

Management of the Schneiderian membrane perforation during the maxillary sinus elevation procedure: a case report

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Summary

The maxillary sinus elevation is a standard and predictable procedure allowing the realization of dental implant rehabilitation in patients with severe bone atrophy in the lateral-posterior areas of the maxilla. Despite the presence of validated surgical methods and the broad availability of biomaterials, the procedures aimed at increasing the bone volume by lateral antrostomy still entail complications with different degrees of relevance. The prosthetic and surgical outcome is based on a successful coping with these aspects. The perforation of the Schneiderian membrane is one of the most frequent events for which a variety of protocols and approaches have been suggested by different authors. In this work is presented a case study in which a technique to repair the sinus mucosa laceration occurring during a maxillary sinus elevation procedure has been successfully adopted.

Key words: Schneiderian membrane, maxillary sinus augmentation, sinus lift complications, underwood septa.

Introduction

Nowadays, the rehabilitation by prosthetic implants, even in edentulous areas of the maxillae affected by severe bone atrophies, is an inescapable need leading

to the development of standardized, predictable and safe regenerative techniques (1,2). The maxillary sinus elevation is a surgical procedure that increases vertically the available bone volume on the lateral-posterior areas of the maxilla giving the possibility to place osseointegrated implants (3,4). Thanks especially to the ample indications from the literature (1-4), this procedure represents an excellent potential for the resolution of the bone atrophies associated to edentulism. Nevertheless, such kind of intervention is still characterized by complications, often predictable and yet unavoidable, posing limitations to its successful application (5-8). The most common adverse events reported are: i) haemorrhage, mainly due to lesions of the intramural artery, an anastomoses between the infraorbital artery and the posterior superior alveolar artery, frequently localized on the site in which the surgeon makes the bone window to reach the antral cavity; ii) laceration of the Schneiderian membrane, usually occurring with a range of incidence comprised between 7% and 35% of cases (9-11). The latter may occur during different phases of the procedure: during the preparation of the antrostomy, while removing or turning over the bone window, during the membrane raising or upon grafting. Moreover, there are some anatomical risk factors, like: Underwood's septa, which are bony walls partitioning the sinus, usually with a vertical progress; the angle between the buccal and palatal walls of the antral cavity, as analyzed on perpendicular tomographic sections, especially when below 30°; irregularities of the sinus floor due to the protrusion of the root profiles; previous sinus surgery; a decreased height of the residual alveolar ridge. Since discontinuities in the Schneiderian mucosa impair the functional homeostasis of the antral cavity and negatively affect the surgical outcome by bacterial contamination of the graft and dispersion of the particulate, several authors have studied and suggested specific repair techniques for each type of perforation (12-16).

Schneiderian membrane perforation: predisposing factors, classification and management

The maxillary sinus elevation is a standard and predictable surgical procedure to rehabilitate severe vertical bone atrophies in the lateral-posterior areas of the maxilla by placement of osseointegrated implants (6,8,17-22). However, it is known that complications like haemorrhage and perforation of the Schneiderian membrane may affect negatively the outcome of such procedure. In most reported cases, intra-operative bleeding is due to the lesion of the anastomoses between the infraorbital artery and the posterior superior

alveolar arteries at an average distance of 19 mm from the apical ridge, with a tendency to superficialize in conditions of marked bone resorption. Such localization often coincides with the area where the antrostomy of access to the sinus cavity is carried out (9-11,14).

However, the most frequent unfavourable event associated to such intervention is the laceration of the sinus mucosa. Such event is often predictable, but not avoidable, since it is strictly associated to anatomic-pathological predispositions (23-26). In the literature, the following predisposing factors have been identified: previous phlogistic processes, irregularities of the sinus floor, e.g. due to root protrusions, thickness of the membrane below 1,5 mm, limited expansion of the anterior recess, angle between buccal wall and socket below 30°, former surgical treatments, reduced height of the alveolar ridge (27-34). In particular, the Underwood's septa, present on average in 31% of the maxillary sinuses with a height of about 8 mm (range 3,5-2,2 mm), can involve all areas of the sinus. Usually they are partial, they run vertically in buccal-palatal direction and are higher at the level of the medial wall; more rarely they are multiple within the same antrum (8,24-26,29,35-37).

The laceration of the sinus mucosa affects negatively the surgical outcome by increasing the risk of iatrogenic sinusitis, impairment of functional homeostasis and dispersion of the graft material in the antral cavity as well its bacterial colonization (38-40). Among several possibilities of repair of the perforation, as reported in the international literature (8,19,20,41-45), we refer here to the study of Fugazzotto and Vlassis (2003), which classifies the lesions of the sinus mucosa in relation to size and position and associates to each class a specific therapeutic indication (46). Class 1 identifies the perforations below 5 mm in size that extend to the upper border of the antrostomy, for which it is simply required a further detachment of the membrane to allow the seal of the lesioned flaps (46,47); class 2A describes lacerations located at the borders of the osteotomy, delimited from at least 4-5 mm of intact tissue, with the suggestion to enlarge the limits of the bone window and to apply a resorbable membrane in case of failed sealing of the margins of the perforation (46-49); classes 2B and 3 correspond respectively to lacerations that develop laterally from the antrostomy, delimited by less than 4-5 mm of intact tissue, and to central lesions, often preexisting and determined by former dental avulsion or oroantral fistulae. These latter can be managed with the same treatment, known as modified Pouch Technique (46-49).

The original technique, known as "Loma Linda Pouch", consists in covering the whole sinus with a collagen membrane simulating the natural membrane, and the graft material is completely covered in its centre by folding the membrane on the lateral wall. However, in this manner, an external barrier is created that totally isolates the biomaterial from the blood supply coming from the walls of the sinus, thus representing an obstacle to the maturation of the graft and the recovery

process (46-49). In the modified method, the cover of the sinus walls is still carried out with the support of a resorbable membrane located only on the surface of the Schneiderian membrane, leaving the bone walls free so that the blood supply from the bone can favour the vascularization and thereby the integration of the graft into this virtual space. Moreover, in such technique the resorbable membrane is fastened at the superior border of the antrostomy through titanium or surgical steel pins before being reinserted in the sinus cavity; a second membrane is positioned on the antrostomy externally, to further protect the biomaterial (46). It has been demonstrated that the protection of the osteotomic window increases implant survival if some prerequisites are respected: membrane stability, sterility and optimal cohesion, compactness and handiness of the graft material (1,6,50-62).

Case report

The reported clinical case has been managed in collaboration with the Departmental Unit of Odontostomatology and Maxillo-Facial Surgery of the San Camillo Forlanini Hospital (Rome, Italy). The patient (female, 45 years old) asked for a functional and aesthetical rehabilitation of the lateral posterior area of the right emi-maxilla. Personal anamnesis excluded the presence of pathologies contra-indicating the implant rehabilitation as well as attitudes such as smoking. The physical exam and the radiographic evaluation (orthopantomography) highlighted the presence of root residuals 1.4, 1.6 and of the element 1.8 compromised for periodontal evaluation (Fig. 1). In order to proceed in the best conditions such elements have been extracted. After four weeks the mucosae upon the post-extractive sockets were perfectly recovered. The anatomical state, according to Chiapasco's classification, was attributed to class A in the area of element 1.5 and class C in the molar region (5). The individual prosthetic plan pointed towards the choice of an implant supported cemented fixed prosthesis, following optimization of the sites through surgical procedure of lateral maxillary right sinus



Figure 1 - Pre-operative orthopantomogram.

elevation. The intervention was carried out in day hospital. Four block anaesthesias were executed at the level of the superior posterior alveolar nerve, the major palatine nerve, the infraorbital nerve and the nasopalatine nerve, and one anaesthesia by infiltration of the fornix and the palatine mucosa (articaine 4% and vasoconstrictor 1:100.000). Thereafter, a trapezoidal mucoperiosteal flap with linear main incision between distal margin 1.3 and area 1.7 has been set up, together with divergent release incisions extended 5 mm beyond the mucogingival line. The flap has been opportunisticly detached and folded down to highlight the maxillary bone surface. The antrostomy, of rectangular shape with round corners and approximate size of 20 x 15 mm, has been carried out with piezoelectric devices. The detachment of the membrane was initiated with piezoelectric devices and terminated with manual devices. Despite the absence of evident anatomical abnormalities and the accuracy of the surgical procedure, a perforation of the Schneiderian membrane of about 8 x 6 mm occurred (Fig. 2).

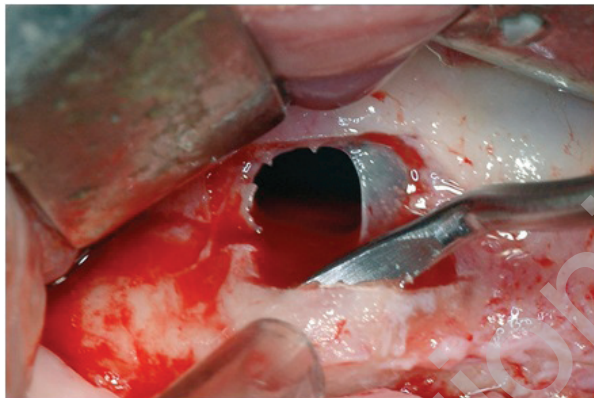


Figure 2 - Maxillary sinus membrane perforation

Following the suggestions of Fugazzotto and Vlassis, we chose to continue with the procedure and decided to repair the lesion through the modified Pouch Technique (46). A resorbable membrane of freeze-dried bovine pericardium (Tutopatch, Tutogen GmbH) was modelled and blocked with titanium pins above the superior border of the antrostomy and was then folded in the



Figure 3 - A resorbable membrane of freeze-dried bovine pericardium positioned according to modified pouch technique.

inner part of the sinus to for the graft containment (Fig. 3). According to the suggestions of several authors (11,50,51,53,54,60,62,63) we used as filler a compact and consistent material in order to avoid the dispersion of particles in the sinus and thereby the possibility of phlogistic processes due to bacterial colonization of the graft. The material is a human-derived bone paste in blocks, called Bioset, available on request in Italy at Rizzoli Orthopaedic Institute (I.O.R.), that is the Italian national public bank of the musculoskeletal tissue; this product contains demineralized bone matrix (DBM) and bone corticospongious particulate carried in a thermoplastic gel of suine collagen (Fig. 4).



Figure 4 - A human-derived bone paste in blocks, called Bioset, containing demineralized bone matrix (DBM).



Figure 5 - Plastic consistency and easy manipulation of Bioset.

The particulate component acts as a natural osteoconductive matrix at low resorbing activity, the DBM allows the release of morphogenetic proteins, preserved by a peculiar sterilization process undergone by the material (BioCleanse®), while the carrier confers consistency and easy manipulation: it is preserved at -20°C for 6 months or at -80°C for 5 years and it becomes plastic, malleable and adhesive when warmed in hot water in its sterile package up to a temperature between 43°C and 49 °C, while becoming stable in size and consistency at body temperature (Fig. 5). We have compacted only 2 cc of bone paste internally (Fig. 6), since overfilling has been shown to be responsible of

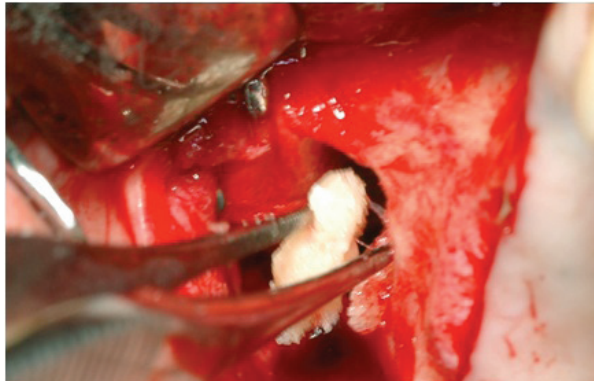


Figure 6 - Maxillary sinus filled with Bioset.

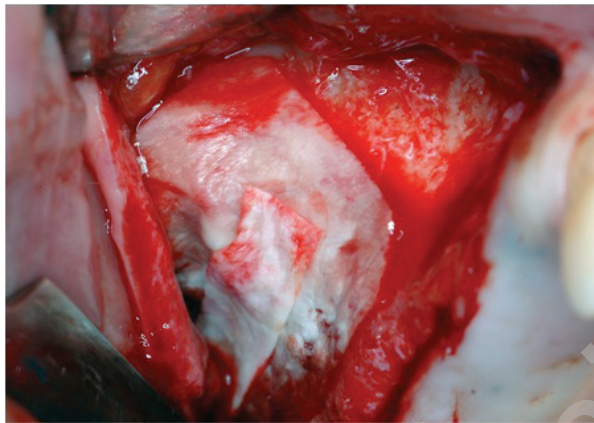


Figure 7 - A second resorbable membrane applied above the antrostomy.

the necrosis of the sinus membrane with dispersion of material and chronic sinusitis; thereafter, a second resorbable membrane above the antrostomy has been applied (Fig. 7). Finally, mattress suture horizontal with non resorbable monofilament was carried out.

The patient underwent antibiotic, analgesic and anti-edemic therapy for seven days. After six months the case has been evaluated clinically and radiographically. We could ascertain complete recovery of the tissues, integration of the graft and absence of phlogistic complications. We therefore proceeded with the placement of three implant fixtures of conic shape, diameter 4,5 x 12 mm, and one of 4,5 x 10 mm sand blasted and acid etched (TiRADIX s.r.l.). During the preparation of the sites of implant a bone biopsy was performed with a trephine bur (internal diameter of 2 mm). The sample was fixed by buffered formalin, stained with hematoxylin-eosin and observed at the optic microscope (40x). The sections showed the presence of lamellar bone tissue with osteocyte lacunae (Fig. 8). Some lacunae appeared without cells, separated by fibro-vascular tissue containing amorphous material. We noted lamellar bone in development, deposited in proximity of young trabeculae. The active process of bone rearrangement was highlighted by the presence of osteoclasts and osteoblasts (courtesy of Prof. G. Soda, Department of Experimental Medicine, Sapienza

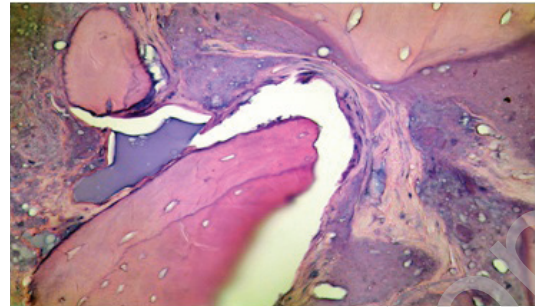


Figure 8 - Histology of bone neoformation at six months after sinus lift (40x, H&E).

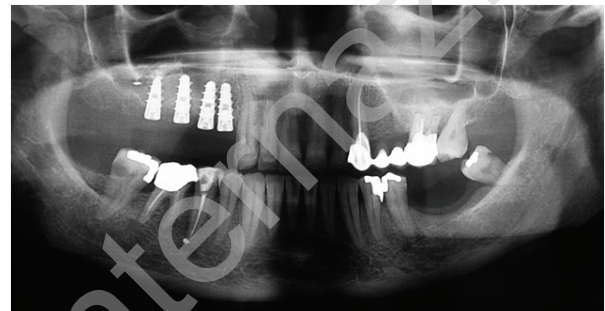


Figure 9 - Orthopantomogram at six months after implants placement

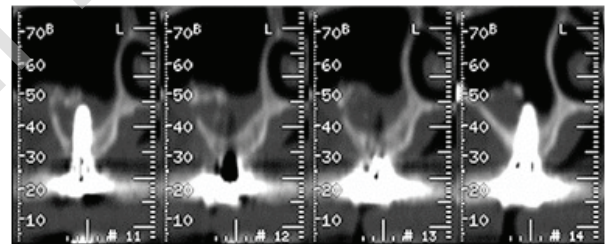


Figure 10 - Paraxial views of TC dentaScan at one year after prosthetic rehabilitation.

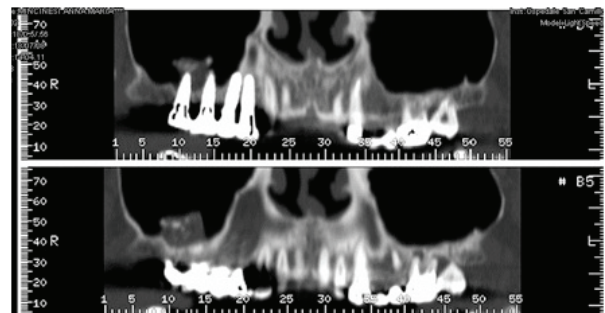


Figure 11 - Panoramic views of TC dentaScan at one year after prosthetic rehabilitation.

University of Rome).

The orthopantomographic radiography and TC exam with the specific software dentaScan (Figs. 9, 10, 11), performed one year after prosthetic rehabilitation, show the reorganization of the hard tissues in the antrum

and around the fixtures. The case was subsequently rehabilitated with a cemented metalloceramic fixed prosthesis. The clinical result appeared aesthetically and functionally satisfactory also two years after dental implant surgery (Fig. 12).



Figure 12 - Clinical result at two years after implant surgery.

Conclusions

The maxillary sinus elevation is a surgical standard and highly predictable procedure allowing the positioning of osseointegrated implants also in case of serious bone atrophy of the maxilla (8,64). However, this procedure is not devoid of complications. The most frequent is the perforation of the Schneiderian membrane, occurring in 7-35 % of cases. The factors affecting such incidence are often anatomical (8-11,24-26,28,36,37). Despite accurate pre-surgical radiographic investigations, in some cases the laceration is unavoidable even when the surgical manoeuvres are performed at best (17,21,22,27,30,32-34). In the past some authors suggested stopping the procedure in case of perforation and postponing it after recovery (44). Despite Hernández-Alfaro demonstration of an inverse relationship between the size of the laceration and the implant survival, it is currently not suggested to interrupt the surgical procedure (29). In the reported clinical case the repair of the Schneiderian membrane allowed a radiological, clinical and histological success. Therefore, the evolution of biomaterials currently available and the standardization of the techniques allow a higher predictability of success and extend the applicative possibilities of such procedure.

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