Incidence, Diagnosis, and Treatment of Sinus Graft Infection After Sinus Floor Elevation: A Clinical Study

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**Purpose:** The aims of this clinical study were to evaluate the occurrence of sinus graft infection and the results of a planned surgical and pharmacologic treatment regimen to eliminate infections and preserve the graft. **Materials and Methods:** Patients were consecutively treated with sinus floor elevations using the lateral window technique. If a clinical diagnosis of sinus graft infection was made for a patient, a postoperative computed tomographic scan was performed to diagnose involvement of the sinus cavity. **Results:** Of 198 patients treated with 274 sinus grafts, 8 (2.3%) developed a sinus graft infection. These patients were treated with the same surgical and pharmacologic regimen. Symptoms of infection were recognized, the infected graft was removed, and the remaining graft material was cleansed. The remaining defect was not filled with new graft material; instead, it was left to heal for an extended healing period (average of 10.6 months), and residual bone defects were corrected during implant placement. Acute symptoms of infection disappeared within 48 hours of treatment and all patients healed uneventfully thereafter. All 24 implants placed have survived to date (with implant loading times ranging from 1 to 9 years), resulting in a 100% implant survival rate for these sites with postoperative infection. **Conclusions:** The overall clinical outcome, including patient satisfaction, achievement of optimal graft volume without subsequent sinus elevation, and long-term implant survival, confirmed the success of this treatment protocol. INT J ORAL MAXILLOFAC IMPLANTS 2012;27:449–457

**Key words:** postoperative infection, sinus elevation, sinus graft, sinus graft infection, sinusitis

Since the proximity of the maxillary sinus may result in inadequate bone height to host implants, sinus augmentation in the posterior maxilla is often necessary. Sinus augmentation is the most common technique to overcome the limitations associated with posterior maxillary reconstruction. The lateral window approach for sinus augmentation was first described by Boyne and James.1 Sinus augmentation is a well-documented, frequently performed, and predictable procedure with established methods, clinical success, and a low rate of complications.2–5 However, despite success rates of more than 90%, various intraoperative and postoperative complications have been reported in the literature, including sinus membrane perforation and infection.6–10 The most frequent intraoperative complication is membrane perforation, and in most cases this can be corrected during surgery.11 Postoperative complications, such as sinus graft infection, are rare, and no method of treatment has been systematically evaluated. In sinus floor elevation procedures, an infected graft is particularly difficult to treat, as the graft itself lies within the sinus cavity, underneath the elevated sinus membrane.

Sinus graft infection is considered a major complication requiring urgent treatment, because there is risk that the infection could spread throughout the graft and the sinus cavity or the adjacent anatomical structures.12 To date, no general treatment protocol for sinus graft infection has been described in the literature that was evaluated in multiple patients.

The aims of this clinical study were to evaluate the occurrence of sinus graft infection and the results of a planned surgical and pharmacologic treatment regimen for any sinus graft infections.
MATERIALS AND METHODS

Patient Population
This clinical study reports on patients who were consecutively treated with sinus floor elevations. Prior to treatment, all patients were informed about possible complications and the planned 6-month healing period prior to implant placement and loading, and all provided informed consent for all surgical interventions.

Sinus Floor Surgery
Patients were premedicated with amoxicillin (2 g, 1 hour before surgery); if they were allergic to penicillin, they received 600 mg clindamycin instead. Sinus floor augmentations were performed using the lateral window technique. Autogenous bone and anorganic bovine bone mineral (ABBM) (Bio-Oss, Geistlich Pharma) were used as grafting materials, and a collagen membrane (Bio-Gide, Geistlich Pharma) was placed over the lateral window. Patients were treated with either a sagittal sandwich layer bone graft or 100% ABBM graft. The sagittal sandwich layer bone graft consisted of vertical layers of ABBM, plus autogenous bone harvested intraorally, and was performed as previously described.

Following the surgery, patients were prescribed either 500 mg amoxicillin three times a day for 1 week or 300 mg clindamycin four times a day for 1 week. In addition, an anti-inflammatory medication (50 mg diclofenac potassium three times a day) were prescribed for 1 week following surgery. In addition to systemic antibiotics, for any patients with concomitant sinusitis, conservative pharmacologic management consisting of a nasal decongestant spray (oxymetazoline hydrochloride, Nasivine 0.05%; Merck) was used three times a day for 4 days, as recommended by the otolaryngologist.

Treatment Plan for Infected Grafts
If a clinical diagnosis of sinus graft infection was made for a patient, a postoperative computed tomographic (CT) scan was performed to diagnose the involvement of the sinus cavity. If abnormal CT results were seen, an otolaryngologist was consulted for additional advice. The planned treatment regimen for sinus graft infection involved both surgical intervention to treat the infected graft material and systemic pharmacologic treatment of the infection.

All sinus graft infections were planned to be treated locally with the same surgical approach. The full-thickness flap from the original sinus floor elevation procedure was re-elevated to expose the lateral area of the bone graft. Any loose membrane pieces were removed from the surgical site, and any loose, grayish-looking bone graft particles were irrigated with sterile saline. Then, a more confined, intact, immobile, immature, healthy-looking graft zone was found and was gently curetted until all loose graft particles were removed.

It was the subjective decision of the clinician to determine which graft area was not involved in the infection. Because it was not possible to objectively determine whether a graft zone was infiltrated with bacteria, a locally applied antibiotic was used empirically to treat the remainder of the sinus graft and reduce the risk of persistent infection. Thus, the remaining bone graft was infiltrated with 100 to 200 mg of doxycycline powder diluted with 0.1 to 0.2 mL of saline to form a putty. The doxycycline putty was placed in the bone graft for 2 minutes and was then washed out of the site with sterile saline. Doxycycline, a wide-spectrum antibiotic with anti-inflammatory properties, was used; it has been used safely and does not interfere with bone formation. The defect was gently curetted again to re-establish bleeding of the site to ensure the formation of a blood clot. No further treatment of the created defect within the maxillary sinus graft was initiated at this stage, resulting in a five-wall defect within the sinus graft and preserving the elevated state of the sinus. The flap was readapted and sutured to achieve primary closure (Fig 1).

Following surgical treatment, all patients received systemic medications to prevent the infection spreading throughout the remainder of the graft and to the sinus or to other adjacent vital anatomical structures. A systemic antibiotic (amoxicillin clavulanate potassium, 1 g two times a day) and an anti-inflammatory medication (50 mg diclofenac potassium three times a day) were prescribed for 1 week following surgery. In addition to systemic antibiotics, for any patients with concomitant sinusitis, conservative pharmacologic management consisting of a nasal decongestant spray (oxymetazoline hydrochloride, Nasivine 0.05%; Merck) was used three times a day for 4 days, as recommended by the otolaryngologist.

The total healing time prior to implant placement was extended to allow time for the five-wall defect to fill in with newly formed bone. Any remaining bone deficiencies were treated at the time of implant placement.

RESULTS

During the years 2001 to 2010, 198 patients (93 men, 105 women) required grafting of 274 sinus sites for implant placement. The mean age of this cohort was 53 years (range, 30 to 80 years; nine patients did not provide their age). Normal clinical healing occurred in most patients and was characterized by maximum postoperative swelling at 48 hours that decreased gradually and disappeared completely after 10 days. Reports of pain were negligible, and any discomfort was primarily associated with tension from the swelling.

Eight patients experienced one or more of the following clinical symptoms of sinus graft infection between
1 and 3 weeks after sinus elevation: severe pain, fistulous tract extending into the oral cavity, recurrent facial swelling at 2 to 3 weeks, abscess, elevated body temperature, or loss of bone graft particles through the fistulous tracts or through the borders of the flap (“popcorn sign”) (Table 1). When these symptoms were observed, a post-operative CT scan was performed in all eight patients to diagnose the involvement of the sinus cavity.

CT scans for two of the eight patients indicated sinus involvement, a sequela of the sinus graft infection; one patient showed thickening of the sinus membrane, and the other patient’s CT revealed complete...
The eight sinus graft infections were treated locally in anticipation of planned surgical intervention for the infected graft was recommended.

Table 1  Data on Patients with Sinus Graft Infections

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Sex</th>
<th>Age (y)</th>
<th>No. of sinus sites</th>
<th>Infected site</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>50</td>
<td>2</td>
<td>Right</td>
<td>Fistula, loss of graft particles, swelling, concomitant sinusitis</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>44</td>
<td>1</td>
<td>Left</td>
<td>Pain, swelling, abscess with pus</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>40</td>
<td>2</td>
<td>Right</td>
<td>Pain, fistula, loss of graft particles, swelling, abscess</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>66</td>
<td>2</td>
<td>Right</td>
<td>Pain, swelling, abscess</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>42</td>
<td>1</td>
<td>Right</td>
<td>Pain, loss of graft particles, swelling, abscess</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>72</td>
<td>2</td>
<td>Left</td>
<td>Pain, swelling, abscess, temperature, concomitant sinusitis</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>53</td>
<td>2</td>
<td>Right</td>
<td>Swelling, pain, abscess</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>65</td>
<td>1</td>
<td>Right</td>
<td>Swelling, abscess, loss of graft particles</td>
</tr>
</tbody>
</table>

Mean
SD
Range

*Pre = crestal bone height prior to the sinus floor elevation. If available, this was measured from a CT scan. For those patients without a CT scan, the remaining alveolar bone height was measured under magnification and calculated from panoramic radiographs. Consideration was given to the magnification rate. Post = postaugmentation bone height, including crestal bone (as measured from a CT scan).

Mk III = Brånemark System, Mk III, Nobel Biocare; Mk IV = Brånemark System, Mk IV, Nobel Biocare.

Results of Systemic Pharmacologic Treatment
Following surgical treatment of the sinus graft infection, all eight patients received systemic medications to prevent the infection from spreading throughout the remainder of the graft and to the sinus or to other adjacent vital anatomical structures. None of the patients were allergic to penicillin and all were therefore treated with the same medication. The two patients with concomitant sinusitis also received nasal spray, as recommended.

After the infections were treated in all eight patients, the acute symptoms disappeared within 48 hours, and all patients healed uneventfully afterward. The total healing time prior to implant placement was an average of 10.6 months in these patients. After the healing period, all defects demonstrated bone fill and were greatly reduced in size. The remaining bone deficiencies were primarily implant fenestrations, where the placed implant penetrated the remainder of the five-wall defect. Representative histologic specimens obtained from the implant side (corresponding to the five-wall defect) of one patient at implant placement showed normal, healthy new bone (Fig 2).

The infection was eliminated in all eight surgical sites, and none of the patients treated for sinus graft infection have shown any long-term problems to date. Implants were placed in the sites that had been infected. All 24 implants placed have survived to date (with implant loading times ranging from 1 to 9 years), resulting in a 100% implant survival rate in these eight surgical sites with postoperative infection.

opacification of the sinus cavity. The latter patient had displayed only one clinical sign—severe pain at 1 to 2 weeks postsurgery—but it resolved after a few days. No additional clinical symptoms occurred in this patient until 6 weeks, when the patient had an elevated temperature and recurrent facial swelling without an intraoral fistula, and surgical intervention was considered at this time. The two patients with abnormal findings on their CT scans, received consultations from an otolaryngologist. An endoscopic exam revealed a patient middle meatus without signs of purulent drainage; therefore, conservative pharmacologic management in anticipation of planned surgical intervention for the infected graft was recommended.

Results of Surgical Intervention
The eight sinus graft infections were treated locally with the surgical approach described earlier. In most instances, breakdown of the collagen membrane was observed, along with loose bone graft particles floating in purulent exudate. In all eight patients, it appeared that the infection had not yet involved the entire graft, but in all instances there was a marked difference between the aforementioned graft zones (ie, loose particles floating in pus/stable immature graft zone). Re-entry procedures revealed no detectable communication between the remaining defect and the sinus cavity in any of the patients, including the two patients who had concomitant sinusitis.
Sinus elevation is considered a safe and effective grafting procedure for the treatment of the resorbed posterior maxilla. However, regardless of the care taken, problems can occur, and numerous postoperative sequelae, ranging from discomfort to the appearance of cysts and other complications of the sinus cavity, have been described in the literature.2,5,7–10

### Table 1 Data on Patients with Sinus Graft Infections

<table>
<thead>
<tr>
<th>Healing time (mo)</th>
<th>Crestal bone height (mm)*</th>
<th>No. of implants placed: dimensions and type</th>
<th>Loading time</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.40</td>
<td>4</td>
<td>16</td>
<td>9 y</td>
</tr>
<tr>
<td>12.13</td>
<td>5</td>
<td>14</td>
<td>7.5 y</td>
</tr>
<tr>
<td>6.90</td>
<td>4</td>
<td>13</td>
<td>5 y</td>
</tr>
<tr>
<td>16.60</td>
<td>2</td>
<td>13</td>
<td>2.5 y</td>
</tr>
<tr>
<td>13.50</td>
<td>4</td>
<td>13</td>
<td>1.5 y</td>
</tr>
<tr>
<td>7.3</td>
<td>2</td>
<td>17</td>
<td>1 y</td>
</tr>
<tr>
<td>10.56</td>
<td>3.5</td>
<td>15.5</td>
<td>4.19 y</td>
</tr>
</tbody>
</table>

Mean 10.56 3.5 15.5 4.19 y

SD 3.57

Range 6.4–16.6

**Fig 2** Representative histologic specimens taken from the right first premolar area (core taken from a crestal approach through the implant site) of patient no. 3 demonstrate regeneration into the previous five-wall defect 7 months after treatment of the infection.

- **Fig 2a** Under the remaining mucosa (dark blue, top), the specimen shows fragmented vital bone. The lower part shows mature trabecular bone with a lamellar structure and marrow spaces (×50).

- **Fig 2b** Osteoblasts are producing osteoid tissue on the surface of the newly formed bone (×200).

- **Fig 2c** Mature trabecular bone with lamellar structure and bone marrow is present in the middle of the biopsy specimen (×200).

- **Fig 2d** Active osteoblasts (OB) and osteoclasts (OC) demonstrate ongoing bone remodeling (×400). There are no signs of acute inflammation.

### DISCUSSION

Sinus elevation is considered a safe and effective grafting procedure for the treatment of the resorbed posterior maxilla. However, regardless of the care taken,
Sinus graft infection is a major but infrequent complication; a meta-analysis revealed that infections occur in up to 4.7% of sinus graft procedures.2 Treatment strategies reported in the literature for sinus graft infections include administration of systemic antibiotics, endoscopic exploration of the sinus, surgical exploration, and rinsing.9,17 However, no detailed treatment protocol for postoperative sinus graft infection has been reported in any of these publications. The signs and symptoms of sinus graft infection are described in the present paper, along with a detailed protocol for its treatment. There may be superficial infections in which the use of antibiotics alone could be effective. However, previous experience at Loma Linda University in treating sinus graft infection with antibiotics only usually did not result in resolution of the graft infection, which typically progressed further, necessitating complete graft removal. Therefore, it was deemed prudent to treat these eight sinus graft infections with both surgical and systemic pharmacologic treatment.

The treatment regimen described herein is a result of more than 30 years of experience in performing sinus grafts and managing sinus graft complications, and it represents the evolution of a treatment protocol over this period of time. It must be emphasized that there were no detectable communications between the infected graft and the sinus cavity, as observed during the re-entry procedure, in any of the patients, including the two patients who had concomitant sinusitis. Patients with a communication between the infected graft and the sinus cavity, or patients who develop infections and who do not respond to this treatment, may need to be treated more aggressively with complete graft removal and/or endoscopic sinus surgery by an otolaryngologist to prevent more serious complications. The complications reported in the present cohort of patients could be controlled with such a localized approach. Early recognition of signs and symptoms is critical to prevent a spread or increase in the severity of the infection.

The goal of the treatment described herein was to eliminate the infection and to prevent its progression to the sinus cavity and additional vital structures. The strategy of the surgical approach was to immediately eliminate the source of infection in such a way that the infection did not compromise successful dental implant placement. The surgical treatment seems logical, but it must be considered empirical, since there are no objective tools to confirm that any infection remained in the sinus graft after the cleansing procedure. Although the choice of doxycycline powder for mixture with the remaining bone graft is considered empirical, doxycycline is an effective broad-spectrum antibiotic with anti-inflammatory properties.15 It was used safely in a study of sinus augmentation with follow-up through 6 years, mixed with ABBM at the time of grafting, and did not interfere with bone regeneration.16

The choice of systemic antibiotics used to treat the infections in these eight patients was amoxicillin clavulanate potassium, which has been shown to be effective in the treatment of acute sinusitis.18 However, other antibiotics have been reported to be effective in the treatment of sinusitis.19 Collection of infected material for bacterial culture at the time of surgery may also be extremely useful.

The overall clinical outcome, including patient satisfaction, histologic evidence, achievement of optimal graft volume without subsequent sinus elevation, and long-term implant survival, was successful, since the objectives were achieved in all eight patients. Early treatment and eradication of an infection are necessary to prevent it from spreading to the sinus cavity and the surrounding bone, possibly causing greater damage.

One of the eight patients reported herein developed sinusitis that completely obliterated the sinus cavity (Fig 3). This patient had pain at 1 to 2 weeks postsurgery, but no additional symptoms such as fistula formation or swelling were noted until 6 weeks postsurgery, when recurrent swelling, pain, and elevated temperature were observed; at this time, sinusitis was
Figs 3c and 3d  Panoramic view and cross-sectional CT scan images demonstrate loss of integrity of the bone graft at the central part, a suspected internal fistulous tract into the sinus cavity, and complete sinusitis that obliterated the sinus cavity (arrow).

Fig 3e  The patient was treated for sinus graft infection at 6 weeks after sinus grafting on the basis of the CT scan and consultation with an otolaryngologist. After flap elevation, purulent exudate (arrow) and loose grayish particles were visible, confirming infection of the graft.

Figs 3f and 3g  The mesiodistal and buccolingual dimensions of the defect were measured after the cleansing procedure.

Fig 3h  Application of the doxycycline putty.

Figs 3i and 3j  Postoperative CT scans confirm complete healing of the sinusitis at 4 weeks after emergency treatment of the sinus graft and infection. Note the large five-wall defect. Remnants of the internal suspected fistulous tract are still identifiable (arrow).

Fig 3k  The defect has been reduced 1 year after sinus infection treatment and subsequent uneventful healing. Note that the majority of the defect is filled in with bone, but a moderate defect remains. In the eight patients treated, this was the largest remaining defect.

Fig 3l  The defect is covered with a bone graft.

Fig 3m  Follow-up CT scan after implant loading (18 months after the infection was treated) demonstrates complete healing of the sinusitis and good bone graft incorporation. Note the healthy and open ostium complex.

Fig 3n  Panoramic radiograph demonstrates stable bone after 10 months of loading.
diagnosed. This patient clearly had an infection as early as the other seven patients but it was not diagnosed because the severe pain had resolved and there were no other symptoms until 6 weeks. The CT scan for this patient showed not only the obliterating sinusitis, but a suspected internal fistula between the graft and the sinus cavity, suggesting an etiology for the sinusitis. Because middle meatal patency was evident on endoscopic examination, the same surgical and pharmacologic treatment of the graft used for the other seven patients with infection, in addition to conservative medical and pharmacologic treatment of the sinusitis, was also effective for this patient. During the surgical procedure, however, a communication between the graft and the sinus was not detected. This patient exemplifies why early diagnosis and treatment are necessary, since untreated sinusitis may lead to more severe complications. Consultation with an otolaryngologist should be considered advisable in all situations in which the CT scan shows that there is a concomitant sinusitis to confirm whether sinus patency and sinusitis can be managed conservatively or additional surgical treatment is necessary. It is recommended that an individual treatment plan for each patient who develops a sinus graft infection and sinusitis should be based on evaluations by both the treating and the consulting clinicians.

All eight patients were treated with a staged sinus grafting approach for implant placement. In the event that a complication occurs, treatment is easier and more successful if an implant is not involved, as bacteria may adhere to the implant surface. In a study that used a simultaneous technique for implant placement, the leading cause of implant loss was infection. This finding, in light of the results reported herein, suggests that such complications may be controlled more easily and more predictably when a staged technique is utilized. As demonstrated in these patients, the thorough elimination of infected graft material can enable bone regeneration in areas to which the infection has not yet spread and even permit regeneration of the majority of the resulting five-walled bone defect, as demonstrated by the histologic specimens showing new bone formation in a previously “empty” space (Fig 2). A similar phenomenon was demonstrated in a report of new bone formation, where no grafting material was used during sinus elevation procedures, and in cases of spontaneous bone fill after postoperative sinus graft infection.

The decision to add no new augmentation material during the treatment of sinus infection was a safety measure to prevent repeated infection. Instead, any remaining minor bone defects were treated at the time of implant placement. In terms of the overall treatment for a sinus graft infection, an apical fenestration on a placed implant can be easily treated with guided bone regeneration and is a relatively minor complication compared to infection and potential loss of the entire sinus graft.

In the cohort of patients treated between 2001 and 2010, a preoperative CT scan was not obtained for all patients. Only traditional spiral CT scans were available during the time that many of these patients were treated, and CT scans were expensive and difficult to access. Today, however, preoperative low-dose cone beam CT scans are readily available and are advisable in all cases. Guidelines for diagnosing preoperative risks based on CT findings should be developed but are beyond the scope of this clinical study.

CONCLUSION

Within the limitations of the eight patients reported herein, this cohort from a clinical study of 198 patients represents the successful use of a surgical and pharmacologic regimen to treat the complication of sinus graft infection that salvages the graft and does not necessitate complete removal of the graft. The overall clinical outcomes, including patient satisfaction, histologic observations, achievement of optimal graft volume without subsequent sinus elevation, and long-term implant survival, confirmed the success of treatment in all eight patients. The results of treatment in these eight patients should be confirmed by multicenter studies in a larger patient population prior to routine clinical use.

REFERENCES