Closure of oroantral communications using heterologous biomaterials stabilized by porcine cortical lamina: A case series

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Abstract: Purpose: To describe a surgical technique for oroantral communication closure and bone regeneration that can meet the needs of an effective, less invasive, and simpler surgery using approaches and biomaterials used in guided bone regeneration (GBR) techniques. The main objective was to close the communication, and the secondary was to achieve bone regeneration. **Methods:** This retrospective and monocentric case series was conducted using data obtained from the medical records of 28 patients with oroantral communications with bone deficits greater than 3 mm and treated with heterologous cortico-cancellous collagenic graft covered with resorbable collagen membranes and heterologous cortical lamina. The primary outcome was closure of the communication, and the secondary outcome was bone augmentation, both tested radiographically and clinically. **Results:** 28 subjects were treated consecutively for the closure of oroantral communications. The subjects included 16 men and 12 women. The mean age was 57.5 years. Closure was successful in all 28 cases, and radiographic control after 6 months showed bone regeneration in all the cases. This technique was effective in isolating the maxillary sinus from the oral cavity, showing results in terms of seal and healing, and bone regeneration. (*Am J Dent* 2024;37:33A-36A).

Clinical significance: Oroantral communications are frequent in dentistry, requiring special expertise and interventions affecting patient morbidity. The use of a heterologous cortical lamina can allow effective closure of the communication, preventing migration of pathological epithelia while increasing the bone ridge.

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Introduction

The maxillary sinus is the largest of the paranasal sinuses. It is an internally hollow structure, pyramidal in shape, composed of five thin bony walls that are covered by a mucosa called the Schneiderian membrane.

The maxillary sinus must remain isolated from the buccal cavity to perform its physiological functions. However, there is a close continuity between the maxillary sinus floor and the upper distal dental ridges, particularly between the roots of the second premolar, first molar, and second molar. The distance between the sinus floor and apices is 7 mm in the first premolar region and 2 mm in the second molar region, with the shortest distance above the distobuccal apex of the second molar.[1] Some studies[2] have shown that the mean distance from the apex to the floor of the maxillary sinus decreases with increasing age. This continuity exposes the maxillary sinus to infectious and traumatic insults in case of dental compromise of these elements, which, if not treated correctly, can lead to communication between the mouth and maxillary sinus, thus establishing odontogenic sinusitis.[3]

Oroantral communication (OAC) is a complex defect involving the soft and hard tissue layers.[4] OACs may close spontaneously, especially when the defect is smaller than 5 mm.[5] Nevertheless, to our knowledge, it has never been proven that small OACs (< 5 mm) heal independently. In addition, it is difficult to clinically determine the size of an OAC.[6] To prevent the development of chronic sinusitis and fistulas, it is generally accepted that these defects should be closed within 24 to 48 hours.[6,7] Currently, the closure of OACs is usually performed by a surgical procedure. In the case of a small OAC, suturing the gingiva may be sufficient to close the perforation. When adequate closure is not achieved, a flap procedure is the treatment of choice. When deciding how to treat an OAC, several aspects should be considered: the size of the communication, time of diagnosis, and presence of an infection.[8]

Furthermore, the selection of the treatment strategy is influenced by the amount and condition of the tissue available for repair and the possible placement of dental implants in the future. Surgical therapy for the closure of OACs has several disadvantages, such as the need for surgical expertise and equipment, postoperative pain and swelling, and possibly a permanent decrease in buccal sulcus depth. Several techniques have been used over the years.[7]

This study evaluated a surgical technique for OAC closure and bone regeneration that can meet the needs of an effective, less invasive, and simpler surgery using approaches and biomaterials used in bone augmentative procedures. The main objective was to close the communication, and the secondary objective was to achieve bone regeneration.

Material and Methods

Study type and design - This retrospective, observational case series was conducted using data obtained from the medical records of consecutively treated patients from 2015 to 2022. The Ethics Committee of the Agostino Gemelli University Hospital Foundation IRCCS approved this study (Protocol number 0009738/22).

The investigations were conducted following the 1975 Declaration of Helsinki on human experimentation, as revised in 2013 for ethical approval. Subjects selected by the inclusion

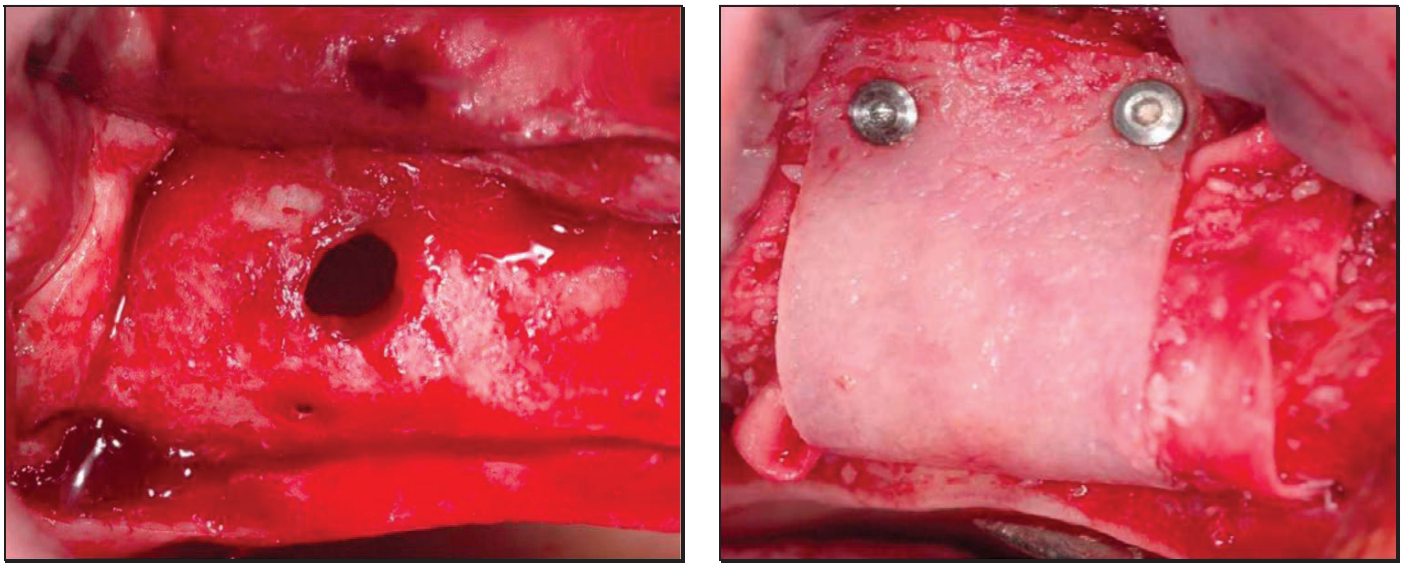

Figure. **A**: Intraoperative view of the OAC. **B:** Placement of a heterologous cortico-cancellous graft (Gen-Os) covered with resorbable collagen membranes at the level of the maxillary sinus floor (Evolution). A rigid heterologous cortical plate (Lamina) was inserted above and stabilized with pins.

and exclusion criteria were required to sign the written informed consent form for all the data collected for the study.

Study population - Twenty-eight subjects with OACs with bone deficits greater than 3 mm were selected based on the following inclusion criteria: age > 18 years; systemically healthy subjects; smokers and non-smokers; able to provide written informed consent. The exclusion criteria were as follows: subjects irradiated in the head and neck; uncontrolled diabetes; general contraindications for oral surgery; pregnant or breastfeeding; abuse of alcohol or other drugs.

Data were collected regarding the patient's age, sex, dimensions (mesiodistal × vestibule-palatal in mm) area, and etiology of the OAC. OAC was diagnosed using CBCT and clinically confirmed and measured at the crestal level using a millimeter-scale probe. OAC closure techniques are based on a heterologous cortical-cancellous graft covered with resorbable collagen membranes and a rigid heterologous cortical lamina to increase stability, thickness, and resorption time.

Surgical procedures - All the surgeries were performed by the same operator who had experience in treating OAC, ensuring standardization of the technique.

Before the surgery, each patient took oral amoxicillin 875 mg/clavulanic acid 125 mg (Augmentin[a] 1,000 mg) on the morning of the surgery and continued twice daily for a total of 5 days. The surgeon administered a local anesthetic (articaine hydrochloride 4% with adrenaline 1:100,000, Septanest[b]) before the surgery.

Regarding the anesthetic technique used, local anesthesia was administered starting from the most distal area. First, the posterior superior alveolar nerve, and subsequently more mesially, in the fourth area, the infraorbital nerve was anesthetized. Palatally, the greater palatine and nasopalatine nerves were anesthetized. When necessary, the local anesthetic was administered in areas that were still sensitive to pain. This sequence of anesthesia allowed us to obtain excellent results by making the last one less annoying for the patient at the palatal level.

Technique description - Following a crestal incision using a scalpel and 15c blade, a full-thickness mucoperiosteal flap was raised using a periosteal elevator. It was thus possible to make the communication more visible and easier to approach the sinus (Fig. A). At this phase, it was useful to collect the blood that came out of the flap incision using a syringe without a needle and set it aside to mix it with the heterologous cortico-cancellous bone. After the detachment of the Schneiderian membrane, a heterologous cortico-cancellous collagenic graft (OsteoBiol Gen-Os[c]), covered with a resorbable collagen membrane (OsteoBiol Evolution[c]) was inserted vestibularly and palatally inside the maxillary sinus (Fig. B). The membrane was positioned in excess and stabilized on the crestal walls of the defect because of the flap or, when necessary, by pins. Care was taken when inserting the graft in contact with the palatal and vestibular walls of the maxillary sinus.

Then a heterologous cortical lamina (OsteoBiol Lamina,[c] Semi-Soft thickness 1 mm) was inserted and oversized by approximately 2 mm compared to the existing defect. The cortical lamina was stabilized by a thermoplastic gel (OsteoBiol TSV Gel[c]) or pins (Fig. B). The flap was then repositioned, resulting in a primary closure with two horizontal mattress sutures and a continuous crestal suture.

Non-absorbable 4/0 threads in the pseudomonofilament of polyamide[d] sutures were used to obtain closure by primary intention.

After the surgery, the subject continued antibiotic therapy and received nasal decongestant and steam inhalation. All patients were advised to refrain from blowing their noses, inflating balloons, playing wind instruments, or drinking through a straw. The sutures were removed 10 days after surgery.

Postoperative follow-up - Control appointments were made at 1, 10, and 15 days, and at 1, 3, and 6 months after the intervention. All the subjects received detailed instructions regarding their oral hygiene. X-ray control and CBCT was performed 6 months after the surgery.

Results

Twenty-eight subjects were treated consecutively for the closure of OACs (Table). The subjects included 16 men and 12

Table. Clinical data and results.

Subject	Age	Zone	Mesio-distal	Vestibulo-palatal	Etiology	Complications	Healing time (days)	Bone gain 6 mo (mm)
1	66	2.5-2.7	17	8	Implant complication	No	15	10
2	59	2.3	3	3	Implant complication	No	15	12
3	41	2.6	7	3	Strange body	No	15	6
4	51	1.6	3	33	Classic	No	15	1
5	70	1.6	3	3	Classic	No	15	1
6	65	1.7	4	3	Classic	No	15	1
7	56	2.7	4	3	Classic	No	15	6
8	59	1.5	3	3	Strange body	No	15	1
9	62	1.6	3	3	Classic	No	15	8
10	69	2.3	3	3	Strange body	No	15	1
11	62	1.6	6	6	Classic	No	30	6
12	59	1.6	6	4	Classic	No	15	12
13	45	1.4	5	4	Classic	No	15	15
14	41	2.5-2.6	7	4	Classic	No	15	8
15	42	2.6	8	3	Classic	No	15	6
16	55	1.5	3	4	Classic	No	15	11
17	62	2.6	6	5	Classic	No	15	14
18	67	1.6	4	4	Classic	No	15	1
19	45	1.6	5	3	Strange body	No	15	5
20	63	1.7	6	4	Classic	No	15	7
21	71	2.7	4	4	Strange body	No	15	3
22	49	1.5	4	3	Implant complication	No	15	12
23	65	1.6	6	4	Classic	No	15	8
24	58	2.3	3	3	Classic	No	15	5
25	64	1.6	5	4	Strange body	No	15	4
26	41	1.4	3	3	Implant complication	No	15	12
27	69	1.6-1.7	15	7	Classic	No	15	7
28	53	2.6-2.7	7	3	Classic	No	15	9

women. Their mean age was 57.5 years ± 9.68 (range, 41-71 years). Seventeen subjects had OACs in quadrant I and 11 in quadrant II. OACs were created for complications after tooth extraction in 18 subjects, implantation complications in four subjects, and foreign body complications in six subjects.

The lesion had a mean size of 5.5 mm ± 3.4 (range, 3 to 17 mm) in the mesiodistal direction, and 4.9 mm ± 1.3 (range, 3 to 8 mm) in the vestibule-palatal direction. Eight perforations were 3-4 mm in diameter, and the other seven were larger than 6 mm.

Primary outcome - All the interventions were performed without unforeseen circumstances and closure was successful in all 28 subjects. Treatments with a cortico-cancellous graft cover, resorbable collagen membranes, and the lamina were well tolerated by all subjects, and soft tissue healing was regular in 15 days.

Secondary outcome - Radiographic examination after 6 months showed bone reformation and restoration of the maxillary sinus in all the cases. After 6 months, the mean bone gain was 6.9 mm ± 4.3 over a range of 1-15 mm.

Discussion

The closure of oroantral communications was studied using heterologous biomaterials to support bone regeneration and stabilize the closure using approaches and biomaterials used in GBR techniques. The results of this case series showed that the use of these techniques seems to be a valid alternative and support for the treatment of oroantral communications with a diameter greater than 3 mm.

Sinus membrane elevation is a common procedure to increase the volume of the maxillary sinus bone floor before the insertion of dental implants.[9] The closure of oroantral communications is indispensable for preventing bacterial access to the maxillary sinus and treating odontogenic sinusitis.[10]

A recent study[11] showed that the layer of periosteum cells at the base of the sinus membrane, which has an osteogenic function, plays a key role in bone regeneration after sinus lift. Lundgren et al[12] investigated the process of bone regeneration after a sinus lift and found that even without the insertion of bone graft material, there was sufficient bone regeneration. This is because the basal cell layer of Schneider's membrane initiates bone regeneration and production in the absence of any calcified structure providing osteoprogenitor cells, and humoral factors, acting as a primary vector using the blood clot alone.

However, a volumetrically stable sub-antral filling material is required to stabilize the loosened sinus membrane, and for the formation of a blood clot to achieve sufficient augmentation heights and widths for implant insertion later.[13]

The choice of material is very important in sinus surgery. However, the ideal bone graft has not yet been determined. It depends on the location, volume of bone loss, local and general context, etiology, and individual properties of the substitute.[10]

Autologous bone is considered the gold standard in terms of osteogenic potential because it provides osteoblasts and organic and inorganic matrices for osteoinduction and osteoconduction.[10] The bone can be taken extraorally, mainly from the iliac crest,[14] or intraorally, mainly from the chin.[15] However, a limited amount of bone is available at intraoral sites, and when autogenous bone is harvested from the oral cavity, such as the mandibular ramus or symphysis, the amount is often insufficient for the procedure.[16] On the other hand, the extraoral site usually requires general anesthesia, increasing the time and cost of treatment and causing significant morbidity.[17] Furthermore, autologous bone tends to promote bone resorption, which reduces the initial graft volume and donor site morbidity. Bohr et al[18] showed that the advantage of freshly harvested autolo-

gous bone grafts at the augmentation site over deproteinized bone is only true in the first 5 days after surgery. To overcome these problems, bone substitutes were used instead or mixed with bone.

In this study, we used three materials: a porcine cortico-cancellous bone mix collagenated in granules, a resorbable membrane in heterologous mesenchymal tissue made up of collagen fibers, with a micro-rough side and a smooth side,[19] and a hard collagenated, resorbable porcine cortical bone lamina,[20] which was added to achieve greater stability and longer resorption time. This guarantees the stability and prolonged protection of the underlying graft.

Special attention must be paid to the vascularization of the inserted material, because a good restoration of the alveolar ridge, in the timely healing process after bone regeneration, is necessarily preceded by sufficient angiogenesis and vascularization of the scaffold. If the inserted material is not well perfused, it could constitute a foreign body within the sinus, with all the resulting complications and subsequent failure of the surgery. It is a mechano-sensitive process to be strictly taken into consideration: the macro- and micro-movements of the flap by the muscular activity in and around the oral cavity, around the maxillary bones, and inside the maxillary sinus from the activity of the respiratory tract cannot be avoided; however, improving the angiogenesis process during the healing phase could be alleviated.[13]

This study shows that the heterologous cortico-cancellous graft technique covered with resorbable collagen membranes and heterologous cortical lamina is effective in isolating the maxillary sinus from the oral cavity, obtaining adequate results in terms of sealing and healing of the OAC communication and reformation of the hard tissue, sufficient to avoid recurrence of the OAC.

Regarding the secondary outcome of bone gain, favorable results were obtained, thus enabling bone regeneration also useful for the placement of implants for posterior implant-prosthetic rehabilitation after post-surgical healing of the site. This technique is easier for the clinician to manage than other commonly used techniques (e.g., Bichat's adipose bubble traction); moreover, the use of heterologous materials allows unlimited availability and reduces patient morbidity compared with autologous material harvesting.

Among the limitations of the study, we report that this is a case series in which no other techniques or other materials for treating OAC communications were compared. However, due to the limited number of patients included in the study, and the lack of one or more control groups, further studies are necessary to validate the results obtained. Histological examinations to study the newly formed bone quality and reaction to bone substitutes are also warranted in future studies.

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