Accidental Displacement of Dental Implants into the Maxillary Sinus: A Report of Nine Cases

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ABSTRACT

Purpose: To report on the clinical, radiological, and anatomical features of patients suffering accidental displacement of dental implants into the maxillary sinus.

Materials and Methods: A retrospective observational study of nine cases of dental implant displacement into the maxillary sinus was made. Data concerning patients' features, diagnostic criteria, and treatment performed were collected.

Results: Mean patient age was 56.7 years, and men predominated (6:3). Implant displacement was diagnosed in all cases by clinical and radiological examination. In seven patients, the implant was surgically removed without complications. Only three patients reported sinus symptoms following displacement.

Conclusions: The displacement of implants into the maxillary sinus is usually related with a poor surgical planning or inadequate surgical technique. Because of the anatomy and physiology of the posterior area of the maxilla, it is essential to ensure good primary stability in order to avoid this complication. If the implant migrates into the maxillary sinus, it should be removed in order to avoid sinus pathology.

KEY WORDS: complications, dental implant, maxillary sinus, maxillary sinus augmentation, posterior maxilla

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The reported incidence of complications following dental implant placement is between 5 and 10%.¹⁻³ Several anatomical features of the maxilla may prompt a higher rate of implant failure than that recorded in the mandible.⁴ Implant rehabilitation in this region is often complicated by the presence of type IV alveolar bone (poor quality, low-density cancellous bone, and a very thin cortical layer). In fact, implant loss in type IV bone accounts for 16% of all failed implant placements.⁵ Another important aspect is the progressive pneumatization of the maxillary sinus. This factor, along with crestal bone defects, often leads to insufficient bone height in posterior areas of the maxilla.

Most papers addressing complications following implant placement in the maxilla focus on invasion of the maxillary sinus, which may lead to infection caused by implant mucosa contact, a lack of primary stability, perforation of the sinus cortex, formation of oral–antral communications, and impaired osseointegration. However, few authors mention implant displacement into the maxillary sinus, and most of these papers present isolated cases.^{1,6–9} This report on nine patients seeks to identify the major clinical and anatomical features of the complication, and to provide the clinician with guidelines regarding how to avoid implant displacement, as well as the available treatment options.

MATERIALS AND METHODS

A retrospective study was made of nine patients with accidental displacement of a dental implant into the maxillary sinus, attended between 2001 and 2007 by different surgeons in several medical centers. A total of 10 implants were found displaced inside the maxillary sinus. Diagnosis of this complication was made by intraoral clinical examination and also through panoramic radiographies (PRs). In two cases, use was also made of a computed tomography (CT) performed after implant displacement.

The following data were collected: age, gender, smoking habit, type of edentulism, location, diameter and length of the displaced implant, prior sinus bone augmentation procedures, clinical signs and symptoms of sinus infection, time elapsed from implant placement to migration into the maxillary sinus, and treatment performed in each case. A descriptive statistical analysis was made using the Statistical Package for the Social Sciences v12.0 (SPSS; SPSS Inc., Chicago, IL, USA).

RESULTS

The mean patient age was 56.7 years. Implant displacement was more frequent in men (66.7%), smokers (55.6%), and partially edentulous patients (77.8%). Table 1 shows the main clinical features of our sample. In all cases, PRs were performed. Displaced implants were located in the area of the upper second premolar and first molar. Implant length ranged between 7 and 15 mm, and were mostly around 3.75 to 4 mm in diameter. Six months prior to implant placement, patient 4 had undergone bilateral sinus floor elevation; later, two implants migrated into the sinus cavity. In most cases, accidental displacement of the implant occurred prior to prosthetic loading, except in cases 1 and 6 where this complication was, respectively, diagnosed 6 and 4 months after prosthesis completion (Figure 1).

In three cases, the implants revealed a considerable shift of position over time within the maxillary sinus (Figure 2, A–D and Figure 3, A–B). In two patients, CT scans were performed after implant displacement (see Figure 2, E–F).

Regarding the surgical techniques used to remove the implants, a lateral wall approach was used in six cases (see Figure 2, G-L and Figure 3, C-F), and in case 9 the fixture was extracted through the alveolar ridge. All procedures were made under local anesthesia (articaine in a 4% solution with epinephrine 1:100,000 [Ultracain, Normon; Madrid, Spain]). A horizontal incision was made in the alveolar ridge, with releasing incisions at the level of the canine and second molar. After raising a full-thickness flap, the bone was removed from the lateral wall of the maxillary sinus with sterile low-speed handpieces using a tungsten carbide drill, under profuse sterile saline irrigation. The sinus mucosa was raised and perforated through the window in order to locate and extract the implant using elbowed forceps. Healthy maxillary sinus mucosa was left intact; only hyperplastic areas were removed. In five cases, after implant removal a reabsorbable collagen membrane (BioGide®, Geistlich Biomaterials, Wolhusen, Switzerland) was used to seal the lateral wall of the maxillary sinus, and in two cases an additional membrane was used to close the perforation of the sinus membrane (see Figure 3, D-E). In cases 8 and 9, a buccal fat pad flap was selected to cover the bone defect. In these two patients, an additional incision was made in the periosteum above the first upper molar in order to dissect the buccal fat pad which was then sutured over the bone defect allowing a complete covering of the sinus lateral wall in case 8 and of the alveolar ridge defect in case 9. The mucoperiosteal flap was detached to facilitate stress-free repositioning, and 3/0 silk sutures (Silkam, Braun; Tuttlingen, Germany) were used to close the wound. No intra- or postoperative complications were recorded in any of the cases. The two remaining patients rejected the recommendation of an additional surgical procedure, and preferred to undergo a strict radiological and clinical long-term follow-up.

In some patients, the prosthetic rehabilitation was seriously jeopardized by the loss of the displaced implants. In these cases, the fixture should be replaced when the bone site is healed. In some occasions, it might be advisable to perform bone augmentation techniques before implant placement. In case 5, immediately after implant removal, the sinus floor was elevated using a particulate bone graft from the sinus window together with bovine hydroxyapatite (Bio-Oss®, Geistlich Biomaterials, Wolhusen, Switzerland), and another implant

TABLE 1 Clinical Features of the Nine Pat	tients								
Case number	1	2	ю	4	5	9	7	8	6
Gender*	М	Ц	Н	М	М	М	Μ	F	М
Age (years)	47	38	62	46	54	52	75	57	79
Smoking habit	Yes	Yes	No	Yes	No	Yes	No	Yes	No
Previous sinus-lift	No	No	No	Yes (bilateral)	No	No	No	No	No
Implant location [†]	1LM	1RM	1RM	1RM 1LM	2LPM	1RM	1RM	ILM	1LM
Implant length (mm)	12	7	13	15 13	10	11.5	11.5	10	8.5
Implant diameter (mm)	3.75	5	3.75	3.75	4	3.75	4	4	S
Time from placement to migration (months)	10	9	4	9	4	8	4	4	6
Sinus infection	Yes	No	No	No	No	Yes	No	No	Yes
Surface [‡]	R	М	К	R	R	R	R	R	R
Edentulism	Partial	Partial	Partial	Partial	Total	Partial	Partial	Total	Partial
Treatment [§]	None	LW	ΓW	None	LW and bone	LW	LW	LW and buccal	Crestal and buccal
					augmentation			fat pad	fat pad
Marine Courts									

*M = male; F = female. [†]1LM = left upper first molar; 1RM = right upper first molar; 2LPM = left upper second premolar. [‡]R = rough; M = machined. [§]LW = lateral window approach.



Figure 1 Panoramic radiography of case 6. Displacement of the implant after 4 months of function.

was placed for subsequent rehabilitation of the edentulous area. Another option for patients who refuse additional surgeries could be a tooth-supported bridge (case 3).

Only three patients presented signs and symptoms of sinus infection. However, in six of the seven operated cases, when the schneiderian membrane was perforated, suppuration was seen inside of the maxillary sinus.

After implant removal, the patients were prescribed an antibiotic (amoxicillin 875 mg plus clavulanate 125 mg every 8 hours for 10 days) (augmentine 875/



Figure 2 Case 3. *A–D*, Panoramic radiographies showing the movement of the displaced implant througout time. *E–F*, Computer tomography images. *G–L*, Surgical removal of the implant using a lateral window approach and a BioGide[®] resorbable membrane to seal the lateral sinus window.



Figure 3 Patient 5. *A–B*, Panoramic radiographies showing movement of the implant. *C–F*, Surgical procedure. Note the placement of two resorbable membranes, one to close the perforation and the other to cover the lateral sinus window. *G*, Panoramic radiography immediately after sinus bone augmentation and new implant placement.

125 mg; GlaxoSmithKline, Madrid, Spain), a nonsteroidal anti-inflammatory drug, usually either sodium diclofenac 50 mg every 8 hours (Diclofenaco Llorens 50 mg; Llorens, Barcelona, Spain) or ibuprofen 600 mg every 8 hours for 7 days (Algiasdin 600; Esteve, Barcelona, Spain), a single dose of a corticosteroidal drug (methylprednisolone 40 mg [Urbason 40 mg; Aventis Pharma, Madrid, Spain]), and a mouthrinse (0.12% chlorhexidine digluconate every 12 hours for 15 days [Clorhexidina Lacer[®]; Lacer, Barcelona, Spain]). In some cases, oral antihistamines were prescribed, such as ebastine (Ebastel[®], Almirall, Barcelona, Spain), one tablet every 12 hours for 7 days. Postoperative instructions and use of the prescribed drugs were explained verbally and also on a printed sheet of paper given to the patient.

DISCUSSION

The accidental migration of dental implants into the maxillary sinus is clearly an unusual complication. The incidence of this accident remains unknown because of the lack of cohort studies and the few case reports that have been published. The etiology of this complication remains unclear. Major factors may include a lack of primary stability because of insufficient bone height resulting from pneumatization of the maxillary sinus, poor quality of the remaining bone, and an inadequate surgical technique. Other authors⁶ attribute it to a combination of low bone density and forces acting on the bone through the prosthesis. Sinus membrane perforation following preparation of the implant bed may facilitate entry in the absence of excessive force caused by change in pressure prompted within the maxillary sinus. However, Adell and colleagues,¹⁰ in a study of 101 implants at depths of between 2 and 4 mm within the maxillary sinus, found no evidence of either sinusitis or displacement. Many authors indeed recommend perforation of the lower cortex of the maxillary sinus in order to improve primary stability. In all the cases examined in the present study, the migrating implant was at least 2 mm longer than the remaining bone height, so we might conclude that in one hand, the primary stability can be enhanced by bicortical anchoring of the implant, but on the other hand, this could be a major risk factor for this complication.

The timing of displacement varied in our cases. Quiney and colleagues,⁷ Iida and colleagues,⁶ and Raghoebar and Vissink⁸ reported cases in which the displacement took place 4 months after surgery, which also happened in four of our cases. In two patients, it took place during the second-stage surgical procedure, as occurred in the cases studied by Galindo and colleagues9 and Gallego-Medina and colleagues.¹ There has been one report of displacement during immediate implant placement.¹¹ Nevertheless, it is more difficult to account for the displacement of a loaded implant with a cemented restoration, as occurred in our series in cases 1 and 6, respectively, 6 and 4 months after prosthesis completion. In fact, displacement has been reported 4, 5, and even 10 years after implant insertion.^{6,9,12} Galindo and colleagues9 considered a number of mechanisms that might account for such a delayed displacement, including changes in intrasinusal or nasal pressure; destruction of bone around the implant, leading to impaired osseointegration; resorption prompted by incorrect distribution of occlusal forces; and detachment of the implant from the prosthetic retention structure.

The atrophic upper maxilla often requires a wellplanned rehabilitation. As part of the preoperative workup, it is advisable to request diagnostic tests using a radiological splint to obtain information on bone morphology and quality around the proposed implant site. The use of surgical splints is also required to help position implants securely, avoiding sinus cavities, and minimizing the risk of implant displacement into the maxillary sinus.

Cases 1, 6, and 9 displayed clinical symptoms consistent with recurrent sinusitis following implant displacement into the maxillary sinus - a finding also reported by other authors.^{7,12,13} In contrast, other published studies^{6,9} – like the rest of our patients – reported no such symptoms. However, it should be taken into account that, in our study, most patients where subjected to the surgical treatment shortly after the diagnosis of this complication. One must think that if these foreign bodies are left inside the maxillary sinus for a long period of time, the incidence of signs and symptoms should be higher. Therefore, the treatment of choice for displacement is the immediate removal of the implant to prevent the patient from developing physical and chemical irritation of the mucosa. Otherwise, this might lead to complete or partial ciliary dysfunction, the onset of sinusitis,^{7,12,13} or even the development of a carcinoma in the maxillary sinus - as has been reported by Birnmeyer and quoted by Pagella and colleagues¹⁴ in a patient with a metal foreign body in the sinus for 48 years. Removal of the implant from the maxillary sinus can be achieved using three different approaches: access through the bone crestal defect (case 9), open surgery using the Caldwell-Luc approach, and trans-nasal or trans-sinus endoscopic removal^{14–16} (see Table 1). In our study, most of the implants were removed using a lateral window approach, because it allows a good surgical access, a low rate of complications, and simple surgical technique. A crestal approach should only be used when a large defect is present on the alveolar ridge. On these cases, this area could be used to locate and extract the implant successfully. However, it is essential to obtain a primary closure of the wound, in order to avoid an oro-antral fistula.

Once the implant has been removed, and if there are no signs or symptoms of sinusitis, guided bone regeneration (GBR) may be accompanied by simultaneous elevation of the sinus floor, as described by Raghoebar and Vissink,⁸ and performed in our series in case 5.

Where implant removal is contraindicated because of systemic pathology, or is rejected by the patient, there should be regular clinical and radiological follow-up. Two of the patients in the present study rejected implant removal surgery, and are scheduled to annual panoramic radiographic controls.

Various treatment options are available to avoid implant migration into the maxillary sinus. These include elevation of the maxillary sinus floor, and bone grafting (particulate and block forms), in order to augment bone height.^{17,18} Where implants are to be placed in the same surgical operation, a minimum remaining bone height of 4 or 5 mm is required¹⁹ to ensure primary implant stability. One study of augmentation of the sinus floor with simultaneous implant placement where the residual alveolar bone height in the posterior maxilla was 1 to 2 mm, reported successful osseointegration of all implants, with no complications.²⁰ However, this can be considered a hazardous undertaking, because the lack of primary stability is, as commented earlier, a major cause of implant displacement. Rasmusson and colleagues,²¹ using an animal model, found that delayed implant placement following sinus floor elevation resulted in better integration and stability of the implants.

Another option is sinus floor elevation using osteotomes, from a crestal approach, in order to increase height and width with minimum injury. A systematic review²² concluded that short-term survival/success rates (3 years) for implants placed with an osteotome sinus floor elevation technique were similar to those of conventionally placed implants, suggesting that this may be a good alternative.

A simpler and less costly option for rehabilitation of the severely reabsorbed maxilla is the use of short implants measuring 5 to 8 mm in length.^{23,24} This option is certainly worth considering, because of the high survival rate and the low incidence of complications. However, it is difficult to achieve a good primary stability with these implants on type IV bone, which might lead to displacement of the fixture into the maxillary sinus. In two of our patients, short implant had been used (case 2: 7×5 mm; case 9: 8.5×5 mm). A number of authors, including Regev and colleagues¹³ and Raghoebar and colleagues,²⁵ suggest that implants destined for the upper posterior maxilla should be at least 10 mm long and 5 mm in diameter. Most displaced implants in the present study were 3.75 or 4 mm in diameter.

The key factor in avoiding implant displacement is ensuring sufficient primary stability. Stability can be assessed at the time of implant placement by measuring insertion torque, or using Osstell[™] (Integration Diagnostics, Göteborg, Sweden) or Periotest[™] devices (Siemens AG, Bensheim, Germany) in cases of low bone density, as well as by monitoring the osseointegration process. Implant morphology exerts a particularly decisive influence on stability. A comparison of primary axial stability in conical versus cylindrical screw implants, using standard and minimal drilling protocols (ie, avoiding the last drill in the sequence), has shown that the conical implant placed using the standard drilling protocol displays greater primary stability with the insertion torque, Periotest, and removal torque tests.²⁶ Greater primary stability has also been achieved by tilting implants between 30° and 35°, in order to place them parallel to the anterior and posterior walls of the maxillary sinus,²⁷ and by using pterygoid²⁸ or zygomatic implants.^{29–31} These therapeutic options obviate the need for more aggressive and complicated surgical techniques, allowing the placement of longer implants in order to ensure good posterior occlusion. Success rates are high, and these techniques prevent implant migration into the maxillary sinus. However, they require the use of tilted prosthetic abutments, and are not wholly free of risks including damage to the internal maxillary artery.

CONCLUSIONS

Displacement of implants into the maxillary sinus is a rare postoperative complication that usually arises during the first 6 months after implant placement. This event is generally a result of poor planning or deficient surgical technique, the main risk factors being inadequate preparation of the implant bed and lack of primary stability.

If the implant migrates into the maxillary sinus, it should be removed in order to avoid sinus pathology.

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CONFLICTS OF INTEREST STATEMENT

The authors have declared no conflicts of interest. [Correction added after online publication 23 October 2009: Conflicts of Interest Statement added.]

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