Int J Clin Exp Med 2015;8(4):4826-4836
www.ijcem.com /ISSN:1940-5901/IJCEM0003640

Original Article

Displacement of a dental implant into the maxillary sinus after internal sinus floor elevation: report of a case and review of literature

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Received November 5, 2014; Accepted January 5, 2015; Epub April 15, 2015; Published April 30, 2015

Abstract: Background: Dental implant placement in the posterior maxilla may be complicated by implant migration into the maxillary sinus. Purpose: To report the clinical and radiological characteristics of a patient who experienced dental implant displacement into the maxillary sinus following sinus floor elevation, and to compare our findings with those of other published reports of the displacement of dental implants. Materials and methods: Implant placement and maxillary sinus elevation were performed simultaneously. The location of the displaced implant was monitored for 8 years, until the ectopic implant was surgically removed using the lateral window approach. The contributing factors, treatment modality, and clinical outcome for our patient were compared with those of patients reported in the literature. Results: The clinical characteristics of our case were similar to those of patients with displaced implants who were also asymptomatic for long periods. The clinical outcome of our case was consistent with that of patients who underwent similar surgeries. Conclusions: Transnasal endoscopic removal of an ectopic implant may be suitable in cases in which the ectopic implant is accessible. Transoral direct approaches are adequate in most cases in which endoscopic approaches may be confounded. The bony-window transoral technique may allow the removal of large implants.

Keywords: Maxillary sinus, dental implant placement, sinus floor elevation, bony-window transoral technique

Introduction

Replacing missing teeth with osseointegrated dental implants is a common surgical procedure, providing long-term relief of tooth loss in most cases. However, dental implant placement is not without its complications. Complications related to dental implants include infection, failure to osseointegrate, bleeding, and migration of the dental implant. Implants installed in the posterior maxilla can migrate into the maxillary sinus. Implant displacement in the posterior maxilla usually occurs during surgery, but it can also occur months or even years of function of implant-supported prostheses [1-4].

The resorption of the alveolar ridge and the progressive pneumatization of the maxillary sinus reduce the height of the edentulous posterior maxilla. Inadequate bone height is the primary cause of implant displacement in the posterior maxilla, and serves as a contraindication for implant surgery [3]. The presence of type-IV alveolar bone also contributes to the displacement of maxillary dental implants [3]. Sinus floor elevation is a surgical technique used to increase bone height at the posterior maxilla before the placement of dental implants. Sinus floor elevation may be performed using an internal or external approach. Internal approaches are less costly, more straightforward procedures that can be performed more rapidly and result in considerably less morbidity than external approaches [5, 6]. Internal approaches produce reliable long-term results for the placement of dental implants in most cases [5, 6].

Clinical reports of the migration of dental implants into the maxillary sinus of patients who had undergone an internal sinus lift before implant placement are scant. We present a case of dental implant migration into the maxillary sinus following internal sinus floor eleva-

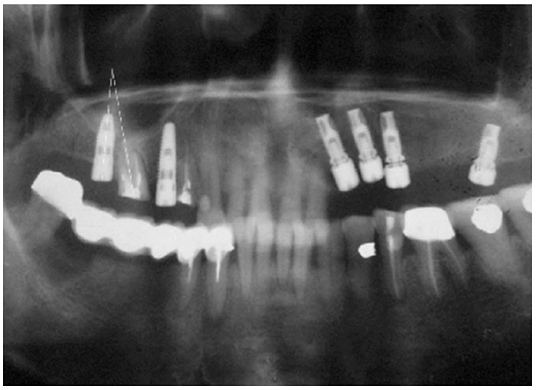

Figure 1. Panoramic radiograph showing the implant following maxillary sinus elevation. A tooth-supported fixed prosthesis had been installed previously from the right mandibular canine to the third molar. The restored occlusal surface of the mandibular right third molar was higher than the right-side functional occlusal plane.

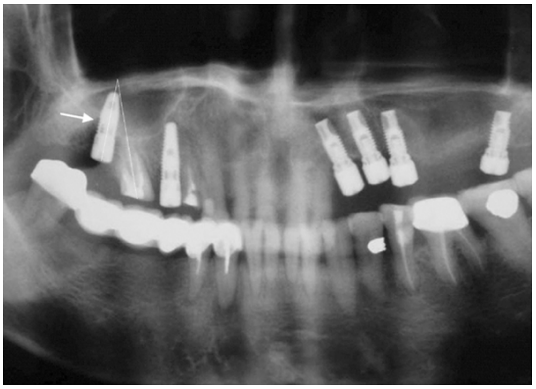

Figure 2. Panoramic radiograph recorded 3 months after implant placement. The loss of opacity near the neck of the right second molar implant indicated bone loss, and was more conspicuous than that detected at the 6-month follow-up examination. The right second molar implant exhibited an apical shift and distal tilting.

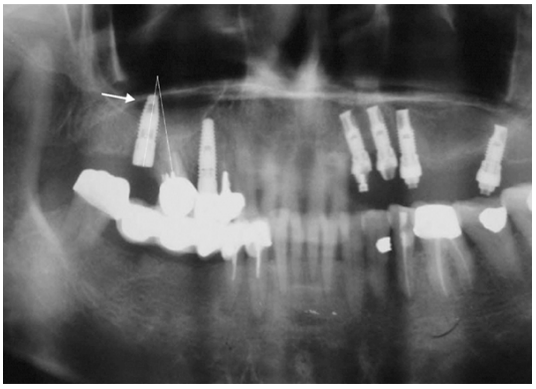

Figure 3. Panoramic radiograph recorded 6 months after implant placement. The loss of opacity near the apex of the right second molar implant indicated bone loss and the bone graft had been lost completely.

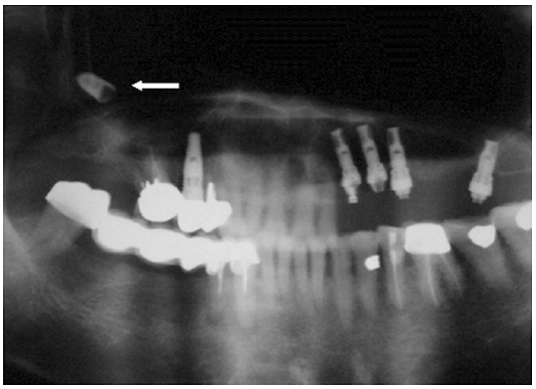

Figure 4. Panoramic radiograph recorded 6 months after implant placement showing the ectopic implant in the maxillary sinus following the attempt to remove it.

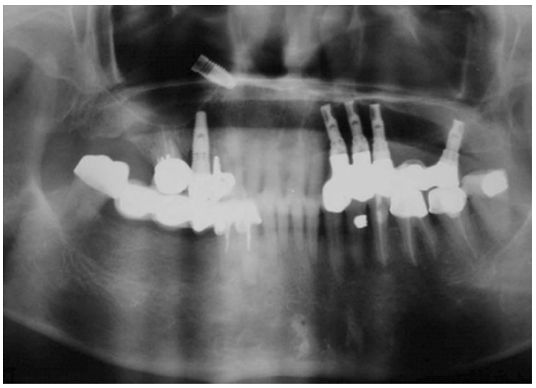

Figure 5. Panoramic radiograph recorded 1 year after the displacement of implant into the maxillary sinus.

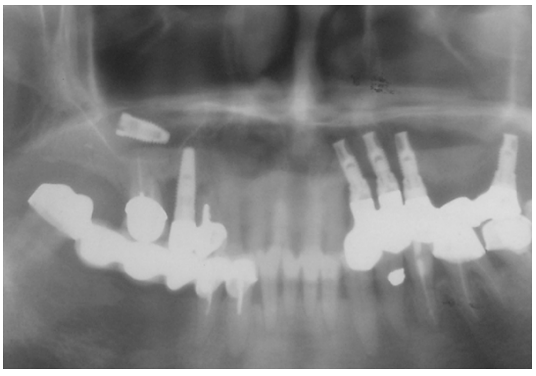

Figure 6. Panoramic radiograph recorded 5 years after the displacement of implant into the maxillary sinus.

tion. The position of the ectopic intrasinal implant was followed until it was removed using a lateral window approach 8 years later. A literature search was performed, and the clinical characteristics, treatment modality, and clinical outcome of our case were compared with those of other patients described in the literature. The factors contributing to dental implant displacement and the available treatment options are discussed.

Case report

Our study was approved by the Hospital Ethics Committee of Zhongshan Hospital and Fudan University (Shanghai, China). Written informed consent was obtained from the patient for the publication of this case report and the accompanying images. In 2005, a partially edentulous 65-year-old woman was referred to our department for implant placement. She exhibited no symptoms of systemic disease, and had no history of smoking. The patient had a loosely fitting, removable partial maxillary denture. The left posterior maxilla was edentulous from the canine to the third molar, and the second premolar and second and third molars were absent from the right posterior maxilla. The first premolar and first molar of the right maxilla had been previously prepared for crowns. A fixed tooth-supported prosthesis was present from the right mandibular canine to the third molar. A panoramic radiograph revealed pneumatization of the maxillary sinuses and advanced absorption of the maxillary alveolar ridge (**Figure 1**).

Implant placement and maxillary sinus elevation were performed in a single operation under local anesthesia. Internal sinus floor elevation, as described by Summers [5], was performed on both sides of the maxilla using the Bio-Oss artificial bone material (Geistlich Pharma, Wolhusen, Switzerland), according to the manufacturer's instructions. The healing abutments were connected simultaneously because the implants exhibited acceptable primary stability (**Figure 1**). The patient was prescribed a 10-day regimen of antibiotic therapy for postoperative prophylaxis, and the wound healing was uneventful. After surgery, the angle of the right second-molar implant changed markedly, with the head of the implant shifting distally, and the implant had begun to recede into the maxilla (**Figure 2**). Six months following implant installation, the root of the implant penetrated the maxillary sinus, and the graft was found to have failed (**Figure 3**).

The patient agreed to the removal of the ectopic implant. However, the implant slipped into the sinus as the temporary abutment was removed. A panoramic radiograph revealed that the implant was located in the superior-external region of the maxillary sinus (**Figure 4**). Because the patient declined to undergo any procedure for the removal of the ectopic implant, the oroantral fistula was sealed with a mucoperiosteal flap. During the subsequent 5 years, the patient exhibited no symptoms of sinus pathology, despite the occasional shifting of the implant within the sinus (**Figures 5** and **6**). Cone-beam computed tomography (CT) images recorded 7.5 years after the implant had entered the sinus showed that it was located adjacent to the nasal cavity and that the Schneiderian membrane had thickened (**Figure 7**). The patient declined surgical removal of the implant, citing that she had remained symptom-free. Six months later, cone-beam CT images showed that the implant remained in the same position and that the swelling of the Schneiderian membrane had decreased (**Figure 8**). The patient agreed to the surgical removal of the ectopic implant. The Caldwell-Luc surgical procedure was performed under local anesthesia using the transalveolar lateral window approach, and the implant was removed from the sinus. Six months later, the lateral wall defect was visible in a cone-beam CT image, but no thickening of the right maxillary sinus was observed (**Figure 9**).

Literature search

To gain a better understanding of the factors that contribute to the displacement of dental implants into the maxillary sinus, we performed a literature search of the major online medical databases using the keywords "implant", "migration", "complications", and "maxillary sinus" to identify articles describing the displacement of dental implants into maxillary sinus that were published before June 2013. The reference sections of the articles retrieved were manually searched for other relevant papers.

Thirty-two articles were identified that described patients (n = 81) who had experienced

Figure 7. Cone-beam computed tomography (horizontal cross-section) image recorded 7.5 years after the displacement of implant into the maxillary sinus.

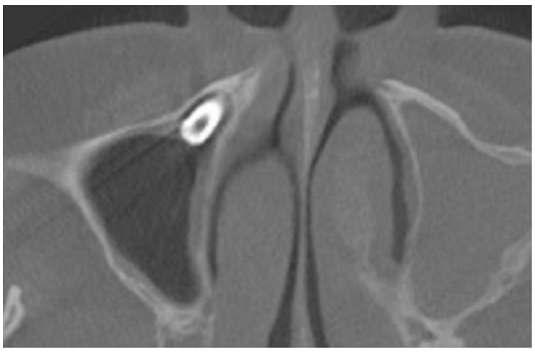

Figure 8. Cone-beam computed tomography (horizontal cross-section) image recorded 8 years after the displacement of implant into the maxillary sinus.

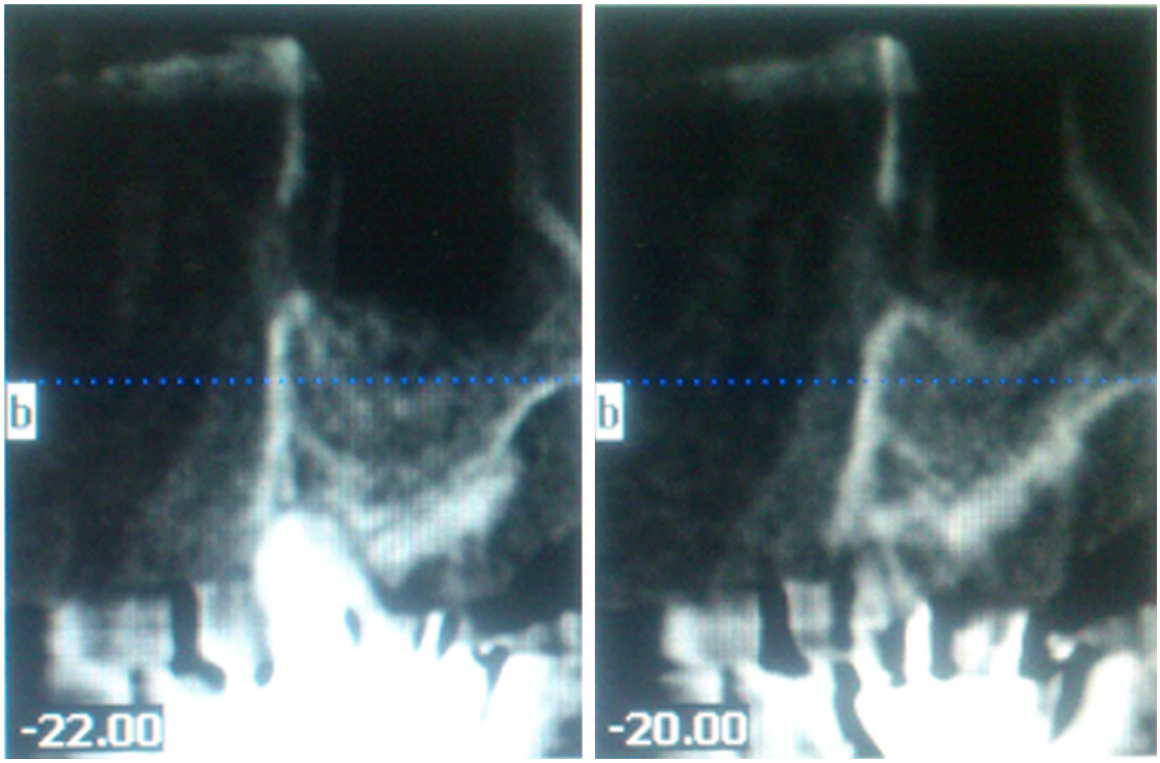

Figure 9. Cone-beam computed tomography (vertical cross-section) images recorded 6 months after the removal of the implant.

implant displacement into the maxillary sinus (n = 84; **Table 1**), among whom 10 different modalities had been used to remove the ectopic implants (**Table 2**) [1-3, 7-35]. Before 2000, reports of implant migration into the maxillary sinus occurred sporadically, consisting of 4 articles describing 11 patients with 12 implants. As the use of implants became increasingly widespread, more cases of implant displacement into the maxillary sinus were reported. Twenty-eight articles describing 70 patients with 72 ectopic implants in the maxillary sinus were published between January 2000 and June 2013, with the number of articles published increasing yearly.

Discussion

The causes of dental implant displacement include poor bone quality, untreated membrane perforation, and the use excessive force during installation [3, 9, 18, 20, 27]. However, the fac-

Table 1. Cases of displaced dental implants reported in the literature

Authors and year published	Cases/Implants (n)	Previous sinus-lift and/or bone graft (n)	Symptoms (n)	CT or surgery findings	Treatments applied
Quiney et al., 1990	1/2	—	yes (2)	—	LW (2)
Ueda and Kaneda, 1992	1	no	yes	—	LW
Regev et al., 1995	2	staged onlay bone graft (1)	no (2)	—	LW (1) and transcrestal (1)
Pagella et al., 1999	7	—	yes (6)/no (1)	—	LW transoral endoscopic
Iida et al., 2000	1	—	no	without sinusitis	removal
Raghoebar and Vissink, 2003	1	no	no	—	LW + SFE
Nakamura et al., 2004	1	—	no	—	LW transoral endoscopic
El Charkawi et al., 2005	1	—	yes	sinusitis	LW transoral endoscopic
Galindo et al., 2005	2	—	no (2)	—	removal (1) and 2 years follow-up (1)
Varol et al., 2006	3	—	—	—	LW transoral endoscopic (3)
Felisati et al., 2007	1	—	no	sinusitis	transnasal endoscopic
Guler and Delilbasi, 2007	2	—	no (2)	—	LW (1) and lost contact with the patient (1)
Kim et al., 2007	1	—	yes	sinusitis	transnasal endoscopic
Kitamura and Zeredo, 2010	1	—	yes	—	transnasal endoscopic
Lubbe et al., 2008	1	—	yes	—	transnasal endoscopic
Chappuis et al., 2009	1	staged sinus lift	no	sinusitis	transcrestal endoscopic
Chiapasco et al., 2009	27	—	yes (13)/no (14)	sinusitis (13), without sinusitis (14)	LW (2**+15), transnasal endoscopic (6), LW+ transnasal endoscopic (4)
Flanagan, 2009	1	—	no	—	LW
Ridaura-Ruiz et al., 2009	9/10	staged sinus lift (1/2)	yes (3)/no (7)	sinusitis (6)	LW (5), LW+SFE (1), transcrestal (1) and follow-up (2/3)
Ucer, 2009	1	—	—	sinusitis	LW transoral endoscopy + SFE
Griffa et al., 2010	1	—	yes	—	transcrestal endoscopic
Kitamura and Zeredo, 2010	1	—	yes	sinusitis	transnasal endoscopic
Kluppel et al., 2010	2	—	no (2)	without sinusitis	LW+SFE (1) and 5 years of follow-up (1)
Ramotar et al., 2010	2	—	yes (1)/no (1)	—	transnasal endoscopic
Galindo-Moreno et al., 2011	2	staged sinus lift (2)	yes (1)/no (1)	—	4 years of follow-up (1) and LW (1)
Sammartino et al., 2011	1	—	no	without sinusitis	LW** with piezosurgery device
Scarano et al., 2011	1	—	yes	sinusitis	LW
Sohn et al., 2011	1	internal sinus lift	no	—	LW* with piezosurgery device + SFE + implant insertion
Tilaveridis et al., 2012	2/3	—	yes (2)/no (1)	sinusitis(2), without sinusitis (1)	LW (1), LW** (2)
Tsodoulos et al., 2012	1	—	no	without sinusitis	LW*
Fusari et al., 2013	1	—	no	without sinusitis	LW with piezosurgical device**
van de Loo et al., 2013	1	—	yes	sinusitis	spontaneously expelled

LW = lateral wall approach; SFE = sinus floor elevation. *nonvascularized replaceable bony window; **vascularized replaceable bony widow.

Table 2. Treatments reported in the literature for the removal of displaced implants from the maxillary sinus

Treatment options	Implants (n)	Subtotal A	Subtotal B
Follow-up	6		
Transcrestal approach	2	Direct approach: n = 42	Transoral: n = 58
LW	36		(LW: n = 54; transcrestal: n = 4)
LW + SFE	3		
LW + SFE + implant insertion	1		
LW transoral endoscopy	13	Endoscopy: n = 32	
LW transoral endoscopy + SFE	1		
Transcrestal endoscopy	2		
Transnasal endoscopy	12		Transnasal: n = 12
LW + transnasal endoscopy	4		Combination: n = 4
Not presented	2		
Lost contact	1		
Spontaneously expelled	1		
Total	84		

LW = lateral window approach; SFE = sinus floor elevation.

tors that contribute to implants migrating into the maxillary sinus remain largely unclear. Limited bone height at the posterior upper maxilla as a result of alveolar ridge resorption or maxillary sinus hyperpneumatization is a predisposing factor for implant migration into the sinus [9, 18]. The advent of sinus elevation techniques have markedly improved the stability of implants installed in the posterior maxilla [36, 37]. However, the migration of implants into the maxillary sinus following sinus floor elevation can occur nonetheless [1, 20, 27].

Galindo-Moreno et al [20]. described 2 cases of maxillary sinus elevation and prosthetic rehabilitation in which an implant migrated through a histopathologically-verified stable composite bone graft. They suggested that the perforation of the Schneiderian membrane, the failure to achieve implant primary stability, and the resorption of the bone graft caused by increased osteoclastic activity may have contributed to implant migration in their patients [20]. Following maxillary sinus elevation in our patient, the height of the residual crest was greater than 5 mm, and the implants exhibited acceptable primary stability. In addition, no perforation of the Schneiderian membrane was detected using the Valsalva maneuver. Nonetheless, the graft was found to have failed 6 months later (**Figure 3**). The loss of the bone graft suggests that an increase in nonspecific osteoclastic activity may have contributed to the migration of the implant, but we were unable to obtain a biopsy of the bone graft for histopathological examination.

Galindo et al. [9]. Proposed that the following processes contribute to the migration of implants into the maxillary sinus: (1) Changes in intrasinal and nasal pressures; (2) Periimplant bone destruction and compromised osseointegration due to an autoimmune reaction to the implant, and (3) bone resorption caused by an incorrect distribution of occlusal forces. In addition, Kluppel et al. [24] suggested that the migration of dental implants into the maxillary sinus occurs more frequently in patients who undergo implant placement and maxillary sinus elevation simultaneously.

A small number of the articles indentified in our review of the literature described implants migrating into the sinus cavity as a result of occlusal forces [16, 24, 25]. In our patient, the previously restored occlusal surface of the right mandibular third molar was higher than the functional occlusal plane of the right maxillary second molar and premolars (**Figure 1**). Therefore, the occlusal forces on the right-side abutment may have been borne unevenly during mastication. Our patient also admitted that she preferred to use her right teeth to chew food because her left posterior maxillary teeth were all implant-supported, whereas 2 of her natural teeth remained in her right maxilla.

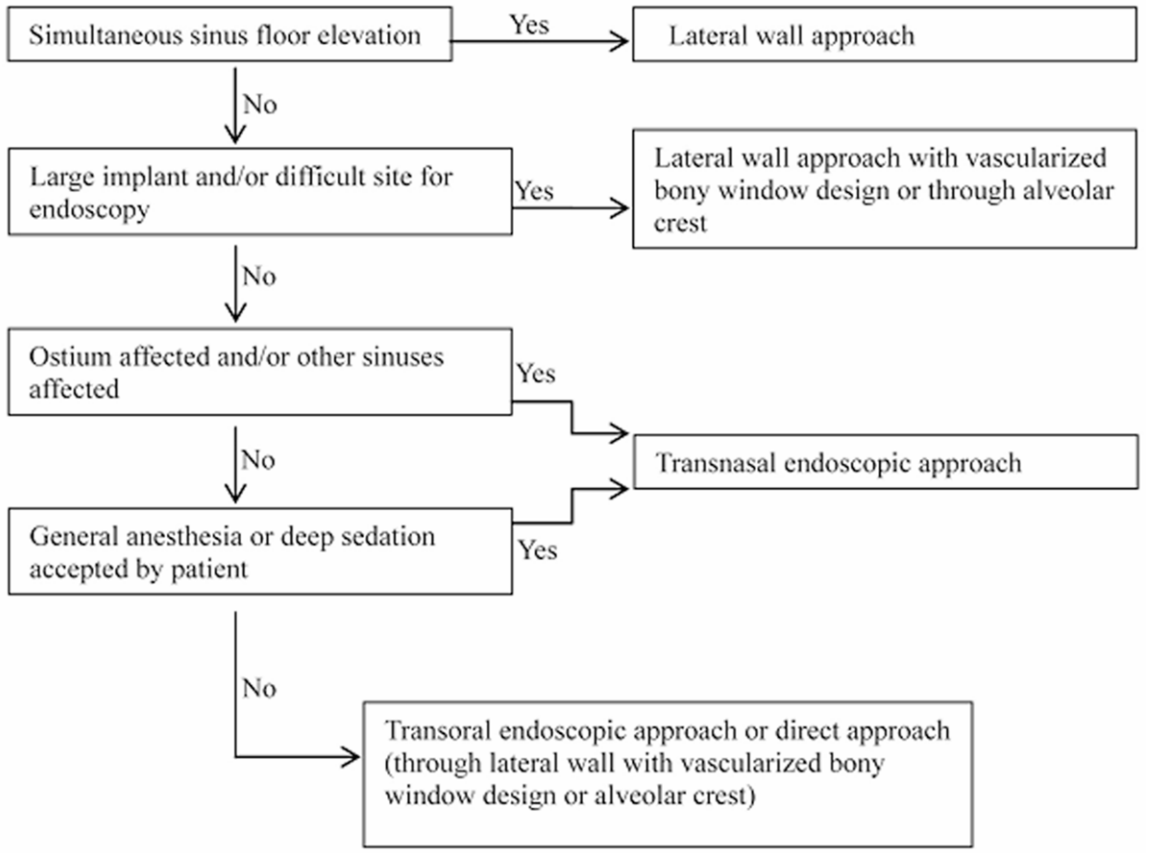

Figure 10. Treatment options for removal of ectopic dental implants from the maxillary sinus.

Therefore, unevenly distributed occlusal forces might have contributed to the migration of the posterior maxillary implant in our patient.

Insufficient osseointegration may also lead to the mobilization of a dental implant. The resorption of bone around an implant and consequent apical mobilization can be radiographically detected. In our patient, the radiograph recorded 3 months after placement shows a low-density area distal to the neck of the implant that was indicative of bone loss (**Figure 2**). However, nonuniformly distributed occlusal forces may have applied greater pressure to the second molar implant, which increased the angle between the axis of the implant and the neighboring tooth by pushing the head distally and the root apically over time (**Figures 2** and **3**), with the apical displacement of the implant perforating the Schneiderian membrane. Consequently, the graft may have been expelled into the sinus, or infection induced via the perforated sinus may have caused the resorption of the graft, resulting in the failure of the maxillary sinus elevation procedure. Therefore, the occlusal changes following implant placement may also have contributed to the loss of the maxillary bone graft.

According to the literature review, implants displaced into the maxillary sinus may remain stationary in the sinus, migrate to another antrum [38], cause airway obstruction [13], or be spontaneously expelled from the antrum. The persistence of an implant in the maxillary sinus may not manifest pathological symptoms or signs of inflammation. Some patients develop sinusitis, which may lead to other major complications. Three modalities have been proposed for the treatment of ectopic maxillary implants, which include the surgical removal of the dental implant from the sinus, simultaneous implant removal and maxillary sinus elevation, and continued follow-up examinations only to monitor the location of the implant and the potential pathological manifestations. Treatment selection is primarily based on the presence of signs of pathology or inflammation associated with the migration, but most of the authors of published reports have suggested that implants should be removed from the sinus to avoid complications [2].

Our search of the literature retrieved reports of 43 asymptomatic intrasinal implants and 37 intrasinal implants that caused sinus disorders. Among the cases with asymptomatic intrasinal implants, CT imaging and visual inspection during surgery revealed that 8 of the implants had indeed caused varying levels of inflammation. We identified only 5 patients with ectopic intrasinal implants (n = 6) in the literature that had been followed. However, most of the follow-up periods were less than 5 years [9, 20, 24, 27]. The longest follow-up period was 7 years, after which the implant was removed due to related sinusitis [29]. In our patient, CT images recorded 7.5 years after the implant had migrated into the sinus showed localized inflammation (**Figures 7** and **8**). Therefore, mounting evidence of the long-term effects of ectopic dental implants in the maxillary sinus suggests that all such implants should be removed to avoid sinus pathology.

The surgical techniques used to remove displaced implants differ depending on the location of the ectopic implant and the symptoms manifested, and are aimed at maintaining the drainage and ventilation of the antrum. González-García et al. [39] classified therapeutic methods for the removal of ectopic intrasinal implants as endoscopic or direct approaches. Through our literature search, we identified 9 implant retrieval options that consisted of endoscopic approaches, direct approaches, or combinations of each (**Table 2**). Transnasal or transoral endoscopic surgeries were used for the removal of 32 implants, and transcrestal or transalveolar direct approaches were used for the removal of 42 implants.

In recent years, endoscopic approaches for the removal of implants have become more widely used, especially the use of transnasal endoscopy, due to the low morbidity and rapid recovery associated with these procedures, and because they often allow the simultaneous opportunity to treat the ostium and affected paranasal sinuses [39]. However, endoscopic procedures require specific training, specialized equipment, and the use general anesthesia. The application of endoscopic procedures is limited by the location [15] and size [12] of the implant because the procedures rely on the removal of the ectopic implant through the ostium.

Transoral direct surgical techniques include lateral window and transcrestal approaches, both of which can be performed under local anesthesia. Both types of direct approaches are minorly invasive procedures, requiring a small ostium in the maxilla to access the sinus. A transcrestal approach limits access to the antrum, and should only be used for cases that specifically require it. The lateral window technique diminishes the integrity of the lateral wall of the maxilla, and the access window may not reossify if bone grafting is not performed simultaneously. Although the risk of morbidity associated with the lateral window surgery is higher than that of endoscopic approaches, it has been the most widely used procedure for removing ectopic implants from the maxillary sinus.

We used the lateral window approach for the removal of the displaced implant from the maxillary sinus of our patient, and the CT images recorded 6 months following the removal of the displaced implant showed the absence of reossification of the lateral access window and thickening of the Schneiderian membrane. The formation of scar tissue at the lateral window incision site may confound a subsequent sinus lift procedure. However, Biglioli and Goisis [40] showed that the use of a harvested bone flap to seal the lateral window can prevent this complication. This procedure maintains the integrity of the sinus lining, ensuring an adequate blood supply for the survival and ossification of the lateral window bone graft.

Piezosurgery has been used to improve the outcome of lateral window surgery. Sammartino et al. [28] used a piezosurgical device to create a greenstick fracture for the vascularized replaceable bony window for the removal of an ectopic implant from the maxillary sinus, and CT images recorded 6 months after surgery showed complete healing of the lateral window. The bony window techniques allow the access window to be placed anteriorly or posteriorly, which is useful for cases in which endoscopic removal may be difficult due to the location of the ectopic implant. The bony window techniques also allow the use of larger access windows for the removal of large implants [7], and improve the healing of the sinus wall, compared with that of the Caldwell-Luc procedure. However, although the use of piezosurgery for the lateral window

approach may represent the best method for removing dental implants displaced into the maxillary sinus, its use is limited to patients with an unobstructed ostium and sinusitis [31].

For patients with an ectopic implant just beneath Schneiderian membrane and no sinus pathology, dentists may choose to perform sinus floor elevation and the removal of the displaced implant simultaneously to minimize the number of surgeries required. In addition, Sohn et al. [32] have reported favorable outcomes for patients who underwent displaced implant removal, maxillary sinus elevation, and new implant installation simultaneously [32]. However, if the Schneiderian membrane is perforated by the displaced implant or during surgery, the resulting inflammation may cause the failure of the bone graft. Although careful suturing and the use of absorbable membrane for sealing the sinus membrane may improve clinical outcomes, surgeons must strive to avoid damaging the sinus lining further when removing ectopic intrasinal dental implants. Based on our experience and the findings of our literature review, we constructed the flow chart in **Figure 10** to aid clinicians in developing treatment plans for the removal of displaced dental implants in the maxillary sinus.

Conclusions

Migration of dental implants into the maxillary sinus has become more common with the increasing widespread use of dental implants. To remove ectopic implants from the maxillary sinus, transnasal endoscopic approaches may be suitable in cases in which the ectopic implant is accessible. Transoral direct approaches are adequate in most cases in which endoscopic approaches may be confounded by the location or size of the displaced implant. Alternatively, the bony window technique for lateral window access may be more suitable for the removal of large implants. The surgical removal of an ectopic intrasinal implant may be performed in combination with maxillary sinus elevation, and the simultaneous installation of a new implant may also be possible in carefully screened patients.

Acknowledgements

This work was supported by grants from the Science and Technology Commission of Shanghai Municipality (grant no. 14JC1490600) and the National Science Foundation of China (grant no. 81001202).

Disclosure of conflict of interest

None.

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References

[1] Chappuis V, Suter VG and Bornstein MM. Displacement of a dental implant into the maxillary sinus: report of an unusual complication when performing staged sinus floor elevation procedures. Int J Periodontics Restorative Dent 2009; 29: 81-87.

[2] Chiapasco M, Felisati G, Maccari A, Borloni R, Gatti F and Di Leo F. The management of complications following displacement of oral implants in the paranasal sinuses: a multicenter clinical report and proposed treatment protocols. Int J Oral Maxillofac Surg 2009; 38: 1273-1278.

[3] Guler N and Delilbasi C. Ectopic dental implants in the maxillary sinus. Quintessence Int 2007; 38: e238-239.

[4] Pelayo JL, Diago MP, Bowen EM and Diago MP. Intraoperative complications during oral implantology. Med Oral Patol Oral Cir Bucal 2008; 13: 239-243.

[5] Summers RB. The osteotome technique: Part 3--Less invasive methods of elevating the sinus floor. Compendium 1994; 15: 698, 700, 702-694 passim; quiz 710.

[6] Simon BI and Greenfield JL. Alternative to the gold standard for sinus augmentation: osteotome sinus elevation. Quintessence Int 2011; 42: 863-871.

[7] El Charkawi HG, El Askary AS and Ragab A. Endoscopic removal of an implant from the maxillary sinus: a case report. Implant Dent 2005; 14: 30-35.

[8] Felisati G, Lozza P, Chiapasco M and Borloni R. Endoscopic removal of an unusual foreign body in the sphenoid sinus: an oral implant. Clin Oral Implants Res 2007; 18: 776-780.

[9] Galindo P, Sanchez-Fernandez E, Avila G, Cutando A and Fernandez JE. Migration of implants into the maxillary sinus: two clinical cases. Int J Oral Maxillofac Implants 2005; 20: 291-295.

[10] Iida S, Tanaka N, Kogo M and Matsuya T. Migration of a dental implant into the maxi-

llary sinus. A case report. Int J Oral Maxillofac Surg 2000; 29: 358-359.
[11] Kim JW, Lee CH, Kwon TK and Kim DK. Endoscopic removal of a dental implant through a middle meatal antrostomy. Br J Oral Maxillofac Surg 2007; 45: 408-409.
[12] Nakamura N, Mitsuyasu T and Ohishi M. Endoscopic removal of a dental implant displaced into the maxillary sinus: technical note. Int J Oral Maxillofac Surg 2004; 33: 195-197.
[13] Pagella F, Emanuelli E and Castelnuovo P. Endoscopic extraction of a metal foreign body from the maxillary sinus. Laryngoscope 1999; 109: 339-342.
[14] Quiney RE, Brimble E and Hodge M. Maxillary sinusitis from dental osseointegrated implants. J Laryngol Otol 1990; 104: 333-334.
[15] Raghoebar GM and Vissink A. Treatment for an endosseous implant migrated into the maxillary sinus not causing maxillary sinusitis: case report. Int J Oral Maxillofac Implants 2003; 18: 745-749.
[16] Regev E, Smith RA, Perrott DH and Pogrel MA. Maxillary sinus complications related to endosseous implants. Int J Oral Maxillofac Implants 1995; 10: 451-461.
[17] Ueda M and Kaneda T. Maxillary sinusitis caused by dental implants: report of two cases. J Oral Maxillofac Surg 1992; 50: 285-287.
[18] Varol A, Turker N, Goker K and Basa S. Endoscopic retrieval of dental implants from the maxillary sinus. Int J Oral Maxillofac Implants 2006; 21: 801-804.
[19] Flanagan D. A method to retrieve a displaced dental implant from the maxillary sinus. J Oral Implantol 2009; 35: 70-74.
[20] Galindo-Moreno P, Padial-Molina M, Sanchez-Fernandez E, Hernandez-Cortes P, Wang HL and O'Valle F. Dental implant migration in grafted maxillary sinus. Implant Dent 2011; 20: 400-405.
[21] Griffa A, Viterbo S and Boffano P. Endoscopic-assisted removal of an intraorbital dislocated dental implant. Clin Oral Implants Res 2010; 21: 778-780.
[22] Kitamura A. Removal of a migrated dental implant from a maxillary sinus by transnasal endoscopy. Br J Oral Maxillofac Surg 2007; 45: 410-411.
[23] Kitamura A and Zeredo JL. Migrated maxillary implant removed via semilunar hiatus by transnasal endoscope. Implant Dent 2010; 19: 16-20.
[24] Kluppel LE, Santos SE, Olate S, Freire Filho FW, Moreira RW and de Moraes M. Implant migration into maxillary sinus: description of two asymptomatic cases. Oral Maxillofac Surg 2010; 14: 63-66.
[25] Lubbe DE, Aniruth S, Peck T and Liebenberg S. Endoscopic transnasal removal of migrated dental implants. Br Dent J 2008; 204: 435-436.
[26] Ramotar H, Jaberoo MC, Koo Ng NK, Pulido MA and Saleh HA. Image-guided, endoscopic removal of migrated titanium dental implants from maxillary sinus: two cases. J Laryngol Otol 2010; 124: 433-436.
[27] Ridaura-Ruiz L, Figueiredo R, Guinot-Moya R, Pinera-Penalva M, Sanchez-Garces MA, Valmaseda-Castellon E and Gay-Escoda C. Accidental displacement of dental implants into the maxillary sinus: a report of nine cases. Clin Implant Dent Relat Res 2009; 11 Suppl 1: e38-45.
[28] Sammartino G, Trosino O, di Lauro AE, Amato M and Cioffi A. Use of piezosurgery device in management of surgical dental implant complication: a case report. Implant Dent 2011; 20: e1-6.
[29] Scarano A, Perrotti V, Carinci F and Shibli JA. Removal of a migrated dental implant from the maxillary sinus after 7 years: a case report. Oral Maxillofac Surg 2011; 15: 239-243.
[30] Ucer TC. A modified transantral endoscopic technique for the removal of a displaced dental implant from the maxillary sinus followed by simultaneous sinus grafting. Int J Oral Maxillofac Implants 2009; 24: 947-951.
[31] Fusari P, Doto M and Chiapasco M. Removal of a dental implant displaced into the maxillary sinus by means of the bone lid technique. Case Rep Dent 2013; 2013: 260707.
[32] Sohn DS, Jung HS, Kim KH, Song KJ, An HW and Min KH. Removal of displaced foreign body from the maxillary sinus using replaceable bony windows and saline irrigation, followed by suctioning of the foreign body. Implant Dent 2011; 20: 112-117.
[33] Tilaveridis I, Lazaridou M, Dimitrakopoulos I, Lazaridis N and Charis C. Displacement of three dental implants into the maxillary sinus in two patients. Report of two cases. Oral Maxillofac Surg 2012; 16: 311-314.
[34] Tsodoulos S, Karabouta I, Voulgaropoulou M and Georgiou C. Atraumatic removal of an asymptomatic migrated dental implant into the maxillary sinus: a case report. J Oral Implantol 2012; 38: 189-193.
[35] van de Loo S, Kessler P and Lethaus B. Spontaneous transmaxillary-transnasal implant loss: a case report. Implant Dent 2013; 22: 117-119.
[36] Olson JW, Dent CD, Morris HF and Ochi S. Long-term assessment (5 to 71 months) of endosseous dental implants placed in the augmented maxillary sinus. Ann Periodontol 2000; 5: 152-156.
[37] Smiler DG. The sinus lift graft: basic technique and variations. Pract Periodontics Aesthet Dent 1997; 9: 885-893; quiz 895.

[38] Haben CM, Balys R and Frenkiel S. Dental implant migration into the ethmoid sinus. J Otolaryngol 2003; 32: 342-344.
[39] Gonzalez-Garcia A, Gonzalez-Garcia J, Diniz-Freitas M, Garcia-Garcia A and Bullon P. Accidental displacement and migration of endosseous implants into adjacent craniofacial structures: a review and update. Med Oral Patol Oral Cir Bucal 2012; 17: e769-774.
[40] Biglioli F and Goisis M. Access to the maxillary sinus using a bone flap on a mucosal pedicle: preliminary report. J Craniomaxillofac Surg 2002; 30: 255-259.