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Reduction in visual acuity and intraocular injuries in orbital floor fracture

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Abstract: Blow-out fracture of the floor of the orbit is an increasingly recognized trauma. It may be an isolated injury, but because of various mechanisms may be also accompanied by the damage of other components of the visual system. The triad of clinical symptoms in blow-out fracture of the orbital floor includes: double vision, the enopthalmos and impaired sensation in the area of infraorbital nerve. Change of the position of the eyeball may lead to displacement and stretching of the optic nerve, which may result in the traumatic optic neuropathy.

The aim of this paper is the evaluation of effectiveness of surgical and conservative tactics in the treatment of blow-out fracture of the floor of the orbit, accompanied by intraocular injuries, on the basis of retrospective study of the patients treated from 1971 to 2014.

Material and methods: Based on a retrospective analysis of medical records of a group of 752 patients treated in our Department due to blow-out fracture of the orbit, during 44 years (1971–2015), intrabulbar injuries were found in 98 (13%) patients, and decrease in visual acuity was observed in 84 (11.2%) patients. In patients with decreased visual acuity values of sight acuity ranged from light perception to 0.8, in 3 patients the blow-out fracture of the orbit was accompanied by the superior orbital fissure syndrome, while in four patients orbital apex syndrome was observed.

Statistical analysis of parameters of sight acuity before and after treatment was performed. The Wilcoxon test was used for dependent measurements (repeated), visual acuity after treatment was significantly higher than before.

Due to the complexity of the injury, treatment of orbital floor fracture requires a multidisciplinary approach, in the team of maxillofacial surgeon, ophthalmologist, radiologist and neurologist.

Key words: blow-out fracture of the orbit, traumatic optic neuropathy, intraocular injury.

Introduction

Blow-out fracture of the floor of the orbit, in Wanyura's terminology — the isolated fracture of the orbital floor, is an increasingly recognized trauma. Orbital fracture usually accompanies the extensive craniofacial fractures, while isolated fracture of the floor and/or the medial wall is less common. There are three theories explaining the mechanism of the fracture of the floor of the orbit. According to Smith, Regan and Converse [1, 2] a blunt trauma to the eyeball, leads to a sudden increase in pressure within the orbit, periocular tissues transmit the force of the injury to the bony walls of the orbit and the increase of pressure causes the breakage of the thinnest wall- its floor and/or medial wall, leading to an isolated fracture of the floor of the orbit. According to Fujino [3] theory indirect trauma to the lower orbital rim only leads to its deflection and the force of the trauma is moved further to the floor of the orbit, leading to it's fracture. A third theory by Pfeiferr [4] says that trauma to the eyeball, resulting in its movement into the orbit, at a distance of less than 2.5 cm from the orbital cone and contact with the bony wall, leads mechanically to damage of the orbital floor. According to Converse [2] during injury the change of the position of the eyeball leads to changes in the course of the optic nerve and it's post-traumatic neuropathy (TON). In long-term experience of our Department blow-out fracture of the orbit was diagnosed on the basis of persistent posttraumatic diplopia, presence of the orbital "hernia" or fading of the infraorbital foramen in the radiographs of the paranasal sinuses in Waterse's projection (the indirect symptom by Bilewicz). Currently, the progress of diagnostic imaging and necessity of CT in patients with head injuries leads to more frequent diagnosis of blow-out fracture of the orbit immediately after the injury. The triad of clinical symptoms in blow-out fracture of the orbital floor includes: double vision, the enopthalmos and impaired sensation in the area of infraorbital nerve. In 8–18% [5] cases blow-out fracture of the orbital floor may be accompanied by intraocular damage, usually in the form of concussion of the retina that interfere with the classic image of the fracture. In addition to intraocular injuries traumatic optic neuropathy and even blindness may occur. Due to the complexity of the injury, treatment of orbital floor fracture requires an interdisciplinary approach, in the team of maxillofacial surgeon, ophthalmologist, radiologist and neurologist. Surgery is the treatment of choice in patients with orbital floor fracture and consists of transconjuctival, or less often subcilliary revision of the floor of the orbit, release of the entrapped periocular tissues and reconstruction of the continuity of the bone. The reconstructive material can be autogenic bone graft harvested from the anterior wall of the maxillary sinus, parietal bone, temporal bone, iliac crest, perpendicular plate of ethmoid bone, cartilage of the septum of the nose, cartilage of the rib [2, 5] or titanium mesh in order to restore the continuity of the orbit and allow proper function of extraocular muscles. Surgical reconstruction of the fracture should be carried out as soon as possible after the injury, only in case of concomitant intraocular injuries, the revision of the orbit can be postponed to 10–14 days, until regression of intrabulbar pathologies. Change of the position of the eyeball may lead to displacement and stretching of the optic nerve, which may result in the traumatic optic neuropathy. Restoring the correct position of the eyeball most often restores visual acuity just as before the trauma.

Material and methods

Based on a retrospective analysis of medical records of a group of 752 patients treated in our Department due to blow-out fracture of the orbit, during 44 years (1971–2015), ocular injuries were found in 98 (13%) patients, and decrease in visual acuity was observed in

84 (11.2%) patients. In patients with decreased visual acuity values of sight acuity ranged from light perception to 0.8, in 3 patients the blow-out fracture of the orbit was accompanied by the superior orbital fissure syndrome, while in four patients orbital apex syndrome was observed. Forms of intraocular injuries are presented in Table 1. The cause of injury in 65 (65%) patients was personal assault, in 23 (23%) cases unintentional strike in the area of the orbit, rarely fall — 11 (11%) patients. Surgery was performed in 88 (90%) patients, conservative treatment in 10 (10%) patients. In patients with reduction in visual acuity pharmacological decongestant treatment was introduced, surgical treatment was delayed until the improvement of the vision and regression of accompanying intraocular injuries. The patients were consulted by ophthalmologist and neurologist. Pharmacological decongestant and dehydrative treatment was conducted using dexamethasone phosphate (Dexaven) or 20% solution of mannitol, vitamins B1, B6, B12 were also introduced. Intravenous steroid therapy was conducted in the scheme: 24mg of Dexaven in first day, followed by 16mg-8mg in the second day, 8mg-8mg in the third day, 6 mg-6 mg in the fourth day, 4mg-4mg fifth day, with modifications depending on the clinical condition. In patients with decreased visual acuity and post-traumatic blindness, and no improvement during therapy, visual evoked potentials (VEP) examination was performed, to monitor changes during treatment. In the group of patients with a reduction of acuity of sight of total 84 patients, conservative treatment was applied in 10 (12%) patients, surgical treatment in 74 (88%) patients, in this group time from injury to surgery ranged from 1 to 56 days, on average 16 days after injury. In patients with a fracture of the orbital floor, presenting symptoms of superior orbital fissure 1 patient was enrolled to conservative treatment, surgery was performed in 2 patients, on average 34 days after the injury. In patients with TON surgery was introduced in 7 patients, time from injury to treatment ranged from 1 to 36 days, an average of 6 days.

Table 1. Intraocular injuries.

Intraocular injury	Subconjuctival hemorrhage	Retinal commotion	Ablation of retina	Changes in the disc of n.II	Hemorrhage into the vitreous body	Choroidal rupture	Subluxation of the lens	Rupture of the eyeball	Pupillary sphincter rupture
Number of patients	61	31	8	7	3	1	1	1	1

Results

Statistical analysis of parameters of sight acuity before and after treatment was performed. The Wilcoxon test was used for dependent measurements (repeated), and the graph shows the median (solid bars) and quartiles (whiskers). Visual acuity after treatment was significantly higher than before ($P < 0.05$; median higher after the treatment). (Table 2, Fig. 1)

Table 2. Acuity of sight before and after treatment.

Measurment	Acuity of sight							p
	Average	SD	Median	Min	Max	1. quartile	3. quartile	
Before treatment	0.48	0.26	0.55	0	0.9	0.3	0.7	p <0.001
After treatment	0.75	0.27	0.8	0	1	0.6	1	

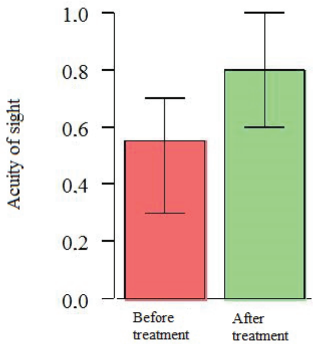

Fig. 1. Acuity of sight before and after treatment.

Statistical analysis of the relationship between the age of the patient and the change in visual acuity before and after treatment, using the Spearman correlation coefficient, indicated that the coefficient of correlation between age and the change in visual acuity is –0.035 and is statistically insignificant ($p > 0.05$), so the two properties do not depend significantly from each other. (Table 3, Fig. 2)

Table 3. The relationship between the age of the patient and the change in visual acuity before and after treatment.

Tested features	Correlation coefficient	p	Direction of the relationship	Strenght of the relationship
Acuity of sight — improvement and age	–0.035	0.777	–	–

Analysis of relationship between time from injury to treatment and the change in visual acuity before and after treatment showed that the correlation coefficient between the time of injury to the treatment and the change of visus is –0.302 and is statistically significant ($p < 0.05$), so the two properties are significantly dependent on each other. This relationship is negative, which means that the longer the time from injury to the treatment, the worse treatment outcome. (Table 4, Fig. 3)

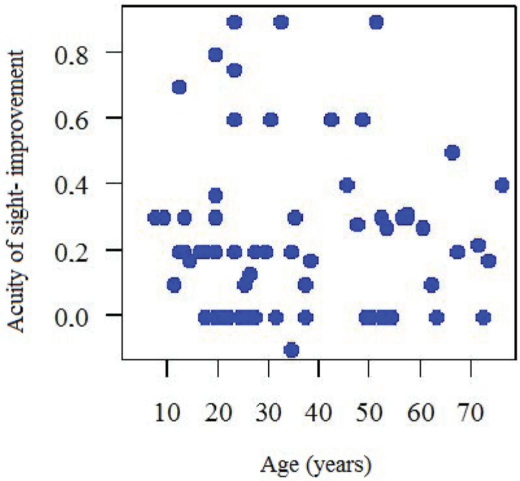

Fig. 2. The relationship between the age of the patient and the change in visual acuity before and after treatment.

Table 4. The relationship between the time of injury to the treatment and the change in visual acuity before and after treatment.

Tested features	Correlation coefficient	p	Direction of the relationship	Strenght of the relationship
Acuity of sight — improvement and time from injury to tratment	−0,302	0,018	negative	medium

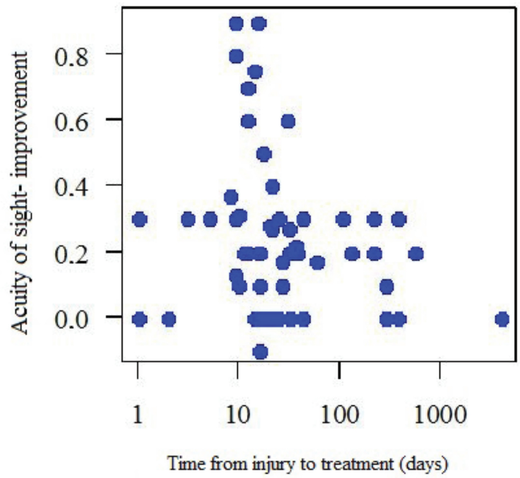

Fig. 3. The relationship between the time of injury to the treatment and the change in visual acuity before and after treatment.

An analysis of the relationship between the use of steroids and the change between the visual acuity before and after treatment was performed. Visual acuity had a normal distribution in the analyzed groups (p Shapiro-Wilk less than 0.05), so the analysis was performed using the Mann-Whitney test, and the graph shows the median (solid bars) and quartiles (whiskers). The p in the Mann-Whitney test is less than 0.05, and therefore steroids influence the treatment effect (improving it). (Table 5, Fig. 4)

Table 5. The relationship between the use of steroids and the change between the visual acuity before and after treatment.

Steroidtherapy	Acuity of sight — improvement							p
	Average	SD	Median	Min	Max	Q1	Q3	
Steroid therapy	0.32	0.28	0.3	−0.1	0.9	0.1	0.5	p = 0.005
Without steroid therapy	0.14	0.12	0.17	0	0.3	0	0.2	

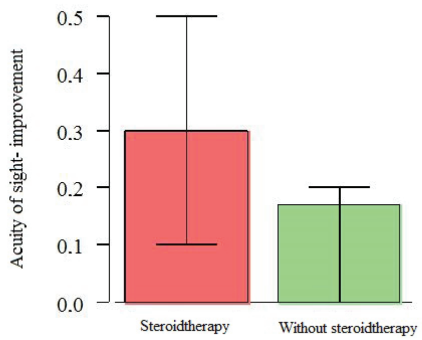

Fig. 4. The relationship between the use of steroids and the change between the visual acuity before and after treatment.

In patients with TON the maintenance of visual acuity at initial level is considered as positive outcome of treatment. In four patients with TON and post traumatic blindness, who failed to respond to decongestant treatment, visual evoked potentials examination revealed a decrease in the amplitude and prolonged latency of wave P 100, persisting in subsequent studies.

Discussion

Blow-out fracture of the floor of the orbit may be an isolated injury, but because of the different mechanisms may be also accompanied by the damage of other components of the visual system. Intraocular damage in patients treated at the Department was found in 13% of patients. These data are similar to the results reported by other authors [5]. In the case of uncomplicated fractures, surgery should be performed as soon as possible after the injury. The method of surgical reconstruction depends on the experience of treating team.

According to our own experience treatment consists of transconjuctival revision of the orbital floor with a reconstruction of bone defect with autogenic bone graft from the anterior wall of the maxillary sinus. Surgical reconstruction of blow-out fracture of the orbit complicated by intraocular injuries should be postponed until 14 days after injury, untill the regression of intraocular injuries, but if posssible not longer, due to the better results of surgical treatment in 14 days after injury compared with delayed reconstructions [6]. Blow-out fracture of the orbital floor with the reduction of visual acuity is an indication for hospitalization immediately after the injury and the introduction of decongestant treatment in order to protect optic nerve. The pharmacological treatment immediately after the injury and perioperatively consists of steroids administered intravenously and orally [7–9]. According to Saxen and Samardzic current strategies may distinguish three main patterns of steroids: a moderate dose of 60–100 mg oral prednisolone, high dose of methylprednisolone — 1g per day, administered intravenously and mega dose — 30 mg/kg per day. According to Saxena [7] the role of steroids is based on their anti-inflammatory and decongestant role in the immediate vicinity of the optic nerve and optic nerve channel, by which the optic nerve is protected secondarly from damage by the pressure of surrounding tissues. In moderate doses steroids are also neuroprotective to optic nerve by inhibiting the lipid peroxidation induced by free radicals. The use of mega doses of steroids is controversial because of the possible neurotoxic action and side effects like psychosis, immunosuppression and impaired glucose metabolism [8]. The results of pharmacological and surgical treatment of TON are comparable [8–13]. Traumatic optic neuropathy is most commonly associated with the damage of the optic nerve within it's canal [14], in the course of blow-out fracture of the orbit, the TON may occur as a result of compression of periocular tissues moved into the optic nerve. In patients with TON, visual evoked potentials (VEP) examination is advisory when it comes to control and prognosis of treatment. Maintained prolonged latency and a decrease in the amplitude of the P100 wave is a poor prognostic sign [15]. The shorter the time between injury and treatment, the better outcome.

Conclusions

Blow-out fracture of the orbit with a decrease in visual acuity, is an indication for the hospitalization on the day of injury, with the aim of pharmacological protection of the optic nerve. Ophthalmological examination of patients with blow-out fracture of the orbit, performed on the day of trauma allows for early diagnosis of coexisting intraocular injuries resulting in reduction of visual acuity. Intraocular injuries occur in almost 13% of patients with a blow-out fracture of the orbital floor, a reduction in visual acuity occurs in 11% of patients with blow-out fractures. Prognosis depends on the initial reduction of visual acuity and the time from injury to initiation of treatment.

Conflict of interest statement

There is no conflict of interest, that could affect the content of this article.

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