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LATERAL SINUS FLOOR ELEVATION IN CASES OF AN INTACT AND PERFORATED SCHNEIDERIAN MEMBRANE

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Abstract

The study comprised 20 lateral sinus floor elevation cases performed in 18 patients. During surgery, in four cases, a perforation of the Schneiderian membrane was detected. An attempt to suture the perforated membrane may increase the risk of enlarging the perforation. Therefore, we suggest a more conservative protocol be applied in all four cases where perforation occurred. The procedure consists of the 3-layer technique: an absorbable oxidized cellulose gauze moisturized with Dicynone was placed in this area. Under it, as a second layer, a PRF membrane is applied and then covered with a slow-resorbable collagen membrane. At that point, the surgery continues with the placement of the bone substitute material, and the sinus-lifting is finalized according to the selected protocol.

The clinical studies demonstrate that the bone graft has a slower healing rate in areas with perforation, which is a proof of the osteogenic properties of the Schneiderian membrane. The cases described reveal that using this surgical protocol is risk-free and has a high success rate.

Key words: sinus floor elevation, Schneiderian membrane perforation, PRF

Introduction. The sinus floor elevation procedure is designed to compensate for a bone height deficiency in the distal maxillary area. Recently, this technique has become more commonly used in implant-supported restorations when

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indications are present. In 1980, Boyne [1,2] was the first to describe the surgical technique for lateral sinus floor elevation, which consists of the opening of a mucoperiosteal flap, followed by a bone window preparation in the lateral wall of the maxillary sinus, Schneiderian membrane elevation, and placement of a bone substitute material under it. Numerous modifications and improvements have been proposed in terms of instruments, operative technique, and the properties of the bone substitute material. The perforation of the Schneiderian membrane occurs relatively frequently during the lateral sinus lift, ranging from 7% to 56% [3,4], or an average of 31% of the cases [5,6]. Most commonly, it occurs during the lifting of the lateral bony wall, but it may happen when the membrane is elevated from the inferior and anterior aspects of the sinus or due to the presence of the septum of the sinus floor [7,8].

In terms of the indications for the sinus floor elevation procedure, some anatomical characteristics of the maxilla and the maxillary sinus must be taken into consideration individually. The size and volume of the sinus as well as the positioning of the access window are of utmost importance [7]. They should be done in such a way as to provide sufficient space for the application of the bone substitute material. The sinus membrane has to be with preserved integrity, and the residual alveolar bone should be at least 4–5 mm. The distance between the upper alveolar ridge and the antagonistic part of the mandible must be at least 5 mm, but it is not desirable to be over 12 mm [9].

During the surgery, it must be taken into consideration, along with the internal shape of the maxillary sinus floor, to assess the possible risks during the process of raising the Schneiderian membrane [10,11]. Sometimes recessions, concavities, or septa might be present. These particularities can complicate the raising of the bony window as well as the elevation of the Schneiderian membrane [12]. The septa are present in about 30% of the patients, mostly in the premolar and molar regions [13]. The absolute contra-indications for sinus floor elevation surgery are: acute inflammatory diseases of the sinus mucosa; tumours or cystic formations in the area of the maxillary sinus; Meniere disease; or substantial bone atrophy with a residual alveolar bone height of less than 2 mm [14].

Operative technique. After determining the indications for sinus floor elevation surgery, the necessary specialized and general surgical instruments are prepared and arranged. The surgery can be performed under local anesthesia or sedation. The anesthesia aims to block all the nerves responsible for the innervation of this area: the infraorbital nerve, the alveolar superior posterior nerves, and the greater palatine nerve. Supraperiosteal infiltration can be additionally performed in the attached mucosa of the premolar and molar areas [1,2,9]. The surgery starts with an incision in the area of the attached gingiva crestally, along with two releasing incisions (a trapezoid flap). The boundaries of the flap are chosen according to the volume of the necessary sinus augmentation. Following the elevation of the full-thickness mucoperiosteal flap, the anterior wall of the sinus

is exposed, and a bony window is prepared. The latter can be performed using different instruments: a scraper, a piezosurgery tip, or a surgical straight-angle handpiece and a round bur. To achieve reduced trauma to both soft tissues and bone, as well as excellent visibility in the operative field, the use of a piezosurgical unit is recommended [15].

The elevation of the bony window should be done atraumatically. The Schneiderian membrane must be carefully raised from the bottom up and sideways toward the bony window with delicate movements to prevent a perforation. A resorbable membrane was placed underneath the sinus mucosa. The bone substitute material was subsequently applied to the sinus floor without exerting excessive pressure. A mixture of harvested and milled autogenous bone and bone substitutes can be used. Once the necessary volume is achieved, the material is covered with a resorbable membrane. Then, the flap must be adapted and sutured. The sutures are normally removed between the 10th and 14th days following the surgery. After six to eight months after the operation, the implants can be placed in this area.

In the case of perforation, an absorbable oxidized cellulose gauze (Gelita-Cel Standard, Gelita Medical GmbH, Eberbach, Germany) moisturized with Dicynone 250 mg/2 mL (Sanofi Winthrop Industrie, Paris, France) was placed underneath. A PRF membrane is applied as the second layer, and then, as the third layer, a slow-resorbable collagen membrane is placed. At that point, the surgery continues with the placement of bone substitute material, and the surgery is finalized according to the protocol selected.

Results. The current study included 18 cases: 12 males and 6 females. Twenty sinus floor elevations were performed. In two cases, sinus floor elevation was performed bilaterally; in the other 16 cases, unilaterally. The patients were aged between 37 and 58. During the surgery, in four cases (20%), a perforation of the Schneiderian membrane was found. In cases where a perforation occurred, the clinical approach was to apply a protocol with a three-layered conservative closure of the perforation, as described above. As postoperative medications, amoxicillin (875 mg) and clavulanic acid (125 mg) were prescribed twice daily for 7 days, along with a 0.12% mouth rinsing solution of chlorhexidine. In the cases of repaired perforation, additional therapy with Metronidazole (3×250 mg for 5 days) was prescribed, as well as a 0.118% solution of Muconasal Plus (Opella Healthcare, France).

In all cases, the postoperative period passed without complications. In the cases with perforation, due to the applied conservative approach, neither clinical nor radiological signs of an inflammatory process in the sinus were present. The implant placement was postponed for the second surgical stage, eight months after the sinus floor elevation.

To illustrate the clinical protocol used, one of the cases with Schneiderian membrane perforation is described below. The patient, N.S., a female aged 42,

seeks help from our clinic regarding the restoration of the missing teeth on both sides distally in the upper jaw. From the clinical and radiographic examinations, it was found that the existing teeth (13, 11, 21, 23, 24, and 25) were stable and suitable for tooth-supported fixed prosthetic restorations. In the edentulous distal area, a sufficient quantity of keratinized mucosa was available. A CBCT was made to assess the quality and quantity of the remaining bone structure in relation to the sinuses. The available bone height was between 3.97 and 5.97 mm on the right side and between 2.15 and 5.30 mm on the left side (Fig. 1).

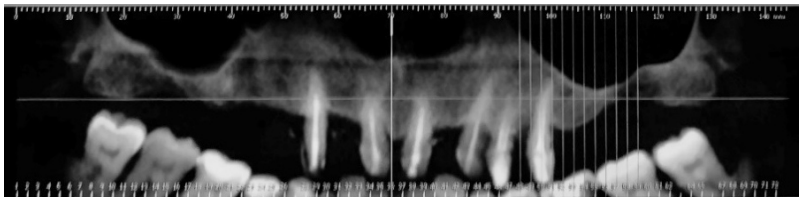


Fig. 1. Initial CBCT (cone-beam computed tomography) examination of the maxilla. Sufficient bone atrophy in the distal parts of the jaw was detected bilaterally. The available bone height in the examined area is insufficient for implant placement

The patient was informed that a sinus floor elevation is necessary if implant therapy is chosen for the restoration of the missing premolars and molars. The surgical procedures were performed under local anesthesia and sedation. Bilateral sinus floor elevation was performed consecutively, first on the left and then on the right side. A trapezoid-shaped mucoperiosteal flap was raised from the first left premolar to the tuberosity area. The anterior sinus wall on the left was exposed. The bone window in the area above teeth 26 and 27 was prepared using a piezosurgery device (Piezosurgery Touch, Mectron s.p.a., Italy). The sinus membrane was carefully elevated below, sideways, and then upwards. The sinus floor was visualized, and a resorbable membrane was inserted under the sinus mucosa. A resorbable bone substitute was inserted. The bone graft was covered and protected using a resorbable membrane that was fixed with a titanium pin. The flap was mobilized, adapted, and sutured using 5/0 Vicryl (Johnson & Johnson Medical N.V., Belgium). On the right side, the operation was conducted in the same way. Despite the careful manipulation, a perforation occurred during the elevation of the sinus membrane (Fig. 2A). The membrane perforation was covered with several layers. As a first layer, a hemostatic stripe of Gelita-Gel was applied and moistened with Dicynone (Fig. 2B). As a second layer, a PRF membrane (Fig. 2C) was prepared in a centrifuge from the preliminary blood taken from the patient, and a third layer consisting of a resorbable collagen membrane was placed. The bone grafting material was inserted, and the alveolar ridge was modelled. The bone graft was covered with a resorbable membrane and stabilized using titanium pins (Fig. 2D). The flap is then mobilized, adapted, and sutured using 5/0 Vicryl.

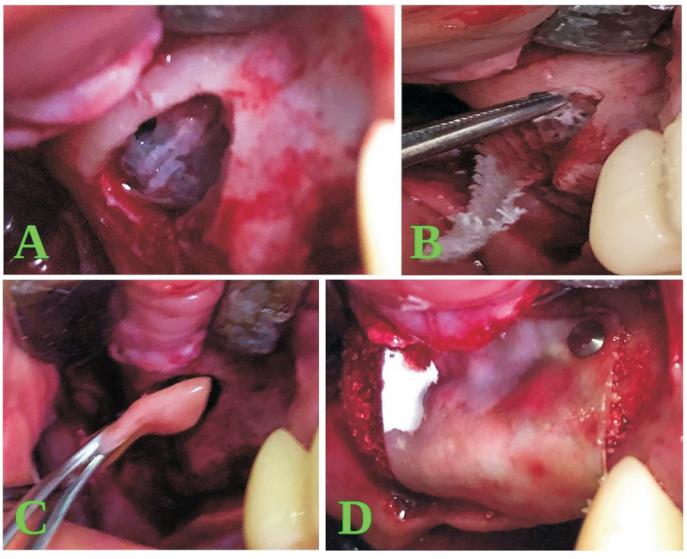


Fig. 2. Fixing of the perforation of Schneiderian membrane: A. Sinus membrane perforation; B. Placement of the hemostatic stripe; C. Insertion of a PRF membrane below the hemostatic dressing; D. Covering of the lateral bone window with a resorbable collagen membrane and its fixation

A medication with Amoxicillin 875 mg and Clavulanic Acid 125 mg twice daily for 7 days, along with 2×1 tablets of Kalcikinon for 30 days, as antibacterial and hemostatic therapy, was prescribed. The postoperative period passed without complications. The sutures were gradually removed in two steps — on the 10th and 14th days after the operation. CBCT was performed eight months later, and it was found that the bone had been successfully augmented and the desired bone volume had been achieved (Fig. 3). The height of the alveolar bone on both the left and right sides is eight to ten millimeters. Two implants were placed on the right (in the area of the teeth 14 and 16) and two implants in the areas of 25 and 27 (Fig. 3).

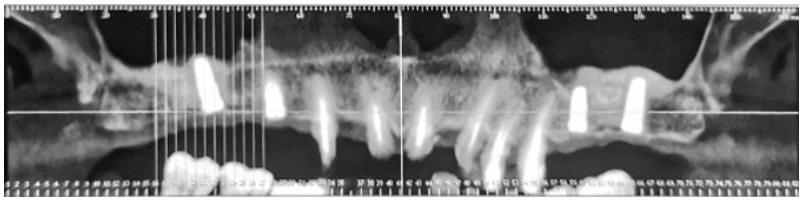


Fig. 3. CBCT following implant placement: The maxillary sinuses are free of inflammatory changes. The exact implant positions are shown, as is the increased available bone height of the grafted area

The consistency of the bone grafting material on the right side was softer than that on the left side. The bone density was found to be lower in the areas where

perforation occurred. This was also confirmed in other patients with perforations. The disturbed vascularization in the area of perforation most likely reduces the concentration of osteogenic factors of the Schneiderian membrane in this area. The latter causes the healing process and substitution of the bone graft with bone tissue to be delayed on the side of the perforation.

Discussion. Tearing of the Scheiderian membrane, hemorrhage, migration of the graft, and infection are the most common maxillary sinus graft problems [7, 8, 13]. Various factors, such as recessions, high septa in the sinus cavity, and an uncareful surgical elevation technique, can cause perforation during surgery [3, 5, 6]. To the best of our knowledge, there is no study relating to the preliminary assessment of the elasticity of the Schneiderian membrane. It is known that the sinus membrane is fine and delicate, with an average thickness of 0.5–0.13 mm [9]. It entirely covers the sinus cavity and consists of pseudostratified epithelium with minor salivary glands on its surface. During its elevation from the bone walls, it vibrates coherently with respiratory movements through the nose. This phenomenon allows us to establish its integrity or perforation. The most frequent location for sinus membrane perforations is near the bone window edge. Their recovery requires careful separation from the surrounding bone. The attempts to suture directly pose a risk of perforation, causing an enlargement of the opening [6, 16] due to poor visibility and limited access. Therefore, in many cases, it is appropriate to apply a more conservative approach by covering the perforation with an absorbable collagen membrane, or PRF. The collagen membranes can reduce the osteogenic properties of the Schneiderian membrane due to their dense structure [4], as well as a reduction in achieved bone volume [10]. The reduced bone density found in the cases described above is fully consistent with those data. Simunek et al. [17] have reported the successful management of membrane perforations using a strip of oxidized, regenerated cellulose saturated with blood, which converts into a gelatinous mass, forming a tight and mechanically resistant seal. With successful repair of the sinus membrane, the success rate of the operation is similar to that in cases without perforation. The latter applies to small defects, from five to ten millimeters. Barbu et al. [16] reported a success rate of 84% after suturing the perforation and, respectively, 93% when it is covered with a collagen membrane. Similar data were published by Kim et al. [7] (91%), and Díaz-Olivares et al. [5] (97.7%). With defects larger than ten millimeters, cases with successful augmentation are significantly fewer—74.14% [7]. The higher success rate found in our cases can be explained by the three-layer covering of the perforation. This method does not allow the passage of even a minimum amount of bone substitute material into the maxillary sinus and creates conditions for a safe healing process.

Conclusion. The precise application of the steps of the lateral sinus floor elevation contributed to the successful elevation of the Schneiderian membrane in 16 cases. In four cases, the perforation that occurred was treated using conserva-

tive approaches and the described 3-layer protocol. This protocol presents several advantages over attempts to suture the membrane that risk ending in further enlargement of the perforation. The bone substitute in the areas where perforation occurred presents delayed healing compared to areas where the sinus membrane integrity was preserved, which is clinical proof of the osteogenic potential of the Schneiderian membrane. Therefore, in cases of perforation, simultaneous implantation is not recommended. The clinical and radiographic data following the application of this protocol provide excellent results in cases where perforation of the sinus membrane has occurred.

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