Vol. 13 No. 1, November 2021
The Journal of Korean Academy of Osseointegration 2021, 13(1) 16-22

Alveolar ridge augmentation using simultaneous sinus bone graft and ramal block bone graft on a severely atrophied posterior maxilla: a case report

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Insufficient vertical and horizontal alveolar bone is found frequently in the posterior maxilla, resulting from bone resorption and pneumatization of the maxillary sinus after the loss of teeth. Although maxillary sinus bone grafting alone can provide adequate bone height and width for implant placement, it can lead to an unfavorable dental prosthesis biomechanically and esthetically due to the greater crown-implant ratio. In the present case, a 59-year-old female patient received alveolar ridge augmentation using guided bone regeneration with ramal block bone graft and sinus bone graft to overcome a severely atrophied alveolar ridge. During the postoperative period, grafted bone was exposed partially with signs and symptoms of infection. However, it could be treated conservatively with curettage of infected bone only. Three implants were placed approximately 10 months after bone grafting without any significant complications. This case report suggests that simultaneous sinus bone graft and ramal block bone graft can be a feasible treatment option to overcome severely insufficient height and width of the alveolar bone. **(THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2021;13(1):16-22)**

Key words: Alveolar ridge augmentation, Block bone graft, Sinus bone graft, Dental implant

INTRODUCTION

Insufficient vertical and horizontal residual alveolar bone is one of the contributing factors that makes it difficult to place dental implants in the maxillary posterior region. After the loss of posterior maxillary teeth, alveolar bone resorption usually occurs in bucco-palatal and vertical apical directions, resulting in an atrophied alveolar ridge with narrow width and reduced height[1]. In addition, pneumatization of the maxillary sinus results in downward displacement of the maxillary sinus floor[2]. In the study by Kim et al.[3], implants placed in the posterior maxilla exhibited the lowest success rate due to the large amount of cancellous bone and maxillary pneumatization resulting in the lack of proper alveolar bone height. Since an implant located within the alveolar bone has to resist occlusal forces, a sufficient quantity and quality of supporting bone around the implant are required for long-term success[4,5].

After the first attempt to place a dental implant with sinus floor elevation in the mid-1970s, several surgical methods have been developed to reconstruct the alveolar bone in the posterior maxilla to be favorable for implant placement, including maxillary sinus bone grafting with sinus floor elevation, autogenous block bone grafting, distraction osteogenesis, guided bone regeneration (GBR), the ridge splitting technique, and the subperiosteal tunnel technique[6-8]. In determining the surgical method for reconstruction of maxillary posterior alveolar bone, the residual height and width of alveolar bone and the degree of pneumatization of the maxillary sinus usually are considered. However, when the residual alveolar bone is severely insufficient, two or more methods should be performed simultaneously or in stages to obtain sufficient bone volume.

Vertical ridge augmentation is one of the most difficult and complicated bone augmentation procedures, with a relatively high complication rate, even though it is often required to reconstruct severely atrophied alveolar ridges[9-11]. When vertical ridge augmentation is combined with other additional bone augmentation techniques, the surgical difficulty and complication rate can increase. The aim of this case report is to describe a patient with a severe atrophied alveolar ridge in the posterior maxilla who received implant treatment after simultaneous maxillary sinus bone grafting with sinus floor elevation and autogenous onlay block bone graft for vertical ridge augmentation.

Received September 26, 2021, **Revised** October 26, 2021, **Accepted** October 27, 2021

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CASE REPORT

A 59-year-old female patient with a chief complaint of mobility of the fixed dental prosthesis in the posterior maxilla visited the Department of Oral and Maxillofacial Surgery at Seoul National University Dental Hospital. The prosthesis was supported by the left upper first premolar, implant at the left upper second premolar, and left upper second molar (Figure 1). In the clinical and radiographic examinations, the prosthesis exhibited mobility greater than 2 degrees, and severe alveolar bone loss around the supporting teeth and implant of the prosthesis was observed. Except for drug allergies to aceclofenac and amoxicilline, there were no specific underlying diseases. In the treatment planning stage, the patient preferred to establish a plan for dental rehabilitation after extractions of the diseased teeth and implant. Therefore, surgical extractions of the supporting teeth and removal of the implant were performed under local anesthesia. Treatment planning for dental rehabilitation was established 3 months after extractions of the teeth and removal of the implant. In the radiographic examination with a panoramic view and cone-beam computed tomography, a severe alveolar bone defect was observed, with the remaining alveolar bone height ranging from 1.5 mm to 2.5 mm in the edentulous area (Figure 2). Placement of three dental implants after simultaneous maxillary sinus floor elevation, sinus bone grafting, and ramal block bone grafting was planned.

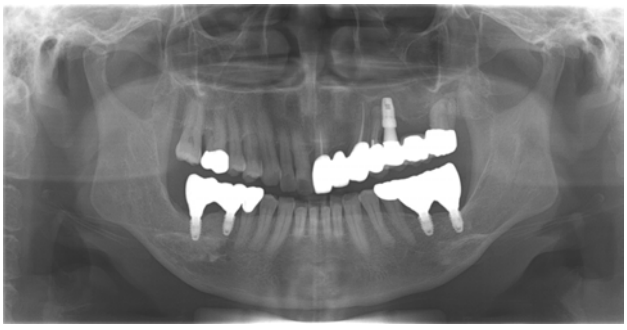

Figure 1. Panoramic radiograph at initial examination.

Surgery for alveolar ridge augmentation and sinus bone grafting with maxillary sinus floor elevation was performed under general anesthesia (Figure 3). A vertical incision was created at the area distal to the left maxillary canine. Through the vertical incision, subperiosteal pocket formation was performed before the crestal incision to increase the space for the volume of the grafted bone. After elevation of a full mucoperiosteal flap, maxillary sinus floor elevation and sinus bone grafting using 1.7 cc of allogenic bone (Sure-oss, Hansbiomed, Daejun, Korea) were conducted through the lateral approach. Conventional harvesting of mandibular ramal block bone was performed at the size of 20 mm (length) × 10 mm (width) × 4 mm (height). Harvested ramal block bone was then grafted on the alveolar bone vertically and stabilized using three micro-screws 1.2 mm in diameter and 8 mm in length (Leforte, Jeil-medical, Seoul, Korea). To fill the space between the block bone and the underlying alveolar bone and achieve ridge augmentation with greater volume, further GBR was performed using 1.7 cc of allogenic bone (Sure-Oss, Hansbiomed, Daejun, Korea) and bio-gide (Geistrich Pharma AG, Wolhusen, Switzerland). Primary closure of the grafted area was carried out through releasing incisions.

At the follow-up visit 4 weeks after surgery, wound dehiscence with partial exposure of the grafted bone at the distal region of the recipient site was observed (Figure 4). Patients were recommended to rinse with chlorhexidine digluconate 0.12% and maintain appropriate oral hygiene. Eight weeks after bone grafting, the patient exhibited signs and symptoms of infection

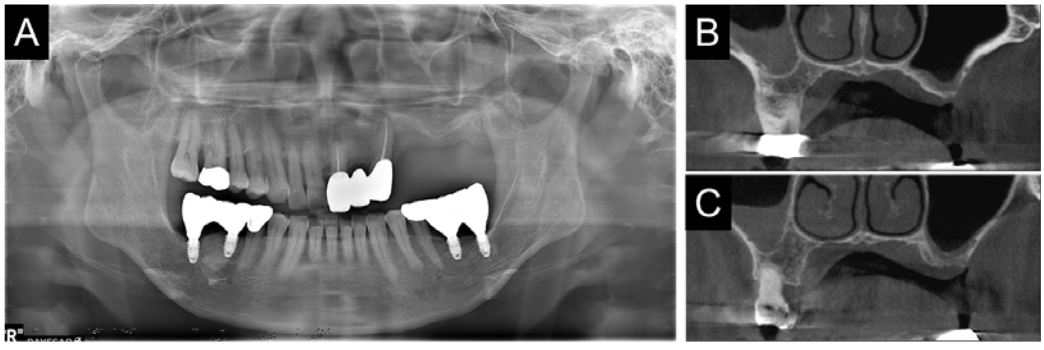

Figure 2. Radiographic examination before bone grafting for implant placement. (A) Panoramic radiograph after extraction of teeth (#24 and #27) and removal of implant (#25); (B, C) Reconstructed coronal view of cone-beam computed tomography at the posterior maxilla (#25~26 area).

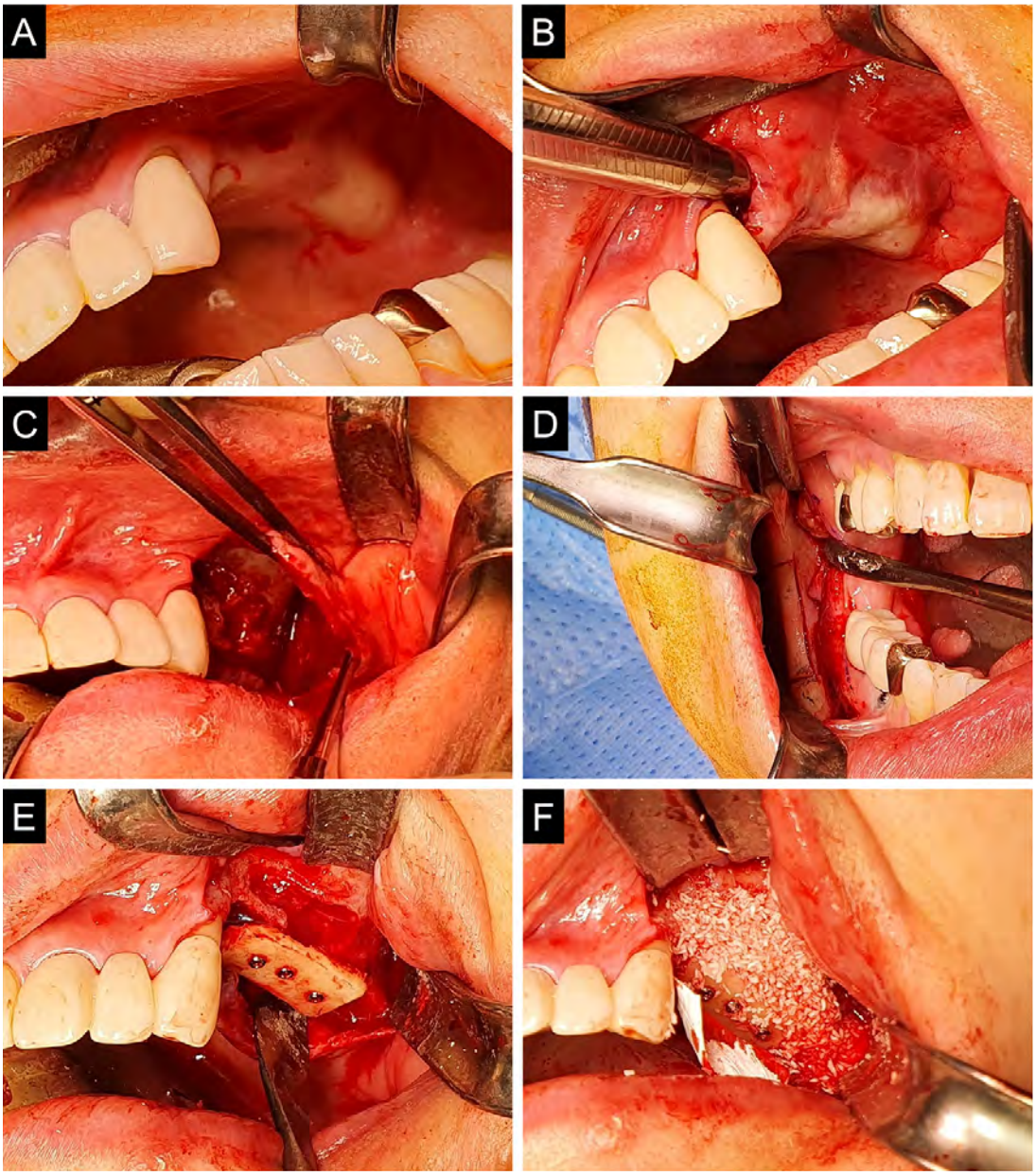

Figure 3. Intraoperative clinical photographs. (A) Initial intraoral photograph; (B) Subperiosteal tissue expansion; (C) Sinus floor elevation using the lateral approach and bone grafting; (D) Harvesting of the block bone from the mandibular ramus; (E) Stabilization of the ramal block bone; (F) Guided bone regeneration.

at the exposed bone and underwent the removal of screws for stabilization of the block bone and curettage of the infected particulated bone and inflamed soft tissue under local anesthesia. Postoperative medication was prescribed as follows: cefaclor 250 mg three times per day for 7 days and ibuprofen/arginine 200/185 mg three times per day for 7 days. Even though there were no signs of infection with decreased bony exposure 5 months after grafting, trimming of non-vitalized cortical bone was performed due to a sustained wound dehiscence, allowing for the exposed site to be completely re-epithelized. After 10 months of bone grafting, complete mucosal healing was observed without any significant complications, and the placement of three dental implants (Luna, Shinhung, Seoul, Korea) on #24 (4.5 × 11.5 mm), #25 (4.5 × 10.0 mm), and #26 (4.5 × 10.0 mm) (Diameter × Length) was performed under local anesthesia (Figure 5). There were no specific unusual complications until 3 months after implant placement.

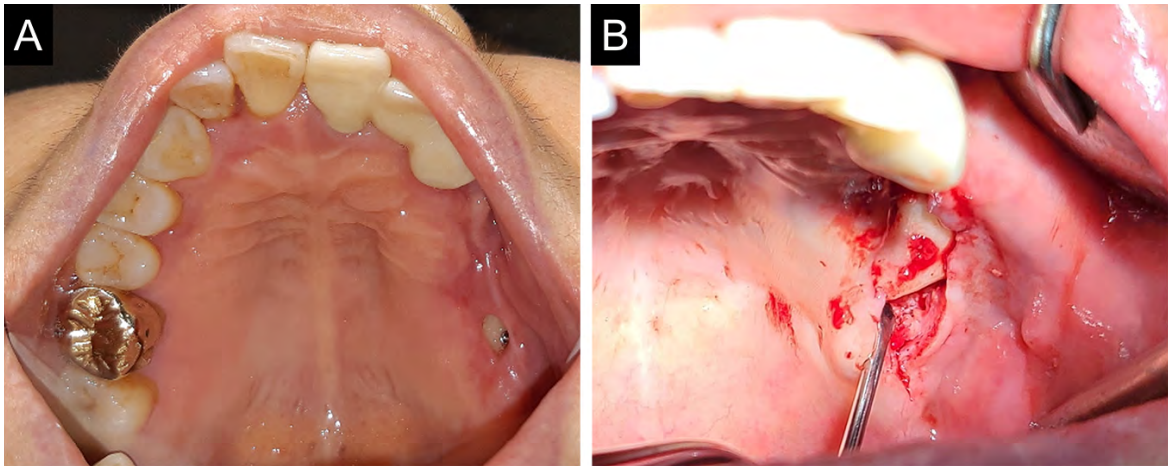

Figure 4. Management of the exposed graft bone. (A) Exposure of the grafted bone 4 weeks after bone grafting; (B) Curettage of the infected particulated bone and inflamed soft tissue 8 weeks after bone grafting.

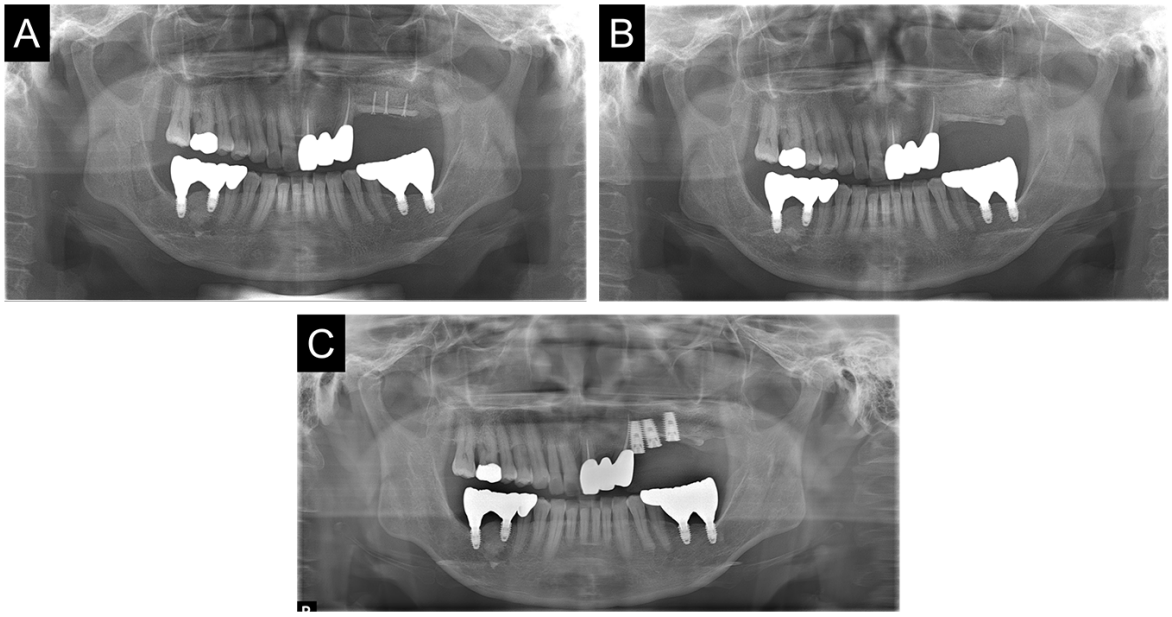

Figure 5. Panoramic radiographs after bone grafting. (A) Immediately after bone grafting; (B) After removal of the stabilization screws and curettage of the infected bone; (C) After implant installation.

DISCUSSION

Sufficient height and width of the residual alveolar ridge are essential to achieve optimal placement and stability of dental implants[11]. To increase the available alveolar bone in atrophic posterior maxilla, sinus bone grafting techniques and alveolar ridge augmentations are used frequently. Sinus bone grafting after maxillary sinus floor elevation through a lateral or crestal approach is a well-established and predictable surgical procedure with clinically successful outcomes. However, for patients with insufficient vertical height of the maxillary alveolar ridge, increase of available bone height using only sinus bone grafting can lead to unfavorable prosthetic results biomechanically and esthetically with improper crown-implant ratios[9]. In contrast, vertical ridge augmentation can provide a favorable crown-implant ratio with increased height of the alveolar ridge and enables the esthetic placement of prostheses. However, when insufficient residual alveolar bone height is mainly due to a severely pneumatized maxillary sinus, it is difficult to achieve sufficient residual alveolar bone required for optimal implant

placement only with vertical ridge augmentation, and maxillary sinus bone grafting is necessary.

For alveolar ridge augmentation, the GBR technique using particulate bone substitutes and barrier membranes has been successfully performed for several decades, especially for widening the width of the alveolar bone[12]. Though the GBR technique using particulate bone substitutes is considered suitable when the defect is small, it can be challenging when the defect is large or for vertical bone augmentation because the particulate bone substitutes do not provide three-dimensional stability[13,14]. In addition, the use of a reinforced non-resorbable membrane or titanium mesh can increase the potential success of GBR for large defects or vertical augmentations, however, the use of these barriers has been reported to increase the required bone healing time and risk of dehiscence[8,15].

Block bone grafting has been used as another bone grafting method for large alveolar bone defects. Although various block bones, such as autogenous block bones, allogenic block bones, or xenogenous bone blocks, have been used, several investigators have proposed autogenous bone blocks as the gold standard for bone grafting due to its osteogenetic, osteoinductive, and osteoconductive properties[16-18]. Autogenous block bones can be harvested from iliac bone, ribs, the skull, clavicles, or the mandible. Among them, mandibular ramal bone is one of the most commonly used donor sites in alveolar ridge augmentations for implant placement due to its decreased morbidity and invasiveness[19]. Though several possible complications, such as inferior alveolar nerve injury and dental root injury, can occur, the surgical procedure for harvesting ramal bone is relatively easy compared to that for other donor sites with lower complications rates. In addition, this harvesting does not affect the facial morphology. With respect to postoperative bone resorption, it has been reported that membranous bone such as the mandible exhibits lower resorption compared to endochondral bone such as the iliac bone[20,21].

In this case report, the patient with a severely atrophied posterior maxilla successfully received the placement of multiple dental implants after simultaneous sinus bone grafting through the lateral approach and vertical alveolar ridge augmentation using a mandibular ramal block bone graft. Several investigators reported that simultaneous sinus bone grafting and vertical alveolar ridge augmentation exhibits several difficulties in the surgical procedures, which could be one of the factors that causes failure of the implant and graft[9,10]. Block bone in large volumes can make primary closure difficult, and the failure of tension-free primary closure through releasing incisions creates postoperative wound dehiscence, which can lead to graft failure. In addition, since the bone graft material is placed on either side of thin alveolar bone, delayed healing or partial necrosis of the grafted bone can occur due to poor blood supply. In this case report, wound dehiscence was observed at the distal region of the recipient site 4 weeks postoperatively, and the patient exhibited signs of infection 8 weeks after grafting.

Exposure of the grafted bone is one of the most common complications after bone grafting, and it can result in complete loss of the graft. In a recent systematic review by Sanchez-Labrador et al.[22], the calculated overall dehiscence rate was 12.8% for the xenogenic block bone graft group and 9.8% for the autogenous block bone graft group. However, exposure of the bone can be successfully treated by several conservative methods, including the application of chlorhexidine solution or removal of the necrotic part of the grafted bone[23]. Removal of the exposed region in the grafted bone can be repeated multiple times based on the extent of the exposed bone[24]. Penarrocha-Diago et al. reported that, although eight grafts exhibited dehiscence postoperatively, five showed re-epithelialization after application of chlorhexidine mouth rinse. In the study by Sanchez-Labrador et al.[22], the failure rate of block bone grafts was 6.1% for autogenous bone and 6.8% for xenogenic bone which was lower than the overall dehiscence rate.

For determination of successful management of exposed bone, the amount of time of bone exposure has been regarded as the most important factor for treatment[24]. Barone and Covani[7] reported 4 exposures of 129 grafted bone sites for maxillary ridge augmentation, which consisted of 3 early exposures and 1 late exposure. In their study, all the early exposed block bone was removed completely, whereas the grafted bone with late exposure was successfully treated with fixation screw removal. In the study by Proussaefs et al.[25], 2 patients with bone exposure at 3 months after grafting did not exhibit any clinical or histological necrotic changes, while 1 patient with bone exposure at 2 weeks after grafting showed necrosis of the grafted bone. In the present report, wound dehiscence was found 4 weeks after grafting, and the patient exhibited signs and symptoms of infection 8 weeks after grafting. Although exposure of the grafted bone occurred at a relatively early stage, it could be

treated with minimal surgical intervention and conservative treatment including oral hygiene management and antibacterial mouth rinses. This might be because the infection was limited to particulate bone grafting posterior to the block bone. In addition, given that revascularization begins in the first week after bone grafting and lasts until 6–8 weeks[26], the grafted block bone might have already revascularized or was in the process of revascularization.

CONCLUSION

This case report suggests that simultaneous sinus bone grafting and ramal block bone grafting can be a feasible treatment option to overcome severely insufficient height and width of alveolar bone. Although exposure of the grafted bone can occur postoperatively, it can be treated conservatively with curettage of infected bone only when the exposed site is limited and the infection is well-controlled.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

REFERENCES

1. Schropp L, Wenzel A, Kostopoulos L, et al. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. Int J Periodontics Restorative Dent 2003;23:313-323.
2. Cawood JI, Howell RA. A classification of the edentulous jaws. Int J Oral Maxillofac Surg 1988;17:232-236.
3. Kim SH, Kim S, Lee KW, et al. The effects of local factors on the survival of dental implants: a 19 year retrospective study. Jkap 2010; 48:28-40.
4. Griffin TJ, Cheung WS. The use of short, wide implants in posterior areas with reduced bone height: a retrospective investigation. J Prosthet Dent 2004;92:139-144.
5. Sato Y, Shindoi N, Hosokawa R, et al. Biomechanical effects of double or wide implants for single molar replacement in the posterior mandibular region. J Oral Rehabil 2000;27:842-845.
6. Lazzara RJ. The sinus elevation procedure in endosseous implant therapy. Curr Opin Periodontol 1996;3:178-183.
7. Barone A, Covani U. Maxillary alveolar ridge reconstruction with nonvascularized autogenous block bone: clinical results. J Oral Maxillofac Surg 2007;65:2039-2046.
8. Cucchi A, Vignudelli E, Napolitano A, et al. Evaluation of complication rates and vertical bone gain after guided bone regeneration with non-resorbable membranes versus titanium meshes and resorbable membranes. A randomized clinical trial. Clin Implant Dent Relat Res 2017;19:821-832.
9. Lee EY, Kim ES, Kim KW. Vertical augmentation of maxillary posterior alveolar ridge using allogenic block bone graft and simultaneous maxillary sinus graft. Maxillofac Plast Reconstr Surg 2014;36:224-229.
10. Kang DW, Yun PY, Choi YH, et al. Sinus bone graft and simultaneous vertical ridge augmentation: case series study. Maxillofac Plast Reconstr Surg 2019;41:36.
11. Barone A, Toti P, Menchini-Fabris GB, et al. Early volumetric changes after vertical augmentation of the atrophic posterior mandible with interpositional block graft versus onlay bone graft: A retrospective radiological study. J Craniomaxillofac Surg 2017;45:1438-1447.
12. Chiapasco M, Romeo E, Casentini P, et al. Alveolar distraction osteogenesis vs. vertical guided bone regeneration for the correction of vertically deficient edentulous ridges: a 1-3-year prospective study on humans. Clin Oral Implants Res 2004;15:82-95.
13. Park YH, Choi SH, Cho KS, et al. Dimensional alterations following vertical ridge augmentation using collagen membrane and three types of bone grafting materials: a retrospective observational study. Clin Implant Dent Relat Res 2017;19:742-749.
14. Rocchietta I, Simion M, Hoffmann M, et al. Vertical bone augmentation with an autogenous block or particles in combination with guided bone regeneration: a clinical and histological preliminary study in humans. Clin Implant Dent Relat Res 2016;18:19-29.
15. Soldatos NK, Stylianou P, Koidou VP, et al. Limitations and options using resorbable versus nonresorbable membranes for successful guided bone regeneration. Quintessence Int 2017;48:131-147.
16. Xuan F, Lee CU, Son JS, et al. Vertical ridge augmentation using xenogenous bone blocks: a comparison between the flap and tunneling procedures. J Oral Maxillofac Surg 2014;72:1660-1670.
17. Schwartz-Arad D, Levin L, Sigal L. Surgical success of intraoral autogenous block onlay bone grafting for alveolar ridge augmentation. Implant Dent 2005;14:131-138.
18. Khoury F, Hanser T. Three-dimensional vertical alveolar ridge augmentation in the posterior maxilla: a 10-year clinical study. Int J Oral Maxillofac Implants 2019;34:471-480.
19. Cha HS, Kim JW, Hwang JH, et al. Frequency of bone graft in implant surgery. Maxillofac Plast Reconstr Surg 2016;38:19.
20. Phillips JH, Rahn BA. Fixation effects on membranous and endochondral onlay bone graft revascularization and bone deposition. Plast Reconstr Surg 1990;85:891-897.
21. Zins JE, Whitaker LA. Membranous versus endochondral bone: implications for craniofacial reconstruction. Plast Reconstr Surg 1983; 72:778-785.
22. Sanchez-Labrador L, Molinero-Mourelle P, Perez-Gonzalez F, et al. Clinical performance of alveolar ridge augmentation with xenogeneic bone block grafts versus autogenous bone block grafts. A systematic review. J Stomatol Oral Maxillofac Surg 2021;122:293-302.
23. von Arx T, Buser D. Horizontal ridge augmentation using autogenous block grafts and the guided bone regeneration technique with collagen membranes: a clinical study with 42 patients. Clin Oral Implants Res 2006;17:359-366.
24. Capelli M. Autogenous bone graft from the mandibular ramus: a

technique for bone augmentation. Int J Periodontics Restorative Dent 2003;23:277-285.
25. Proussaefs P, Lozada J, Kleinman A, et al. The use of ramus autogenous block grafts for vertical alveolar ridge augmentation and implant placement: a pilot study. Int J Oral Maxillofac Implants 2002; 17:238-248.
26. Marx RE. Bone and bone graft healing. Oral Maxillofac Surg Clin North Am 2007;19:455-466.