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Graftless sinus augmentation with simultaneous dental implant placement: clinical results and biological perspectives

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Abstract. After a sinus lifting procedure, the compartment around the implants under the sinus mucosal lining in the sinus floor is filled with a blood clot from surrounding bleeding. The aim of this study was to evaluate the feasibility of bone formation following graftless sinus lifting with the simultaneous placement of dental implants. Thirty graftless sinus lifting procedures were performed and 72 dental implants placed in 18 consecutive patients, using the lateral window approach. Clinical and radiological follow-up was conducted throughout the 6-month healing period. Biopsies of 30 cases were collected at 6 months post-treatment: 15 biopsies were taken from the newly formed bone near the basal floor and 15 from the newly formed bone near the elevated membrane. New bone consolidation in the maxillary sinus was apparent radiologically and histologically at 6 months after sinus augmentation, providing an average 6.14 ± 1.34 mm of bone-gain. Based on histological analysis and histomorphometric data, the consolidated bone in the augmented sinus comprised 56.7 ± 11.9% to 59.9 ± 13.4% vital bone tissue. Out of the 72 implants placed, only four failed, indicating a 94% overall implant survival rate. Based on this case series, blood clot can be considered autologous osteogenic graft material, to which osteoprogenitors can migrate, differentiate, and regenerate bone.

Key words: sinus lifting; maxillary sinus; Schneiderian membrane; fibrin clot.

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Sinus lifting procedures are performed routinely to provide the required height of proper and stable bone tissue around inserted dental implants.[1,2] The surgical technique of maxillary sinus Schneiderian membrane (MSSM) lifting with immediate/simultaneous installation of dental implants, generally results in significant bone formation.[1,3–8] The recently reported graftless MSSM elevation procedure and the subsequent augmentation of bone have greatly changed our perspective of bone

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neoformation potential.[8–10] The blood clot formed under the lifted MSSM appears to be of critical importance in bone neoformation potential, precluding the need for exogenous graft materials.[11–13] Computed tomography (CT) data have demonstrated no difference in bone density following the use of allogeneic filling materials versus following a graftless sinus procedure.[12] The compartment made in-between the MSSM and the maxillary bone floor, including the blood clot formed, bears very high osteogenic potential, and as such, is assumed to be one of the most important factors dictating the success of graftless sinus procedures.[11–13] Review papers have recently concluded that ungrafted sinus lifting is a reliable and established technique; however, the exact mechanism of bone augmentation is still not well understood.[8,9]

Recent studies have provided some insight into the mechanism and source of osteoprogenitor cells leading to bone formation following graftless sinus lifting.[14,15] The osteogenic potential of the MSSM and the bone-forming cells beneath the membrane has been demonstrated in both in vitro and in vivo assays, and osteoprogenitor cells originating from the sinus membrane have been shown to drive bone formation.[14,15] Subcutaneous bone formation after transplantation of a MSSM folded around a fibrin clot has also been demonstrated.[14] These studies strongly indicate the importance of the MSSM and its component cells, as well as the fibrin clot, to a certain extent, in the bone formation processes.

On the other hand, Cicconetti et al.[16] and Bianco and Robey[17] have proposed that the osteogenic potential is inherent to the sinus maxillary bone floor or, more accurately, to the maxillary tuberosity and the maxillary/mandibular periosteum. These bone sites have been shown to be the sources of osteoprogenitor cells, as sample explants of the maxillary tuberosity and mandibular periosteum have been found to contain cells with early expressed osteogenic markers that could form bone structures upon ectopic transplantation.[16]

In the present clinical study, 18 patients underwent 30 graftless maxillary sinus lifting procedures followed by the immediate insertion of 72 dental implants without exogenous graft material filler. Only blood clots occurring from bleeding due to the surgical procedure filled the compartment beneath the tented MSSM. The aim of this study was to assess new bone formation within and over the compartment created and around implants under the sinus mucosal lining in the sinus floor. Moreover, it was aimed to assess the biological contribution of either or both the MSSM and the maxillary floor to the new bone formation, as well as to analyze the new bone tissue formed near the basal floor and the elevated membrane at 6 months after the procedure.

Materials and methods

Patient selection

The study patients (n = 18) were partially or completely edentulous in the posterior maxilla and required unilateral or bilateral maxillary sinus augmentation.

Study design

All participants were informed about the surgical treatment procedure and provided their written consent to participate in the study. The study was approved by the necessary ethics committee and was conducted between 2011 and 2013. Patients were only eligible if they were physically healthy, with no medical history of systemic or local diseases, such as certain bone metabolism disorders that could contraindicate sinus or implant surgery. A ridge bone height of at least 4 mm, required for primary stabilization of the implants, was a key inclusion criterion. The complexities of implant rehabilitation were described and the patients were provided with necessary information about the procedure, including the prognosis, complications, and any potential hazard. Smoking was not considered a contraindication, but patients were informed that it can reduce success rates of the procedure and compromise the sinus lift.

The surgical protocol and the criteria described by Buser et al.[18] were used to evaluate the osseointegration of implants. In accordance with the criteria, implant mobility was considered a failure and required implant removal. The implant survival rate was calculated by measuring the time elapsed from implant placement to the last follow-up visit or implant removal. For radiographic analysis, preoperative panoramic view examinations (OC200D; Instrumentarium Dental, Tuusula, Finland) and dental cone beam computed tomography (CBCT) scans (i-CAT; Imaging Sciences, Hatfield, PA, USA) were performed to evaluate the available maxillary alveolar bone height, as well as any possible existing sinus pathology. Software programs were used to calculate the existing preoperative residual bone height in millimetres. The measurement of the elevated membrane was performed using the apical point of the implant as a standard reference point after the surgery.

Surgery

All participants received dexamethasone (6 mg) 1 h before surgery and oral prophylactic antibiotics 45 min before surgery. Patients routinely received 2 g amoxicillin–clavulanate before surgery. In the case of a penicillin allergy, 600 mg clindamycin was administered. Antibiotics were administered postoperatively for 10 days: 875 mg amoxicillin–clavulanate twice a day, or 300 mg clindamycin three times daily for those with a penicillin allergy. The surgery was performed under local anaesthesia (2% lidocaine and 1:100,000 epinephrine).

After exposing the posterior maxillary edentulous area and the lateral maxillary sinus wall using a crestal incision, a buccal mucoperiosteal flap was raised and an osteotomy made in the anterior wall of the sinus using a 5-mm-radius round drill in an oval or rectangular fashion, 5–6 mm cranial to the intended implant site (Fig. 1). After exposing the sinus membrane, it was dissected carefully from the

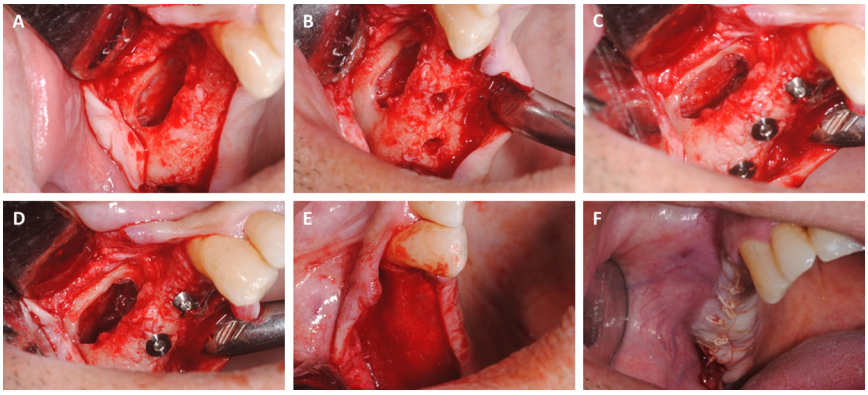

Fig. 1. Sinus lifting procedure. (A) The maxillary sinus lateral wall is exposed and a bone window is cut out. (B) Sinus elevation. (C) and (D) 'Tenting' of the sinus mucosal lining membrane by simultaneous installation of implants in the residual sub-antral bone. (E) and (F) The dental membrane is placed over the lateral window and the incision is then closed with resorbable sutures.