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## Potential Adverse Events of Endosseous Dental Implants Penetrating the Maxillary Sinus: Long-Term Clinical Evaluation

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**Objectives/Hypothesis:** The aim of this study was to evaluate the nature and incidence of long-term maxillary sinus adverse events related to endosseous implant placement with protrusion into the maxillary sinus.

**Study Design:** Retrospective cohort study.

**Methods:** All patients who underwent placement of endosseous dental implants with clinical evidence of implant penetration into the maxillary sinus with membrane perforation were included in this study. Only patients with a minimum follow-up of 5 years after implant placement were included in this study. Maxillary sinus assessment was both clinical and radiological.

**Results:** Eighty-three implants with sinus membrane perforation in 70 patients met the study's inclusion criteria. Mean age was 65.96 years  $\pm$  14.23. Twelve patients had more than one implant penetrating the maxillary sinus, and seven of them had bilateral sinus perforation. Estimated implant penetration was  $\leq 3$  mm in all cases. The average clinical and radiological follow-up was 9.98 years  $\pm$  3.74 (range 60–243 months). At the follow-up appointments, there were no clinical or radiological signs of sinusitis in any patient.

**Conclusion:** This long-term study, spreading over a period of up to 20 years, indicates that no sinus complication was observed following implant penetration into the maxillary sinus. Furthermore, absence of occurrence of such complications is related to the maintenance of successful osseointegration. A contrario, and in the presence of an acute or chronic maxillary sinusitis, the differential diagnosis must always consider other potential odontogenic and nonodontogenic etiologies.

**Key Words:** Dental implant, sinus membrane perforation, maxillary sinusitis.

**Level of Evidence:** 2b.

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### INTRODUCTION

Missing teeth can be replaced by endosseous dental implants placed in the alveolar bone. Osseointegrated implants have become the therapy of choice to rehabilitate fully and partially edentulous ridges.<sup>1–4</sup> The posterior maxilla often provides limited bone height secondary to pneumatization of the sinus or the resorption of the alveolar ridge or a combination of both. To compensate the lack of bone height, several bone augmentation techniques are continuously refined. These procedures were initially presented by Tatum et al.<sup>5</sup> in the 1970s and first published by Boyne et al.<sup>6</sup> in 1980. In 1994, Summers<sup>7</sup>

introduced the osteotome sinus floor elevation. In this technique, the Schneiderian membrane is elevated using sinus osteotomes through a crestal approach, and implants are simultaneously placed. Through the years, several authors have recommended bicortical (crestal bone and sinus floor) implant anchorage.<sup>8–10</sup> As a consequence, implants placed in the posterior maxilla may penetrate the maxillary sinus. Acute or chronic sinusitis and other maxillary complications related to endosseous implant placement have been described,<sup>11–17</sup> but the incidence and clinical relevance of such complications remain controversial.<sup>18–21</sup>

The aim of this long-term retrospective study was to evaluate the nature and incidence of maxillary sinus adverse events related to endosseous implant placement with protrusion into the maxillary sinus.

### MATERIALS AND METHODS

#### Patient Selection

Between January 1989 and December 2007, all patients who underwent placement of endosseous maxillary implants at the Department of Oral Surgery and Oral Medicine, University of Geneva, with clinical evidence of implant penetration into the maxillary sinus with membrane perforation (drill perforation or membrane perforation with sinus osteotome technique) were included in this study. Only patients with a minimum follow-up period of 5 years after implant placement were included. Patients treated with sinus elevation techniques (lateral sinus

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lift or osteotome sinus-floor elevation techniques) with filling materials were not included in this study.

## Surgical and Prosthetic Procedures

Placement of the endosseous implants was carried out under local anesthesia. All patients received perioperative antibiotic prophylaxis with clindamycin (Dalacin C; Pfizer SA, Zurich, Switzerland)  $2 \times 300$  mg by mouth 1 hour before surgery, followed by  $3 \times 300$  mg by mouth daily for 5 days; or amoxicillin (Amoxi-Mepha, Mepha Pharma SA, Aesch/BL)  $2 \times 750$  mg by mouth 1 hour before surgery, followed by  $3 \times 750$  mg by mouth daily for 6 days. All preoperative radiographs (panoramic and periapical) were analyzed under standard conditions on a viewing box. For the measurement of preoperative residual bone height, the surgeon took vertical linear measurements from the alveolar crest to the inferior limit of the maxillary sinus, using an implant scale (with measurements graduated according to the magnification factor) provided by the implant manufacturer. Patients were asked about any history of maxillary sinusitis-related symptoms, and they were informed about the risk of sinus membrane perforation due to implant placement. All implants were placed following a standardized one-stage surgical procedure. Rough-surfaced transmucosal Straumann implants with either titanium plasma sprayed (TPS) or sand-blasted, large-grit, acid-etched (SLA) surfaces (Institute Straumann AG, Basel, Switzerland) were inserted. All implants were placed achieving good primary stability. Diagnosis of sinus penetration was confirmed during implant bed preparation ("drill aspiration" phenomenon or after osteotome use), and the membrane perforation was confirmed with a gauge. Following surgery, the antibiotic fusafungine (Locabiot nasal spray, Servier SA, Satigny, Switzerland) was prescribed three times per day during 4 days. Perforation of the sinus floor was further confirmed based on a panoramic radiograph or a periapical radiograph.

At postoperative controls (1 and 3 weeks after implant placement) and before prosthetic rehabilitation, all patients were specifically asked about sinus symptoms, including nasal bleeding, congestion or obstruction, nasal secretion, and pain or tenderness in the infraorbital region. Following an osseointegration phase, ranging from 2 to 6 months, prosthetic rehabilitation was initiated.

## Data Collection

A custom database on FileMaker pro software (FileMaker Inc., Santa Clara, CA) was used to keep the records on preoperative planning, intraoperative and postoperative complications, as well as clinical follow-up. Recorded information included patient's age, gender, smoking habits, implant location, implant diameter and length, and available bone height at the time of implant placement. Implant specific data are the subject of a separate study.

## Maxillary Sinus Assessment

At the clinical and radiological follow-up (minimum 5 years) all the patients were specifically asked about signs and

symptoms consistent with a diagnosis of acute or chronic rhinosinusitis.<sup>22–25</sup> According to the clinical practice guideline for adult sinusitis of the American Academy of Otolaryngology – Head and Neck Surgery (AAOHN), these symptoms included: mucopurulent drainage, nasal obstruction, facial pain-pressure-fullness, and decreased sense of smell.<sup>22</sup> Other factors such as headache, dental pain, halitosis, fatigue, cough, ear pain and fever were accounted for.<sup>23–25</sup> Acute rhinosinusitis was diagnosed as up to 4 weeks of purulent (not clear) nasal drainage, accompanied by nasal obstruction, facial pain-pressure-fullness, or both. Chronic rhinosinusitis was diagnosed if two or more symptoms persisted beyond 12 weeks.<sup>22</sup> Additionally, radiologic examinations such as panoramic or periapical X-rays were performed.

## RESULTS

Eighty-three implants with sinus membrane perforation in 70 patients (40 females; 30 males) met the study's inclusion criteria. Mean age was  $65.96 \text{ years} \pm 14.23$ , ranging from 26 to 89 years, and seven of the subjects were smokers (Table I). Twelve patients had more than one implant penetrating the maxillary sinus, and seven of them had bilateral sinus perforation (Tables II and III). Implants were localized in the premolar or molar areas. Estimated implant penetration was  $\leq 3\text{mm}$  in all cases. The average clinical and radiological follow-up was  $9.98 \text{ years} \pm 3.74$  (range 60–243 months). At the follow-up appointments, there were no clinical or radiological signs of sinusitis in any patient. Out of the 83 implants, two implants were diagnosed with peri-implantitis and treated accordingly without further recurrence. Radiological follow-up demonstrated a normal bone healing process in all subjects. Two patients reported biannual episodes of maxillary fullness and discomfort related to flu, with no modification in the incidence after implant placement.

## DISCUSSION

Limited bone height in the posterior maxilla is one of the major problems hindering rehabilitation with dental implants. Through the years, several authors have recommended bicortical (crestal bone and sinus floor) implant anchorage.<sup>8–10</sup> Higher removal torque values and greater bone-to-implant contact have been reported for bicortically anchored implants in rabbits.<sup>10</sup> Sinus membrane perforation due to implant placement can occur during instrumentation (drilling or use of sinus osteotome) or during implant insertion. In this retrospective study, 83 implants perforated the maxillary sinus membrane accidentally either when drilling or when using sinus osteotome. Membrane perforation was confirmed with the gauge. When perforation was diagnosed, the shorter implant according to residual bone height was inserted with a protrusion into the maxillary sinus.

TABLE I.  
Patient Characteristics, Number of Implants, and Follow-Up Time.

| Patients              | Implants | Age                             | Smokers | Follow-up                     |
|-----------------------|----------|---------------------------------|---------|-------------------------------|
| 70                    | 83       | $65.96 \text{ years} \pm 14.23$ | 7       | $9.98 \text{ years} \pm 3.74$ |
| 40 female;<br>30 male |          | 26 – 89 years                   |         | 60–243 months                 |

TABLE II.  
Sinus/Implants Characteristics.

|          |    | Sinus R | Sinus L | Sinus R & L |
|----------|----|---------|---------|-------------|
| Sinus    | 77 | 28      | 35      | 7           |
| Implants | 83 | 29      | 40      | 14          |
| Patients | 70 | 28      | 35      | 7           |

R = right; L = left.

Sinusitis of dental origin is a well-recognized entity<sup>25–27</sup> and accounts for about 10% to 12% of all maxillary sinusitis.<sup>25</sup> Odontogenic maxillary sinusitis has various etiologies, including dental infection (periapical granulomas, periodontal infections, or inflammatory cysts in the molar and bicuspid area), oroantral fistulas, foreign bodies (root fragments or fillings, broken instruments pushed into the sinus), or odontogenic cysts large enough to obstruct the maxillary sinus.<sup>26–28</sup> Depending on the technique used for implant placement, complications including perforation of the sinus membrane, bone loss, or sequestrum formation and dental implant migration into the sinus have been reported.<sup>11,16,29,30</sup> Studies addressing implant-associated sinus complications are scarce.<sup>11–17,29,30</sup> The reported complications are mostly related to the presence of a foreign body in the maxillary sinus such as migrated dental implants<sup>16,29,30</sup> or bone substitutes used for sinus augmentation techniques.<sup>12</sup> Furthermore, complications can be associated with non-osseointegrated implants, maintaining an oroantral fistula that provides a spreading path for the microorganisms from the oral cavity.<sup>17,31</sup> Animal and human studies indicated that implant protrusion per se into the maxillary sinus cavity is not related to the development of sinus complications.<sup>19–21,31</sup> Petruson et al. has studied the reaction of the sinus mucosa around dental implant penetration of the maxillary sinus cavity; endoscopic technique showed normal mucosa with no signs of increased secretion or infection around the implants.<sup>32</sup> In the present study, no bone substitutes were used for sinus elevation techniques, and all the implants maintained successful osseointegration at the control visit. This could explain the absence of sinus complication in this study population.

Suspicion of acute or chronic rhinosinusitis is based on clinical symptoms and signs, but symptom-based criteria alone for chronic rhinosinusitis are relatively nonspecific.<sup>22</sup> Consequently, diagnosing chronic rhinosinusitis requires that inflammation be documented, in addition to persistent symptoms. Radiographic imaging is one way of showing inflammation of the paranasal sinuses.<sup>22</sup>

TABLE III.  
Perforation Number and Distribution.

|         | 1  | 2 | 3 |
|---------|----|---|---|
| Sinus R | 34 | 1 | 0 |
| Sinus L | 38 | 3 | 1 |

R = right; L = left.

Standard periapical and panoramic radiographs are useful in searching for dental pathology. These radiographs are generally not helpful in documenting the presence of sinus inflammation, and they are less specific and sensitive than computerized tomography (CT) scanning for analyzing the degree of sinus abnormalities.<sup>25,27</sup> As a result, their use has declined and they have been replaced by CT scanning. Lund and Mackay suggested a rhinological-staging system. It included a radiological score that permitted effective evaluation and allowed communication with other specialists about the severity of rhinosinusitis.<sup>33</sup> Out of the various systems that have been developed, the Lund-Mackay score has proved to be an effective assessment method and an easy imaging research tool to use in practice.<sup>34,35</sup> In this present study, clinical examination of the sinuses at the time of implant control showed no signs of pathology. Plain films for implant control purposes seemed sufficient and no further radiological investigation was deemed necessary. Thus, no Lund-Mackay scores for head and neck CT were calculated.

Length on implant penetrating could inhibit the spontaneous recovery of membrane perforation after implant placement. Jung et al. reported that penetrated implants into the sinus floor less than 2 mm was covered by the sinus mucosa in mongrel dogs. CT scans showed that implant protrusion of > 4 mm in the maxillary sinus can cause thickening of the sinus mucosa around the implants. However these sinuses remained asymptomatic.<sup>19,20</sup> In our study, estimated implant penetration was ≤3mm in all cases and no signs of sinus problem were seen.

## CONCLUSION

This follow-up long-term study, spreading over a period of up to 20 years, indicates that no sinus complication was observed following implant penetration into the maxillary sinus. Furthermore, absence of occurrence of such complications is related to the maintenance of successful osseointegration. A contrario, and in the presence of an acute or chronic maxillary sinusitis, the differential diagnosis must always consider other potential odontogenic and nonodontogenic etiologies.

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