The change of maxillary sinus ostium in diameter following Sinus floor elevation surgery using Cone beam computed tomography

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I. Introduction

The elevation of the floor of the maxillary sinus with an autogenous bone graft in a severely resorbed edentulous maxilla is a generally accepted pre-implantology procedure to enable successful placement of endosseous implants in an optimal prosthetic position. An often mentioned drawback of this procedure is the development of maxillary sinusitis after augmentation. The clinical diagnosis of sinusitis is characterized by a typical triad of symptoms, i.e. nasal congestion, pathological secretion or obstruction, and headache. When using general accepted Ear Nose and Throat (ENT) criteria for diagnosing sinusitis, however, development of postoperative chronic maxillary sinusitis has been reported to occur in 1.3% of the patients that underwent such a procedure.

Although not many patients develop maxillary sinus pathology-related complaints after sinus floor elevation surgery, this procedure carries the inherent risk of compromising sinus physiology. It is generally assumed that the maxillary sinus physiology is affected by the altered anatomy (i.e. the lifted sinus floor in combination with a bulging or injured subsurface of the lifted sinus mucosa). Displacement of grafts into the maxillary sinus can result in a foreign-body reaction and cause serious complications. Mucosal swelling may also lead to reduction of the patency of the ostio-meatal unit. This unit plays a key role in the development of sinusitis, through impairment of the mucociliar cleansing system. If the maxillary sinus is (partly) filled up by hematoma or seroma and/or the patency of the maxillary ostium is reduced, maxillary sinusitis might develop, compromising the success of the grafting procedure.

Therefore preoperative observation of the ostio-meatal unit and the mucosal lining of the maxillary sinus is of great importance to evaluate sinus clearance and to diagnose maxillary sinusitis. The aim of this study was to evaluate the change of maxillary sinus ostium and physiology after maxillary sinus floor elevation surgery.

II. Materials and Methods

A total of 35 patients (20 men and 15 women), with a mean age of 50 years (range 19 to 76 years), were examined by cone beam computed tomography (CBCT). The total of 40 sinuses which are excluded by any sign of pathology had been evaluated on the patients. Preoperative
CBCT scanning was done parallel to the floor of the nasal cavity, and these images were reconstructed with i-CAT program (ISI, USA). Pre operative diameters of the maxillary sinus ostium which is bounded below by the uncinate process (U) and above by the lower bony portion of the ethmoid sinuses (E) was measured from the coronal view perpendicular to the hard palate (Fig. 1).

Implant placement was performed simultaneously with the sinus elevation procedure using the lateral window technique and autogenous bone graft. In 5 cases, sinus elevation surgery were complicated by large perforations of the sinus membrane, which were treated with a pericardium membrane (Tutoplast, Tutogen, Germany) that acted as a barrier. And it were administered decongestant (pseudoephedrine HCl, 60mg/1day, orally) in addition to antibiotics and analgesics for 3days.

Next day, postoperative CT scanning was performed and diameters of ostium were remeasured on same position. Obstruction degrees of maxillary sinus cause by

III. Results

Diameters of maxillary sinus ostium were significantly (t-test, p-value<0.05) decreased from a mean 3.25 mm to a mean 1.52 mm (mean of differences : 1.73 mm) between preoperative and postoperative measurement. In 19 sinuses obstruction of ostium were showed in postoperative CT images. And obstruction degrees of maxillary sinus were observed: Type 1 in 7 cases, Type 2 in 24 cases , Type 3 in 7 cases  and Type 4 in 2 cases(Table 1). But none of all patients showed symptoms or clinical signs of sinus pathology at 3 months postoperative evaluation.

![Fig. 1. Anatomy of maxillary sinus in CT scan and classification of sinus obstruction level mucosal swelling, postoperative hematoma or seroma were distinguished into 4 types (Fig. 1);
Type 1 : limited to sinus floor obstruction
Type 2 : limited to sinus lateral wall obstruction
Type 3 : below ostium not complete obstruction
Type 4 : complete obstruction of maxillary sinus](image)

Table 1. CHANGE OF OSTIUM DIAMETER, FREQUENCY OF SINUS MEMBRANE PERFORATION AND POSTOPERATIVE SINUS OBSTRUCTION TYPE
Fig. 2. Type 1: limited to sinus floor obstruction

Fig. 3. Type 2: limited to sinus lateral wall obstruction

Fig. 4. Type 3: below ostium not complete obstruction
IV. Discussions

This report is the prospective evaluation of sinus physiology in patients that had no pathologic signs of maxillary sinus. It became clear that negligible mucosal reactions were seen after elevation surgery of the maxillary sinus floor. None of all patients developed purulent maxillary sinusitis.

The normal physiology of the maxillary sinus is highly dependent on the proper function of both the maxillary sinus ostium and the mucosal lining\(^7,8\). Augmentation of the maxillary sinus does not affect the maxillary sinus ostium, which is located far from the operative field in the upper portion of the medial wall. However, elevation of the mucosa and insertion of grafts or implants might be disturbing to the lining mucosa and a source of chronic inflammation and sinusitis\(^9\).

Diminished maxillary sinus drainage is closely related to structural and mucosal factors responsible for the size of the maxillary ostium. Therefore, all factors that disturb sinus drainage, such as septal deviation, nasal polyposis, allergy, obstructive lung disease, and infundibular pathology, have to be evaluated by preoperative screening and treated accordingly before augmentation. The risk of developing maxillary sinusitis is increased in patients with disturbed clearance of the sinus\(^10-18\).

A maxillary sinus floor elevation procedure reduces the volume of the maxillary sinus. As a result of the iatrogenic damage caused by raising the maxillary membrane, a transient or persisting effect on the ciliated antral mucosa can be expected. Among other effects, when the maxillary sinus is filled up with blood, structural delay of the maxillary sinus clearance is thought to occur. This could result in blocking of the ostio-meatal unit, which is a potential risk on development of sinusitis. However, the results of this study show no clinical signs of sinusitis development in all patients. This indicates that a normal maxillary sinus at the time of surgery seems to have a high potential for regaining its function postsurgery and the maxillary sinus mucosa is capable of adapting adequately to the changes induced by elevation procedure\(^19,20\).
Mucosal injury and postoperative swelling as can be expected after sinus floor elevation surgery may influence the mucociliar barrier function and effectiveness of the cleansing system, resulting in divergent radiographic findings. Specially in clearance compromised patients, this balance system of aggressive and defensive forces is expected to be vulnerable, as represented by endoscopic findings grade 3 and 4. A proper anamnestic assessment of preexisting sinus clearance impairment may detect patients who are at risk for an impaired recovery of the maxillary sinus mucosa following elevation.

The occurrence of iatrogenic sinus membrane perforations during surgery seems not to be related to the development of postoperative sinusitis in healthy patients. Small perforations of the mucosa cannot induce serious damage to the maxillary sinus and therefore are not a contraindication to the continuation of surgery, provided that they do not allow the passage of graft material inside the maxillary sinus. While large perforations of the maxillary sinus membrane could result in the discharge of bony fragments into the maxillary sinus and thus cause maxillary sinusitis. It has been reported that large sinus membrane perforations should be repaired with collagen membrane. The patient under consideration did not develop maxillary sinusitis after surgery, probably because of adequate sealing of the large iatrogenic perforation in the sinus membrane. And it is better to recommend decongestant medical therapy for the upper airways in these cases.

The increase in bacterial growth after sinus floor elevation might possibly be the effect of the surgical procedure, which affected the maxillary mucosal lining and especially the mucosal defense system. A mildly decreased sinus clearance probably facilitates the temporary presence of microorganisms. Vascular injury following surgery, mucosal swelling, the presence of old blood and a decrease of the patency of the ostio-meatal unit might reduce the oxygen pressure in the sinus, resulting in an impaired sinus clearance. This environment possibly favors growth of pathogenic bacteria in the maxillary sinus. In contrast, after recovery of the sinus, the environment might be comparable to the preoperative situation.

If patients develop chronic maxillary disease after maxillary augmentation procedures, special care is needed to prevent loss of the bone graft. Intervention is necessary to establish adequate drainage of the maxillary sinus and to remove sequestra that may be responsible for maintaining this undesirable situation. In Table 2, guidelines for the treatment and prevention of transient and chronic sinusitis are given. In this study, the cases of mucosal perforation and Type 4 obstruction were administered nasal decongestant to prevent sinitis in addition to antibiotics and analgesics.

Table 2. GENERAL GUIDELINES FOR THE TREATMENT OF TRANSIENT AND CHRONIC MAXILLARY SINUSITIS AFTER ELEVATION OF THE MAXILLARY SINUS FLOOR

<table>
<thead>
<tr>
<th>Transient sinusitis</th>
<th>1. Use of decongestants and antibiotics</th>
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<td></td>
<td>2. Follow-up after 2 weeks</td>
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<td></td>
<td>3. If no recovery, transient sinusitis has possibly evolved into subacute sinusitis needing further treatment: a. Continuation of decongestants and antibiotics</td>
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V. Conclusions

The placement of implants in the posterior maxilla with the maxillary sinus floor elevation with an autogenous bone graft is now generally accepted as a successful and biologically sound procedure with a reasonably good prognosis. However, the procedure is not always free of complications. Therefore, prior to sinus floor elevation surgery, preoperative evaluation and diagnosis through CT images should be performed. If a normal, or mild mucosal inflammatory aspect of the sinus mucosa is found, without any sign of pathology in the infundibular area (containing the ostiomeatal unit), sinus floor elevation surgery can be performed. In this study, diameters of maxillary sinus ostium were significantly decreased and sinus obstructions were observed frequently in Type 3 after sinus floor elevation surgery. But these situations were transitionally, the 3-month postoperative radiographic examination revealed complete recovery of the maxillary sinus physiology in all patients.

REFERENCES


Abstract

Cone beam computed tomography를 통해
상악동 거상술 시행한 환자에서 상악동구 직경 변화에 대한 연구

장호열, 소승걸, 박재봉, 김현철, 박일해, 이상철

리빙웰 치과 병원, 리빙웰 치의학 연구소

상악동은 관골 돌기부터 비강에 이르는 상악체 속에 존재하는 피라미드형의 빈 공간이다. 상악동은 비강외벽의 전상방에 존재하는 상악동구를 통해 중비도로 개구된다. 퇴축된 상악구치부의 무치악부에서 lateral window를 통해 상악동 거상술을 시행하고 임프란트를 식립하는 술식은 보편화된 방법이다. 하지만 상악동 거상술 시 점막의 손상이나 술 후 부종으로 인해 상악동구의 개방성이 감소되거나 폐쇄될 수 있고 심한 경우 상악동염과 같은 술후 합병증을 유발할 수 있다. 본 연구에서는 술 전 술 후의 CBCT영상의 분석을 통해 상악동 거상술을 시행한 환자의 상악동구의 직경의 변화를 측정한 결과 또한 임프란트시술 전 술 후 상악동염의 발생률의 위험을 높이는 상악동 질환의 존재 여부에 대한 확인의 중요성에 대해 고찰하고자 한다.