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FROM CHRONIC SINUSITIS TO SINONASAL TUMORS: THE EXPANDING ROLE OF FESS IN MODERN SURGERY

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ABSTRACT

Objective: The objective of this study was to explore the evolving role of Functional Endoscopic Sinus Surgery (FESS) - the gold standard in the treatment of chronic rhinosinusitis and other sinus diseases. Advances in diagnostic imaging, surgical instruments, and navigation systems have significantly improved the safety and efficacy of this technique. This study provides an overview of the FESS technique, and its expanding indications - application in the treatment of selected sinus tumors, such as inverted papilloma, juvenile nasopharyngeal angiofibroma (JNA), and osteomas.

Methods: A narrative review of the literature was conducted, focusing on the development of FESS, its surgical technique, safety profile, and clinical outcomes. Special attention was given to its comparison with traditional open approaches in both inflammatory and neoplastic conditions of the sinonasal tract.

Key Findings: The analysis revealed that technological progress - particularly in diagnostic imaging, surgical instruments, and intraoperative navigation - has significantly improved the precision and safety of FESS. Clinical evidence demonstrates that endoscopic resection of sinonasal tumors often achieves recurrence rates equal to or lower than those associated with open surgery, while minimizing morbidity, hospitalization time, and facial disfigurement. Successful outcomes depend on appropriate patient selection, meticulous preoperative planning, and the surgeon's expertise.

Conclusions: Functional Endoscopic Sinus Surgery is a safe and effective modality for treating a wide range of sinonasal diseases, including chronic rhinosinusitis and selected benign tumors. With proper patient selection, preoperative planning, and surgical expertise, FESS offers substantial benefits over traditional open approaches, including reduced morbidity and improved recovery. Continued technological advancements and long-term outcome studies will further refine its role in comprehensive sinonasal care.

KEYWORDS

Functional Endoscopic Sinus Surgery, Chronic Rhinosinusitis, Sinonasal Tumors, Inverted Papilloma, Juvenile Nasopharyngeal Angiofibroma, Osteoma, Minimally Invasive Surgery

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Introduction

Functional Endoscopic Sinus Surgery (FESS) has made considerable progress since its initial implementation. The first endoscopic examination of the sinuses occurred in 1902 (Homsí & Gaffey, 2025). However, for the majority of the last century, the practice of FESS was not carried out consistently, remaining sporadic until the significant changes of the 1970s.

Since the 1970s, endoscopic sinus surgery has changed a lot due to modern technology. This includes better surgical tools, improved imaging techniques, advanced simulation methods, and accurate navigation systems. Together, these innovations make the surgeries more effective and safer (Kennedy, 2006).

FESS is a minimally invasive procedure that enhances the precision of diagnostics and visibility during surgical interventions. By using advanced endoscopic techniques, FESS allows for greater access to the sinus cavities while minimizing trauma to the surrounding, healthy structures. This method not only promotes improved patient outcomes and comfort but also makes it easier to obtain the effective management of various sinus-related conditions (Kennedy, 1985). This technique is primarily known for treating chronic sinusitis (Bera & Rao, 1997), but it has gained more versatile applications in recent years (Govindaraj et al., 2010).

Methodology

This narrative review was conducted by systematically examining published literature on the role of Functional Endoscopic Sinus Surgery (FESS) in the management of chronic rhinosinusitis and benign sinonasal tumors, including inverted papilloma, juvenile nasopharyngeal angiofibroma (JNA), and osteomas. Relevant scientific articles were identified through searches in electronic databases such as PubMed, Scopus, and Google Scholar, using keywords including “functional endoscopic sinus surgery,” “chronic rhinosinusitis,” “inverted papilloma,” “juvenile nasopharyngeal angiofibroma,” “osteoma,” and “endoscopic sinonasal surgery.” The inclusion criteria focused on peer-reviewed studies published in English between 1985 and 2025, comprising clinical trials, retrospective analyses, systematic reviews, and narrative reports that examined the efficacy, safety, and expanding indications of FESS. Studies comparing endoscopic and open surgical approaches were also included. Data were extracted to synthesize evidence regarding surgical techniques, outcomes, recurrence rates, complications, and patient selection criteria. The gathered information was analyzed to provide an updated overview of the expanding role of FESS in modern sinonasal surgery.

Surgical Technique and Procedural Overview of FESS

The procedure is performed under general anesthesia using a stiff nasal endoscope, which provides better visualization of the sinonasal structures. The surgeon begins by inspecting the nasal cavity and searching for key anatomical landmarks, including the middle turbinate, uncinate process, and sinus ostia (Kennedy, 1985; Stammberger, n.d.).

The first step involves, in most cases, resection or medialization of the uncinate process to reveal the ethmoid infundibulum. Afterwards, the ostia of the following sinuses: maxillary, frontal, anterior and posterior ethmoid, or sphenoid should be identified and enlarged. This ensures better drainage of sinus contents. From now on, it is possible to remove the diseased mucosa, polyps, or other obstructive tissue. It is achieved by using specialized instruments such as microdebriders, forceps, and suction devices (Homsí & Gaffey, 2025; Korkmaz & Korkmaz, 2022).

Continuous endoscopic visualization during the procedure can minimize the damage to critical surrounding structures, including the lamina papyracea, the cribriform plate and fovea ethmoidalis, the nasolacrimal duct, the internal carotid artery and the optic nerve (Khademi et al., 2022). Hemostasis is maintained with topical vasoconstrictors, for example, epinephrine or oxymetazoline. Bipolar electrocautery is commonly used to control persistent bleeding. Some research papers recommend using warm saline irrigation (approximately 50 °C), not only to maintain the clarity of the endoscope but also to induce mucosal edema and help in hemostasis (Altaf et al., 2025; Moshaver et al., 2009).

Postoperative care includes nasal packing or splints and topical corticosteroids to promote healing and reduce inflammation. The main goal of FESS is to restore sinus ventilation, improve mucociliary clearance, and reduce the frequency and severity of sinus infections (Eloy et al., 2017).

Indications for FESS

FESS is primarily performed to manage chronic rhinosinusitis that does not respond to medical treatment, nasal polyps, antrochoanal polyps, and sinus mucocoeles. However, indications for endoscopic sinus surgery may also involve the closure of cerebrospinal fluid leaks, decompression of the orbital and optic nerves, dacryocystorhinostomy, repair of choanal atresia, removal of foreign bodies, management of nosebleeds and the excision of tumors of the sinonasal tract (Kar et al., 2024) - an indication that will be the focus of this study.

The expanded endonasal approach has made it possible to excise benign sinonasal tumors through minimally invasive methods, building on earlier endoscopic innovations such as those by Jankowski in the early 1990s, and gaining significant momentum with the foundational work published by Jho and Carrau in 1996 (Jankowski et al., 1992; Jho & Carrau, 1996; Tajudeen & Kennedy, 2017).

Since then, this approach has evolved to become an alternative to traditional open surgeries. Along with the progress of surgical instrumentation and imaging techniques, it can offer better visualization, reduced morbidity, shorter hospitalization time, and improved postoperative outcomes (Fanos, 2024; Jiang et al., 2022; Nicolai et al., 2008). It is necessary to point out that this technique requires pre-operative evaluation of each patient. The choice of surgical approach depends on many factors, including surgeon experience, patient preference, underlying health status, histopathological findings, and tumor stage (Banhiran & Casiano, 2005).

Tumors of sinonasal tract are relatively rare compared to other head and neck tumors. In the past, these lesions were mainly removed by open methods, such as transfacial or craniofacial approaches (Banhiran & Casiano, 2005).

Inverted papilloma

Inverted papilloma is a benign but locally aggressive neoplasm of the nasal cavity. It is also known for its possible transformation into a malignant tumor. Histologically, it is characterized by invagination of squamous epithelium into the underlying stroma. It most often occurs in men in the 5th–6th decade of life. It usually originates from the lateral wall of the nose and spreads to the surrounding sinuses. Typical symptoms include unilateral nasal obstruction and bleeding (Upadhyaya & Rao, 2022).

Traditionally, it was treated with lateral rhinotomy and medial maxillectomy. Studies show that endoscopic treatment gives comparable or even better results in terms of recurrence (e.g. 12% vs. 18% in the study by Lawson (Lawson et al., 2003), 3% vs 24% in the study of Pasquini (Pasquini et al., 2004)), fewer complications and a shorter hospital stay.

The authors propose specific criteria for qualifying for endoscopic treatment. This procedure is recommended for lesions located on the lateral wall of the nasal cavity and those that extend to the ethmoid sinus, sphenoid sinus, or the medial wall of the maxillary sinus. Early recurrences can be effectively treated on an outpatient basis, which is why endoscopic procedures have become the method of choice in cases of limited neoplastic lesions (Banhiran & Casiano, 2005).

Juvenile angiofibroma

Juvenile angiofibroma of the nasopharynx (JNA) is a benign but locally aggressive and highly vascularized tumor that occurs almost exclusively in boys and young men. The most common symptoms are recurrent nosebleeds and unilateral nasal obstruction. Complications may include massive hemorrhages and intracranial invasion (López et al., 2017).

Imaging diagnostics (CT, MRI, angiography) allows for precise assessment of the extent of the lesion, as well as the vessels feeding the tumor. Preoperative embolization significantly reduces bleeding and improves surgical conditions. The goal of treatment is complete removal of the tumor while minimizing neurological risk and blood loss. Classic open techniques can disrupt the development of the facial skeleton in young patients, which is why endoscopic methods are currently preferred, which are less invasive and equally effective (Kopeć et al., 2014).

Studies by Nicolai (Nicolai et al., 2003), Roger (Roger et al., 2002), and Önerci (Önerci et al., 2003) have shown high efficacy of endoscopic treatment - most patients were free from the disease with a low risk of recurrence and little blood loss. In some cases, laser (Nd:YAG, KTP) and intraoperative navigation were also used. Complications were rare and mostly harmless (e.g. adhesions, cysts) (Fyrmpas et al., 2012).

Since JNA may show a tendency to spontaneous regression, some authors suggest that small remnants of asymptomatic tumor may be monitored only. Treatment may be postponed until clinical symptoms appear, such as bleeding or pressure on adjacent structures (Patrick M. Spielmann, Richard Adamson, Kenneth Cheng, Robert J. Sanderson, 2008).

Osteomas

Sinus osteomas are the most common benign tumors in this area, usually developing slowly and asymptotically. About half of them do not grow at all, and in the remaining ones the growth rate is on average about 1 mm per year. Although they do not undergo malignant transformation, they can cause symptoms by pressing on the structures of the orbit or brain and blocking the sinus openings. This leads to sinusitis, mucous cysts (mucocoeles), facial deformity or visual impairment (Buyuklu, F., Akdogan, M.V., Ozer, C. and Cakmak, O., 2011).

Treatment is not necessary for small, asymptomatic lesions - regular imaging tests every 2 years are sufficient. Indications for surgery include rapid tumor growth (>1 mm/year) and clinical symptoms. Most symptomatic osteomas are located in the frontal and ethmoid sinuses (Buyuklu, F., Akdogan, M.V., Ozer, C. and Cakmak, O., 2011).

The choice of surgical technique (endoscopic, external, or combined) depends on the location and size of the tumor, the patient's anatomy, and the experience of the surgeon. Endoscopic removal is preferred in cases of favorable anatomy and smaller extent of the lesion, while external access (e.g. frontal sinus

osteoplasty) is reserved for large, lateral tumors or tumors infiltrating the orbital or cranial structures (Cokkeser et al., 2013; Schick & Steigerwald, 2001).

Endoscopic techniques, thanks to modern tools (e.g. powerful curved drills, navigation during surgery), allow for precise and minimally invasive tumor removal. In some situations, when complete resection carries an elevated risk of complications, it is better to leave a small, safe tumor remnant than to pursue radical removal. In addition, reconstruction of the orbital plate after osteoma resection is not necessary if the periorbita remains intact or minimally damaged (Cheng et al., 2013; Karpishchenko & Bolozneva, 2015; Rampinelli et al., 2025). However, when the defect is larger, grafts from the thigh fascia lata or nasal septum flaps are used. Control endoscopic examinations are recommended, and in case of uncertainty - CT approximately one year after the procedure (Castelnuovo et al., 2012; Ledderose et al., 2011; Turri-Zanoni et al., 2012).

The Turri-Zanoni (Turri-Zanoni et al., 2012) study showed that even large osteomas of the frontal sinus, including those with orbital involvement, could be successfully removed endoscopically—31 of 60 cases were treated with a nasal-only approach, with a mean follow-up of 73 months. Importantly, there was no tumor recurrence.

The differential diagnosis should include osteofibroma, which – unlike osteoma – has a tendency to recur and requires complete excision together with the capsule (Eller & Sillers, 2006; Nivean et al., 2022).

Complications and weak points of FESS

Determining the exact frequency of complications after FESS is difficult due to variable reporting. Major complications occur in about 0–1.5% of cases, and minor complications in about 1.12–20.8% (McMains, 2008).

Orbital injuries: During surgery in the maxillary and ethmoid sinuses, there is a risk of damage to the orbital wall. It is crucial to properly visualize and dissect the uncinate process away from the orbital wall. During ethmoidectomy, the lamina papyracea should be assessed on CT. The course of the optic nerve and carotid artery and the presence of ethmoid-sphenoid cells should also be checked (Kar et al., 2024).

Skull base damage and cerebrospinal fluid (CSF) leaks: Anatomical factors such as the skull base slope, sinus height, bone thickness, and defects in the bone of the skull base should be evaluated in the CT-scan. The longer and deeper the cribriform plate is, the higher the risk of damage. Most injuries occur in the cribriform and lateral lamella (Homsí & Gaffey, 2025). If CSF leakage occurs during surgery, the site of the leak should be immediately located and secured (Hosemann & Draf, 2013).

Bleeding (epistaxis): Standard postoperative bleeding lasts several days, but intense bleeding requires urgent intervention. The airway should be secured, and any anticoagulants should be discontinued. Bleeding can be stopped with vasoconstrictors, tamponade, and electrocoagulation. In difficult cases, embolization or ligation of the sphenopalatine artery is considered. Knowledge of the nasal vascularization is crucial (Kar et al., 2024).

It is worth noting that open techniques enable the removal of the tumor in its entirety (en bloc). This may be particularly important in the case of tumors of uncertain histopathological nature. FESS in most cases enables the resection of the tumor in a piecemeal manner. This may make it difficult to assess oncological margins and increase the risk of leaving microscopic remnants of the lesion. For this reason, in some cases - especially in the case of malignant or very extensive tumors - classical surgical techniques remain the preferred option (López et al., 2022).

Discussion

The findings underline the transformative impact of FESS on sinonasal surgery. Beyond functional restoration in chronic sinus disease, the procedure now serves as a viable alternative to invasive open techniques in tumor management. However, limitations remain: endoscopic surgery often necessitates piecemeal resection, which may complicate margin assessment in cases of malignant or extensive tumors. Moreover, the learning curve is steep, and outcomes are strongly linked to surgeon experience and institutional resources. Balancing minimally invasive approaches with oncological safety remains an important challenge. Future directions should focus on integrating advanced imaging, robotics, and long-term outcome data to refine surgical indications and further improve patient safety.

Table 1. Comparative overview of FESS versus traditional open approaches in sinonasal surgery

Aspect	FESS	Traditional Open Approach
Invasiveness	Minimally invasive (transnasal access)	Highly invasive (external incisions, craniofacial access)
Visualization	Enhanced with endoscopes and navigation systems	Direct but limited, especially in deep or narrow spaces
Hospitalization & Recovery	Shorter hospitalization, faster recovery	Longer hospitalization, delayed recovery
Aesthetic outcomes	No external scars	Visible scars, possible facial deformity
Complications	Mainly minor (adhesions, bleeding)	Neurological, cosmetic, functional
Oncological margins	Piecemeal resection; margin assessment may be limited	En bloc resection possible; more reliable margin control
Recurrence rates (benign tumors)	Comparable or lower recurrence rates	Historically higher or similar recurrence rates
Learning curve	Steep; requires specialized training and technology	Well established
Indications	Chronic rhinosinusitis, selected benign tumors	Extensive or malignant tumors, cases requiring en bloc removal

Conclusions

Functional Endoscopic Sinus Surgery is a safe and effective modality for treating a wide range of sinonasal diseases, including chronic rhinosinusitis and selected benign tumors. With proper patient selection, preoperative planning, and surgical expertise, FESS offers substantial benefits over traditional open approaches, including reduced morbidity and improved recovery. Continued technological advancements and long-term outcome studies will further refine its role in comprehensive sinonasal care.

Disclosure

Author's Contribution:

Conceptualization - Aleksandra Kaźmierczyk; Methodology - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Software - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Check - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Formal analysis - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Investigation - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Resources - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Data curation - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Writing (rough preparation) - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Writing (review and editing) - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Visualization - Aleksandra Kaźmierczyk, Jędrzej Kęsik, Daria Madycka, Małgorzata Słaboń, Karol Stępnia, Wiktor Telega, Kinga Wnuczek, Joanna Wrona, Weronika Skrzypek, Jan Wojtas; Supervision - Aleksandra Kaźmierczyk; Project administration - Aleksandra Kaźmierczyk;

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