A Paradigm for Evaluation and Management of the Maxillary Sinus Before Dental Implantation

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Objectives: To determine a paradigm for evaluating and managing maxillary sinus conditions before dental implantation via preoperative sinonasal assessment.

Study Design: Prospective cohort study.

Methods: Eighty-four patients who underwent dental implantation with or without sinus augmentation were included. Maxillary sinus conditions were classified into groups 1 to 6 according to cone-beam computed tomography (CT) findings: 1) nonspecific findings, 2) solitary polyp or cyst, 3) mucosal thickening, 4) air–fluid level or fluid accumulation, 5) near-total opacification of the maxillary or other paranasal sinus, and 6) calcification spots in the maxillary sinus. Dental implantation with or without sinus augmentation was suggested with postoperative sinus observation (groups 1–3), after medication for acute sinusitis (group 4), and after comprehensive treatment of chronic or fungal sinusitis (groups 5–6). Intraoperative and postoperative sinus-related complications were recorded.

Results: Two patients (groups 1 and 3) developed acute rhinosinusitis after sinus augmentation; both recovered completely with medical treatment. Schneiderian membrane perforation occurred during sinus lift surgery in six patients (group 1): five recovered after conservative medical therapy and close observation, whereas one required endoscopic sinus surgery and recovered well. No chronic rhinosinusitis developed after dental implantation.

Conclusion: Craniofacial CT is crucial for pre-dental implantation sinonasal evaluation. The risk of dental implant-related chronic rhinosinusitis is low for patients with cysts, polyps, or mucosal thickening in the maxillary sinus. However, preventive endoscopic sinus surgery is recommended for patients with incurable chronic rhinosinusitis, fungal sinusitis, and large polyps or cysts.

Key Words: Dental implant, maxillary sinusitis, sinus augmentation, cone beam computed tomography.

Level of Evidence: 4.

INTRODUCTION

Dr. Leonard Linkow performed the first modern dental endosseous implant in 1952. However, dental implant placement in the maxilla has not been widely implemented due to close proximity of the maxillary sinus and complications arising from surgery. The sinus lift technique introduced by Tatum1 and Boyle and James2 resolved this problem. After introduction of the sinus lift procedure, Tatum described the lateral window approach and Summers introduced a new crestal approach using an osteotome. The search for safer and simpler sinus elevation procedures is ongoing.

Although the lateral window approach and crestal osteotome technique have been shown to be safe and predictable procedures for increasing alveolar bone height for appropriate positioning of dental implants in regions close to the maxillary sinus, complications associated with these procedures are not rare. Kim et al. reported that the incidence of sinusitis after sinus lift surgery was 9.8%, and it was higher with the lateral approach (12.1%) than with the crestal approach (4.1%).3 In most cases, this can be resolved with antibiotic therapy. Chronic maxillary sinusitis requiring surgical intervention occurs in 1.3% of all patients,4 and often leads to medical disputes.

According to a review of the literature and the findings of our previous study, the possible causes of chronic maxillary sinusitis after dental implantation include sinus penetration by the implant,5 formation of an oroantral fistula,6 uncontrolled graft infection,5 dislodged bone grafts or dental implants with a foreign body reaction,7 perforation of the Schneiderian membrane,8 postoperative obliteration of the ostium,9 and preoperative chronic rhinosinusitis.4 Endoscopic sinus surgery is the first choice of surgery because of its low morbidity and good prognosis.10

The risk of rhinosinusitis after dental implant surgery is higher in patients with preoperative chronic
sinusitis, which is a major concern for dentists. Before placing dental implants, dentists usually acquire cone-beam computed tomography (CBCT) images or panoramic radiographs to confirm the height of the alveolar bone and to determine the necessity for the sinus lift procedure. Maxillary sinus lesions in various stages of severity often are revealed in imaging findings, and these patients are first advised to consult ear, nose, and throat (ENT) specialists. However, there is no specific protocol for maxillary sinus evaluation and management before dental implant surgery. Therefore, we designed this prospective clinical study to determine a paradigm for evaluating and managing maxillary sinus conditions before dental implantation by assessing preoperative sinonasal characteristics using CBCT and determining their association with implant-related rhinosinusitis.

MATERIALS AND METHODS

The institutional review board of Chang Gung Memorial Hospital (Taoyuan, Republic of China) approved this study, and all the patients provided written informed consent. All patients who underwent endosseous maxillary implant surgery performed by Dr. F-Y Lee in the Department of Periodontics at Chang Gung Memorial Hospital between January 2013 and December 2015 were included in this study.

When the need for dental implants was determined, a detailed medical and dental history was obtained and thorough oral examinations were performed for all patients in this dental department. Craniofacial CBCT also was performed to evaluate the height of the alveolar bone and determine the necessity for sinus lift procedures. The patients were subsequently referred to the ENT department for further evaluations.

In the ENT department, all patients underwent complete sinonasal evaluations, including careful history-taking and local examinations. They also were asked to complete the Sino-Nasal Outcome Test 22 (SNOT-22). In addition, all patients were assessed for possible general and specific risk factors for sinonasal diseases after sinus lift or dental implant procedures, including smoking, allergic rhinitis, previous nasal surgery or trauma, history of chronic and/or recurrent rhinosinusitis, and other systemic diseases that may affect the physiology of the nose or sinuses. Nasal fiberoptic endoscopy was performed to evaluate the condition of the nasal mucosa, septum, turbinate, mental grooves, and osteomeatal complex.

Craniofacial CBCT images were carefully assessed to evaluate the sinonasal condition, including anatomical alterations such as septal deviation and concha bullosa; patency of the maxillary sinus ostium; the presence of oroantral fistulae; and the presence of any sinonasal abnormality, particularly in the maxillary sinus. On the basis of these findings, patients were categorized into six groups (groups 1–6) (Fig. 1): those with 1) nonspecific findings, 2) a solitary polyp or cyst, 3) mucosal thickening, 4) air–fluid level or fluid accumulation (most often indicating acute infection or inflammation), 5) near-total opacification of the maxillary sinus or other paranasal sinuses (most often indicating chronic rhinosinusitis), and 6) calcification spots in the maxillary sinus (most often indicating fungal sinusitis).

After these assessments, the ENT risk for each patient was established. For patients with normal maxillary sinuses (group 1), we considered that the risk of postoperative chronic rhinosinusitis was very low. For patients with small polyps, cysts, or mucosal thickening (groups 2 and 3), we suggested close observation after dental implant surgery with or without sinus augmentation. These patients were instructed to return for follow-up if they experienced any nasal discomfort after surgery. However, if a large cyst or polyp was present (height of cyst or polyp more than half the height of the maxillary sinus), we discussed the outcomes of preventive surgery with the patients to aid in deciding on their treatment plan. For patients

Fig. 1. Cone beam computed tomography findings in the maxillary sinus before dental implantation. (A) Nonspecific finding, (B) solitary polyp or cyst, (C) mucosal thickening, (D) air–fluid level or fluid accumulation (most often indicating acute infection or inflammation), (E) near-total opacification of the maxillary sinus or other paranasal sinuses (most often indicating chronic rhinosinusitis), and (F) calcification spots in the maxillary sinus (most often indicating fungal sinusitis).
with acute rhinosinusitis (group 4), medical therapy was prescribed and follow-up examinations conducted until recovery, following which further implant treatment was planned with Dr. F-Y Lee. Patients with chronic or fungal sinusitis (groups 5 and 6) were informed of a high risk of implant failure and were advised not to undergo implant surgery until complete resolution of the sinusitis. Endoscopic sinus surgery was suggested for patients with chronic rhinosinusitis to increase the survival rate of dental implants and decrease the possibility of complications after implant surgery. All the patients followed our suggestions.

The outcomes of sinus lift and dental implant surgeries were assessed during follow-up visits in the dental department where the surgeries were performed, and all intraoperative and postoperative complications were recorded. If patients presented with any symptom or sign related to rhinosinusitis, they were referred to the ENT department for further evaluation and treatment. Patients who did not present with any signs or symptoms underwent ENT assessments, including nasal fiberoptic endoscopy. SNOT-22 evaluation, and sinus radiography (if panoramic radiography was not available), at 3 months after surgery. The patients followed our suggestions.

### RESULTS

In total, 84 patients were included in this study. The average age of patients was 48.8 years, and the male:female ratio was approximately 2:1. The average SNOT-22 score was 14.55, which was similar to the score of a healthy population. The patient characteristics are listed in Table I.

#### Preoperative CBCT Findings

Preoperative CBCT findings revealed nonspecific findings in 46.4% patients. Solitary polyps or cysts were observed in 22.6% patients; mucosal thickening in 20.2% patients; and fluid accumulation in the maxillary sinus, which could represent acute infection or inflammation, in 7.2% patients. Only 1.2% patients showed near-total opacification of the maxillary sinus or other paranasal sinuses, which is a characteristic of chronic rhinosinusitis. Finally, 2.4% patients exhibited few calcification spots with mucosal thickening in the maxillary sinus, which sometimes were accompanied with sclerotic changes in the sinus wall. These are similar to classical findings of fungal sinusitis. The findings from craniofacial CBCT before sinus augmentation are summarized in Table II.

#### Postoperative Complications

Two patients, belonging to groups 1 and 3, respectively, developed acute rhinosinusitis after sinus augmentation, and both recovered completely after medical treatment. Schneiderian membrane perforation occurred during sinus lift surgery in six patients belonging to group 1, five of whom recovered after conservative medical therapy and close observation. The remaining patient underwent endoscopic sinus surgery because of disease progression and demonstrated good recovery (Fig. 2). No case developed chronic rhinosinusitis after dental implantation. One patient, who complained of nasal discomfort after dental implantation, showed normal findings on follow-up sinus computed tomography (CT).

### DISCUSSION

In the present study, we determined a paradigm for evaluating and managing maxillary sinus conditions before dental implantation by assessing preoperative sinonasal characteristics using CBCT and determining their association with implant-related rhinosinusitis.

Our findings revealed a normal maxillary sinus without definite abnormal findings in almost half of the patients (46.4%); this rate was similar to rates (43.7–53.2%) found in several other studies. Such patients can safely undergo dental implant procedures, with accompanying explanations regarding possible sinus-related complications. The most common abnormal CT findings were solitary cysts or polyps and mucosal thickening, and we suggested implant surgery with close sinus observation to these patients, considering that most of them were asymptomatic according to their SNOT-22 results. Fan et al. reported that all 18 implants
placed in 16 patients with sinus membrane thickening of more than 2 mm were successful. Similar results were observed in the present study, with no case of postoperative chronic rhinosinusitis or implant failure.

Air–fluid level or fluid collection in the maxillary sinus, which mostly represents acute rhinosinusitis, was noted on preoperative CBCT scans in approximately 7.2% of patients in the present study. This condition easily is cured by medication. The only concern is chronic rhinosinusitis that fails to respond to medical treatment, particularly fungal sinusitis. In most cases of fungal sinusitis in the present study, the disease was in the early stage, with mild symptoms. Preoperative CBCT only showed mucosal thickening, with few calcification spots (Fig. 3). Careful evaluation of preoperative CT scans is essential to rule out chronic rhinosinusitis, particularly fungal sinusitis, to prevent possible implant failure in the future.

In the present study, two patients with a normal sinus or mild mucosal thickening on preoperative CBCT and endoscopy developed acute sinusitis after sinus augmentation. These patients showed complete recovery after 2 weeks of antibiotic therapy. We believe that the acute sinusitis in these patients was not associated with the preoperative severity of mucosal thickening, but rather with the recovery capacity of the maxillary sinus. The incidence of postoperative acute sinusitis in the present study was lower than 5%, similar to that in a previous study. Sinusitis without chronic changes can be cured by medical treatment alone.

The membrane perforation rate in patients treated with sinus augmentation is reported to be between 9% and 44%. Most studies did not consider small perforations be of major concern. If the perforation exceeds 5 mm, repair is required to prevent the later incidence of sinusitis and to increase the survival of dental implants. In the present study, six patients developed obvious Schneiderian membrane perforation during sinus augmentation. The image in Figure 2 shows marked leakage. We observed a normal sinus condition before sinus augmentation. Preoperative cone beam computed tomography only shows mucosal thickening with a few calcification spots (arrow). A fungal ball with pus is noted in the maxillary sinus during surgery (upper right). [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]
before sinus augmentation, with a series of changes in the sinus mucosa after leakage. The patient underwent endoscopic sinus surgery and received dental implants, and was in good condition thereafter. Because the other five patients exhibited less leakage, we treated them with medical therapy only, which led to complete recovery. These findings give rise to an important question: should patients with graft material leakage from sinus membrane perforation receive aggressive or conservative therapy? We suggest that if the maxillary sinus ostium is patent on CT or endoscopy, observation followed by conservative therapy will be beneficial because the movements of the sinus membrane cilia may transfer most leaked material to the nasal cavity, from where it will be eliminated. Surgery only should be considered when conservative therapy fails.

The requirement of preventive functional endoscopic sinus surgery remains controversial. Torretta et al. suggested that patients with presumably reversible ENT contraindications to sinus floor elevation, such as
chronic sinusitis, endo-antral foreign bodies, and nose deformity, should resolve these issues before dental implant surgery to prevent sinusitis resulting from sinus augmentation and implant procedures. According to our experience, surgery should be performed in patients with incurable chronic sinusitis; large maxillary sinus cysts or polyps; and suspected fungal sinusitis before dental implantation. Patients with mucosal thickening, polyps, or nasal septal deviation should be kept under further observation. According to our previous study, cysts or polyps with a height exceeding half the height of the maxillary sinus should be treated before dental implant surgery. The reasoning for this is that the average height of the maxillary sinus is 33 mm and the ostium of the maxillary sinus will not be obstructed with an additional height of 10 mm, which usually is necessary for sinus augmentation as long as the height of the thickened mucosa or polyp is less than one-half that of the maxillary sinus. We applied this protocol in our study and encountered no case of chronic rhinosinusitis after dental implant surgery.

Figure 4 shows the final paradigm based on the results of our study. If the findings of preoperative CT are normal, we can consider that the incidence of postoperative chronic rhinosinusitis will be very low and decide on treatment accordingly. After treatment, the patients should be closely monitored. If fluid collection, which mostly represents acute sinusitis, is observed, patients can receive medical treatment and follow-up evaluations. If there is mucosal thickening or a small polyp or cyst in the maxillary sinus, patients should be monitored. If a large cyst or polyp is present, the outcomes of preventive surgery should be explained to the patient to aid in making a decision regarding their treatment. Finally, if there is opacification of the sinus, which mostly represents chronic sinusitis; or calcification spots and/or sclerotic changes in the sinus wall, which mostly represent fungal sinusitis, patients should be advised to undergo functional endoscopic sinus surgery to increase the survival rate of dental implants and to decrease the possibility of postimplantation complications.

In terms of the choice of treatment for patients with dental implant-related chronic rhinosinusitis, endoscopic sinus surgery should be the first choice of surgery because of the good prognosis and low morbidity. Over 60% patients with dental implant-related chronic rhinosinusitis with preserved dental implants did not exhibit recurrence. Therefore, we believe that dental implants can be preserved unless they are mobile or severely infected, or if the patient develops recurrent sinusitis. However, the sinus mucosa above the dental implants must be kept intact during endoscopic sinus surgery.

The role of the otorhinolaryngologist should not only be limited to the treatment of complications, such as rhinosinusitis, after dental implantation but also should include evaluation and preventative steps before the implantation. Pignataro et al. suggested that an otorhinolaryngologist should be a primary figure in the approach to any sinus lift procedure, which should comprise three steps to ensure success of the surgery: a preventative diagnostic step, a preventative therapeutic step, and a diagnostic therapeutic step. Our evaluation paradigm led to zero incidence of chronic rhinosinusitis after dental implantation, thus providing a good medicolegal assurance for both patients and dentists.

CONCLUSION

We determined a paradigm for evaluating the maxillary sinus before dental implant surgery with or without sinus augmentation. Our findings suggest that craniofacial CT before dental implantation is crucial not only to determine the height of the alveolar bone and the necessity of sinus lift procedures but also to evaluate the sinonasal condition. Relative to that in a healthy population, the risk of dental implant-related chronic rhinosinusitis is not high in patients with cysts, polyps, or mucosal thickening in the maxillary sinus; these patients can undergo dental implant surgery and sinus augmentation with close postoperative monitoring of the sinus. Preventative endoscopic sinus surgery before dental implantation only should be suggested to patients with incurable chronic rhinosinusitis, fungal sinusitis, and large polyps or cysts.

BIBLIOGRAPHY


