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REVIEWARTICLE

MANAGEMENT OF LARGE IATROGENIC NASOANTRAL FISTULAS:A NARRATIVE REVIEW, EVIDENCE SYNTHESIS, AND ILLUSTRATIVE CLINICAL CASE

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Abstract

Background: Large iatrogenic nasoantral fistulas remain a challenging problem in maxillofacial surgery because chronic inflammation, epithelialization of the tract, and poor local tissue quality often compromise healing. Successful treatment requires not only closure of the communication but also restoration of normal sinonasal function and long-term tissue stability.

Objective: To review contemporary surgical approaches for the management of large nasoantral fistulas and to illustrate the clinical application of current reconstructive principles through a representative clinical case.

Methods:A narrative review of the literature was performed using PubMed, Scopus, and Web of Science databases. Publications addressing nasoantral and oroantral fistulas, buccal fat pad reconstruction, palatal mucosal grafting, endoscopic sinus surgery, and postoperative stabilization techniques were analyzed. To demonstrate the practical implementation of these concepts, a patient with a large chronic iatrogenic nasoantral fistula following previous Caldwell–Luc surgery was treated using a multilayer reconstructive approach.

Results: The reviewed literature indicates that while conventional flap techniques remain effective for small defects, larger fistulas generally require more complex reconstructive strategies. Multilayer closure combining vascularized tissue support and epithelial surface coverage appears to provide greater stability and lower recurrence rates. In the presented case, reconstruction using a vascularized buccal fat pad, palatal mucosal graft, endoscopic assistance, and silicone stabilization resulted in complete closure of the fistula without postoperative complications or recurrence during follow-up.

Conclusions: Current evidence supports a biologically oriented approach for the treatment of large nasoantral fistulas. Reconstruction based on vascularized tissue transfer, epithelial barrier restoration, preservation of sinus physiology, and adequate postoperative stabilization offers a predictable solution for complex defects. The presented case illustrates the successful clinical application of these principles and highlights the importance of combining reconstructive and functional surgical concepts.

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INTRODUCTION

Nasoantral and oroantral fistulas are pathological communications between the maxillary sinus and the nasal or oral cavity and continue to represent a significant reconstructive challenge in maxillofacial surgery and rhinology. While small defects may occasionally close spontaneously, larger communications often become epithelialized and progress to chronic fistulas associated with recurrent infection, persistent mucosal inflammation, impaired sinonasal function, and a substantial reduction in quality of life [1,2]. Successful treatment requires re-establishing the separation between the oral cavity and the maxillary sinus while preserving normal sinus function and minimizing the risk of recurrence.

The maxillary sinus is lined by specialized respiratory mucosa that maintains sinus health through an efficient mucociliary clearance system. Under physiological conditions, coordinated ciliary activity transports mucus toward the natural maxillary ostium in the middle meatus, allowing adequate drainage and ventilation[3,4]. Disturbance of this mechanism may lead to maxillary sinus mucus retention, bacterial colonization, chronic inflammation, and progressive mucosal alterations [5]. Consequently, persistent communication between the maxillary sinus and adjacent anatomical spaces may disrupt normal sinus physiology and initiate a cycle of inflammation, impaired drainage, and tissue deterioration[6].

For many decades, the Caldwell–Luc procedure was considered the standard surgical approach for the treatment of chronic maxillary sinus disease, odontogenic sinusitis, benign maxillary lesions, and various inflammatory conditions [7,8]. The technique provided wide transantral access to the maxillary sinus and enabled direct removal of pathological tissue. However, its relatively radical nature frequently resulted in disruption of normal sinus mucosa and the creation of non-physiological drainage pathways. Long-term clinical and radiological studies have shown that previous Caldwell–Luc surgery can result in persistent anatomical and functional changes, including mucosal fibrosis, remodeling of the sinus walls, reduction of sinus volume, chronic mucosal thickening, and impaired ventilation [9,10]. Such alterations may promote chronic sinonasal inflammation and create unfavorable conditions for subsequent reconstructive procedures.

A better understanding of sinonasal physiology has gradually shifted surgical management from radical procedures toward function-preserving approaches. Functional Endoscopic Sinus Surgery (FESS) focuses on maintaining mucosal integrity, restoring natural ostial drainage, and preserving mucociliary transport [10,11]. Comparative studies have demonstrated that endoscopic techniques are associated with improved symptom control, reduced postoperative morbidity, and better preservation of long-term sinus function when compared with traditional Caldwell–Luc surgery [11-13]. As a result, contemporary reconstruction of maxillary sinus defects increasingly aims not only to close the pathological communication but also to restore normal sinonasal physiology.

Large iatrogenic nasoantral fistulas are among the most difficult defects to manage in clinical practice[14]. They may occur following Caldwell–Luc surgery, trauma, tumor resection, failed reconstructive procedures, odontogenic interventions, implant-related complications, or sinus augmentation surgery[15]. Defects large iatrogenic nasoantral fistulas exceeding 10 mm rarely heal spontaneously because epithelialization of the fistulous tract prevents normal tissue adhesion and closure. In addition, chronic inflammation, fibrosis, and scar formation frequently compromise local vascularity and reduce the predictability of conventional closure techniques.

From a biomechanical standpoint, reconstruction of large nasoantral fistulas presents additional challenges. Respiratory movements, coughing, sneezing, swallowing, and speech generate repetitive pressure changes across the defect site. These forces may interfere with tissue integration, impair neovascularization, and increase the likelihood of wound dehiscence or recurrence. Therefore, successful closure iatrogenic nasoantral fistulas depends not only on adequate tissue coverage but also on biological support and stable fixation during the early stages of healing[16].

Numerous surgical techniques have been described for the management of nasoantral and oroantral fistulas, including buccal advancement flaps, palatal rotational flaps, buccal fat pad reconstruction, free mucosal grafts, and various multilayer closure methods [17-21]. Buccal advancement flaps remain widely used because of their technical simplicity, accessibility, and reliable blood supply. Nevertheless, their effectiveness decreases in larger defects due to increased flap tension, reduced tissue mobility, vestibular shortening, and a higher risk of postoperative dehiscence [22,23]. Palatal rotational flaps provide durable keratinized tissue coverage but may be limited by donor-site morbidity and restricted mobility in extensive posterior defects.

Growing understanding of tissue biology has significantly changed the way large fistulas are reconstructed. Current evidence increasingly favors multilayer closure techniques that combine mechanical separation of anatomical compartments with enhanced vascularization and tissue regeneration [24,25]. Among the available reconstructive options, the buccal fat pad has gained particular importance because of its close anatomical proximity, rich vascular supply, low donor-site morbidity, and capacity to support rapid tissue integration. Anatomical studies have demonstrated that the buccal fat pad receives blood supply from branches

of the facial, maxillary, and superficial temporal arteries, creating favorable conditions for graft survival and epithelialization [26-29].

Beyond its vascular advantages, the buccal fat pad contains adipose-derived stromal cells and biological mediators involved in tissue repair and angiogenesis. Experimental studies have shown that VEGF and other angiogenic mediators contribute to neovascularization, further supporting the use of vascularized adipose tissue in complex reconstruction[30]. Clinical investigations have reported favorable outcomes with buccal fat pad-based techniques in the treatment of large oroantral and nasoantral communications, including recurrent cases [31]. Although vascularized tissue provides excellent biological support, long-term success often requires restoration of a durable epithelial barrier. Palatal mucosal grafts offer keratinized epithelial coverage capable of protecting the reconstructed area from oral contamination and mechanical stress. Consequently, the combination of vascularized tissue support and epithelial surface restoration represents an important advancement in the management of large fistulas, providing both biological integration and mechanical protection [32-34].

Postoperative stabilization is another critical factor influencing reconstructive success. Survival of free grafts depends on close adaptation between the graft and recipient bed during plasmatic imbibition, inosculation, and early vascularization. Even minimal micromovement may disrupt capillary ingrowth and compromise healing. For this reason, silicone splints have increasingly been used as supportive devices capable of stabilizing reconstructed tissues, preventing synechiae formation, and creating favorable conditions for postoperative healing [35-38].

In addition to reviewing the available literature, this article presents a clinical case of a large chronic iatrogenic nasoantral fistula measuring approximately 18 × 14 mm that developed following previous Caldwell–Luc surgery. By integrating published evidence with clinical experience, we aim to discuss current reconstructive strategies for large nasoantral fistulas, examine the biological basis of multilayer soft-tissue reconstruction, and evaluate the contribution of endoscopic visualization and silicone stabilization to achieving predictable long-term functional outcomes.

MATERIALS AND METHODS

Study Design

This study was designed as a narrative review combined with an illustrative clinical case report. The primary objective was to evaluate contemporary evidence regarding the surgical management of complex nasoantral perforations and fistulas and to analyze the clinical outcomes of a reconstructive technique utilizing transseptal visualization, double-layer soft-tissue closure, and modified silicone splint stabilization.

Literature Search Strategy

A comprehensive literature search was conducted using the PubMed, Scopus, and Web of Science databases. Publications published between January 2011 and March 2026 were considered eligible for screening. The search strategy was developed to identify studies addressing the diagnosis, pathophysiology, and surgical management of nasoantral and oroantral fistulas, as well as investigations evaluating reconstructive materials and postoperative stabilization techniques.

The principal search terms included: “nasoantral fistula,” “oroantral fistula,” “oroantral communication,” “Caldwell–Luc surgery,” “buccal fat pad,” “Bichat fat pad,” “free palatal graft,” “silicone splint,” “maxillary sinus reconstruction,” “endoscopic sinus surgery,” and “double-layer closure.” Various combinations of keywords and Boolean operators (AND, OR) were used to optimize retrieval of relevant studies.

The initial electronic search identified 128 potentially relevant publications. After removal of duplicate records and preliminary screening, studies were evaluated according to their titles and abstracts. 24 publications were ultimately considered directly relevant to the objectives of the review and were included in the final evidence synthesis.

Eligibility Criteria

Studies were included if they met one or more of the following criteria:

- Investigated surgical closure of nasoantral or oroantral fistulas;
- Evaluated outcomes of buccal fat pad grafts, palatal grafts, or multilayer closure techniques;
- Examined complications and long-term consequences of Caldwell–Luc surgery;

- Assessed endoscopic approaches to maxillary sinus surgery;
- Reported clinical outcomes associated with silicone splints or other stabilization methods;
- Included randomized controlled trials, clinical studies, retrospective analyses, systematic reviews, narrative reviews, or representative case reports relevant to the management of fistulous communications.

Particular emphasis was placed on higher levels of evidence, including randomized controlled trials, comparative clinical studies, and comprehensive reviews addressing surgical outcomes and postoperative healing.

Exclusion Criteria

Studies were excluded when they:

- Were performed exclusively in animal models;
- Contained insufficient methodological information;
- Did not provide clinically relevant outcome data;
- Addressed sinonasal conditions unrelated to fistula management;
- Were duplicate publications or conference abstracts without accessible full-text data.

Evidence Synthesis

Because of the heterogeneity of study designs and outcome measures, quantitative meta-analysis was not feasible. Therefore, a qualitative evidence synthesis approach was adopted. The selected literature was analyzed according to major thematic domains, including fistula etiology, maxillary sinus physiology, complications of Caldwell–Luc surgery, reconstructive techniques, biological properties of buccal fat pad grafts, multilayer closure strategies, and postoperative stabilization methods. The findings from the literature were subsequently correlated with the diagnostic findings, surgical protocol, and postoperative outcomes observed in the presented clinical case. This integrated approach enabled the comparison of contemporary scientific evidence with real-world clinical experience and facilitated the development of evidence-based recommendations for the management of large iatrogenic nasoantral fistulas.

RESULTS

The reviewed studies indicate that the outcome of nasoantral and oroantral fistula reconstruction is influenced by multiple factors, including defect size, tissue vascularity, the condition of the surrounding mucosa, stability of wound closure, and preservation of physiological sinus drainage. Reported success rates varied among different techniques and were closely related to the biological characteristics of the recipient site.

Small fistulas (<5–10 mm) were generally associated with favorable healing when treated with conventional local flap procedures such as buccal advancement flaps and palatal rotational flaps. However, several studies reported reduced effectiveness of these techniques in larger defects because of increased flap tension, limited tissue mobility, vestibular shortening, and a higher risk of wound dehiscence.

For moderate and large defects, vascularized tissue transfer was consistently associated with more predictable clinical outcomes. The pedicled buccal fat pad flap demonstrated several advantages, including rich vascularity, rapid epithelialization, and reliable coverage of three-dimensional defects. Nevertheless, some authors noted that its use may be limited in exceptionally large defects because of insufficient tissue volume.

Free palatal mucosal grafts provided a durable epithelial barrier and good resistance to mechanical and microbial irritation. Their success, however, depended largely on the vascularity of the recipient bed, making them less predictable when used as a single reconstructive layer in poorly vascularized tissues.

Several recent studies highlighted the benefits of multilayer reconstruction. Double-layer closure techniques combining vascularized tissue support with epithelial surface coverage were associated with improved mechanical stability, enhanced tissue integration, fewer postoperative complications, and lower recurrence rates when compared with single-layer approaches.

Across the reviewed studies, multilayer reconstruction was consistently associated with the most favorable outcomes in defects larger than 10 mm, particularly when chronic inflammation, epithelialized fistulous tracts, recurrent disease, or compromised soft-tissue quality were present.

Comparative outcomes of major curgical closure techniques are presented in Table 1.

Table 1. Comparative Outcomes of Major Surgical Closure Techniques

Technique	Main Indications	Advantages	Limitations
Buccal advancement flap	Small and moderate defects	Simple technique, good accessibility	Vestibular shortening, flap tension
Palatal rotational flap	Moderate anterior defects	Provides keratinized tissue, durable coverage	Donor-site morbidity, limited mobility
Buccal fat pad flap	Large defects	Excellent vascularity, rapid healing	Limited volume in extensive defects
Free palatal mucosal graft	Surface epithelial reconstruction	Strong epithelial barrier	Requires vascularized recipient bed
PRF-assisted closure	Small defects, enhanced healing	Improved tissue regeneration, autologous material	Limited evidence for large fistulas
Double-layer closure	Large defects (>10 mm)	High stability, vascular support, predictable healing	Technically demanding
Endoscopic-assisted closure	Posterior fistulas	Improved visualization, minimally invasive access	Requires surgical experience
Transseptal endoscopic approach	Complex posterior defects	Better access and instrument control	Limited clinical availability

Biological Advantages of Double-Layer Reconstruction

A recurring finding throughout the literature was that successful closure of large fistulas requires both reliable separation of the oral and sinus cavities and a biological environment favorable for tissue healing.

The vascularized buccal fat pad contributes to reconstruction by providing a highly perfused tissue layer capable of supporting angiogenesis and graft survival. Histological studies have shown abundant capillary networks together with regenerative properties related to adipose-derived stromal cells and angiogenic mediators.

The palatal mucosal component serves as a protective epithelial barrier that reduces bacterial contamination and mechanical irritation. The combination of a vascularized internal layer and an epithelial external layer creates favorable conditions for tissue maturation, enhances long-term stability, and reduces the risk of recurrenc. Table 2. demonstrating biological role of components used in multilayer reconstruction

Table 2. Biological Role of Components Used in Multilayer Reconstruction

Component	Biological Function	Clinical Benefit
Buccal fat pad	Vascular support and angiogenesis	Improved graft survival
Palatal mucosa	Keratinized epithelial protection	Resistance to contamination
PRF membrane	Growth factor release	Enhanced early healing
Local mucosal flap	Primary soft-tissue closure	Immediate separation of cavities

Radiological Findings and Differential Diagnosis

Several studies emphasized the importance of radiological assessment in the evaluation of complex fistulas. Cone-beam computed tomography (CBCT) allows detailed assessment of defect dimensions, sinus involvement, bone remodeling, and adjacent anatomical structures, making it a valuable tool for diagnosis and surgical planning.

Chronic postoperative fistulas were most commonly characterized by smooth bony margins, localized remodeling, and varying degrees of mucosal thickening. In contrast, aggressive pathological conditions frequently demonstrated irregular bone

destruction, invasive soft-tissue changes, and involvement of surrounding anatomical structures. Radiological findings and differential diagnosis presented in Table 3.

Table 3. Radiological Characteristics of Iatrogenic Fistulas and Aggressive Pathology

Radiological Feature	Iatrogenic Fistula	Aggressive Disease
Bone margins	Smooth remodeling and sclerosis	Irregular osteolytic destruction
Sinus mucosa	Thickening, fibrosis, fluid accumulation	Soft tissue mass formation
Adjacent structures	Preserved anatomy	Invasion and destruction
Osteomeatal complex	Inflammatory obstruction	Destructive changes

Comparison of Surgical Paradigms

The reviewed literature illustrates a gradual shift from traditional radical procedures toward more functional and minimally invasive treatment concepts. Although the Caldwell–Luc approach provides wide surgical access, extensive disruption of sinus mucosa may adversely affect long-term sinus physiology. Functional endoscopic sinus surgery (FESS) focuses on preservation of mucosal integrity, restoration of physiological drainage pathways, and maintenance of mucociliary function. Comparative studies have reported reduced postoperative morbidity, faster recovery, and improved preservation of sinus function following endoscopic management. Traditional versus functional endoscopic approaches presented in Table 3.

Table 4. Traditional Versus Functional Endoscopic Approaches

Parameter	Caldwell–Luc Approach	Functional Endoscopic Surgery
Access	Transantral radical approach	Physiological transnasal approach
Mucosal management	Extensive removal	Preservation of mucosa
Drainage	Artificial opening	Natural ostium restoration
Sinus function	Frequently impaired	Preserved
Postoperative morbidity	Higher	Lower
Recovery	Longer	Faster

Postoperative Stabilization and Silicone Splints

Postoperative stabilization emerged as an important factor influencing both graft survival and long-term closure success. Several studies reported that silicone splints help maintain close adaptation between reconstructed tissues and the recipient bed, reduce graft movement, minimize hematoma formation, and decrease the likelihood of postoperative adhesions.

In addition, mechanical stabilization appears to facilitate epithelial maturation during the early stages of healing, particularly when free grafts or multilayer reconstruction techniques are used. The available literature therefore supports the use of stabilization devices as an important adjunct in the management of complex fistulous defects.

Taken together, the reviewed studies suggest that successful treatment of large nasoantral and oroantral fistulas depends on careful assessment of defect characteristics, tissue quality, and sinus condition. The most predictable outcomes are generally achieved when vascularized tissue support, epithelial coverage, preservation of sinus physiology, and adequate postoperative stabilization are incorporated into a comprehensive reconstructive strategy.

The findings summarized above formed the basis for the treatment approach used in the clinical case presented below. The principles of multilayer reconstruction, vascularized tissue support, preservation of sinus physiology, and postoperative stabilization were subsequently applied in the management of a large chronic iatrogenic nasoantral fistula.

Clinical Application of Evidence-Based Reconstructive Principles: An Illustrative Clinical Correlation

The principles identified through the reviewed literature, including accurate defect assessment, restoration of anatomical separation, vascularized tissue support, multilayer reconstruction, and preservation of maxillary sinus function, represent essential

components for the predictable management of large chronic nasoantral communications. Their clinical relevance can be demonstrated through the following illustrative case correlation.

The presented clinical situation involved a large chronic iatrogenic nasoantral fistula characterized by persistent communication between the oral cavity and the maxillary sinus, compromised local tissue conditions, and chronic inflammatory alterations. In accordance with the reconstructive concepts emphasized in the literature, comprehensive preoperative evaluation was considered essential for defining the anatomical characteristics of the defect and selecting an appropriate closure strategy.

Cone-beam computed tomography (CBCT) assessment demonstrated a well-defined bony defect with remodeled margins and localized maxillary sinus mucosal changes, findings consistent with a chronic postoperative communication rather than an active destructive process. Preoperative imaging was used to evaluate the extent of the osseous defect, surrounding bone quality, and sinus condition for individualized reconstructive planning (Figure 1).

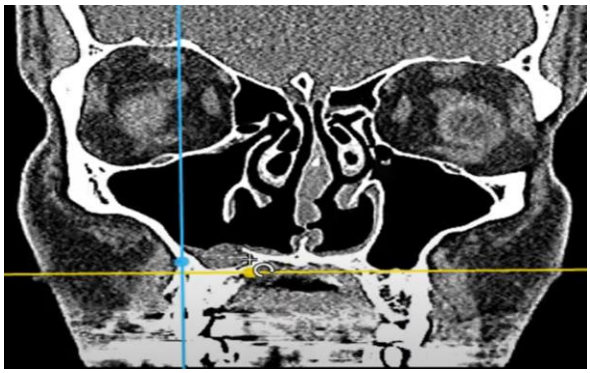

Figure 1. Preoperative radiological assessment of a chronic nasoantral communication.

Following the principles of contemporary reconstructive approaches, management was based on the concept of multilayer tissue restoration rather than simple mechanical closure. After elimination of the fistulous pathway and preparation of the recipient site, a vascularized soft tissue layer was incorporated to provide biological support and enhance tissue regeneration.

The use of a buccal fat pad flap offered a reliable vascularized component, creating a favorable environment for angiogenesis and long-term tissue stability. Subsequent epithelial coverage with a palatal mucosal graft provided an additional protective barrier, reducing the risk of contamination and reinforcing separation between the oral cavity and maxillary sinus (Figure 2).

Figure 2. Multilayer surgical reconstruction using vascularized soft tissue and mucosal coverage.

Postoperative stabilization was performed to maintain close adaptation of the reconstructed tissues during the early healing phase. This approach reflects the evidence-based understanding that mechanical stability, protection of the repair site, and maintenance of sinus–oral separation contribute significantly to successful healing outcomes. Postoperative clinical examination together with radiological evaluation demonstrating complete epithelialization of the surgical site, stable integration of the reconstructed tissues, restoration of maxillary sinus aeration, and absence of recurrent oroantral communication during follow-up (Figure 3).

Figure 3. Postoperative fibroscopy and CT scan confirming successful epithelialization and sinus pneumatization.

This clinical correlation supports the findings of the reviewed literature, demonstrating that successful

management of large chronic nasoantral fistulas depends on a combination of anatomical reconstruction, vascularized tissue support, epithelial restoration, and appropriate control of the sinus environment. Rather than relying on a single closure technique, predictable outcomes are achieved through a biologically oriented, multilayer reconstructive strategy.

The present narrative review demonstrates that the management of large nasoantral and oroantral fistulas has progressively evolved from conventional defect closure toward a biologically oriented reconstructive concept. The analysis of current evidence indicates that successful treatment depends not only on elimination of the pathological communication but also on restoration of tissue integrity, vascular support, epithelial continuity, and preservation of maxillary sinus function [2,18,20,34].

The findings of this review are consistent with previous publications emphasizing that treatment selection should be based on both anatomical and biological characteristics of the defect. Earlier approaches mainly focused on mechanical closure using local flaps, including buccal advancement and palatal rotational techniques. These methods remain valuable for small and uncomplicated communications because of their simplicity, accessibility, and reliable vascularity. However, similar to observations reported in previous reviews, their predictability decreases in large chronic defects where fibrosis, epithelialized fistulous pathways, previous surgical intervention, and compromised tissue quality may reduce healing potential [1,2,18,19,34].

The present evidence synthesis further supports the concept that defect size alone should not determine reconstructive planning. Although limited communications may heal following single-layer closure, larger chronic fistulas require restoration of multiple tissue components. Multilayer reconstruction provides mechanical separation, vascularized support, and epithelial protection, representing a transition from simple closure toward principles of biological reconstruction [14,16,26,27,34].

Among available reconstructive strategies, vascularized buccal fat pad-based techniques have gained particular importance for extensive defects of the posterior maxillary region. Previous studies have demonstrated that the buccal fat pad provides favorable vascular characteristics, anatomical accessibility, minimal donor-site morbidity, and potential regenerative properties. In comparison with non-vascularized materials, vascularized tissue transfer offers improved resistance to infection and enhances early tissue integration through continuous blood supply [20-25,29,31].

The reviewed literature also suggests that vascularized tissue should not be considered only as a space-filling material but as an active biological component of reconstruction. The presence of vascular and stromal elements may contribute to angiogenesis, tissue maturation, and improved wound stability. However, current evidence indicates that vascular support alone may be insufficient for long-term protection in large defects. Therefore, combined approaches incorporating an epithelial surface layer have increasingly become preferred because they simultaneously address biological integration and resistance to oral contamination [25,30-33].

The importance of sinus functional preservation represents another major finding of this review. Earlier surgical concepts often emphasized closure of the oral–sinus communication, whereas contemporary approaches increasingly recognize that restoration of sinus physiology is equally important. Radical procedures such as Caldwell–Luc access provide effective exposure but may alter normal sinus anatomy and mucociliary function. Modern endoscopic principles focus on maintaining physiological drainage pathways and minimizing unnecessary tissue disruption. Therefore, current management increasingly combines reconstructive closure with functional sinus rehabilitation [7-12,41,42].

Another important trend identified in the literature is the integration of minimally invasive visualization techniques. Endoscopic assessment and advanced imaging methods allow more accurate evaluation of fistula morphology, sinus conditions, and surrounding structures. These technologies may improve surgical precision, especially in anatomically complex defects, while reducing unnecessary tissue trauma [6,11,13,44,46].

The role of postoperative stabilization is also increasingly recognized. Healing after multilayer reconstruction depends on maintaining stable contact between tissues and preventing early displacement. The use of supportive measures during the initial healing period may improve adaptation of reconstructed tissues and create favorable conditions for epithelial maturation [21,35,36-38].

The clinical correlation presented in this review demonstrates the practical application of these evidence-based principles. The combination of vascularized buccal fat pad reconstruction, palatal epithelial coverage, and postoperative stabilization reflected the reconstructive concepts identified in the literature and resulted in stable restoration of the oral–sinus barrier. This clinical example supports the concept that predictable outcomes are achieved through integration of anatomical repair, biological support, and functional management rather than through a single surgical maneuver [14,20,26,27,31].

Compared with previous reviews that primarily focused on closure techniques, the current synthesis highlights a broader reconstructive philosophy emphasizing tissue quality, vascularization, sinus physiology, and long-term functional recovery. Nevertheless, available evidence remains heterogeneous, and definitive treatment algorithms are still limited [2,20,34].

LIMITATIONS OF CURRENT EVIDENCE

Despite significant advances in the management of nasoantral and oroantral fistulas, several limitations remain within the current literature. Most available studies are based on retrospective analyses, case series, and clinical reports, while high-quality prospective comparative studies remain limited [1,2,19,34].

Direct comparison between treatment modalities is difficult because published studies include heterogeneous patient populations with differences in defect size, chronicity, previous surgery, infection status, sinus pathology, and follow-up duration. In addition, standardized criteria for evaluating treatment success are not consistently applied. Many studies primarily report anatomical closure rates, whereas fewer evaluate long-term sinus function, patient-reported outcomes, and quality of life [1,18,19,34]. The role of regenerative approaches, including platelet-rich fibrin, growth-factor-based therapies, and tissue-engineering concepts, remains promising but requires further clinical validation. Current evidence suggests potential benefits for healing enhancement; however, these approaches cannot yet replace established vascularized reconstructive techniques in large complex defects [30,32,33].

The present clinical correlation should also be interpreted within the limitations of an illustrative application rather than a comparative clinical trial. Its purpose is to demonstrate the translation of evidence-based principles into clinical practice rather than to establish superiority of a specific technique [14,16,26,27].

FUTURE TRENDS

Future directions in nasoantral and oroantral fistula reconstruction are expected to focus on individualized, minimally invasive, and biologically enhanced treatment strategies [11,13,16,32].

Three-dimensional imaging, CBCT-based assessment, and digital surgical planning are becoming increasingly important for precise evaluation of defect morphology and selection of appropriate reconstructive approaches. These technologies allow better understanding of the relationship between the fistula, maxillary sinus, and surrounding anatomical structures [3,4,6,15].

The combination of endoscopic sinus management with multilayer oral reconstruction represents another important development. Hybrid approaches may improve management of complex posterior defects by combining accurate sinus control with reliable tissue reconstruction while preserving physiological drainage [11,13,41,42]. Regenerative medicine may further influence future treatment through advanced biomaterials, growth-factor delivery systems, and tissue-engineered constructs designed to enhance vascularization and accelerate tissue maturation. However, their clinical role should be established through well-designed prospective studies [25,30,32,33]. Future research should focus on multicenter clinical trials, standardized outcome measurements, and long-term assessment of functional recovery. The development of patient-specific biomaterials, digitally guided reconstruction, and individualized biological treatment protocols may represent the next stage in fistula management [16,25,30,32].

CONCLUSIONS

Management of large nasoantral and oroantral fistulas requires an integrated approach combining anatomical reconstruction, tissue biology, and preservation of sinus function. The evidence reviewed demonstrates that while conventional single-layer closure remains effective for limited defects, large chronic communications benefit from multilayer reconstruction strategies supported by vascularized tissue and epithelial restoration. Contemporary treatment concepts have shifted from simple closure toward biologically guided reconstruction, where vascular support,

mechanical stability, and sinus physiology are considered essential components of long-term success**.** The illustrative clinical application presented in this review demonstrates how these principles can be translated into practice. The combination of vascularized tissue transfer, epithelial barrier restoration, and postoperative stabilization provided predictable healing and restoration of the oral–sinus separation**.** Future advances will likely depend on integration of modern imaging, minimally invasive sinus management, regenerative technologies, and personalized reconstructive planning to achieve improved functional and long-term outcomes.

DECLARATIONS

Conflict of Interest

The author declare no conflict of interest.

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Ethical Approval

Ethical approval was not required as this is a narrative review of published literature.

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