

CAN WE PREDICT MAXILLARY SINUS MUCOSA PERFORATION?

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Summary: This study was carried out to evaluate the prevalence of sinus mucosa perforation occurred during maxillary sinus mucosa elevation surgery, its relation to objective conditions and to the causative medical history, and its influence on postoperative sinusitis, as well. One hundred and forty-six sinus lift procedures have been evaluated in 118 patients. The prevalence of the sinus mucosa perforation was evaluated and subdivided into four groups according to its size and way of treatment. No relation was observed between the perforation and the presence of sinus septa, smoking, radiographic thickening and cyst-like lesions of the maxillary sinus, and previous sinus allergy ($P < 0.05$). Despite of high prevalence of the perforation of the mucosa (56.16%), no signs of bone graft infection or maxillary sinusitis were noted in any of our patient.

Key words: Maxillary sinus; Mucosa perforation; Sinus lift

Introduction

The aim of the dental implantology is to make implant treatment possible to all patients who may benefit from it. The advanced bone loss and the spongy bone available in the posterior upper jaw pose serious challenges for implant therapy. Recently, the maxillary sinus floor elevation (sinus lift operation) has opened up a new way of placing endosseous implants despite marked bone lack (4,43). One of the most complications during the procedure is sinus mucosa perforation (SMP) (30,37). It is generally agreed that every effort should be made to minimize SMP. However, this is not always possible, because the sinus mucosa is extremely thin, friable, and easily perforated (20). SMP can cause loss of graft material within the sinus that can lead to a sinusitis (3,17,25,26,35,41). Furthermore, a greater bacterial penetration into the graft material through the torn mucosa, and risks of graft contamination can be increased (17). To our knowledge, SMP have not been separately investigated yet.

Materials and methods

All patients who demanded sinus augmentation and endosseous implants were included in this study (118 patients, 58 men and 60 women). The age was ranging from 29 to 58 years with mean of 42 years. Each patient was either partially edentulous in a posterior maxilla quadrant requiring fixed restoration or was totally edentulous indicating fixed removable prosthesis. The medical history including smoking and maxillary pathology-related symptoms was recorded. Patients with a recent history of acute maxillary sinusitis

were excluded. Patient was considered a smoker if the patient smokes at least one cigarette daily for more than six months continuously. Preoperative planning consisted of clinical examination of the upper alveolar crest and radiographic assessment with panoramic radiographs. Water's projection or computer tomographies were used when required. This radiographic survey was also used to identify possible maxillary sinus septa. All patients received appropriate antibiotics that were started 24 hours preoperatively and continued for one week.

One hundred and forty-six sinus lift procedures were carried out as described by Boyne and James (4). Once SMP was identified, the sinus elevation procedure was modified and the SMP management was performed depending on the perforation size (Fig. 1, 2). The mucosa was elevated around the perforation, not to enlarge its size and then covered using a small piece of hemostat absorbable fabric (Surgicel®, Ethicon, Johnson&Johnson) to prevent migration of materials into the sinus cavity (Fig. 3). When the SMP was sealed (negative nose-blowing test), the procedure was completed in routine fashion (Fig. 4). We registered the prevalence and the size of SMP. The operated sinuses were comprised into three groups: Group A no perforation occurred during the operation (64 sinuses), in Group B small perforations (< 2 mm diameter) were registered without need of treatment (15 sinuses), and Group C (66 sinuses) included sinuses with all perforation covered by Surgicel®. When SMP was very large and we could not close it, the procedure was abandoned and it could be tried again after a minimum six weeks. It was standard to perform the Valsalva's maneuver in all of our operations to confirm the absence or the sufficient treatment of



Fig. 1: SMP occurred during the lateral wall osteotomy.



Fig. 2: SMP became larger during mucosa dissection.



Fig. 3: The mucosa elevation was performed carefully around the SMP and then it was covered with Surgicel®.

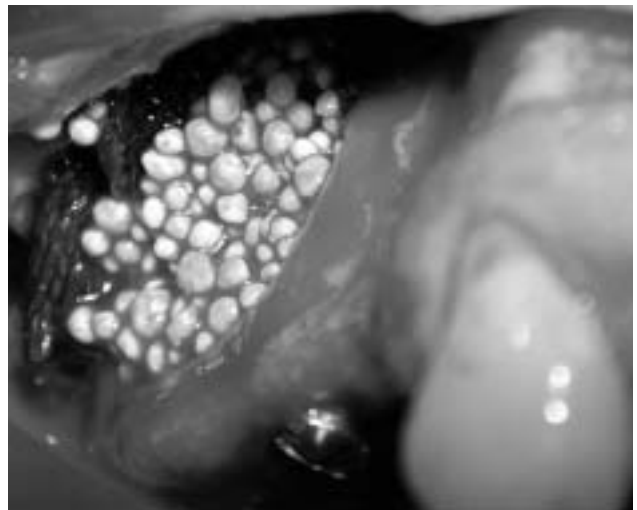


Fig. 4: Once the SMP is sealed, the procedure was completed in routine fashion.

the SMP. We used following augmentation materials: β -tricalcium phosphate ceramic (Cerasorb®, Curasan-Pharma, Kleinostheim, Germany), deproteinized cancellous bovine bone (Bio-Oss®, Geistlich, Wolhusen, Switzerland), and natural red alga (Algipore®, Friadent, Mannheim, Germany). These materials were mixed with the patient's intravenous blood and used alone or in combination with autograft harvested from maxillary tuberosity. Our decision concerning the simultaneous implant placement was not changed if the SMP was properly managed. The patients were called for clinical and radiographic check-ups and asked especially about sinus related pathology (e.g. infection of the maxillary sinus, loss of bone particles through the nose, etc.).

The aim of this study was to evaluate the prevalence of SMP being occurred during the sinus lift procedure, its relation to the objective conditions and causative medical

history, and its influence on postoperative sinusitis. The correlation between these conditions and SMP was evaluated statistically using the Fisher's exact test.

Results

Sinus mucosa perforation occurred in 82 of our 146 operations (56.16 %). Table (1) and figure (5) demonstrate SMP size, number, prevalence, and its treatment. The lowest prevalence of SMP was observed in radiographically evident thickening of the sinus mucosa (30 %) (Tab. 2). The prevalence of SMP in radiographically visible cyst-like sinus lesions was 100 % (Tab. 2).

Using Fisher's exact test ($P < 0.05$), we did not find any correlations between SMP and all of the above-mentioned findings ($P = 0.101$) and ($P = 0.259$), respectively.

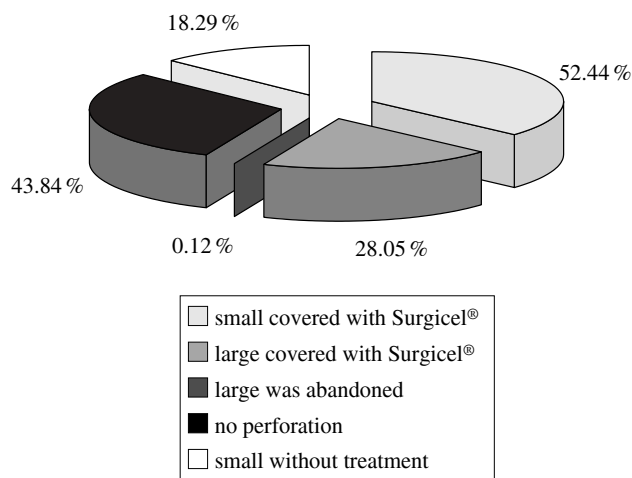


Fig. 5: SMP percentage and its treatment.

Tab. 1: The number and treatment of SMP.

Sinus mucosa perforation (SMP) (n = 82)		
Size	Number	Treatment
Small (< 2 mm)	15	without treatment
Small (< 2 mm)	43	covered with Surgicel®
large (> 2 mm)	23	covered with Surgicel®
large (> 2 mm)	1	abandoned

Some relationship, we figured out in the presence of sinus septa ($P = 0.058$), but statistically the correlation was not significant.

No relationship was registered in smoking patients ($P = 1.000$) and in patients with allergic anamnesis ($P = 1.000$). No relation was found between SMP and smoking patients with sinus septa ($P = 0.177$).

Despite of high prevalence of SMP, no signs of bone graft infection or maxillary sinusitis were noted in any patient.

Discussion

The present study did not confirm the relation between SMP and the objective conditions as well as the causative medical history related to sinus as was mentioned by some authors (2, 18). We recognized the SMP in 56,16 % of our operations. The prevalence of the SMP in this study was very high in comparison with most other authors. Their re-

sults ranged individually from 0 % up to 58 % (0 % Peleg (22), 11 % Leonardis (13), 14 % Loukota, (15), 17 % Wannfors (39), 20 % van den Bergh (37), 30 % Hallman (6), 34 % Timmenga (32), 36 % Raghoobar (26), 40 % Mazor (16), and 16 % to 58 % Krennmair (12). However, these authors did not explain if they published all or only the treated SMP.

It has been mentioned that because the mucosa is strongly adherent to the sinus septa, the elevation of the mucosa without SMP is considered being almost impossible (2,9). In our results, we did not confirm this experience, which can be explained as a consequence of more careful operation technique when the presence of sinus septa was expected. Cigarette smoking is considered as a pathophysiologic parameter that was found to be deleterious to the sinus graft (21,42). We did not notice higher percentage of SMP among smokers. Therefore, smoking can be judged as the pathophysiologic risk factor for the graft success but not for SMP. According to our results, the radiographic thickening of the sinus mucosa, usually indicating chronic sinusitis, allergy etc., did not increase the prevalence of the SMP. Furthermore, it facilitated mucosa elevation. As well as, the radiographic cyst-like lesions of the maxillary sinus did not predispose the patients to a higher SMP percentage. Anyway, it is recommended to treat it before the sinus procedure to avoid graft infection.

Many authors (7,40,41) proved by endoscopic examination the migration of augmentation material particles through the sinus mucosa. From our point of view, there are clinically observed and unobserved SMP. The latter may occur during application of the augmentation materials due to sharp edges of some of them. Many materials have been suggested to cover the perforation (resorbable cellulose membrane, collagen, cortical bone partition, demineralized laminar bone membrane) or it can be glued together with a fibrin sealant (16,27,28,31,36,37). In addition, it is recommended to use a block graft rather than particulated grafts, when perforation is larger than 5 mm (10,31). Pikos (24) described the technique of closure of the SMP using resorbable suture. From our experience Surgicel® is a cheap, satisfactory material for closing of different SMP sizes.

It was surprising that despite of high prevalence of SMP, we registered no sinusitis during our study. Timmenga et al. (32) reported that two sinuses from 85 sinuses developed subacute maxillary sinusitis and in one of these patients the sinus mucosa had been perforated accidentally during the surgical procedure. However, probably some

Tab. 2: Observation results.

	Sinus septa	Cyst-like lesions	Mucosa thickness	Smoking	Allergy	Smoking and septa
The number of the cases	16	3	10	23	6	3
Perforation occurrence	13	3	3	13	3	2
Percentage	81.25 %	100 %	30 %	56.5 %	50 %	66.7 %

transient sinusitis, as Perko (23) mentioned, might happen in a number of our patients, but was not enough obvious to differentiate it from postsurgical symptoms.

There are different ways how to keep the graft mixture in solidified mass and to prevent graft particle migration. Hallman et al (6) added fibrin glue (Tisseel®, Duo Quick Immuno, Vienna, Austria) to graft material to make it easier to handle and to hinder particles from migration in case of SMP. Patient's blood, as we noticed, can act in a similar way as tissue glue in discouraging particle extravasations.

The following rules were essential in all our operations. First, any hole in the mucosa should be closed. When SMP was small, there was no need for further measures because the epithelial lining "falls together" when lifting the door so there is not a great chance of losing graft material into the sinus (37). Second, the sinus mucosa should be completely elevated before graft placement. According to the graft-healing hypothesis in the sinus, mentioned by several authors, the bone formation in an augmented maxillary sinus originates from the floor and the lateral walls and the mucosa does not possess any osteogenetic potential (1,4,7,8,38). That means if there is any unelevated mucosa between the augmentation material and the osseous bed, consolidation will not occur. At the same time the graft will not be secure enough for the placement of osseointegrated implants and predisposes to infection or failure (5). Postoperative maxillary cysts following maxillary sinus elevation were reported. On the histologic examination, their membrane consisted of sclerous sinus mucosa lined with respiratory ciliated epithelium (14,19).

It is known from some authors' observation that less bone formation is depicted close to sinus mucosa (8,18). The sinus mucosa does not have apparent osteogenic potential and its contribution as an angioblast-osteoblast source and/or as endoperiosteum is just becoming understood, but it is probably secondary in importance in sinus graft healing (29). Therefore, the most important task for the mucosa, during sinus grafting, is to act as a net for the graft material.

More than one type of management have been reported how to reduce SMP prevalence. Kent et al. suggested leaving very thin part of sinus wall above the mucosa during osteotomy preparation to avoid SMP with the rotatory instrument. However, the operator must use excessive force to infracture the rest wall of the sinus cavity and this may result in a large tear in the sinus mucosa (11). Ziccardi recommended the use of a diamond bur in contrast to a fluted bur, because it tends to displace the mucosa rather than grab and tear it. Torrella et al. described technique when the sinus fenestration osteotomy was made by ultrasound technique, which reduced the risk of SMP and improved the quality of the osteotomy (33).

Conclusion

The authors concluded that no relations were noted between SMP and the preoperative condition (sinus septa,

smoking, radiographic thickening of the mucosa, radiographic cyst-like lesions of the sinus, and sinus previous allergy). SMP can be problematic but if it is appropriately managed, it does not harm the healing process of the bone graft and could hardly be connected with the development of postoperative sinusitis. On the other hand, it would be convenient to analyze larger number of patients to confirm the relation between SMP and preoperative conditions.

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