Case Report
Sinus floor elevation using tricalcium phosphate plate

Hidemichi Kihara, Kyoko Takafuji, Wataru Hatakeyama, Kenta Oriso, Akihiro Fukutoku, and Hisatomo Kondo
Department of Prosthodontics and Oral Implantology, School of Dentistry, Iwate Medical University, Morioka, Japan

Abstract: When the sinus is enlarged, it may be necessary to elevate the floor of the maxillary sinus using the crestal or lateral approach. This report describes a case where sinus floor elevation was performed using tricalcium phosphate (TCP) plates supported by implant bodies, and only the blood clot was present around the implant bodies. Cone-beam computed tomography images, taken one year after the lateral approach, revealed the presence of a TCP-like radio-opacity, which was not visible after two years. About seven years after the surgery, the patient’s superstructure and occlusion were stable. Furthermore, the grafted TCP was completely absorbed, and the implant body appeared to be in good condition, with no signs of bone resorption around the implant.

Keywords: bone augmentation, dental implant, sinus floor elevation, tricalcium phosphate

Introduction
The placement of a dental implant in the maxillary molar region depends on the volume of the bone in the area. From an anatomical viewpoint, an enlarged maxillary sinus obviously affects the treatment plan. In such cases, it is necessary to perform a maxillary sinus floor elevation, using the crestal or lateral approach. The crestal approach is less invasive and can shorten the treatment period. Furthermore, the occlusal load can be applied relatively earlier because the implant placement and bone augmentation are performed simultaneously. However, the vertical distance from the maxillary sinus floor to the alveolar crest must be 4-6 mm or more when the crestal approach is used [1,2] to avoid damaging the sinus floor mucosa [3].

In 1980, Boyne et al. described the maxillary sinus floor elevation technique using the lateral approach with transplantation of the autologous bone and bone marrow [4]. Mainly, the iliac bone was used as the grafted bone during the lateral approach [5]; however, artificial bones, such as decalcified freeze-dried bone, freeze-dried bone, xenogeneic bone, and hydroxyapatite have been used over the past few years. Currently, artificial bones are used in almost all cases [6-8]. Although artificial bones are commonly used for the lateral approach, the newly formed bone tissue may regenerate, filling the gaps between the artificial bone particles. Consequently, it might take a longer time to acquire osseointegration than it would with the autogenous bone graft. Therefore, in terms of osseointegration, the presence of autogenous bone is desirable around the rough surface of the implants. However, the sole use of autologous bone, such as iliac bone grafts, will result in sequential bone resorption, and the implants will seem to protrude into the maxillary sinus floor on the X-ray image.

Herein, a new method is presented, in which tricalcium phosphate (TCP) plates were supported by the implant body and only the blood clot was infused into the empty space around the implants.

Case Report
A 54-year-old woman visited the implant clinic at Iwate Medical University in January 2011, with chief complaints of poor aesthetics and difficulty eating. Intraoral and radiographic examinations revealed the presence of caries, chronic periodontal disease, periapical periodontitis, collapse of vertical dimension of occlusion, and the mandible shifting to the left side (Fig. 1). The patient had no removable partial denture despite the absence of several molars in the maxilla or mandible. The patient complained of pain and a clicking noise in the temporomandibular joint while opening the mouth, and the maximum opening distance was about 20 mm. The treatment plan involved removing all the teeth and then fabricating a fixed denture, to be installed with dental implants, because almost all teeth presented with poor prognoses. After consultation, the patient was prepared to undergo the treatment, which involved the reconstruction of the occlusion with implants in relation to the maxilla and mandible. The extraction of teeth with poor prognoses and caries, periodontal treatment, and fabrication of removable dentures in the maxilla and mandible were performed as initial treatment. Appropriate horizontal and vertical determinations of occlusion were reconstructed. Additionally, the patient was trained to open the mouth wider, and the temporomandibular disorder was treated.

Diagnosis of dental implant treatment and installation of the implant body
Based on the findings of cone-beam computed tomography (CBCT), the distance between the sinus floor and crest of alveolar bone was about 2 mm in the maxillary right molar region and 1 mm in the left side (Fig. 2). A lateral approach was used to lift the sinus with a TCP plate (BrainBase, Tokyo, Japan), supported with implants, in November 2011 (The Ethics Committee of Iwate Medical University approved the protocol and TCP use; approval number 01155). The TCP was inserted into the maxillary sinus through a lateral window that was opened from the maxillary sinus wall (Fig. 3A), and the implant body (Brånemark, Nobel Biocare, Zürich, Switzerland) was installed from the alveolar crest. The initial fixation of the implant body was performed, and the TCP was elevated like a tent (Fig. 3B). Secondary surgery was performed six months after implant placement. The X-ray findings after the secondary surgery confirmed a TCP-like radio-opacity at the top of the implant in the molar regions on both sides; in addition, there were new bone-like findings around the implant body (Fig. 4). An interim restoration was placed in the upper jaw, and an implant was placed in the mandible’s molar region.

Follow-up after surgery and use of the final superstructure
One year after the lateral approach, CBCT findings revealed a clear, TCP-like radio-opacity, which was not visible after two years (Fig. 5). After using the first and second interim prostheses, the final prosthesis in the maxilla was manufactured with a porcelain-fused metal and retained with a screw in December 2013 (Fig. 6). As of August 2019, no temporomandibular joint disorder was observed, and the occlusion was stable (Fig. 7A). The grafted TCP appeared to be absorbed and was not visible on the panoramic radiograph; the implant body appeared to be in good condition, with no signs of bone resorption (Fig. 7B).

Discussion
A previous study indicated that lifting of the sinus was feasible without the use of graft materials [9]. Therefore, it was presumed that it was possible to regenerate bone even if there is no bone graft material around the implant.

In another study, the TCP that was grafted into the maxillary sinus was absorbed, albeit in a very slow manner; it was replaced with new bone in about 6 months to 1 year [10]. However, in the current case report, a TCP-
like radio-opacity was clearly observed on the CBCT image at 1 year, and the TCP degradation process could take longer than 1 year. Considering the slower than expected TCP absorption rate in this study, only applying TCP particles during the lateral approach might be a negative factor for achieving osseointegration, despite using a granular grafted material.

In the present case study, the implants were used to support the TCP because initial fixation could be obtained. Titanium bone screws are used in cases where obtaining initial fixation is impossible. However, this method may not be appropriate if the TCP plate cannot be fixed with an implant body or titanium screw because of the maxillary sinus morphology.

In this case report, sinus floor elevation was performed in an edentulous maxilla by placing TCP plates in the molar region. The results suggested that TCP plates could be used effectively to maintain space for the induction of newly-formed bone tissue. The plates will be absorbed in about three years and substituted by the new bone. Although this method was successful in the current case report, it might be necessary to confirm the safety and prognosis of TCP plates in additional studies. Moreover, further studies are required to determine how TCP’s conductive ability affects bone formation.

Acknowledgments
This work was supported by JSPS KAKENHI Grant Numbers JP16K11631.

Conflict of interest
The authors declare no conflict of interest.
References

1. Berengo M, Sivolella S, Majzoub Z, Cordioli G (2004) Endoscopic evaluation of the bone-added osteotome sinus floor elevation procedure. Int J Oral Maxillofac Surg 33, 189-194.
2. Nedir R, Bischof M, Vazquez L, Semmelder-Muncler S, Bernard JP (2006) Osteotome sinus floor elevation without grafting material: a 1-year prospective pilot study with ITI implants. Clin Oral Implants Res 17, 679-686.
3. Geminiani A, Tsagardia A, Chochlidakis K, Papastryridakos PV, Feng C, Ercoli C (2017) A meta-analysis of complications during sinus augmentation procedure. Quintessence Int 48, 231-240.
4. Boyne PJ, James RA (1980) Grafting of the maxillary sinus floor with autogenous marrow and bone. J Oral Surg 38, 613-616.
5. Kortebein MJ, Nelson CL, Sadove AM (1991) Retrospective analysis of 135 secondary alveolar cleft grafts using iliac or calvarial bone. J Oral Maxillofac Surg 49, 493-498.
6. Kumar M, Chopra S, Dao D, Gupta M, Memoalia J, Verma G (2018) Direct maxillary sinus floor augmentation for simultaneous dental implant placement. Ann Maxillofac Surg 8, 188-192.
7. Ding Y, Wang X (2018) Long-term effects of bone morphogenetic protein-2-loaded calcium phosphate on maxillary sinus lift surgery for delayed and simultaneous dental implantation. J Craniofac Surg 29, e58-61.
8. Franceschetti G, Farina R, Minenna L, Riccardi O, Stacchi C, Di Raimondo R et al. (2019) The impact of graft remodeling on peri-implant bone support at implants placed concomitantly with transcristal sinus floor elevation. A multicenter, retrospective case series. Clin Oral Implants Res, Sep 18, doi: 10.1111/ocl.13541.
9. Silva LD, de Lima VN, Faverani LP, de Mendonça MR, Okamoto R, Pellizzer EP (2016) Maxillary sinus lift surgery-with or without graft material? A systematic review. Int J Oral Maxillofac Surg 45, 1570-1576.
10. Okada T, Kamai T, Tachikawa N, Munakata M, Kanagai S (2017) Histological and histomorphometrical determination of the biogradation of β-tricalcium phosphate granules in maxillary sinus floor augmentation: a prospective observational study. Implant Dent 26, 275-283.

Fig. 7 Intraoral and panoramic X-rays images 7 years and 9 months after the lateral approach, and 5 years and 8 months after wearing the superstructure. The patient had an uneventful course during the follow-up period.