Treatment of Sinus Graft Infection After Sinus Floor Elevation: A Series of Four Case Reports

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This report of cases aims to share our treatment experiences in 4 sinus graft infection cases after sinus floor elevation and simultaneous implant placement. The preoperative and postoperative intraoral and radiographic photographs were collected and used to assess the treatment outcomes. The sinus cavity status, bone augmentation results, and implant stability were used as measurements to determine the treatment effectiveness. Four patients received partial graft removal as their surgical treatment for sinus graft infection combined with antibiotic therapy, with or without immediate secondary grafting. After early intervention, antibiotic therapy, and partial debridement of the infected sinus grafts, radiographic and clinical outcomes indicate successful resolution of the graft infection and stable bone graft levels around the implants. The keys to the successful management of the sinus graft infection were: early detection of the infection; early intervention, including partial debridement of the infected graft particles; and antibiotic therapy.

Key Words: sinus graft infection management, sinus floor elevation, dental implant

INTRODUCTION

Implant surgery performed in the posterior maxilla is often confronted with the problem of bone deficiency. At the same time, maxillary sinus floor elevation turned out to be the most commonly used method to solve.[1] Tatum first performed sinus floor elevation in 1974,[2] and first published by Boyne and James in 1980.[3] Due to the gradual modification over decades, the standardized sinus floor elevation procedure has already been well-established with high clinical success rates and low complication incidences.[4–8] The complications of sinus floor elevation include intraoperative bleeding, Schneiderian membrane perforation, mucous retention cyst, loss of graft material, implant migration, sinus graft infection, and sinusitis.[9] Due to the increasing demand for implants, sinus floor elevation was widely employed. Sinus graft infection as a rare but severe complication after maxillary sinus floor elevation has gradually attracted the attention of surgeons, with an approximate incidence of 2%–5%.[9,10] The causes of sinus graft infection remain controversial. The causes were edema, hematoma, or graft dislodgement, impaired mucus production, and impaired ciliary function.[9] Although the incidence of sinus graft infection is rare, the ensuing consequences are severe, including the failure of bone augmentation and implant restoration, which require the surgeons to do urgent intervention.

The current treatment of sinus graft infection after maxillary sinus floor elevation has yet to be standardized. Most surgeons prefer the management mainly based on the 4 stages proposed by Testori.[9] A sequential procedure, including antibiotic therapy and surgical treatment, is recommended. However, the dosage and time point of the intervention of antibiotic therapy are various, and the extent of graft removal is heterogeneous.[1] Partial graft removal could avoid secondary bone augmentation and reduce the visiting frequency.[11] However, previous studies have shown that partial debridement of bone grafting materials in the sequence of simultaneous implant placement has not achieved a satisfactory result.[12,13]

The purpose of this report of cases is to present the clinical management of sinus graft infection in 4 patients and to review the existing literature on the topic of sinus graft infection.

CASE REPORTS

Four patients (1 male and 3 females; mean age: 52.5 years) who were confronted with the complication of sinus graft infection after undergoing sinus floor elevation and simultaneous implant

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Table

Patients' demographics and clinical data*

Case	Age	Sex	Systemic Disease	Period* (day)	Alveolar Bone Height (mm)	Lateral Wall Thickness (mm)	Number of Implant	Implant Sites (No.)
1	67	Female	N	10	2–5	0.8–1.8	2	25, 27
2	55	Female	Hyperglycemia	11	3–5	0.5–0.7	2	25, 26
3	60	Male	N	14	4–5	1.2–1.7	1	27
4	28	Female	N	12	1–4	0.6–0.8	2	25, 27

*Duration between sinus graft elevation and the appearance of clinical symptoms of sinus graft infection.

placement between 2015 and 2021 were included in this report. The diagnosis of sinus graft infection was based on the clinical manifestations of local infection at an early stage after sinus floor elevation surgery, and cone beam computerized tomography (CBCT) was used to confirm the uneven density of bone graft materials as a supplementary diagnostic tool. The infection mainly occurs within 2 weeks after sinus floor elevation.[9] The clinical manifestations of sinus graft infection include swelling over the lateral window site, local tenderness and pain, fistula formation, flap dehiscence, and suppuration from a fistula or the incision line.[9] Preoperative and postoperative intraoral photographs were collected.

Before the implant surgery, CBCT was performed to measure the available alveolar bone height in the edentulous area and to ensure that the sinus was disease free.[14] All patients received CBCT examination immediately after the surgery, except case 1, to confirm implant placement results and sinus floor elevation. The sinus floor elevation and simultaneous implant placement were carried out by experienced physicians after a standardized procedure.[7] Bio-Osteon (Beijing YHJ Science and Trade Co., Beijing, China) in combination with autogenous bone was used as grafted material for the sinus floor elevation. Cefaclor (375 mg, 2 times daily) was given as routine postoperative antibiotic prophylaxis for 7 days, and a compound paracetamol tablet (450 mg, as needed for pain) was prescribed as an analgesic for 7 days if necessary. Radiographic examination was performed with the local infection's clinical manifestations to evaluate the extent of inflammation. Posttreatment CBCT was conducted to assess the recovery of sinus graft infection and the effects of osteogenesis and implantation.

Patients diagnosed with sinus graft infection were treated with saline or antibiotics irrigation, partial debridement of bone grafting materials, and medical therapy, including cephalosporins and nonsteroidal anti-inflammatory drugs (NSAIDs) with or without immediate secondary grafting. Surgical treatments were performed before the formation of pus. Irrigation was continued until there were no free-floating bone graft particles, the remaining bone materials were hard and clumped, and blood exudation was found in the area, which was regarded as the completion of partial debridement. The sinus cavity status, bone augmentation result, and implant status were used to measure the treatment outcomes. The demographics and clinical data of patients are listed in Table.

Case 1

In case 1, a 67-year-old woman was diagnosed with periodontitis and was undergoing scaling and root planing. The second premolar, first molar, and second molar in the left maxillary were lost, and the alveolar bone height in the edentulate area ranged from 2 to 5 mm. The thickness of the lateral wall of the maxillary sinus ranged from 0.8 to 1.8 mm (Figure 1a). The lateral window technique for sinus floor elevation was performed using Bio-Osteon combined with autogenous bone, and 2 implants (5 × 11.5 mm; NobelReplace, Nobel Biocare, Sweden) were simultaneously inserted into the areas of the second premolar and second molar in the left maxillary with nonsubmerged healing (Figure 1b and c). Regular postoperative therapy was prescribed for 7 days. On the 10th day after surgery, local swelling and discomfort occurred in the operative area, and systematic antibiotic therapy using Cefaclor (375 mg, 2 times daily) was employed for another 7 days. On the 18th day, the patient declared a subjective sense of swelling relief, while the boundary of the swelling lessened, and a sense of fluctuation was mentioned (Figure 1d). Local incision and drainage were performed. The same antibiotic therapy was prescribed for another 3 days. On the 26th day, the swelling had subsided. However, a fistula was found in the buccal mucosa. Meanwhile, the radiography showed poor osseointegration of the implants. Surgical debridement was performed on the 26th day (Figure 1e). The full-thickness flap from the original sinus floor elevation procedure was re-evaluated. After re-elevating the full-thickness flap, the bone graft's lateral area was exposed, granulation tissue and bone defect were found in the bone grafting area, and part of the implants were exposed. The granulation tissue and infected bone graft material were obliterated through debridement and saline irrigation, and immediate secondary grafting was performed using Bio-Osteon and collagen membrane (Figure 1f). On the return visit one month later, no sign of inflammation was present in the left maxilla, and the surgical wound had healed well. Seven months later, radiographic examination showed a view of stable implant placement and reliable bone graft level (Figure 1g). In comparison, the prosthesis had been completed 7 months after the surgical debridement (Figure 1h). Posttreatment CBCT was taken after 15 months (Figure 1i), confirming reliable outcomes of bone augmentation, implant placement, and a disease-free sinus.

Case 2

In case 2, a 55-year-old woman with uncontrolled hyperglycemia. The second premolar and first molar in the left maxillary were missing, the alveolar bone height in the edentulate area ranged from 3 to 5 mm, and the lateral wall thickness of the maxillary sinus ranged from 0.5 to 0.7 mm (Figure 2a). The lateral window technique for sinus floor elevation was performed using Bio-Osteon combined with autogenous bone. At the same time, one implant (4.0 × 11.5 mm; SICace, SIC invent, Switzerland) and one

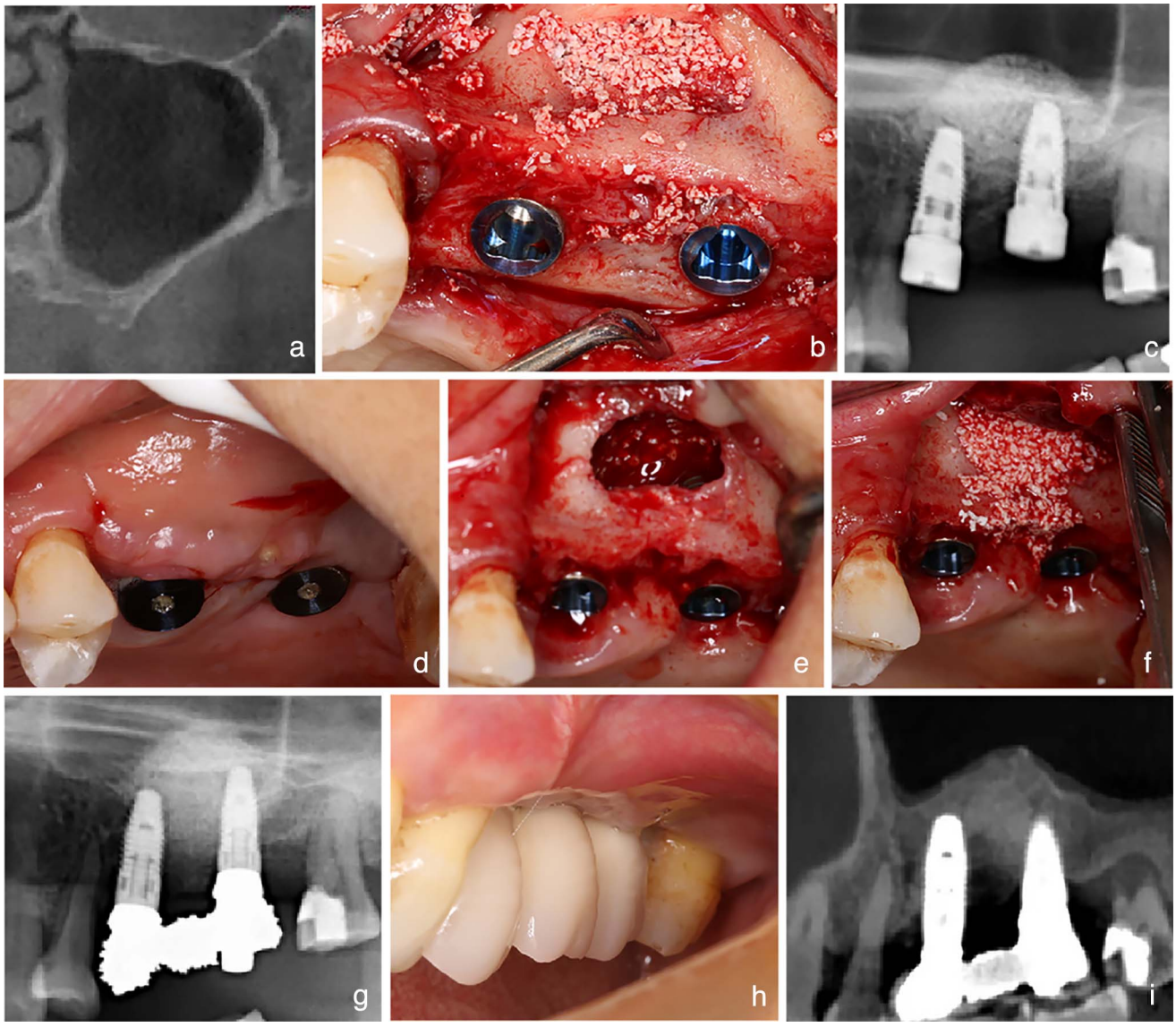

Figure 1. (a) preoperative CBCT; (b) intraoperative image; (c) postoperative radiographic examination; (d) 18 days after surgery; (e) surgical debridement; (f) immediately secondary grafting; (g), (h) 7 months after surgical debridement; (i) CBCT 15 months later.

implant (4.5 × 11.5 mm; SICace, SICinvent) were simultaneously inserted into the areas of the second premolar and first molar in the left maxillary with submerged healing. During surgery, the weak lateral wall was found to be partially fractured, and a titanium nail was employed to secure the fractured bone (Figure 2b–d). Routine postoperative antibiotic prophylaxis was employed for 7 days. On the 7th day after surgery, local swelling and blood-like exudation were found in the operative area (Figure 2e). Therefore, drainage using saline and antibiotic therapy (Cefaclor, 375 mg, 2 times daily for 3 days) was conducted.

On the 11th day, the swelling persisted along with pain, and CBCT showed the uneven density of bone graft materials with no abnormality in the sinus cavity or implants (Figure 2f). A full-thickness flap in the same area of the sinus graft elevation was performed to access the surgical site. A large amount of exudation was noted after the full-thickness flap was elevated (Figure 2g). Irrigation using gentamycin and saline was performed to remove the infected bone graft particles until there were no free-floating bone graft particles. In contrast, the remaining bone materials were hard and clumped. Secondary grafting using Geistlich Bio-Oss (Geistlich Pharma, Wolhusen, Switzerland) was immediately conducted after debridement was completed (Figure 2h). Cefaclor (375 mg, 2 times daily for 6 days) and compound paracetamol tablet (450 mg, as needed for pain) were prescribed. Six days after the operation, the clinical manifestations lessened, while local swelling remained, and the CBCT showed a relatively uniform density of bone graft material. Cefaclor (375 mg, 2 times daily for 5 days) was prescribed. Fourteen days after the surgery, the swelling had decreased significantly, and antibiotic therapy (Cefaclor, 375 mg, 2 times daily for 3 days) was still prescribed. Six months after the treatment, the gingiva was healthy, and the CBCT showed a uniform density of bone graft material (Figure 2i). Seven months after the surgical debridement, the gingival mucosa in the operation area showed no signs of redness or swelling (Figure 2j). In contrast, the CBCT

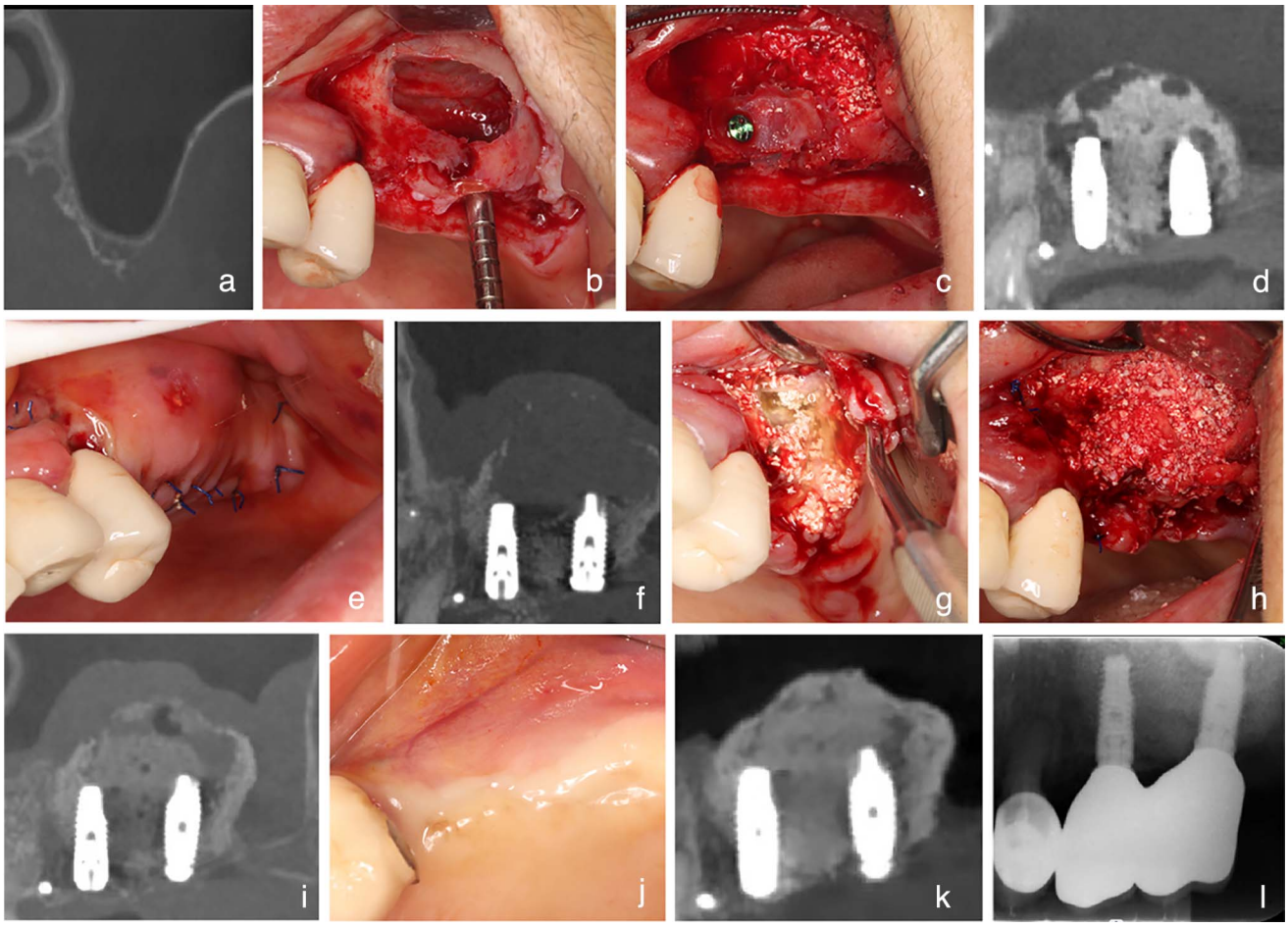

Figure 2. (a) preoperative CBCT; (b), (c) intraoperative image; (d) postoperative CBCT; (e) 7 days after surgery; (f) CBCT on 11th day; (g) surgical debridement; (h) immediately secondary grafting; (i) CBCT on 6 days after surgical debridement; (j), (k) 7 months after surgical debridement; (l) 8 months after surgical debridement.

showed stability of bone graft level and implant placement and a disease-free maxillary sinus (Figure 2k). The subsequent prosthesis procedure was completed 8 months after the surgical debridement (Figure 2l).

Case 3

In case 3, a 60-year-old man who lost the second molar in the left maxillary presented with alveolar bone height ranging from 4 to 5 mm in the edentulate area, and the thickness of the maxillary sinus lateral wall ranged from 1.2 to 1.7 mm. A maxillary sinus cyst was identified through CBCT before the operation (Figure 3a). The lateral window technique for sinus floor elevation was performed using Bio-Osteon accompanied with autograft, and one implant of 4.7 × 11.5 mm (SICmax, SIC invent, Switzerland) was simultaneously inserted into the area of the second molar in the left maxillary with submerged healing. The cyst was maintained and pushed backward during surgery, and the Schneiderian membrane perforation was carefully sutured (Figure 3b–d). Routine postoperative antibiotics treatment was administered for 7 days. On the 14th day after surgery, local swelling and pain occurred in the operative area (Figure 3e), while CBCT showed a displacement of bone graft materials (Figure 3f). A full-thickness flap was re-elevated in the original position of sinus graft elevation to expose the infected graft. Debridement was performed to remove the displaced bone graft materials and granulation tissue (Figure 3g and h). In addition, Cefaclor (375 mg, 2 times daily for 5 days) and a compound paracetamol tablet (450 mg, as needed for pain for 5 days) were prescribed for medical therapy. The local inflammation disappeared 2 weeks after the treatment, and the gingiva received satisfactory healing. CBCT was taken 6 months later and showed stable bone graft level and implant placement (Figure 3i). The gingival mucosa displayed a healthy appearance, and the restoration was subsequently completed 7 months after the surgical debridement (Figure 3j and k).

Case 4

In case 4, a 28-year-old woman was undergoing orthodontic treatment. The second premolar, first molar, and second molar in the left maxillary were absent, while the alveolar bone height in the edentulate area ranged from 1 to 4 mm, and the lateral wall thickness ranged from 0.6 to 0.8 mm (Figure 4a). The lateral window technique was used for sinus floor elevation, and Bio-Osteon and autograft were used for bone grafting. One implant (4.0 × 11.5 mm; SICace, SIC invent) and another implant (4.7 × 9.5 mm;

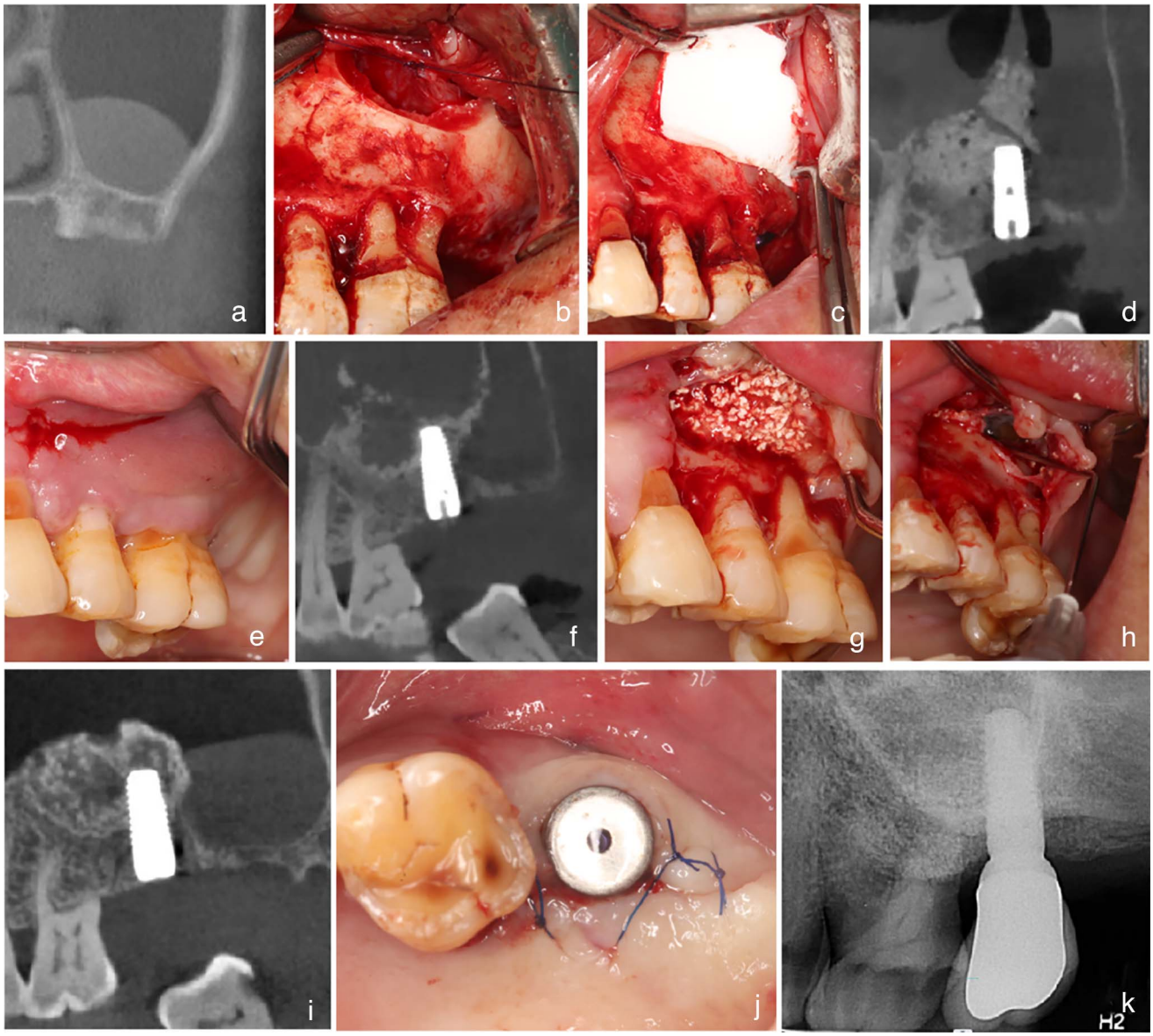

Figure 3. (a) preoperative CBCT; (b), (c) intraoperative image; D) postoperative CBCT; (e), (f) 14 days after surgery; (g), (h) surgical debridement and irrigation; (i), (j) CBCT and image 6 months after surgical debridement; (k) radiographic examination after finished restoration.

SICmax, SIC invent) were simultaneously inserted into areas of the second premolar and second molar in the left maxillary with submerged healing. The bone graft covered the exposed root surface of the first premolar (Figure 4b–d). Regular postoperative antibiotic prophylaxis was prescribed for 7 days. On the 12th day after surgery, the operative area showed local swelling and blood-like exudation (Figure 4e). At the same time, CBCT revealed displacement of the bone graft materials and swelling of maxillary sinus mucosa (Figure 4f). In the same area where sinus graft elevation surgery was performed, a full-thickness flap was re-elevated, and the lateral area of the infected graft was exposed. Debridement was performed to remove the displaced bone substitute (Figure 4g), in conjunction with saline irrigation and Geistlich Bio-Oss replacement covered by collagen membrane (Figure 4h). Cefaclor (375 mg, 2 times daily for 5 days) and compound paracetamol tablet (450 mg, as needed for pain for 5 days) were used as medical therapy. The local inflammation disappeared one month after the treatment, and the surgical wound healed well (Figure 4i). CBCT taken 6 months later showed a uniform density of bone graft material (Figure 4j). The prosthesis procedure was completed one year after the surgical debridement (Figure 4k and l).

Discussion

In this case report, we described 4 cases diagnosed with sinus graft infection after sinus floor elevation and simultaneous implant placement. Partial graft removal was conducted as surgical treatment accompanied with antibiotic therapy with or without immediate secondary grafting and received the outcome of disease-free sinus, effective bone augmentation, and stable implant placement.

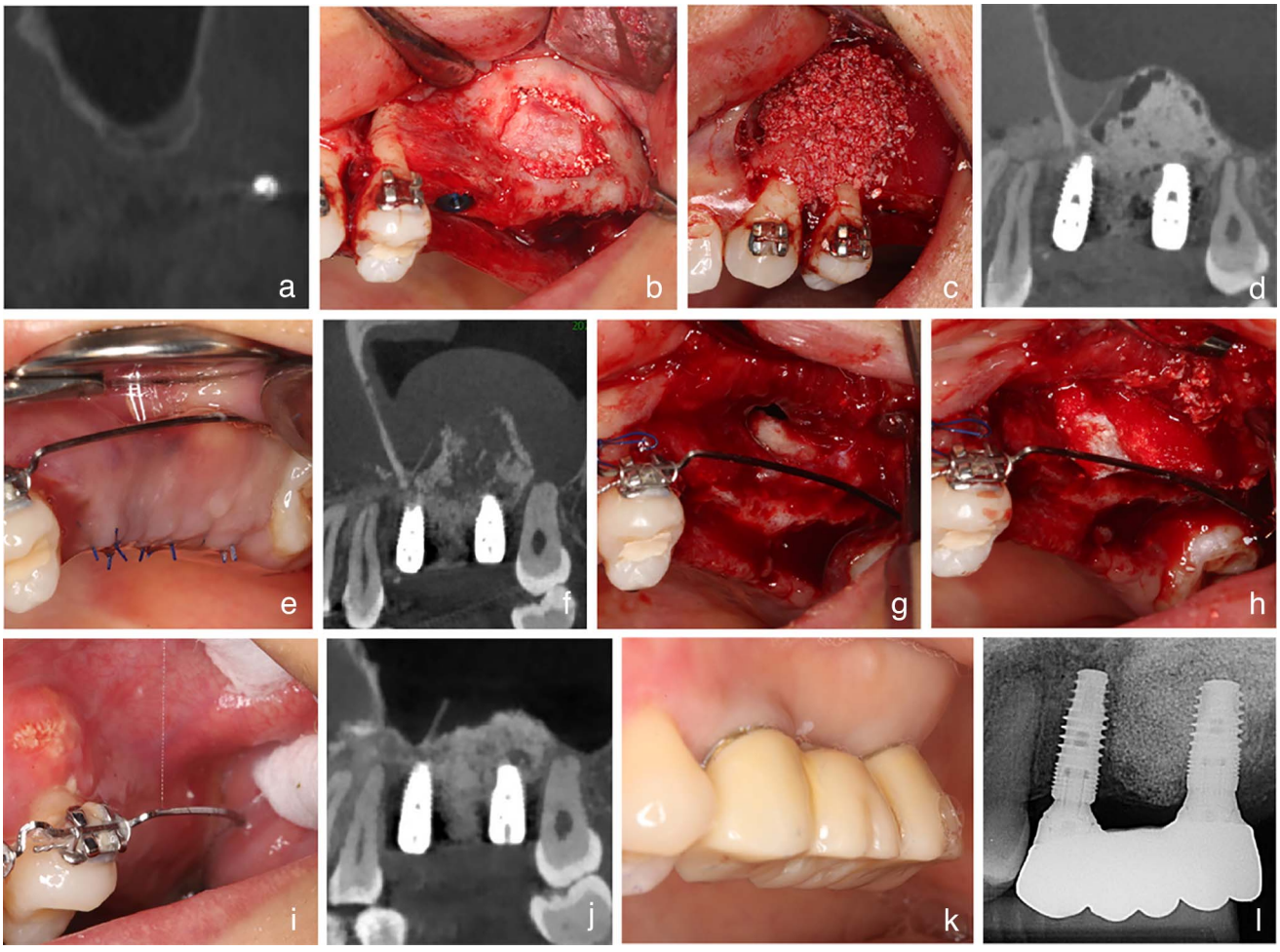

Figure 4. (a) preoperative CBCT; (b), (c) intraoperative image; (d) postoperative CBCT; (e), (f) 12 days after surgery; (g), (h) surgical debridement and immediately secondary grafting; (i) 1 month after surgical debridement; (j) CBCT 6 months after surgical debridement; (k), (l) image and radiographic examination after finished restoration.

Sinus graft infection is the most frequent infection after sinus floor elevation surgery. The separate incidence of sinus graft infection has yet to be described, since sinus graft infection is always found in conjunction with sinusitis. The incidence was measured approximately as 2%–5%.[9] Thus, the number of enrolled patients was limited because of the low incidence of this complication. Although previous study findings suggested sinusitis was always found in the case of sinus graft infection,[1] it is necessary to distinguish sinus graft infection from sinusitis because their managements are different.[15,16] Acute sinusitis mainly presents the clinical symptoms of infection inside the sinus cavity, including characteristic nasal congestion and postural pain, with systemic manifestations of headache and fever.[9]

In contrast, the most common symptom of sinus graft infection is swelling over the lateral window site. Other symptoms include local tenderness and pain, fistula formation, flap dehiscence, and suppuration from a fistula or the incision line. The increasing intrasinus pressure could also trigger nasal congestion. The clinical symptoms of sinus graft infection mainly appear within 2 weeks after sinus floor elevation, although some may occur after a few months.[9] In our cases, the period between sinus floor elevation surgery and the appearance of clinical symptoms of sinus graft infection ranges from 10 to 14 days. Meanwhile, the clinical symptoms described by our patients did not mention features such as nasal congestion or postural pain. Regarding radiographic analysis, the CBCT taken after the appearance of local infection symptoms presented images of uneven density of bone graft materials, indicating sinus graft infection. After the surgical intervention for sinus graft infection, the thickness of maxillary sinus mucosa decreased and gradually returned to normal levels. The causes of sinus graft infection have not been determined, but the etiology of sinusitis was thought to be related to sinus graft infection. The contamination of the graft material, instruments, or membrane in the surgical region by saliva or bacteria, lapses in the chain of sterility, extended surgical time, and perforation of the Schneiderian membrane are thought to contribute to the complication.[9]

The adverse outcomes of sinus graft infection include the failure of bone augmentation and implant placement. Therefore, intervention should be considered immediately after diagnosis. Testori et al[9] proposed a sequential 4-stage treatment for infection, described as (1) reinstitution and/or change of antibiotic therapy; (2) insertion of the drain with antibiotic therapy; (3) partial or complete debridement of the graft material; (4) total debridement of

the graft and sinus cavity through intraoral or functional endoscopic sinus surgery, or combined approach. Surgical treatment accompanied by antibiotic therapy was the most common strategy to treat sinus graft infection.[1] In our report, patient 1 received antibiotic therapy reinstitution before debridement, and patient 2 underwent drainage with antibiotic therapy before debridement. However, neither of them achieved effective control of infection. Both of them underwent further surgical debridement and finally achieved a successful outcome.

In previous studies, amoxicillin was the most commonly used antibiotic for postoperative prophylaxis with a duration of 5 to 10 days.[1] In this report of cases, Cefaclor was used as the routine postoperative antibiotic prophylaxis for 7 days. Once the sinus graft infection is diagnosed, the type of antibiotic and treatment duration should be reconsidered. Antibiotics such as metronidazole, clindamycin, and quinolones should be considered.[1] A treatment duration of 7 to 14 days is preferred for sinus graft infection. In the cases above, patient 1 resumed antibiotic therapy using Cefaclor for another 7 days before surgical treatment, but the outcome was unsatisfactory. If antibiotic therapy fails to control the infection, further surgical intervention should be considered. The surgical treatment includes drainage and graft debridement through oral approach and/or functional endoscopic sinus surgery.[17] Ayna et al[18] only used H_2O_2 irrigations for intraoral drainage as surgical treatment, and received a disease-free sinus and successful sinus floor elevation. However, others mostly performed drainage in accompanied with graft debridement. Efficacy of complete or partial debridement is worth exploring. Complete removal of the graft does not guarantee a successful implant placement and prolongs the duration of the treatment, requiring a secondary grafting. Although the success rate of partial removal is heterogeneous. Urban et al[11] reported a 100% success rate in sinus grafts through partial removal, whereas Park et al[12] (4/7) and Chaushu et al[13] (3/9) presented a relatively low success rate. Partial graft removal could effectively shorten the treatment course and avoid secondary grafting. However, the success rate of the operation heavily depends on the technical sensitivity of the surgeon. In this report of cases, we described 4 cases of sinus graft infection. In case 1 and case 2, we performed the surgical intervention of drainage with antibiotic therapy before debridement; however, the effect was limited. The other 2 cases underwent surgical debridement immediately after the sinus graft infection was diagnosed. All 4 cases received the surgical treatment of partial graft removal without additional grafting surgery and achieved successful bone augmentation results and implant placement. Our experience indicated that early diagnosis and intervention are essential. Partial debridement in conjunction with antibiotic therapy could effectively treat sinus graft infection.

There are many local and systemic risk factors of sinus graft infection. Local factors include pre-existing localized sources of infection such as periapical periodontitis and untreated periodontal diseases adjacent to the surgical site, asymptomatic chronic or allergic maxillary sinus disease, maxillary sinus cysts, and severely thickened maxillary sinus mucoperiosteal flap that blocks the drainage of maxillary sinus.[9] The presence of maxillary sinus cyst in case 3 was a risk factor for sinus graft infection, suggesting that more attention should be given in the presence of cysts. Inadequate attached gingiva and a thin lateral wall of the maxillary sinus, which provide relatively insufficient blood supply, may also impede postoperative wound healing. Systemic factors included age, uncontrolled diabetes, anemia, and so on. Simultaneous and delayed implant placement showed a similar survival rate of sinus floor elevation under the right circumstances, and there is currently no evidence of a direct relationship between simultaneous implant placement and sinus graft infection.[19] However, infection may cause the loss of implant, and implant placement increases the difficulty of thorough debridement. Therefore, systemic and local conditions of patient should be carefully evaluated to determine whether simultaneous implant placement should by performed.

The lateral walls and the media walls are the main walls involved in the lateral approach sinus floor elevation procedure. The lateral wall contains vessels, nerves, and antral septa or ridges, while in some patients the lateral wall may only consist of a thin cortical layer less than 1 mm.[9] The cortical layer could not provide adequate blood supply, which might be a potential risk of postoperative infection. A study suggested that the thickness of the lateral wall of the maxillary sinus was related to the occurrence of membrane perforation.[20] Thicker lateral walls showed more difficulty in detaching the membrane from the inner bony sinus and were more prone to perforate the membrane.[21,22] However, no studies have proven a relationship between lateral wall thickness and postoperative infection until now. In this report, the minimum lateral wall thickness was found less than 1 mm in 3 cases, and the maximum lateral wall thickness was measured less than 1 mm in 2 out of the 3 cases. This suggests that thin lateral wall of the maxillary sinus might be involved in triggering sinus graft infection. Patients with thin lateral wall thickness require careful management to prevent insufficient blood supply. Further study is needed to explore the relationship between them.

Conclusion

The present report illustrates the successful management of sinus graft infection in patients with sinus floor elevation with bone grafts and implant placement. The keys to the successful management of the sinus graft infection were: early detection of the infection; early intervention, including debridement of the infected graft particles; and antibiotic therapy with cephalosporin.

Abbreviations

CBCT: cone beam computerized tomography
NSAIDs: nonsteroidal anti-inflammatory drugs

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Note

There is no conflict of interest to declare.

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