

# Early and Delayed Effect of Functional Endoscopic Sinus Surgery on Intraocular Pressure

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## Abstract

**Introduction** Due to the close anatomical relationship between the paranasal sinuses and the orbit, involvement or injury of the orbit from paranasal sinuses procedures may occur.

**Objectives** We aimed to study the early and delayed effect of endoscopic sinus surgery on intraocular pressure (IOP).

**Methods** We included in the study 38 patients with chronic rhinosinusitis (CRS), undergoing FESS. We performed FESS with the standard anterior to posterior approach. We measured IOP at the same time one day before surgery as well as day 1 and 6 weeks after surgery.

**Results** One day after surgery, mean IOP in the right eye was  $14.176 \pm 1.91$  mm Hg and in the left eye was  $13.79 \pm 2.42$  mm Hg with statistically non-significant difference from preoperative values. Six weeks postoperative, the mean IOP in the right eye was  $15.14 \pm 2.28$  mm Hg. The difference between the mean preoperative and postoperative IOP values was found to be statistically significant ( $p = 0.0012$ ). While in the left eye, mean postoperative IOP was  $15.14 + 2.23$  mm Hg. The difference between the mean preoperative and postoperative IOP values was also found to be highly statistically significant ( $p = 0.0005$ ).

**Conclusion** Delayed significant increase in IOP can occur after FESS. Thus, special measures must be taken to reduce IOP to protect the patients' eye from the risk of increased IOP, especially in patients with glaucoma.

## Keywords

- ▶ sinusitis
- ▶ nose
- ▶ endoscopy

## Introduction

Chronic rhinosinusitis (CRS) is one of the most common diseases in the otolaryngologic field. Functional endoscopic sinus surgery (FESS) represents the preferred surgical treatment for CRS.<sup>1</sup>

FESS was initially driven by Messerklinger's work in the late 1970s.<sup>2</sup> It was then popularized and standardized in the beginning of the 1980s, particularly by Kennedy et al<sup>3</sup> and

Stammberger<sup>4</sup> with their studies regarding the philosophy of clearing the natural ostium of the diseased sinus.

Due to the close anatomical relationship between the paranasal sinuses and the orbit, involvement or injury of the orbit from procedures the paranasal sinuses may occur.<sup>5</sup>

The ocular complications after FESS include: nasolacrimal duct injury, extraocular muscle injury; periorbital, intraorbital, or retrobulbar hematoma; and even optic nerve injury. The risk of injury is correlated to the anatomical variations, the history of

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previous surgery, the extent of the disease, and the skills of the surgeon.<sup>6,7</sup>

Normal intraocular pressure (IOP) is essential for normal eye structure and function.

When the balance of aqueous formation and drainage is altered, IOP changes. The IOP elevation results in corneal edema, iris atrophy, cataract and optic nerve atrophy. The common symptoms of increased IOP are blurred vision, epiphora, headache, nausea, vomiting, or a sensation of pressure in the eyes.<sup>1</sup>

Some studies have described the relationships between conventional sinus surgery and IOP.<sup>8,9</sup> A previous research<sup>1</sup> described the early effect of FESS on IOP; however, in the current study, we aimed at detecting whether or not there is a delayed effect for this type of surgery on IOP.

## Patients and Methods

Thirty-eight patients were included in this prospective study. All included patients were suffering from nasal polyps refractory to medical treatment (according to Lanza and Kennedy<sup>10</sup>) and had been scheduled for FESS. Exclusion criteria included patients that had diabetes mellitus, hypertension, glaucoma, ocular hypertension, previous ocular trauma, history of ocular surgery, defect in lamina papyraria, and patients within two days of using topical corticosteroid eye drops. Any systemic conditions, such as carotid-cavernous fistula and pulmonary hypertension, which may induce changes in episcleral venous pressure were also excluded because the fluctuation of episcleral venous pressure results in changes in IOP.

All patients included in this study signed an informed consent. All patients underwent medical history analysis, examination, diagnostic nasal endoscopy, and CT. We classified nasal polyps following the staging classification proposed by Johanson et al<sup>11</sup>; level 0 - absent, level I - polyp in the middle meatus, level II - polyp going through the middle turbinate with clear nasal floor, level III - polyp filling up the entire nasal cavity.

## Surgical Procedure

Each nasal cavity was packed (in middle meatus) with a piece of gauze soaked with topical vasoconstrictor (with adrenaline dissolved in saline in a concentration of 1:200,000.) fifteen minutes before surgery, to be removed at the beginning of surgery.

We performed all surgeries under general anesthesia with oral endotracheal tube with the standard anterior to posterior approach for FESS (middle meatal antrostomy, anterior ethmoidectomy, posterior ethmoidectomy, sphenoidotomy, skull base clearance, and/or frontal sinus clearance). Used intranasal packing was removed on the first morning after surgery. We prescribed postoperative antibiotics and analgesics.

IOP was measured for both eyes in all patients using Goldmann applanation tonometry, and dilated funduscopy as baseline data one day before surgery. Then, we measured IOP on day 1 postoperatively and, lastly, at 6 weeks after surgery.

## Statistical Analysis

We used the SPSS statistical software package (version 18.0; SPSS, Inc., Chicago, IL, USA) for statistical comparisons and descriptive statistics. A *p* value < 0.05 was considered statistically significant.

## Results

This study included 38 patients: 22 males (57.9%) and 16 females (42.1%). Their ages ranged from 16 to 56 years with a mean of 35.3 years.

All patients underwent preoperative endoscopic nasal examination (76 nasal sides) and various grades of nasal polyposis were detected. Grade 0 was detected in 12 nasal sides (15.8%), grade 1 in 18 sides (23.7%), grade 2 in 28 sides (36.8%), and grade 3 in 18 sides (23.7%) (► **Table 1**).

No major complications were observed in this study; only minor complications in the form of nasal adhesions between the inferior turbinate and septum (in two cases).

Moreover, we found no significant correlation between the postoperative changes in IOP values and the grades of nasal polyposis (*R* value = 0.3521; *R*<sup>2</sup>, the coefficient of determination, was 0.124).

We found that the mean preoperative pressure was 13.1 ± 2.5 mm Hg (range, 10 - 18 mm Hg) in the right eye and 12.89 ± 2.23 mm Hg (range, 10 - 17 mm Hg) in the left eye, and the difference between the mean IOP values between the two sides was found to be statistically non-significant (*p* = 0.7862, *t* = 0.2732) (► **Tables 2 and 3**).

One day after surgery, the mean postoperative IOP in the RT eye was 14.176 ± 1.91 mm Hg (range 10 -17 mm Hg) and the difference between the mean preoperative and postoperative IOP values was statistically non-significant (*p* = 0.1589, *t* = 1.4403), whereas in the left eye mean postoperative IOP was 13.79 ± 2.42 mm Hg (range 10 - 19 mm Hg). The difference between the mean preoperative and postoperative IOP values was also statistically non-significant (*p* = 0.0961, *t* = 1.6859). Also, we observed that the difference in the postoperative IOP values between both eyes one day after surgery was statistically non-significant (*p* = 0.4428, *t* = 0.7718) (► **Table 2**).

Six weeks after surgery, the mean postoperative IOP in the right eye was 15.14 ± 2.28 mm Hg (range 10-18 mm Hg) and the difference between the mean preoperative and postoperative IOP values was found to be statistically significant (*p* = 0.0012, *t* = 3.4027), whereas in the left eye the mean postoperative IOP was 15.14286 ± 2.23 mm Hg (range 11 - 18 mm Hg). The difference between the mean

**Table 1** Results of endoscopic nasal examination

Grade of nasal polyp	Number of nasal sides	%
0	12	15.8
1	18	23.7
2	28	36.8
3	18	23.7

**Table 2** Difference in IOP between preoperative and 1 day postoperative

	Pre-operative IOP (38 patients)		1 day post-operative IOP (38 patients)		t test	p value	Significance
	Mean	SD	Mean	SD			
Right	13.1	2.5	14.176	1.91	1.4403	0.1589	Non-Significant
Left	12.89	2.23	13.79	2.42	1.6859	0.0961	Non-Significant

Abbreviations: IOP, intraocular pressure; SD, standard deviation.

**Table 3** Difference in IOP between preoperative and 6 weeks postoperative

	Pre-operative IOP (38 patients)		6 w post-operative IOP (28 patients)		t test	p value	Significance
	Mean	SD	Mean	SD			
Right	13.1	2.5	15.14	2.28	3.4027	0.0012	Significant
Left	12.89	2.23	15.14	2.34872	3.6808	0.0005	Extremely statistically significant

Abbreviations: IOP, intraocular pressure; SD, standard deviation; w, week.

preoperative and postoperative IOP values was also highly statistically significant ( $p$  value = 0.0005,  $t$  = 3.6808). Moreover, the difference in the postoperative IOP values between right and left eyes 6 weeks after surgery was statistically non-significant.

We also performed endoscopic nasal examination during follow-up until 6 weeks after surgery for a second-look evaluation. The results presented no significant findings.

## Discussion

Functional endoscopic sinus surgery (FESS) has gained popularity in the diagnosis and treatment of paranasal sinus diseases.<sup>12</sup> However, orbital negative sequels may occur due to its close anatomical relation with the paranasal sinuses.<sup>5</sup>

The incidence of serious complications of endoscopic sinus surgery reportedly reaches 0.5%. Orbital injuries can range from eye pressure, pain, retrobulbar hemorrhage, and compromised extraocular muscle movement with sequential binocular diplopia to blindness.<sup>13-16</sup>

Intraocular pressure (IOP) may be defined as the resulting balance between aqueous humor production and removal. Its increase is considered to be one of the main risk factors leading to the development of glaucoma. IOP is a variable value affected by multiple factors: age, gender, race, tobacco consumption, local ocular problems, obesity, hormonal changes, and physical exercise, among others.<sup>17-19</sup>

No clear line exists between safe and unsafe IOPs. In general, in cases in which the IOP is less than 30 mm Hg, the eye can be observed, and in cases in which the IOP is more than 40 mm Hg, a poor vision result may ensue.

The IOP can be measured clinically by various types of tonometers, including the Goldmann applanation tonometer, noncontact tonometer, and Tonopen. The Goldmann applanation tonometer is the most valid and reliable.<sup>20</sup> That is why we used it in current study.

In the current study, the mean preoperative IOP rose 1 day postoperatively, but this increase was found to be statistically non-significant. In contrast, six weeks after surgery, we had noticed that the mean IOP increased in both eyes and this increase, surprisingly, was statistically significant in both eyes.

The postoperative results one day after surgery of this study agree with the results of Lin et al,<sup>1</sup> who found also that the postoperative increase in the average IOP values is statistically non-significant, taking into consideration that Lin et al<sup>1</sup> studied the early effect of FESS on IOP as they measured IOP in three consecutive days after surgery.

The mechanism by which IOP is raised post-FESS whether in the early or late postoperative period is not clearly understood. Vascular mechanism is one of the proposed mechanisms for increased IOP post FESS. The eyes and paranasal sinuses are anatomically, neighboring structures. The eyeball, orbit, and parts of the sinonasal areas share the same vascular supply from the ophthalmic artery.

The venous drainage of the orbit and ocular structures is via the central retinal vein (drains into the superior ophthalmic vein) and the vortex vein (drains into the inferior ophthalmic vein). The vascular supplies of the sinuses are partial from the anterior and posterior ethmoidal arteries those are also derived from the ophthalmic artery, and the anterior and posterior ethmoidal veins drain into the superior ophthalmic vein.<sup>21</sup>

Lin et al<sup>1</sup> observed that the post-FESS symptoms of epiphora and eye pressure were similar to the symptoms of increased IOP. Given that the eyes and sinonasal region have the same origin of vascular supply, they decided to elucidate whether FESS would result in a significant change in the IOP before and after surgery. They detected increased IOP. In the early postoperative period, in agreement with the current study, these changes were statistically insignificant.

A possible cause of increased IOP postoperatively could be excessive gauze packing and overinflated antral balloons of the Foley type, after the Caldwell-Luc operation. This may induce

hypertropia and compression of the central retinal artery. Gelman et al<sup>8</sup> reported a case of acute ocular hypertension following the use of an antral balloon after repairing fractures on the floor of the orbit via a Caldwell-Luc antrotomy.

Another study was done by Papangelou and Christidis<sup>9</sup> to investigate whether there would be any effects on the IOP in patients who underwent a Caldwell-Luc operation for chronic sinusitis or antral polyps. They found that some changes of IOP occurred whether or not the maxillary sinus walls were denuded of mucous membrane.

They performed endoscopic grading for nasal polyposis preoperatively and observed various grades; however, when correlating the postoperative changes in IOP values with the grades of nasal polyposis, they found no correlation.

Many researchers studied the effect of endotracheal intubation on IOP and found a transient increase in the IOP intraoperatively and in the early postoperative period. Malti and Geeta<sup>22</sup> reported that endotracheal intubation is associated with tachycardia, hypertension, and increase in intraocular pressure and that the latter may not have any adverse effect in patients with healthy eyes but has deleterious effects on a diseased or an injured eye. They also concluded in their study that laryngeal mask airway insertion is a suitable alternative to endotracheal intubation in patients having penetrating eye injuries, glaucoma, and strabismus in whom elevation of intraocular pressure is likely to be detrimental.

Langham et al<sup>23</sup> and Murphy<sup>24</sup> stated that endotracheal intubation can lead to adrenergic stimulation may cause vasoconstriction and an increase in central venous pressure which has a closer relationship to intraocular pressure than systemic pressure. It can produce an acute increase in intraocular pressure by increasing the resistance to the outflow of aqueous humor in the trabecular meshwork between the anterior chamber and the Schlemm's canal.

In fact, these mechanisms would explain the early increase in IOP. Nonetheless, the cause of delayed increase in IOP remains unclear, so further studies are needed to explain the effect in IOP post-FESS.

To the best of our knowledge, this the first study to deal with the delayed effect of FEES on IOP. However, further studies are still needed to study the delayed effect of FESS on IOP in unilateral cases, as our study only included cases with bilateral sinonasal pathology.

It is important to note the risk of potential rise of IOP after surgery in patients scheduled for FESS and that had preoperative increase IOP, such as patients of glaucoma. Thus, preoperative ophthalmological consultation is important to protect the patient from the hazard of possible increased IOP.

## Conclusion

Delayed significant increase in IOP can occur after FESS. Therefore, special measures are necessary preoperatively to reduce IOP and protect the patient's eye from the hazard of increased IOP, especially in patients with glaucoma. Further studies are still needed to explain the cause of this delayed significant rise in IOP post-FESS.

## Conflict of Interest

The authors declare no conflict of interest.

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The authors declare no financial support or interest to this study.

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