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## Maxillary sinus floor elevation surgery

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# Chapter 8

## General Discussion



## **Introduction**

Currently, sinus floor elevation surgery with autogenous bone grafts and/or bone substitutes is a generally accepted surgical procedure that enables reliable implant insertion (Raghoobar et al. 1997, 2001). There is, however, still discussion in the literature regarding such a procedure, particularly regarding the morbidity of this procedure and the maxillary sinus performance post-elevation (Bhattacharyya 1999; Doud Galli et al. 2001). The most frequently reported complication of this procedure is the development of maxillary sinusitis (Timmenga et al. 1997, 2001, 2002). Post-elevation maxillary sinusitis has been reported to develop in up to 26% of the cases, fortunately usually as a temporary condition that can be adequately treated. Especially with regard to a better understanding of potential effects of the elevation procedure on maxillary sinus performance and their possible treatment, it is interesting to gain more insight in the effects of this procedure on the morphology and function of the antral mucosa and the maxillary sinus physiology. The main research outcomes of the various chapters of this thesis are discussed in a broader perspective in this general discussion.

## **Effects on the antral mucosa**

Post-elevation, morphological examination showed that no significant changes were apparent in the antral epithelium and submucosa. At most, there was a tendency towards an increase of the goblet cell-ratio. One third of the patients showed thickening of the basal lamina. The mild inflammatory mucosal reaction that occurred post-operatively was not different from the responses that can be observed in the maxillary sinus of healthy individuals not having been exposed to maxillary sinus surgery. Therefore, this mild inflammatory reaction must be considered as a sign of the normal physiologic activity of the mucosal airway defence system (Kauffman and Tomee 1997). Thus, the outcomes of our morphologic studies strongly support the hypothesis that the maxillary sinus mucosa is capable of adapting adequately to the changes induced by a sinus floor elevation procedure (Timmenga et al. 2002).

## Effects on sinus physiology

Elevation of the floor of the maxillary sinus with autogenous bone grafts and/or bone substitutes will result in an altered maxillary sinus environment, at least in a reduction of the volume of the maxillary sinus. Consequently, vascular injury following surgery, mucosal swelling, stasis of old blood, and a decreased patency of the ostio-meatal unit all might be of influence on the oxygen pressure in the sinus. Theoretically, reduction of the oxygen pressure might result in a temporarily impaired sinus clearance, affecting the mucosal defence system (Aust and Drettner 1978; McGowan et al. 1993).

The results of this study have shown that temporary clearance impairment in preoperatively healthy patients result in only (sub)-clinical effects on maxillary sinus physiology. In case of pre-operative sinus clearance disturbances, sinus floor elevation surgery may provoke exacerbations of sinusitis. Sinus drainage obstructing phenomena might be aggravated by inflammation, when associated with a sinus floor elevation procedure (Timmenga et al. 1997). Another possible effect of the elevation procedure on the clearance of the maxillary sinus might be its influence on the microbial environment. An elevation procedure might result in an outgrowth of (potentially) pathogenic micro-organisms or the introduction of micro-organisms that are not part of the commensal flora of the maxillary sinus. Our study showed a significant increase in positive sinus culture results three months post-elevation when compared with the pre-operative results. These three-months post-elevation cultures showed a low growth density of mostly low pathogenic micro-organisms. A clinical implication related to the increase of culture results was not found (Timmenga et al. 2002). Nine months post-elevation, culture results were comparable with the culture results that were found pre-elevation. The current opinion about the microbiologic colonisation of the maxillary sinus is that this cavity is not sterile (Hartog 1997). Therefore, in our opinion, bacterial growth induced by sinus floor elevation, in the absence of clinical symptoms does not appear to be of significant relevance. Post-operatively, an environment was created in the sinus that temporarily favoured and/or diminished the clearance mechanism of the maxillary sinus. This effect was fully recovered at the nine months' evaluation. For clearance compromised patients, the temporary negative effect on maxillary sinus clearance might favour the development of post-elevation sinusitis.

## **Patient related factors**

In this study, only patients without actual clinical and radiographic signs of sinusitis were included. Patients with a history of a disturbed clearance function of the maxillary sinus were included only in case of absence of preoperative clinical and radiographic signs of actual sinusitis. In case of other medical compromising factors, e.g. diabetes mellitus, internal screening and regulation were performed preoperatively. With respect to anamnestic pre-disposing sinus clearance disturbing factors, two subgroups of patients were distinguished in this study. It was shown that post-elevation maxillary sinusitis more frequently developed in patients with pre-disposing factors for maxillary sinusitis than in patients without pre-disposing factors (Timmenga et al. 1997). Thus, even if such patients do not have actual clinical or radiographic signs of sinusitis, further pre-surgery ENT screening should be considered in this subset of patients. Consequently, in case of structural clearance disturbance, ENT interventional surgery might be indicated before the elevation procedure can be performed, even if the patient is clinically symptom free.

The potential effects of ageing and smoking on morbidity of the elevation procedure and graft survival are unknown. They were not subjects of evaluation. These aspects should be included in further studies. Apart from negative effects of tobacco smoking on the human organism in general, effects on sinus clearance and the bone graft might be expected as well (Jensen et al. 1998; Wallace 2000). With respect to ageing, diminished maxillary vascularisation, in older edentulous patients, might be affecting the elevation procedure as well (Staudt et al. 1977; Solar et al. 1999; Traxler et al. 1999).

## **Factors related to surgery**

Sinus floor grafting is thought to be a technique-sensitive procedure (Jensen et al. 1998). The experience of the surgeon, elevation and graft fixation technique, the occurrence of sinus membrane perforations, contamination during surgery and wound closure are thought to be factors related to surgery with clinical implications for the development of post-operative complications.

During surgery, delicate tissue handling is mandatory, in particular to preventing (vascular) damage of the vulnerable Schneiderian membrane. Accidental perforations of the sinus membrane may occur as a result of the elevation proce-

ture. It has been assumed that shedding of bone particles via the perforation into the maxillary sinus may be a possible cause of post-elevation maxillary sinusitis (Raghoobar et al. 2001). Therefore, there is a need for proper techniques to close such perforations during surgery, especially since such perforations are not exceptional occurrences. Placement of cortical bone just below the perforation has been shown to be an appropriate technique to seal such perforations. Raghoobar et al. (2001) reported that no relationship between membrane perforations and the development of maxillary sinusitis was present when using such a technique, although in 30% of their patients a (minor) preoperative perforation was observed. Other techniques used for closing (large) membrane perforations include the use of collagen (Block and Kent 1998; Picos 1999), fibrin adhesive (Sullivan et al. 1997), and suturing (Raghoobar et al. 2001).

With regard to the elevation procedure, the graft should be shaped to fit the antral floor. Delayed graft incorporation might be expected when the sinus is overfilled and /or in old edentulous patients due to limited maxillary vascular supply. Successful incorporation and survival of the bone graft requires adequate infiltration of the graft mass by endothelial cells (Chen et al. 1994; Wong 2000). Therefore, comparable to fracture healing, stability of the graft is thought to be important (Bruder et al. 1994; Raghoobar et al. 1997).

Contamination of the sinus or bone graft during sinus floor elevation surgery is likely to occur. This contamination, however, does not result in clinical complications in many cases (Misch 1992). It should be mentioned, that shifts in antral microbiology, as were found in our study, showed to be temporary, and obviously without clinical consequences. The explanation for this is not known. Preoperative administration of antibiotics and adequate wound closing possibly might play a role in preventing such post-operative complications.

To prevent wound dehiscence, and protracted contamination from the oral cavity, the muco-periosteal flaps should be closed tensionless, but watertight, at the end of the surgical procedure. In cases in which a wound-dehiscence, wound infection or fistula developed, maxillary sinusitis did not occur, however. A possible explanation might be that the maxillary sinus mucosa in immunological homeostasis has an innate effective defence system, and a high regenerative capacity and thus will quickly return to normal once the sinus regains its adequate ventilation and drainage (Stammberger 1989; Jensen et al. 1998). Another explanation might be that a relationship between oral soft tissue reactions and sinusitis did not exist.

## Consequences

Maxillary sinusitis, either transient or chronic, is the most widely reported complication that may develop after elevation of the maxillary sinus floor with autogenous bone and/or bone substitutes. According to the commonly accepted ENT definition for sinusitis (Yonkers 1992) this disorder is suspected to be present in a patient complaining of headache, pain or tenderness in the region of the maxillary sinus, in combination with rhinorrhea, and postnasal drip. Conventional radiographic examination (e.g. according to Waters' projection) might show a sharp boundary between a radiopaque and radiolucent area (suggestive of an air-fluid level), or an opaque lining of the maxillary sinus suggestive of a thickening of the maxillary sinus mucosa. In case of transient sinusitis, the duration of complaints is 6-8 weeks at most. Absence of purulent discharge supports this diagnosis. Chronic sinusitis has a duration of at least 8 weeks. The endoscopic presence of polypoid sinus mucosal thickening often supports the diagnosis of chronic sinusitis. Although it was shown that post-elevation transient sinusitis more frequently develops in patients with pre-disposing factors for maxillary sinusitis than in patients without pre-disposing factors (Timmenga et al. 1997), this finding does not have any clinical implications as its treatment is rather simple and effective. Chronic sinusitis, however, may need ENT-intervention, to improve sinus clearance structurally.

As already mentioned, there is no consensus in the literature regarding the percentage in which maxillary sinusitis will develop following an elevation procedure, which varies from 0 to 26%. The discrepancy between the reported percentages might be due to the wide variety of criteria and methods (i.e. clinical, radiographic and/or endoscopic) used for diagnosing maxillary sinusitis, the surgical procedure applied, and patient related factors. In many previous reports, the occurrence of accidental perforations of the sinus membrane was mentioned as an important reason for the development of post-elevation maxillary sinusitis. In our study in approximately 30% of the patients the membranous lining had been perforated, and using the 'cortical bone plating technique', development of post-elevation maxillary sinusitis did not appear to be related to sinus membrane perforations (Raghoobar et al. 1997, 2001; Timmenga et al. 1997). A possible explanation for development of chronic maxillary sinusitis in our study might be that, despite careful inspection, accidental perforations were not detected, or that the cortical bone plating technique was not performed successfully.



## **Prevention of post-elevation maxillary sinus pathology**

Pre-operative screening on pre-existent sinus clearance impairment should be performed. Using anamnestic, clinical and radiographic examination, predisposing sinus clearance disturbances may be distinguished. In case of structural clearance disturbances patients should be referred to the ENT-department. ENT-surgery might be indicated pre-elevation to improve sinus ventilation and/or clearance e.g. in case of polyposis in the infundibular area, obstructing the ostio-meatal unit.

With regard to the pre- and peri-surgical condition, antibiotics should be administered to prevent sinusitis, starting one hour pre-operatively and to be continued for at least 48 hours. Only a short-lived effect of antibiotic treatment on the (avascular) inserted graft might be expected, preventing inflammation of the graft (Kucers et al. 1997). Preventing inflammation of surrounding soft tissue probably plays a role as well (Laskin et al. 2000). A pre-operative mouthwash with chlorhexidine 0.12% might reduce oral contamination (Young et al. 2002). However, it should be mentioned that the effect of mouthwashes, in preventing post-operative complications following oral surgery, is questionable. Decongestants should be prescribed post-elevation to improve the patency of the ostio-meatal unit. Systemic and topical corticosteroids are thought to be important additional medication for reduction of post-operative swelling.

## **Treatment of post-elevation maxillary sinus pathology**

Despite thorough pre-operative patient evaluation and sinusitis preventing measures, post-elevation maxillary sinusitis still might occur as a post-operative surgical complication.

In case of transient sinusitis, decongestants, and antibiotics have to be administered for two weeks. Clinical examination and conventional radiography (Waters' projection) usually will show complete recovery.

In case of chronic maxillary sinusitis, ENT-intervention is indicated. Additional examination (CT-scanning, antroscopy) might be necessary. Sinus lavage will be performed, and depending the culture results, the patient needs antibiotics. When present, antral sequestrums should be removed and functional sinus surgery (e.g. nasal antrostomy and/or anterior ethmoidectomy) should be performed. When the appropriate measures for sinus recovery are taken, the compromised

sinus will regain its ventilation and clearance. These procedures are thought to be required to support the preservation of the bone graft.

## Future research

Although the results of this thesis suggest that the incidence of post-elevation maxillary sinusitis is rather low, development of post-elevation maxillary sinusitis still might occur and puts forward many unanswered questions. In particular, when treating patients with structural pre-operative clearance disturbances (e.g. post-radiation therapy, or at the presence of sicca-syndrome) future research is needed for development of protocols, and guidelines, to perform sinus floor elevation surgery in sinus clearance compromised patients successfully.

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