (nerve damage, severe hemorrhage during surgery due to inferior alveolar blood vessel damage, and other complications). Friberg, et al[5] monitored 10 patients over a period of 7 months, during which 30% of the patients complained of deteriorated sensitivity and paralysis. Other researchers reported that following implant placement using nerve repositioning, a 93.8% success rate was recorded in the follow-up that lasted 41.3 months as the median. A 33.3% nerve damage was reported for the procedure wherein a window was created in the posterior section of the mental foramen; it was 77.8% for the technique that used osteotomy on bone blocks including the mental foramen[6]. In contrast, 21.1% of the 15 patients exhibited nerve damage-related symptoms after the repositioning of 19 nerves and implant placement, but the patients in question recovered almost fully within 1 ~ 6 months, with only 1 patient showing permanently deteriorated sensitivity[7].

The inferior alveolar nerve develops functional abnormality resulting from damage to the surrounding blood vessels when extended by more than 5% of its original length. Thus, it is crucial for surgeons to avoid excessive traction while performing the procedure. Performing inferior alveolar nerve repositioning and implant placement simultaneously will increase the success rate. Note, however, that deteriorated nerve sensitivity is an unavoidable adverse effect that is observed in most cases after the surgery, though not without some individual differences. Thus, it is imperative that sufficient explanation be offered to the patient before he or she signs a written consent. In case of sensitivity impairment, physical therapy and other conservative therapy regimen (e.g., Vitamin B and steroids administration, capsaicin application, hot pack, massage, ultrasonic therapy, EAST) will need to be implemented aggressively. In this case report, the patient complained of

deteriorated sensitivity as well as abnormal sensory response in her lips and right mandibular area right after the surgery. The symptoms in the lips were eliminated 1 month after the surgery; the abnormal symptoms in the right mandibular area persisted, but they were no longer serious. The patient did not complain of other sensory deteriorations thereafter throughout the monitoring period.

Surgeons could consider horizontal veneer onlay bone grafting in cases wherein the patient undergoing implant placement exhibits horizontal alveolar atrophy due to excessive alveolar resorption or aesthetic problems are expected following placement. Onlay grafting uses bone blocks harvested from the mandible to augment the width of the maxillary anterior portion; it is recognized to be quite an effective technique. Using autogenous bone block grafts harvested from the central incisors or the ascending ramus could accelerate -- as reported in some studies -- the re-formation of blood vessels and ensure a relatively low level of resorption[8,9]. In this study, we did not use a buffer membrane because we utilized bone blocks. Regarding the use of a buffer membrane, studies report contradicting findings: on the one hand, the membrane could prevent resorption, and using it can consequently be beneficial; on the other hand, the use of the membrane is unnecessary because bone grafts harvested from the mandible exhibit a lower level of resorption[10].

During bone block grafting, ensuring firm bonding is also crucial. This can be realized by refining the harvested bone graft, aligning the outer-lateral portion of the graft to the residual alveolar bone with precision, and firmly fixing them together with titanium screws (diameter of 1mm ~ 1.6 mm). In a case such as ours wherein the damaged area in the maxilla is small, surgeons could lift a minimum amount of flap, create a pouch in the labial section, and insert the harvested bone blocks therein to avoid additional procedures for fixing the grafts. We consider bone-block grafting to be highly effective in complementing the amount of bone loss in the horizontal edentulous space only if the clinician pays full attention to the precise location of the graft, stable bonding, and minimum trauma to the surgery site and carries out thorough post-operative care.

We selected the mandibular ramus and the coronoid process as the donor areas of the autogenous bone grafts. Compared to harvesting from the central mental portion, harvesting from the ramus is not without disadvantages, e.g., thinner cortical bone, poorer field of vision, and likelihood of damaging the inferior alveolar nerve. Nevertheless, the ramus approach offers a number of advantages including very little wound dehiscence in the donor area after surgery, lower likelihood of swelling and bleeding following the procedure, and very slim chance of causing sensory impairment in the surrounding teeth. Many studies reported that selecting the mandibular ramus led to fewer incidences of complications compared to opting for the mental portion[11,12]. On the other hand, selecting the coronoid process allows surgeons to harvest a large quantity of bone grafts; it is less likely to cause nerve damage or complications involving the donor area as well. Nonetheless, this approach makes it difficult for surgeons to operate under local anesthesia and poses a risk of causing post-surgical symptoms in the temporomandibular joint (TMJ) because of the temporary change occurring in the temporalis muscle during dissection and bone harvesting. Thus, prior to the surgery, clinicians must check the patient's medical history for any TMJ-related condition. Without particular TMJ history, post-operative TMJ symptoms may be alleviated with conservative therapy or even without any therapeutic intervention. In our case, we noticed a transient mouth-opening limitation in the patient after the procedure, but the symptom was successfully treated with conservative regimen such as training the patient to do home exercises.

Peri-implantitis can be attributed to many factors such as poor oral hygiene, history of periodontitis, smoking, diabetes, overload, thickness of the surrounding mucosa, width and diameter of the attached gingiva, and surface treatment of the implants. If the surrounding area of the implants shows excessive plaque and tartar, discharge, and probing depth (PD) of less than 3mm, the condition may be effectively contained with mechanical treatment only using carbon fiber curette and rubber cup. If PD is 4 ~ 5mm, and probing results in bleeding, however, mechanical treatment as well as sterilization should be carried out at the same time using chlorhexidine (CHG) solution (0.1%, 0.12%, 0.2%) or gel. If PD is greater than 6mm, all three of the mechanical, sterilization, and antibiotic treatments should be performed. A sufficient level of concentration must be maintained for the antibiotics to let them penetrate the subgingival biofilm for 7 ~ 10 days. The most effective method for sterilizing the surface of implants has yet to be identified, although popular suggestions include air polisher, citric acid, and CHG. In addition, CO2 laser, Er:Yag laser, and various other lasers are being used clinically, and cases are being

reported. Their efficacy remains controversial, however[14]. In this case report, we observed continued bone loss in both the lower molars as well as excessive gingival atrophy, which led to more than 50% bone loss in the fixture around Implant No. 44 with thinner mucosa and smaller attached gingiva. Thus, we performed curettage, CHG-based chemical sterilization, and KEY laser-based rinsing of implant surface and administered localized antibiotics such as monocline for a total of 2 treatment cycles, with each cycle 4 months apart from the other. The treatment helped curb bone loss in areas other than Implant No. 44. The patient continued to complain of pain around the implant in question. Thus, we removed the fixture, performed GBR, and carried out re-placement after 3 months. Although there are ongoing discussions as to the association between the width of the attached gingiva and peri-implantitis, we consider the presence of the attached gingiva to be of tremendous help in maintaining the implant on a longer-term basis since the gingiva could help enhance the convenience of oral hygiene maintenance and the protection against detrimental external stimuli.

IV. Conclusions

In this paper, we reported a challenging case wherein the conventional implant protocol was found to be ineffective due to alveolar resorption and atrophy. We implemented various surgical procedures and successfully ensured implant placement and prosthetic restoration, the results of which were relatively satisfactory. Although vertical or horizontal alveolar atrophy remains a big risk in implant placement, surgeons can still guarantee satisfactory outcomes if they have accurate understanding of the strengths and weaknesses of various surgical techniques, implant adjustment, matters requiring caution during surgery, and related complications and response measures and if they establish a detailed, thorough treatment plan.

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