

VERSATILITY OF THE MAXILLARY SINUS APPROACH TECHNIQUES IN ORAL IMPLANTOLOGY

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Abstract: There is a variety of techniques for elevating the antral floor for the insertion of the dental implants, they all derive from the two great branches Caldwell-Luc (the approach of the sinus through the laterally wall and the osteotomy (through the crestal approach). There are more variants such as the hydraulic condensation of the sinus or the trepanation osteotomy technique.

Cuvinte cheie: sinus maxilar, tehnici de augmentare, sinus intern, sinus extern

Rezumat: Există o varietate de tehnici pentru elevarea planșeului antral în vederea inserării de implantate dentare, toate derivă din cele două ramuri mari Caldwell-Luc (abordul sinusului prin peretele lateral și osteotomia prin abord crestal). Există mai multe variante cum ar fi tehnica condensării hidraulice a sinusului sau osteotomia prin trepanare.

SCIENTIFIC ARTICLE OF THEORETICAL PREDOMINANCE

The history of the augmentation of the maxillary sinus

In the beginning of the 60', Boyne has published the first grafting technique of the maxillary sinus. It was done to the patients with pneumatized sinuses and insufficient interocclusal space for the restoration through complete maxillary prosthesis. Boyne has done sinus lifting, followed by the reduction maxillary tuberosities to create the necessary interocclusal space. The used technique was Caldwell-Luc: the osteotomy of the laterally sinus wall with the membrane lifting and the augmentation with the graft from autogenous bone fragments.

In 1980, Boyne and James were the first to describe the utilization of the autogenous bone as material for sinus grafting, with the aim to increase the posterior maxillary bone mass, for implant insertion, also through the Caldwell-Luc technique. Three months after the surgery they have inserted the lamellar implant. In 1994, Summers has introduced a less aggressive procedure: sinus lifting technique through osteotomy.

This technique allows the immediate insertion of the implants or the adequate preparation of the situs for their following placement. Then, the hydraulic pressure determined by the graft material exerts lateral and apical forces, resulting the lifting of the sinus floor (of the membrane).

The nasal cavity is surrounded by four paranasal sinuses situated in the following bones: maxillary, frontal, sphenoid, ethmoid. The maxillary sinuses are the largest ones situated laterally to the nasal cavity. They have pyramidal shape, with the basis towards the nasal wall and the apex towards the body of the zygomatic bone.

The communication with the nasal cavity is done through a hole which opens in the medial nasal meatus.

The maxillary bone is spongy, with soft trabeculae, occasionally there can be identified septa, complete or incomplete, which part the situs in multiple cavities. The bone septa can be identified mainly in the middle of the maxillary sinus (41%), but also in the mesial (24%) or distal extensions (35%). When they are present, the sinus augmentation becomes difficult for the clinician since the septa are associated

with a greater possibility of membrane perforation.

The sinus flap is a pseudostratified cylindrical epithelium, with cilia with the purpose to evacuate the mucus and the certain dust particles entered within the sinus through the airways. The evacuation is done through the ostium in the middle nasal meatus.

The average dimensions of the maxillary sinus are: 33mm width and 38mm length.

The pneumatization of the sinus takes place once the teeth are lost and is increased with the age, the volume ranging between 4,5 si 35,2cm³.

The vascularization of the maxillary bone is ensured by:

- The arteries: -maxillary (internal and external) superior labial, anterior ethmoidal, the incisal artery (branch from the sphenopalatine artery), the great and small palatine vessels.
- The veins:- sphenopalatine (from the medial region), the pterygoid plexum

The maxillary branch of the trigeminal nerve ensures the sensorial innervation. Comparing to other sinuses, a low vascularization can be observed, less osteoblasts and elastic fibres.

The smaller quantity of osteoblasts can be explained through the continuous pneumatization of the sinus. The low number of the elastic fibres eases the decoloration of the sinus membrane. The increase of the sinus volume throughout life, limits, in most of the cases, the required quantity of crestal bone for the implant insertion. (1)

Indications and contraindications for the sinus lifting

The teeth maintain the height of the maxillary sinus; after their loss, the sinus is extended or is pneumatized, with the reduction of the available bone quantity. The molars are the most frequent teeth lost through decay, fractures, endodontical complications or periodontal diseases. The sinus lifting technique is relatively invasive, with precise indications and contraindication for the guarantee of the success of the procedure. This way, the indications include patients without medical history or sinus pathology. For implant insertion and obviously for following prosthetic restorations, the necessity of

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CLINICAL ASPECTS

the sinusal grafting procedure will be established, decision based on the remaining bone quantity after the pneumatization of the sinus.

The radiological evaluation through the utilization of the orthopantomography or the C.T. scan will determine the height of the alveolar bone in the posterior maxillary.

The augmentation procedure of the sinus will be indicated when the invasion of the antrum by the implant can't be avoided.

Generally the insertion of an implant with a length of about 10mm is recommended for a predictable and favourable surviving rate, especially in the posterior maxillary.

The contraindications may include: unbalanced medical conditions (for ex. Sugar diabetes, high blood pressure, cardiovascular afflictions, afflictions of the immune system, etc.), the great smokers (>more than a package a day), pathology or severe congestion of the sinus where an otolaryngology surgery is imposed, as well as the malformation of the therapeutical irradiation of the sinus.

All these will prone the patients to postoperative complications: the infection of the graft material, the loss of the augmented bone and the oroantral fissure.(2)

The planification of the treatment stages:

The clinical situations which impose the sinusal grafting vary from unilateral edentation to the complete reconstruction of the posterior edentulous segment.

For an efficient analysis and determination of the necessity of the surgical intervention there are necessary:

1. The determination of the medical status of the patient (certain medical conditions will contraindicate the operative procedures)
2. The establishment of a treatment plan preoperatively configured;
3. The panoramic radiological evaluation and/or C.T. To determine the necessary bone volume and to detect the pathology or the anomalies which could directly or indirectly affect the maxillary sinus;
4. The determination of the topography, the direction and the necessary number of implants on the correctly mounted study casts, to finally allow the creation of a surgical stent.

As to what concerns the remaining bone volume, postoperatively the relation between the residual alveolar bone up to the sinusal floor (the height of the remaining bone) and the width of the crest is evaluated, to determine the type of bone required for the augmentation (Fugazzotto).

For the sinusal augmentation there have been used bone grafts in the shape of particles or blocks, originating from various sources. It has been reported that the grafts of bone particles have increased chances of success comparing to the block ones. Most of the materials of bone grafts have osteogenic (selfgrafts), osteoinductive (selfgrafts/allografts) or osteoconductive (xenografts/alloplastic grafts) properties.

When it comes to the type of bone particles used, Cammack and colleagues have not identified significant differences between the bone neof ormation percent generated by the mineral freeze-dried bone allograft (FDDBA) or by the DFDBA – demineralized freeze-dried bone allograft, no matter the augmented spot. In the case of the sinusal augmentation the bone neof ormation has varied around the value of 42% in the case of both types of bone grafts.

This is why the choice of bone graft is determined especially by the doctor's preferences and not necessarily by the performance of the used material.

It has been proved that the utilization of a barrier membrane inserted through the lateral bone fenestration

improves the success rate of the implant in the grafted sinus.

Moreover, the understanding of the way through which the barrier generates the selective cell repopulation has increased the importance granted to the concept of epithelial exclusion to restore the lost periodontal tissues, as well as the guided bone regeneration. This fact owes to the variability of the types of periodontal tissues which repopulate the area during the healing.

In 1976, Melcher suggested that there are four different types of cells which dictate the type of later periodontal following periodontal healing.

These cells come from epithelial gingival tissues, the lamina belonging to the connective tissue, the bone and the periodontal ligament. Thus, with the help of a membrane, the cells derived from the bone will have the potential to regenerate the lost bone volume within the maxillary sinus.

The barrier membranes can be: resorbable, most frequently used (collagen membranes) and nonresorbable (expanded polytetrafluorethylene).(3)

Surgical techniques

The lateral window technique

After the local anesthesia through infiltration, two vertical incisions are done, joined along the alveolar crest, and the whole thickness of the muco-periosteal flap is decolated towards the vestibule. The window is shaped in the lateral wall of the sinus (the maxillary vestibular plate) with a diamond coated burr at low speed or with a piezoelectric machine until a blueish coloration is seen through transparency. The created bone window is rotated horizontally with the sinusal membrane pushed inwards, becoming a part of the lifted sinus. A curved instrument is inserted (elevator) along the inferior border of the window to separate the membrane from the bone. The decolation is continued anteriorly, posteriorly, superiorly and mesially until the complete elevation is done. The clinician must be sure that the pointed end of the elevator remains in contact with the bone, and the smooth side in contact with the sinusal membrane during the decolation of the sinusal membrane.

After the decolation of the sinusal membrane, in the resulted space in the lower third of the sinus, the bone augmentation will be done, with particles or block.

Then, a collagen membrane is applied to cover the bone window created and the flap is stitched passively for the primary closure.

It is recommended to wait for a period of healing of about 6 months for the initial bone maturation. (5)

The piezoelectrical technique

The surgical techniques through lateral fenestration and osteotomy have been most commonly used for the sinus augmentation. The perforations of the sinusal membrane have been however associated with these conventional techniques, such as the piezoelectrical method. This has been proved to have favourable results with minimal complications, and especially with the avoidance of the accidental perforations of the sinusal membrane.

The piezoelectrical surgical devices use ultrasonic vibrations with low frequency active only on hard surfaces which spread in contact with the soft tissue and this is why they don't perforate the thin membrane of the sinus.

These systems have various surgical heads for the manipulation of the bone but also of the soft tissue, chosen according to the thickness of the bone and used to shape the lateral window. Then the decolation of the sinusal membrane is continued with a conventional scoop for the first 2 mm around the created bone window. Finally the lifting piezoelectrical surgical heads are used to complete the elevation of the sinusal

membrane.

The bone graft is introduced in the created space after the decolation and the lifting of the membrane. The bone graft is introduced in the created space after the decolation and the lifting of the membrane, and the procedure later follows the operative steps identical with the ones of the previously described technique, of the lateral fenestration. (7)

The sinusal augmentation combined with the guided bone regeneration

Generally, the vestibular augmentation (lateral) of the alveolar crest is done in combination with the elevation of the sinusal floor, especially when the patient has been edentulous for a longer period.

The placement of a bone graft in the vestibular wall of the crest will result in a wider crest, thus offering the necessary space for the implant insertion with the corresponding diameter. There can be used autologous grafts and/or allografts to obtain the desired augmentation. Also, the technique of the crestal expansion can be a predictable option for the crests more than 3mm in width.

Using either rotating burs, or adequate surgical piezoelectrical heads, an osteotomy is done along the edentulous crest, joined with other two marginal vertical osteotomy lines.

With the help of the specific elevators or of the proper chisels, introduced through the line of crestal osteotomy, the bone vestibular plate is gently extended and is mobilised laterally. In the resulted space, the bone graft is introduced, with or without the immediate insertion of the implant. (1)

The internal osteotomy technique

In the attempt to do a sinus lifting in a less aggressive way, previous to the insertion of the dental implants, *Summers* proposed the osteotomy technique.

This method excluded the necessity of a bone window in the laterally bone wall followed by its rotation for the decolation of the sinusal membrane.

This technique assumes the sinus lifting technique obtained rather through the internal lifting of the sinusal membrane with the help of osteotoms, used in the order of the sizes to push the residual alveolar bone towards the sinusal floor with or without simultaneous bone grafting.

The result allows either the immediate insertion of the implants, or later one, with the corresponding preparation of the future insertion situs.

Though the author of this technique has not mentioned the desired quantity of existent residual bone, most of the studies have mentioned the necessity of the existence of a minimum quantity of bone of 6 mm between the crest and the sinusal floor.

The set of instruments for the osteotomy chosen by *Summers*, similar to the shapes of the roots, comprises 4 calibrated instruments, each osteotom increasing in diameter. The tips are concave and blunt and are used to progressively enlarge the spot of the osteotomy.

The helicoidal phasis is stopped at 1 mm beneath the sinus floor and, with the help of the osteotoms the bone graft is pushed through the created hole. Then, the hydraulic pressure of the graft material lifts the sinusal floor, in average with 4mm. (3)

The management of the sinusal septa

The incidence of the unique sinusal septa ranges between 24-41%, with various size and localization. The identification of the septa before the sinus lifting procedure will lower the rate of complications and its localization will dictate the shape and size of the osteotomy of the lateral wall. The septa is isolated through a lateral osteotomy technique carefully conducted with the clear delimitation of two compartments, mesially and distally to the septa. (5)

The medication associated to the sinusal augmentation

The sinus lifting method is considered to be an invasive procedure and, thus, preoperative and postoperative medication is recommended. The antibiotics are usually given preoperative to lower the infectious risks (10%).

The main types prescribed include: *Amoxiciline* (500mg at 8 hours, for 10 days)

Azithromicine (250mg, at 12 hours in the beginning and then once a day, for 10 days) and *Clindamicine* (150 mg at 6 h, for 10 zile). For the success of the procedure, the preoperative utilization of the antibiotics (24 h before) is much more efficient than the mere postoperative administration.

The postoperative antiinflammatory medication (nonsteroids or corticosteroids), is also recommended. The usual antiinflammatories include *Ibuprofen* (800mg at 8 h for 5 days and *Metilprednisolon* (doses gradually reduced).

Also, decongestionants and antihistaminics are recommended for 14-21 days, once a day, a few days preoperative and continuing postoperative for 10-14 days.

The antiseptical solutions for oral irrigations with *Clorhexidina* 0,12% are indicated to reduce the accumulation of bacterial plate postoperative in the operated area. (8)

Postoperative recommendations

- The application of ice bags to minimize the postoperative risk.
- The avoidance of excessive pressure, such as nose blowing, smoking, using the straw since they can influence the coagulation process and the closing of the wound.
- An easy diet and the avoidance of the mastication on the operated side to minimize the traumatic irritations.
- Irrigations with mouth rinse based on clorhexidina, to reduce the bacterial dental plate ;
- The hospitalising at intervals of 1-, 3-, si 4- weeks postoperative, certainly if complications in the first days are excluded.

The prognostic and success rate in the case of the implants inserted in the augmented sinuses

Despite the used technique for the sinusal augmentation and the implant insertion, for a predictable successful result a minute surgical technique is imposed and a sufficient clinical experience.

Wallace and Froum, in 2003, have conducted a study systematized connected to the technique of the lateral window, concluding that it is advantageous to use the graft particles associated with the implant insertion with rough surface and the covering of the bone window with barrier membrane to increase the chances of success of the procedure. The utilization of the membrane has proved a success rate of 93,6% comparing with 88,7% in the cases when it was not used. Similarly, the granular graft is more efficient than the block graft (92,3% comparing to 83,3%), The implants with rough surface have proved a superior survival rate.

Emerich and Stappert conclude in the year 2005 that on the long term (<3 years), the clinical success of the inserted implants has been similar to the one of the implants placed without associated bone augmentation in a maxillary with a partial edentation (95,7% and respectively 96%). (7)

Postoperative complications

The perforation of the sinusal membrane represents one of the main associated complications with the sinus lifting procedure.

The presence of the sinusal septum can increase the incidence of oral-antral communication. Prezenta unui sept sinusal poate creste incidenta de comunicare oro-antrala. Ulm has reported the existence of a sinusal septa in about 30% of the sinuses, its positioning being close to the premolar region

(middle of the sinus).

The anatomy of the sinus also influences the risk of membranary perforation. Cho and collaborators examined different angles from within the maxillary sinus and identified that the small angle between the vestibular alveolar wall and the palatinal one has been associated with a greater number of perforations. They have divided the values of this angle in 3 groups:

- **group 1-** (>30degree) with 7,5% perforation rate
- **group 2-** (31-60degree) with 28,6% perforation rate
- **group 3-** (<61degree) without perforation risk

Vlasis and Fugazzotto have suggested 5 different classes, associated with the sinus elevation through the lateral window according to the localization and extension of the perforation. When the perforation can be isolated, according to the spread and localization, the closure of the communication can be done by folding the sinus membrane membranei sinusale on top of itself and by placing a collagen membrane. If the perforation continues to grow in dimension and can't be isolated, then the procedure must be abandoned and retaken in 4 months.

Other possible complications associated with the augmentation of the maxillary sinus may include: the injuring of the infraorbital nerve, echimosis, the dehiscence of the soft tissues and, of course associated infections (up to 10%).(8)

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