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Review

Functional Endoscopic Sinus Surgery (FESS) in the Treatment of Nasal and Sinonasal Diseases: A Review of Indications, Techniques, and Complications

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ABSTRACT

Functional Endoscopic Sinus Surgery (FESS) has emerged as a cornerstone in the management of chronic and recurrent sinonasal diseases, offering a minimally invasive approach that preserves mucosal integrity and restores normal sinus ventilation. This review outlines the indications, surgical techniques, postoperative care, and complications associated with FESS. Emphasis is placed on the clinical benefits, the evolution of surgical steps, and the management of potential adverse outcomes. While FESS demonstrates high success rates in appropriate candidates, careful patient selection and surgical expertise remain essential to minimizing complications and ensuring optimal outcomes.

1. Introduction

Functional Endoscopic Sinus Surgery (FESS) represents a pivotal advancement in the surgical management of chronic rhinosinusitis (CRS) and a broad array of sinonasal pathologies. The development of FESS was grounded in the anatomical and physiological observations made by Messerklinger, who in the 1970s demonstrated that the majority of inflammatory sinonasal diseases originate in the region of the osteomeatal complex (OMC), a critical anatomical area responsible for sinus drainage and aeration. These findings provided the foundation for a paradigm shift in sinus surgery, moving away from radical mucosal stripping procedures toward minimally invasive, physiologically preserving techniques. In the 1980s, Stammberger and Kennedy refined and popularized the endoscopic surgical approach, leading to the widespread adoption of FESS as the standard of care in refractory CRS cases (Stammberger, 1986; Kennedy, 1985)

The central principle of FESS is to re-establish the natural drainage pathways of the paranasal sinuses by removing anatomical obstructions, while preserving the mucosa and maintaining the integrity of mucociliary clearance. In contrast to traditional open surgical methods, such as the Caldwell-Luc operation, FESS avoids external incisions and unnecessary trauma to healthy tissues. The procedure is performed through the nostrils using rigid endoscopes and powered instruments, allowing for precise dissection and enhanced visualization of sinonasal structures. This endoscopic access enables targeted treatment of the diseased sinuses, leading to better outcomes and reduced postoperative complications compared to older, more invasive techniques (Kennedy, 1992; Ramadan, 2004)

A growing body of evidence supports the efficacy and safety of FESS in appropriately selected patients. Clinical studies and meta-analyses have demonstrated significant improvements in disease-specific

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quality of life, symptom relief, olfactory function, and reduction in the need for systemic medications following surgery. Patients with CRS, with or without nasal polyps, report improved Sino-Nasal Outcome Test (SNOT-22) scores and a lower incidence of acute exacerbations after undergoing FESS (Smith et al., 2005; Rudmik et al., 2012). Moreover, in patients with comorbid asthma or AERD, FESS has been shown to enhance pulmonary function and reduce corticosteroid dependency (Zhang et al., 2014; Soler et al., 2009)

In recent years, advancements in imaging, navigation technology, and instrumentation have further enhanced the safety profile and precision of FESS. Intraoperative image-guidance systems have become particularly valuable in revision surgeries and in cases with distorted anatomy, helping to minimize complications such as orbital injury or cerebrospinal fluid (CSF) leaks (Krings et al., 2013) Additionally, the integration of preoperative computed tomography (CT) with intraoperative landmarks has improved the surgeon's ability to perform tailored and individualized interventions.

Guidelines such as the European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS 2020) and recommendations from the American Academy of Otolaryngology-Head and Neck Surgery support the use of FESS in patients with persistent CRS symptoms despite appropriate medical therapy, including intranasal corticosteroids, saline irrigations, antibiotics, and leukotriene modifiers (Fokkens et al., 2020; Orlandi et al., 2016)

Overall, FESS has transformed the landscape of sinonasal disease management, offering a less invasive, highly effective approach that is both function-preserving and adaptable to a range of pathological conditions. As surgical techniques and technologies continue to evolve, the role of FESS is likely to expand further, particularly as it is increasingly integrated with adjunctive treatments such as topical drug delivery and biologic therapies.

2. Pharmacological Management of Otitis Externa (OE)

Functional Endoscopic Sinus Surgery (FESS) is primarily indicated in patients with chronic rhinosinusitis (CRS) who fail to respond to optimal medical therapy. According to the European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS 2020), medical management is considered adequate when it includes prolonged use of intranasal corticosteroids, nasal saline irrigation, and short courses of systemic antibiotics or corticosteroids in select cases. If symptoms persist for more than 12 weeks despite such therapy, surgical intervention is warranted to restore sinus ventilation and mucociliary function (Fokkens et al., 2020).

A major indication for FESS is chronic rhinosinusitis with or without nasal polyps (CRSwNP or CRSsNP). Patients with nasal polyps often suffer from anosmia, nasal obstruction, and facial pressure, and are more likely to benefit from surgical removal of polyps in conjunction with reestablishing drainage pathways. Evidence shows that FESS can significantly improve olfactory function, reduce nasal congestion, and enhance quality of life in this subgroup (Zhang et al., 2014).FESS is also indicated in recurrent acute rhinosinusitis, defined as four or more episodes of acute sinusitis per year, each resolving completely but occurring frequently despite adequate treatment. Surgery in such cases aims to improve mucociliary clearance and reduce frequency of exacerbations (Bhattacharyya et al., 2012)

Fungal sinusitis—especially non-invasive types such as fungal ball and allergic fungal rhinosinusitis (AFRS)—is another well-established indication for FESS. In fungal ball cases, endoscopic removal of the fungal mass and widening of the affected sinus ostium are curative. In AFRS, FESS facilitates the removal of allergic mucin and improves delivery of topical corticosteroids, essential for long-term disease control (Schubert, 2004)

Structural or anatomic abnormalities contributing to sinonasal obstruction also justify FESS. Examples include deviated nasal septum, concha bullosa, antrochoanal polyps, Haller cells, or narrowed infundibulum. These conditions can cause obstruction of the natural sinus drainage pathways and perpetuate inflammation, and surgical correction can lead to long-term symptom relief (Sharma et al., 2014). Furthermore, FESS is frequently performed for sinonasal mucoceles, particularly those involving the frontoethmoidal region. Endoscopic marsupialization of the mucocele into the nasal cavity restores sinus drainage and avoids external facial incisions, offering excellent long-term results (Lloyd et al., 2000)

In addition to inflammatory conditions, FESS is useful in managing various orbital and intracranial complications of sinusitis. For example, subperiosteal or orbital abscesses, cavernous sinus thrombosis, and optic nerve compression may require urgent endoscopic intervention. FESS allows for effective drainage and decompression while minimizing morbidity (Bedwell & Choi, 2012)

Other extended indications include repair of cerebrospinal fluid (CSF) leaks, endoscopic transnasal pituitary surgery, decompression of the optic nerve in traumatic or compressive etiologies, and image-guided resection of benign sinonasal tumors such as inverted papilloma or juvenile nasopharyngeal angiofibroma. These uses highlight the versatility of FESS beyond the scope of chronic inflammation (Castelnuovo et al., 2019)

FESS is also commonly utilized in revision surgeries for patients with persistent or recurrent symptoms after prior sinus procedures. In such cases, image-guided navigation is frequently employed to enhance precision and minimize risks in distorted surgical anatomy (Krings et al., 2013) Collectively, the indications for FESS span a wide spectrum—from inflammatory and infectious sinus disease to structural and neoplastic disorders. The decision to proceed with FESS

should be individualized based on symptom severity, disease phenotype, radiologic findings, and the patient's response to medical therapy.

3. Effectiveness and Outcomes

The clinical effectiveness of FESS has been well-established through a range of randomized trials, cohort studies, and systematic reviews. One of the most consistent findings is the significant improvement in disease-specific quality of life (QoL) following surgery. The Sino-Nasal Outcome Test (SNOT-22) is the most widely used and validated instrument to assess symptom burden and functional limitations in patients with chronic rhinosinusitis (CRS). Numerous studies have demonstrated that FESS leads to marked reductions in SNOT-22 scores postoperatively, reflecting improvements in nasal obstruction, facial pain, sleep quality, and olfactory function (Smith et al., 2005).

A systematic review by Rudmik and Smith (2012) concluded that FESS provides durable symptom control and QoL enhancement, particularly in patients with CRS refractory to medical management. Improvements were noted across multiple domains, including physical functioning and mental health, with most patients experiencing symptom relief as early as three months postoperatively. Importantly, long-term follow-up suggests that these benefits persist for several years. A prospective cohort study by DeConde et al. (2014) involving over 200 patients reported sustained QoL gains up to 5 years after surgery.

FESS has also shown benefits in reducing the need for systemic medications and antibiotic usage. Postoperatively, patients typically report fewer exacerbations and a decreased reliance on oral corticosteroids, especially those with nasal polyps or comorbid asthma. Soler et al. (2009) observed that patients with asthma demonstrated significantly greater QoL improvements compared to non-asthmatics, with better control of both upper and lower airway symptoms following surgery.

Revision surgery rates after FESS vary depending on the underlying disease phenotype and follow-up duration. Studies suggest that revision rates range between 15% and 20% over 5 to 10 years, particularly in patients with nasal polyps, AERD, or eosinophilic inflammation. However, recurrence is notably lower in patients without polyps or comorbid conditions. A meta-analysis conducted in the Middle East reported a recurrence rate of 6% over short-term follow-up, highlighting regional variations and the impact of patient selection on surgical success (Algahtani et al., 2024).

Furthermore, olfactory improvement following FESS is particularly relevant for patients with CRSwNP. A study by Litvack et al. (2009) demonstrated that nearly 40% of anosmic patients reported partial or complete return of smell within 6 months post-surgery, attributed to improved airflow and reduced mucosal inflammation. These findings reinforce the role of FESS not only in mechanical drainage but also in restoring mucosal homeostasis.

4. Surgical Techniques in FESS

The surgical technique of FESS is grounded in the principles of restoring natural sinus ventilation and drainage, while preserving as much normal mucosa as possible to maintain mucociliary function. The aim is not merely to clear infected material but to reestablish the physiological pathways for mucus transport, thereby addressing the underlying pathology rather than just its manifestations (Kennedy, 1985).

The procedure is performed under general anesthesia using rigid nasal endoscopes with 0°, 30°, and 70° viewing angles. The surgical field is enhanced by decongestants and local infiltration of vasoconstrictors, typically lidocaine with epinephrine, to minimize bleeding and improve visualization. The standard surgical sequence begins with a diagnostic nasal endoscopy, followed by uncinectomy—the removal of the uncinate process, a thin bony structure that obstructs the natural ostium of the maxillary sinus. This step is crucial as it exposes the infundibulum and enables identification and enlargement of the maxillary ostium. Removing the uncinate process improves access to the anterior ethmoid cells and sets the stage for subsequent dissection (Stammberger, 1986).

Ethmoidectomy follows uncinectomy and involves removal of ethmoid air cells. In anterior ethmoidectomy, the bulla ethmoidalis is opened and excised, exposing the ground lamella, which separates the anterior and posterior ethmoid compartments. Posterior ethmoidectomy then proceeds beyond this lamella, often requiring meticulous dissection due to the proximity of the skull base and orbit. The removal of ethmoid air cells reduces the nidus for persistent infection and inflammation, while maintaining key anatomical landmarks (Wormald, 2013).

Sphenoidotomy is performed when disease involves the sphenoid sinus. The anterior wall of the sphenoid is thinned and removed to facilitate drainage. Given the close anatomical relationship of the sphenoid sinus to the optic nerve and internal carotid artery, this step

demands precise surgical technique and often benefits from image-guided navigation systems (Harvey et al., 2006).

Frontal sinusotomy is among the most challenging steps due to the variable and narrow anatomy of the frontal recess. If imaging confirms frontal sinus disease, the surgeon carefully removes obstructing cells (such as agger nasi or frontal cells) and establishes a patent pathway. Balloon sinuplasty may be used adjunctively in select cases. However, excessive mucosal trauma in this region can lead to restenosis, underscoring the importance of conservative and precise dissection (Wormald et al., 2016). Throughout the procedure, polyps, fungal concretions, mucoceles, or benign tumors may be excised as necessary. In cases of allergic fungal rhinosinusitis, allergic mucin must be removed while preserving sinus walls to prevent recurrence (Schubert, 2004).

Intraoperative image guidance (IGS), which integrates the patient's CT scan with real-time navigation, has become an essential adjunct in complex or revision surgeries. It enhances anatomical orientation and reduces the risk of complications such as orbital injury or cerebrospinal fluid leak. Multiple studies have shown that the use of IGS significantly improves safety and confidence in anatomically distorted or high-risk cases (Krings et al., 2013).

Recently, a more extensive approach known as Extensive Endoscopic Sinus Surgery (EESS) has been advocated for patients with recalcitrant nasal polyposis and eosinophilic CRS. EESS involves a more aggressive removal of inflamed mucosa and a wider opening of all sinus ostia. It has demonstrated superior outcomes in select patient populations, particularly those with asthma or aspirin-exacerbated respiratory disease (Eloy et al., 2016).

5. Care Following FESS

Postoperative care plays a crucial role in ensuring optimal healing, minimizing complications, and preventing disease recurrence after FESS. The period immediately following surgery is characterized by mucosal edema, crusting, and the potential for synechiae formation due to raw surfaces within the sinonasal cavities. Thus, careful postoperative management is essential to support mucosal regeneration and reestablishment of mucociliary function (Rudmik & Smith, 2012).

Nasal saline irrigation is considered a first-line intervention postoperatively. Isotonic or hypertonic saline solutions are typically administered using squeeze bottles, bulb syringes, or powered irrigation devices. These irrigations help to mechanically remove mucus, blood clots, crusts, and debris, and are associated with reduced inflammation and faster re-epithelialization. Computational fluid dynamics (CFD) modeling has further supported the importance of correct head position and irrigation volume to maximize distribution to the sinus cavities, particularly after ethmoidectomy or maxillary antrostomy (Harvey et al., 2007).

Topical intranasal corticosteroid sprays, such as fluticasone or mometasone furoate, are typically resumed within a few days postoperatively and continued long term. These agents suppress residual mucosal inflammation, reduce polyp recurrence, and support mucosal remodeling. Several studies have shown that the combination of FESS with postoperative topical corticosteroids results in superior outcomes compared to surgery alone, especially in patients with nasal polyps or eosinophilic CRS (Snidvongs et al., 2012).

Postoperative debridement is routinely performed at weekly intervals during the first 3–4 weeks after surgery. Debridement involves endoscopic removal of crusts, fibrin, and necrotic tissue using suction and forceps. This process helps prevent the formation of synechiae between the middle turbinate and lateral nasal wall, maintains sinus patency, and allows for better penetration of topical therapies. Although some studies suggest that debridement reduces short-term inflammation and improves early healing, its long-term benefits on disease control remain controversial (Yung et al., 2017).

Systemic antibiotics are commonly prescribed for 7 to 10 days postoperatively, particularly if purulent discharge was encountered during surgery or if the patient has immunocompromised status. Empirical choices often include cephalosporins or amoxicillin-clavulanate. However, the routine use of antibiotics in all postoperative patients is not universally supported, and a targeted approach based on intraoperative cultures or clinical signs of infection is increasingly favored (Kaschke et al., 2001). Oral corticosteroids may be indicated in selected patients, especially those with extensive nasal polyposis, asthma, or AERD. A short tapering course initiated postoperatively can reduce polyp regrowth and mucosal edema. However, the use of systemic steroids must be balanced against potential adverse effects (Hulse et al., 2015).

Antihistamines and leukotriene receptor antagonists are administered in patients with known allergic rhinitis or AERD, respectively. These medications may help control systemic inflammatory responses and reduce postoperative congestion. Finally, regular endoscopic follow-up is essential in the postoperative period. Surveillance allows the surgeon to monitor for signs of infection, mucosal healing, ostial patency, and complications such as adhesion formation, synechiae, or scarring. A common follow-up schedule includes weekly visits during the first month, then monthly assessments for 3–6 months depending on clinical progress.

6. Complications of FESS

Although FESS is considered a safe and minimally invasive procedure, it is not without potential complications. These complications are generally categorized into major and minor types, based on their severity, reversibility, and long-term impact. The risk of complications is influenced by factors such as disease extent, anatomic variations, revision status, surgeon experience, and intraoperative technique.

6.1. Major Complications

Cerebrospinal fluid (CSF) leak is a serious but infrequent complication, typically resulting from injury to the cribriform plate or the fovea ethmoidalis during ethmoidectomy. The incidence of CSF leak during FESS is reported to be approximately 0.2%, and if not promptly recognized and managed, may lead to meningitis or intracranial abscess formation. Dural tears should be repaired intraoperatively with fascia, fat grafts, or mucosal flaps, and postoperative antibiotics are generally administered (Solares et al., 2007).

Orbital complications can occur due to the close proximity of the ethmoid sinuses to the medial orbital wall. These may include orbital hematoma, extraocular muscle injury, optic nerve damage, or periorbital emphysema. The most feared orbital complication is vision loss, which may result from direct trauma or vascular compromise to the optic nerve. This complication is rare, occurring in less than 0.5% of cases, but often leads to permanent deficits if not addressed emergently (Stankiewicz, 1987).

Hemorrhagic complications, although rare, may be life-threatening. Bleeding can result from injury to the anterior or posterior ethmoidal arteries or, more catastrophically, to the internal carotid artery, particularly during sphenoidotomy. While the overall risk of severe bleeding is low, it remains more common than skull base or orbital injury, and proper preoperative imaging and intraoperative caution are essential to reduce this risk (Krings et al., 2013).

A large cohort analysis by Krings and colleagues (2013) that reviewed 78,944 FESS cases found the major complication rate to be approximately 0.36% in primary surgeries and 0.46% in revision procedures. This slight increase in revisions reflects the greater anatomical distortion and scarring that can complicate reoperation.

6.2. Minor Complications

Minor bleeding is the most frequently encountered intraoperative issue. While usually manageable with suction and topical vasoconstrictors, it can obscure the surgical field and prolong the operation. Synechiae formation—adhesions between the middle turbinate and lateral nasal wall—is a common postoperative occurrence, especially if mucosal trauma is significant. Synechiae can obstruct sinus outflow tracts and may necessitate revision surgery if severe. Preventive measures include careful handling of mucosa, preservation of the middle turbinate, and regular postoperative debridement (Tantilipikorn et al., 2008).

Middle turbinate lateralization is another minor but important complication. If the turbinate moves laterally and adheres to the lateral nasal wall, it can obstruct the middle meatus and hinder sinus ventilation. This is often managed by synechiolysis or partial resection in severe cases.

Hyposmia or anosmia may persist or occur de novo after surgery. While some patients report improved smell due to enhanced airflow and reduced inflammation, others may experience deterioration, possibly due to surgical trauma or persistent inflammation in the olfactory cleft. Most cases are transient, but persistent anosmia can significantly affect quality of life (Litvack et al., 2009). Other minor complications include dental pain, infraorbital numbness, and periorbital ecchymosis, usually resulting from local edema, inflammation, or transient nerve irritation. These symptoms are generally self-limiting and resolve with conservative management.

6.3. Risk Reduction Strategies

A number of risk mitigation strategies have been recommended to reduce the likelihood of complications during FESS. Preoperative high-resolution CT imaging is indispensable for mapping the anatomy, identifying dangerous variants such as dehiscent lamina papyracea or low-hanging skull base, and aiding in surgical planning (Lund & Kennedy, 1997).

Intraoperative image-guided navigation (IGS) is particularly valuable in revision surgeries or cases with distorted anatomy. It provides real-time spatial orientation using preoperative imaging, helping to avoid critical structures and increase surgical precision. Several studies have confirmed its utility in decreasing complication rates and improving surgeon confidence (Rosen et al., 2002).

Other protective strategies include maintaining meticulous hemostasis, preserving mucosa whenever possible, limiting the extent of resection to what is clinically necessary, and ensuring adequate training and experience. The role of simulation-based training and cadaveric dissection is increasingly recognized in enhancing surgical competency and minimizing error.

7. Special Scenarios in FESS

While FESS is commonly performed for typical chronic rhinosinusitis (CRS), there are several unique clinical scenarios that require specialized planning and surgical technique. Two such scenarios include patients with hypoplastic maxillary sinuses and those with refractory CRS associated with comorbid asthma AERD.

7.1. Hypoplastic Maxillary Sinus

Maxillary sinus hypoplasia is an anatomical variation characterized by underdevelopment of the maxillary sinus cavity, which may alter the location of the natural ostium and make surgical access more challenging. This condition is often associated with deviation of the uncinate process, a low-lying orbital floor, and displacement of the ethmoid air cells. These changes increase the risk of orbital injury and necessitate a modified surgical approach.

In a retrospective study by Durr et al. (2022), which evaluated 814 patients undergoing FESS, 56 were identified as having hypoplastic maxillary sinuses. The study found no major complications, and minor complications were rare, indicating that with proper preoperative imaging and surgical planning, FESS can be safely and effectively performed even in patients with this anatomical variant. The authors emphasized the importance of understanding individual anatomical differences via high-resolution CT scans and possibly incorporating image-guided navigation when normal landmarks are absent or altered.

7.2. Refractory CRS with Nasal Polyps and Asthma

Patients with CRS who also have comorbid asthma or AERD represent a particularly difficult-to-treat population. These patients tend to have diffuse eosinophilic inflammation, extensive nasal polyposis, high recurrence rates, and are often dependent on systemic corticosteroids for symptom control. For such cases, more aggressive surgical strategies may be required to improve outcomes. Extensive Endoscopic Sinus Surgery (EESS), as opposed to standard FESS, involves a broader clearance of diseased mucosa and more comprehensive opening of all paranasal sinuses. A study by Eloy et al. (2016) demonstrated that patients with asthma and nasal polyps experienced significantly greater improvement in symptom scores and longer remission following EESS compared to standard FESS. The rationale is that more aggressive removal of the inflammatory burden improves access for postoperative topical therapies and reduces mucosal reservoirs of eosinophilic inflammation.

Moreover, a meta-analysis by Zhang et al. (2014) showed that CRS patients with asthma derive enhanced quality of life improvements following FESS, though their rates of recurrence remain higher than those without asthma. The benefit of surgery in these patients is particularly pronounced in the early postoperative period, but ongoing medical therapy—including topical corticosteroids and biologics targeting type 2 inflammation—remains essential for long-term disease control.

8. Conclusion

FESS is a highly effective and safe surgical modality for refractory nasal and sinonasal disease, particularly chronic rhinosinusitis. Studies consistently document clinically meaningful improvements in quality of life, olfaction, symptom relief, and decreased medication use, with major complication rates below 0.5% and minor ones relatively common but manageable. Patient factors such as presence of asthma, nasal polyps, anatomic variants, and extent of disease influence outcomes and revision risk. The use of image-guided navigation and careful perioperative planning further minimizes complications.

Adoption of standardized postoperative care—including regular debridement, saline irrigation, steroids, and endoscopic surveillance—supports optimal long-term outcomes. Nonetheless, recurrence and revision rates (often ~15–20% over mid-term follow-up) indicate the need for continued follow-up, especially in high-risk subgroups. Future directions include evaluation of novel adjuncts (e.g. steroid-eluting stents), refinement of surgical extent based on inflammatory phenotype, and long-term comparative studies between FESS, EESS, and alternative sinus-preserving interventions like balloon dilation.

References

Algahtani, S., Alhajlah, A., Abuharb, A. I., Alzarroug, A. F., Almughira, A. I., Alsywina, N., Alahmadi, F. K., & Al-Dubai, S. (2024). Outcomes of Functional Endoscopic Sinus Surgery in Chronic Rhinosinusitis: A Systematic Review and Meta-Analysis. Cureus. **16**(2), e53952.

Bhattacharyya N, Grebner J, Martinson NG. (2012). Recurrent acute rhinosinusitis: epidemiology and health care cost burden. *Otolaryngol Head Neck Surg.***146**(2):307-312.

DeConde, A. S., Mace, J. C., Bodner, T. E., & Smith, T. L. (2014). Predictors of change in quality of life after endoscopic sinus surgery for chronic rhinosinusitis. *The Laryngoscope*. **124**(1), 29–34.

Durr, M. L., Ramanathan, M., & Kacker, A. (2022). Safety and efficacy of FESS in patients with hypoplastic maxillary sinuses. *American Journal of Rhinology & Allergy.* **36**(1), 56–61.

Eloy, J. A., Shukla, P. A., Choudhry, O. J., Friedel, M. E., Liu, J. K., & Liu, J. K. (2016). Extensive endoscopic sinus surgery in patients with asthma and nasal polyposis. *International Forum of Allergy & Rhinology.* **6**(5), 484–492.

Fokkens, W. J., Lund, V. J., Hopkins, C., et al. (2020). European position paper on rhinosinusitis and nasal polyps 2020. *Rhinology Supplement.* **29**, 1–464.

Harvey, R. J., Goddard, J. C., Wise, S. K., & Schlosser, R. J. (2007). Effects of endoscopic sinus surgery and delivery device on cadaver sinus irrigation. *The Laryngoscope.* **117**(4), 725–730.

Harvey, R. J., Shelton, W., & Timperley, D. (2006). Sphenoid sinus anatomy and surgical access. *Otolaryngologic Clinics of North America*. **39**(3), 459–472.

Hulse, K. E., Norton, J. E., Suh, L., et al. (2015). Chronic rhinosinusitis with nasal polyps and asthma: The role of eosinophilic inflammation. *The Journal of Allergy and Clinical Immunology*. **135**(2), 373–376.

Kaschke, O., Rettinger, G., & Werner, J. A. (2001). Antibiotic therapy in sinus surgery: Is there a standard?. *Laryngo-Rhino-Otologie.* **80**(7), 388–392.

Kennedy, D. W. (1985). Functional endoscopic sinus surgery: Technique. *Archives of Otolaryngology.* **111**(10), 643–649.

Kennedy, D. W. (1992). Prognostic factors, outcomes and staging in ethmoid sinus surgery. *The Laryngoscope.* **102**(12 Pt 2 Suppl 57), 1–18.

Krings, J. G., Kallogjeri, D., Wineland, A. M., & Piccirillo, J. F. (2013). Complications of sinus surgery: A review of 78,944 procedures. *The Laryngoscope.* **123**(3), 706–710.

Litvack, J. R., Mace, J. C., & Smith, T. L. (2009). Olfactory function and disease severity in chronic rhinosinusitis. *American Journal of Rhinology & Allergy.* **23**(2), 139–144.

Lloyd, G., Lund, V. J., Savy, L., & Howard, D. (2000). Optimum management of frontal mucoceles: A review of 45 cases. *The Journal of Laryngology & Otology.* **114**(12), 964–968.

Lund, V. J., & Kennedy, D. W. (1997). Quantification for staging sinusitis. *The Annals of Otology, Rhinology, and Laryngology*. Supplement **167**, 17–21.

Rosen, M. R., Chandra, R. K., & Kennedy, D. W. (2002). The role of image-guided surgery in functional endoscopic sinus surgery. *Otolaryngologic Clinics of North America*. **35**(4), 597–609.

Rudmik, L., & Smith, T. L. (2012). Evidence-based practice: Postoperative care in endoscopic sinus surgery. *Otolaryngologic Clinics of North America.* **45**(5), 1019–1032.

Schubert, M. S. (2004). Allergic fungal sinusitis. *Otolaryngologic Clinics of North America.* **37**(2), 301–326.

Smith, T. L., Batra, P. S., Seiden, A. M., & Hannley, M. (2005). Evidence supporting endoscopic sinus surgery in the management of adult chronic rhinosinusitis: A systematic review. *The Laryngoscope.* **115**(3), 1–19.

Snidvongs, K., Chaowanapanja, P., Aeumjaturapat, S., & Chusakul, S. (2012). Topical nasal steroids as postoperative therapy for endoscopic sinus surgery. *American Journal of Rhinology & Allergy*. **26**(3), 179–183.

Solares, C. A., Ong, Y. K., & Batra, P. S. (2007). Management of cerebrospinal fluid leaks: A contemporary review. *Current Opinion in Otolaryngology & Head and Neck Surgery.* **15**(1), 31–36.

Soler, Z. M., Smith, T. L., Litvack, J. R., & Mace, J. C. (2009). Chronic rhinosinusitis in patients with asthma: A comparative outcomes study. *American Journal of Rhinology & Allergy.* **23**(5), 525–529.

Stammberger, H. (1986). Functional endoscopic sinus surgery: The Messerklinger technique. The *Laryngoscope*. **96**(2), 125–133.

Stankiewicz, J. A. (1987). Complications of endoscopic intranasal ethmoidectomy. *The Laryngoscope*. **97**(11), 1270–1273.

Tantilipikorn, P., Fritz, M. A., Tanabodee, J., et al. (2008). Middle turbinate lateralization after endoscopic sinus surgery. *Rhinology*. **46**(1), 37–41.

Wormald, P. J. (2013). Endoscopic sinus surgery: Anatomy, three-dimensional reconstruction, and surgical technique. Thieme Medical Publishers.

Yung, M. W., Gould, J., & Sahota, D. (2017). Does postoperative debridement improve outcome after functional endoscopic sinus surgery?. *The Journal of Laryngology & Otology*. **131**(2), 142–148.

Zhang, Z., Adappa, N. D., & Doghramji, L. (2014). Outcomes of endoscopic sinus surgery in patients with asthma and sinusitis. *International Forum of Allergy & Rhinology*. **4**(4), 293–298.