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Risk factors and clinical outcomes of sinus membrane perforation during lateral window sinus lifting: analysis of 120 patients

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Abstract. The aim of this study was to identify the risk factors associated with sinus membrane perforation and the effect of sinus membrane perforation and other risk factors on graft success and postoperative sinusitis. Sinus membrane perforation, graft failure, and postoperative sinusitis were tested for an association with age, sex, operator experience, side of the operation, residual bone height, presence of septa, presence of a mucous retention cyst, and smoking (χ^2 test). Logistic regression analysis was used to model the odds ratio (OR) with corresponding risk factors. One hundred and twenty patients were included in this study. A total of 22 (18.3%) perforations occurred. A residual bone height of 3–6 mm (OR 6.808, $P = 0.002$) and presence of septa (OR 4.023, $P = 0.025$) were identified as significant risk factors. Twenty-eight (23.3%) sinus grafts were classified as failed. Membrane perforation (OR 16.819, $P < 0.005$) and residual bone height of 3–6 mm (OR 5.363, $P = 0.01$) were identified as significant risk factors for graft failure. None of the risk factors investigated in this study was significantly associated with postoperative sinusitis. These results suggest that the presence of septa and a residual bone height of 3–6 mm are associated with an increased risk of sinus membrane perforation, and that sinus membrane perforation has a negative effect on graft success.

Key words: sinus lifting; sinus floor elevation; sinus membrane perforation; risk factors; complications.

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Bone remodelling after tooth extraction and maxillary sinus pneumatization often create a clinical challenge for dental implant placement in the posterior maxilla. First described by Tatum[1] and then published by Boyne and James[2], sinus lifting has become a reliable procedure to overcome a vertical bone deficiency in the posterior maxillary region. Sinus lifting can be performed either by a transcrestal approach or lateral window approach, depending on the available bone. The

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transcrestal approach is a less invasive technique and has been reported to have predictable outcomes when there is more than 5 mm of bone available[3,4]. However the lateral window approach is recommended when there is less than 4–5 mm of residual bone available[5,6].

Lateral window sinus lifting is a technique that is commonly used to increase the bone height, and it allows the placement of dental implants either simultaneously or in a staged manner[7,8]. Although this procedure is considered safe, various complications may arise during or after the surgery. The most common complication is sinus membrane perforation. The average incidence of sinus membrane perforation was reported to be 23.5% in a recently published meta-analysis[9]. Perforation of the sinus membrane during the lateral osteotomy or membrane elevation may lead to other complications, including migration of the graft into the sinus proper, sinusitis or infection, graft loss, and implant failure[10–13]. Additionally, it has been shown in experimental/in vivo studies that the sinus membrane has osteogenic properties[14–16], and clinical studies have shown that sinus lifting without bone grafts results in bone regeneration[17–21]. Therefore the sinus membrane plays an important role in sinus lifting procedures not only by maintaining graft or bone substitute material, but also by enhancing bone formation and graft maturation. Several factors have been proposed as risk factors for membrane perforation, including sinus membrane thickness, smoking, residual bone height, operator experience, the presence of septa, lateral wall thickness, and gingival phenotype[12,13,22,23].

In this context, the first aim of this study was to identify the risk factors associated with sinus membrane perforation. The second aim was to identify the effect of sinus membrane perforation and other risk factors on graft success and postoperative sinusitis.

Patients and methods

This retrospective study was performed on 120 consecutive patients who underwent unilateral, lateral window sinus lifting surgery in the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Çukurova University, between March 2015 and September 2016. The Ethics Committee of Çukurova University approved the study. Patients who needed dental implants in the posterior maxilla and who had a bone height between the sinus floor and the alveolar crest of less than 6 mm were included in the study. Exclusion criteria were the following conditions: osteoporosis requiring active medical treatment, previous radiation therapy in the head and neck region, renal or liver disease, uncontrolled diabetes mellitus, chronic use of steroids, alcoholism, drug abuse, and local pathology or inflammation at the site of surgery.

Demographic data and smoking status of the patient, seniority of the operating surgeon, and the side of the surgery were noted before surgery. The residual alveolar bone height, presence of septa, and presence of a mucous retention cyst were determined by evaluating the patient cone beam computed tomography (CBCT) scans.

All operations were performed under local anaesthesia and all patients received 2 mg/kg methylprednisolone intravenously 30 minutes before the surgery. A full-thickness mucoperiosteal flap with a crestal and a buccal vertical incision was used to expose the lateral wall of the maxilla. The lateral maxillary wall osteotomies were done using diamond burs of 6 mm and 8 mm in diameter, from a specific sinus lifting kit (DASK Advanced Sinus Kit; Dentium, Seoul, South Korea). To access the membrane, the bone was removed completely with sinus curettes, rather than in-fracturing into the sinus. Following sinus membrane elevation, a gentle Valsalva manoeuvre was used to determine the membrane integrity. Perforations smaller than 5 mm were repaired with a collagen membrane (Collagen AT; Centro Di Odontoiatria Operativa, Padova, Italy). Sinus membrane perforations were recorded intraoperatively. All sinus lifts were grafted with xenograft only (Cerabone; Botiss Biomaterials GmbH, Berlin, Germany). After the surgery, 875 mg amoxicillin + 125 mg clavulanate, 600 mg ibuprofen, and 0.12% chlorhexidine digluconate, two times daily for 7 days, were prescribed to all patients.

Sinus grafting was classified as failed if one of the following conditions occurred: (1) graft infection; (2) the height of the grafted area was less than 8 mm at the second stage surgery; (3) an implant loss occurred from the grafted area.

Postoperative sinusitis was evaluated first by clinical examination and was then verified by postoperative CBCT scans.

Statistical analysis

Categorical variables were expressed as numbers and percentages where appropriate. Sinus membrane perforation, graft failure, and postoperative sinusitis were tested for an association with the corresponding risk factors using the χ^2 test. Logistic regression analysis was used to model the odds ratio (OR) of sinus membrane perforation, graft failure, and postoperative sinusitis by the corresponding risk factors. All analyses were performed using IBM SPSS Statistics version 20.0 software (IBM Corp., Armonk, NY, USA). The level of statistical significance for all tests was set at 0.05.

Results

One hundred and twenty patients (70 male, 50 female) were included in this study. The mean age of the patients was 53.5 ± 12.9 years (ranging from 18 to 76 years). Fifty-six patients (46.7%) were smokers. Three oral and maxillofacial surgeons performed 60 sinus lifts (50%), three senior residents performed 32 sinus lifts (26.7%), and four junior residents performed 28 sinus lifts (23.3%). Fifty-four sinus lifts (45%) were performed on the dominant hand side of the operator, whereas 66 sinus lifts (55%) were performed on the non-dominant hand side of the operator. Seventy-five patients (62.5%) had a residual bone height of $\leq$3 mm, whereas 45 (37.5%) had a residual bone height between 3 mm and 6 mm. A total of 184 implants were placed at the grafted sites, either simultaneously or in a delayed fashion, and three implants failed after a mean 20.2 months (range 12–32 months) of follow-up.

A total of 22 (18.3%) perforations occurred. Twenty-one of these were smaller than 5 mm and repaired with a collagen membrane. One perforation was too large to be repaired and bone grafting was postponed. The prevalence of sinus membrane perforation is shown in Table 1. Age, sex, presence of a mucous retention cyst, smoking, side of the operation, and operator experience did not affect the sinus membrane perforation rate statistically. A residual bone height between 3 mm and 6 mm and the presence of septa were associated with a statistically significant increase in the sinus membrane perforation rate. In a logistic regression analysis of sinus membrane perforation with sex, age, side, operator experience, residual bone height, presence of septa, presence of a mucous retention cyst, and smoking as risk factors (Table 2), only a residual bone height between 3 mm and 6 mm (OR 6.808, $P = 0.002$) and the presence of septa (OR 4.023, $P = 0.025$) were identified as significant risk factors.

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