AN OVERVIEW OF Sinus Augmentation PROCEDURES

Introduction

The sinus-lift technique was introduced by Dr. Oscar Hilt Tatum Jr. in 1975, and was first published by Drs. Philip Boyne and R. A. James in 1980.

Initially the technique was used for achieving an optimal intercrestal distance needed for dentures. In 1980, Boyne and James started to place implants in the newly created bone. By 1990, a modification of Tatum’s original technique had become a standard clinical procedure.

This procedure has contributed considerably to the expansion of implantology. Others in the field have developed several modifications to the original surgical approach, and the procedure is constantly evolving.

In the past, LeFort I osteotomies with interpositional bone onlays, using rib or iliac crest, were also used. However, these techniques are only applicable when there is sufficient interarch distance. In addition, significant postoperative morbidity is associated with these approaches.

Anatomy

The maxillary sinus usually presents as a single chamber with five walls forming a quadrilateral pyramid shape, with its apex pointing laterally in the zygomatic process.

Adult dimensions are approximately 2.5cm wide, 3.75cm high, 3cm deep, bounded by the orbital roof superiorly, the hard palate, alveolus and dental portion of the maxilla inferiorly, and the zygomatic process laterally, and finally, a thin plate of bone separating the cavity from the infratemporal and pterygopalatine fossa posteriorly.

Its large, flat, quadrangular base supports both the median and lateral walls of the nasal cavity. The Schneiderian membrane covering the sinus floor contains multilayered columnar cells, basal cells, beaker cells, an underlying basal membrane and the tunica propria. It is a pseudostratified ciliated epithelium that functions by removing debris and bacteria from the sinus.

Surgical techniques

Reconstruction of the edentulous posterior maxilla presents a number of challenges.

The area is frequently characterized by post-extraction buccolingual and apicoocclusal ridge atrophy (caused by involutional absorption of alveolar bone due to a lack of trophic stimulus), pneumatization of the sinuses, low bone density, and the highest occlusal loads. Presence of periodontal disease before tooth loss also leads to extensive bone resorption.

The residual alveolar ridge may be of such morphology and position in relation to the opposing arch as to preclude ideal positioning of implants, and is often type IV in quality. Such sparsely trabeculated, poor-quality bone is a significant contributing factor to greater failure rates in a number of studies.
Sinus grafting is generally required to provide sufficient bone volume. This procedure is technically demanding and involves many factors that might affect the survival of the graft and implant, such as the type of graft, the surgical technique and the type of implants.

The technique chosen may depend on the height and width of the ridge, the implant length and the amount of grafting required. The clinician also has to keep in mind his or her surgical skill and experience, and the armamentarium available.

Following a supracrestal incision with mesial and distal releasing incisions extending well into the buccal fold, a full thickness mucoperiosteal flap is reflected. 1

**Lateral approach**

The lateral window approach is an extensive and technique-sensitive procedure. A sharp, broad-based instrument (such as a Freer Elevator) is placed against the inferior edge of the membrane and moved along the bone, allowing the instrument to strip and elevate the membrane, thus exposing the medial nasal wall.

Different options are described for preparing the lateral window, such as conventional osteotomy using rotating instruments (round burs), trephines, piezotomography and lasers. Irrigation with saline is required.

Complications include membrane perforation, bleeding, infection, and infra-orbital nerve laceration. The postoperative discomforts described include swelling, bruising discoloration, disability, hematoma and pain.

The tapping force used for fracturing the cortical plate on the sinus floor is also difficult to control, so some patients may find the procedure uncomfortable. 2–3

**Crestal approach**

Most authors recommend the less-invasive crestal approach for simultaneous implant placement. As a result, there must be sufficient bone (ridge height of at least 5mm–6mm) for initial implant stability. Osteotomes or a combination of osteotomes and spade or trephine drill are used.

An instrument such as an osteotome is used to fracture the sinus floor. This technique is often difficult to control and harbors a high risk of tearing the membrane. Another technique with crestal access is the balloon sinus lift.

**Balloon techniques**

The use of a water balloon to elevate the membrane is an easy, truly minimally invasive, elegant technique with very little discomfort. This technique produces encouraging results and has low complication rates.

The balloon is introduced into the sinus and inflated. Some kits use an elastic catheter. The membrane is elevated by forcing saline through the catheter. As a result, we know in advance the amount of free-space volume generated. This provides another advantage. Some authors have used this technique immediately after extraction.

In the Choukroun technique, an autologous leukocyte and platelet-rich fibrin concentrate is used instead of bone grafts. Some authors have reported excellent results with this technique. In some studies, platelet concentrate was used as an aid in membrane detachment. This allows for a more controlled lifting of the membrane. 4–5

**Technique choice**

The choice of technique depends on the ridge height (i.e., being greater or less than 5mm) and on the possibility of achieving primary stability. In contrast to the nearly unlimited possibilities of membrane elevation...
in the lateral technique, the osteotome procedure cannot be used to elevate the membrane more than 5mm or 6mm (in fact, in some studies the membrane was only 3mm—4mm). Some experts also advocate for concomitant buccolingual ridge augmentation.

In both cases, the membrane must be gently separated from the sinus floor and elevated to contain graft material that is placed inferiorly. It is essential to produce a cavity that will limit the amount of graft material inserted. This improves implant survival and reduces complications.

**Complications**

A number of intraoperative and postoperative complications have been reported. Complications have been classified as: intraoperative, early postoperative and late postoperative. The most frequent complication—which between 10 percent and 60 percent of patients experience—includes a perforation in the Schneiderian membrane.

The literature states that there are many complications, such as sinus-membrane perforation, membrane acute or chronic sinusitis, cyst, mucocele, delayed wound healing, hematoma, and loss and sequestration of bone.

**Sinus perforation**

Factors that can influence the chance of perforation include anatomical variations, the surgeon’s level of experience, and previous sinus infection or surgery.

Anatomical factors consist of thickness of the lateral maxillary sinus wall, connection between membrane and oral mucosa, narrow and wide sinus maxillary sinus septa, and a longitudinal septum. The presence of the sinus septa can hinder membrane elevation and greatly increase the likelihood of perforation.

Previous sinus surgery and absence of alveolar bone are also high risk factors. Therefore, imaging studies such as a CT scan may be required to assist in recognizing possible variations.

Dr. Manuel Chanavaz classified complications into several categories, including soft-tissue perforation and sinus infection hemosinus. Dr. Michael Pikos described sinus perforations by size: small (5mm–10mm) and large (greater than 10mm).

Membrane perforation may cause further complications, such as increased risk of infection due to communication with other sinuses. Graft particles could also migrate into the sinus and induce polyps or other sinus diseases.

The clinical significance of perforation is controversial. The success of grafting is dependent primarily on the neovascularization of the graft mass, which is reported to derive mainly from the sinus floor.

Consequently, it is assumed that the regenerative result of the bone grafting is inferior following membrane perforations. It is recommended by some that simultaneous implant placement not be carried out following severe perforations. However, some researchers propose that membrane perforation played an insignificant role in bone-graft complications.

While some studies recommend abandoning the procedure in case of a perforation, many studies suggest that wide perforation is not an absolute indication for abandoning unless the membrane is largely destroyed.

One such study has reported that perforations can occur with any technique, but are more likely to occur when the membrane is raised past the 10mm mark from the alveolar crest.6-7

**Repairing membrane perforations**

There are many options described for treating perforations. The most common involves resorbable collagen membrane under the perforation. Other studies have described folding the membrane up against itself, using sutures, fibrin glue, lamellar bone sheets, or Surgicel to close the perforation.

To be utilized as a repair material, any of these requires an effective seal and easy manipulation. Also tissue reaction, including inflammation or foreign-body reaction, should be minimal.

It is very difficult to repair a tear or perforation by suturing because of the tear’s inaccessibility and friable characteristics. Sometimes a sinus membrane perforation cannot be detected.

Small perforations usually do not need treatment because the membrane folds itself during the elevation. Large perforations are usually managed by a cancellous graft or procedure abandonment.

**Antibiotics**

An antibiotic is usually required from one to two days prior to surgery and for 5 days to 10 days after surgery.

It is important that the surgeon decorates the bone and obtains blood marrow so that the systemic antibiotics search the bone graft.

In spite of the best of aseptic precautions, every surgical site is infected to some degree. Hydrating the bone-graft material with an antibiotic has been described in literature. Some authors have mentioned systemic antibiotics to maintain blood levels to infiltrate the graft site.

There are not many studies regarding antibiotics in bone grafts in sinus augmentation procedures. However, using antibiotics in bone grafts has been a standard practice in neurosurgery orthopedics, and in maxillofacial and oral surgery. This is important, as sinus grafts have little blood supply.

Salivary contamination, the use of instruments that come in contact with oral fluids and mucosa, remnants of apical pathology, periodontal infections, small sinus perforations, and the simple act of breathing will seed the surgical site with pathogens, and graft hydration with antibiotics is required.

Many clinicians have reported postoperative infections that are not cleared by oral antibiotics. These complications can be minimized by judicious use of antibiotics in graft material.

Choukroun and associates found that bone grafts with metronidazole were significantly more homogenous than those without metronidazole. However, more studies on this topic are necessary.

*Continued on p. 30*
Types of graft material

Various types of graft materials have been successfully utilized. Autogenous and xenogenic bone or a mixture of materials have been used, and are associated with high success rates.

Common intraoral donor sites include the maxillary tuberosity, the zygomaticomaxillary buttress, the mandibular symphysis, the body and ramus of the mandible, and the iliac crest.

When a smaller amount of autogenous bone graft is needed, an intraoral donor site is suitable and local anesthesia is sufficient for such a procedure. Corticocancellous bone, onlay grafts, or guided bone regeneration techniques using several graft materials are associated with high success rates.8–11

Autogenous bone has long been considered the “gold standard.” But in order to avoid the problems associated with it, alternative materials have been developed.12

Particulate and block grafts include autogenous bone freeze, dried-bone allografts (mineralized or demineralized) xenografts hydroxyapatite (resorbable or nonresorbable), resorbable tricalcium phosphate or various combinations of these materials.

Some studies have shown that the use of grafting materials is not a prerequisite for predictable bone formation, which can occur simply after membrane elevation. Others show that because any grafting material has to be resorbed and replaced, this could possibly decrease the speed of new bone formation. However, techniques that rely on absolute preservation of membrane integrity for their success can be demanding.

Success rates

Since survival rates in the posterior maxillae are different from other oral sites, it would be sensible to compare implant survival after augmentation to the survival in conventional implant placement in this particular area.

A sinus augmentation can be deemed successful if sufficient bone is generated to allow placement of an implant of at least 11mm. If a buccolingual ridge augmentation is performed concomitantly, then the procedure can be deemed successful if at least 4mm-wide implants can be placed without generation of any fenestrations and dehisences.

The success rate depends on multiple variables, such as implant and graft type, height of residual bone, timing of implant placement, type of intervention, prosthetic restoration adopted, and patient characteristics and habits.13–15

The amount of residual alveolar bone height is frequently cited as an important prognostic factor. Some studies have shown no difference in survival rate for implants placed in grafted sinuses with membrane intact or with perforation.16 Other studies have shown lower survival rates where there is membrane perforation.

An implant crown ratio greater than 1.0 and a wider diameter increase the ability of the restoration to absorb loading forces, and thus enhances the survival. Some studies have shown that maxillary implants longer than 10mm have a better prognosis than those that are shorter.

Many studies have shown no differences in measures of success, such as the plaque index, gingival index pocket depth, and implant stability between the different types of augmentation procedures performed.

Studies have shown that survival varied between 75 percent and 100 percent for non-augmented and augmented areas.

Conclusion

The various sinus-lift techniques explained in this article allow for minimal complications and create a new foundation for dental implants, while strengthening the sinus wall.

Clinical and radiographic examinations and various studies have demonstrated similar results, despite the use of different surgical approaches. An approach guided by a CT scan could be even less invasive than sinus lifts, and could minimize complications.