CLINICAL CASE REPORT

Delayed Implant Fixture Displacement into the Maxillary Sinus Five Years Post-Loading: Unraveling the Causes - A Case Report

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Reports of implant fixtures dislocating into the maxillary sinus during sinus graft procedures are well-documented. However, cases of fixtures migrating into the sinus long after placement have yet to be reported. This case report details the surgical extraction of a displaced screw and cement-retained prosthesis, including a fixture and its abutment, from the maxillary sinus after a minimum of 5 years under functional load. The extracted implant was subsequently examined using scanning electron microscopy and energy-dispersive x-ray spectroscopy. We found that the migration commenced with peri-implantitis surrounding the implant, replacing the second molar. This was accompanied by a loss of cement from the crown on this implant and concurrent loosening of the abutment screw on the implant, replacing the first molar. We hypothesize that the inability of the bony tissue surrounding the second molar implant to withstand occlusal forces resulted in forming a bony sequestrum. This process ultimately precipitated the migration of the fixture, along with its abutment and adjacent necrotic bone, into the sinus cavity.

Key Words: antroliths, dental implant, late displacement, sinus graft, case report

INTRODUCTION

The validation of sinus graft protocols[1] and bone graft materials,[2,3] combined with advancements in implant surface technology that facilitate osseointegration even in environments with insufficient bone volume and/or quality,[4] have significantly improved the success rates of implants placed in conjunction with sinus grafts. These rates are now on par with implants inserted in other anatomical regions.[5]

Nevertheless, sinus grafts continue to pose challenges for many clinicians due to the risk of complications, such as membrane perforations, sinusitis, bleeding, implant migration, and benign paroxysmal positional vertigo.[6] Implant migration typically results from clinician error during placement in regions where perforation of the Schneiderian membrane is unavoidable. The often poor bone quality of the posterior maxilla hinders the achievement of primary stability, increasing the probability of implant migration into the sinus through the perforated membrane.[7] A migrated implant, in conjunction with a persistent oroantral fistula, may lead to sinusitis. It can move within the sinus cavity if not removed, causing patient discomfort. Removal is imperative, even for asymptomatic patients, to prevent infection from spreading to adjacent paranasal sinuses or other regions.[8–10]

The first report of implant displacement was by Quiney, an otolaryngologist, and his colleagues in 1990.[11] Before the year 2000, when the success rates of sinus grafts were relatively modest, there were few instances of implants migrating into the sinus cavity. However, as the success rate of sinus grafts subsequently began to increase and more clinicians undertook the procedure, there was a corresponding increase in reports of implant displacements.[12] Despite this, there are few publications on this topic, with most cases described as migration during the surgical implant placement or shortly thereafter.[10]

The expected healing sequence after implant placement, before successful osseointegration, involves stages of bone compression, bone resorption, formation of a provisional matrix, development of woven bone, transition to parallel-fibered bone, and finally, the formation of lamellar bone.[13,14] Early displacement, which disrupts this sequence, typically occurs during the bone resorption stage due to mechanical pressure, forcing the implant into the sinus cavity through the perforated Schneiderian membrane.[15] This displacement is frequently a result of excessive force applied in areas with deficient bone quantity and/or quality. It is thought to be precipitated by an autoimmune response or a change in pressure within the maxillary sinus.[8,10,12] Conversely, late displacement, after implant loading, is attributed to premature loading in areas of inadequate bone quality or excessive loading

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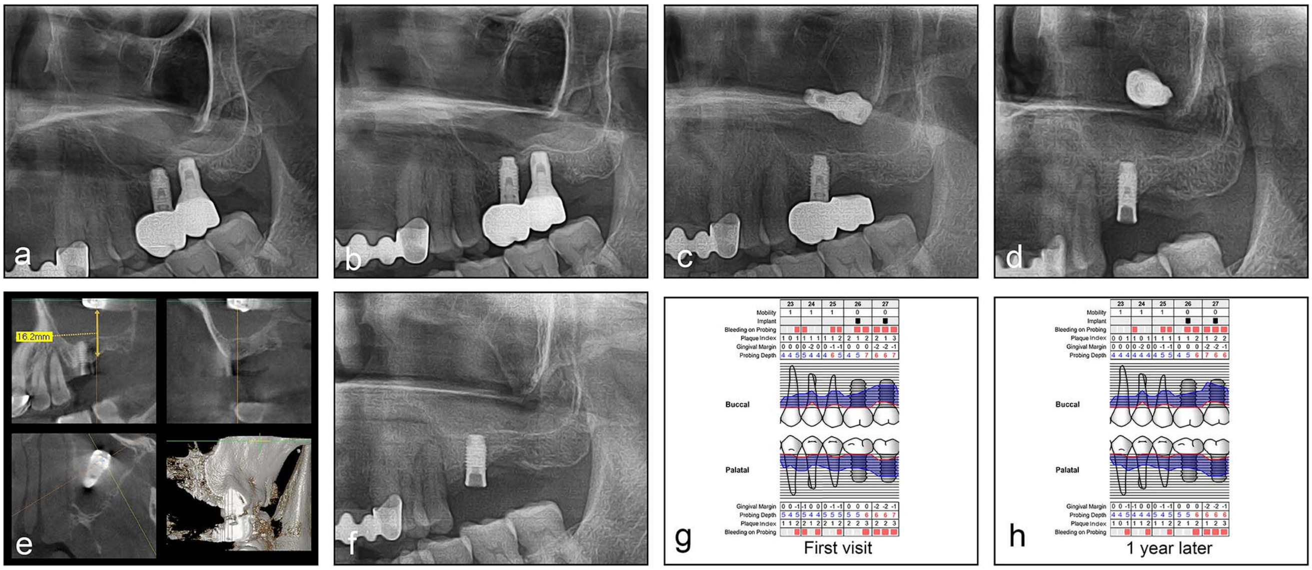


Figure 1. Panoramic radiograph and CBCT (a) First visit (November 18, 2014); (b) 1 year later without incidence (December 22, 2015); (c) late displacement of implant after at least 5 years of functional loading (February 21, 2021); (d), (e) fixture and abutment remaining in sinus for 22 months without treatment (December 7, 2022); (f) after fixture removal (December 23, 2022); (g) periodontal/peri-implant chart at first visit (November 18, 2014); (h) periodontal/peri-implant chart after 1 year (December 22, 2015).

in regions with extensive marginal bone loss due to peri-implantitis.[10,15,16]

There have been few reports concerning implants migrating into the maxillary sinus after several years of functional loading. Therefore, this case report discusses the surgical extraction of a fixture and its abutment (screw-and cement-retained prosthesis [SCRP]) that had migrated into the maxillary sinus after a minimum of 5 years of functional use. Additionally, this report explores the underlying causes of this displacement by examining the limestone-like deposit enveloping the fixture's surface and the bony sequestrum attached to the fixture, using scanning electron microscopy (SEM) and energy-dispersive x-ray spectroscopy (EDS).

Case Report

This case report received approval from the Public Institutional Review Board designated by the Ministry of Health and Welfare (P01-202302-01-041). The patient provided written informed consent before the study, which was conducted per the checklist for case reports (CARE 2016). The patient was a 59-year-old man who relocated to Daegu, South Korea, after receiving 2 implants with splinted crowns on his upper left arch in 2011. The performance of sinus augmentation at the time of the initial implant placement was uncertain, as the procedure was conducted at a different dental clinic. However, the sinus floor's contour suggested sinus augmentation, likely via a crestal approach, had been performed. On November 28, 2014, the patient sought treatment at a private dental clinic in Daegu for peri-implantitis around the previously placed implant (Figure 1a). His medical history included over 10 years of treatment for stage 1 hypertension and type 2 diabetes mellitus. There was no history of osteoporosis. Additionally, he had a 20-pack-year smoking history. His chief complaints associated with the upper left arch were halitosis, bleeding, and food trapping resulting from periodontitis, though these issues had not caused functional impairments.

To address the peri-implantitis, the fixture surface was detoxified using doxycycline and chlorhexidine, followed by subgingival curettage. A panoramic radiograph was taken on December 22, 2015, to confirm the absence of peri-implantitis progression around the left-side implants (Figure 1b).

Subsequently, the patient adhered to biannual supportive periodontal therapy visits until January 11, 2019. However, due to the COVID-19 pandemic, he could not return to the clinic for 2 years. On February 21, 2021, he presented to the clinic with displacement of the fixture and its abutment into the maxillary sinus concerning the upper left arch (Figure 1c).

The initial consideration was that an otolaryngologist should remove the fixture endoscopically, and the patient was referred accordingly. However, upon assessment, the otolaryngologist concluded that the combined length of the fixture and abutment was excessively long, necessitating the removal of a substantial portion of the septum for implant retrieval. Given the extensive trauma this procedure would inflict on the patient, the otolaryngologist recommended that the patient be sent back to the dental clinic for treatment via an intraoral approach. However, the patient could not return to the dental clinic until December 7, 2022 because of personal circumstances. During this visit, a panoramic radiograph and cone beam computerized tomography were conducted (Figure 1d, e). Surgical excision of the fixture via a lateral wall approach was successfully carried out on December 22, 2022 (Figure 1f).

Materials and Methods

Surgical procedure

Thirty minutes before surgery, 80 mg of gentamicin (Shinpoong Pharm. Co. Ltd.) and 50 mg of Tridol (tramadol HCl)

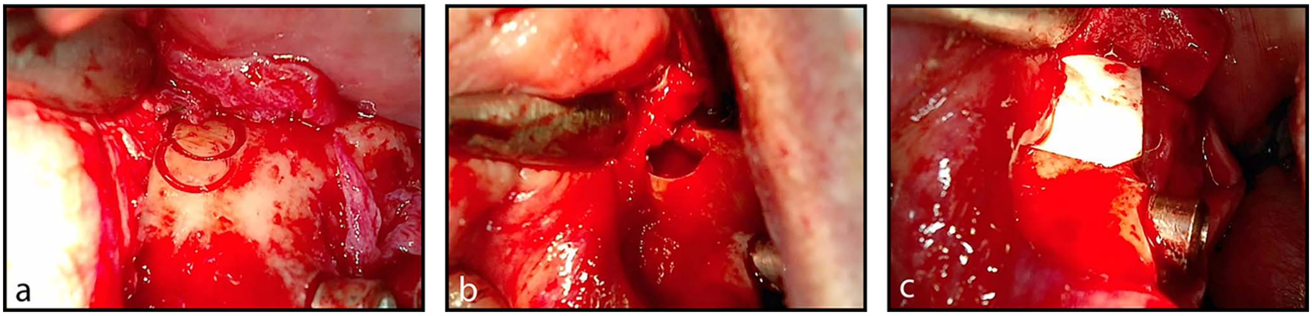


Figure 2. Surgical procedure. (a) C-reamer of SLA (Neobiotech) was used for osteotomy; (b) creating a lateral window; (c) collagen membrane (CollaGuide, Oscotec) was used to obturate the lateral window.

(Yuhan Pharm. Co.) were administered intramuscularly for antibiotic prophylaxis and analgesia. Preoperative mouth rinsing was performed with 0.12% chlorhexidine digluconate (Hexamedine solution 250 mg, Bukwang Pharma Co.). Local anesthetic containing 1:100,000 epinephrine (lidocaine with epinephrine, Yuhan Pharm) was injected into the buccal gingiva and posterior palatal area to anesthetize the middle superior alveolar nerve, the posterior superior alveolar nerve, and the greater palatine nerve. Surgical access was obtained through a crestal incision with 2 vertical-releasing incisions at the mesial side and the tuberosity area, followed by the elevation of a mucoperiosteal flap. A lateral osteotomy was created using a C-reamer (SLA kit, Neobiotech Co.) (Figure 2a). The fixture was stabilized within the sinus cavity using a suction tip and a sinus curette and then extracted using Hartman nasal dressing forceps with a cup-shaped jaw (Aesculap Surgical Instruments) (Figures 2 and 3). Upon removal, the fixture appeared to be encapsulated in bony tissue, which was itself enveloped by a limestone-like substance (Figure 3). The oroantral communication was sealed with a cross-linked porcine type 1 collagen membrane (CollaGuide, Oscotec. Inc.) (Figure 2c). Wound closure was achieved using tension-free sutures with absorbable 3-0 chromic gut (Ailee Co.). Postoperatively, the patient was prescribed antibiotics (625 mg of amoxicillin and clavulanic acid [Augmentin] 3 times a day), a nonsteroidal anti-inflammatory drug (275 mg of naproxen sodium, 3 times a day), a combination of antihistamine and nasal decongestant (60 mg of pseudoephedrine [Actifed] 3 times a day), and an expectorant (30 mg of ambroxol HCl [Mucopect] 3 times a day) for 6 days. Oral hygiene was maintained with 0.12% chlorhexidine digluconate mouthwash (Hexamedine solution 250 mg, Bukwang Pharma) for the same duration. The patient was advised to avoid sneezing, blowing the nose, bending over, swimming, and smoking postoperatively. At the follow-up appointment, a panoramic radiograph confirmed the absence of complications such as sinusitis or oroantral fistula, indicating successful healing.

SEM and EDS analysis

The implant fixture and the attached abutment were sputter-coated with gold to prepare for examination using high-resolution field SEM (Model S-4800, Hitachi Ltd, Japan). Observations were made at an acceleration voltage of 15 Kv and at magnifications of 30×, 70×, and 120× (Figure 3). EDS was used to identify the elemental composition of the limestone-like substance that had accumulated on the implant surface during the 22 months it was exposed to the environment within the maxillary sinus cavity (Figure 4).

Results

SEM of the limestone-like substance encasing the fixture revealed a surface without the typical morphology of bony tissue expected in a sequestrum. Instead, it exhibited a rough, granular texture resembling the surface of construction cement or bricks (Figure 3). EDS analysis showed that the composition of the substance included elements such as carbon, oxygen, phosphorus, and calcium. The molecular formulas derived from the molecular weights and ratios of these elements correspond to calcium phosphate ($Ca_3(PO_4)_2$) and calcium carbonate ($CaCO_3$), which are known constituents of antroliths (Figure 4).[17,18]

Discussion

In February 2021, the patient presented to the dental clinic complaining of severe motility, reporting significant mobility of the implant prosthesis and sensations of movement within his left maxillary sinus. Subsequently, a panoramic radiograph was obtained to determine the location of the displaced implant. A recent systematic review indicated that since 2018, most cases of displaced implant extractions have been managed by otolaryngologists under general anesthesia using a transnasal endoscopic approach,[19] leading to the patient's referral to an otolaryngologist.

However, the otolaryngologist deemed the total length of the fixture and abutment too extensive to extract without removing a significant section of the septum, which would have subjected the patient to excessive trauma. Therefore, the patient was directed back to the dental clinic. Unlike other patients with antroliths, who typically experience symptoms, this patient did not report any significant discomfort. This lack of pain, coupled with the patient's personal obligations, resulted in a 22-month gap before he returned to the clinic for further treatment (Figure 1d).

When an implant migrates into the sinus cavity, Caldwell-Luc surgery is commonly employed, akin to the technique for removing a root tip from the sinus.[8,20] However, retrieval of

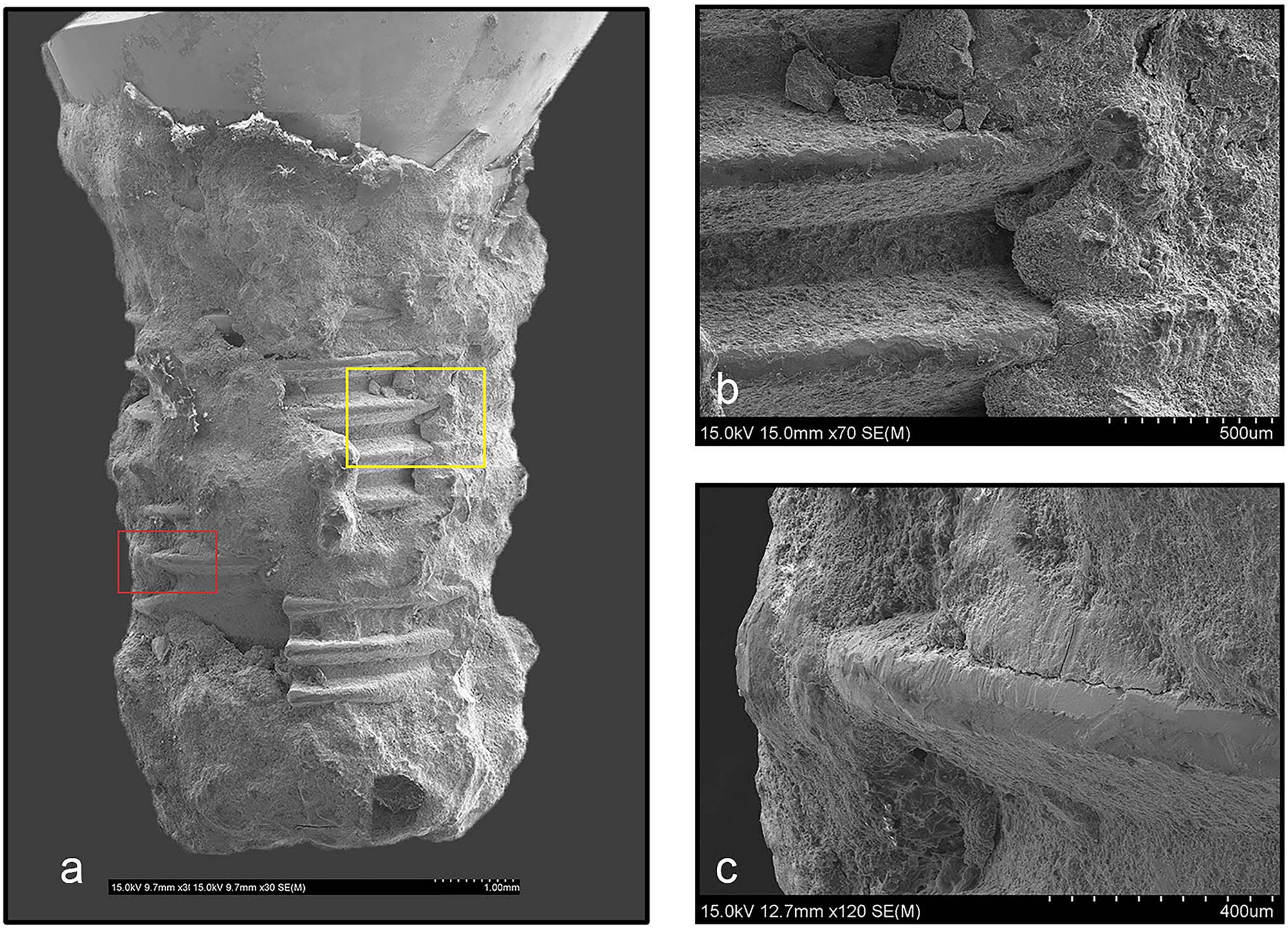
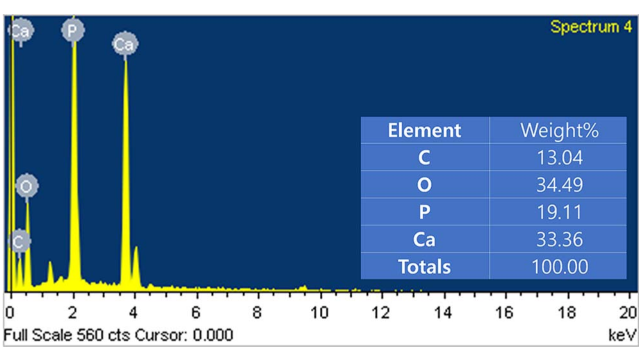


Figure 3. SEM analysis. (a) ×30 magnification; (b) ×70 magnification, marked in yellow in 3(a); (c) ×120 magnification, marked in red in 3(a). Because the fixture underwent late displacement, most of the fixture surface had been osseointegrated. The fixture was exposed to the environment inside the sinus cavity for 22 months, so there was a thin limestone-like substance, believed to be calcified, covering the fixture and the osseointegrated bony tissue that became a sequestrum before the displacement.

the fixture is challenging due to its mobility within the sinus. Typically, saline is first injected into the maxillary sinus, followed using an endoscope or a metal suction tip for removal.[6,20] In this dental case, a more contemporary lateral wall approach was used.[8] The fixture was extracted through a lateral osteotomy created by a C-reamer from SLA (Neobiotech). Using a suction tip and Hartman nasal dressing forceps with a concave tip, the fixture was successfully removed. To close the osteotomy, a resorbable collagen membrane was applied (Figure 2). The patient was prescribed appropriate medications and postoperative care instructions and subsequently healed without any adverse effects or complications.



Element	Weight%
C	13.04
O	34.49
P	19.11
Ca	33.36
Totals	100.00

Figure 4. EDS analysis. The thin limestone-like substance covering the fixture surface and the sequestrum include C, O, P, and Ca. When the molecular weight and proportions of each element from the sample were considered, it seems that the substance is composed of calcium phosphate ($Ca_3(PO_4)_2$) and calcium carbonate ($CaCO_3$), which formed inside the sinus cavity for 22 months, similar to how antroliths form.

Though several cases have been documented of implant fixtures dislodging into the sinus cavity, these have predominantly involved early displacements occurring during the implantation. In contrast, this report details a rare occurrence wherein the implant remained functional for over 5 years before migrating into the sinus cavity, where it was retained for 22 months before extraction. The prosthesis type in this instance was an SCRP, designed to minimize the drawbacks of both screw- and cement-retained types—namely the high misfit risk between fixture and superstructure, and the irretrievability and potential subgingival cement overflow, respectively—while preserving their respective benefits.[21]

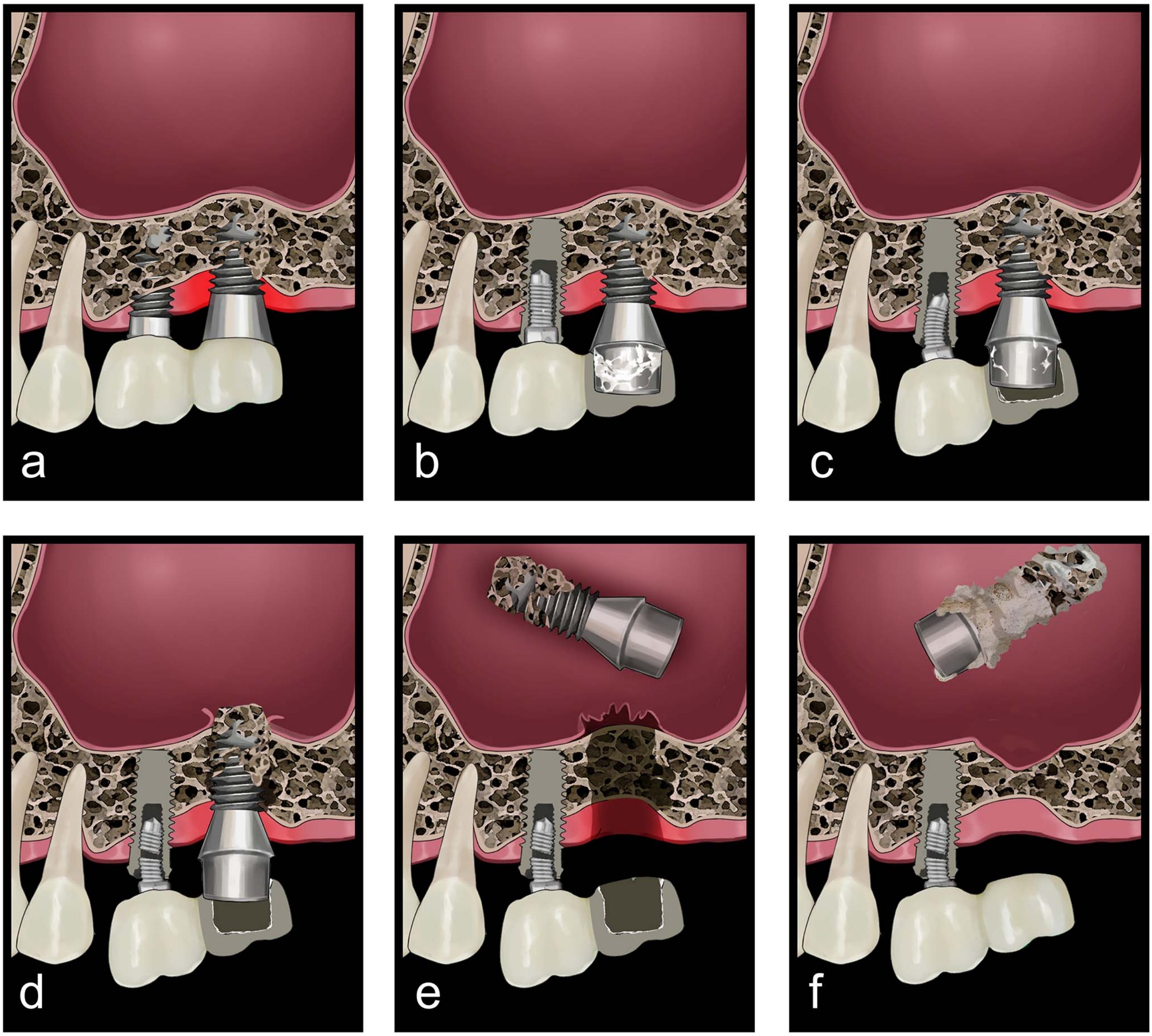


Figure 5. Proposed process of late displacement and calcification of the surface of the displaced implant. (a) # 27: Peri-implantitis; (b) #26: screw loosening, #27: cement loss; (c) #26: screw bending, #27; beginning of fixture displacement; (d) #26: screw fracture, #27; surrounding bone becoming a sequestrum and continuation of fixture displacement; (e) Complete displacement of fixture into the sinus cavity; (f) Fixture remained inside the sinus cavity for 22 months, and calcium phosphate and calcium carbonate adhered to the implant surface, similar to how antroliths form.

SCRP, while mitigating some disadvantages of cement-type prostheses, is associated with long-term problems, such as cement washout. Consequently, they demand precise retention designs and robust cement for enduring fixation.

In 2019, Froum et al reported the displacement of a cement-retained implant prosthesis into the sinus cavity after 6.5 years of functional loading.[15] They observed that the late migration could have been due to overload after cement washout or bone loss associated with peri- implantitis that led to implant loosening. When it comes to assessing the reason and mechanism underlying the fixture and abutment displacement in our case, we believe that initially, marginal bone loss caused by peri-implantitis resulted in an unfavorable crown-to-implant ratio, which led to an increased torque and thus overload. Then, it seems to us that the implant that replaced the second molar underwent cement loss, which was then followed by loosening and bending of the abutment screw on the implant that replaced the first molar. Continued exposure to occlusal forces would have led to the suprastructure apically pushing the fixture integrated in bone, similar to lesions seen in bisphosphonate-related osteonecrosis of the jaw. Eventually this would have resulted in screw fracture and gradual migration of the fixture that replaced the second molar into the sinus cavity, bringing the abutment and necrotic bone along with it (Figure 5). As this case demonstrates, when there is overload in a region with poor bone quantity and quality, it may be possible for a sequestrum around an implant fixture—which is usually seen in patients with bisphosphonate-related osteonecrosis of the jaw[22]—to form even without the patient taking medications for osteoporosis.

When the retrieved implant underwent SEM and EDS analysis, it appeared that the implant surface had undergone exogenous calcification during the 22 months it was situated in the sinus cavity environment (Figures 3 and 4). Shenoy et al (2013) identified the sources of antral foreign bodies as either endogenous (teeth, bony fragments, blood, pus, mucus, and fungi) or exogenous (cotton, paper, dental burs, and dental implants).[18] These antral foreign bodies can act as nuclei for calcification, with fungi colonizing their surfaces becoming calcified, initiating antrolith formation. The principal constituents of antroliths are $Ca_3(PO_4)_2$ and $CaCO_3$.[17] The EDS analysis of the limestone-like substance enveloping the implant surface indicated it comprised carbon (C), oxygen (O), phosphorus (P), and calcium (Ca). By calculating the molecular formula from the elements' molecular weights and their proportions in the sample, we deduced that the substance consists of $Ca_3(PO_4)_2$ and $CaCO_3$, which likely accumulated through a process akin to antrolith formation. At the same time, the fixture remained in the sinus cavity for 22 months.

Conclusions

This case report details the extraction of an implant fixture and its abutment that had migrated into the maxillary sinus after more than 5 years of functional use, employing a lateral window technique. SEM and EDS analyses were used to characterize the limestone-like deposits and necrotic bone encasing the late-displaced fixture. It is posited that peri-implantitis initially developed around the implant that replaced the second molar, precipitating cement degradation. Subsequently, the abutment screw of the implant that replaced the first molar loosened. We hypothesize that the bone surrounding the second molar implant could not endure the occlusal forces, leading to the formation of a sequestrum and consequent migration of the fixture into the sinus cavity, along with its abutment and the associated necrotic bone. SEM and EDS analyses indicated that the fixture's surface was enveloped in calcifications. Future research should investigate how bone surrounding osseointegrated implants becomes sequestrum under excessive load and the calcification process of exogenous materials within the sinus cavity.

Acknowledgments

The authors declare no conflicts of interest.

References

1. Fugazzotto PA. Augmentation of the posterior maxilla: a proposed hierarchy of treatment selection. *J Periodontol*. 2003;74:1682–1691.

2. Jensen OT, Shulman LB, Block MS, Iacono VJ. Report of the Sinus Consensus Conference of 1996. *Int J Oral Maxillofac Implants*. 1998;13:11–32.

3. Wallace SS, Froum SJ. Effect of maxillary sinus augmentation on the survival of endosseous dental implants. A systematic review. *Ann Periodontol*. 2003;8:328–343.

4. Del Fabbro M, Rosano G, Taschieri S. Implant survival rates after maxillary sinus augmentation. *Eur J Oral Sci*. 2008;116:497–506.

5. Del Fabbro M, Wallace SS, Testori T. Long-term implant survival in the grafted maxillary sinus: a systematic review. *Int J Periodontics Restorative Dent*. 2013;33:773–783.

6. Kim J, Hyonseok J. A review of complications of maxillary sinus augmentation and available treatment methods. *J Korean Assoc Oral Maxillofac Surg*. 2019;45:220–224.

7. Galindo P, Sánchez-Fernándo, E, Avila G, Cutando A, Fernandez JE. Migration of implants into the maxillary sinus: two clinical cases. *Int J Oral Maxillofac Implants*. 2005;20:291–295.

8. Manor Y, Anavi Y, Gershonovitch R, Lorean A, Mijiritsky E. Complications and management of implants migrated into the maxillary sinus. *Int J Periodontics Restorative Dent*. 2018;38:e112–e118.

9. Brescia G, Fusetti S, Apolloni F, Marioni G, Saia G. Displaced dental materials in the maxillary sinus: an original series. Analysis and definition of a surgical decision-making process. *Ann Otol Rhinol Laryngol*. 2019;128:177–183.

10. Núñez-Márquez Salgado-Peralvo AO, Peña-Cardelles JF, Kewalramani N, Jiménez-Guerra A, Velasco-Ortega E. Removal of a migrated dental implant from a maxillary sinus through an intraoral approach: a case report. *J Clin Exp Dent*. 2021;13:e733.

11. Quiney RE, Brimble E, Hodge M. Maxillary sinusitis from dental osseointegrated implants. *J Laryngol Otol*. 1990;104:333–334.

12. Ding X, Qing W, Guo X, Yu Y. Displacement of a dental implant into the maxillary sinus after internal sinus floor elevation: report of a case and review of literature. *Int J Clin Exp Med*. 2015;8:4826.

13. Berglundh T, Abrahamsson I, Lang NP, Lindhe J. De novo alveolar bone formation adjacent to endosseous implants: a model study in the dog. *Clin Oral Implants Res*. 2003;14:251–262.

14. Abrahamsson I, Berglundh T, Linder E, Lang NP, Lindhe J. Early bone formation adjacent to rough and turned endosseous implant surfaces: an experimental study in the dog. *Clin Oral Implants Res*. 2004;15:381–92.

15. Froum SJ, Elghannam M, Lee D, Cho S-C. Removal of a dental implant displaced into the maxillary sinus after final restoration. *Compend Contin Educ Dent*. 2019;40:530–535.

16. Safadi A, Ungar OJ, Oz I, Koren I, Abergel A, Kleinman S. Endoscopic sinus surgery for dental implant displacement into the maxillary sinus-a retrospective clinical study. *Int J Oral Maxillofac Surg*. 2020;49:966–972.

17. Duce MN, Talas DU, Özer C, Yildiz A, Apaydin FD, Özgür A. Antrolithiasis: a retrospective study. *J Laryngol Otol*. 2003;117:637–640.

18. Shenoy V, Maller V, Maller V. Maxillary antrolith: a rare cause of the recurrent sinusitis. *Case Rep Otolaryngol*. 2013; 2013:527152.

19. Miyao T, Osato S, Miyao I, Nakajima Y, Shirakawa M. Analysis of retrieval of dental implants displaced into ectopic locations between 2015–2017 and 2018–2020: scoping review of literature. *J Oral Med Oral Surg*. 2020;28:28.

20. Chappuis V, Suter VGA, 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.

21. Heo YK, Lim YJ. A newly designed screw-and cement-retained prosthesis and its abutments. *Int J Prosthodont*. 2015;28:612–614.

22. Kwon TG, Lee C-O, Park JW, Choi SY, Rijal G, Shin HI. Osteonecrosis associated with dental implants in patients undergoing bisphosphonate treatment. *Clin Oral Implants Res*. 2014;25:632–640.