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SYSTEMATIC REVIEW

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What are the outcomes of dental implant placement in sites with oroantral communication using different treatment approaches?: a systematic review

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Abstract

Background Oroantral fistula is a pathologic condition caused by various procedures including extraction, trauma and implant insertion. To date, various techniques have been suggested for oroantral fistula management. The aim of this review was to evaluate the outcomes of oroantral communication/fistula closure techniques followed by simultaneous or delayed implant placement.

Methods Based on the search strategy, an electronic search for English-language clinical studies was performed in PubMed, Web of Science, Scopus and Google Scholar from January 2000 until December 2024. All studies with the focus on the outcomes of oroantral communication/fistula closure followed by simultaneous or delayed implant placement were included.

Results Initial research led to 56 studies. Following removal of duplicates and irrelevant studies, full texts of 20 articles studies. Finally, 15 studies were included in the review. In 3 and 11 studies, implant placement was performed simultaneously or delayed, respectively and one reported both protocols. The largest and smallest diameter of fistula were 20 mm and 4 mm, in order. Different treatment protocols including bone grafting, buccal fat pad and collagen strip technique were performed in included studies. None of the studies mentioned undesirable effects during follow-ups.

Conclusion All treatment modalities offered acceptable outcomes. However, because of heterogeneity of studies, no standard treatment protocol can yet be suggested. However, influential factors including defect characteristics, patient's medical history and sinus health, location and accessibility must be considered prior to choose the best treatment approach.

Keywords Dental implantation, Dental implants, Oral pathology, Oroantral fistula, Maxillary sinus, Schneiderian membrane

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Background

Oro-antral communication (OAC) indicates a connection between the maxillary sinus and the oral cavity. If this communication is left unclosed for more than three months, especially in defects larger than half a centimeter, it usually progresses to oroantral fistula (OAF) or chronic inflammation of the sinus membrane [1–6]. This is a pathological condition which acts as a path for

bacteria penetration and can further cause chronic maxillary sinusitis [1, 4, 6]. Remained OAC might lead to sinusitis with the reported rate of 50% within 24 h and 90% after 2 weeks [1, 3]. The presentation of symptoms associated with OAC can be highly variable depending on the size and location of the fistula, as well as the individual's overall health and may not appear until well after the formation of the fistula making early detection challenging [7]. The most commonly reported symptoms associated include epistaxis, fluid leakage from the oral cavity to the nose, pain, postnasal drip, altered voice quality and facial swelling [6, 7]. The typical sign during a dental exam is appearance of small bubbles in the oral cavity during the Valsalva maneuver [7].

The most common etiologies of OAC are unsuccessful maxillary sinus lift, bone grafting, implant removal/insertion and posterior maxillary teeth extraction in the proximity to the sinus floor which may cause maxillary sinus perforation with a range of frequency from 0.31% to 4.7% [1, 5, 6, 8]. Other OAC causes include trauma, infection and pathology [1]. A close relationship between the maxillary molars and the sinus is observed in 20% of cases [2]. OACs with a size of <2 mm often close spontaneously, while communications >3 mm can progress to an OAF in the absence of treatment [3]. In order to select the best approach for OAF closure, factors including dimensions of communication, presence of infection and foreign body, the timing of diagnosis, patient's medical history, future reconstruction treatment plan and clinician's experience have considerable effects [5, 6, 9, 10].

Though various approaches have been introduced for OAC management including buccal advancement flaps, platelet-rich fibrin (PRF) applications and ligature suture, there is no definitive consensus on the ideal treatment method [5, 6, 11]. It is critical to consider several factors as location and size of the defect, adjacent teeth epithelialization, concomitant secondary sinus infection and alveolar ridge height to achieve more success [7, 12]. Small communications, measuring less than 3 mm in diameter, without an infection, can often heal without intervention [7]. The most widespread surgical approach with high success rate for large (> 4 mm) or non-resolving OAC is rotation or advancement of local flaps such as the buccal or palatal mucosa, buccal fat pad, submucosal tissue, or tongue tissue [4, 5, 8].

Surgical removal of the epithelial tract has always been considered the standard method [4, 13]. However, the persistent chronic fistula and those with failed previous surgical closure; with subsequent morbidity and deficient vascular state are not only difficult to manage, but also requires more advanced surgical maneuvers [4, 8]. The buccal fat pad (BFP) pedicled flap had obtained wide acceptance for coverage of defects of ≤ 5 mm and resisting OAF since the perfusion, blood supply and the capacity of the fat pad is adequate consistency, ensuring a stable double layered soft tissue closure without noticeable complications [4, 5, 7, 10]. One of the major drawbacks with repairing OACs and OAFs with only simple soft tissue coverage techniques is the inability in inducing hard tissue regeneration, as well as decreased vestibular depth, Schneiderian membrane fusion with the soft tissues and difficulty in prosthetic rehabilitation [1, 4–6, 14, 15]). For this problem, allogeneic, xenogeneic and alloplastic materials can be successfully used in OAC/OAF management for bone grafting and sinus lift procedure [1, 3, 4, 6, 16].

Prior to the recent trends in dental implant use, simple closure of these various local flaps was usually sufficient to precede further conventional prosthetic treatment in most OAF cases. However, modern dental implants often require more reconstructed bone at the implantation site [17]. Although many surgical techniques are described for maxillary reconstruction before dental implants in common OAF, there is little evidence of the long-term implants success when used as clinical adjuncts in the repair of an OAC [18]. Hence, the goal of this study was to review surgical approaches of OAC closure and outcomes of further implant placement to help surgeons choose an appropriate treatment pathway for such cases.

Methods

This systematic review was conducted according to the recommendations of the principles of PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) statement. The protocol of this systematic review has been registered in the PROSPERO (CRD420250656072).

Eligibility criteria

All clinical studies which mentioned OAC/OAF closure techniques followed by immediate or delayed implant placement, as well as implant related outcomes were considered eligible for the current review.

Information sources

An electronic search of information sources including PubMed/MEDLINE, Google Scholar, EMBASE, Scopus and Web of science was performed. Additionally, a further hand search was conducted for assessing publications which were not electronically distinguished. The search was performed from January 2000 until December 2024.

Search strategy

The following focused question was formulated to address the literature and outline the search strategy:

What are the treatment modalities and their success rates to place dental implants in the area of OAC or OAF with simultaneous or delayed approach? The PICO for the present study was defined as follows:

> Population (P): patients who received dental implants simultaneous or after OAC/OAF closure.
> Intervention: treatment modalities for OAC/OAF closure.
> Comparison (C): None.
> Outcome (O): Success rate.

The electronic search was performed to select the relevant studies. The search was limited to studies published in English language using the following keywords: "oro-antral communication" AND/OR "oro-antral fistulae" AND/OR "dental implant" AND/OR "OAC" AND/OR "OAF".

All clinical studies focusing on OAC/OAF closure followed by dental implant placement were included. Abstracts, letters and reviews were excluded. The irrelevant studies and those performed only OAC closure without implant placements, studies without results of inserted implant after closure and grafting and implant placement after large pathology lesions were not considered in the review process. Also, studies were excluded if they had evaluated results other than OAC closure and implant placement. De-duplicating was further performed.

Selection process

Two independent authors conducted the search according to the mentioned keywords. Also, they performed the initial screening of titles and abstracts from the selected studies based on the eligibility criteria. Finally, the eligible studies were included and the other two authors performed the review on full texts. Any disagreements between the reviewers were resolved following discussions.

Data collection process/items

Two independent reviewers performed data collection. Data regarding study type, patients' characteristics, OAC dimension, OAC closure technique, OAC closure outcome, implant placement procedure and implant placement results in term of implant survival, patient satisfaction and any kind of sign or symptoms were extracted and further classified in two separate tables. Any disagreement was resolved following discussion.

Risk of bias assessment

Two independent reviewers performed risk of bias assessment. The criteria used for the assessment of quality of the included studies were obtained from Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach which consider five different categories of bias: (1) Inappropriate eligibility criteria;(2) Inappropriate methods for exposure and outcome variables; (3) Not controlled for confounding; (4) Incomplete or inadequate follow-up; (5) Other limitations. The degree of bias was categorized as low risk, unclear risk and high risk and the results were reported in a tabular format. The resolve of disaccords was also carried out.

In addition to GRADE approach, the criteria for the assessment of quality of the included studies obtained from The Joanna Briggs Institute (JBI) Critical Appraisal Checklist was used for Case Reports and Case Series. The degree of bias was categorized as low risk, moderate risk and high risk. Quality assessment was conducted. The resolve of disaccords was also carried out.

Results

Study selection

Initial research led to 56 studies. Following duplicates' removal, 47 ones remained. Following assessment of titles and abstracts, 24 more irrelevant studies were excluded. Full texts of the remained 20 articles were screened and 5 studies did not meet the inclusion criteria because of the following reasons: (1) Two Studies did not place implants after OAF closure, (2) One study had no reports regarding the outcome of closure and implant placement, (3) In two studies, implant placement was performed after large pathology lesion.

Finally, 15 studies were included in our review and their data was extracted and further classified in 2 tables. In Table 1 with 3 studies, implant placement was performed simultaneously with OAF closure; while in Table 2 including the rest 12 studies, there were intervals between OAF closure and implant placement. One study was mentioned in both tables as it reported different cases of simultaneous and delayed implant placement (Fig. 1, Tables 1, 2, and 3).

Study characteristics

In the first group, all included studies were case reports and in the second group, 4 and 8 studies were case reports and case series, respectively. In 14 studies, OAF closure and implant placement was performed in 10 s molars and 9 first molars' area. In only one case series, surgeries were performed in atrophic posterior maxillae [8]. In the 2nd group, the largest reported size of OAF was ≥ 20 mm [6], while the smallest size was 4 mm [22]. In the first group, 3 studies used membrane and bone graft [15, 18, 19], while one study performed BFP approach [3].

Table 1 Search strategy process

Data bases	Initial results	Screened studies for eligibility	Exclusion reasons	Journals of included records
Pubmed	25	9	-Only OAC closure without implant placement: 2 - No results of installed implant after closure and grafting: 1 - Implant placement after large pathology lesions: 2	-Nigerian journal of clinical practice: 1 -Implant dentistry: 2 -Journal of oral implantology: 1 -Journal of maxillofacial surgery: 1 -Medicina: 2 -Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics: 3 -Journal of craniofacial surgery: 3 -Journal of clinical and experimental dentistry: 1
Web of science	9	4		
Scopus	6	3		
Google scholar	7	3		
Total	47	19	5	14

In the second group, OAF closure techniques used were membrane + Allograft [6], zygomatic graft [2], sandwich technique [1], chin and/or retromolar bone blocks [17], iliac crest bone block [8], collagen strip technique (CST) [5], modified endoscopic sinus surgery (MESS) [9]), Le Fort I osteotomy + BFP flap [20], BFP flap [10], Bone substitutes + membranes [19, 21, 22].

Follow-up and reported outcomes

Eleven studies mentioned follow-up periods with the mean time of 19.9 months. The maximum and minimum follow-up period were 5 years [18, 19] and 4 months [8], respectively. In 2 studies, cone beam computed tomography (CBCT) evaluation was performed follow-up periods [19, 22]. In another study, histologic assessment was used to evaluate new bone formation after 6 months [6]. One study mentioned satisfaction score among its study outcomes [8]. In two studies, marginal bone loss around implants was reported to be minimum (< 2 mm) [8, 21]. Wound dehiscence, maxillary sinusitis and OAF reoccurrence were among other reported outcomes in the included studies. Among the studies with delayed implant placement, a minimum of 3 months was stated prior to second intervention. Tables 1 and 2 shows more details regarding the included studies.

Risk of bias

The risk of bias of the 15 observational studies in humans (case report and case series) was assessed according to the Grade Criteria for observational studies. We identified a high risk of bias in all studies for one of these categories: Inappropriate eligibility criteria. Only 40% of the studies included a correction for confounding factors. 93% of studies reported follow up. We did not find any evidence of other limitations and, therefore, we scored these this category as unclear risk. Table 4 shows more details about bias in the included studies rated as "low", "unclear" and "high" risk of bias for each of the five categories of bias.

Based on JBI Critical Appraisal Checklist, the degree of bias was measured moderate for the included researches. Almost all studies lacked blindness and randomization. Some scores were inapplicable for included clinical studies. Focusing on the high-risk items, only 2 out of 10 case reports clearly reported the presence of adverse events after the surgeries, while in 2 case series, no statistical analysis was performed for variables; with the exception of age. Tables 5 and 6 show more details about reported bias in the included studies.

Discussion

OAC is defined as a pathologic condition which connects oral cavity with the maxillary sinus. This pathologic communication, if exceeds > 0.5 mm, can proceed to an epithelial tract during 3 months [4, 23]. Several modalities have been proposed for OAC/OAF closure including platelet rich fibrin (PRF), soft tissue flaps, adipose tissue vestibular flaps, etc. [2, 6]. According to Otero et al., patients with residual bone height of 4 mm or less in the posterior maxilla may have a higher risk of implant failure following sinus elevation [16]. However, their study also indicated that the application of PRF may be an effective method for reducing the time needed for new bone formation, which could potentially improve implant success rates in these patients [16].

Despite similar rates of success for different techniques, diverse factors like location and amount of bone atrophy, presence of infection, patient's medical history and timing of diagnosis should be considered prior to treatment selection [2, 20]. Our present study focused on reviewing OAC/OAF closure techniques in adjunct with simultaneous/delayed implant placement.

Among 36 patients that were included in the present review, 5 patients received OAC closure simultaneous

Table 2 Oro-antral communication closure and simultaneous implant placement

Author/year	Study type	Sex/age	Signs & symptoms	OAC closure & implant placement	Medical care after closure	Outcome (SCR, SVR, BL, follow up)
Hirsch Doobrow et al., 2008 [18]	CR	F 73y	-Clinically broken maxillary 2nd molar -Atraumatic tooth & cystic like soft tissue extraction -Sinus perforation	-Socket debridement -Folded CM over small perforation, extending laterally over socket walls -SE (CM + FDBA & Ca sulfate) -An HA-coated 6.5 * 10 mm implant	Broad spectrum AB & + 0.12% CHX solution BID for 2 min for 2 w	-Implant loading: after 6 m -Follow up: quarterly basis for 1 st y after loading: occlusal adjustments & debridement – 5 yrs follow-up: No radiographic evidence of bone loss or clinical signs of mobility or suppuration
Cortes et al., 2010 [3]	CR	F 42y	-No relevant medical history -Tooth extraction 1 m prior due to periodontal infection & PA radiolucency -No signs of sinus infection but OAC at this moment	-Upper 2nd molar extraction with advanced endodontic & periodontal disease with OAF elimination -SE above defect -BFP graft for OAC closure - Anterior sinus floor reconstruction: a monocortical graft & a xenograft after OAF/OAC treatment – 2 implants in upper 2nd premolar & pterygoid zone	-	-No complications & 6 m later, final prosthetic rehabilitation, employing a 3-unit screw-retained prosthesis – 3 yrs follow up: Well-osseointegrated
Kara et al., 2015 [15]	CR	1.M, 27y 2.M, 22y	1. Radiolucency around roots related to sinus & sinus perforation at tooth socket 2.OAC caused by upper 1 st molar extraction 3. Radiolucency in alveolar bone between 2nd upper premolar & upper molar 4.Positive Valsalva in both	Same protocol in both patients: -SE -A membrane to close perforation -Particulate graft material inserted into space between maxillary alveolar process & sinus mucosa -Simultaneous implant	-	1.Follow-up at 47 m: -No radiographic evidence of bone loss or clinical signs of mobility or suppuration -Healthy maxillary sinus 2.Follow-up at 40 m: -No radiographic evidence of bone loss or clinical signs of mobility or suppuration -No complications related to maxillary sinus
Park et al., 2024 [19]	CR	M 57 y	-Smoker -No systemic diseases -OAF in maxillary left posterior region following dental implant placement and continuous bone resorption -incision & drainage for sinus graft infection after sinus augmentation -Fistula remained unclosed	-Pre operative AB (amoxicillin/clavulanate potassium 375 mg, TID) for 2 w -Presence of bone defect (1.7 cm) -SE -Performing a pouch within maxillary sinus, creating a space -Protection of perforated sinus mucosa with a contoured d-PTFE membrane - 4 SLA-textured implants utilization -Filling of elevated space with a synthetic bone graft substitute -Cortical bone shell graft from lateral window of the right side & covered with a resorbable CM	-Systemic AB: amoxicillin/clavulanate potassium 375 mg, TID for 2 w -Strict avoidance of nose blowing & smoking	-Uneventful healing after 2 w & 6 m -Successful closure of recurrent OAF -CBCT 12 months after prosthesis delivery: reduced mucosal thickening & well-maintained sinus graft & d-PTFE membrane without complications -No exposure of membrane into sinus

AB Antibiotic, *BFP* Bichat fat pad, *BL* bone loss, *Ca* Calcium, *CHX* Chlorohexidine, *CM* Collagen membrane, *CR* Case report, *d-PTFE* Titanium-reinforced high-density polytetrafluoroethylene, *F* Female, *FDBA* Freeze dried bone allograft, *HA* Hydroxyapatite, *min* Minutes, *m* Months, *M* Male, *OAC* Oroantral communication, *OAF* Oroantral fistula, *SE* Sinus elevation, *SCR* success rate, *SVR* survival rate, *TID* Three times a day, *w* weeks, *y(rs)* Year(s)

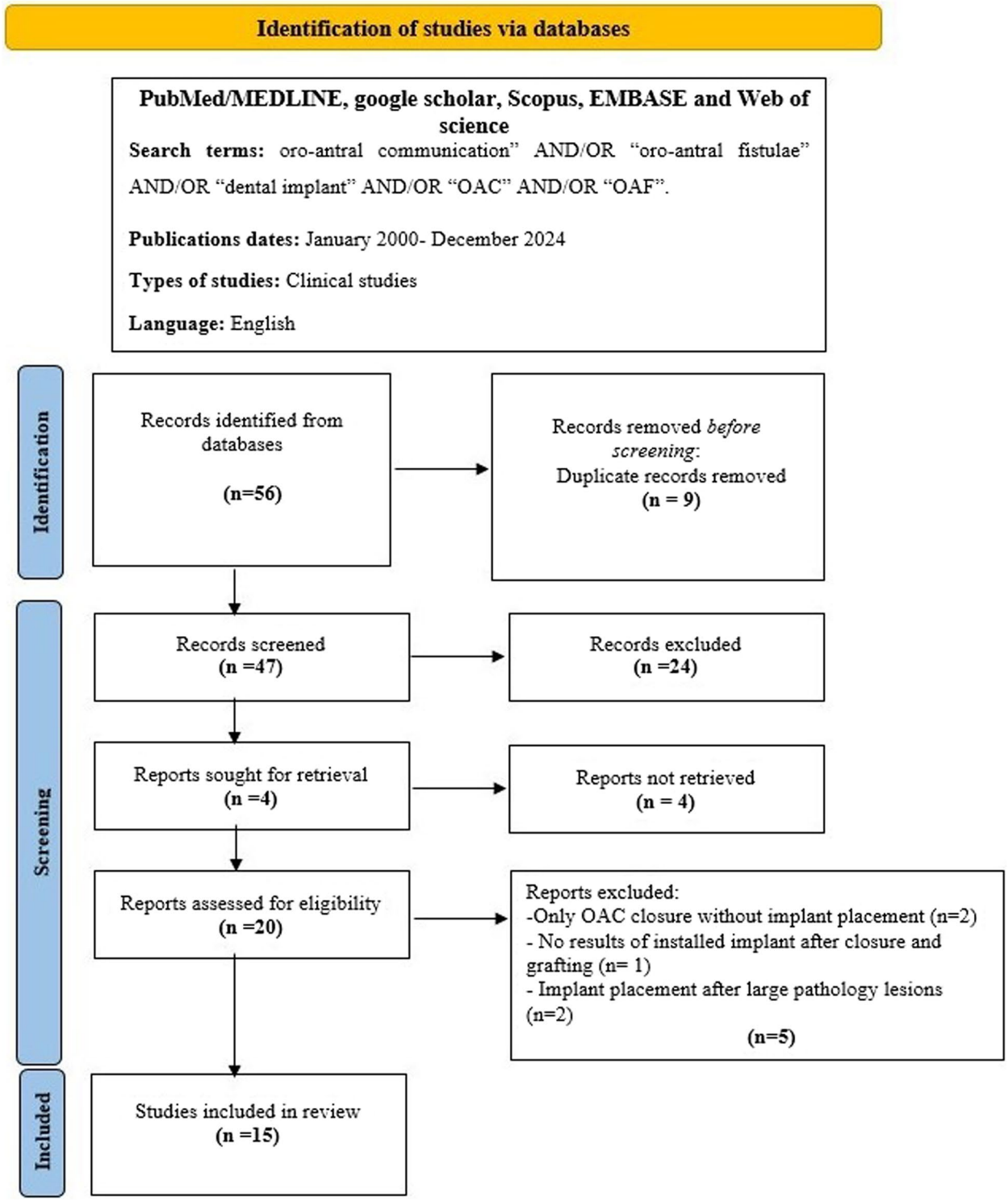

Fig. 1 PRISMA flowchart

Table 3 Oroantral communication closure and delayed implant placement

Author/year	Study type	Sex/Age	Signs & symptoms	OAC size	OAC closure	Medical care	Closure result	Implant placement	Result
Baek et al., 2021 [6]	CR	F 36y	-History of pericarditis & long-term steroid use -Pus & gingival swelling in #17 -Tooth #17 extraction -OAC -Collagen plug insertion in extraction socket -After 2 m: Pinpoint OAF, while large size of OAC remained	≥ 20 mm in diameter	Sinus bone graft by an absorbable membrane in shape of a pouch in a healthy sinus without any sinusitis, except for OAC: -Fixing the CM to external alveolar bone with bone tacks -Pushing the barrier membrane into sinus through OAC in form of a pouch -Allograft filling & coverage of alveolar crest area with a CM	Pain relievers (Aceclofenac 100 mg) & AB (Augmentin 625 mg) BID & TID, respectively, for a w	-Complete closure of OAC -No complications during approximately 2 y	6 m post-op: -GBR (Allograft covered with an absorbable membrane & fixed with 3 bone tacks) for vertical bone augmentation of #16 & 17	6 m after implant surgery: -Sufficient hard tissue volume – 1st stage implant surgery for #16 & #17 -Modified periosteal fenestration as a FGG for vestibular loss & a lack of buccal attachment mucosa observed with OAC closure & GBR -High primary stability & sufficient marginal bone width Histologic & histomorphometric analyses: -Newly formed bone deposition around residual allogenic bone graft & satisfactory incorporation between them - 27.3% new bone, 29.4% allograft & 43.3% connective tissue -Final prosthesis after 5 m
Pen˜arrocha-Diago et al., 2007 [2]	CR	F 52y	-Pain & inflammation in region of maxillary 2nd molar & grade II mobility -Radiolucency in relation to sinus + loss of bone support around tooth apices -Tooth removal -OAC secondary to extraction -Positive Valsalva	-	On same day as extraction: -Sterile saline solution irrigation –Window preparation (10 mm * 8 mm) in anterior sinus wall -Membrane separation from internal surface of bone graft, with care to avoid perforation -Zygomatic bone graft placed within maxillary molar socket -Graft fixation in alveolus	Amoxicillin (500 mg TID for 1 w) & ibuprofen (600 mg TID for 4 days) & 0.12% CHX MW	Sealing of OAC & integration of zygomatic bone graft	3 m later: -No need of SE -Implants placement -RF measurements: 64 & 57, respectively	After 3 m: -A screw-retained fixed prosthesis insertion, with an acceptable esthetic result & good marginal adaptation -No complications after 1 y

Table 3 (continued)

Author/year	Study type	Sex/Age	Signs & symptoms	OAC size	OAC closure	Medical care	Closure result	Implant placement	Result
Ogunsalu, 2005 [1]	CR	M 40y	OAC following maxillary 2nd molar extraction	-	Sandwich technique: – 2 resorbable membranes surrounding a bone substitute (Cancellous xenograft granules) with additional onlay grafting with same bone substitute to regenerate subantral bone -Prepared sandwich tucked into OAC & formed a convexity toward sinus & a concavity toward alveolar bone -Rough surface of sandwich faced alveolar bone & additional granules filled into concavity -Marginal alveolectomy & suture	-	8 m: Creation of a new maxillary sinus bony floor & subantral bone of good quality & height that permits implant placement	One implant 12 m after initial surgery	Successfully treated
Ahmed and Askar, 2011 [17]	CS	8 patients, Mean age:43y	-Patients with OAF/unsuccessful OAF closure & planned for subsequent implant placement -Clinical sign: Small fistulas + unilateral nasal discharge in mouth rinsing - mild symptoms of chronic sinusitis -Sinus lining prolapse in 1 case only in form of painless exophytic fragile soft tissue	6–13 mm	-Surgical widening of OAF -A corticocancellous block graft from chin &/or retromolar regions -Dividing the block graft into 2 pieces: 1/One piece to reconstruct sinus floor & to bridge across bony defect 2/2nd piece for reconstruction of buccal alveolar plate at site of OAF (lateral grafting) -Residual bones prepared in form of particulate to fill the residual spaces between alveolar walls & sinus floor	-Amoxicillin/sulbactam (375 mg) BID, analgesic for pain control, nasal decongestant (Otrivin 0.05%) & systemic decongestant for 2 days -Amoxicillin/clavulanic acid &/or metronidazole BID & analgesic (ibuprofen) to remove any residual infection & inflammation & pain control -Irrigation of affected sinus with physiologic saline solution + iodine-containing solution diluted with physiologic saline solution (1:1) to control infection (for 2 w)	-No wound dehiscence (except 1 case), infection, maxillary sinusitis, graft rejection, or OAF recurrence -Mucosal dehiscence in 1 patient 1 w postop -Soft tissue defect healed by secondary intention within 3 w -Shortening of vestibular depth in all cases (No additional intervention needed)	-Implant placement in 4 cases after 4 m In 2 cases: -One case: Simultaneous implant placement & sinus lift -The 2nd case: Alveolar grafting followed by implant placement after another 3 m	-Normal bone healing clinically & radiographically at time of implant placement -No OAF recurrences nor implant failures after loading for 6 m

Table 3 (continued)

Author/year	Study type	Sex/Age	Signs & symptoms	OAC size	OAC closure	Medical care	Closure result	Implant placement	Result
Lee, 2008 [8]	CS	3 patients	Initial treatment: implants + sinus lifting & bone grafts -Major complaint: large OAF caused by failure of previous procedure in atrophied posterior maxilla -Heavy smoker: 2 male patients	-	-Anterior iliac crest corticocancellous bone -One piece of corticocancellous block placed over OAF to bridge across bony defect -Residual bones in particulate shape grafted in sinus -Initially firm stabilization of grafted corticocancellous block over OAF complete sinus filling - Palatal pedicled flap to cover orally exposed graft bone through OAF	-Before surgery: AB (Augmentin) & analgesics (Airtal) for 2–4 w -After 1–2 m of waiting, surgery was perfomed -After closure: Routine AB & analgesics for 1 w postop to prevent infection & pain	In all cases: -Successful reconstruction & restoration -No intraoperative complications -Stable graft bone	Dental implants approximately after 5–6 m	-No implant failures after loading for 4 to 18 m -Only minimal marginal bony resorption (2 mm) around 3 implants -No wound dehiscence, maxillary sinusitis, or OAF recurrence -Mean satisfaction score after final restoration: 8.3 (scale: 0–10)
Cheng and Tatakis, 2020 [5]	CR	M, 55y	-Crater-like soft tissue appearance at #13 edentulous area – 8 mm implant placed 3 to 4 mm subcrestally with more than half of fixture length into maxillary sinus, - No sign of bone augmentation -No symptoms or signs of sinus infection	Oval with a long axis diameter of 5 mm	-Implant stability confirmation after implant exposure -Evident OAC following implant explanation -CST: A CM (30 × 6 mm) folded in U shape -Placing the bottom of U-shaped strip level equal to sinus floor with 2 strip ends folded across socket margins in buccal & lingual aspect -Center of U-shape functioning as a "basket" to hold graft & serving as a platform for sinus membrane to heal -Placement of 2nd piece of CM over graft across ridge buccal-lingually	-AB (Amoxicillin 500 mg, tid for 1 w) -Analgesic (Ibuprofen 400 mg, TID) -Antimicrobial rinse (0.5 oz, BID for 2 w) -Avoidance of mechanical plaque control at site for 2 w	-	After 6 m: Two staged approach implant placement with simultaneous indirect sinus augmentation at healed edentulous ridge with good primary stability	- 5 m follow up: implant uncovery & final restoration delivery, followed by maintenance visits every 4 m – 13m follow up: Successful outcomes -No symptoms during entire treatment period

Table 3 (continued)

Author/year	Study type	Sex/Age	Signs & symptoms	OAC size	OAC closure	Medical care	Closure result	Implant placement	Result
Rachellea Mustakim et al., 2023 [9]	CR	M 52y	-No signs of nose blockage -Discomfort in maxilla after implant placement in area of #27 -Radiographic signs of bone graft material loss & partially destroyed #27i alveolar bone with mild swelling in soft tissue & severe mucosal thickening in maxillary sinus -Exposed implant fixture + soft tissue dehiscence + Peri-implantitis + OAF + sinusitis	-	-Explant & inflamed tissue removal -Copious sinus irrigation using saline & nasal packing -OAF closure with MESS	-	– 5 days postop: removal of nasal packing + sinus irrigation -Biopsy result: maxillary sinusitis & inflamed fibrous tissue around graft material – 6 w: Subsidence of sinus haziness radiographically	– 3 m later: Implant placement with sinus lifting & bone grafting using Oragraft & Bio-Oss – 6 m later: Healing abutment	– 3 m later: Prosthesis delivery -No signs & symptoms of maxillary sinusitis
Pigache et al., 2016 [20]	CR	1.F, 60y 2.F, 41y	-Initially treated with implants for completely edentulous maxillae – 1st patient: Edentulous -Presence of acute sinusitis & maxillary osteitis following sinus lift in both patients -No signs of acute infection -Persistent OAF for both 1. Undergone a SE using a lateral approach 2. Undergone bilateral SE via crestal approach	-	-Maxillary reconstruction via Le Fort I osteotomy (without pterygomaxillary disjunction to only anterior part of maxilla moved downward.) -Immediate grafting & OAF closure -At down fix stage: Complete removal of sinus membrane, including biomaterial remains & fibrous tissue, as well as fistula removal -Calvarial bone harvesting in form of bone plates & bone chips; -Disposal of particulate graft on sinus floor & tightly packed at base -Cortical plate placed above & compressed downward to compact graft -Suturing a BFP flap over bone plate recovering graft	Avoid nose blowing & sneezing for 1 m, CHX MW 6 times a day for 15 days & amoxicillin-acid clavulanic for 3 w	-Successful closure -In 1 st patient, a dehiscence occurred 2 m postop, on onlay graft zone leading to a localized graft loss -AB + MW	-Implants placement 6 m after grafting & loading further 6 m later -Follow-up was 6 y for 1 st patient & 3 y for 2nd -Implants insertion 6 m after graft & material removal via a crestal approach	-No complications reported -No complications in follow-up, after implants loading

Table 3 (continued)

Author/year	Study type	Sex/Age	Signs & symptoms	OAC size	OAC closure	Medical care	Closure result	Implant placement	Result
Galletti et al., 2016 [10]	CR	F, 52y	-Chronic gastroesophageal reflux & depression -No allergies nor toxic habits -Unsuccessful maxillary rhinosinusitis of odontogenic origin	1.5 cm diameter located at buccal aspect of maxillary molar region	-Removal of inflammatory tissue, pus & biomaterial granules under constant irrigation with sterile saline – 1-cm horizontal incision in reflected periosteum, posterior to zygomatic buttress -A blunt clamp towards temporomandibular angle to localize & prolapse buccal extension of BFP to cover OAC entirely	AB (500 mg levofloxacin, p.o. TID for 15 days), an analgesic (1 g paracetamol, p.o. TID for 3–4 days), a nasal corticosteroid nasal spray (64 µg/nebulizationbudesonide, QD for 15 days), a sterile saline solution nasal spray (1 nebulization BID for 15 days & a MW (0.12% CHX digluconate BID for 15 days)	At 3 m: Complete closure of OAC -CT 12 m after surgery: No opacification of maxillary sinus - Extraction of upper 2nd premolar & 2nd molar due to periodontal disease	3 m: 2 internal hexagon implants in 2nd premolar & 2nd molar region	No complications during osteointegration period and rehabilitation period
Park et al., 2024 [19]	CR	1.M 43 y 2.F 66 y	1. Non-smoker, severe sinus graft infection & recurrent OAF following sinus augmentation, implant placement 2. Non-smoker with well-controlled diabetes mellitus Underwent sinus augmentation resulted in severe edema & pus discharge and persistent OAF	1.- 2. 1.5 * 2 cm	1.2-w course of AB (amoxicillin/clavulanate potassium 375 mg, tid) -GBR: particulate bone, a cortical bone shell graft from ascending ramus, & a barrier membrane (Pouch filling) 2. Nasal irrigation plus 2 w course of AB (amoxicilin/clavulanate potassium 375 mg tid). Debridement on infected bone graft & surrounding granulation tissue. Elevating sinus mucosa forming a pouch. Saline irrigation & suctioning inflammatory exudate. Covering top of pouch with CM & filling pouch with granulate bone substitute. Covering entrance of pouch with cortical bone shell graft from contralateral sinus window. Covering surgical site with CM	1. AB (ciprofloxacin 500 mg) & a NSAID for 2 w. Was instructed to refrain from blowing nose 2. AB (ciprofloxacin 500 mg) & analgesic anti-inflammatory drug for 2 w. Advised not to blow nose	1. Uneventful healing without complications -After 5 y: No significant mucosal thickening 2. Uneventful healing + OAF closure - Area filled with bone like tissue after 6 m & some contraction of bone graft area	1.After 6 m: Placement of 4 HA-coated implants 2. 6 m: 3 implants placement	1.6 m: Uncovering 2 m after uncovery: Delivery of prosthesis -Scar tissue on buccal side without discomfort - Well-maintained augmented bone & implants 5 y after prosthesis delivery 2. 5 m after implant placement: prosthesis delivery

Table 3 (continued)

Author/year	Study type	Sex/Age	Signs & symptoms	OAC size	OAC closure	Medical care	Closure result	Implant placement	Result
Hu et al., 2023 [21]	CS	10 patients Mean age: 36 y (G 1: 5) 37 Y (G 2: 5)	-Chronic OAC + need for implant installation	-	G 1: Transalveolar approach -Oroantral margins connected by tension-free 5–0 vicry l sutures & rotated into sinus cavity -SE -An U shaped CM as a barrier between bone graft & sinus layer -Advanced buccal or rotational palatal flap with interrupted mattress sutures G2: Lateral Window Approach -Oroantral margins sutured together & dissected from alveolar bony wall -Creating lateral window above OAF -exposure of residual sinus mucosa & further detached from inner wall of sinus through lateral window -Membrane placed over lifted sinus membrane & space filled with bone graft material -Bone block repositioned to its original place in anterior wall of maxilla + 2 CMs applied to cover anterior wall and alveolar ridge individually	-AB & analgesics for 7 days -Avoiding activities like nose blowing, sneezing, sucking on a straw & vigorous sport, for 2 w	G1: Milder post-op reactions G2: -Providing more bone volume after 6 m (alveolar bone height) -Greater pain at 1 st day & 3rd day + facial swelling at 7 days -No severe complications in either group -Successful OAF closure & alveolar bone reconstruction -No signs of infection, OAF recurrence or nerve impairment in either group	6 m post-op	-No implant failures after loading for 8 to 20 m -Minimal marginal bony resorption – 3 to 6 m after implant placement, a 2nd surgery + subsequent prosthetic treatment + maintenance visits every year -Shortening of vestibular depth in 3 cases but not compromising the prosthetic procedure
Hotta et al. 2024 [22]	CR	F, 59 y	-Nonsmoker, occlusal pain and mobility prior to extraction of #16 -No improvement of OAC to OAF after 3 m -No membrane thickening	4 mm bone defect at fistula site	-Sinus floor elevation (Two lateral windows) + PRP + PRF membranes + 50:50 mixture of low-crystalline carbonate apatite granules and FDBA -Coverage of window with collagen membrane	-	NM	7 m post-op: Placement of 3 bone level taper implants	– 4 m post-implantation: Prosthesis delivery – 15 m follow-up: CBCT and PA evaluation revealed bone resorption in sinus, stopping at the apex of implants

AB Antibiotic, *AC* Apico-coronal, *BFP* Buccal fat pad, *BID* Two times a day, *CHX* Chlorohexidine, *CM* Collagen membrane, *CR* Case report, *CS* Case series, *CST* Collagen strip technique, *CT* Computed tomography, *F* Female, *FDBA* Freeze dried bone allograft, *FESS* Functional endoscopic sinus surgery, *FGG* Free gingival graft, *FPD* Fixed partial denture, *G* Group, *h* Hours, *m* Months, *M* Male, *MESS* modified endoscopic sinus surgery, *MW* Mouth wash, *min* Minutes, *NM* not mentioned, *OAC* Oroantral communication, *OAF* Oroantral fistula, *PA* Periapical, *Post-op* Post-operation, *Pre-op* Pre-operation, *QD* quaque die, *RF* Resonance frequency, *SE* Sinus elevation, *TID* Three times a day, *w* Week(s), *y* Year(s)

Table 4 Risk of bias in the human observational studies examined. The chart reports the risk of bias in the reviewed human observational studies estimated for each of the GRADE categories and expressed as percentage of studies with "low", "unclear" or "high" risk score [1–3, 5, 6, 8–10, 17–22]

	Inappropriate eligibility criteria	Inappropriate methods for exposure and outcome variables	Not controlled for confounding	Incomplete follow up	Other limitations	Risk of bias
Baek et al, 2021[6]						High
Hu et al, 2023[21]						Moderate
Park et al, 2024[19]						Moderate
Rachellea Mustakim et al, 2023[9]						High
Galletti et al, 2016[10]						High
Pigache et al, 2016[20]						High
Pen˜arrocha-Diago et al, 2007[2]						High
Cheng and Tatakis, 2020[5]						High
Lee, 2008[8]						High
Ahmed and Askar, 2011[17]						High
Hirsch Doobrow et al, 2008[18]						High
Cortes et al, 2010[3]						High
Kara et al, 2015[15]						High
Ogunsalu, 2005[1]						High
Hotta et al. 2024[22]						High

High risk Unclear risk Low risk

with implant insertion, while the remaining cases had an interval of 3–12 months between two surgeries.

Closure technique

Various methods have been used in the included studies. In Baek's study, a modification of Loma Linda technique was performed using a combination of collagen membrane in the shape of pouch and allograft filling through a lateral approach [6].

The mentioned superiority of this technique was the possibility of performing sinus floor elevation and sinus perforation closure at the same time. Moreover, guided bone regeneration (GBR) procedures were more predictable in the created environment [6, 19].

In one study, socket sealing was performed using a harvested bone block from zygoma through a lateral window in anterior sinus wall. This approach led to complete closure of OAC after 3 months and there was no need to

Table 5 The Joanna Briggs Institute (JBI) critical appraisal checklist for case reports

Hotta et al. 2024	Galletti et al, 2016	Park et al., 2024	Kara et al, 2015	Pigache et al, 2016	Mustakim et al, 2023	Cheng and Tatakis, 2020	Doobrow et al, 2008	Ogunsalu, 2005	Cortes et al, 2010	Pen˜arrocha-Diago et al, 2007	Baek et al, 2021	
												Were patient's demographic characteristics clearly described?
												Was the patient's history clearly described and presented as a timeline?
												Was the current clinical condition of the patient on presentation clearly described?
												Were diagnostic tests or assessment methods and the results clearly described?
												Was the intervention(s) or treatment procedure(s) clearly described?
												Was the post-intervention clinical condition clearly described?
												Were adverse events (harms) or unanticipated events identified and described?
												Does the case report provide takeaway lessons?

: Yes
: No
: Unclear
: Not applicable

perform additional sinus lifting prior to implant placement [2].

In another study, the authors chose sandwich technique for OAF closure in maxillary 2nd molar area. This technique consisted of 2 resorbable membrane surrounding a combination of xenograft and onlay graft. According to the authors' claims, since no donor site was necessary, less time and lower costs, as well as less discomfort, would be achieved. In addition, this technique focuses on the use of xenografts as a natural osteoconductive material with the ability to promote bone formation through an exclusive patented process [1]. On the other hand, another study used a combination of rehydrated freeze-dried demineralized bone and calcium sulfate in conjunction with collagen membrane for OAC closure and immediate implant placement [18].

Another modification of bone grafts was used in Cortes' study. In this case report, OAC closure was done using BFP graft and sinus floor was reconstructed using a monocortical graft and xenograft [3].

In a case report, CST was applied in the form of U shape with no use of autogenous bone or rotational flap, aiming to minimize post-operative patient discomfort, vestibular depth changes and alternations of keratinized tissue. Moreover, allograft was placed in the socket for ridge preservation. By well-adapting collagen strip, this technique could have positive outcomes in terms of bone graft stabilization and complete OAC closure [5].

Various biomaterials, as well as their combinations have been chosen in afore-mentioned studies. In consistent with the previous studies [24], it seems impossible yet to define a specific type or combination of bone grafts. Defects' characteristics, amount of needed bone graft, accessibility to donor sites, expected time of healing and sinus' health condition would personalize the treatment approach.

Iliac graft and chin/retromolar bone blocks were harvested in 3 studies. Although multiple advantages including absence of visible scar, easy accessibility and reduced operation time was mentioned, undesirable events like shortening of vestibular depth and additional alveolar grafting were observed [8, 17, 19]. On the other hand, extra-oral donor sites always require an additional surgical site, increased morbidity and risk of infection [25].

MESS technique was the treatment of choice in Mustakim's study. According to this case report, this

Table 6 JBI critical appraisal checklist for case series

Lee, 2008	Hu et al., 2023	Ahmed and Aksar, 2011	
			Were there clear criteria for inclusion in the case series?
			Was the condition measured in a standard, reliable way for all participants included in the case series?
			Were valid methods used for identification of the condition for all participants included in the case series?
			Did the case series have consecutive inclusion of participants?
			Did the case series have complete inclusion of participants?
			Was there clear reporting of the demographics of the participants in the study?
			Was there clear reporting of clinical information of the participants?
			Were the outcomes or follow up results of cases clearly reported?
			Was there clear reporting of the presenting site(s)/clinic(s) demographic information?
			Was statistical analysis appropriate?

: Yes
: No
: Unclear
: Not applicable

technique resulted in good clinical outcomes, with no sinus scar tissue or maxillary cysts, while maintaining physiologic function of sinus [9]. Harduin-Couto et al. suggested using an endoscope in Summers technique for a secure elevation in the transalveolar approach up to 5.5 mm in healthy patients ensuring the integrity of the sinus membrane and reported a 91.66% implants survival rate after 10 years [26].

Timing selection

In the 11 studies with delayed implant insertion, a wide range of time intervals (3–12 months) was observed. Only in one study, implant placement was performed as the 3rd step because 3 months after MESS technique, titanium plate removal and sinus lifting were performed and following an additional 3 months, implants were placed [9].

Although in none of the studies the rational beyond the waiting time prior to implant placement was not defined specifically, it seems that at least 3–4 months is required before second surgery in order to successfully place implants in grafted sites with adequate stability. Nevertheless, the healing time should be determined for each patient individually,

Requirements

Despite the fact that none of the included studies reported undesirable outcomes, following notes might be useful for OAC/OAF closure treatment planning:

1. In cases of minimal alveolar bone height (5 mm), as well as implants' initial stability of at least 30 N/cm^2, simultaneous sinus lifting procedure and implant insertion can be performed [8].
2. Perforations with 5–10 mm of size can be successfully managed by collagen membranes, while larger ones require additive interventions, including bone block grafts [15].
3. CST can be applied in cases with the minimal residual bone height. Hence, the presence of trauma, infection and pathology might reduce the bone height and further compromise CST application [5].
4. In cases of active sinus infection, 1–2 months prior to surgery commencement was suggested [8].

Conclusion

In conclusion, OAC/OAF is a potential complication of oral surgery. Due to the nature of the studies included in this review, no single definitive protocol could be recommended for the management of OAC/OAF. Despite the

promising results reported in various studies, multiple factors should be taken into account when selecting a treatment protocol for OAC/OAF including sinus health, patient's medical history, defect's size and location, time and cost, as well as accessibility should be considered. However, this study was not without limitations. All the included studies were case reports and case series. Furthermore, none of them reported quantitative value of available bone after OAF closure or survival/success rate. Hence, future studies with larger sample size and multiple test groups, as well as longer follow ups are recommended to precisely investigate their effectiveness and to improve our understanding of the most effective treatment protocol.

Abbreviations

BFP	Buccal fat pad
CST	Collagen strip technique
GBR	Guided bone regeneration
MESS	Modified endoscopic sinus surgery
OAC	Oroantral communication
OAF	Oroantral fistula
PRF	Platelet rich fibrin
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis

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References

1. Ogunsalu C. Dental implant therapy in the treatment of an oroantral communication after exodontia. Implant Dent. 2005;14:232–6. https://doi.org/10.1097/01.id.0000174905.76350.d2.
2. Peñarrocha-Diago M, García B, Gomez D, Balaguer J. Zygomatic bone graft for oral-antral communication closure and implant placement. J Oral Implantol. 2007;33:305–9. https://doi.org/10.1563/1548-1336(2007)33[305:ZBGFOC]2.0.CO;2.
3. Cortes D, Martinez-Conde R, Uribarri A, del Valle AE, Lopez J, Aguirre JM. Simultaneous oral antral fistula closure and sinus floor augmentation to facilitate dental implant placement or orthodontics. J Maxillofac Surg. 2010;68:1148–51. https://doi.org/10.1016/j.joms.2009.09.078.
4. Gibaly A, Mounir M, Mounir S. A combined staged novel approach for reconstruction of persisting Oro-antral fistulae defects utilizing tripled layer closure and open sinus lifting. Egypt Dent J. 2019;65:3295–303. https://doi.org/10.21608/EDJ.2019.74759.
5. Cheng GL, Tatakis DN. Collagen strip technique: a novel approach for ridge preservation and concomitant oroantral communication management after implant explantation. Clin Adv Periodontics. 2020;10:135–9. https://doi.org/10.1002/cap.10092.
6. Baek JH, Kim BO, Lee WP. Implant placement after closure of oroantral communication by sinus bone graft using a collagen barrier membrane in the shape of a pouch: A case report and review of the literature. Medicina. 2021;57:626. https://doi.org/10.3390/medicina57060626.
7. Oliva S, Lorusso F, Scarano A, D'Amario M, Murmura G. The Treatment and Management of Oroantral Communications and Fistulas: A Systematic Review and Network Metanalysis. Dent J. 2024;12:147. https://doi.org/10.3390/dj12050147.
8. Lee BK. One-stage operation of large oroantral fistula closure, sinus lifting, and autogenous bone grafting for dental implant installation. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;105:707–13. https://doi.org/10.1016/j.tripleo.2007.09.020.
9. Mustakim KR, Eo MY, Lee JY, Cho YJ, Seo MH, Kim SM. Appropriate Implant Rehabilitation in Patients with Iatrogenic Oroantral Fistula and Odontogenic Maxillary Sinusitis. J Craniofac Surg. 2023;34:e92–6. https://doi.org/10.1097/SCS.0000000000009099.
10. Galletti C, Cammaroto G, Galletti F, Camps-Font O, Gay-Escoda C, Bara-Casaus JJ. Dental implants after the use of bichat's buccal fat pad for the sealing of oro-antral communications. A case report and literature review. J Clin Exp Dent. 2016;8:e645. https://doi.org/10.4317/jced.53318.
11. Arı I, Adiloğlu S, Aktaş A, Kızılkaya AE. Assessment of Treatment Approaches for Oroantral Communication and Fistulas. Curr Res Dent Sci. https://doi.org/10.17567/currresdentsci.1507220
12. Daif ET. Long-term effectiveness of the pedicled buccal fat pad in the closure of a large oroantral fistula. J Oral Maxillofac Surg. 2016;74:1718–22.
13. Adamska P, KaczorukWieremczuk M, Pylińska Dąbrowska D, Stasiak M, Bartmański M, Zedler A, Studniarek M. Treatment of Oroantral Communication and Fistulas with the Use of Blood-Derived Platelet-Rich Preparations Rich in Growth Factors: A Systematic Review. Int J Mol Sci. 2024;25:11507. https://doi.org/10.3390/ijms252111507.
14. Saleh EA, Issa IA. Closure of large oroantral fistulas using septal cartilage. Otolaryngol Head Neck Surg. 2013;148:1048–50. https://doi.org/10.1177/0194599813482091.
15. Kara MI, Yanik S, Sari F, Buyukkurt C. Simultaneous oroantral communication closure, sinus-lifting, and particulate bone grafting and immediate dental implant perforation. Niger J Clin Pract. 2016;19:556–8. https://doi.org/10.4103/1119-3077.183300.
16. Otero AIP, Fernandes JCH, Borges T, Nassani L, Castilho RdM, Fernandes GVdO. Sinus Lift Associated with Leucocyte-Platelet-Rich Fibrin (Second Generation) for Bone Gain: A Systematic Review. J Clin Med. 2022;11:1888. https://doi.org/10.3390/jcm11071888.
17. Ahmed MS, Askar NA. Combined bony closure of oroantral fistula and sinus lift with mandibular bone grafts for subsequent dental implant placement. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011;111:e8-14. https://doi.org/10.1016/j.tripleo.2011.01.003.
18. Doobrow JH, Leite RS, Hirsch HZ. Concomitant oroantral communication repair and immediate implant placement: a five-year case report. Implant Dent. 2008;17:176–81. https://doi.org/10.1097/ID.0b013e318166dbe7.
19. Park WB, Bae MS, Park W, Lim HC, Han JY. A Novel Approach for the Treatment of Recurrent Oroantral Fistula Occurring at an Infected Sinus Augmentation Site. Medicina. 2024;60:343. https://doi.org/10.3390/medicina60020343.
20. Pigache P, Anavekar N, Raoul G, Ferri J. Maxillary reconstruction for sinus lift complications with oro-antral fistula: the Le Fort I approach. J Craniofac Surg. 2016;27:464–8. https://doi.org/10.1097/SCS.0000000000002383.

21. Hu YK, Qian WT, Xu GZ, Zou DH, Yang C. A Study of Two Novel Techniques for One-stage Closure of Chronic Oroantral Fistula and Sinus Floor Lift. J Craniofac Surg. 2023;34:1799–803. https://doi.org/10.1097/SCS.0000000000009362.
22. Hotta Y, Ito K, Komatsu S, Saito T, Teramoto Y, Hotta H. A Case of Simultaneous Sinus Augmentation and Oroantral Fistula Closure for Implant Preparation. J Oral Implantol. 2024;50:589–94.
23. Haas R, Watzak G, Baron M, Tepper G, Mailath G, Watzek G. A preliminary study of monocortical bone grafts for oroantral fistula closure. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003;96:263–6. https://doi.org/10.1016/S1079-2104(03)00375-5.
24. Ekhlasmandkermani M, Amid R, Kadkhodazadeh M, Hajizadeh F, Abed PF, Kheiri L, Kheiri A. Sinus floor elevation and simultaneous implant placement in fresh extraction sockets: a systematic review of clinical data. J Korean Assoc Oral Maxillofac Surg. 2021;47:411–26. https://doi.org/10.5125/jkaoms.2021.47.6.411.
25. Amid R, Kheiri A, Kheiri L, Kadkhodazadeh M, Ekhlasmandkermani M. Structural and chemical features of xenograft bone substitutes: A systematic review of in vitro studies. Biotechnol Appl Biochem. 2021;68:1432–52. https://doi.org/10.1002/bab.2065.
26. Harduin-Couto M, Gonçalves AO, Rizzato M, Oliveira ER, Fisher-Trindade H, Fernandes GV. Endoscopic analysis of alterations in sinus floor elevation approaching the summers technique and immediate implant: A clinical trial with 10 years follow-up. Int J Sci Dent. 2022;58:77–96.

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