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 ± 1.91 mm Hg and in the left eye was 13.79 ± 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 ± 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.

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.1

FESS was initially driven by Messerklinger’s work in the late 1970s.2 It was then popularized and standardized in the beginning of the 1980s, particularly by Kennedy et al3 and Stammberger4 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.5

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
previous surgery, the extent of the disease, and the skills of the surgeon.\(^6,7\)

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.\(^1\)

Some studies have described the relationships between conventional sinus surgery and IOP.\(^8,9\) A previous research\(^1\) 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 polyp refractory to medical treatment (according to Lanza and Kennedy\(^10\)) 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 paperatia, 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 Johansson et al\(^11\): 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%) (\(\textbf{Table 1}\)).

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 (\(R = 0.3521; R^2\), 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 (\(p = 0.7862, t = 0.2732\)) (\(\textbf{Table 2} \) and \(\textbf{3}\)).

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 (\(p = 0.4428, t = 0.7718\)) (\(\textbf{Table 2}\)).

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 IOP values was also statistically non-significant (\(p = 0.1589, t = 1.4403\)).

<table>
<thead>
<tr>
<th>Grade of nasal polyp</th>
<th>Number of nasal sides</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>12</td>
<td>15.8</td>
</tr>
<tr>
<td>1</td>
<td>18</td>
<td>23.7</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
<td>36.8</td>
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<tr>
<td>3</td>
<td>18</td>
<td>23.7</td>
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\(\textbf{Table 1}\) Results of endoscopic nasal examination
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. However, orbital negative sequelae may occur due to its close anatomical relation with the paranasal sinuses.

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.

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.

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 accurate and reliable. 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., who found also that the postoperative increase in the average IOP values is statistically non-significant, taking into consideration that Lin et al. 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 ethmoid veins drain into the superior ophthalmic vein.

Lin et al. 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. Gel- 
man et al. 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 antrostomy.

Another study was done by Papangelou and Christidis 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 intuba- 
tion on IOP and found a transient increase in the IOP intra-
operatively and in the early postoperative period. Malti and 
Geeta 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 
tubation in patients having penetrating eye injuries, glaucoma, 
and strabismus in whom elevation of intraocular pressure is 
likely to be detrimental.

Langham et al. and Murphy 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 intra-
ocular 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 is 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 preopera-
tive increase IOP, such as patients of glaucoma. Thus, preop-
erative 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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