Since its introduction, sinus floor augmentation has generated great interest in the international scientific community and been subject to many changes in procedure. The first documented maxillary sinus augmentations using bone grafts date back to the work of Philip J. Boyne in the 1960s. An access osteotomy to elevate the sinus membrane can be performed by a vestibular or a crestal approach.

The main advantage of the crestal approach is that it is less invasive than the vestibular one, which, while it gives the surgeon a view of the site, creates patient discomfort. A minimally invasive crestal surgical approach was proposed by Tatum in 1986 and subsequently refined by Summers in 1994.

The approach theoretically described by Summers can be successful if the residual bone height is at least 5.6 mm. Depending on whether the bone material resulting from the osteotomy or other graft materials are used, we get the OSFE technique (osteotome sinus floor elevation) or the BAOSFE technique (bone-added osteotome sinus floor elevation).

If the ridge is lower than 5.6 mm and cannot offer primary stability, an implant placement procedure is required that takes longer than the sinus lift procedure.

In the delayed approach, an osteotomy to the sinus floor is performed using a 5-mm trephine drill. Following that, the bone cylinder obtained by the trephine drill is pushed forward using a No. 5 osteotome with a concave tip. As a result, the Schneiderian membrane is lifted by the cylinder. Under no circumstances must the osteotome penetrate the sinus. As early as 1985, Muller et al. suggested avoiding such instruments if the force required was greater than 20 MPa, so as not to cause tissue damage from excessive compression.

In 2001, Fugazzotto developed a modification of this method for situations where a molar extraction was performed that included the interradicular septum and at least 50 percent of the postextractive alveoli in the cylinder to be elevated.

The crestal bone defect is then filled with bone substitute in the stages before healing. The delayed approach forces the patient to undergo at least two surgical procedures. The insertion of the implant, by contrast, may be performed concurrently with a crestal sinus lift if primary stability can be guaranteed. Summers described this technique in 1995. Using an appropriate range of osteotomes (whose tip must never enter the sinus), he managed to lift the membrane by pushing the collected bone towards the apex to allow enough room for the fixture.

A modification of the Summers method is to use osteotomes of ascending length with crestal stops. They are alternatively concave and convex as their size increases. This approach ensures a
reduction of the perforation risk and a better compaction of the bone because of the characteristic shape of these osteotomes. In the BAOSFE, Summers inserted graft material by compacting it with his osteotomes inside the osteotomy site until the Schneiderian membrane was sufficiently detached. With this technique, the final quantity of material introduced is determined by how much the membrane can stretch (Winter et al. 2002), a characteristic that is not easily evaluated.

The shrinkage of about 1–2 mm that each sinus lift undergoes during the healing process must also be taken into account. Implant lengths must be related to the possible final dimension of the augmented ridge (Cosci and Luccoli 2000). The authors themselves raised the issue of greenstick fracture of the sinus floor, which often causes lacerations, and suggested the use of a special drill.

The piezoelectric bone surgery technique was introduced in 2000. Selective cutting can reduce the membrane perforation rate by 7 percent. This technology has allowed the development of a sequence of piezoelectric implant site preparation tools with instruments that provide access to the sinus membrane without trephine or traditional drills that present a high perforation risk.

Since 2003, various techniques have been designed with the aim of raising the membrane through an elastic balloon inflated by hydraulic pressure. Although several studies have shown high success rates, a possible complication is balloon rupture, which may lead to a possible simultaneous rupture of the membrane.

The purpose of this report is to assess the extent to which the sinus membrane can be augmented with special screw elevators, designed by the lead author, in the presence of at least 3 mm of space between the crown margin of the bone crest and the sinus floor, using hydrodynamic pressure (idrodissection) in combination with bone grafts.

**Materials and methods: demographic details**

Between May 2006 and March 2010, 29 patients (20 women and nine men) underwent surgery using a crestal sinus lift technique (Sinus Physiolift) and contextual placement of 32 implants. Of the patients, five smoked an average of eight to nine cigarettes per day. The average age at the time of surgery was 51 years (range: 20 to 72 years).

**Inclusion and exclusion criteria**

Patients were included in this study according to the following criteria:

- Partial edentulism under the maxillary sinus
- Minimum distance between the sinus floor and the crown margin of the bone crest of 3 mm (Fig.1)
- Absence of sinus disease
- Absence of systemic disease and, in the case of diabetes, regular check-ups
- Patients willing to sign informed consent
- Primary stability of at least 20 Ncm
- Patients willing to undergo CT examinations

Exclusion criteria included:

- Parafunction, bruxism or clenching
- Heavy smokers (more than 10 cigarettes per day)
- Poor oral hygiene
- Patients undergoing chemotherapy or radiotherapy associated with taking biphosphonates
‘The main advantage of the crestal approach is that it is less invasive than the vestibular one, which, while it gives the surgeon a view of the site, creates patient discomfort.’

_Pre-surgical treatment_

All of the patients underwent two or more sessions of professional oral hygiene in the weeks prior to surgery.

For the proper execution of the surgical study, a cone beam or traditional CT with a barium X-ray mask (30 percent on the teeth and 10 percent on the base) was required.

Starting on the day preceding the surgery, antibiotic coverage with amoxicillin/clavulanic acid was administered every 12 hours for six days. Additionally, a 0.12 percent chlorhexidine rinse for two times a day was prescribed for a total of six days starting on the day before the surgical procedure.

_Surgical treatment_

All patients underwent conscious sedation and pain control therapy:
- Cortisone (4 mg Bentelan)
- Benzodiazepines (diazepam, 1 mg boluses to achieve the effect)
- NSAIDs (ketorolac tromethamine, 1 vial during surgery)
- Fargan (promethazine 1 mg used in consolidation only in patients already taking other medicines for the nervous system)
- Local anesthesia was performed in a plessic way in association with mepivacaine with a 1:100,000 adrenaline ratio (Septanest, 4 percent Septodont).

A bevelled intrasulcular crestal incision, extending from the mesial to the distal tooth, was performed. A full-thickness flap was elevated on the bone crest only. Following skeletonization of the ridge under the control of a surgical guide, the implant site was prepared with Piezosurgery 3 (Mectron Medical Technology, Carasco, Italy). The “bone implant” power was set following the protocols designed by Vercellotti, mainly with regard to the initial steps with an IM1 and an IM2P instrument up to 1 mm from the sinus floor (Figs. 2–4).

The baseline cortical sinus was eroded with an OT9 instrument to obtain an access hole of 2.4 mm in diameter (Fig. 5). The screw elevator was thus added by an implantology micromotor (20 Ncm, 20 rpm) in the prepared site as far as the cortical basal. However, the inside of the sinus did not have to be penetrated. The hollow screw was stable and ensured watertight integrity (Figs. 6, 7).

Once the screw elevators were inserted, the Physiolifter was connected, which joined the elevator with the syringe containing 3 ml of physiological saline solution (Figs. 8–10). It is worth mentioning that the syringe had been filled before its connection to the screw elevators to avoid the formation of air bubbles inside.

Then, pressing the Physiolifter, saline solution was injected into the sinus after checking for potential liquid loss due to incorrect insertion of the screw elevators. In this manner, the membrane was gradually separated.

The tube of the Physiolifter was later disconnected and the Valsalva maneuver was performed to drain the saline solution from the maxillary sinus. The same maneuver was also performed to verify the integrity of the membrane. If the patient feels water in the nose, the membrane is lacerated and the intervention has to be stopped.

After the screw elevator had been unscrewed and a preparation of the crestal portion of the implant tunnel with the IP 2-3 insert (Fig. 11), heterologous bone was compacted into the hole (Figs. 12, 13) according to Del Fabbro et al., who have demonstrated that this type of graft is associated with the highest implant success rates. Without activating the pedal, the graft material remaining in the implant site was pushed into the sinus using the OT9 instrument.

In the case of resistance of the graft material, a way to operate more smoothly was to intermittently activate the machine with the saline supply as low as possible. After freeing the channel implant, a conical implant (BIOMET 3i, Palm Beach Gardens, Fla., U.S.A.) of the appropriate diameter and length was inserted in a submerged healing procedure (Figs. 14, 15).

This technique, devised for single tooth gaps, can be used even if several teeth are missing and there is excessive pneumatization of the maxillary sinus. The
The surgical procedure is identical for the second implant site where a second screw elevator is inserted. It must be ensured during this procedure that the first screw elevator is impenetrable by applying a special airtight seal so that the system is not pneumatized during the second lift.

Follow up and evaluation of the rise

All patients were recalled six months after surgery. An intraoral control X-ray was taken using a parallel-beam technique to check the amount of lifting and radiopacity (Figs. 16, 17). The WixWin visualization software (Gendex Dental Systems, Des Plaines, Ill., U.S.A.) was used for comparative measurement of the different X-rays. The measurement system was calibrated by referring to the linear distance between five implant coils (5 x 0.9 mm).

The vertical distance was measured at the implant axis, between the sinus floor and the highest point of the lifted area. This action was performed for each implant inserted, and an average was calculated for each patient in order to obtain one single value. Later, the difference between the values of the follow-up and the corresponding measurements on baseline X-rays was calculated.

Results

Between May 2006 and March 2010, 29 patients with an average age of 51 years received this special treatment. At baseline, the distance between the sinus floor and the crown margin of the bone crest was 4 ± 1 mm. The volume of saline added was 4 ± 1 ml. The radiographic controls showed that the graft material was distributed evenly around the implants, suggesting the integrity of the membrane.

At the time of surgery, radiographic controls showed an average height increase of 7.3 ± 1.5 mm. Six months after surgery, this figure had been reduced by about ± 0.5 mm on average. At reentry, two implants were not osseointegrated and were replaced after one month with implants of the same diameter and length, as the height increase was stable. All the other implants were osseointegrated.

Discussion

The maxillary sinus has always limited the placement of osseointegrated implants. A growing need was perceived to overcome this anatomic limit by offering a stable solution at reduced biological cost. In our implant age, patients cannot and should not accept removable restorations. These are easy enough to provide, but the patient cannot achieve full social reintegration.

There are many ways to perform a sinus lift. Some are now highly predictable and so easy to perform that they have become an everyday part of the oral surgeon’s armamentarium.

The vestibular approach to the sinus allows direct visual control, and it is therefore easier to achieve results. On the other hand, the postsurgical period is debilitating. Until recently, this was considered to be the only way to realize a major sinus lift as the crestal approach does not allow extensive extended lifting in most cases. This approach is certainly less disabling but, as already mentioned, it does not offer a view of the area where surgery is performed, which must therefore be explored by instruments, a feat that requires great sensitivity.

Traditional techniques cause a lot of patient discomfort because procedures fracturing the sinus floor and the raising and compaction of the graft material inevitably require the use of osteotomes, and a “hammer and chisel” are definitely not pleasant and are difficult for the surgeon to control.

We believe that the gold standard is a procedure where patient discomfort is minimal and where the possibility exists to achieve a large volume increase. Liquids are incompressible, and pressure is distributed through them in a uniform and progressive...
way. This led us to consider the use of hydrodynamic pressure to obtain the desired result. The water-balloon procedure was a good idea, but this method is not completely controllable because of the elastic resistance of the balloon, which does not allow safe elevation of the membrane.

To ensure that the system remains sealed, we designed special screw elevators that, through intimate contact between the coils and the basal cortex, allow us to use the pressure-tube syringe of the system efficiently.

**Conclusion**

In our clinical practice, we have not seen more complications in terms of membrane perforation compared to traditional methods, and the extent of augmentation is much greater than other crestal techniques. The most important benefit is the much less debilitating postoperative phase. Less time is spent in the surgery and the surgeon is less stressed during the procedure. Although the number of cases in this study was limited and the operator was an experienced surgeon, the results were very encouraging. (However, this technique does not replace the big sinus lift in case of residual bone height less than 3 mm.) The procedure should be learned carefully and slowly as the technique is operator-dependent. However, an extended follow-up is necessary to assess the stability of the result.

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**about the authors**

Rosario Sentineri, DDS, MD, earned an advanced degree in medicine and surgery from the University of Genova in 1983. He specialized in odontostomatology and graduated with cum laude status in 1987. Sentineri is the founder and active member of the Piezosurgery Academy as well as a visiting professor at the University of Chieti, Italy. In addition, as the inventor of special Bone Expanders, Sentineri is an international referee of the Atrofic Ridge Expansion Technique. He also invented a crestal sinus augmentation technique using hydrodinamic pressure and special hollow screws.

Rosario Sentineri, DDS, MD
Piazza De Ferrari 4/10 Genoa, Italy
Tel. +390102474533
E-mail: rosario.sentineri@gmail.com

Giorgio Dagnino, DDS, earned an advanced degree in odontostomatology and prostodontics from the University of Genova, Italy, and graduated with cum laude status and an academic medal in 2010. In 2010, Dagnino completed the annual post-graduate course in restorative dentistry (Dr. Adamo Monari). He is a former student of Rosario Sentineri, MD, DDS, and completed his post-graduate course in Atrofic Ridge Expansion in 2011.