



OPHTHALMIC COMPLICATIONS OF FUNCTIONAL ENDOSCOPIC SINUS SURGERY

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✧ Functional endoscopic sinus surgery (FESS) is an effective and safe surgical technique, which revolutionized the surgical management of nasal cavity and paranasal sinus diseases. The intimate connection between paranasal sinuses and the orbit places the orbital content at a risk of injury during sinus surgery, especially that of ethmoid sinuses. The orbit, the optic nerve, extraocular muscles and the lacrimal drainage system could be damaged during FESS. The risk of injury correlates to anatomical variations, degree and severity of disease, previous procedure results, and surgical experience. Ophthalmic complications can vary in severity from minor ones, such as localized hematomas, to extremely dangerous, such as optic nerve injury, that could lead to complete blindness. In order to minimize the risk of such complications, it is necessary to consider probable anatomic variations of paranasal sinuses and orbit, which are to be detected by CT scan before surgery.

✧ **Keywords:** functional endoscopic sinus surgery (FESS); complication; orbit.

ОФТАЛЬМОЛОГИЧЕСКИЕ ОСЛОЖНЕНИЯ ФУНКЦИОНАЛЬНОЙ ЭНДОСКОПИЧЕСКОЙ ХИРУРГИИ ОКОЛОНОСОВЫХ ПАЗУХ

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✧ Функциональная эндоскопическая хирургия околоносовых пазух (ФЭХП) представляет собой эффективный и безопасный оперативный метод, который произвёл революцию в хирургическом лечении заболеваний полости носа и околоносовых пазух. Тесная связь между пазухами носа и глазницей с её содержимым создаёт опасность их травмирования во время хирургии пазух, особенно при вмешательстве на решётчатом лабиринте. Во время ФЭХП могут быть повреждены глазница, зрительный нерв, глазодвигательные мышцы и слёзные пути. Риск травмы тесно связан с анатомическими особенностями, степенью и тяжестью заболевания, результатами предыдущих операций, а также опытом хирурга. Глазные осложнения могут варьировать по степени тяжести от незначительных, таких как локализованные гематомы, до крайне опасных, например, повреждение зрительного нерва, приводящее к полной слепоте. Для минимизации риска развития этих осложнений необходимо учитывать возможные анатомические варианты строения околоносовых пазух и глазницы, которые должны выявляться с помощью компьютерной томографии на предоперационном этапе.

✧ **Ключевые слова:** функциональная эндоскопическая хирургия пазух (ФЭХП); осложнения; глазница.

BACKGROUND

In the last few decades, functional endoscopic sinus surgery (FESS) has been widely used as a safe and effective method for the treatment of nasal cavity and paranasal sinus diseases [1–3]. FESS is performed to restore proper ventilation of the paranasal sinuses and create anatomical connection between the paranasal sinuses and the nasal cavity, which is essential for their normal functioning [4].

Owing to the close anatomical contiguity between the paranasal sinuses and the orbital cavity, FESS is associated with risk of orbital injury and other potentially severe complications [5]. In general, the risk of orbit injury is contingent upon the surgeon's experience, disease severity, surgical history, and specific anatomical features [6, 7]. The most perilous surgical interventions are infundibulotomy (for the medial wall of the orbit), antrostomy (for the lower wall of the orbit), and particularly any interventions in the ethmoid labyrinth [8, 9]. In 1929, H.P. Mosher wrote, "intranasal ethmoidectomy is one of the easiest ways to kill a patient" [10]. However, surgical and technological advancements have helped reducing the risk of complications [11, 12]. Invention of the shaver/microdebrider (electrosurgical instrument with a rotating cutter and constant vacuum aspiration) in 1990s was a significant breakthrough with regard to surgical interventions of the nasal cavity and paranasal sinuses. However, Stankiewicz et al. [13] found that the aspiration process is associated with an increased risk of detachment of the periorbita and dura mater and may result in a breach of the orbital or cranial cavity. Any damage to the orbital lamina and the consequent injury to the periorbital or orbital fat entail the risk of orbital complications. If the intervention is not stopped in time, the tip of the instrument can aspirate and damage the surrounding tissue. This can lead to injury of the medial rectus muscle and the optic nerve [14].

The frequency of ophthalmic complications after FESS does not exceed 1% [15–17].

The following specific anatomical features make the orbit particularly vulnerable to various complications during endoscopic surgery:

- 1) The lateral wall of the orbit is formed by the ethmoid bone.
- 2) The orbital lamina (*lamina papyracea*) is a very thin bone plate, which can be easily damaged, especially in children and elderly patients.
- 3) The optic nerve lies in the medial plane close to the lateral wall of the posterior ethmoidal cells (Onodi cells) and the sphenoid sinus.
- 4) The ethmoid artery (located above) is at risk of damage.

5) Damage to the tear duct (anterior to the uncinate process of the ethmoid bone) is also possible [9, 18–20].

In general, ophthalmic complications associated with FESS could be classified as follows:

- 1) Minor (class I): injury to orbital lamina; periorbital hemorrhage; orbital emphysema; transient diplopia; eyelid edema; and lipogranuloma.
- 2) Moderate (class II): injury to the nasolacrimal canal.
- 3) Major (class III): injury to oculomotor muscles; permanent diplopia; orbital hematoma; optic nerve injury; subperiosteal abscess; orbital cellulitis; and enophthalmos [15].

Clinical manifestations of orbital injuries range from pain and diplopia to absolute blindness [13, 21].

In the present study, we sought to determine the frequency of ophthalmic complications associated with FESS.

MATERIALS AND METHODS

We conducted a retrospective analysis of 920 clinical records of patients with chronic polypoid rhinosinusitis, who were treated between 2012 and 2016 at the Department of Otorhinolaryngology at the Pavlov First Saint Petersburg State Medical University. The sample included 423 males (45.97%) and 497 females (55.02%). The mean age of patients was 45 (range: 17–86) years. The diagnosis was established after otorhinolaryngological and ophthalmic examinations and cone-beam (Figures 1 and 2) or multislice computed tomography. The study included patients who underwent surgical intervention in the frontal, sphenoid, or ethmoid sinuses. All the patients underwent endonasal surgery. The frequency of complications is shown in Table 1.

All surgeries were performed under general anesthesia by the same surgeon. Procedures included the removal of polyps using a shaver (microdebrider) and subsequent opening of the maxillary sinus, frontal sinus, sphenoidal sinus, and the cells of the ethmoid labyrinth. Front tamponade of the nasal cavity was performed to maintain intraoperative hemostasis. The details of surgical procedures are provided in Table 2.

RESULTS AND DISCUSSION

Minor complications were encountered in 7 (0.76%) patients; moderate complications occurred in only one (0.11%) patient. None of the patients experienced major complications. The overall

Ophthalmic complication rate in FESS

Table 1

Таблица 1

Частота офтальмологических осложнений при функциональной эндоскопической хирургии околоносовых пазух

Type of complication	The number of patients (abs.)	%
Minor: • periorbital hemorrhage; • orbital emphysema	6 1	0.65 1.1
Moderate: • nasolacrimal canal injury	1	1.1
Major	0	0
Total	8	0.87

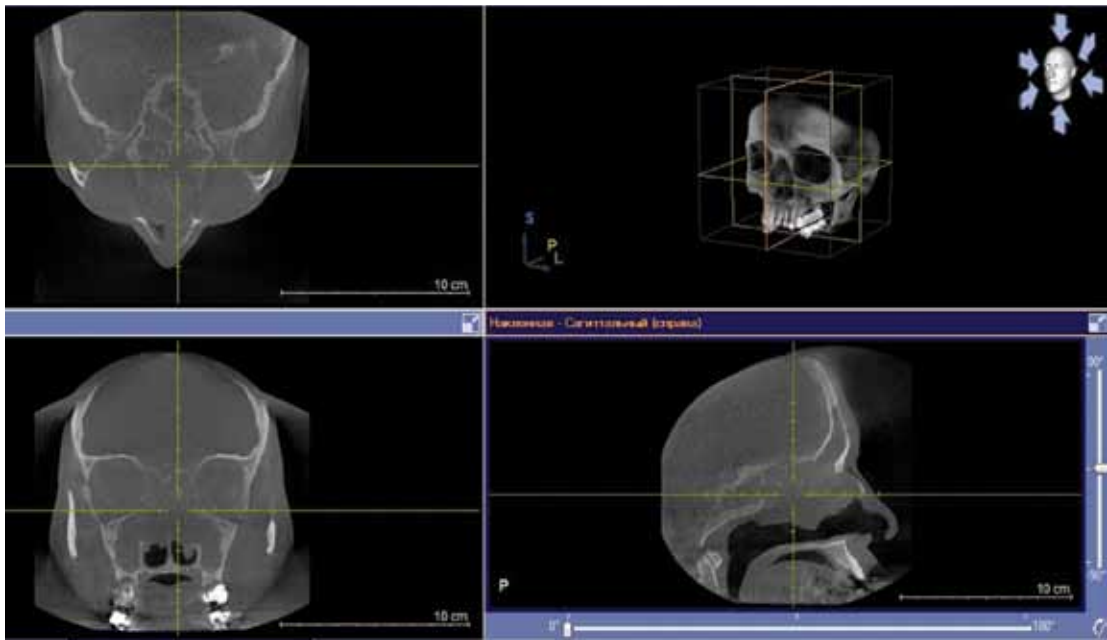


Fig. 1. CT scan of paranasal sinuses, chronic polypous rhinosinusitis

Рис. 1. Компьютерная томограмма околоносовых пазух, хронический полипозный риносинусит

incidence of ophthalmic complications in the study population was 0.87%, which is consistent with that reported elsewhere [15–17].

Minor complications were primarily associated with injury to the orbital lamina during ethmoidectomy. Patients who experienced ophthalmic complications were immediately counseled by an ophthalmologist. Conservative treatment including systemic therapy to resolve edema and close follow-up were used. Canthotomy and cantholysis were not performed.

In the only case of injury to the nasolacrimal canal, the injury was sustained after the removal of the uncinatе process of the ethmoid bone. Restoration of the lacrimal system was carried out by endonasal laser dacryocystorhinostomy during the postoperative period.

No major complications were observed in the present study population. According to currently available data, complications such as orbital hematoma, optic nerve injury, and injury to oculomotor muscles are more commonly associated with ethmoidectomy, sphenoidectomy, and frontoethmoidectomy (reported incidence is approximately 0.1%) [9, 22]. Orbital hematoma may develop because of arterial or venous bleeding. Injury to anterior ethmoidal artery, which lies along the roof of the ethmoid labyrinth posteriorly to the frontal recess, is the most frequently reported cause of bleeding. This artery is typically located within the skull base; however, in some cases it may be located outside the skull base. The injured artery tends to retract into the orbit, which causes rapid bleeding in a confined space resulting in orbital hematoma. Injury

Extent of surgeries in the analyzed group

Объём операций в анализируемой группе

Table 2

Таблица 2

Surgery	Number of surgeries (n)	Number of surgeries (%)	Number of complications (n)	Number of complications (%)
Ethmoidectomy	551	59.9	5	0.54
Sphenoethmoidectomy	219	23.8	1	0.11
Frontoethmoidectomy	97	10.5	2	0.22
Frontosphenoethmoidectomy	53	5.8	0	0
Total	920	100	8	0.87

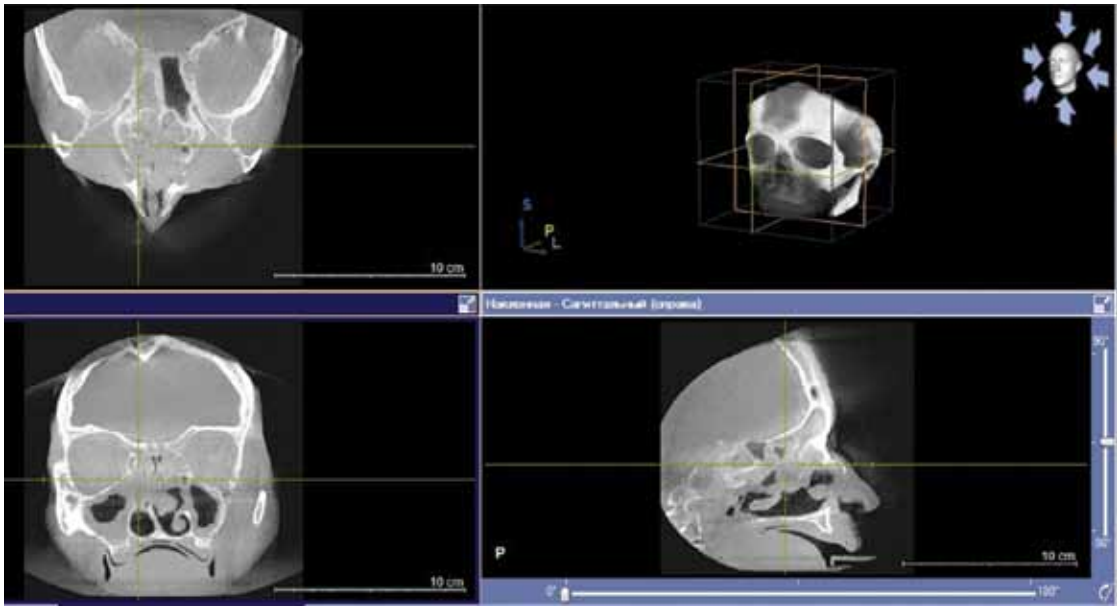


Fig. 2. CT scan of paranasal sinuses: a shadowing of ethmoid sinus cells and of the right maxillary sinus of mucus edema type

Рис. 2. Компьютерная томография околоносовых пазух: определяется затенение клеток решётчатого лабиринта и правой верхнечелюстной пазухи по типу отёка слизистой оболочки

to the posterior ethmoidal artery is less common because of its anatomical location, which renders it less accessible to surgical instruments. Early signs of orbital hematoma include sharp reduction in visual acuity, preseptal edema, bruising, exophthalmos, and increased intraocular pressure. These complications are quite serious as they may result in blindness caused by optic nerve compression in the retrobulbar space and require immediate treatment [15, 16, 19]. Direct injury to the optic nerve is also rare and is usually associated with mechanical trauma caused by the shaver (microdebrider) [23]. Injury to the oculomotor muscles occurs because of preoperative or intraoperative damage to the orbital lamina. It may lead to diplopia because of muscle entrapment by the bone fragments, direct injury to oculomotor muscles, or secondary injury induced by nerve trauma [24, 25].

- The following measures are recommended to prevent intraoperative complications:
- Preoperative assessment of the outline of the orbital cavity, infraorbital and supraorbital structures and their thickness using computed tomography.
 - Preoperative identification of the anterior ethmoid artery location is necessary to prevent intraoperative bleeding. The bony protrusion at the junction of the medial rectus muscle and the superior oblique muscle is an optimum point of orientation for determining the location of this artery.
 - Identification of sphenoethmoidal cells (Onodi cells) prior to FESS helps averting damage to the optic nerve and the internal carotid artery.
 - The optic nerve and the carotid artery form a groove (unilateral or bilateral) in the lateral wall of the sphenoid sinus. Some of these grooves

may possess dehiscent areas, which increase the risk of damage to the optic nerve and carotid artery. Preoperative assessment using an axial computed tomogram will help avoid iatrogenic complications.

- General anesthesia and controlled hypotension help minimize intraoperative blood loss.
- Topical decongestants, prothrombotic agents, and a bipolar cautery should be available during surgery.
- If the orbital lamina is injured, the thickness of periorbital fat and periorbital should be estimated. In the absence of any signs of orbital or periorbital trauma, the surgery can be continued. If the periorbital is injured and the periorbital fat is opened, intraocular pressure must be measured. The presence of periorbital fat or periorbital in the surgical field can be determined by careful eye ballottement and endoscopic examination.
- Blind cauterization should be avoided to prevent injury to the optic nerve and oculomotor muscles. Bipolar cauterization is effective when bleeding is not associated with the orbit itself.
- Patient's eyes should be kept opened during endoscopic surgery. Any signs of swelling, bruising, or afferent pupillary defect call for immediate cessation of surgery.
- Nasal tamponade over the opened top of the orbit should be avoided to prevent optic nerve compression.

CONCLUSIONS

Ophthalmic complications of FESS are rare but potentially dangerous events. The frequency of major complications is <1%. A thorough preoperative examination is critical to minimizing the risk of complications. Specific anatomical features of the paranasal sinuses and the orbit should be assessed prior to the surgery using computed tomography and magnetic resonance imaging (if necessary).

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