Bone Augmentation by the Dredging Method for Dental Implant Placement in Alveolar Bone Resorbed due to a Postoperative Maxillary Cyst

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ABSTRACT
To evaluate physiological bone regeneration in the case of a postoperative maxillary cyst (POMC) treated using the deflation and dredging method to augment bone for implant placement. In the case of bone resorption, bone augmentation is required to place a stable implant. Before bone augmentation, the reason for bone resorption must be taken into consideration and should be treated first. The deflation and dredging method, which was originally developed for treating ameloblastoma, can be applied to treat POMC because of the similar treatment objectives of complete epithelium removal and enhancement of bone regeneration. In the first surgery, the cyst wall and overlying alveolar bone were removed under local anesthesia for deflation and histopathological examination. Three months after the deflation, new bone formation was observed along the inner surface of the cavity, the cavity itself became smaller, and the cyst could be easily enucleated. Thereafter, dredging was performed twice at intervals of 3 months. No epithelial cells were found on histopathological examination of the bone excised during dredging, and the bony cavity was filled with regenerated bone. Six months later, the implant body was placed, and the final prostheses were set after another 6 months. There has been no recurrence of POMC for >3 years after the last dredging. Treatment of the POMC and bone augmentation can be performed as a serial treatment without any invasive maneuvers, such as, bone harvesting and grafting. Bone regeneration is expected to occur under proper conditions of preparation.

Keywords: Bone augmentation, Deflation, Dredging method, Implant, Postoperative maxillary cyst.

BACKGROUND
A maxillary sinus augmentation is a reliable technique that ensures implant placement of inadequate alveolar bone in the atrophic maxillary molar region. In cases where the alveolar height is reduced by the expansion of a maxillary cyst, direct bone grafting alone is not sufficient. Preoperative treatment of the cyst is necessary for reliable implant placement.

The deflation and dredging method was developed for the treatment of ameloblastoma.1,2 It consists of the following four steps: deflation, enucleation, dredging, and follow-up. Deflation is the first step that relieves the intracystic pressure and allows bone formation from the margin. Enucleation is the second step, wherein the entire cystic wall is removed together with the surrounding bone tissue. In dredging, which is the third step, the scar tissue covering the bone surface and the surrounding bone tissue are removed. This step is performed repeatedly to remove any tumor cell remnants in the newly formed bone and the scar tissue and to accelerate new bone formation.

Although there is a difference between benign tumors and cysts, we applied the dredging method in a 69-year-old male patient with postoperative maxillary cyst (POMC) because of the similar objectives of the eradication of the pathology and the acceleration of bone regeneration.

TECHNIQUE
A radiolucent lesion (18-mm diameter) was observed on the left maxillary sinus floor on cone-beam computed tomography (Fig. 1). The patient gave a history of Caldwell-Luc operation of the left maxillary sinus due to sinusitis approximately 40 years ago. Hence, the cyst was suspected to be a POMC.

In the first surgery, a small part of the cyst wall and the overlying buccal alveolar bone were removed under local anesthesia for deflation by relieving the intracystic pressure (Fig. 2). The removed specimen was sent for histopathological examination. Although a small number of epithelial cells were observed, ciliated pseudostratified columnar epithelial cells specific to the sinus membrane were not obvious due to chronic inflammation.
Fig. 1: At the first visit, the radiolucent area (18-mm diameter, arrows) and extraction socket (arrowhead) identified on cone-beam computed tomography.

Fig. 2: Deflation and biopsy. The cyst wall in the front and the overlaying thin bone were excised. The posterior cyst wall in the sinus side is clearly visible in the cavity. A running suture was made around the wound so that the site remained open.

Fig. 3: Although a small number of epithelial cells (arrows) are seen, ciliated pseudostratified columnar ones are not obvious due to chronic inflammation. Lymphocytic infiltration (arrowhead) of the proliferative connective tissue can be seen.

Fig. 4: Cone-beam computed tomography taken before the second dredging. The extraction socket healed well with the remodeling of the alveolar crest (arrowhead). The original radiolucent area of the cyst became smaller with the newly formed bone from the margin (arrows).

(Fig. 3). Considering the histopathological report and the history of Caldwell-Luc operation under local anesthesia, the final diagnosis of POMC was made.

Three months after the deflation, the remaining cyst was removed completely (second surgery). The cavity had become obviously smaller. The cyst wall could be easily enucleated, and new bone formation was seen even at the site where adhesion between the intact sinus membrane and the cyst wall was previously seen. Thus, perforation into the sinus could be avoided.

Another 3 months later, the first dredging was performed (third surgery). Scar tissue covering the bone cavity was removed to accelerate the new bone formation and to eradicate any embedded residual epithelial cells for the prevention of POMC recurrence.

Furthermore, another 3 months later (Fig. 4), the second dredging was performed for the same purpose (fourth surgery). No epithelium was found on histopathological examination. The original cyst cavity was filled with regenerated bone.

Approximately 6 months later, the implant body was placed, and the final prostheses were set another 6 months later (Figs 5 and 6). There has been no recurrence of POMC for >3 years after the last dredging.

**Discussion**

Irrespective of the modalities, bone grafting is usually performed in cases with insufficient alveolar bone height to provide a base for implant placement.\(^3\) Formerly, the presence of a maxillary sinus cyst was considered a contraindication for this method.\(^5\) However, simultaneous implant placement with the removal of the antral pseudocyst\(^6\) and maxillary sinus floor elevation, even in the presence of pseudocysts,\(^7\) have been reported. Thus, cystic lesions...
of the maxillary sinus are no longer contraindications for sinus augmentation. On the contrary, the failure of implant placement associated with maxillary cysts has also been reported.  

Thor et al. demonstrated that bone grafting is not always required, and the mere lifting of the sinus mucosal membrane is sufficient for bone augmentation because the bone will be generated in the vacant cavity created between the sinus floor and the membrane. 

However, in the daily clinical setting, primary bone grafting and secondary implant placement are still routinely performed. We believe that a favorable condition of the alveolar bone, both in quality and in quantity, should be prepared in advance, for stable implant placement. Patients with POMC are also candidates for pretreatment to reduce complications.

According to Block, while performing bone grafting in the enucleated cavity of POMC, regardless of whether it is simultaneous or secondary, the bone should be harvested. In other words, further invasive treatment should be performed. In this aspect, the dredging method is reasonable because the treatment for POMC and bone augmentation can be performed conservatively. Bone harvesting is mostly not required.

The dredging method stimulates potential biological reactions for bone generation. Bone augmentation can be achieved without bone grafting. In our opinion, the resorption in the spontaneously regenerated bone will be less than that in grafted bone. We believe that this method is not limited as long as the lesion is derived from the epithelium and the peripheral extent of bone resorption is not too large, keeping the expanded surface smooth. For the success of this technique, it is a fundamental requirement that patients should be strongly willing to undergo and complete treatment even if the treatment duration is long and repeated surgeries are required. Scheduled follow-up is also mandatory. This is a versatile method for cases with alveolar bone reduction caused not only by POMC but also by lesions, such as, odontogenic keratocyst and ameloblastoma.

The deflation method is similar to marsupialization, in which the cyst wall is sutured to the oral epithelial membrane. However, the dredging method was established to remove all the targeted tumor cells or epithelial cells of the cyst wall in combination with the removal of the regenerated bone by repeated surgery. It was originally developed as a conservative treatment for ameloblastoma that often recurs if simple enucleation is performed. This method, the depth to which the newly formed bone should be removed depends on previous histopathological findings. Deeper dredging of the bone, occasionally to the original bone level, is performed in the region where remnants of the tumor and/or daughter cysts were observed in the last enucleation. The final objective of the dredging method is the complete eradication of tumor cells or epithelial cells of the cyst wall.

Marsupialization was developed for decreasing the size of the cyst or abscess. The created surgical window exposes the cyst to the oral cavity. Many articles have reported the effectiveness of marsupialization as a suitable treatment option for cystic lesions of the jaws, especially for larger lesions in which primary enucleation is difficult or functional and/or anatomical disturbance is expected postoperatively.

However, there is some confusion regarding the definition of the treatment modalities. The serial treatment of marsupialization, enucleation, and adequate bone curettage may be ostensibly similar to the dredging method, far from marsupialization alone. However, conceptually, especially for tumor lesions, the dredging method depends substantially on the individual condition and all the following considerations: how to enucleate the lesion, how to convert a multicystic lesion to a unicystic lesion by removing the septum, the sequence of enucleation, how often and how deep the curettage should be performed, where the lesion should be finally concentrated and removed en bloc, whether the teeth included in the cavity need to be extracted or some teeth can be salvaged by root canal treatment in combination with apicectomy, and the length of follow-up. The dredging method includes not only the method but also the philosophy in combination with the strategy itself.

The dredging method can be a reliable option for the treatment of patients with reduced alveolar bone height due to POMC. However, evaluations of more cases are required to assess its effectiveness objectively.

**Conclusion**

The dredging method enabled the regeneration of bone suitable for implant placement along with the eradication of the epithelial remnants of POMC. In contrast to the simple removal of the cyst, a
Bone Augmentation by the Dredging Method for Dental Implant Placement in Alveolar Bone

secondary sinus floor elevation was not required, and physiological bone regeneration was possible.

Ethics Statement/Confirmation of the Patient’s Permission

Ethical approval was not required. The patient’s permission was obtained.

References

1. Kawamura M, Inoue N, Kobayashi I, et al. “Dredging Method” - a new approach for the treatment of ameloblastoma. Asian J Oral Maxillofac Surg 1991;3:81–88.
2. Ohira Y, Yamada T, Kakuguchi W, et al. Modified “Dredging Method” for complicated solid/multicystic ameloblastoma in the mandible: report of a case treated by fractionated enucleation. J Oral Maxillofac Surg Med Pathol 2019;31(2):121–125. DOI: 10.1016/j.jomsp.2018.11.001.
3. Aghaloo TL, Misch C, Lin GH, et al. Bone augmentation of the edentulous maxilla for implant placement: a systematic review. Int J Oral Maxillofac Implants 2016;31:19–30. DOI: 10.11607/jomi.16suppl.g1.
4. Ziccardi VB, Betts NJ. Complications of maxillary sinus augmentation. Jensen OT, ed. The sinus bone graft. Carol Stream, IL: Quintessence Publishing; 1999. pp. 201–208.
5. Medikari RS, Sinha KA. Sinus floor augmentation in presence of mucocele eroding maxillary sinus wall: a case report with 3 years follow-up. Clin Adv Periodontics 2020;10(2):81–87. DOI: 10.1002/cap.10083.
6. Tang ZH, Wu MJ, Xu WH. Implants placed simultaneously with maxillary sinus floor augmentations in the presence of antral pseudocysts: a case report. Int J Oral Maxillofac Surg 2011;40(9):998–1001. DOI: 10.1016/j.ijoms.2011.02.038.
7. Galzignato PF, Sivolella S, Cavallin G, et al. Dental implant failure associated with a residual maxillary cyst. Br Dent J 2010;208(4):153–154. DOI: 10.1038/sj.bdj.2010.156.
8. Thor A, Sennerby L, Hirsch JM, et al. Bone formation at the maxillary sinus floor following simultaneous elevation of the mucosal lining and implant installation without graft material: an evaluation of 20 patients treated with 44 Astra Tech implants. J Oral Maxillofac Surg 2007;65(7):64–72. DOI: 10.1016/j.ajoms.2006.10.047.
9. Block MS. Bone levels are preserved after simultaneous sinus elevation at time of implant placement. J Oral Maxillofac Surg 2019;77(10):2019–2026. DOI: 10.1016/j.joms.2019.06.177.
10. Gardner DG. Some current concepts on the pathology of ameloblastomas. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1996;82(6):660–669. DOI: 10.1016/S0107-2104(96)80441-0.
11. Briki S, Elleuch W, Karray F, et al. Cysts and tumors of the jaws treated by marsupialization: a description of 4 clinical cases. J Clin Exp Dent 2019;11(6):e565–e569. DOI: 10.4317/jced.65563.