

# Protection of the Sinus Membrane when Performing Sinus Lift Surgery using Heterologous Bone Block or Cortical Lamina Grafts

**Author:** \_Danilo Alessio Di Stefano\*, Raffaele Vinci\*\*, Adriano Piattelli\*\*\*

\* Adjunct Professor, Dental School, Vita-Salute San Raffaele University & IRCCS San Raffaele, and private practice, Milan, Italy.

\*\* Associate Professor, Faculty of Medicine, Vita-Salute San Raffaele University & IRCCS San Raffaele, Milan, Italy.

\*\*\* Full Professor, Department of Medical, Oral and Biotechnological Sciences, "G. d'Annunzio" University Chieti Pescara, Chieti, Italy.

## \_Summary

The rehabilitation of the atrophic posterior maxilla often requires the execution of a maxillary sinus floor augmentation which, in cases where the atrophy is significant and also associated with several adjacent teeth, is preferably managed through the lateral approach, if full control of the surgical act is also desired. If performed concomitantly, the operations of detachment of the sinus membrane, grafting of particulate/biomaterial and implant insertion are associated with the risk of membrane perforation, which is one of the most frequent and feared complications in this type of surgery. The placement of bone grafts or membranes under the sinus membrane in the form of thin blocks or cortical bone laminae can help to prevent perforations after detachment and - if they have occurred - to manage them. They also contribute to building up a new 'cover' that will allow greater preservation of the graft over the years. The case presented in this paper illustrates the placement of a spongy bone block to protect the sinus membrane after its detachment and before the simultaneous placement of osseointegrated implants.

## \_Introduction

Sinus lift is one of the most frequent operations in the rehabilitation of the atrophic posterior maxilla<sup>1</sup>. Since its introduction by Tatum<sup>2, 3</sup>, and Boyne and James<sup>4</sup>, it has been the subject of a number of studies that proved its safety, efficacy and repeatability<sup>5-7</sup>. Some authors, including Summers<sup>8</sup> and others<sup>7, 9-11</sup>, proposed the crestal approach as a low-invasive alternative compared

to the lateral access described in the original technique. The latter, however, is still preferable when the residual thickness of the bone ridge is less than 4-5 mm<sup>12, 13</sup>. A lower thickness, however, does not prevent the simultaneous placement of implants with sufficient primary stability, by applying appropriate implant site under-preparation protocols, and adequate implant macromorphologies, whose planning is made possible, or greatly facilitated, by the possibility of performing quantitative and repeatable measurements of both bone density and primary implant stability<sup>14</sup>. While avoiding the need for a second operation and speeding up the patient's rehabilitation, concomitant implant placement involves a longer duration of surgery, more trauma, a more difficult post-operative course and a greater risk of infection. It also entails the need to perform a higher number of surgical procedures and, inherently, an increased likelihood of complications, especially intra-operative. Common complications of this surgery include the perforation of the membrane<sup>14, 15</sup>. In this paper, the author briefly describes the use of heterologous bone grafts of equine origin, obtained through a process of antigen elimination that preserves their mechanical properties. Bone grafts are placed so as to protect the sinus membrane - after its detachment - from subsequent mechanical actions, implant insertion and filling with biomaterial, which could potentially lead to its perforation.

## Materials and Methods

The 66-year-old, non-smoking patient came to the surgeon's attention requesting the rehabilitation of the left upper jaw, where the teeth 2.4 through 2.7 were missing (Fig. 1). After clinical and radiographic evaluation, also through CBCT (Cone beam computed tomography), the patient was proposed a rehabilitation plan based on the execution of a sinus lift and the simultaneous insertion of three osseointegrated implants. The patient gave her informed consent to the treatment.

### Surgical procedure

The patient underwent preoperative oral hygiene one week before surgery. The treatment was performed under antibiotic coverage with Amoxicillin/Clavulanic acid 1 g (Augmentin, Glaxo-SmithKline, Verona, Italy), administered 1 hour before surgery, and then every 12 hours for 12 days. The patient was also made to rinse with Chlorhexidine 0.2% (Corsodyl, Glaxo-SmithKline) to be continued for two weeks after surgery. As analgic therapy, Nimesulide 100 mg (Aulin, Angelini, Ancona, Italy) and Dexamethasone sulfate 4 mg/1ml (Soldesam, Laboratorio Farmacologico Milanese, Caronno Pertusella, Italy) were prescribed. Granular Ketoprofen 80 mg (Oki, Dompé, L'Aquila, Italy) was also prescribed to be taken as needed, in quantities not exceeding one sachet every eight hours for seven days.

The surgical area was anesthetised using Articaine hydrochloride 40 mg with adrenaline 1:100,000. A full-thickness, slightly paracrestal flap was then lifted and autologous particulate was harvested using a bone scraper (SafeScraper Twist, Meta, Reggio Emilia, Italy) to be later used for grafting in combination with the biomaterial (Fig. 2).

The first implant was then inserted (Stone, IDI Evolution, Concorezzo, Italy) in position 2.5, after measurement of bone density using a measuring probe connected to the handpiece of a special micromotor (TMM2, IDI Evolution, Concorezzo, Italy), and the site for implant insertion in position 2.6 was prepared (Fig. 3).

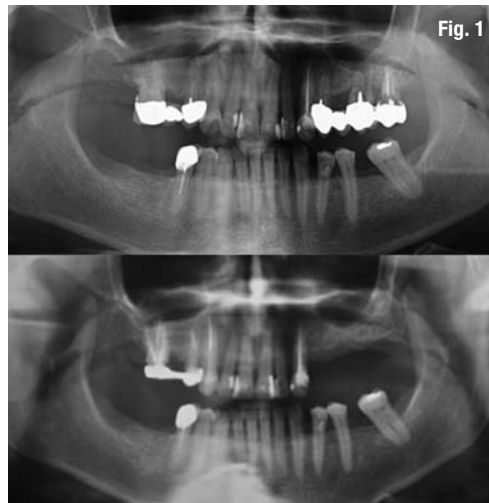


Fig. 1

The patient had missing teeth in the upper left posterior area (bottom picture) as a result of the extraction occurred two years before of some teeth - from 2.4 to 2.7 - supporting a bridge (top picture, previous X-ray brought by the patient).

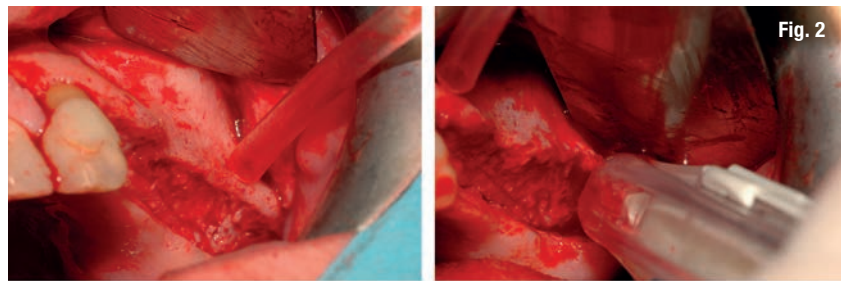


Fig. 2

A full-thickness flap is opened and autologous particulate is harvested to be mixed with a granular bone substitute.

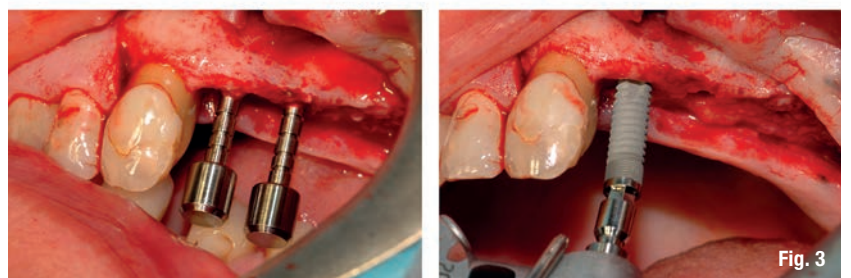
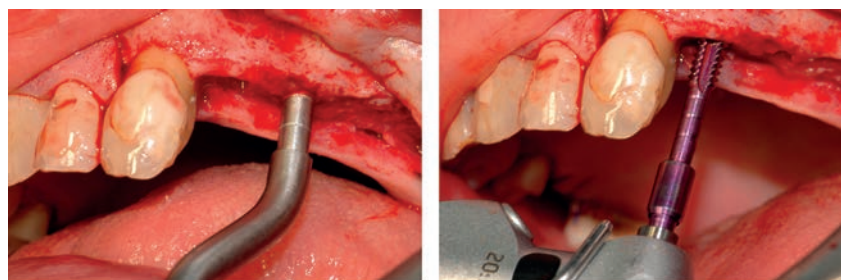
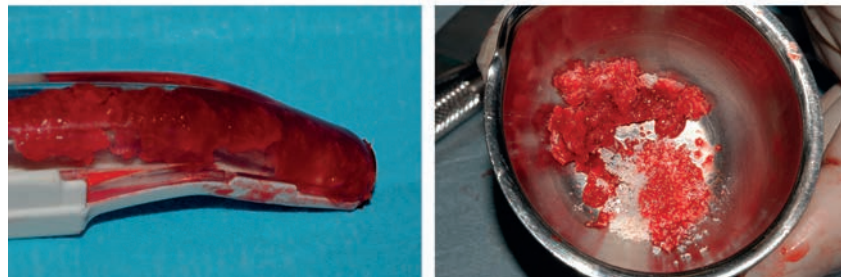
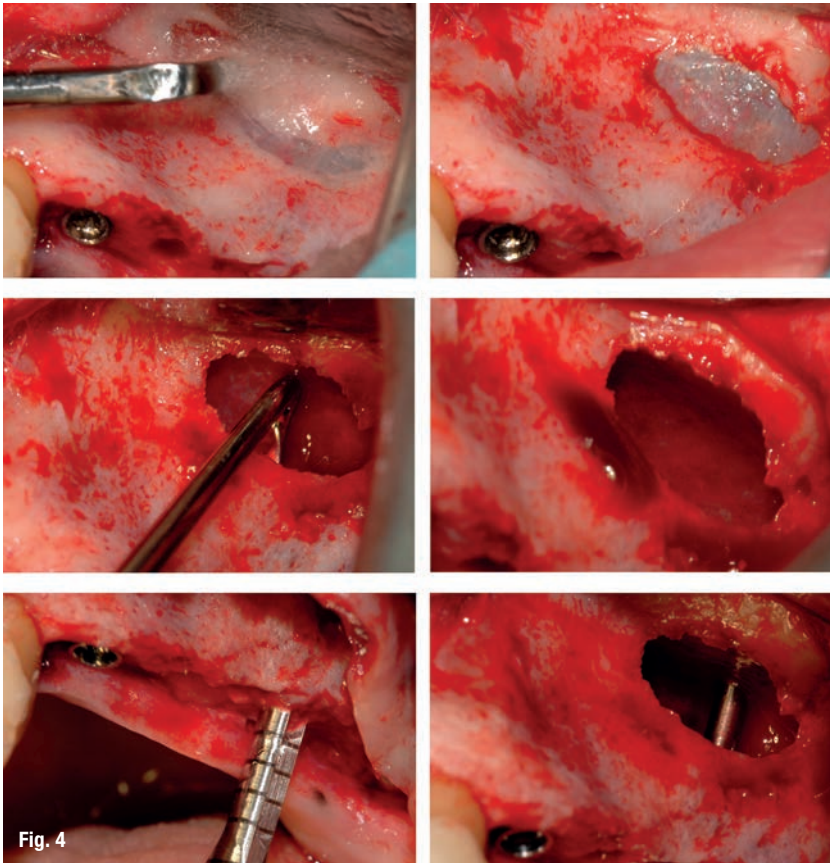


Fig. 3

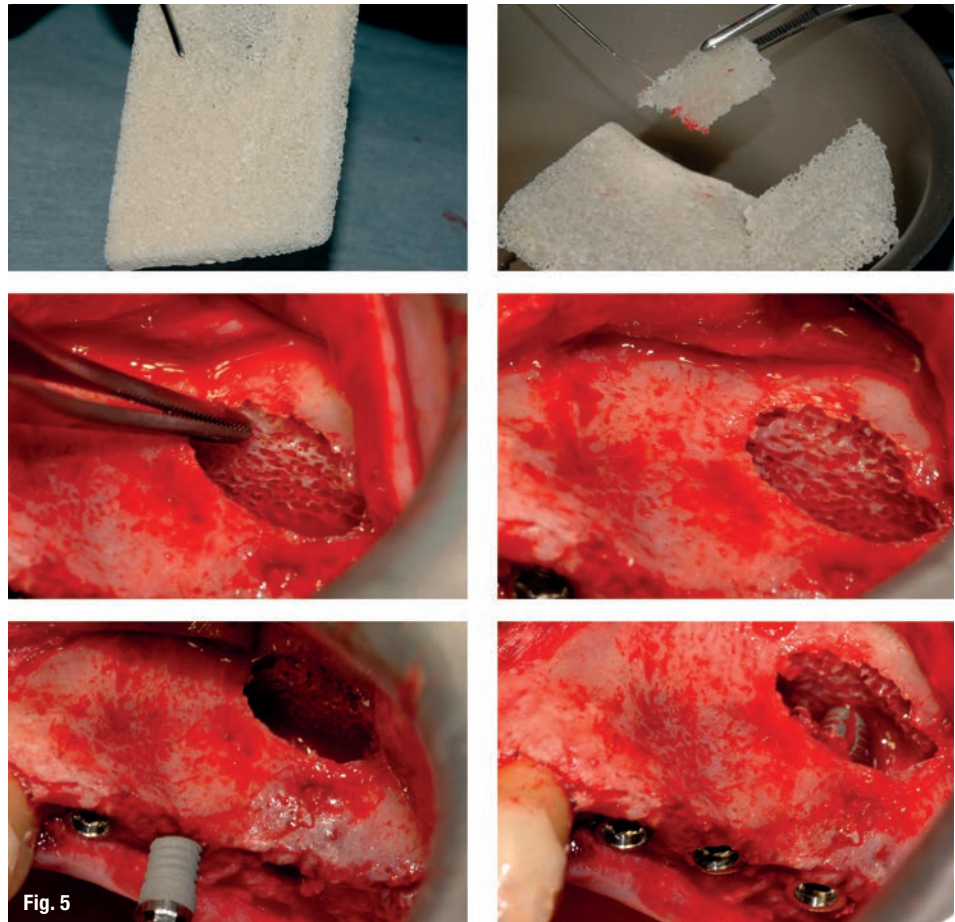
Preparation of the implant sites in position 2.5 and 2.6 and placement of the first implant in position 2.5. Before enlargement of the implant site using the last burr, bone density is read using a probe connected to the handpiece of a special micromotor (second image above). The information is used to rationally decide on an appropriate under-preparation protocol.



**Fig. 4** Execution of the antrostomy: lifting the sinus membrane and preparing the third implant site in position 2.7. Also in this case, the preparation of the implant site was preceded by the quantitative measurement of bone density (not shown).

The osteotomy was performed using piezo-electric tips; the sinus membrane was then detached and lifted and the implant site in position 2.7 was prepared to accommodate the third implant (Fig. 4). The preparation of the sites in position 2.6 and 2.7 was also carried out after reading the bone density. Since bone density was low, it was decided - for all three implants - to use an under-preparation protocol where the last burr had a diameter 12.5% lower than the diameter of the implant thread, as also described in Arosio et al.<sup>14</sup>

Before insertion of the two implants in position 2.6 and 2.7, the sinus membrane was protected using a rigid spongy bone block of equine origin obtained through an enzymatic antigen elimination process (Osteoplant, Bioteck, Arcugnano, Italy). The block was trimmed using end-cutting rongeurs to obtain a portion of the appropriate size for subsequent insertion underneath the sinus membrane (Fig. 5). The implant in position 2.7 was then inserted (Stone, IDI Evolution, Concorezzo, Italy), its apex resting on the newly inserted block, so as not to come into contact with the sinus membrane (Fig. 5).



**Fig. 5** Placement of a block of equine spongy bone under the sinus membrane: a block of suitable size is cut, and then hydrated with physiological solution before being placed into the socket. The second and third implants are inserted. The apex of the implant in position 2.7 rests on the bone block and does not come into contact with the sinus membrane.

The socket was then partially filled using equine-derived bone granules (Osteoxenon, Bioteck, Arcugnano, Italy), hydrated with sterile physiological solution and mixed with the previously harvested autologous particulate. After inserting the third implant in position 2.6 (Stone, IDI Evolution, Concorezzo, Italy), filling of the socket was completed using the same bone granules and another portion of the block used previously (Fig. 6). The access window to the sinus was closed using an absorbable collagen membrane (Biocollagen, Bioteck, Arcugnano, Italy). The flap was then sutured with a 5-0 non-absorbable suture (Monomyd, Butterfly, Cavenago, Italy). No intra- or post-operative complications were observed. The control CBCT showed the correct positioning of the implants, the adequate filling of the sinus, and the correct interposition of the bone block between the apex of the implant in position 2.7 and the sinus membrane (Fig. 6).

After an adequate healing time, and following the usual procedures of removal of the sutures, uncovering of the implants and conditioning of soft tissues, the definitive metal-ceramic prosthesis was delivered 4 months later (Fig. 7). The patient was checked at least annually thereafter. Radiographic examinations at 1 year and 7 years after surgery confirmed the preservation of peri-implant bone levels over time, and the prosthesis appeared to be fully functional (Fig. 7).

### Discussion and conclusions

The technique presented here makes use of a bone substitute block of equine origin to protect the sinus membrane, after its detachment, from the subsequent operations of filling with biomaterial and simultaneous implant placement, both requiring procedures that may potentially increase the probability of membrane perforation. This technique essentially reproduces the approach outlined by Tulasne using bone harvesting from calvaria: the membrane is protected from any mechanical interactions by placing a bone graft between the implants and the membrane<sup>15, 16</sup>.

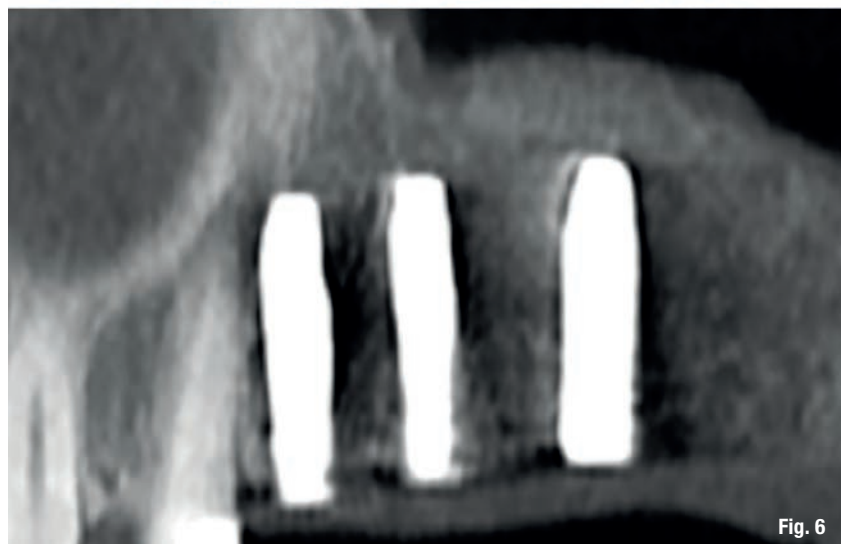
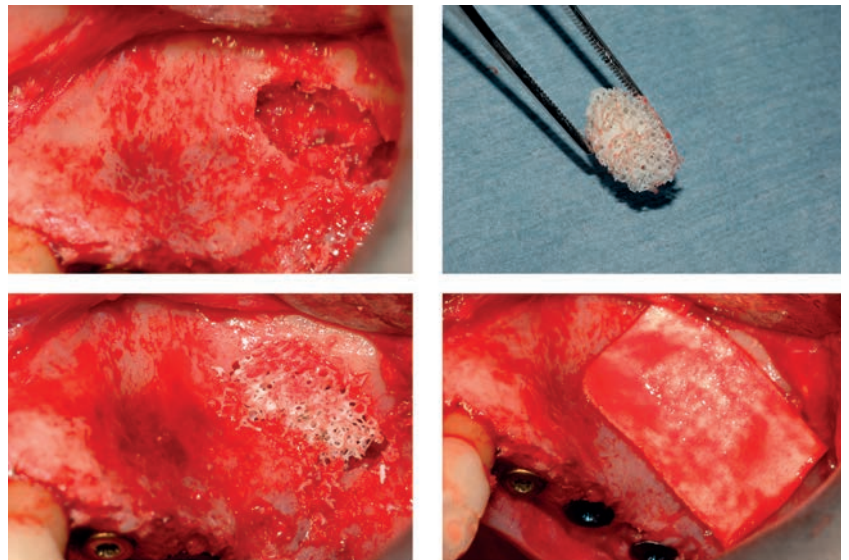


Fig. 6

**Fig. 6** Filling is completed with a mixture of autologous bone and equine-derived bone granules; another fragment of the previously described bone block is also used. The control CBCT shows correct sinus filling and the correct position of the bone block between the implant apex and the sinus membrane.

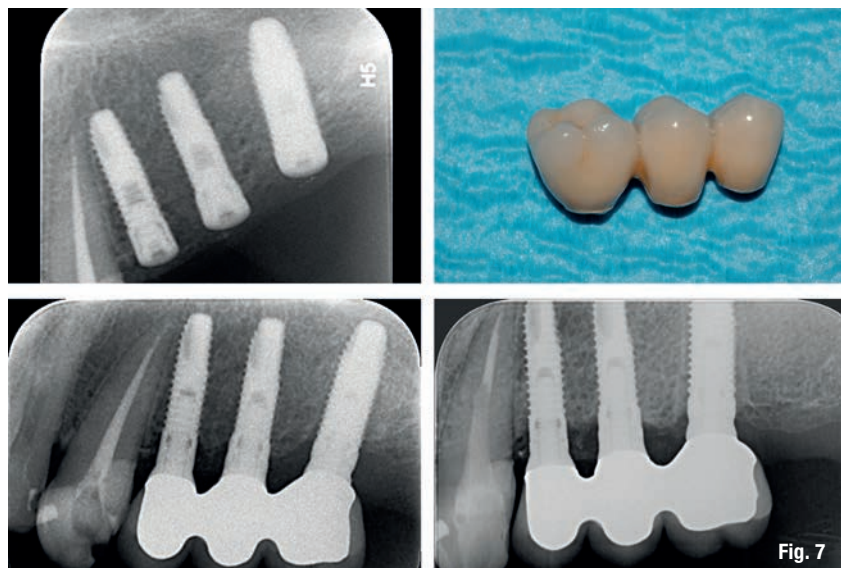
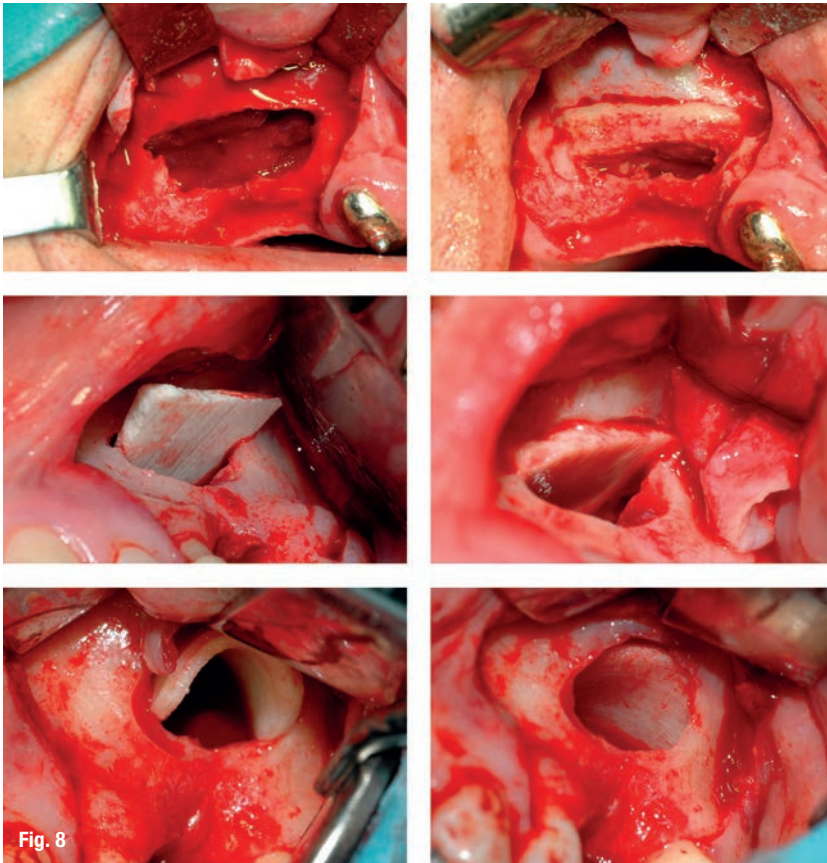


Fig. 7

**Fig. 7** Endoral examination after surgery (top left); the definitive prosthesis and two follow-up endoral examinations taken 1 year (bottom left) and 7 years (bottom right) after implant placement. Peri-implant bone levels are essentially unchanged.

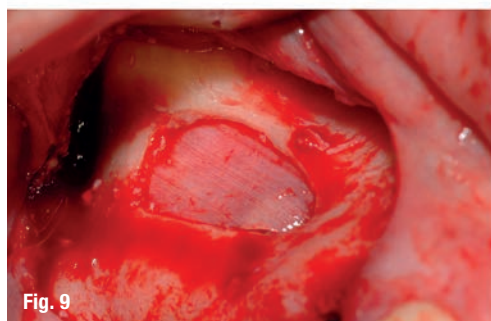
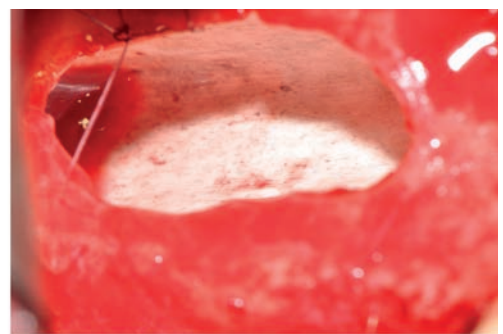
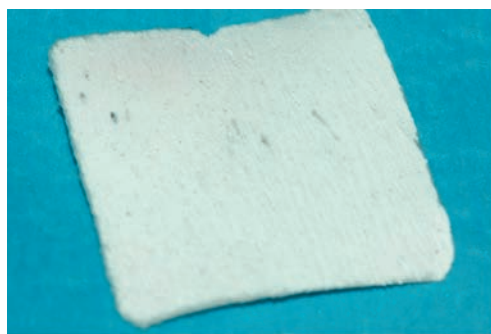


**Fig. 8** Alternative sinus membrane protection techniques using equine bone grafts. The first two images illustrate the traditional Tulasne technique using an autologous bone graft from calvaria. This technique can be reproduced using a lamina of equine cortical bone approximately 2.5mm thick, which can be inserted either like a drawer, by creating two slots as in the original Tulasne technique (second row images) or, taking advantage of the fact that the hydrated cortical bone becomes flexible, by inserting it folded into the socket and allowing it to stretch under the membrane due to elasticity (last two images).

The use of bone substitutes of equine origin (specifically, flexible cortical bone laminae with a thickness of about 2.5 mm) has already been studied by the author, with medium-term follow-up (7 years), as in the case presented here<sup>17</sup>. This technique can be performed either by making two slots in the apical position, in which to slide the cortical lamina, or by inserting it folded under the membrane, and then letting it relax thus exploiting its elasticity (Fig. 8). On several occasions, the author also used a thinner version (0.2 mm) of the cortical bone lamina, which is more similar to a membrane, to protect the sinus membrane (Fig. 9). It should be noted that the same grafts have also been successfully used to manage membrane perforations, even of significant size<sup>18</sup>.

The result of the presented case, in terms of implant success and maintenance of the regenerated bone volume, is consistent with previous studies on the use of collagen-preserved equine bone substitutes in the performance of one- and two-stage sinus floor augmentation<sup>14, 19, 20</sup>. The result obtained in sites of low bone density is consistent with the rational approach described by the author, whereby quantitative measurement of site-specific bone density at the implant placement site is a key parameter in deciding the extent of under-preparation to be performed to provide the implant with appropriate primary stability according to the planned loading protocol<sup>14, 21, 22</sup>.

**Fig. 9** The same operation can be carried out using an equine cortical membrane (top left), which is not dissimilar to the cortical bone lamina shown in figure 8, but of a lower thickness (0.2 mm): exploiting its elasticity the cortical lamina is placed under the sinus membrane where it will stretch and adapt (top right). In the case shown, after completing the filling of the socket (bottom right), a second cortical membrane, identical to the first, is placed under the margins of the antrostomy to close the socket. A collagen membrane is then placed to cover the vestibular area.



**Fig. 9**

Whether the interposition of bone block or cortical lamina grafts under the sinus membrane during simultaneous implant placement is actually more effective in maintaining a more stable grafted and regenerated bone volume over time, in preventing dispersion of the particula-

te graft into the sinus in the event of tear, and in decreasing the likelihood of sinus membrane tears than the traditional approach will need to be the subject of comparative prospective studies specifically designed for this purpose.

## \_bibliography

## implants

- Danesh-Sani SA, Loomer PM, Wallace SS. A comprehensive clinical review of maxillary sinus floor elevation: anatomy, techniques, biomaterials and complications. *Br J Oral Maxillofac Surg.* 2016 Sep;54(7):724-30.
- Tatum H Jr. Maxillary and sinus implant reconstructions. *Dent Clin North Am.* 1986 Apr;30(2):207-29.
- Tatum OH, Jr, Lebowitz MS., Tatum CA., Borgner RA. Sinus augmentation. Rationale, development, long-term results. *NY State Dent J.* 1993 May;59(5):43-8.
- Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. *J Oral Surg.* 1980 Aug;38(8):613-6.
- Del Fabbro M, Wallace SS, Testori T. Long-term implant survival in the grafted maxillary sinus: a systematic review. *Int J Periodontics Restorative Dent.* 2013 Nov-Dec;33(6):773-83.
- Chiapasco M, Casentini P, Zaniboni M. Bone augmentation procedures in implant dentistry. *Int J Oral Maxillofac Implants.* 2009;24 Suppl:237-59.
- Esposito M, Felice P, Worthington HV. Interventions for replacing missing teeth: augmentation procedures of the maxillary sinus. *Cochrane Database Syst Rev.* 2014 May 13;(5):CD008397.
- Summers RB. A new concept in maxillary implant surgery: the osteotome technique. *Compendium.* 1994 Feb;15(2):152, 154-6, 158 passim.
- Cosci F, Luccioli M. A new sinus lift technique in conjunction with placement of 265 implants: a 6-year retrospective study. *Implant Dent.* 2000;9(4):363-8.
- Fugazzotto PA. The modified trephine/osteotome sinus augmentation technique: technical considerations and discussion of indications. *Implant Dent.* 2001;10(4):259-64.
- Trombelli L, Franceschetti G, Stacchi C, Minenna L, Riccardi O, Di Raimondo R, Rizzi A, Farina R. Minimally invasive transcrestal sinus floor elevation with deproteinized bovine bone or p-tricalcium phosphate: a multicenter, double-blind, randomized, controlled clinical trial. *J Clin Periodontol.* 2014 Mar;41(3):311-9.
- Testori T, Del Fabbro M, Weinstein R, Wallace S. Maxillary Sinus Surgery and Alternatives in Treatment. *Quintessence Pub.* 2009.
- Lundgren S, Cricchio G, Hallman M, Jungner M, Rasmusson L, Sennerby L. Sinus floor elevation procedures to enable implant placement and integration: techniques, biological aspects and clinical outcomes. *Periodontol 2000.* 2017 Feb;73(1):103-120.
- Arosio P, Greco GB, Zaniol T, Iezzi G, Perrotti V, Di Stefano DA. Sinus augmentation and concomitant implant placement in low bone-density sites. A retrospective study on an undersized drilling protocol and primary stability. *Clin Implant Dent Relat Res.* 2018 Apr;20(2):151-159.
- Tessier P. Autogenous bone grafts taken from the calvarium for facial and cranial applications. *Clin Plast Surg.* 1982; 9(4):531-8.
- Tulasne JF. Sinus grafting with calvarial bone. In: *The sinus bone graft.* O.T. Jensen ed. Quintessence. Chicago, 1999; p.107-16.
- Di Stefano DA, Cazzaniga A, Andreasi Bassi M, Ludovichetti M, Ammirabile G, Celletti R. The use of cortical heterologous sheets for sinus lift bone grafting: a modification of Tulasne's technique with 7-year follow-up. *Int J Immunopathol Pharmacol.* 2013 Apr- Jun;26(2):549-56.
- Di Stefano DA, Cazzaniga A. Tecniche rigenerative e ricostruttive in chirurgia pre-implantare. Elsevier. Milan, 2012.
- Di Stefano DA, Gastaldi G, Vinci R, Cinci L, Pieri L, Gherlone E. Histomorphometric Comparison of Enzyme-Deantigenic Equine Bone and Anorganic Bovine Bone in Sinus Augmentation: A Randomized Clinical Trial with 3-Year FollowUp. *Int J Oral Maxillofac Implants.* 2015 Sep- Oct;30(5):1161-7.
- Di Stefano DA, Gastaldi G, Vinci R, Polizzi EM, Cinci L, Pieri L, Gherlone E. Bone Formation Following Sinus Augmentation with an Equine-Derived Bone Graft: A Retrospective Histologic and Histomorphometric Study with 36-Month Follow-up. *Int J Oral Maxillofac Implants.* 2016 Mar-Apr;31(2):406-12.
- Di Stefano DA, Arosio P. Correlation Between Bone Density and Instantaneous Torque at Implant Site Preparation: A Validation on Polyurethane Foam Blocks of a Device Assessing Density of Jawbones. *Int J Oral Maxillofac Implants.* 2016 Sep-Oct;31(5):e128-35.
- Di Stefano DA, Arosio P, Gastaldi G, Gherlone E. The insertion torque-depth curve integral as a measure of implant primary stability: An in vitro study on polyurethane foam blocks. *J Prosthet Dent.* 2017 Jul 8. pii: S0022-3913(17)30300-1.