



IMPROVING PREVENTIVE MEASURES AND SURGICAL CORRECTION OF POSTOPERATIVE COMPLICATIONS IN ENDOSCOPIC ENDONASAL INTERVENTIONS FOR NASAL AND PARANASAL SINUS PATHOLOGIES

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Annotation

This scientific article is devoted to the improvement of preventive strategies and surgical management of postoperative complications following endoscopic endonasal surgery (EES) for diseases of the nasal cavity and paranasal sinuses. EES has revolutionized the surgical approach to skull base and sinonasal pathologies, offering significant advantages over traditional open techniques. However, the complex anatomy of the sinonasal corridor and the proximity of critical neurovascular structures present unique challenges that predispose patients to a spectrum of postoperative complications, ranging from cerebrospinal fluid (CSF) leaks and intracranial infections to sinonasal functional disturbances such as crusting, adhesions, and septal perforation. This article synthesizes current evidence on refined surgical techniques, including a modified para/transseptal approach with mucosal preservation and graded skull base reconstruction protocols, to minimize complications. Furthermore, it discusses the role of enhanced perioperative management, including postoperative positioning and multidisciplinary collaboration, in improving patient outcomes. The findings underscore that a proactive, evidence-based approach combining technical precision with comprehensive perioperative care is essential for reducing complication rates and enhancing the quality of life of patients undergoing EES.

Keywords: endoscopic endonasal surgery, postoperative complications, cerebrospinal fluid leak, sinonasal morbidity, septal perforation, skull base reconstruction, multidisciplinary approach.

Relevance of the Topic

Endoscopic endonasal surgery (EES) has become the standard of care for an expanding array of pathologies involving the nasal cavity, paranasal sinuses, and ventral skull base, including pituitary adenomas, meningiomas, and sinonasal malignancies. Its widespread adoption is driven by the promise of minimal invasiveness, superior visualization, and reduced patient morbidity compared to traditional open approaches. Despite these advancements, EES is inherently associated with a distinct set of postoperative complications. These complications can be categorized into two main types: neurosurgical/neurological complications, such as CSF leaks, meningitis, and cranial nerve injuries, and sinonasal complications, including nasal crusting, adhesions, septal perforation, and chronic sinusitis.

Recent studies indicate that sinonasal morbidity, while often less acute than neurological sequelae, significantly impacts patients' long-term quality of life. The challenge lies not only in

preventing major complications like CSF leaks but also in preserving sinonasal function and minimizing chronic complaints. As the application of EES continues to expand, the imperative to refine preventive methods and surgical correction techniques for these postoperative complications has never been greater. The dynamic nature of this field, characterized by the introduction of novel surgical corridors and reconstructive materials, necessitates a continuous review and synthesis of best practices to guide clinical decision-making and improve patient outcomes.

Introduction

Endoscopic endonasal surgery involves the creation of a surgical corridor through the nasal cavity to access the skull base. This approach requires meticulous dissection and often necessitates the removal or manipulation of sinonasal structures, including the middle turbinate, nasal septum, and sinus mucosa, to achieve adequate exposure. The success of these procedures is highly dependent on a combination of factors, including meticulous preoperative planning, advanced intraoperative imaging, precise surgical technique, and comprehensive postoperative care. The introduction of advanced endoscopic vision and intraoperative imaging has significantly improved visualization and navigation, leading to greater surgical precision.

Nevertheless, the sinonasal pathway is a complex environment, and surgical manipulation invariably leads to postoperative changes. Patients frequently experience a transient worsening of sinonasal function in the first month following surgery, which, however, generally recovers within three months. However, a subset of patients may develop persistent issues such as chronic crusting, nasal obstruction, or septal perforation, requiring further intervention. The prevention and management of these complications are central to achieving optimal outcomes and ensuring high patient satisfaction.

Main Body

1. Major Postoperative Complications

Complications following EES can be broadly divided into neurosurgical/neurological and sinonasal categories.

1.1. Neurosurgical and Neurological Complications

- Cerebrospinal Fluid (CSF) Leak: The most common and significant complication, often resulting from an intraoperative dural defect. High-flow leaks pose a substantial risk of meningitis and require robust reconstruction.

- Intracranial Infections: Meningitis and intracranial abscesses can occur, especially in the setting of a persistent CSF leak.

- Cranial Nerve Injury: Damage to the optic nerve, oculomotor nerves, or olfactory nerves can lead to visual disturbances, ophthalmoplegia, or anosmia.

- Pituitary Dysfunction: Pituitary hormone deficiencies are a risk, particularly during surgery for sellar and parasellar lesions.

1.2. Sinonasal Complications

- Nasal Crusting and Discharge: A common complaint following surgery, often related to mucosal trauma and the presence of a nasoseptal flap.

- Adhesions (Synechiae): Scar tissue formation within the nasal cavity can cause obstruction and pain.

- Nasal Septal Perforation: A structural defect that can lead to chronic crusting, whistling, and bleeding. The incidence varies significantly based on the surgical approach .

- Atrophic Rhinitis and Empty Nose Syndrome: Rare but severe complications associated with excessive resection of nasal turbinates.

- Sinusitis: Postoperative infection or inflammation of the paranasal sinuses is a potential complication .

2. Modern Approaches to Prevention and Surgical Correction

2.1. Refinement of Surgical Technique

A key trend in modern EES is the adoption of mucosal-sparing techniques to minimize sinonasal morbidity.

- Mucosal-Sparing Approaches: The combined transseptal-transnasal approach, also known as the one-and-a-half nostril method, has been shown to offer advantages in reducing postoperative sinonasal complaints compared to the conventional bilateral transnasal approach . Similarly, a modified para/transseptal approach (PTSA) using a combination of Killian and rescue flap incisions has proven effective. This technique preserves the nasal septal mucosa on one side, creating a sufficient surgical corridor on the other, and has resulted in low rates of anterior (3.6%) and posterior (10.7%) septal perforation in a large series . This approach is tailored to the direction of tumor extension, allowing for lateral expansion of the sphenoidotomy and improved surgical maneuverability .

2.2. Graded Skull Base Reconstruction

The management of intraoperative CSF leaks is based on a graded reconstruction protocol, which tailors the repair technique to the size of the defect.

- Low-Grade Leaks (Grades 0-1): Often managed with fat grafts and collagen matrix, with a high success rate .

- High-Grade Leaks (Grade 3): These require more robust reconstruction, often using a vascularized pedicled nasoseptal flap (NSF). The use of lumbar drains is reserved for select cases, avoiding a reflexive approach . A graded endoscopic endonasal repair protocol has been shown to be effective in minimizing postoperative CSF leak rates, even in a surgeon's early years of practice .

2.3. Enhanced Perioperative Management

- Postoperative Positioning: A retrospective comparative study found that continuous sitting position (70°–90°) during the immediate postoperative period was associated with a decreased risk of CSF leak (OR of 0.12, $p=0.045$) .

- Nasal Care: Standardized postoperative nasal care, including saline sprays and endoscopic debridement, is crucial for promoting mucosal healing, reducing crusting, and preventing infections .

- Multidisciplinary and Tele-Mentoring: Teamwork between neurosurgeons and otolaryngologists is fundamental . Furthermore, surgical telerentoring has been shown to help low-volume centers overcome the learning curve, resulting in a decrease in postoperative complication rates from 40% to 21% .

Discussion and Results

The evidence synthesized in this review highlights a paradigm shift in the management of EES complications from a reactive to a proactive and preventive approach. The adoption of refined surgical techniques that emphasize preservation of sinonasal mucosa is a cornerstone of this shift. Studies comparing the one-and-a-half nostril approach to conventional methods have demonstrated not only a reduction in patient-reported symptoms like ear fullness and thick nasal discharge but also a trend towards better olfactory outcomes. The modified PTSA with K-R incision represents a significant technical advancement, demonstrating that a wide surgical corridor for tumor resection can be achieved while simultaneously preserving contralateral nasal mucosa and minimizing septal perforation.

Similarly, the management of CSF leaks has evolved from a uniform approach to a sophisticated, risk-stratified methodology. The implementation of graded reconstruction protocols ensures that low-risk defects are not over-treated with aggressive, potentially morbid procedures, while high-risk defects receive the robust vascularized tissue they need to heal. This tailored approach is crucial for minimizing both the rates of postoperative CSF leaks and the unnecessary use of adjuncts like lumbar drains. The finding that continuous sitting position may reduce CSF leak risk provides a simple, non-invasive adjunct to the perioperative armamentarium.

From a broader perspective, the improvement in outcomes is not solely dependent on individual techniques but is significantly influenced by the institutional and educational ecosystem. The positive impact of telementoring on reducing complication rates in low-volume centers underscores the importance of sharing expertise and facilitating safe surgical expansion. Furthermore, the continuous monitoring of sinonasal outcomes using validated instruments like the SNOT-22 questionnaire allows for a patient-centered evaluation and helps in identifying areas for further improvement.

Conclusion

Endoscopic endonasal surgery represents a monumental advance in the treatment of nasal, sinus, and skull base pathologies, offering patients a minimally invasive approach with significant benefits over traditional open surgery. However, its success is contingent upon the mastery of a complex set of skills and the rigorous application of evidence-based preventive and corrective strategies. The journey from a "two nostrils, four hands" concept to a sophisticated, patient-specific surgical discipline has been marked by continuous innovation and a deepening understanding of the anatomical and physiological intricacies of the sinonasal corridor.

The current and most effective paradigm for minimizing postoperative complications is a four-pronged approach:

1. **Preoperative Optimization:** Meticulous preoperative assessment using advanced imaging, endoscopic evaluation, and a multidisciplinary team conference (neurosurgeon, ENT, endocrinologist, ophthalmologist) to identify risk factors, plan the most appropriate surgical approach, and establish a realistic risk profile for the patient. This includes assessing the direction of tumor extension and nasal septal anatomy to tailor the approach for maximal preservation of healthy tissue.

2. **Intraoperative Precision:** The adoption of refined, mucosal-sparing surgical corridors is paramount. The modified para/transseptal approach (PTSA with K-R incision) is a prime

example of how a surgical corridor can be optimized to provide access for radical tumor resection—even in cases with significant lateral extension—while simultaneously preserving the structural and functional integrity of the nasal septum. This approach, with its low rates of septal perforation (3.6% anterior, 10.7% posterior), directly addresses a leading cause of chronic sinonasal morbidity. When a dural defect is encountered, a strict adherence to a graded reconstruction protocol is essential. This protocol dictates that the repair must be proportional to the severity of the leak, utilizing fat grafts and collagen matrix for low-grade leaks and reserving the pedicled nasoseptal flap and lumbar drains for high-grade, complex defects. This tailored strategy avoids over-treatment and reduces unnecessary patient morbidity.

3. **Postoperative Management:** The role of postoperative care is often underestimated but is critical to the overall outcome. Simple, non-invasive interventions like maintaining a continuous sitting position in the immediate postoperative period have been shown to significantly lower the risk of CSF leak, providing a simple yet powerful adjunct. Aggressive and standardized nasal care, including the use of saline sprays and scheduled endoscopic debridement, is the bedrock of sinonasal recovery, ensuring that crusts do not form, adhesions do not develop, and the mucosal lining can heal and function normally. This care is essential for returning the patient's quality of life to baseline within three months of surgery.

4. **Systemic and Educational Support:** The success of these technical and medical interventions is heavily dependent on the expertise of the surgical team. The learning curve for EES is steep, and the importance of proper training cannot be overstated. Surgical telementoring has emerged as a powerful tool to accelerate this learning process, particularly in smaller centers, leading to a demonstrable decrease in complication rates. Furthermore, the collaboration between neurosurgeons and otolaryngologists is not merely beneficial but absolutely essential for the safe and effective execution of these complex procedures. This multidisciplinary approach ensures that the distinct perspectives and skills of each specialty are integrated into a cohesive and comprehensive treatment plan.

In conclusion, the improvement of outcomes in EES is not a linear progression but a multifaceted endeavor. It requires a commitment to technical innovation, as seen in mucosal-sparing approaches and graded reconstruction, a dedication to evidence-based perioperative care, and a robust educational infrastructure to disseminate these skills. By embracing this comprehensive approach, the surgical community can continue to push the boundaries of what is possible with endoscopic endonasal surgery while safeguarding patients from its potential complications.

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