Sinus Membrane Lift Using a Water Balloon Followed by Bone Grafting and Implant Placement: A 28-Case Report

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Purpose: The objective of this study was to assess the efficacy and safety of a minimally invasive sinus lift using an inflatable water balloon followed by bone grafting and implant placement. ***Materials and Methods:*** A total of 28 patients with a single tooth missing in the posterior maxilla underwent a water balloon sinus lift, followed by bone grafting and implant placement. Baseline bone height was 4.92 ± 1.24 mm. Implant site preparation employed a pilot drill and osteotomy followed by water balloon elevation. The mean inflated balloon volume was 0.67 ± 0.17 mL. Bio-Oss was filled under the elevated sinus membrane using a dedicated instrument. Twenty-eight total implants (diameter: 3.8 to 5.0 mm) were placed. Pre- and postoperative panoramic films or computed tomographs (optional) were taken for every case to measure and compare the results of the sinus membrane lift using a water balloon. Postoperative patient reactions including swelling, discoloration, discomfort, hematomas, and disability were recorded. ***Results****:* Successful sinus membrane water balloon lifting procedures were performed in 26 cases; two procedures were aborted due to sinus membrane perforation. A total of 26 implants were placed. The mean inflated balloon volume was 0.67 ± 0.17 mL and radiographic examination showed the mean elevated height by balloon to be 10.9 ± 2.06 mm. Computed tomography showed the bone graft distributing evenly around implants. Patients were extremely pleased with the results and needed very little medical attention after surgery. The mean follow-up was 15.9 ± 2.94 months. One implant was lost due to infection. ***Conclusion:*** The use of a water balloon to elevate the sinus membrane is a truly minimally invasive technique and is associated with very little discomfort. This method has encouraging results, is easy to learn, and is associated with low complication rates. *Int J Prosthodont 2009;22:243–247.*

The widespread use of implants for the replacement of missing teeth has led to the use of more sophisticated surgical techniques in sites that previously were considered as contraindications to implant therapy. The posterior region of the edentulous maxilla frequently presents insufficient bone for rehabilitation by means of endosseous implants. Maxillary sinus lifting using a bone graft was first introduced by Boyne and James[1] and Tatum.[2] This technique has been used to permit the placement of endosseous implants in edentulous or excessively pneumatized maxillae. Although the lateral maxillary window approach, also known as the Caldwell-Luc approach, may yield very successful clinical results for sinus grafting, this method has many shortcomings.[3] Limitations of the lateral maxillary approach include sinus membrane perforation (10% to 35%),[4] bleeding, infection, infraobital nerve laceration, and the need for extensive surgical expertise.[5] Postoperative discomfort including swelling, discoloration, disability, hematoma, and pain occur very often.[5]

The other technique currently in practice is a limited sinus elevation using an osteotome, which yields an average bone height of 3 ± 0.8 mm.[6] According to standard protocol, the osteotome technique can only be used when the ridge height is more than 5 mm and implants are placed simultaneously with the elevation of the sinus floor.[7] Moreover, this procedure can also be complicated by membrane perforation and tear.[8]

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Kfir et al[9] reported a minimally invasive technique for sinus membrane balloon elevation followed by implant placement. This procedure had satisfactory bone augmentation results (usually > 10 mm) and good implant durability. For patients, this procedure eliminates the complications, discomfort, disfiguration, and disability associated with the traditional lateral window approach.

The aim of the present study was to evaluate the efficacy and safety of a minimally invasive technique for sinus membrane elevation using a water balloon followed by bone grafting and implant placement via the osteotomy site and to report on the preliminary clinical results.

Materials and Methods

A total of 28 patients with a single tooth missing in the posterior maxilla underwent a water balloon sinus lift followed by bone grafting and implant treatment at the Department of Implant Dentistry, Peking University School of Stomatology. Each patient received an explanation regarding the procedure and signed a consent form. Preoperative computerized tomographs (CT) (optional) and panoramic radiographs were taken to assess mucosa thickness, pathology, bone height, and sinus structure. Baseline bone height was 4.92 ± 1.24 mm.

Surgical Technique

Local anesthesia (via infiltration of the posterior superior alveolar nerve and greater palatine nerve) was executed using articaine hydrochloride (Merignac Cedex). An alveolar horizontal full-thickness flap was performed. No vertical releasing incision was employed and the flap was reflected not exceeding the alveolar ridge. Implant site preparation employing a 2-mm-diameter pilot drill, followed by one with a diameter of 2.8 mm, reached about 1 mm short of the sinus floor. Then, the sinus floor was gently elevated using osteotomes (Altatec Biotechnologies) ranging from 3.8 mm to 4.3 mm or 5.0 mm in diameter**.** After examining the integrity of the sinus membrane by way of the Valsalva maneuver, the dedicated inflatable balloon (Hager & Meisinger) was anchored and the balloon was slowly inflated with gentle inflating pressure using an inflator syringe filled with 0.9% normal saline. Once the desired elevation (usually > 10 mm) was obtained, the balloon was deflated and removed. A second test of membrane integrity was completed in the same manner as previously mentioned. A mix of autologous platelet-rich fibrin (obtained by centrifugation of 20 mL of patients' blood divided into two test tubes and spun for 10 minutes at 1,600 RPM, Heraeus Centrifuge) and Bio-Oss particles (Geistlich Pharma) was filled under the elevated sinus membrane using dedicated instruments (USTOMED). After bone transplantation, implants (CAMLOG Biotechnologies) ranging from 3.8 to 5.0 mm in diameter were placed and primary closure was performed with 4-0 absorbable sutures in 23 cases. The nonsubmerged technique was used in three cases. Prosthetic rehabilitation was delivered 4 weeks after implant exposure.

Postoperative Care

Patients were discharged with a single, 600-mg dose of Ibuprofen for the treatment of pain and Velosef 0.5 g tid for 7 days for prophylaxis.

Clinical and Radiographic Evaluations

Postoperative patient reactions were also documented. Surgical complications including severe bleeding, infection, and implant failure were evaluated postoperatively.

Pre- and postoperative panoramic films or CTs (optional) were taken for every case to measure and compare the results of the sinus membrane lift procedure using a water balloon. Periapical films were employed to observe the marginal bone resorption and osseointegration after permanent prostheses delivery.

Results

Between May 2006 and February 2007, 28 patients with a mean age of 40.2 ± 12.35 years received this particular treatment. Among them, 14 were women. Baseline bone height was 4.92 ± 1.24 mm. The mean inflated balloon volume was 0.67 ± 0.17 mL. CT scans showed the bone graft distributing evenly around implants and the shapes of the elevated spaces appeared hemispheric on panoramic views. Radiographic examination showed mean elevated height by balloon to be 10.9 ± 2.06 mm. The bone graft was stable and integrated with the implant well after operation. Minor complications were recorded, including a mild, self-limiting nosebleed that happened in one patient right after surgery. No patient required medication for the alleviation of swelling and in general, patients needed little medical attention postoperatively. A total of 26 implants were placed and restored with permanent prostheses. The mean follow-up was 15.9 ± 2.94 months. Only three implants were nonsubmerged in this study. One implant was lost 2 weeks postoperatively due to infection. The implant was again placed 3 months later and healed uneventfully. Two procedures were aborted due to sinus membrane perforation, but sinus grafting and implant placement were successfully performed via the Caldwell-Lucapproach 4 weeks later. Two cases are shown to demonstrate the technique of the procedure step-by-step and the follow-up results (Figs 1 and 2).

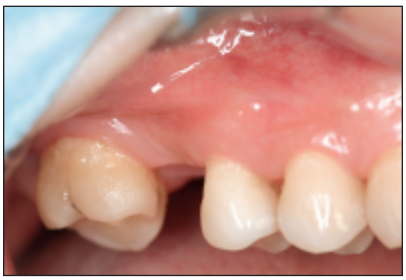


Fig 1a *(above)* The right maxillary first molar was lost but adequate buccal bone was retained.

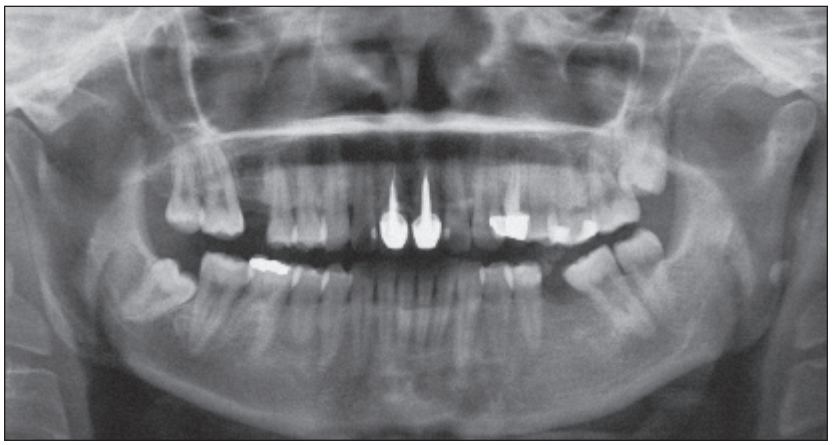


Fig 1b *(right)* Preoperative panoramic radiograph showed the residual bone height to be 5.4 mm.

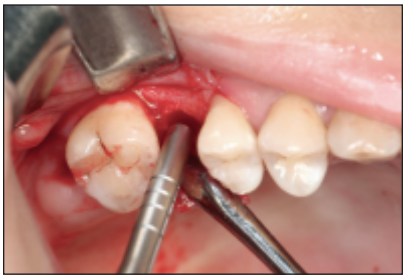


Fig 1c An osteotome was used to elevate the sinus floor.

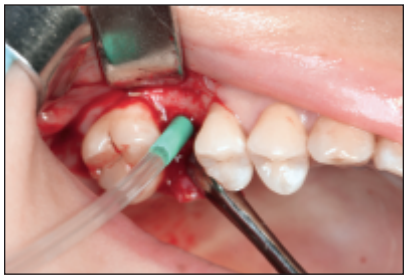


Fig 1d The inflated balloon was anchored.

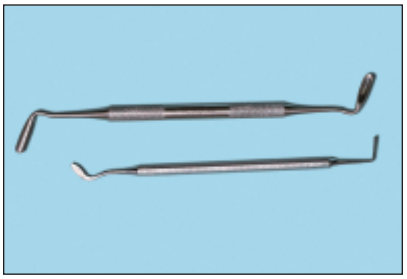
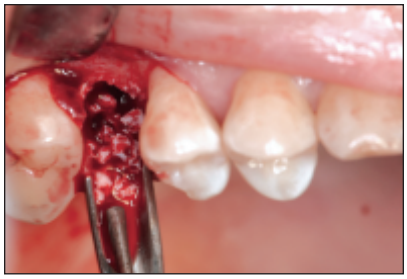
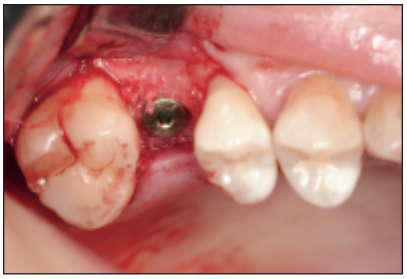


Fig 1e An example of the fine bone instruments used to insert the bone graft.

Fig 1f *(left)* A mixture of Bio-Oss and autologous platelet-rich fibrin was used as the bone graft.

Fig 1g *(right)* The implant was placed simultaneously





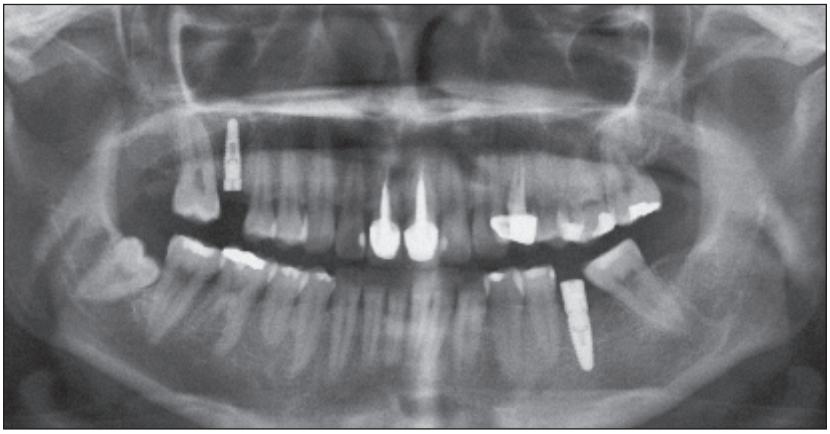


Fig 1h *(above)* Six-month postoperative panoramic radiograph showed a stable bone graft.

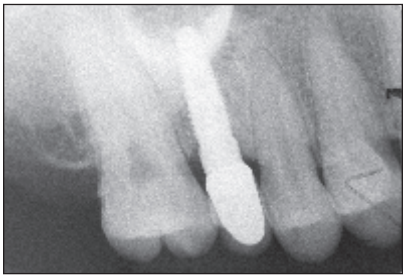


Fig 1i *(top right)* The peri-implant marginal bone was stable 12 months after permanent prostheses delivery.

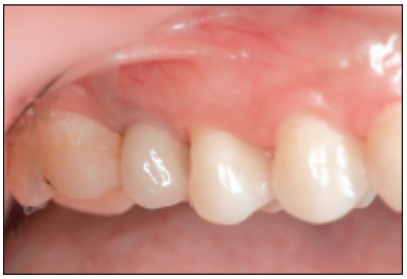


Fig 1j *(bottom right)* Final clinical results showed healthy peri-implant soft tissue.

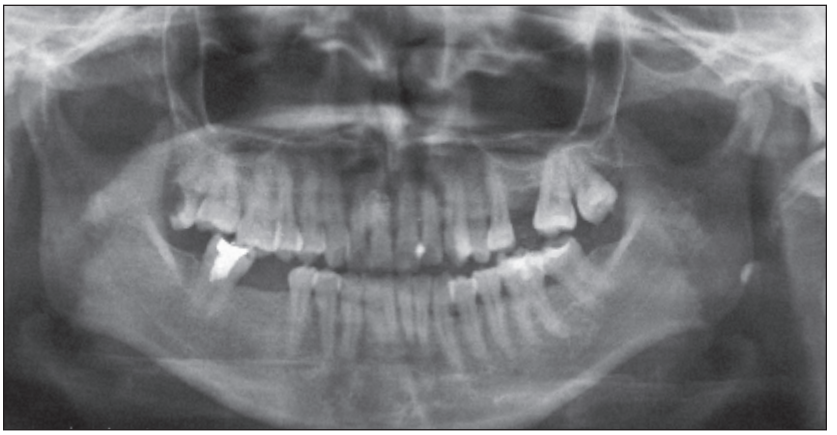
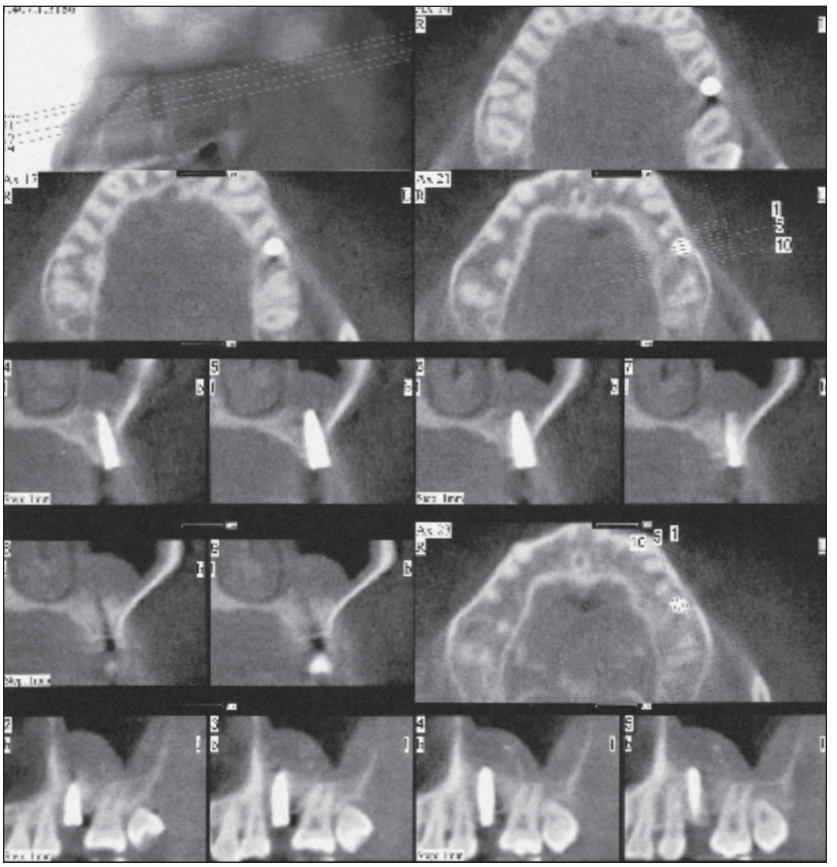


Fig 2a Preoperative panoramic radiograph showed the residual bone height to be 3.3 mm.



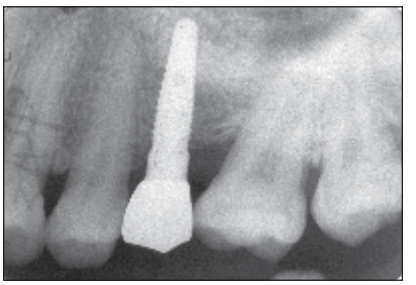


Fig 2b *(left)* CT scans showed the bone graft distributed evenly around the implant.

Fig 2c *(above)* Periapical radiograph showed a stable marginal bone and acceptable osseointegration around the implant 13 months after prostheses delivery.

Discussion

Since this study was planned in order to evaluate the feasibility and importance of this method for general practitioners and doctors who are not surgical experts, this procedure was performed by random clinicians in the department, including junior clinicians. Therefore, the selection criteria for this study were patients with a single tooth missing in the posterior maxillary area that had insufficient bone height but adequate bone width. An osteotome was employed to condense the bone and ensure initial stability of implants. Only three implants were nonsubmerged because the residual bone height was more than 5 mm with type III bone quality, according to the Lekholm and Zarb classification.[10] For a residual bone height less than 3 mm, the traditional lateral maxillary approach was executed. The results of this study indicate that this sinus membrane water balloon elevation procedure is safe and effective for a single tooth missing in the posterior maxillary area that needs sinus bone grafting, even when performed by junior clinicians who are not surgical experts.

The procedure is truly minimally invasive. A study of sinus membrane balloon elevation when multiple teeth are missing is now being undergone in the same department.

Although every case in this study had preoperative residual bone analysis through orthopantomography or CT examinations, which were very important to plan and evaluate the procedure, the interpreted bone height on the film could not be completely identical to surgical findings and follow exact surgical protocol. With reference to radiographic bone value, the feel of the surgical drill is a key point for a successful sinus membrane lift using a water balloon. During preparation of the implant site, the drill had just reached the sinus floor cortical bone layer when the feeling changed from soft to hard. Then, osteotomes were used step-by-step to elevate the sinus floor about 1 mm and the water balloon was inflated to lift the sinus membrane to the desired height. Sinus membrane perforation was observed when using the pilot drill to prepare the sites in two cases in this study. No balloon rupture was observed when using the balloon to lift the sinus membrane. Kfir et al[9] reported sinus membrane and balloon rupture in one out of 24 cases. This indicates that the force of the water balloon was gentle and spread equally in each direction during sinus membrane elevation.

Xenografts have been very well documented as a sinus grafting material. They have been used alone or as part of a composite graft combined with autogenous bone, venous blood, or platelet-rich plasma.[11] In this study, it seemed that a mixture of Bio-Oss and autologous platelet-rich fibrin (with a ratio 3:1) stimulated bone formation. Although the benefit of platelet-rich fibrin to bone formation around implants is still controversial,[12,13] further studies are needed to elucidate its long-term effects.

Both Wallace and Froum and Del Fabbro et al show a dramatic difference in implant survival when comparing rough to machined implants.[3,11] In this study, CAMLOG implants conditioned with a particle-blasted and acid-etched microstructured surface were used. It is possible that this surface results in high implant durability. Future studies are needed to show implant bone contact for CAMLOG surfaces to confirm this finding.

This study reports on a minimally invasive, single-stage procedure of maxillary bone augmentation. There were no major complications and the procedure yielded satisfactory bone augmentation results and good implant durability. This procedure eliminates the complications, discomfort, disfiguration, and disability associated with the traditional lateral maxillary sinus approach and shortens the time of implant exposure and functionality by more than 6 months. This result is similar to the report by Kfir et al.[9]

Conclusion

The use of water balloon sinus membrane elevation is a truly minimally invasive technique and is associated with very little discomfort. The method is easy to learn with excellent procedural success and low complication rates.

References

1. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. J Oral Surg 1980;38:613–616.
2. Tatum H Jr. Maxillary and sinus implant reconstructions. Dent Clin North Am 1986;30:207–229.
3. Wallace SS, Froum SJ. Effect of maxillary sinus augmentation on survival of endosseous dental implants. A systematic review. Ann Periodontal 2003;8:328–343.
4. Jensen J, Sindet-Pedersen S, Oliver AJ. Varying treatment strategies for reconstruction of maxillary atrophy with implants: Results in 98 patients. J Oral Maxillofac Surg 1994;52:210–216.
5. Jensen OT. The Sinus Bone Graft. Chicago: Quintessence, 1999:203.
6. Nkenke E, Schlegel A, Schultze-Mosgau S, Neukam FW, Wiltfang J. The endoscopically controlled osteotome sinus floor elevation: A preliminary prospective study. Int J Oral Maxillofac Implants 2002;17:557–577.
7. Summers RB. Sinus floor elevation with osteotomes. J Esthet Dent 1998;10:164–171.
8. Berengo M, Sivolella S, Majzoub Z, Cordioli G. Endoscopic evaluation of the bone-added osteotome sinus floor elevation procedure. Int J Oral Maxillofac Surg 2004;33:189–194.
9. Kfir E, Kfir V, Mijirtsky E, Rafaeloff R, Kaluski E. Minimally invasive antral membrane balloon elevation followed by maxillary bone augmentation and implant fixation. J Oral Implantol 2006;32:26–33.
10. Lekholm U, Zarb GA. Patient selection. In: Brånemark P-I, Zarb GA, Albrektsson T (eds). Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry. Chicago: Quintessence, 1985:199–209.
11. Del Fabbro M, Testori T, Francetti L, Weinstein R. Systematic review of survival rates for implants placed in the grafted maxillary sinus. Int J Periodontics Restorative Dent 2004;24:565–578.
12. Marx RE, Carlson ER, Eichstaedt RM, Schimmele SR, Strauss JE, Georgeff KR. Platelet-rich plasma: Growth factor enhancement for bone grafts. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;85:638–646.
13. Wiltfang J, Schlegel KA, Schultze-Mosgau S, Nkenke E, Zimmermann R, Kessler P. Sinus floor augmentation with beta-tricalciumphosphate (beta-TCP): Does platelet-rich plasma promote its osseous integration and degradation? Clin Oral Implants Res 2003;14:213–218.