Original Article

Effect of lamina papyracea ingression on orbito-ocular complications after functional endoscopic sinus surgery

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Received February 1, 2016; Accepted April 27, 2016; Epub June 15, 2016; Published June 30, 2016

Abstract: Objective: This study aims to observe the effect of lamina papyracea ingression on orbito-ocular complications after functional endoscopic sinus surgery (FESS). Methods: Data of computed Tomography (CT) and post-FESS complications were collected in 483 patients undergoing FESS from October 2013 to November 2015. According to the condition of lamina papyracea, all patients were divided into lamina papyracea ingression group (ingression group) and normal group. Results: The patients with lamina papyracea ingression accounted for 11.2% (54/483). Of the 54 patients, 18 had grade-I lamina papyracea ingression, 25 had grade-II lamina papyracea ingression and 11 had grade-III lamina papyracea ingression. The incidence of orbito-ocular complications was significantly higher in the ingression group than in the normal group (16.7% vs 2.6%, P<0.01), and severe complications was more in the ingression group. Conclusion: Before FESS, we should carefully review paranasal sinus CT to find lamina papyracea ingression, avoiding orbito-ocular complications.

Keywords: Lamina papyracea, ingression, orbito-ocular complications

Introduction

Nasal sinuses are strongly associated with orbits, so the incidence and severity of orbito-ocular complication take the first place in all complications caused by operation on nasal sinus. Severe orbito-ocular complications, especially optic nerve injury, often result in lifelong disabilities. One cause of optic nerve injury is that during operation, because lamina papyracea ingression allows intra-orbital fat to prolapse into ethmoid sinus, the intra-orbital fat is usually removed as nasal polyps. This destroys the medial orbital wall, further injuring the intra-orbital optic nerve [1, 2]. In this study, CT images of 483 patients undergoing functional endoscopic sinus surgery (FESS) were retrospectively analyzed to observe the effect of lamina papyracea ingression on orbito-ocular complications; and to draw attention to lamina papyracea ingression, avoiding orbito-ocular complication.

Materials and methods

All study methods were approved by Institutional Review Board and Ethics Committee of the First Affiliated Hospital of Zhengzhou University. All the subjects enrolled into the study gave written formal consent to participate.

Subjects

Pre-operation CT images of 483 patients with chronic rhino-sinusitis who underwent FESS performed by the same surgeon in our hospital from October 2013 to November 2015 were collected. The patients with infraorbital ethmoid cell and/or suprasphenoid cell were excluded from this study. The 483 patients were divided into lamina papyracea ingression group (ingression group) and normal group. The incidence and prognosis of orbito-ocular complications were retrospectively analyzed in both groups.

Diagnostic criteria for chronic rhino-sinusitis [3]: Patients had two or more symptoms including nasal obstruction, viscous or purulent nasal discharge, gas pains in head and face, hyposmia or anosmia. And the patients’ symptoms must include one of nasal obstruction, and viscous or purulent nasal discharge. Nasal endoscopy indicated viscous or purulent secretion from mitteler nasengang and/or olfactory cleft, nasal mucous hyperemia and edema, or nasal
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Figure 1. Grade-I left lamina papyracea ingression.

polyps. Sinus CT showed inflammatory lesion of ostiomeatal complex and/or sinus mucosa.

Surgical indications were ① marked anatomic abnormalities affecting drainage of ostiomeatal complex or nasal sinuses; ② nasal polyps affecting drainage of ostiomeatal complex or nasal sinuses; ③ no significant improvement of clinical symptom via pharmacotherapy; ④ intracranial and/or intra-orbital complications.

CT examinations

A sixty-four multi-detector CT scan was used in pre-operation examination. All patients were in supine position and received cross section scan. Scanning range were from the superior border of frontal sinus to the inferior border of processus alveolaris maxillae. Bone algorithm imaging (parameters: reformation slice thickness of 0.625 mm, increment of 0.6 mm and pitch of 0.562), and multi-planar reformation of multi-slice CT were used for continuous and dynamic observation of ethmoidal sinus and its adjacent structures in cross, coronal and sagittal planes.

Statistical analysis

Statistical treatment was performed with SPSS20.2 software. $X^2$ test was used for comparison of enumeration data. Statistical significance was established at $P<0.05$.

Results

General data

In this study, there were 483 patients. Of the 483 patients, 223 were men and 206 women, with an age range from 18 to 71 years. In normal group, there were 223 males and 206 females. Of the 429 patients, 38 had type-I chronic rhino-sinusitis, 93 had type-II and stage-I chronic rhino-sinusitis, 72 had type-II and stage-II chronic rhino-sinusitis, 89 had type-II and stage-III chronic rhino-sinusitis, and 137 had type-III chronic rhino-sinusitis. In normal group, 216 patients underwent FESS for the first time, while the rest of these patients (213 patients) received re-FESS due to recurrence.

In_ingression group, there were 33 males and 21 females. Of the 54 patients, 8 had type-I chronic rhino-sinusitis, 11 had type-II and stage-I chronic rhino-sinusitis, 12 had type-II and stage-II chronic rhino-sinusitis, 14 had type-II and stage-III chronic rhino-sinusitis, and 9 had type-III chronic rhino-sinusitis. In ingression group, 35 patients underwent FESS for the first time, while the rest of these patients (19 patients) received re-FESS due to recurrence.

CT manifestations of lamina papyracea ingression

Lamina papyracea ingression refers to lamina papyracea depression which was arc-shaped or slit-shaped in CT imaging. According to the proportion of depression depth to normal space between lamina papyracea and perpendicular plate of ethmoid, lamina papyracea ingression were divided into 3 levels, namely grade I (proportion were less than one third, Figure 1), grade II (proportion were from one third to two third, Figure 2) and grade III (proportion were more than two third, Figure 3). In
the ingression group, 18 patients had grade-I lamina papyracea ingression, 25 patients had grade-II lamina papyracea ingression and 11 patients had grade-III lamina papyracea ingression. Among grade-I lamina papyracea ingression, the depression was located in anterior ethmoid sinus in 9 orbits, in middle ethmoid sinus in 5 orbits, in posterior ethmoid sinus in 4 orbits. Among grade-II lamina papyracea ingression, the depression was located in anterior and middle ethmoid sinuses in 12 orbits, in middle and posterior ethmoid sinuses in 13 orbits. In grade-III lamina papyracea ingression, the depression almost involved anterior, middle and posterior ethmoid sinuses. Intra-orbital fat entered depression area in all the 54 patients, and herniation of intra-orbital fat was consistent with the degree of depression. Marked displacement of medial rectus occurred in 13 orbits, and the transverse diameter of the medial rectus increased with reduction of vertical diameter. In other 41 orbits, the medial rectus exhibited slight displacement or no displacement without marked changes in morphology.

**Orbito-ocular complications**

In the normal group, orbito-ocular complications occurred in 2.6% patients (11/429). Of the 11 patients, 9 had lamina papyracea injury (peri-orbital congestion) and 2 had lacrimal duct injury. In the normal group, no intra-orbital hemorrhage, medial rectus injury, optic nerve injury and peri-orbital infection occurred. In the 11 patients with orbito-ocular complication of normal group, 9 underwent FESS for the first time and 2 received re-FESS due to recurrence.

In the ingression group, orbito-ocular complications occurred in 16.7% patients (9/54). Of the 9 patients, 6 had lamina papyracea injury (peri-orbital congestion, grade II in 4 patients and grade III in 2 patients), one had medial rectus injury (grade-III), one had optic nerve injury (grade-II) and one had peri-orbital infection (grade-II). In the ingression group, no intra-orbital hemorrhage and lacrimal duct injury occurred. In the 9 patients with orbito-ocular complication of normal group, 5 underwent FESS for the first time and 4 received re-FESS due to recurrence. The incidence of orbito-ocular complications was significantly higher in ingression group than in normal group ($X^2=20.61, P<0.01$).

**Typical case**

A male 37-year-old patient, who complained of purulent nasal discharge and hyposmia for 15 years, was admitted into our hospital. Nasal endoscope showed left deviation of nasal septum, bilateral inferior turbinate hypertrophy, multiple polyps in middle nasal meatus, and insufficient nasal ventilation. Sinus CT indicated bilateral ethmoiditis and maxillary sinusitis combined with nasal sinus cyst (Figure 4). The patient was diagnosed with type-II and stage-II chronic rhino-sinusitis and nasal polyp. FESS plus septoplasty were performed on the patient under general anesthesia after pre-operative examinations. Six hours after operation, the patient came to consciousness from general anesthesia and complained of right orbito-ocular...
Lamina papyracea ingression

Figure 5. Right intra-orbital disorderly signal and optic nerve injury in a MRI image of the same patient with type-II and stage-II chronic rhino-sinusitis and nasal polyp 6 hours after operation.

Figure 6. A. Right intra-orbital disorderly signal in an axial CT image of the same patient with type-II and stage-II chronic rhino-sinusitis and nasal polyp one month after operation. B. Right intra-orbital disorderly signal in a coronal CT image of the same patient with type-II and stage-II chronic rhino-sinusitis and nasal polyp one month after operation.

Ilar swelling, visual loss and no light perception. Physical examination showed mydriasis, abolition of direct and indirect light reflexes, clear dioptic media, off-white optic disc with unclear outline, retinal angiospasm and cherry red spot in macula lutea in the right eye. Emergency magnetic resonance imaging (MRI) displayed abnormal signals of fat in the right orbit (Figure 5). Finally, our active treatment for the patient’s eyesight was not effective. CT image still exhibited optic nerve injury in the right eye one month after operation (Figure 6).

Discussion

Previous studies reported a low incidence (6.5% to 7.0%) of lamina papyracea variations including defect, dehiscence or ingression; and these variations were typically caused by dysostosis, and insufficient or excessive pneumatization of ethmoidal cellules [4-6]. In this study, pre-operation CT images of 483 patients undergoing FESS were retrospective analyzed, and the incidence of lamina papyracea ingression was found to be 11.2%. Morphology, localization and depth of ingestions could be clearly displayed in CT transverse and coronal views, and it is better to observe the scope of ingestion in transverse view than in coronal view.

The excessive ingression of lamina papyracea usually results in displacement of medial rectus and herniation of intra-orbital fat into ethmoidal sinus, so the inwards-transferred lamina papyracea is usually misdiagnosed as ethmoidal bulla during operation. This increases the risk of medial rectus injury. Accidentally damaging the inwards-transferred lamina papyracea and medial rectus during operation may cause some complications such as visual disorder, intra-orbital hematoma and ocular motility disorders [7]. In this study, chi-square test indicated that the incidence of complications was significantly higher in the ingression group than in the normal group (P<0.01); severe complications such as visual loss and peri-orbital infection occurred in ingression group, while in normal group no severe complications were found. The lamina papyracea ingression is more severe, the possibility of complication occurrence was greater. In the typical case, the patient had type-II and stage-II chronic rhino-
Lamina papyracea ingression

sinusitis combined with nasal polyp. Pre-
operation CT displayed grade-Ii lamina papyra-
cea ingression. During operation, intra-orbit fat
was mistakenly regarded as nasal polyp due to
bleeding, and was removed, resulting in intra-
orbital optic nerve injury. Therefore, CT imaging
should be carefully reviewed to identify wheth-
er there is lamina papyracea variations in the
patents with chronic rhino-sinusitis before
FESS. We must pay attention to surgical proce-
dures. When the ethmoid sinus is opened: if
there is yellow tissue, we must clarify whether it
is the intra-orbital adipose tissue. Slight injury
for the lamina papyraceas is not enough to
exhibit clinical symptoms. Most clinical compli-
cations are caused by wrong operation on intra-
orbital tissues. For example, laceration of intra-
orbital vessels, caused by traction of intra-
orbital fat, can lead to intra-orbital hemorrhage
which readily allows dynamical system to dam-
age intra-orbital fat, medial rectus and even
optic nerve. Therefore, further traction should
be avoided for the adipose tissue which enters
the ethmoid sinus. For the re-FESS due to
recurrence, the operative field is poor because
of severe hemorrhage and hyperosteogeny, so
it is necessary to control hemorrhage, avoiding
complications caused by wrong operations due
to unclear operative field.

Disclosure of conflict of interest

None.

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