

Surgical treatment of chronic rhinosinusitis after sinus lift

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ABSTRACT

Background: The sinus lift (or sinus augmentation) is a common procedure to improve maxillary bone stock before dental implantation. Chronic rhinosinusitis (CRS) is a potential complication of this procedure and may be refractory to medical treatment. Functional endoscopic sinus surgery has previously been used to address CRS, however, results of previous studies indicated that implant removal is required. There are limited follow-up data available.

Objective: The purpose of this study was to characterize the long-term outcomes and efficacy of endoscopic sinus surgery for refractory CRS after sinus lift, including the ability to salvage dental implants.

Methods: This was a retrospective case series that described nine patients who, between June 2011 and September 2016, underwent endoscopic sinus surgery for CRS after a sinus lift procedure. The presenting symptoms of the patients, medical management, imaging results, operative procedures, and outcomes were reviewed.

Results: The majority of patients developed symptoms (mucopurulent nasal drainage, facial pain and/or pressure, nasal congestion, and foul smell) within 3 months of implant placement and were treated with at least three courses of antibiotics before referral to an otolaryngologist. All the patients underwent wide endoscopic maxillary antrostomy, with no surgical complications or postoperative reports of infection. There was a statistically significant improvement in 22-item Sino-Nasal Outcome Test scores ($t(8) = -2.908$; $p = 0.02$) and discharge, inflammation, and polyps/edema endoscopic scores ($l_z = -2.539$; $p = 0.011$) between pre- and postsurgical treatment. Four patients had their dental implants removed before presentation. Among the five patients who presented with intact dental implants, none required removal before or after functional endoscopic sinus surgery.

Conclusion: Functional endoscopic sinus surgery was a reasonable and efficacious treatment option for patients who presented with paranasal sinus disease after a sinus lift. Dental implant removal may not be a requirement for successful treatment of CRS associated with sinus lift procedures.

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Treatment of patients who are edentulous and with dental implantation is a common and popular practice among dental practitioners.¹ According to the American Academy of Implant Dentistry, ~3 million people in the United States have implants, with ~500,000 Americans undergoing dental implant surgery each year.² One of the most common challenges is insufficient bone quantity in the posterior maxilla. To address this issue, O. Hilt Tatum² pioneered the first sinus lift operation in 1974. Since then, several iterations of the sinus lift procedure (also called sinus augmentation) have arisen with the common goal of addressing insufficient bone quantity and quality for the implant cradle. Nowadays, this procedure commonly involves introducing a bone graft or a bone substitute to the posterior maxilla, the area around the premolar and molar teeth, and the lower schneiderian membrane. Although the complication rate is low, operative risks of this procedure include wound infection, sinusitis, schneiderian membrane perforation, graft or barrier membrane exposure, graft infection, cyst formation, flap dehiscence, and sinusitis.^{3–6} Chronic rhinosinusitis (CRS) that originates from the adjacent maxillary sinus is a well-documented complication of a sinus lift procedure, with a recent study that reported an incidence of 2.3%.⁷

Otolaryngologists are frequently consulted in the evaluation and treatment of these patients. Infection in the presence of two foreign bodies, bone graft material and the implant, adds to the complexity of treating this particular disorder. The traditional surgical approach to an infection

in this setting includes removal of the bone graft and implant. Unfortunately, there are a limited number of publications that detail the presentation of this complication^{8–10} and even fewer that discuss surgical management.¹⁰ Kayabasoglu *et al.*⁸ describe four patients with CRS after a sinus lift procedure. None of these patients underwent sinus surgery, and the follow-up interval for these four patients was not included in the article. The investigators reported that two of the patients achieved recovery with a 10-day course of clindamycin, one patient lost a dental implant, and one patient received two rounds of antibiotics. Doud Galli *et al.*¹⁰ report 14 cases of CRS after a sinus lift procedure and focus on removal of graft material from within the maxillary sinus. Six patients in this study lost their implants, although the timing of implant loss relative to sinus surgery is unclear and neither implant preservation nor duration of follow-up was reported.¹⁰ The objective of the present article was to evaluate surgical treatment and long-term outcomes for CRS associated with sinus lift procedures, including the potential for preservation of dental implants in this setting.

METHODS

We conducted a retrospective chart review of patients seen at the University of California—San Francisco for CRS and sinus-related procedures over a 6-year period (2010–2016). We received approval by the University of California—San Francisco Institutional Review Board (15–18499) to conduct this study. The institutionally adopted electronic medical record (Epic Systems Corp., Verona, WI) was searched by using the Current Procedural Terminology (CPT) codes entered by three Otolaryngologists with expertise in sinus disorders (S.D.P., A.H.M., and A.N.G.). The CPT codes used in our inclusion criteria were the following: 31267 (nasal/sinus endoscopy, surgical, with maxillary antrostomy; with removal of tissue from maxillary sinus), 31256 (nasal/sinus endoscopy, with maxillary antrostomy), 31254 (endoscopy procedures on the accessory sinuses), 31276 (nasal/sinus endoscopy, surgical with frontal sinus exploration, with or without removal of tissue from frontal sinus), and 61782 (stereotactic computer assisted volumetric [navigational] procedure, intracranial, extracranial, or spinal).

Records of three known patients diagnosed with CRS after sinus lift surgery were used to ensure that the inclusion criteria were broad enough to identify eligible research subjects. A total of 512 records

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Supplemental Video 1. Endoscopic appearance of the maxillary sinus at 2 months and 1 year after endoscopic sinus surgery for sinus lift-associated chronic rhinosinusitis.

Note preservation of healthy-appearing mucosalized bone graft material

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were returned from the search criteria. All 512 records were reviewed to identify a medical history of a sinus lift procedure before the onset of CRS. Any questions regarding patient eligibility and medical history were individually reviewed with the patient's primary otolaryngologist. A total of 11 subjects were identified for this study. We excluded two subjects on review of their medical history details. Both of these patients had developed chronic sinusitis (one with recurrent facial abscesses) in the setting of bilateral zygomatic implants after a failure to achieve adequate bone stock for standard implants with previous sinus lift procedures.

Patient demographics as well as disease course, radiographic findings, previous medical treatment, extent of surgical intervention, and surgical outcomes were recorded. The 22-item Sino-Nasal Outcome Test (SNOT-22) and the discharge, inflammation and polyps/edema (DIP) endoscopy scores¹¹ were recorded from the clinic appointment before surgery and the most recent follow-up. A paired-samples *t*-test was used to analyze pre- and postoperative SNOT-22 scores. Data are presented as mean ± standard deviation, unless otherwise stated. There were no outliers in the data, as assessed by inspection of a box plot. The assumption of normality was not violated, as assessed by the Shapiro-Wilk test (*p* = 0.639). Endoscopic video recordings (Online Supplemental Material) were available for eight of nine patients. We used a Wilcoxon signed rank test to analyze DIP scores and assessed the data for outliers by inspection of a box plot for values of >1.5 box lengths from the edge of the box. One outlier was detected to be >1.5 box lengths from the edge of the box in a box plot, however, the outlier was kept in the analysis because it did not unduly influence the mean difference nor change the conclusion of the Wilcoxon signed rank test. A histogram was used to determine whether distribution was symmetrical.

RESULTS

Nine patients underwent endoscopic sinus surgery as a treatment for CRS after a sinus lift procedure (Table 1). All the patients met the diagnostic criteria for CRS according to the 2015 clinical practice guidelines.¹² The average age of the study cohort was 63 years old. Four subjects had bilateral sinus lift procedures performed; two of these subjects presented with bilateral CRS and two had only unilateral involvement. The remaining five patients had evidence of disease on the same side as their sinus lift procedure. All the subjects demonstrated evidence of chronic sinusitis on computed tomography (CT), and eight of the nine subjects had subjective symptoms of CRS. One patient who was asymptomatic was found to have mucosal thickening within the maxillary sinus on follow-up. This persisted despite aggressive treatment, and, although he was clinically asymptomatic, the patient elected to undergo definitive treatment to minimize the risk of implant loss.

The majority of the patients presented with symptoms <3 months after the sinus lift procedure (*n* = 7 [78%]), and three patients re-

ported an initial implant-related infection within 1 month of the sinus lift surgery. All the subjects presented with signs of sinusitis within 1 year of their sinus lift surgery. On presentation to the otolaryngologist, the most common signs and symptoms included mucopurulence (*n* = 8 [89%]), facial pain or pressure (*n* = 7 [78%]), nasal congestion (*n* = 5 [56%]), and foul smell (*n* = 5 [45%]). Other less common symptoms were postnasal drip (*n* = 1 [9%]), cough (*n* = 2 [18%]), ocular pruritus (*n* = 1 [9%]), halitosis (*n* = 1 [9%]), aural fullness (*n* = 1 [9%]), and purulent drainage around the implant (*n* = 2 [18%]).

Before presentation to the otolaryngologist, eight of the nine subjects (89%) were treated with antibiotics, with minimal improvement. The number of antibiotic courses before surgery ranged from 1 to 9. Five of the subjects were treated with at least three courses of antibiotics. The most commonly prescribed antibiotics were amoxicillin-clavulanic acid and clindamycin. Other common medical therapies included nasal saline solution irrigation and prednisone taper, neither of which provided significant sustained improvement. Nasal steroid sprays, oral antihistamines, and antibiotic irrigations were used in a minority of the patients. Four patients underwent removal of dental implants before referral, and one of these four was also treated with three rounds of antral puncture and irrigation. A CT evaluation showed a range of disease involvement (Figs. 1 and 2 ; Table 2). The majority of the patients demonstrated complete opacification of the maxillary sinus as well as inflammatory changes within the anterior ethmoid sinuses. Remnants of the bone graft material were seen in four patients. The dental implant was in direct continuity with the contents of the sinus (not covered by bone) in four of the five patients who were not treated with implant removal. Significant involvement of the frontal sinus was seen in five patients. The posterior ethmoid and sphenoid sinuses were spared in the majority of patients.

Endoscopic sinus surgery was performed in all the patients; when present, the implants were left in place. Endoscopic procedures included wide maxillary antrostomy in all the patients, anterior ethmoidectomy (*n* = 5), total ethmoidectomy (*n* = 3), frontal sinusotomy (*n* = 3), and sphenoidotomy (*n* = 1). One of the cases was of a patient with a revision procedure with a previous sinus surgery at a different institution. A wide maxillary antrostomy was created in all the cases, and the sinus was inspected with an angled endoscope and was copiously irrigated. Mucopurulence was identified in eight cases. Results of pathologic examination uniformly revealed sinonasal mucosa with chronic inflammation. Cultures of the sinus contents grew a variety of microbial species, with the majority of them being gram-positive aerobic bacteria: *Staphylococcus aureus* (*n* = 1) and *Staphylococcus epidermidis* (*n* = 3). Anaerobic organisms were also observed, including *Proteus bacilli* (*n* = 1), *Propionibacterium acnes* (*n* = 1), and *Eikenella corrodens* (*n* = 1). Fungal organisms identified included *Penicillium* species (*n* = 1), *Candida parapsilosis* (*n* = 1), and *Exophiala* species (*n* = 1).

The mean postoperative follow-up interval was 18 months, with a range from 2 to 39 months. The participants had a lower postsurgery

Table 1 Patient demographics and clinical details

Age, y	Gender	Time to Onset, mo	Nasal Congestion	Mucopurulence	Foul Smell	Facial Pain	Lund-Mackay Score	Disease Free at Last Follow-up (duration, mo)
56	F	11	Yes	Yes	No	Yes	1	Yes (15)
65	M	<3	Yes	Yes	No	Yes	3	Yes (39)
70	F	<3	No	Yes	Yes	Yes	7	Yes (35)
71	M	<3	No	Yes	Yes	No	8	Yes (8)
69	M	<3	No	No	No	No	6	Yes (25)
60	M	9	Yes	Yes	No	Yes	4	Yes (15)
45	F	<3	Yes	Yes	No	Yes	6	Yes (18)
48	F	<3	No	Yes	Yes	Yes	5	Yes (2)
69	M	<3	Yes	Yes	Yes	Yes	8	Yes (4)

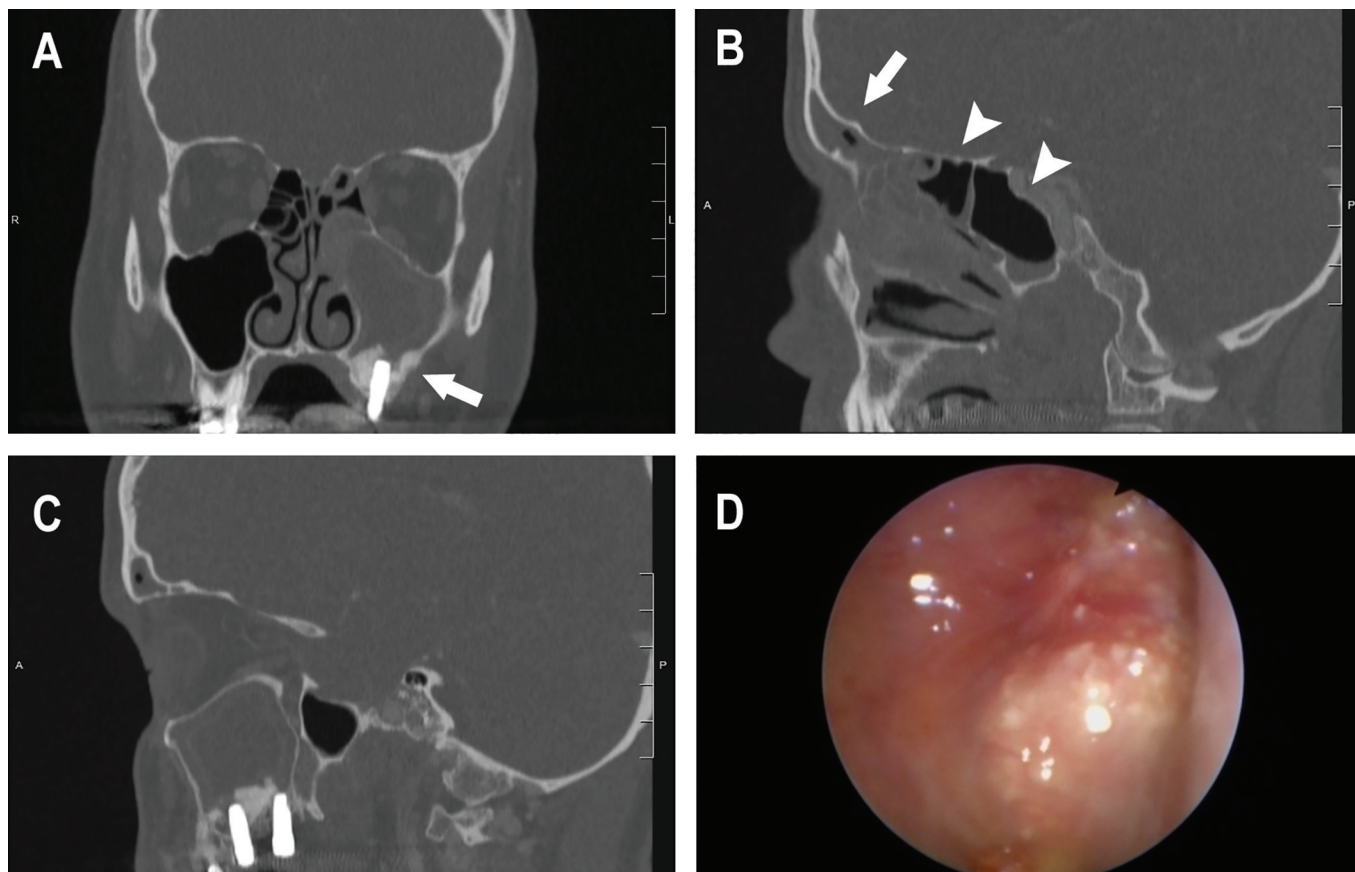


Figure 1. Characteristic computed tomography and endoscopic findings of a patient with chronic rhinosinusitis after a sinus lift procedure. (A) A coronal view, demonstrating complete opacification of the left maxillary sinus, with some loss of the bone graft; a dental implant is seen extending into the bone grafts, but there is a loss of bony coverage at the superior aspect of the implant (arrow). (B) A sagittal view, illustrating involvement of the frontal and anterior ethmoids (arrow) with sparing of the posterior ethmoid and sphenoid sinuses (arrowheads). (C) A sagittal view, demonstrating multiple implants adjacent to the bone graft but with their superior aspects in continuity with the infected sinus cavity. (D) Healthy-appearing mucosalized sinus lift bone graft material in the maxillary sinus as seen through a flexible endoscope within the maxillary sinus 2 months after the endoscopic sinus surgery.

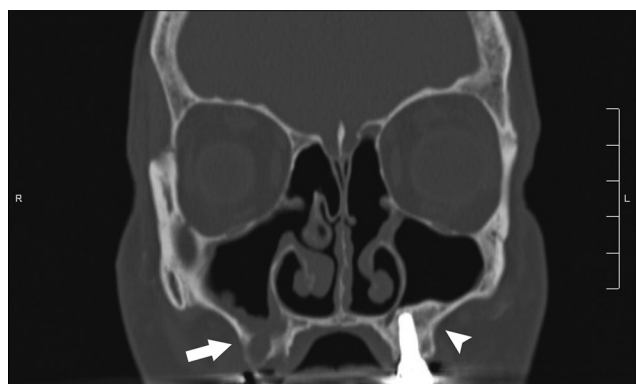


Figure 2. Preoperative coronal computed tomography of a patient who presented for revision surgery with right-sided chronic rhinosinusitis associated with a sinus lift procedure and refractory to maximal medical management; in the right maxillary sinus floor, there is no evidence of residual bone graft; although the dental implant was removed, the implant cavity has no bony coverage and remains in continuity with the inflamed maxillary sinus mucosa (arrow); on the left maxillary sinus, there is preservation of a dental implant and healthy-appearing sinus lift bone graft material (arrowheads).

Table 2 Computed tomography imaging findings among nine patients who presented with refractory chronic rhinosinusitis after a sinus lift procedure

Site of Involvement	No. Patients
Maxillary sinus, complete opacification	8
Maxillary sinus, mucosal thickening without opacification	1
Ethmoid sinus, anterior	8
Ethmoid sinus, posterior	0
Frontal sinus	5
Sphenoid sinus	0

SNOT-22 score for their CRS (32 of 110) as opposed to the presurgery SNOT-22 score (14 of 110). Sinus surgery for CRS after the sinus lift procedure resulted in a decrease of 18 points (95% confidence interval, 4–32) in the SNOT-22 score compared with the SNOT-22 score obtained at the presurgical visit, $p = 0.02$, a SNOT-22 minimal clinically important difference (>9). Of the eight reviewed endoscopic videos, functional sinus surgery elicited an improvement in DIP scores in all eight participants. We observed a statistically significant median decrease in the DIP score after functional sinus surgery (3

compared with the prefunctional sinus surgery for CRS after a sinus lift procedure (12), $z = -2.539$, $p = 0.011$.

DISCUSSION

CRS is a common disease, with significant costs and morbidity to the patient. Although odontogenic disease is a common and well-described etiology for unilateral maxillary sinusitis, dental implantation and sinus lift procedures are less commonly implicated. The current literature indicates an incidence of 10–26% of transient sinusitis among patients who have had sinus augmentation.^{13–15} CRS is less common in this setting, with an estimated prevalence of 3–5%.^{8,16–18} Several recent publications describe the common presenting symptoms and treatment of odontogenic sinusitis. Overall, these symptoms are similar to those seen in our study population of patients with sinus-lift-associated CRS. In a retrospective review of 43 patients with odontogenic sinusitis,¹⁹ 100% of the patients ($n = 43$) presented with facial pressure and discolored nasal drainage, and 28% of the patients ($n = 12$) mentioned a foul smell or taste.

Another case-control study, of 18 patients diagnosed with dental implant-related CRS in the absence of sinus augmentation, reported purulent rhinorrhea and/or postnasal drip ($n = 16$) to be the most frequent concern among their patients.²⁰ These percentages are similar to our study findings, with the most common concerns being mucopurulence (89% of our cohort), facial pressure (78% of our cohort), and foul smell (45% of our cohort). Akin to our study findings, the current literature on odontogenic sinusitis and the few reports on sinusitis after augmentative surgery reported that the symptoms mostly appeared within 3 months of the dental procedure.⁷ In a case series of 10 patients with dental implant-associated sinusitis, the onset was within 1 month in six patients (60%), 1 to 3 months in two patients (20%), 3 months to 1 year in one patient (10%), and >1 year in one patient (10%).¹⁹

The existing literature implies that dental extraction is often necessary for treatment of medically refractory odontogenic sinus disease.¹⁹ This concept has been extrapolated to the treatment of CRS after sinus lift procedures. In four studies,^{19,21–23} the investigators either imply or explicitly advocate for implant removal before or at the time of endoscopic sinus surgery for medically refractory CRS associated with sinus augmentation. Conceptually, a foreign body in the setting of a sinus lift procedure is likely to result in the persistence of sinus inflammation after endoscopic sinus surgery, and grafted bone material surrounding the implant is more susceptible to chronic infection than native bone. In case report study by Bhattacharyya,²⁴ the patient underwent sinus surgery for sinus lift-associated CRS; however, the investigators make no recommendation regarding implant preservation. Similarly, Doud Galli *et al.*¹⁰ describe 14 cases treated with endoscopic maxillary antrostomy but do not report the duration of the follow-up data or the incidence of implant loss after surgery.

More recently, Chen *et al.*²⁰ conducted a case-control study on 18 patients with CRS after dental implants but in the absence of a sinus lift procedure. Among the 18 patients, 15 received endoscopic sinus surgery to treat their CRS; 13 of the 15 patients kept their dental implants intact during endoscopic sinus surgery. Although four patients had recurrence due to the unremoved dental implant and received revised surgery, the majority ($n = 9$) did not experience recurrence during follow-up (mean follow-up time, 19.6 months). Our results indicated that neither bone graft nor implant removal was a requirement for initial surgical treatment of this disorder. Of the nine patients who underwent a sinus lift procedure, seven had an implant placed and five presented to their initial visits with the otolaryngologist with their implants intact. Treatment with endoscopic sinus surgery, including a wide maxillary antrostomy and lavage, uniformly resulted in not only resolution of sinus inflammation but also implant preservation.

In patients with both bone grafting and implant placement, it is unclear whether the graft of the implant led to sinus inflammation. Jung *et al.*²⁵ evaluated whether exposure of dental implants to the maxillary sinus in the absence of sinus lift procedure would always result in sinus complications. The investigators evaluated nine patients with 23 implants that had penetrated into the maxillary sinus by >4 mm. Overall, the investigators did not find any clinical signs of sinusitis, and CT imaging demonstrated only mild mucous membrane thickening around 13 of the 23 implants. Mattos *et al.*²¹ report that all their patients with implant-associated CRS eventually required endoscopic surgery, which supported the idea of early surgical intervention in this patient population. Given the rate of disease resolution and implant preservation in the current study, endoscopic surgery with dental implant preservation may be a reasonable approach in patients for whom initial medical treatment fails.

There were limitations to this study. First, our methodology for subject recruitment involved using surgical CPT codes. As a result, our cohort did not capture sinus lift-associated CRS, which was adequately treated with medical management, and we were unable to assess the efficacy of medical treatment in this patient population. Our results with respect to implant preservation, however, were in stark contrast to much of the existing literature regarding surgical treatment for CRS associated with sinus lift procedures.

CONCLUSION

Endoscopic sinus surgery seemed to be an effective treatment for CRS associated with sinus lift procedures. Our study indicated that removal of the dental implant may not be required for successful treatment of CRS after a sinus lift procedure. Early consultation with an otolaryngologist may limit patient morbidity and maximize implant preservation.

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