Prospective observation of 41 perforations of the Schneiderian membrane during sinus floor elevation

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Abstract

Objectives: The aim of this study was to follow 41 intraoperative perforations of the Schneiderian membrane during sinus floor elevation and to identify potential differences from patients without perforations.

Material and methods: Two hundred and one sinus floor elevations were performed at the department of oral and maxillofacial surgery of the University Hospital of Schleswig-Holstein in the years 2005 and 2006. Forty-one intraoperative perforations (20.4%) were documented and treated according to the following scheme: defects smaller than 5 mm were covered with a collagen membrane. Larger defects were additionally sutured. Particulated jawbone mixed 50:50 with bone substitute (25 cases) and a 50:50 mix of particulated iliac crest bone and BioOss® (six cases) mainly served as graft material in the perforation group. In 12 cases, implants were installed at the time of sinus grafting, and in 27 cases, a second operation was performed.

Results: Four sinus lift procedures had to be discontinued intraoperatively. Over a mean control interval of 162 days, one implant of the 93 inserted had to be replaced in the perforation group. After 1 year, the implant survival rate was 14 out of 14 in the perforation group vs. 81/92 in the control group.

Conclusions: With appropriate treatment, intraoperative sinus membrane perforations did not represent an elevated risk for implant loss, infectious complications or displacement of graft material in the investigated population.

Sinus floor elevation has become a standard procedure in the treatment of the severely resorbed maxilla before insertion of dental implants after its first report over 20 years ago [Boyne & James 1980; Tatum, 1986]. In general, success is highly predictable, unless complications occur [Pikos 1999; Wiltfang et al. 2005].

According to Schwartz-Arad et al. [2004] and Proussaef et al. [2004], perforations of the Schneiderian membrane represent the major intraoperative complication. Possible causes include septa, pathologic conditions or very thin membranes [Pikos 1999]. Incidence rates vary considerably [Pikos 1999], from 12% [Szabo & Toth 2001] up to 35% [Jensen et al. 1994] and even 44% [Schwartz-Arad et al. 2004], while most authors report rates of 20–25% [Khoury 1999; van den Bergh et al. 2000b; Wannfors et al. 2000; Kreisler et al. 2007].

Intraoperative complications are rarely reported in detail and their effects have been investigated to an even lesser extent [Schwartz-Arad et al. 2004]. The aim of this study was to prospectively observe the...
course of 41 intraoperative perforations of the Schneiderian membrane during sinus floor elevation and its influence on postoperative complications like reduced implant survival rates and sinusitis.

### Material and methods

In the years 2005 and 2006, 201 sinus floor elevations were performed at department of oral and maxillofacial surgery of the University Hospital of Kiel. In that population, 41 perforations of the Schneiderian membrane occurred in 34 [24 female, 10 male] patients. All 34 patients with intraoperative perforations were included in a prospective manner. One patient was lost to follow-up. During follow-up visits, complications, implant insertion and implant failure were recorded. The characteristics of the perforation and the control group are presented in Table 1.

Before surgery, clinical examination and panoramic radiographs were obtained.

In the perforation group, 35 operations were external sinus floor elevations through a bone window in the facial sinus wall. One operation was an internal sinus lift procedure. In four cases, the sinus floor elevation was associated with a Le Fort-I-osteotomy, in one case with a reconstruction during a tumor operation of the upper jaw. Three operation sites were suspected to have preexisting defects of the Schneiderian membrane due to previous maxillary sinus operations [two] and trauma [one]. The surgery was performed by three different surgeons.

The procedures in the perforation group were performed under local anesthesia [seven] with intravenous sedation [11] and/or under general anesthesia [23]. Perioperative antibiotics were used routinely.

Augmentations with defects of $<2 \text{ cm}^3$ were filled with bone filter material and bone substitute [Barone et al. 2005] and augmentations of $>2 \text{ cm}^3$ were filled with mandible bone [linea obliqua] or iliac crest bone. In most cases [perforation group 25, control group 105], the maxilla was augmented with a bone graft using an intraoral approach [mandible and maxilla] combined with a bone substitute or with iliac crest bone combined with a bone substitute [six/39, see Table 2].

### Results

We observed 41 perforations [in 34 patients] of the Schneiderian membrane during 201 sinus floor elevations, a rate of 20.4%. Treatment of the perforations is shown in Figs 2 and 3. Four sinus lift procedures had to be discontinued intraoperatively due to the extent of the perforation [two], thin mucosa [one] and a retention cyst [one]. In a second trial, these sinus floor elevations could be performed successfully in all four cases after 6 months.

After sinus floor elevation in the perforation group, one dehiscence of the gingival wound occurred that extended healing time but caused no further graft or implant loss as there was no connection to the Schneiderian membrane. One patient complained

### Table 1. Characteristics of the perforation and the control group are presented

<table>
<thead>
<tr>
<th></th>
<th>With perforation</th>
<th>Without perforation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age</td>
<td>55 years</td>
<td>56 years</td>
</tr>
<tr>
<td>Female</td>
<td>31</td>
<td>86</td>
</tr>
<tr>
<td>Male</td>
<td>10</td>
<td>74</td>
</tr>
<tr>
<td>Right side</td>
<td>21</td>
<td>80</td>
</tr>
<tr>
<td>Left side</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Immediate implant insertions</td>
<td>12</td>
<td>70</td>
</tr>
<tr>
<td>Second operation for implant insertion</td>
<td>27</td>
<td>78</td>
</tr>
<tr>
<td>Implants inserted</td>
<td>93</td>
<td>332</td>
</tr>
<tr>
<td>Lost implants</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Average observation time</td>
<td>162 days</td>
<td>250 days</td>
</tr>
</tbody>
</table>

### Table 2. Bone grafts for augmentation in the groups with and without perforation

<table>
<thead>
<tr>
<th>Bone transplant</th>
<th>With perforation</th>
<th>Without perforation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>41</td>
<td>160</td>
</tr>
<tr>
<td>Jaw bone and substitute</td>
<td>25</td>
<td>105</td>
</tr>
<tr>
<td>Iliac crest bone and substitute</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td>Jaw</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>No</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Only iliac crest bone</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

The frequencies of anatomical abnormalities that eased perforations of the Schneiderian membrane in the perforation group.

In 12 cases, implants were installed at the time of sinus grafting in 29 patients in a second operation in the perforation group, simultaneously 70 times and delayed 78 times in the control group, depending on the bone being present.

After surgery, patients were advised to use nose drops and inhalants. One week after surgery sutures were removed. Patients were asked to come for follow-up visits after insertion of dentures and then once per year. Six months later, sinus floor elevation panoramic radiographs were performed.

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about symptoms of sinusitis. This could be confirmed radiologically. Two implants were not very stable at insertion time, but stability was normal at the time of integration of the dentures. In the control group, one sinusitis and a local infection was documented.

After an interval of 6 months after implant insertion, six implants of 190 in the control group were removed, no implant (of 27) in the perforation group. After 1 year, the corresponding values were 11/92 and 0/14. The mean control interval between implant insertion and the last visit of the perforation group was 162 days. Till now, one implant of the 93 inserted had to be replaced due to loosening. Implant survival rates were not distinctly different between both groups. The other implants showed no mobility and no radiographic signs of bone loss. No gingival infection or pockets > 3 mm were observed.

The implant was lost in a 74-year-old woman who had received a Le Fort-I-osteotomy due to a severely resorbed maxilla. Particulated iliac crest bone combined with a bone substitute served as graft material.

Implant insertion followed 4 months later. Another 3 months later, the patient complained of a swelling over the facial wall of the sinus. As administered antibiotics did not have a sufficient effect, a local incision of the infected site was performed and the implant was removed. After 6 months, the implant could be replaced.

Discussion

The aim of this study was to prospectively observe the course of 41 intraoperative perforations of the Schneiderian membrane during sinus floor elevation. We researched 41 perforations (in 34 patients) of the Schneiderian membrane during 201 sinus floor elevations, a rate of 20.4%. Four sinus lift procedures had to be discontinued intraoperatively. One implant of the 93 inserted had to be replaced due to loosening in the perforation group.

Perforations of the Schneiderian membrane are the most common complication during sinus floor elevation [Schwartz-Arad et al. 2004]. Reported complication rates vary considerably. They start at 12% [Szabo & Toth 2001] in a study with 965 sinus floor elevations reviewed retrospectively. Common rates from a meta-analysis indicate 18.4% [Kreisler et al. 2007]. Two other studies described values of six perforations in 30 operations [20%] (van den Bergh et al. 2000b) and 51 out of 216 cases (23.6%). The highest value in the literature is 36/81 (44%) [Schwartz-Arad et al. 2004]. Our complication rate is at the lower end of the reported rates even though we included operations like Le-Fort-I-osteotomies and immediate reconstructions after tumor surgery. As a complication rate of about 20–30% is high, it is all the more important to evaluate the outcome after a perforation.

Survival rates for implants have values around 90% [Kreisler et al. 2007]. In our study, only one implant had to be replaced. This results in an implant survival of over 99% in an average interval of 5.4 months after implant insertion. Implant survival is a very important criterion as sinus floor elevations are only performed to enable the insertion of implants into the resorbed maxilla. As perforations are early complications, several studies support the assumption that perforations during sinus floor elevations have an influence on implant survival only until dentures are incorporated [Szabo & Toth 2001]. Only after an observation time of a few years can this conclusion be confirmed by our data. The high success rate of implant survival in our study is in accord with reported data that conclude that surgical complications do not significantly influence implant survival [Schwartz-Arad et al. 2004; Ardekian et al. 2006; Barone et al. 2006]. In contrast, a recent study found that the survival rates of implants placed under reconstructed membranes correlate inversely with the size of the perforations [Hernandez-Allar et al. 2008].

In an analysis of 216 sinus floor elevations with 51 perforations, 28 implant failures became evident during the first year after loading [Khoury 1999]. In another study, there was no association between tearing of the sinus mucosa during surgery and postoperative sinusitis or implant failures [Wannfors et al. 2000]. According to the literature, most implant failures occurred 3–6 months after surgery, usually not in association with infection of the

**Fig. 2.** Treatment of the perforations [n = 41].

**Fig. 3.** Perforation of the Schneiderian membrane before [a] and after suture [b].
maxillary sinus. In the study mentioned, reimplantation had been possible in all cases [Jensen et al. 1994]. This supports the thesis that sinus floor perforations had no negative effect on implant survival.

In the present study, four sinus lift procedures had to be discontinued due to the extent of the perforation (two), thin mucosa (one) and a retention cyst (one). This represents a rate of <2%. Other studies report a rate of 1.2% [Szabo & Toth 2001]. In a second operation after 6 months in all four cases of our department, a sinus floor elevation was possible with no further perforation. The prevalence of a complete discontinuation of the operation was pretty low, especially as the success rate of the second operation was 100%.

Nevertheless, it is important to mention that according to van den Bergh et al. [2000a], sinus floor irregularities, septa and mucosal swelling are relative contraindications for sinus floor elevations. Former destructive sinus surgery and tumor surgery of the maxillary sinus are said to represent absolute contraindications [van den Bergh et al. 2000a]. Known risk factors for perforations are an abnormal morphology of the sinus maxillaris and septa [Szabo & Toth 2001]. Especially thin membranes were evident in our patients (27%). In addition, septa (22%) complicated the situation, followed by previous operations and adhesions of the Schneiderian membrane.

Kan et al. [1999] examined, in a group of 60 patients (16 smokers, 44 non-smokers), a total of 228 implants placed in the grafted sinus floor. There was a significant difference in the implant success rate, with 65.3% for smokers and 82.7% for non-smokers. Blomqvist [Blomqvist et al. 1996; Behrens & Härlé 2003; Kreisler et al. 2007] did not establish a significant correlation between tobacco use and implant failure rate in the grafted sinus floor. Diabetics who undergo dental implant treatment do not show a higher failure rate than the normal population, if their plasma glucose level is normal or close to normal [Farzad et al. 2002; Kotsovilis et al. 2006].

The sinus membrane is important to avoid displacement of particular graft materials into the sinus cavity [van den Bergh et al. 2000a]. We used bone chips and bone substitutes (hydroxyapatite). Even small nonobserved perforations that are contingently to be overseen during surgery can pose a risk if left untreated. They should be followed and treated thoroughly, although they can fold together [van den Bergh et al. 2000a, 2000b; Aimetti et al. 2001] and virtually disappear.

In the present study, smaller defects up to 5 mm in diameter were covered with a collagen membrane. This is a common procedure [van den Bergh et al. 2000a, 2000b; Schwartz-Arad et al. 2004]. Larger defects were additionally sutured with a resorbable material to completely close the dehiscence. In most cases, this was feasible through the lateral window. Some authors placed a membrane over larger perforations, to cover the perforation successfully [van den Bergh et al. 2000b; Aimetti et al. 2001].

Immediate implant insertion was performed only if the residual bone was stable and high enough to ascertain high primary stability. When this was not possible, the implants were inserted late.

It should be mentioned again that we pooled different operation types (internal and external) as well as different fillers for the augmented sinus floors. Fillers were similar as all material inserted was particulated and had, thereby, a similar risk for displacement. Further data are needed to exclude different possible outcomes for each combination.

Conclusion

In conclusion, the presented concept to repair membrane perforations provides a secure method to avoid graft from getting lost into the sinus maxillaris with subsequent sinusitis.

This study shows a high implant survival rate after treatment of perforations of the Schneiderian membrane. Our data support the theory that sinus floor perforations have no negative effect on implant survival.

References


