

COMPLICATIONS OF MAXILLARY SINUS AUGMENTATION

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Abstract: Introduction: Maxillary sinus augmentation for implant reconstruction of the posterior maxilla is a predictable procedure which needs to fulfil certain criteria in order to get optimum results. A preoperative evaluation methodology, including a careful selection of patients is very important for the success rate of this type of surgery. The factors that should be taken into account include osteomeatal complex permeability and functional paranasal sinuses. A good surgical technique is essential, including the management of complications. Implant failure, especially after several years, usually indicates an inadequate or poor dispensary treatment plan. The objective of this study is to demonstrate that immediate complications depend heavily on the intraoperative manipulation technique of the implantologist, the instruments used, and when they occur, the treatment is successful if an appropriate surgical and medical treatment is considered. Well treated complications will ensure a high rate of success and a very good long term result. Materials and methods: The resulting data were gathered through statistical analysis of 110 sinus augmentation interventions performed on 79 patients (mean age 49 years old (25-65)), with 342 implants in function for a minimum of 3 years. Preoperatively and postoperatively, OPT examination was mandatory for all patients, while the most difficult cases were examined by computed tomography (CT). Long-term success rates are of 90-97%. By using the autogenous bone or allografts combinations, alloplaste, xenografts and autogenous bone all led to similar results. The survival rate of implants assessed at inclusion and after a successful load was compared between: different augmentation materials; smokers / nonsmokers; presence or absence of intraoperative complications; immediate / delayed insertion of implants. Results: Smoking was considered a relative contraindication in this study, although smoking is considered by some surgeons an absolute contraindication. We encountered perforations of membranes especially due to a partial septum and after trimming the sinus membrane, but the holes were not large, being able to continue the intervention with good results both, immediately and after the prosthetic work. We had an infection in 2 (of 45) patients who were smokers, after receiving a sinus graft, consisting of granular bone and resorbable membrane. We achieved higher success rates in non-smoking patients (82.7%) than in smokers (65.3%). Thus, we concluded that smoking affects the success rate of osseointegration of implants for sinus augmentation, regardless of the number of cigarettes smoked per day. Maxillary sinus grafting has become a common technique for site development and implant reconstruction. We achieved excellent success rates for sinus grafting and implant insertion in both protocols with a single step, and those in two stages. Although the predictability and success rates are very good, there were some cases in which complications occurred.

Cuvinte cheie: complicații imediate în tehnica sinus lift, complicații tardive, sinus lifting, augmentare osoasă

Rezumat: Introducere: Augmentarea sinusului maxilar pentru reconstrucția implantară a maxilarului posterior este o procedură predictibilă care necesită îndeplinirea unor anumite criterii pentru a obține un rezultat optim. O evaluare preoperatorie metodică, incluzând selectarea cu atenție a pacienților, este foarte importantă pentru rata de succes a acestui tip de intervenție chirurgicală. Factorii care trebuie analizați includ permeabilitatea complexului osteomeatal și sinusuri paranazale funcționale. O bună tehnică chirurgicală este esențială, incluzând managementul complicațiilor. Eșecul implantelor, mai ales după câțiva ani, indică de obicei un plan de tratament inadecvat sau o dispensarizare deficitară. Obiectivul acestui studiu este de a demonstra faptul că apariția complicațiilor imediate depinde foarte mult de tehnica de manipulare intraoperatorie a implantologului, de instrumentarul utilizat, iar atunci când apar, tratamentul este unul de succes dacă se are în vedere un tratament corespunzător chirurgical și medicamentos. Complicațiile bine tratate vor asigura o rată mare de succes și un rezultat pe termen lung foarte bun. Material și metodă de lucru: Datele rezultate au fost culese în urma analizei statistice a 110 intervenții de augmentare sinusală realizate pe 79 de pacienți (cu vârsta medie 49 ani (25-65)), cu 342 de implanturi în funcție pe o perioadă de minim 3 ani. Examenul OPT preoperator și postoperator a fost obligatoriu pentru toți pacienții, iar cazurile mai dificile au fost examinate prin computertomograf (CT). Ratele de succes pe termen lung sunt de 90 –

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97%. Folosirea osului autogen sau combinații de allogrefe, alloplaste, xenogrefe și os autogen au dus toate la rezultate similare. Rata de supraviețuire a implanturilor evaluată la momentul integrării și după o încărcare reușită, a fost comparată între: diferite materiale de augmentare, fumători/nefumători, prezența sau absența complicațiilor intraoperatorii, inserția imediată/tardivă a implanturilor. Rezultate: Fumatul a fost considerat o contraindicație relativă în cadrul acestui studiu, cu toate că, fumatul este considerat de către unii chirurși a fi o contraindicație absolută. Am avut perforații ale membranelor cu precădere atunci când am avut un sept parțial iar în urma decolării membranei sinusale aceasta s/a perforat, însă perforațiile nu au fost mari, reușindu-se continuarea intervenției cu rezultate foarte bune atât imediate cât și după protezare. Am avut infecții la 2 (din 45) pacienți care erau fumători după ce au primit o grefă sinusală, constând în os granular și membrană resorbabilă. Am obținut rate de succes mai mari la pacienții nefumători (82,7%) decât la cei fumători (65,3%). Astfel am concluzionat că fumatul afectează rata de succes a osteointegrării implantelor în cazul augmentării sinusale, indiferent de numărul de țigări fumate pe zi. Grefarea sinusului maxilar a devenit o tehnică uzuală pentru dezvoltarea site-ului și reconstrucția implantară. S-au obținut rate de succes excelente pentru grefarea sinusală și inserarea implantelor atât în protocoalele cu o singură etapă, cât și pentru cele în două etape. Cu toate că predictibilitatea și rata de succes sunt foarte bune, au existat anumite situații în care au apărut complicații.

Preoperative assessment

Like in any other surgery, a careful selection of patients increases predictability and success. In our study, as well as in other analysed studies, **absolute contraindications** of the technique include: acute sinusitis; allergic rhinitis; relapse of acute exacerbation of chronic sinusitis; any metabolic disorder that affects the jaws; immunosuppression; presence of maxillary neoplasms.

In addition, any odontogenic cyst, periapical or radicular was removed preoperatively.

The relative contraindications of the sinus graft included some medical conditions which, if left unchecked, can lead to a compromising result, such as the presence of mucocoele in the maxillary sinus, which can generally be ignored, but in our case the treatment of these affections has been accomplished simultaneously with maxillary sinus augmentation.

The evaluation of the patient before an implant reconstruction intervention in the posterior maxillary area included a careful clinical evaluation of maxillary sinus. Radiographs - orthopantomography (OPT) and computed tomography (CT) show the anatomy of the alveolar ridge, intermaxillary relations and valuable information necessary for the placement and the optimal choice of implants.

A physical examination of the maxillary sinus evaluates the infraorbital areas, lateral nasal and the upper lip; there may be tenderness, swelling, asymmetry or bruising. We also assessed the presence of nasal congestion and the presence or absence of epistaxis. Acute sinusitis, allergic or chronic was diagnosed based on the patient's history and clinical evaluation. Generally, symptoms are not specific and include allergic rhinitis. The patient usually complains about a throbbing pain in the maxillary sinus, headache, edema and erythema in the infraorbital area. Although chronic sinusitis has a long evolution (more than 3 months), the symptoms are similar to those of acute sinusitis. Exacerbated chronic sinusitis, acute sinusitis and allergic rhinitis were treated before sinus augmentation surgery. All these diseases share a bacterial etiologic factor leading to the obstruction of osteomeatal complex. The blockage of the normal drainage of mucus from the middle meatus in the posterior nasopharynx may lead to an infection of the sinus graft. These patients were treated with antibiotics, steroids and in some cases even surgery to recover the ostium before grafting.

The preoperative assessment of maxillary sinus pathology included imaging investigations, such as radiographs and CT. Although most of the times, CT is not considered to be compulsory, it was appropriate. For the evaluation of the nasal disease and paranasal sinuses and for the detection of benign or

malignant tumours of the maxillary sinus, CT remains the investigation method of choice. On top of that, it has been revealed any periapical cyst, radicular and odontogenic which is extending in sinus and has not been revealed by radiography. Permeability of the osteo-meatal complex, especially in the presence of mucous cysts is important as it is assessed preoperatively by CT scan. In the maxillary sinus, a variety of mucous cysts may be encountered. Pseudocysts and cysts with mucus retention found in the studied cases, contribute to the thickening of the lining and sometimes sealing the osteomeatal complex after lifting the membrane, leading ultimately to graft infection in some clinical situations. In general, the patients with symptoms of acute sinusitis, chronic sinusitis, allergic rhinitis, neoplasms or cysts, underwent several investigations before sinus augmentation surgery. Pseudocysts, cysts with mucus retention and mucocoele were often treated simultaneously with sinus augmentation.

Intraoperative complications

During sinus elevation surgery, there were some complications. Bleeding was controlled by cautery. Great care must be taken not to damage the mouth flap, which can lead to oro-antral fistula. Careful handling of the flap mouth with good surgical technique will prevent any potential complications. The damage of the infraorbital vascular-nervous package can be caused by the excessive dissection of the mouth flap in order to remove the tensions. It can be caused by trauma while holding the dispenser exercised directly on vascular-nervous package. This injury causes transient feeling of loss of sensitivity of the wing side of the nose, infraorbital region and upper lip regions. The prevention of these injuries requires a very good and careful surgical technique. Punching of the membrane was the most common intraoperative complication associated with maxillary sinus augmentation. During sinus grafting procedure, the sinus membrane should be elevated higher to allow the insertion of the graft below. Sinus membrane is formed by pseudostratified cells, ciliated and cuboid, and has a size varying between 0.3 and 0.8 mm. Because it has very few elastic fibres, sometimes its elevation can be a challenge. Ideally, the membrane is not perforated and allows the insertion of the bone graft below it. In practice however, the perforation of the sinus membrane has been seen in about 7 to 12 % of the cases during elevation. The perforation of the sinus membrane has also been caused by previous interventions over the sinus or it happened during the drilling of the bone window.

When the perforation occurred during the surgery, we have proceeded with the elevation of the membrane in the straight opposed direction rather than in the direction of the rupture in order to prevent an even greater tear. The elevation

has exposed the bone floor as well as the medial, posterior and anterior wall of the maxillary sinus. The small ruptures (less than 5 mm) have been quickly solved by placing a rapidly resorbable collagen membrane over the opening. The larger ruptures together with the complete perforation of the membrane needed the use of a more rigid collagen membrane with longer absorption time. A larger rupture has been caused by the presence of a thin membrane or due to overinstrumentation, as well as due to the presence of the partial septum; sometimes, the rupture has been done on purpose to remove an existent pathology. When a very thin membrane is uncovered (about 0,3mm), despite the greatest care in handling, it can lead to perforation. Most of the clinicians would abandon the grafting intervention and would wait for 6-9 months for the regeneration of the membrane, we however, have proceeded with the grafting intervention and implant insertion. There is the same risk when the large cysts or the polyps have the potential to obstruct the osteo-meatal complex during the membrane elevation. The reopening of the sinus after a previously delayed procedure due to the perforation of the graft, due to failure, existing pathology or a thin membrane, might be difficult.

Even with the loss of an important part of the sinus membrane, it has not been necessary to cease the augmentation surgical intervention. In exchange, we have used a hemostatic, biocompatible membrane (6-8 weeks) to create a barrier which could protect the graft. According to the medial-lateral dimension, this membrane can be used with or without fixation. The greater the medial-lateral dimension, the higher the need to fixate the collagen membrane. In all these cases, the permeability of the osteo-meatal complex has been checked before and after the surgery with the help of the CT scans.

Because the infection rate increases once the membrane is perforated, we have avoided the sinus augmentation and the implant placement in the presence of a great perforation of the membrane. We have preferred to wait at least 4 months for the graft to heal. In general, the perforation of the membrane may lead to long-term or short-term complications due to bacterial contamination. The migration of the graft is one of the possible complications highlighted by the bone granules present in the ostium or the pharynx. The inflammation of the mucosa after sinus augmentation surgery may lead to the obstruction of the osteo-meatal complex, thus increasing the risk for infection. Some authors recommend the use of bone blocks instead of bone particles for perforations greater than 5 mm. Keller et al. sustain that an intact membrane is not critical for the cortical-spongy grafting technique. Jensen et al. have not discovered any infection in the patients treated with selfgrafts even if the perforation rate of the membrane was of 35%.

The presence of a septum in the maxillary sinus has led to an increased rate of membrane perforation. Even if the septum may be distinguished on X-ray, Ulm et al. conclude that the panoramic X rays can lead to a false diagnosis based on the positive or negative identification of an antral septum in 21,3% of the cases. For these reasons, CT scans are recommended for the accurate identification of the septum. Both transillumination, as well as instrumental percussion can be used for the identification of the antral septum during the surgery. Normally, the membrane is thinner in the septum area leading to a perforation during the elevation. By modifying the direction of the bone window by splitting the window in 2 or even 3 areas (depending on the number of septi), even if additionally the vertical bone is cut, this will ease the infrastructure of each separated window. Despite the associated problems with the perforation of the membrane, the septum offers certain advantages for the sinus augmentation.

1. Firstly, it creates more bone walls in the sinus and leads to an increase in the available bone surface for osteogenesis.
2. Secondly, the septum limits the bone graft much easier.
3. Thirdly, the basis of the septum ensures excellent bone stability for the simultaneous placement of the implants.

The obstruction of the osteomeatal complex may arise when the grafting material is excessive, thus preventing the normal flow of the mucus between the middle meatus and the nasopharynx. As it is recommended, we have used the grafted material in a limited amount. Normally, the purpose was to place the grafting material at about 20-25 mm from the sinus floor. Instead, an insufficient grafting material has excluded the simultaneous placement of the implants or their longevity, which led to a new surgical intervention 6 months after the sinus augmentation. The medial wall is an area in which there is frequently placed insufficient grafting material when the elevation of the membrane towards this wall is insufficient. Another area, in which the placement of the grafting material is generally insufficient, is the anterior wall which can easily be forgotten. The initial grafting of the anterior wall is a procedure that many surgeons have developed precisely to prevent this problem just like we did in the presented study. In the necessary cases, we removed the compromised teeth neighbouring the sinus before the augmentation in order to avoid the potential bacterial contamination, waiting for a 2-3-month healing period before the sinus augmentation. The deterioration of the adjacent teeth has been rare and has been avoided through a precise and careful surgical technique. Incidents of loss of vitality of the neighbouring teeth as a result of the sinus augmentation have not been reported.

Immediate postoperative complications

The immediate postoperative complications occurred 7-10 days after the surgical intervention. Even if it is unusual, the opening of the incision line may appear as a result of the graft extravasation, infection or even the complete failure of the graft. This problem has been prevented by the use of an adequate incision line, as well as by the use of a proper suturing material. A complete maxillary prosthesis has been immediately placed if the buccal flap has been well sutured. The partial prosthesis can be used only if it is made of acrylic resin to allow adjustments according to the relief. The bleeding on the incision line is an uncommon phenomenon. The epistaxis is also uncommon and can be solved through a nasal compress. It has also been encountered the premature exposure of the membrane. When this phenomenon occurs, the site is treated as if the graft has failed. There have not been reported premature exposures of the membrane associated with the use of the collagen resorbable membrane.

The paresthesia of the paranasal lateral areas or of the superior labial ones is caused by the improper use of the retractor which causes lesions over the infraorbital nerve. Normally, this phenomenon is transitory (fades away after 3 weeks) although there have not been signalled cases in which the paresthesia period has been of months.

The infection of the grafted sinus, even if it is unusual, may occur 3-7 days after the surgery, however, during this study, there have not been such cases. Despite the postoperative antyprophylaxis, the postoperative infection may occur, sometimes it may lead to the complete failure of the graft. The intraoral swelling over the bone fenestration is the most frequently associated with the infection phenomenon. It appears 1 week after the surgery but it may also appear 3 days after the intervention. The antibiotherapy such as Clindamicine (600mg initial dose and then 300mg 4 times a day) is the election medicine. Metronidazol can also be added (500mg 3 times a day). Sometimes, the infection is restricted to a certain area and

will only respond to the antibiotic therapy. There have not been seen cases in which the symptoms would persist and which imposed an aggressive treatment including incision and drainage.

The delayed postoperative complications

The complications of the augmentation of the maxillary sinus which can appear 3 months after the surgery are very rare. Most of them appear when a one stage surgical technique is used with a two stage approach. The infection of the graft can be manifested as a dehiscence of the mucosa above the access window leading to the partial loss of the graft. The treatment of this situation consists in antibiotherapy followed by the incision and drainage using the initial incision line with an anterior oblique releasing flap. Such as in the case of the immediate postoperative complications, it is important that the tissues regain sensitivity. The debridement of the infected grafts should follow. If there is no active infection present, the regrafting can be done, otherwise a reintroduction of the graft can be done only 3-4 months later. The complete failure of the graft can also appear in these moments, requiring the complete removal of the graft, including the membrane. The reintroduction of the graft can be done 3-4 months later. If implants have been inserted, during the one stage technique, they must be removed along with the graft.

The oro-antral fistula may appear due to an infected graft, which needs closure through a variety of surgical means before the reintroduction of the graft. The failure of the implant can be given by the lack of osseointegration. The migration of the implant either immediately or late after the surgery, can be encountered if the bone volume is inadequate or if the bone density is not appropriate to the stabilization of the implants. Another cause of the implant failure is the insufficient load with bone graft particles leading to the lack of the membrane elevation. This can also happen if the recess of the anterior wall is not correctly grafted. The treatment consists of the reintroduction of the bone graft in these spaces.

The invasion of the grafting site by the connective tissue may appear if the membrane has not been used to cover the bone window. The resorbable collagen membrane on a long period of time solves this problem. The treatment consists of the reintroduction of the bone graft in the resulted space and of the debridement of the connective tissue.

The development of an operative epithelial cyst has been associated with almost any procedure which implies the sinus. This cyst has been first described by Kubo in 1927 and it is believed that it derives from the epithelial tissue which remains after the suture of the sinus. This cyst is known under a variety of names: postoperative maxillary cyst, postoperative buccal cyst, mucocell and paranasal postoperative cyst. The treatment is represented by the simultaneous and complete removal with the bone grafting of the sinusal cavity.

The chronic sinusitis should be treated postoperatively. In general, the chronic sinusitis is manifested through an excessively thick sinusal membrane and most of the times, it is necessary to completely remove the affected sinusal membrane. These patients are more prone to a persistence of the condition. Timmenga et al. have evaluated 45 patients with augmented sinuses for the sinusal pathology on a period of 12-60 months by using a questionnaire, a conventional radiographic examination and a nasal endoscopy. The results show a postoperative sinusitis in 2 out of 5 patients with a predisposition for sinusitis. Also, the reveal of the sinusal membrane has no connexion with the development of the postoperative sinusitis in the patients with healthy sinuses. They have concluded that the postoperative sinusitis seems to be limited in the patients with a predisposition for this disorder.

The chronic infection may appear after an initial infection of the graft leading to a persistent infection, refractory to antibiotics. This happens especially when there is a fungal infection. These patients must endure an aggressive treatment with intravenous medicine and surgical intervention. Finally, the chronic pain may appear secondary to the augmentation of the maxillary sinus, especially in the presence of the implants. Even if it is rare, this problem may persist and may lead to the removal of the implants.

Resuming those presented above, one can notice the fact that the consequences of the different accidents and complications of the sinus lifting procedures regarding the implant prosthetic treatment prognostic, are variable and depend on the type and etiology of the complication, as well as on the extension of the lesion. Within this context, it is essential to know the measures to prevent such complications in relation to:

1. The execution of all the necessary preoperative investigations;
2. The observance of the specific surgical principles for the sinus lifting;
3. The adequate postoperative technique;
4. The observance of the follow-up programme.

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