Clinical Case Report

Medicine®

OPEN

Endoscopically controlled flapless transcrestal sinus floor elevation with platelet-rich fibrin followed by simultaneous dental implant placement

A case report and literature review

Zhenzhen Liu, MS[a], Chunyan Li, DDS, PhD[a], Jing Zhou, BS[b], Xiaolin Sun, DDS, MS[a], Xue Li, DDS, PhD[a], Manlin Qi, MS[a], Yanmin Zhou, DDS, PhD[a,*]

Abstract

Rationale: In this case study, a modified transcrestal approach was applied to the patient of extremely atrophic posterior maxilla. We analysis the Implant Stability Quotient values (ISQ) to monitor implant stability, and the cone-beam computer tomography (CBCT) to evaluate the bone regeneration.

Patient concern: A 26-year-old female patient visited our hospital with no contraindications for dental implants and a loss of the maxillary right first molar.

Diagnose: Examination by CBCT demonstrated the posterior maxilla was extremely atrophic, the residual bone height (RBH) of #16 was 3.5 mm.

Intervention: Patient underwent a endoscopically controlled flapless sinus floor elevation. The maxillary sinus membrane was elevated by two-step, and an implant of 12 mm length was placed simultaneously.

Outcomes: Twelve weeks post-surgery, the implant-level impression was finished and a full-ceramic crown was placed thereafter.

Lessons: The modified transcrestal approach can be applied to augment maxillary sinus with a residual bone height less than 4 mm.

Abbreviations: CBCT = cone-beam computer tomography, ISQ = implant stability quotient, PRF = platelet-rich fibrin, RBH = residual bone height, RFA = resonance frequency analysis, TID = three times a day.

Keywords: bone regeneration, endoscope, platelet-rich fibrin, sinus floor elevation

1. Introduction

The usage of dental implants has significantly increased prosthetic options for the edentulous patient. However, inadequate alveolar bone in the posterior maxilla is a normal limitation for implant placement. In order to permit the insertion of a dental implant, sinus elevation surgery has been increasingly performed. Since the Sinus Consensus Conference of 1996, residual bone height between 5 and 7 mm have been considered by many authors as a prerequisite to perform predictable transcrestal sinus floor elevation procedures.[1] The traditional theory holds that sinus floor elevation via a lateral approach associated with grafts and delayed implant placement should be chosen for the case of residual alveolar height <5 mm.[2] In a multicenter retrospective study, Rosen et al[3] estimated the outcome of the transcrestal approach with the implant placement. The results showed that the survival rate was ≥96% when the residual bone height was ≥5 mm and dropped dramatically to 85% when crestal bone height was ≤4 mm. A possible reason for higher failure rate was maxillary sinusitis caused by infection through invasion of microorganisms of the oral cavity, leading to undetected perforation of the sinus membrane during the surgical procedure. A technique to raise the sinus membrane during the operation under endoscopic control was introduced in the late 1990s.[4,5] Endoscope-guided sinus floor elevation may lower the complication rate.[6] In these studies, however, the residual height of the alveolar crest in the posterior maxilla was >4 mm, and the mean elevated height was <4 mm.[4–6]

Sinus floor elevation procedures could be performed with or without grafting materials.[7] Nevertheless, literatures showed that grafted sinus floor elevation resulted in more new-formed

Editor: N/A.

ZL and CL have contributed equally to this work and are co-first authors.

Funding/support: The work was financially supported by the National Natural Science Foundation of China 81570983 (YZ) and Provincial Key Clinical Specialist Construction Program of Jilin 20165074 (CL).

The authors have no conflicts of interest to disclose.

[a] Department of Oral Implantology, School and Hospital of Stomatology, Jilin University, Changchun, [b] School of Stomatology, Lanzhou University, Lanzhou, China.

[*] Correspondence: Yanmin Zhou, 1500 Qinghua Road, Changchun, 130021, Jilin, China (e-mail: zhouym62@126.com).

Medicine (2018) 97:17(e0608)

Received: 26 March 2018 / Accepted: 6 April 2018

http://dx.doi.org/10.1097/MD.0000000000010608

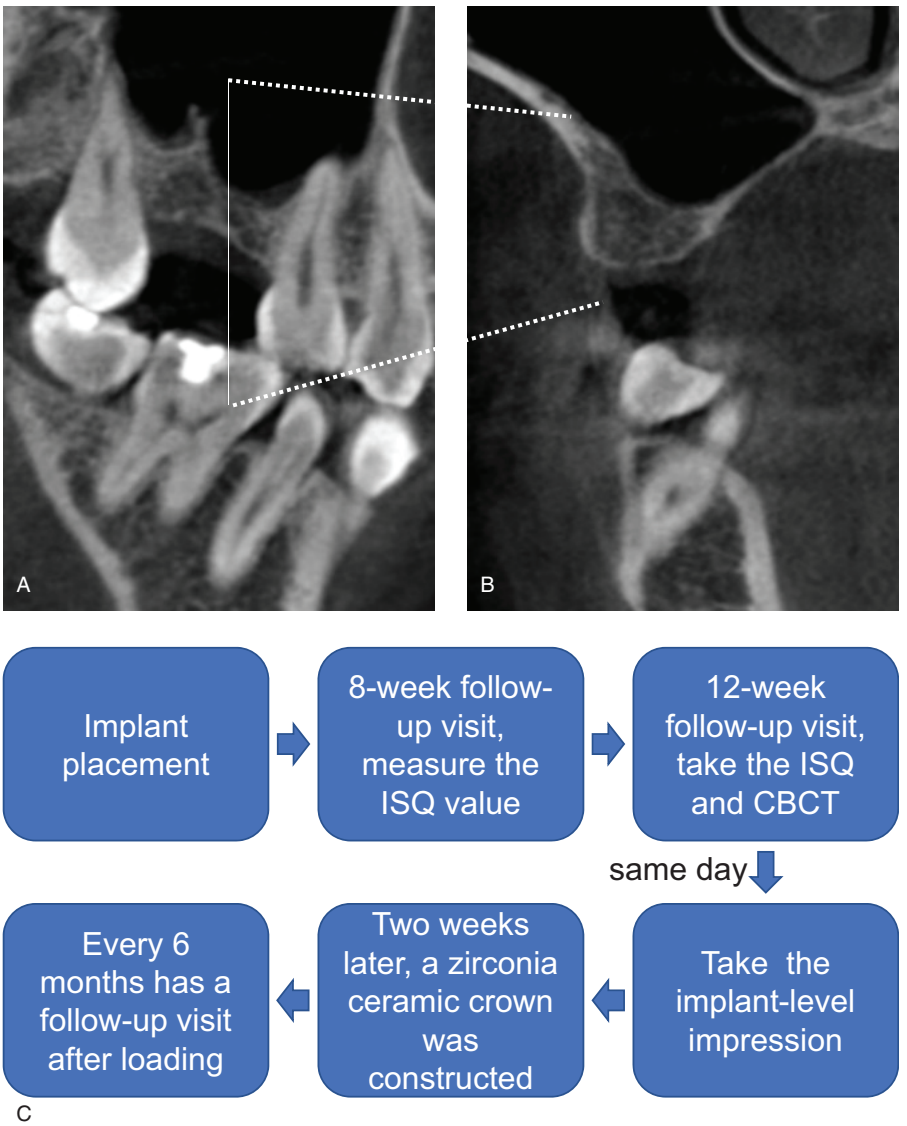

Figure 1. Preoperative CBCT and treatment plan: (A) the sagittal CBCT scan showed the residual bone height of #16 was 3.5 mm; (B) the coronal CBCT scan; (C) flow chart of the treatment plan. CBCT = cone-beam computer tomography.

bone and better implantation than graft-free sinus floor elevation.[8,9] Platelet-rich fibrin (PRF), a second-generation platelet concentrate, has been documented that the 3 dimensional mesh architecture of it can slow release of polypeptide growth factors such as transforming growth factor β1, platelet-derived growth factor, vascular endothelial growth factor, and matrix glycoproteins gradually over at least 1 week, which are beneficial for promoting bone regeneration.[10] It has been described as the sole grafting material in sinus floor elevation procedures, using a lateral[11] or crestal approach.[12]

The aim of this report was to illustrate a modified new technique to help to avoid perforations of the sinus membrane. In the case, the residual height of the alveolar crest in the posterior maxilla was <4 mm, endoscopically controlled flapless transcrestal sinus floor elevation using platelet-rich fibrin as the only grafting material and simultaneous dental implant placement. The final prosthesis was finished in post-operation 3 months.

2. Case report

A 26-year-old woman consulted the Department of Oral Implantology with loss of the maxillary right first molar. The tooth was extracted 1 year ago due to secondary endodontic infection and no prosthesis was performed. All general health prerequisites were met, and she denied smoking habit and the history of bruxism. In all dimensions, sufficient space was available for an implant crown with an anatomical design. Furthermore, the keratinized gingival width of #16 was adequate. Examination by cone-beam computer tomography (CBCT) showed an available residual bone height (RBH) of #16 was 3.5 mm (Fig. 1A, B). Based on the patient's condition, the according treatment plan was drawn up as shown in Fig. 1C.

On the day of surgery, informed consent agreement was signed by the patient before surgery. Patient rinsed with 0.12% chlorhexidine mouthwash for 3 min/time for 3 times prior to the

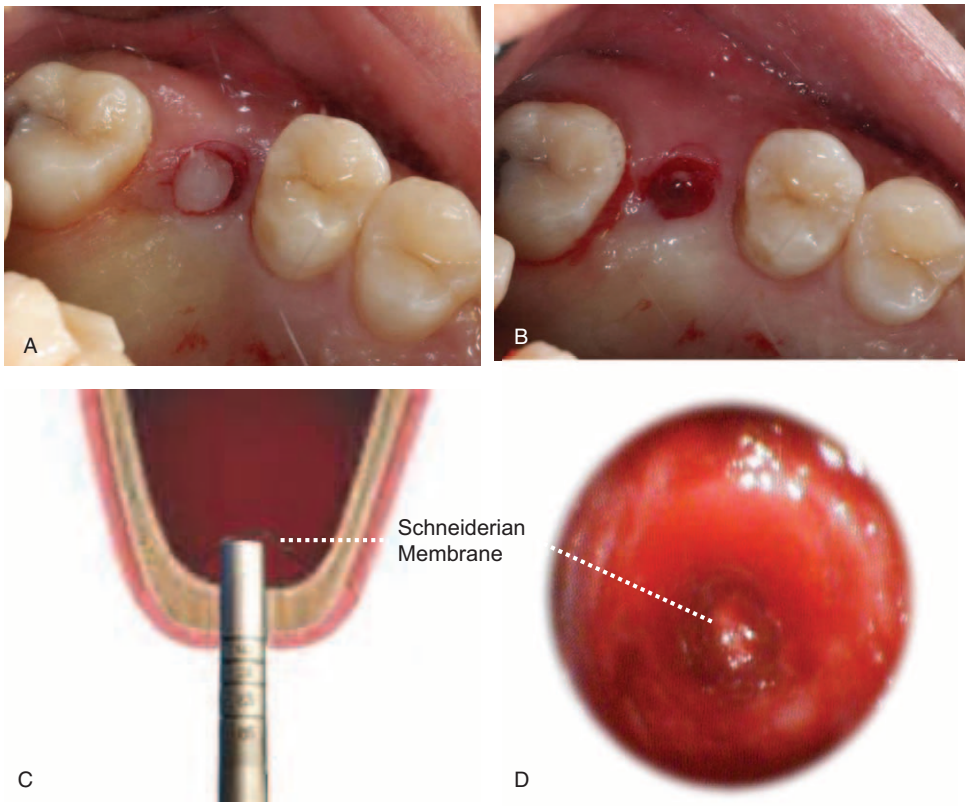

Figure 2. Intraoperative photographs and illustration describing each step of the surgery: (A) punch incision by means of circular tissue punch; (B) the full thickness punch was removed; (C) the sinus membrane was elevated to reach a height of 7 mm; and (D) the integrity of the sinus membrane was monitored via the endoscope.

operation. After local anesthesia using articaine with adrenaline 1:100,000, a motor-driven circular tissue punch (29630, Nobel Biocare, Sweden) of the same diameter of the selected implant was used to punch incision to gain access to bone without elevating the flap (Fig. 2A, B). The osteotomy was prepared to approximately 1 mm before reaching the sinus membrane with a pilot drill at the punch site under permanent cooling with physiological saline solution. After fracturing the cortical bone of the sinus floor with a rounded tapered osteotome 4.3 mm in diameter (ZEPF, Deutschland), the maxillary sinus membrane was elevated to reach a height of 7 mm (Fig. 2C). During the elevation procedure, the integrity of the sinus membrane was constantly monitored via the endoscope (POLYDIAGNOST, Germany) (Fig. 2D). Thirty milliliter whole blood were taken in three glass-coated plastic tubes without an anticoagulant prior to the surgery. And then the blood was immediately centrifuged at 3000 rpm for 10 minutes. A natural fibrin clot was obtained in the middle of the tube. PRF clots were pressed into membranes with sterile dry gauze, and filled in the elevated sinus (Fig. 3A, B). Subsequently, the maxillary sinus membrane was elevated again, and gradually reached a total height of 12 mm (Fig. 3C). Immediately endoscope observed the moving of the membranes of PRF following the membrane of the maxillary by breathing exercise (Fig. 3D). An implant (Φ4.8 mm × 12 mm, Straumann, Switzerland) was installed with a torque of 30 N/cm (Fig. 3E), following with a healing screw placement (Fig. 3F).

Post-surgical care included the administration of antibiotic for 3 days (oral administration, amoxicillin 0.5 g TID, metronidazole 0.3 g TID), and mouthwash twice a day for 7 days (0.12% chlorhexidine).

Resonance frequency analysis (RFA) was determined by measuring "Implant Stability Quotient" (ISQ) at 8 and 12 weeks after implant placement. The ISQ value was measured in 5 directions (occlusal, buccal, lingual, medial, distal) of each implant for 3 times, respectively. CBCT scans were scheduled before and 12 weeks after implant placement, which were used for measurement of bone available and new bone formation around the implant.

Postoperative healing was uneventful. Eight weeks post-surgery, the mean ISQ value = 72.6 in all 5 directions (occlusal, buccal, lingual, medial, distal). Twelve weeks post-surgery, direct contact between bone and implant interface was found in CBCT images. In addition, the cross-sectional view showed that the bone height around the implant was approximately 11 mm (Fig. 4). The mean ISQ value increased to 76.6 in 5 directions (occlusal, buccal, lingual, medial, distal). The implant-level impression was completed (Fig. 5). Two weeks later, a zirconia ceramic crown constructed (Fig. 6). The final result appeared to be satisfactory. At 6 months after loading, the CBCT scan showed the gained bone height was stable (Fig. 7).

3. Discussion

The number of sinus lifts done worldwide is increasingly large,[13] the need for less invasive techniques arises to optimize the results of implants and minify the period of treatment in the posterior maxillary area. Traditionally, a case with residual bone height <5 mm was treated by maxillary sinus elevation by lateral approach. However, sinus floor elevation with a lateral approach

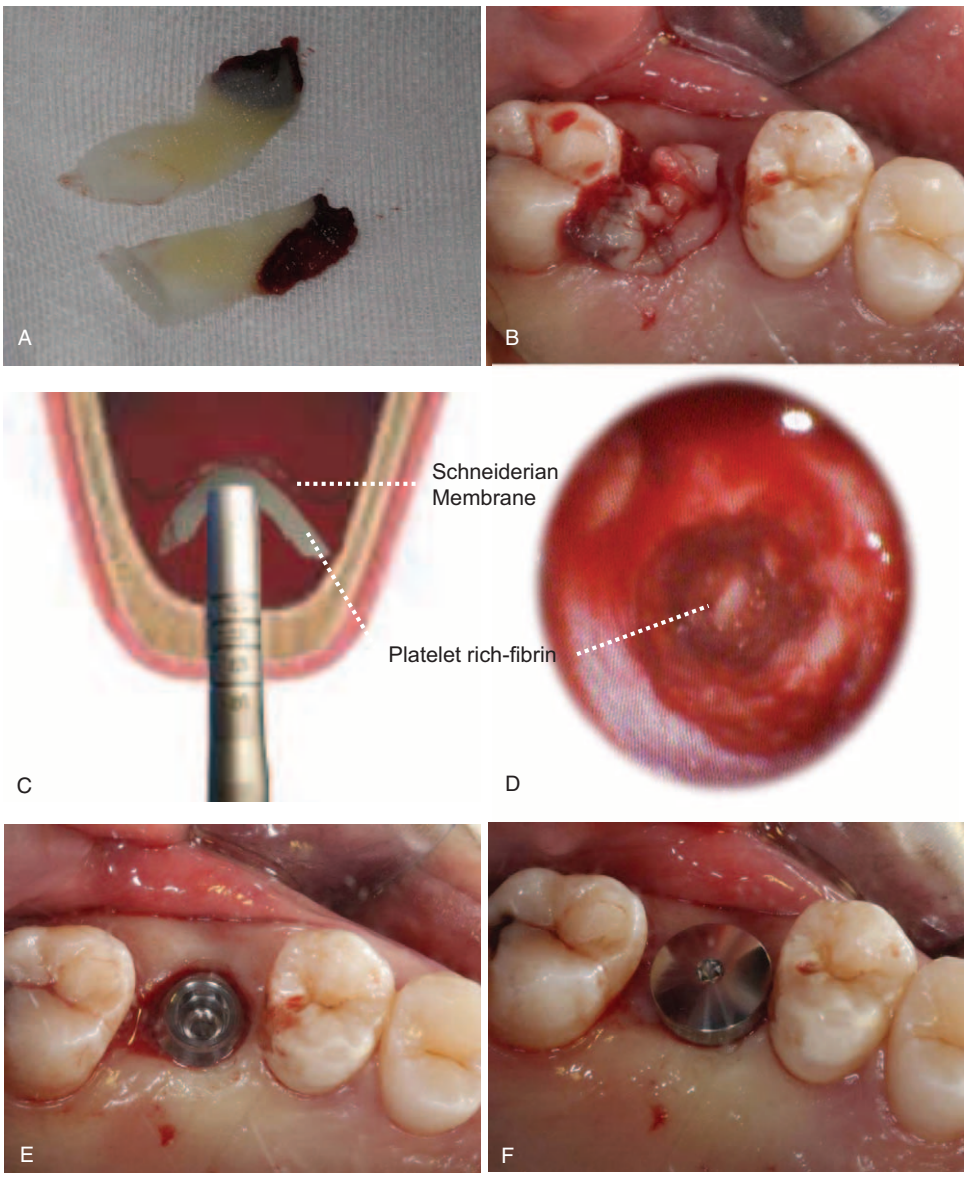

Figure 3. Representative images and illustration describing each step after PRF grafting: (A) PRF clots were pressed into membranes with sterile dry gauze; (B) PRF membranes were filled in the elevated sinus; (C) the sinus membrane was elevated again, and reach a total height of 12 mm; (D) the moving of the membranes of PRF following the membrane of the sinus by breathing exercise was observed via endoscope immediately. The entire maxillary sinus membrane and PRF moved with inhalation and exhalation if there was no perforation. (E) An implant (Φ4.8mm × 12 mm, Straumann, Switzerland) was inserted with a torque of 30 N/cm; and (F) a healing screw was placed. PRF = platelet-rich fibrin.

results in significant postoperative swelling, bleeding and pain, and long healing periods. Compared with lateral approach, transcrestal approach was less invasive. However, it is widely accepted that the transcrestal approach required the more than residual bone height of 5 mm.[3] It is highly desirable to develop a method in maxillary sinus lifting which can alleviate suffering and shorten the treatment duration.

This case firstly reported a sinus floor elevation procedure by a modified transcrestal approach with 3.5 mm of RBH, and the maximum lifting height of the maxillary sinus membrane much larger than 4 mm. Firstly, the sinus floor was elevated to 4 mm with the traditional osteotome approach. Subsequently, the maxillary sinus membrane was elevated again after PRF membranes filled in the elevated sinus. During the sinus floor elevation, the flexible of PRF membranes moderated the force directed to the sinus membrane, which could reduce the morbidity of perforation. Even the blind nature of this procedure prevents the surgeon from identifying sinus membrane perforates, good visualization of the site could be achieved with the endoscope. Only on attaining visual control will it be possible to diagnose a perforation with certainty.[14] Moreover, several clinical studies also indicated the use of PRF as the sole filling material during a simultaneous sinus floor elevation and implantation obtained a high volume of natural regenerated bone.[11,15] From a histologic point of view, PRF in combination with freeze-dried bone allograft in sinus floor elevation could reduce the healing time by half.[16] In this case, even though a tear does occur, we can use the PRF membranes patch it. However, no perforation was monitored during the whole procedure.

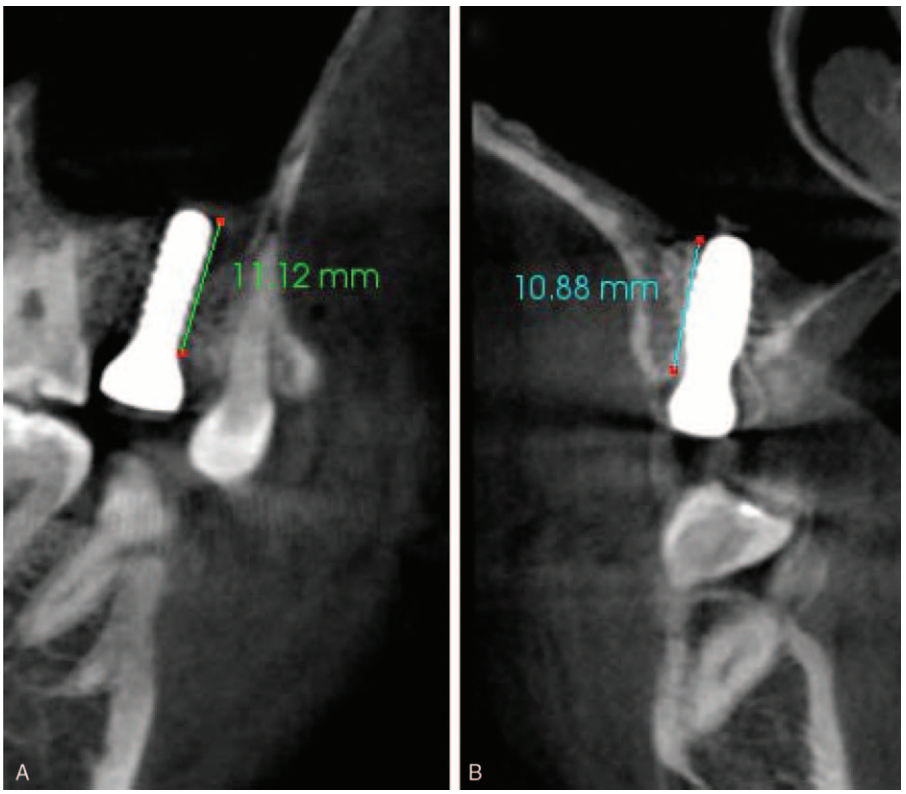

Figure 4. Twelve weeks post-surgery, CBCT showed the bone height around the implant was approximately 11 mm in CBCT: (A) the sagittal CBCT scan; (B) the coronal CBCT scan. CBCT = cone-beam computer tomography.

In this case, no complications were found post-operation. The flapless procedures leaving the periosteum intact on the ridge maintained a better blood supply to the site, and reduced the risk of bone resorption. At the patient level, flapless procedures resulted in fewer complications, such as swelling and pain, and reduced intraoperative bleeding, surgical time, and the need for suturing.

As a suitable method to objectively monitor implant stability longitudinally, RFA technology for monitoring implants after

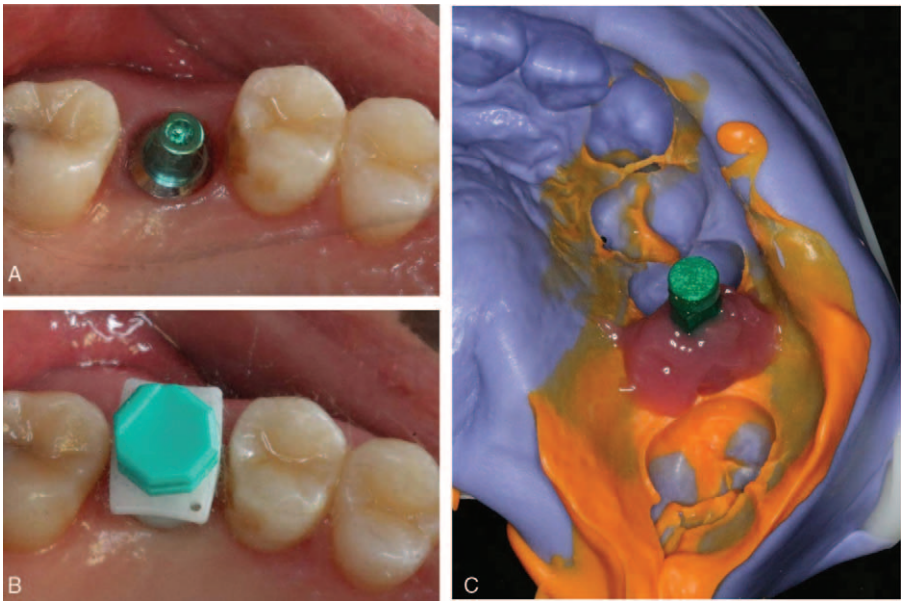

Figure 5. The impression was finished at 12 weeks post-surgery: (A) solid abutment in place; (B) impression cap and positioning cylinder in place; and (C) analog placed in the impression.

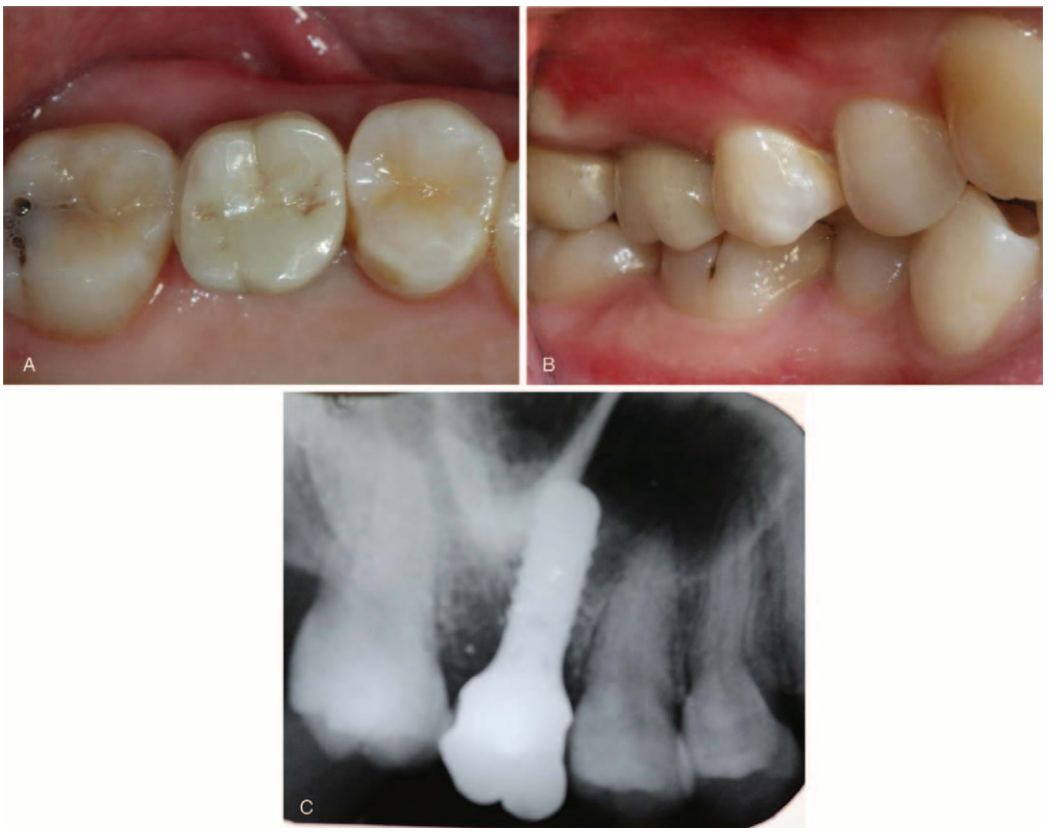

Figure 6. Fourteen weeks post-surgery, a zirconia ceramic crown was constructed, the final result appeared to be satisfactory: (A) occlusal view of the final prosthesis in place; (B) buccal view of the final prosthesis in place; and (C) periapical radiograph immediately after the final prosthesis in place.

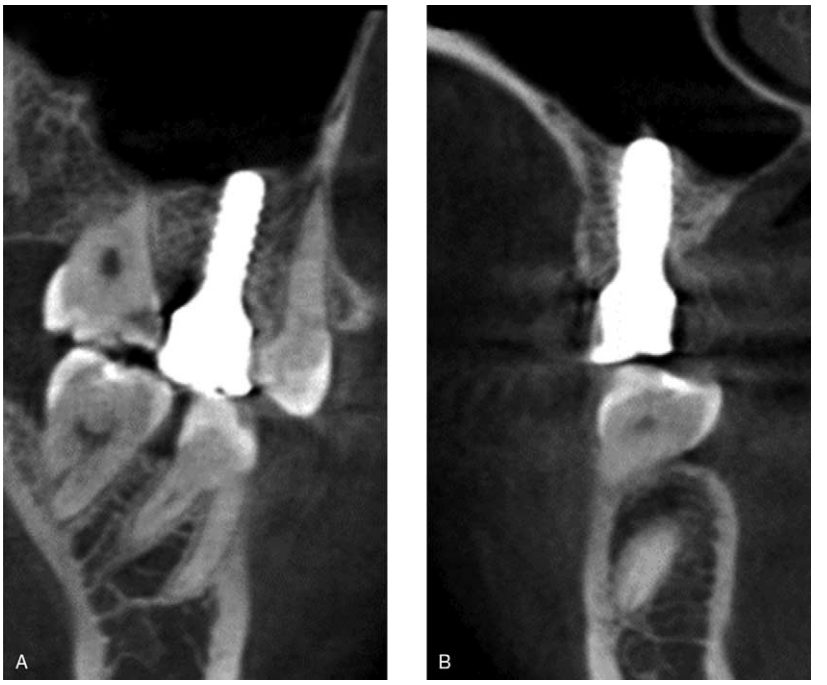

Figure 7. Representative CBCT images of implants after 6 months loading. The results showed the gained bone height around the implant was stable: (A) the sagittal CBCT scan; (B) the coronal CBCT scan. CBCT = cone-beam computer tomography.

sinus lift procedures was described earlier.[17] However, the analysis of the course of ISQ values reflects the relative stability of an implant. Therefore, several measurements should be carried out during each examination to make a valid course assessment possible. Literature has shown the CBCT analysis could be used to evaluate the bone regeneration.[18] In addition, a healing period of approximately 6 months has been the standard of care for implants placed with simultaneous sinus floor elevation traditionally.[19] The threshold level for prosthetic rehabilitation was defined as an ISQ value of 70. This value is based on a clinical study utilizing standard implant placement procedures in the posterior mandible.[20] In this case, 8 weeks after surgery, the mean ISQ value = 72.6, 12 weeks after, the mean ISQ value = 76.6. And 14 weeks after surgery, the final prosthesis was finished, which reduced the whole period of treatment.

The results of this case indicate that simultaneous dental implant placement and endoscope-guided transcrestal approach to flapless sinus floor elevation using platelet-rich fibrin as the only grafting material is viable for patients with an RBH <4 mm, in the edentulous posterior maxilla. But a large number of long-term clinical should be carried to confirm this result.

In conclusion, the modified transcrestal approach can be applied to augment maxillary sinus with an RBH <4 mm. The advantages of the sinus elevation method as used in this study are: the utilization of a minimally invasive surgical approach decreased bone and soft tissue trauma; reduced discomfort of the patient after sinus elevation surgery; the use of the PRF reduced the healing period; and expanded the indications of the treatment of transcrestal sinus elevation.

Acknowledgments

The authors thank Prof. Lin Wang for the fruitful discussion and technique help.

Author contributions

Conceptualization: Yanmin Zhou.
Data curation: Jing Zhou, Manlin Qi.
Investigation: Xiaolin Sun, Xue Li.
Writing—original draft: Zhenzhen Liu, Chunyan Li
Writing—review and editing: Chunyan Li, Yanmin Zhou.
Conceptualization: Jing Zhou.
Data curation: Xiaolin Sun, Xue Li.
Formal analysis: Manlin Qi.
Investigation: Jing Zhou.
Supervision: YANMIN ZHOU.
Writing – original draft: Zhenzhen Liu.
Writing – review & editing: Chunyan Li.

References

[1] Pjetursson BE, Lang NP. Sinus floor elevation utilizing the transalveolar approach. Periodontol 2000 2014;66:59–71.
[2] Fugazzotto PA. Augmentation of the posterior maxilla: a proposed hierarchy of treatment selection. J Periodontol 2003;74:1682–91.
[3] Rosen PS, Summers R, Mellado JR, et al. The bone-added osteotome sinus floor elevation technique: multicenter retrospective report of consecutively treated patients. Int J Oral Maxillofac Implants 1999;14: 853–8.
[4] Engelke W, Deckwer I. Endoscopically controlled sinus floor augmentation. A preliminary report. Clin Oral Implants Res 1997;8:527–31.
[5] Wiltfang J, Schultze-Mosgau S, Merten HA, et al. Endoscopic and ultrasonographic evaluation of the maxillary sinus after combined sinus floor augmentation and implant insertion. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;89:288–91.
[6] Nkenke E, Schlegel A, Schultze-Mosgau S, et al. The endoscopically controlled osteotome sinus floor elevation: a preliminary prospective study. Int J Oral Maxillofac Implants 2002;17:557–66.
[7] Tan WC, Lang NP, Zwahlen M, et al. A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. Part II: transalveolar technique. J Clin Periodontol 2008;35(suppl):241–54.
[8] Nedir R, Nurdin N, Khoury P, et al. Osteotome sinus floor elevation with and without grafting material in the severely atrophic maxilla. A 1-year prospective randomized controlled study. Clin Oral Implants Res 2013;24:1257–64.
[9] Si MS, Zhuang LF, Gu YX, et al. Osteotome sinus floor elevation with or without grafting: a 3-year randomized controlled clinical trial. J Clin Periodontol 2013;40:396–403.
[10] Dohan Ehrenfest DM, Bielecki T, Del Corso M, et al. Shedding light in the controversial terminology for platelet-rich products: platelet-rich plasma (PRP), platelet-rich fibrin (PRF), platelet-leukocyte gel(PLG), preparation rich in growth factors (PRGF), classification and commercialism. J Biomed Mater Res A 2010;95:1280–2.
[11] Simonpieri A, Choukroun J, Del Corso M, et al. Simultaneous sinus-lift and implantation using microthreaded implants and leukocyte- and platelet-rich fibrin as sole grafting material: a six-year experience. Implant Dent 2011;20:2–12.
[12] Toffler M, Toscano N, Holtzclaw D. Osteotome-mediated sinus floor elevation using only platelet-rich fibrin: an early report on 110 patients. Implant Dent 2010;19:447–56.
[13] Starch-Jensen T, Jensen JD. Maxillary sinus floor augmentation: a review of selected treatment modalities. J Oral Maxillofac Res 2017;8:e3.
[14] Emmerich D, Att W, Stappert C. Sinus floor elevation using osteotomes: a systematic review and meta-analysis. J Periodontol 2005;76:1237–51.
[15] Mazor Z, Horowitz RA, Del Corso M, et al. Sinus floor augmentation with simultaneous implant placement using Choukroun's platelet-rich fibrin as the sole grafting material: a radiologic and histologic study at 6 months. J Periodontol 2009;80:2056–64.
[16] Choukroun J, Diss A, Simonpieri A, et al. Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part V: histologic evaluations of PRF effects on bone allograft maturation in sinus lift. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101:299–303.
[17] Hallman M, Sennerby L, Zetterqvist L, et al. A 3-year prospective follow-up study of implant-supported fixed prostheses in patients subjected to maxillary sinus floor augmentation with a 80:20 mixture of deproteinized bovine bone and autogenous bone Clinical, radiographic and resonance frequency analysis. Int J Oral Maxillofac Surg 2005;34:273–80.
[18] Soardi CM, Zaffe D, Motroni A, et al. Quantitative comparison of cone beam computed tomography and microradiography in the evaluation of bone density after maxillary sinus augmentation: a preliminary study. Clin Implant Dent Relat Res 2014;16:557–64.
[19] Rasmusson L, Thor A, Sennerby L. Stability evaluation of implants integrated in grafted and nongrafted maxillary bone: a clinical study from implant placement to abutment connection. Clin Implant Dent Relat Res 2012;14:61–6.
[20] Bornstein MM, Hart CN, Halbritter SA, et al. Early loading of non-submerged titanium implants with a chemically modified sand-blasted and acid-etched surface: 6- month results of a prospective case series study in the posterior mandible focusing on periimplant crestal bone changes and implant stability quotient (ISQ) values. Clin Implant Dent Relat Res 2009;11:338–47.