Endonasal orbitotomy as a first treatment for posttraumatic intraorbital hemorrhages in patients with frontal basilar trauma

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Background: *Intraorbital hemorrhages are one of the most dangerous complications of frontal bone trauma and frontal and orbital trauma because of the close and intricate anatomical relationships among the cranial cavity, orbit, nose and paranasal sinuses. Failure to solve the problem promptly will inevitably lead to disability. Effective treatment requires a multidisciplinary surgical team including a neurosurgeon, otorhinolaryngologist, ophthalmologist and a maxillofacial surgeon.*

Purpose: *To assess the efficacy of endonasal endoscopic transethmoidal orbitotomy (TEO) and transcutaneous orbitotomy (TCO) in patients with post-traumatic intraorbital hemorrhages.*

Material and Methods: *Fifteen patients (9 men and 6 women) with retrobulbar hematoma were included in this study. Patient age ranged from 33 years to 65 years. Of the 15 patients, 8 received endonasal endoscopic TEO and 7, TCO. Preoperatively, each patient underwent an eye examination, ultrasonography of the orbit, and spiral computed tomography of the paranasal and periorbital sinuses. Postoperative examinations were performed at 7 days and 1 month. Exophthalmos was assessed using a Hertel's exophthalmosmeter (ALMAS YZ9). Sivtsev-Golovin charts were used to assess visual acuity. Statistical analyses were conducted using Microsoft Excel and Statistica (StatSoft, Tulsa, OK, USA) software.*

Results: *The preoperative exophthalmos was 18.5 ± 2.12 mm in patients scheduled for TEO and 16.9 ± 1.78 mm in those scheduled for TCO. On day 7 after surgery (the day of discharge), exophthalmos reduced to 6.4 ± 0.77 mm in patients undergoing TEO ($p < 0.0005$) and 8.8 ± 0.94 mm in those undergoing TCO ($p < 0.005$). The preoperative visual acuity (VA) was 0.07 ± 0.03 in patients scheduled for TEO and 0.09 ± 0.05 mm in those scheduled for TCO. On day 7, mean VA improved to 0.81 ± 0.12 ($p < 0.00005$) in patients undergoing TEO, and to 0.56 ± 0.34 in those undergoing TCO. The two groups showed practically the same pattern of a longitudinal decrease in chemosis. Diplopia in upward and downward gaze and any restriction in ocular motility disappeared in patients undergoing TEO by the day of discharge (day 7), which was 4-5 days earlier than in patients undergoing TCO, with a postoperative period 4.25 ± 0.75 days longer ($p<0.05$) in the latter patients. At one month, mean VA improved to 0.89 ± 0.08 ($p < 0.00005$) in patients of the TEO group, and to 0.75 ± 0.15 ($p < 0.005$) in patients of the TCO group.*

Conclusion: *Endonasal endoscopic transethmoidal orbitotomy was significantly more advantageous than transcutaneous orbitotomy, with a faster recovery, particularly, shorter postoperative period, faster restoration of visual acuity and ocular motility, minimum trauma to soft orbital tissues, and no external damage to facial skin.*

Keywords:
endonasal orbitotomy, frontal basilar trauma, retrobulbar hematoma

Introduction

The frontal bone contributes to the anterior portion of the neurocranium and superior part of the facial skeleton. Frontal bone fractures account for 5% to 15% of all facial skeleton fractures, can result from motor vehicle collision, assault, and falls [1, 2], and frequently involve not only the frontal sinus walls and the superior orbital margin, but also the base of the skull as well as the middle facial skeleton [3-5]. Treatment of these fractures is a challenge if there is evidence of intracranial pathology like tear of the dura matter with either nasal liquorrhea or pneumocephalus; foci of contusion (frontal lobe destruction; intracranial hematomas); and intraorbital sequelae (intraorbital hematoma), etc.

Management of orbital cranium pathology has attracted attention of various surgery specialties because of the close and intricate anatomical relationships among the cranial cavity, orbit, nose and paranasal sinuses. Emergency eye conditions are common and represent a challenge that requires prompt management to save sight [6-7].

Eye injuries are a major cause of blindness and approximately 85% of individuals with eye injuries will become visually disabled [7, 8]. Contusions are the most common and account for 33% of all cases of ocular blunt trauma. They are the second most common and second most frequent ocular injuries after penetrating injuries, and may be related to home, motor vehicle collisions, or children games. Despite advances in medical and diagnostic manipulations, emergency eye conditions may still result in a complete loss of vision. Inadequate management of these patients can contribute to their visual disability, making the problem socially relevant [9-12].

The orbit is an osseous cavity which resembles a tetrahedral pyramid with rounded sides and contains the ocular globe and surrounding tissues, with pyramid base extending anteriorly and outward and pyramid apex extending posteriorly and inward. The anterior orbital axis length ranges from 4 cm to 5 cm, the height at the orbital opening is 3.5 cm, and the orbital width, 4 cm. Orbital walls have many dehiscences and openings through which vessels and nerves pass and which can become damaged in the presence of trauma, leading to the development of above intraorbital complications. The orbital walls and their components are as follows:

the orbital roof (composed of the frontal bone and the lesser wing of the sphenoid bone)

the orbital floor (composed of the orbital plate of the maxillary bone, the orbital plate of the zygomatic bone, and the orbital process of the palatine bone);

the lateral orbital wall (composed of the frontal process of the zygomatic bone, the zygomatic process of the frontal bone, and the greater wing of the sphenoid); and

the medial orbital wall which is the thinnest and has the most complex structure (involving the lacrimal bone, the frontal process of the maxilla, the orbital plate of the ethmoid bone, and the anterior portion of the sphenoid bone) [13].

Intraorbital hematoma is a severe complication that can cause optic nerve compression, leading to loss of vision. Intraorbital hematomas can be divided into two categories: retrobulbar and subperiosteal [14].

Contusion of the globe is caused by frontal basilar trauma, with the latter accompanied by orbital wall fracture that develops after retrobulbar injection of a medication, in the presence of coagulopathy, vasculopathy, ocular surgery, neuro-surgery or endonasal microscopic paranasal sinus surgery [14-16].

The condition is diagnosed based on patient complaints (protrusion of the eye from the orbit, bursting orbital pain, pain with ocular movements, diplopia, and emergence of nausea and vomiting due to abruptly elevated intraocular pressure), patient history, patient's objective ocular status (exophthalmos, protrusion, limited ocular motility, displacement of the globe, swollen lids and conjunctiva (chemosis), impaired visual functions such as visual acuity and visual fields, and intraocular pressure), impaired sensitivity at the areas of innervations from the second and third branches of the trigeminal nerve, and reduced tactile cutaneous sensitivity below the eye [8, 17, 18]. Exophthalmometry, ocular tonometry, X-rays, computed tomography (CT), angiography, and magnetic resonance imaging (MRI) of the orbit are used for the diagnosis of intraorbital pathology [9, 13, 16]. The current approach to selecting surgical treatment for frontal and orbital fractures is based on the classical guiding principles of craniofacial surgery [2, 5, 15, 17-23]. This requires a multidisciplinary surgical team including a neurosurgeon, an otorhinolaryngology surgeon, an eye surgeon and a maxillofacial surgeon, because in this condition, the relevant sites are injured.

The purpose of this study was to assess the efficacy of endonasal endoscopic transethmoidal orbitotomy (TEO) and transcutaneous orbitotomy (TCO) in patients with post-traumatic intraorbital hemorrhages.

Material and Methods

Fifteen patients (9 men and 6 women) with intraorbital complication of frontal and orbital trauma were under our surveillance during 2016 to 2019. Patient age ranged from 33 years to 65 years. Intraorbital hematoma was caused by a craniocerebral injury combined with an injury to the paranasal and periorbital sinuses in 10 patients, and occurred following endonasal endoscopic polysinusotomy in 5 patients. The time from traumatic event to surgery was approximately 24 hours and approximately 72 hours for 6 patients with orbital contusion and 4 patients with orbital contusion, respectively, and 2 hours to 4 hours for patients after polysinusotomy. Of the 15 patients, 8 received endonasal endoscopic transethmoidal orbitotomy (TEO) and 7, transcutaneous lateral orbitotomy (TCO).

An eye examination was performed preoperatively and on day 7 and at 1 month postoperatively and included visual acuity assessment with Sivtsev-Golovin charts and assessment of exophthalmos by Hertel's test with an exophthalmosmeter (ALMAS YZ9). Data obtained from the affected and unaffected eyes were compared. Patients underwent orbital ultrasonography and spiral CT of the paranasal and periorbital sinuses. The comprehensive conservative treatment included homeostatic, anti-edematous and antibacterial therapy.

The operative technique was developed at the Otorhinolaryngology Department, the Pyrogov National Medical University of Vinnytsia, and the application for the invention was filed. The operative technique was as follows:

An endoscope was used to visualize medial nasal pathway. First, the Concha nasalis medialis was gently displaced with an elevator. Second, the medieval and posterior ethmoidal cells required to get the approach to the

orbit were opened with bone forceps, the lamina papyracea was gently removed with microforceps, a 1-cm diameter trephine window was made, and the Tenon's capsule was dissected with a sickle knife. The emergence of orbital fat in the trephine window was considered evidence of getting into the orbit after dissecting the Tenon's capsule. Third, a curved clamp was used to open hematoma depending on its location based on orbital CT or ultrasonography. Finally, rubber drains were used to gently evacuate the hematoma into the nasal cavity, and anterior nasal tamponade was gently performed.

The protocol of this study adhered to the ethical standards outlined in the Declaration of Helsinki.

The authors declare no conflict of interest.

Statistical analyses were conducted using Microsoft Excel and Statistica (StatSoft, Tulsa, OK, USA) software. The parametric Student t test was used for unpaired samples. The level of significance $p \leq 0.05$ was assumed. Data are presented as mean and standard error of the mean.

Results

The preoperative exophthalmos was 18.5 ± 2.12 mm in patients scheduled for TEO and 16.9 ± 1.78 mm in those scheduled for TCO. On day 7 after surgery, exophthalmos reduced to 6.4 ± 0.77 mm in patients undergoing TEO ($p < 0.0005$) and 8.8 ± 0.94 mm in those undergoing TCO ($p < 0.005$). The preoperative visual acuity was 0.07 ± 0.03 in patients scheduled for TEO and 0.09 ± 0.05 mm in those scheduled for TCO. On day 7 after surgery, visual acuity improved to 0.81 ± 0.12 and significantly ($p < 0.00005$) in patients undergoing TEO, and improved to 0.56 ± 0.34, but not significantly in those undergoing TCO. The two groups showed practically the same pattern of a longitudinal decrease in chemosis, and chemosis subsided on day 7 after surgery. Diplopia in upward and downward gaze and any restriction in ocular motility disappeared in patients undergoing TEO by the day of discharge (day 7), which was 4-5 days earlier than in patients undergoing TCO, with a postoperative period 4.25 ± 0.75 days longer ($p<0.05$) in the latter patients. At one month after surgery, the visual acuity improved to 0.89 ± 0.08 ($p < 0.00005$) in patients of the TEO group, and to 0.75 ± 0.15 ($p < 0.005$) in patients of the TCO group. In addition, patients of both groups showed complete restoration of ocular motility and no diplopia.

Discussion

Current-era surgery strives to minimize surgical trauma and anatomic distortion, which requires the use of endoscopic techniques [14, 15, 17, 20]. In any case of frontal and orbital trauma, the orbit is injured [4, 5, 15], and, if a CT scan or ultrasonography reveals intraorbital hematoma, the doctor should make a prompt decision on its surgical treatment aiming to reduce IOP promptly [14, 16, 17, 24].

Our clinical study of patients with post-traumatic intraorbital hemorrhages demonstrated that endonasal endoscopic transethmoidal orbitotomy (TEO) was significantly more advantageous than transcutaneous orbitotomy (TCO), with a faster restoration of visual functions and a 4.25±0.75 days shorter in-hospital postoperative period, whereas the literature [24, 25] reported that patients undergoing TCO for this pathology required an in-hospital postoperative period of 10 days to 14 days. It is also noteworthy that TCO has several disadvantages such as cosmetic defects of the eyelids, impaired eyelid motility and a longer rehabilitation period compared with TEO [25].

Therefore, endonasal endoscopic transethmoidal orbitotomy allows minimizing intraoperative trauma to soft orbital tissues and accelerating patient recovery, and is preferable compared to transcutaneous orbitotomy.

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Conflict of Interest Statement:
The authors declare no conflict of interest which could influence their opinions on the subject or the materials presented in the manuscript.