

# Displacement of the full body of a dental implant into the sinus space without membrane perforation and subsequent osseointegration: a case report

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## Abstract

An increasing number of studies have investigated the use of osteotome sinus floor elevation (OSFE) with simultaneous implant placement for maxillary sinus floor residual bone height (RBH) <4 mm. Many studies have reported good clinical results, but very few have reported complications related to this procedure. Here, the case of a 50-year-old female patient with an RBH in the left upper posterior region of 1–4 mm, who underwent OSFE with simultaneous placement of three Bicon short<sup>®</sup> implants, is described. One of the implants was found to be displaced during the second-stage surgery. The displaced implant was removed using piezosurgery, OSFE with simultaneous implant placement was repeated, and the missing tooth was reconstructed 6 months later. This case suggests that OSFE with simultaneous implant placement is feasible for severely atrophic maxillary sinus floor, but carries a risk of implant displacement.

## Keywords

Osteotome sinus floor elevation, implant displacement, short implant, residual bone height, atrophic maxillary sinus floor, piezosurgery

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## Introduction

Osteotome sinus floor elevation (OSFE) is commonly used in clinical practice due to short operation time, small incision approach, light postoperative response, and high lifting efficiency.<sup>1</sup> Early consensus suggested that residual bone height (RBH) was the main criterion for selection of OSFE and lateral window technique.<sup>1</sup> In patients with RBH <4 mm, the recommended procedures are lateral sinus floor elevation (LSFE), bone graft and delayed implant placement.<sup>2</sup> However, as early as 1999, good results at 33 months of follow-up have been reported for maxillary sinus floor bone augmentation and concurrent implants in patients with RBH 1–2 mm.<sup>3</sup> In addition, subsequent studies of cases with RBH <4 mm have reported that simultaneous implant placement with OSFE can achieve satisfactory clinical results,<sup>4–6</sup> even without bone grafting.<sup>7,8</sup> These outcomes may be related to the unique osteogenic capabilities of the maxillary sinus, improvement in surgical instrumentation, lifting methods, implant surface treatment and optimized structural design.<sup>9</sup> Short implants have made the OSFE technique easier to perform,<sup>10–12</sup> however, there is a high risk of surgical complications with OSFE and simultaneous implant placement. Reported complications associated with OSFE include perforation, implant drop into the maxillary sinus, sinusitis, postoperative bleeding, infection, and dizziness,<sup>13</sup> but complications associated with OSFE and simultaneous implant placement in cases with RBH <4 mm have rarely been reported. Herein, the case of OSFE and implant placement in a patient with RBH of 1–4 mm is described

## Case report

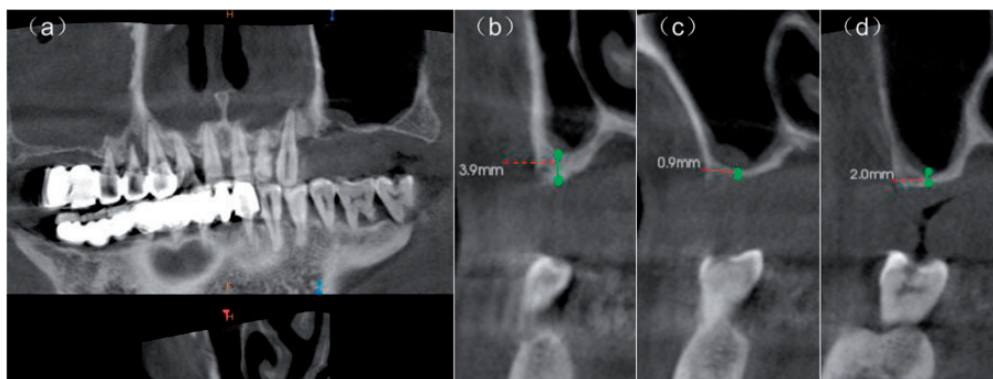
This report was approved by the Ethics Committee of the Fourth Affiliated Hospital of Nanchang University, China. Written

informed consent was obtained from the patient for publication of this case report and accompanying images. The reporting of this study conforms to CARE guidelines,<sup>14</sup> with all patient details de-identified.

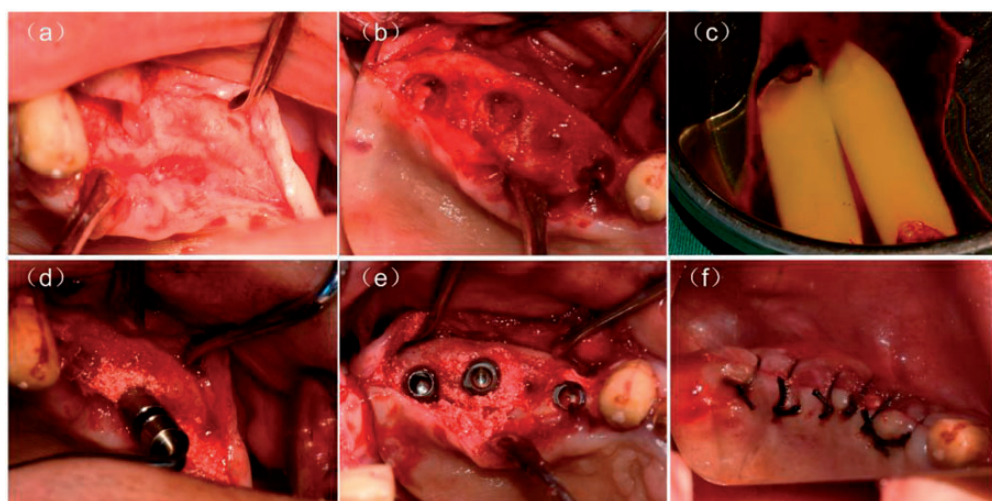
In August 2018, a 50-year old female patient presented at the Department of Oral Implantology at the Fourth Affiliated Hospital of Nanchang University, Nanchang, China, for replacement of her missing posterior teeth in the left upper jaw. The patient had been previously healthy, smoking up to 20 cigarettes/day, and with no history of drug misuse or systemic disease. An intraoral examination showed average general oral health, with obvious gingival recession, loss of left upper posterior teeth and normal occlusal–gingival distance. Cone beam computed tomography (CBCT), performed with a Carestream CS 9300 Select scanner (Carestream Health Inc., Rochester, NY, USA) with tube current, 2–15 mA; tube voltage, 60–90 KV; and scan time, 12–18 s ( $\pm 10\%$ ), revealed that RBHs of the left upper posterior region were 3.9 mm, 0.9 mm and 2.0 mm for International Standards Organisation (ISO) tooth sites 24, 26 and 27, respectively (Figure 1).

Following complete clinical evaluation, implant placements were planned for the three ISO sites (24, 26, and 27) and three surgical options were proposed to the patient, based on the present authors' previous research:<sup>10,15</sup> (1) OSFE with delayed implant placement; (2) OSFE with simultaneous implant placement; or (3) LSFE with delayed implant placement. The treatment plans and expected outcomes were explained objectively to the patient, and the patient selected option (2): OSFE with simultaneous implant placement.

The detailed treatment plan was explained to the patient prior to obtaining written informed consent for implant surgery. The surgical procedure (Figure 2) was performed under local anaesthesia using 4% articaine with 1:100 000 adrenaline (Pierrel



**Figure 1.** Preoperative cone beam computed tomography in a 50 year old female patient showing residual bone height: (a) coronal plane; and International Standards Organisation tooth sites (b) 24; (c) 26 and (d) 27.



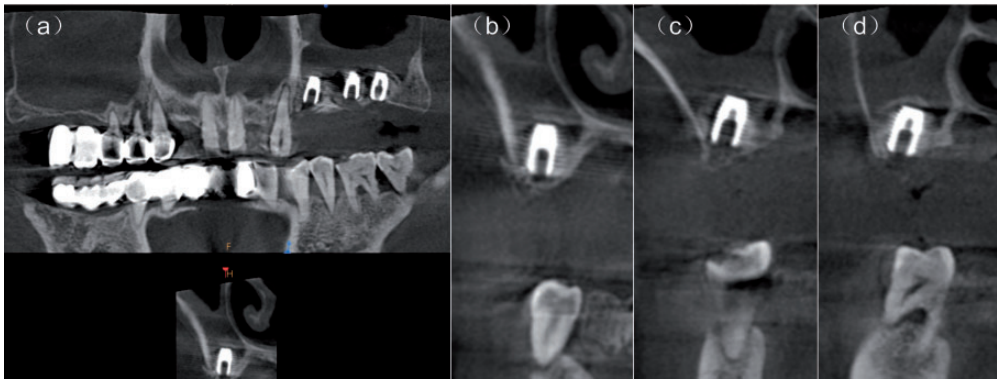
**Figure 2.** Representative procedural images of osteotome sinus floor elevation (OSFE) with simultaneous implant placement in a 50 year old female patient, showing: (a) the alveolar ridge; (b) completion of OSFE; (c) addition of platelet rich fibrin; (d) bone grafting; (e) implant placement; and (f) closed wound.

SpA; Milan, Italy) by intraoral submucosal injection. Hand reaming drills and inner lift osteotome (Bicon; Boston, MA, USA) were used to perform OSFE following a standard protocol, and the sinus mucosa at ISO sites 24, 26, and 27 were all subsequently elevated by 10 mm, according to the scale reference elevation. Valsalva test showed that Schneider's mucosa was intact. Next, platelet rich fibrin was placed into the

maxillary sinus, then 0.75 g  $\beta$ -tricalcium phosphate (SynthoGraft; Boston, MA, USA) was added at an equal distribution to sites 24, 26, and 27. Implants were then inserted subcrestally (about 0.5mm) at sites 24 (model No. 4508; Bicon), 26 (model No. 4508; Bicon) and 27 (model No. 5008; Bicon). Finally, plastic healing plugs were added and the implants were submerged (Figure 2). In the immediate post-operative period, the

patient was advised to take routine precautions (avoid eating for 2 h, cold and soft foods only for the first week, avoid chewing on the affected side, and avoid strenuous exercise), and was prescribed 500 mg oral amoxicillin (three times daily for 5 days), and 0.12% chlorhexidine mouth wash, rinsing three times daily for 7 days. The patient was recalled after 3 days to evaluate wound healing, and was advised to refrain from exercise and vigorous nose blowing for 8 weeks.

At one day following surgery, a CBCT scan revealed that the implants were positioned well (Figure 3). A CBCT scan performed at 6 months following surgery, and before the second-stage operation, revealed implant displacement at position 26 (Figure 4), thus, no treatment was performed on the patient at this time. Plastic healing caps used in the first-stage operation were not visible. The patient was informed and consented to corrective surgery.



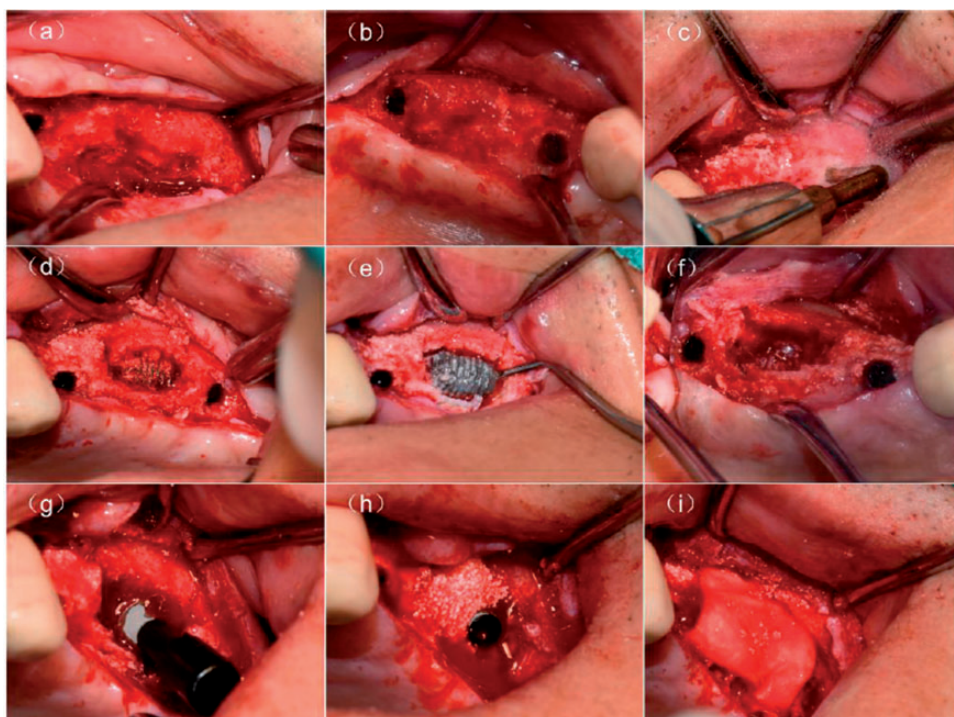
**Figure 3.** Postoperative cone beam computed tomography in a 50 year old female patient at one day following osteotome sinus floor elevation with simultaneous implant placement: (a) coronal plane; and International Standards Organisation tooth sites (b) 24; (c) 26; and (d) 27.



**Figure 4.** Cone beam computed tomography in a 50 year old female patient at 6 months following osteotome sinus floor elevation with simultaneous implant placement, prior to the second stage of treatment, showing implant displacement at International Standards Organisation tooth site 26 (coronal plane).

Bone surrounding the implant was removed by piezosurgery (Woodpecker; Guilin Woodpecker Medical instruments Ltd., Guangxi, China) and good osseointegration of the implant was noted. The patient had requested installation of the prosthesis as soon as possible. Because OSFE with simultaneous implant placement was an option,<sup>16</sup> the bone defect was found to be favourable, and delayed implant placement plan may have increased the trauma, OSFE was repeated at site 26 (Figure 5). The Valsalva test showed an intact sinus floor mucosa and an implant (model No. 6006; Bicon) was placed. The bone defect was grafted with 0.25 g  $\beta$ -tricalcium phosphate (SynthoGraft) and covered with one piece of Kittre Biofilm

(Fujian Kittre Biological Technology Ltd., China; Figure 5). At 6 months following this corrective surgery, the implant at site 26 had healed well and remained in the correct position, and the restoration was completed (Figure 6a). During the second stage of surgery, a non-shoulder abutment (diameter 4.0 mm; height 6.5 mm; angle 15°; Bicon) was placed on the implant at site 24, and plastic healing abutments (diameter 5.0 mm; height 5.0 mm, and angle 0°; Bicon) were placed onto the implants at sites 26 and 27, respectively. An oral impression was taken after 4 weeks, and the teeth were worn after a further 2 weeks. At 6 months following prosthesis installation, the marginal bone level was stable (Figure 6b and c).



**Figure 5.** Representative procedural images of corrective surgery to restore the implant at International Standards Organisation (ISO) tooth site 26, showing: (a) the exposed alveolar ridge; (b) visible healing caps at ISO sites 24 and 27; (c) bone removal by piezosurgery; (d and e) the exposed implant; (f) ISO site 26 with implant removed; (g) osteotome sinus floor elevation with simultaneous implant placement; (h) bone grafting; and (i) biofilm covering the alveolar ridge.



**Figure 6.** Cone beam computed tomography images from a 50 year old female patient who underwent osteotome sinus floor elevation with simultaneous implant placement, showing: (a) panoramic view on the day of prosthesis installation; and (b and c) review at 6 months following prosthesis installation.

## Discussion

With the advancement of implant surface treatment technologies and implant concept, increasing numbers of studies have confirmed that OSFE with simultaneous implant placement can achieve a high success rate in cases of severely atrophic maxillary sinus (RBH <4 mm). For example, a prospective study showed that in cases of RBH  $\leq 4$  mm, the application of OSFE with simultaneous implant placement achieved a 94.6% implant survival rate after 5 years of follow-up.<sup>7</sup> Furthermore, a multicentre, retrospective comparison between RBH  $\geq 4$  mm and RBH <4 mm found that the implant success rate (including survival rate) was similar between the two groups.<sup>17</sup> Overall, the

5-year survival rate of OSFE with simultaneous implant placement is reported to be 94.1–98.05%.<sup>8,18</sup> It is worth noting, however, that the above studies mainly involved very experienced surgeons, and OSFE with simultaneous implant placement is a challenging technology, thus, it is necessary to understand and prevent potential complications.

In the present case, the RBH was only 1–4 mm. Three implants were placed following OSFE, and good primary healing was achieved at sites 25 and 27, showing that OSFE with simultaneous implant placement is feasible when RBH is <4 mm, but may be associated with greater risk in the early stages of healing, which is consistent with Nedir et al.<sup>11</sup> Implant displacement has been reported previously, often involving the

implant having fallen into the maxillary sinus.<sup>13,19,20</sup> To the best of the present authors' knowledge, the present case represents the first published report of submucosal implant displacement in the maxillary sinus. Possible causes of implant displacement reported in the literature are summarised in Table 1.<sup>8,19,21-27</sup>

In the present case, the main cause of implant displacement appeared to be inadequate RBH and insufficient support of the bone or bone graft material around the implant. Sinus lift temporary abutment was not used in this extreme situation, because the patient's gums were thin, it would have been difficult to close the wound without tension, and the risk of abutment exposure was

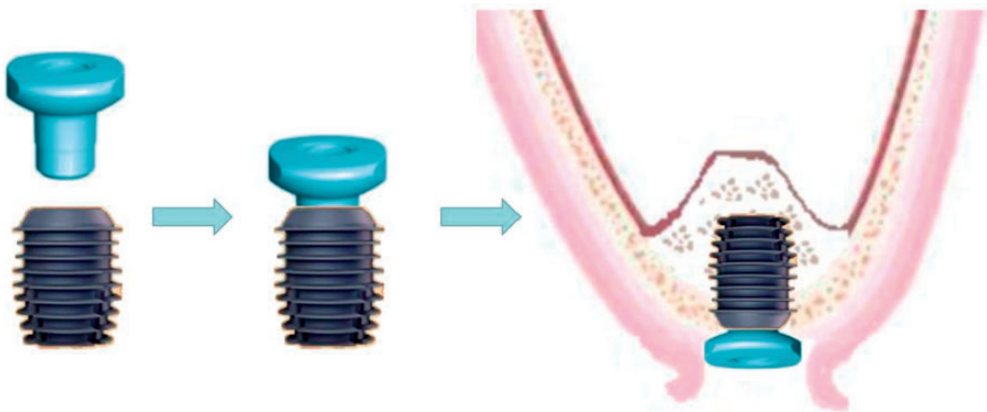
high. Bicon's Sinus Lift Temporary Abutment may be stuck on the top of the alveolar ridge to help the implant stabilize in the implant bed, and the present case suggests that when RBH is insufficient, it is necessary to place a Sinus Lift Temporary Abutment. A sinus lift abutment engages into the implant due to a locking taper connection. The diameter of the Sinus Lift Temporary Abutment is larger than the implant diameter (6, 6.5 or 7 mm), thus sealing the antrostomy and tightening the implant in position (Figure 7). The procedure may be completed by either suturing around or over the sinus lift abutment.<sup>23</sup>

The patient in the present case had a cold and a history of right maxillary sinusitis during the first stage of surgery to place the implants. After six months, the right maxillary sinus inflammation had completely disappeared. Pressure on the implant from the maxillary sinus may also have caused displacement. Under the same conditions without primary stability, the present authors considered that a longer implant may increase the possibility of the implant being affected by external forces,<sup>19</sup> however, results from more case studies are needed to confirm this conjecture.

The precise moment of implant displacement is unknown, but the displaced implant

**Table 1.** Reported possible causes of implant displacement.

Possible cause of implant displacement	Reference No.
Operation error	21, 22
Residual bone height is seriously inadequate	8, 19, 23
No bone / bone graft material support around the implant	19, 24
Early bone loss after surgery	25
Pressure of maxillary sinus	26, 27



**Figure 7.** Schematic showing use of Sinus Lift Temporary Abutment.

was observed to have achieved osseointegration, suggesting that the implant had been displaced in the early stage. The authors suspect that this process may have occurred 0–2 weeks after surgery, as during this period, the osteoclasts are active, and woven bone has not yet formed.<sup>28</sup> Factors that fix the implant in the position of integration are also worth pondering, and may include the presence of additional grafting material from the adjacent sites, and the presence of limiting structures, such as the adjacent implants or internal sinus wall. These factors suggest that the following considerations may be more conducive to implant stability: filling with enough bone graft material, and ensuring limiting structures near the implant bed, such as maxillary sinus base interval, and narrow maxillary sinus shape.<sup>29</sup>

Integrity of the maxillary sinus mucosa is crucial for osseointegration. Only in a stable environment can bone-graft materials be gradually transformed into bone tissue, particularly when RBH is <4 mm, and perforation of the Schneider mucosa may directly affect the success rate of implants.<sup>1,30</sup> In the present case, the integrity of the membrane was ensured during the first surgery and during subsequent corrective surgery, to ensure osseointegration of the implant. Measures that may help prevent implant displacement are summarised in Table 2.<sup>7,23,24,27,31</sup>

The current patient was reported to smoke 20 cigarettes daily, and smoking is known to be a high-risk factor of peri-implant inflammation.<sup>32</sup> The patient was provided with oral health education, and asked to reduce their smoking to less than 10 cigarettes daily, with a re-examination cycle set to once every 3–6 months to reduce the risk of peri-implant inflammation. The surgeon in this study (H-W Wei) has more than 10 years of experience of implant surgery, and a large number of cases with RBH <4 mm have been completed by this surgeon using OSFE with simultaneous implant placement.<sup>10,15</sup> Despite this experience, the complication of implant

**Table 2.** Measures to prevent implant displacement.

Measure	Reference No.
Ensure that there is enough bone/ bone graft material/bone wall around the implant	–
Use a wide-necked implant with relatively higher safety	7
Recommended use of sinus lift temporary abutment when residual bone height is <4 mm	23
As far as possible, ensure the integrity of the Schneider mucosa and place bone graft material so that the air pressure in the maxillary sinus is evenly dispersed	31
Avoid strong sneezing, and try to avoid chewing hard objects on the affected side	24, 27

displacement still occurs, and the present case serves as a reminder for caution in cases with RBH <4 mm, and for oral surgeons to select a surgical procedure that matches their abilities.

In conclusion, the present case suggests that OSFE with simultaneous implant placement is feasible in cases of RBH <4 mm, but there is a risk of implant displacement.

#### Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to inconsistent language expression, but are available from the corresponding author upon reasonable request.

#### Author contributions

XX and ZY-W contributed to writing the paper, HW-W contributed to the conception and design of the study. All authors read and approved the manuscript.

#### Declaration of conflicting interest


The authors declare that there is no conflict of interest.



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