

On the issue of the development of secondary complications in case of eye injuries

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The aim of this work was to study secondary complications in patients with globe injuries hospitalized at the National Center of Ophthalmology named after Academician Z.A.Aliyeva. A retrospective analysis of penetrating and non-penetrating eye injuries (n=2225) was performed in patients hospitalized between 2019 and 2023. The inclusion criteria were the presence of open or closed globe injuries, established on the basis of clinical manifestations and classifications of the Birmingham Eye Trauma Terminology (BETT) and the International Classification of Diseases of the 10th revision (ICD-10, Class VII). Among the studied cases, 1389 (62.4%) were associated with open globe injuries and 662 (29.7%) – with closed globe injuries. It was established that the most critical consequences were secondary bacterial, inflammatory, anatomical and functional complications, as well as long-term secondary conditions, such as subatrophy of the eyeball. It was revealed that the nature of the trauma has a statistically significant influence on the type of developing complications: superficial keratitis and reactive uveitis were more often diagnosed with closed globe injuries, and post-traumatic cataracts with open globe injuries, as well as endophthalmitis and sympathetic inflammation, which later lead to subatrophy of the eyeball. As a result of the analysis, reliable predictors of the complicated course of the post-traumatic period with eye trauma were revealed, such as untimely referral, the presence of a foreign body and the older age of patients. Thus, a high proportion of secondary bacterial complications is observed among patients of the older age group "60 years and older". A clear relationship has been established between the timeliness of referral and the frequency of secondary complications, which emphasizes the critical importance of early diagnosis and timely initiation of treatment for eye injuries. Based on clinical and demographic data, using mathematical modeling methods, an assessment of the risk of developing complications can be carried out, which opens up prospects for individualized prevention and optimization of therapy.

Key words: *Eye injuries, Bacterial complications, secondary infection, risk factors*

INTRODUCTION

The introduction of new technologies into ophthalmic surgical practice often guarantees successful restoration of visual functions after injuries. However, the development of secondary complications, including bacterial ones, can negate any successfully performed operation (Busyreva, 2008). Post-traumatic complications can develop both in the acute and late periods

after an eye injury, affecting various structures of the eye. The most common complications include hyphema, hemophthalmos, retinal detachment, traumatic cataract and endophthalmitis (Nakayama et al., 2019; Jian et al., 2021). Thus, hyphema is observed in contusion injuries in 43.3-57.5% of cases, hemophthalmos in 36.6-37.7%, and retinal detachment develops in 14.3% of observations (Ikramov et al., 2023) According to F.O.Kasymov and co-authors (2015), post-

traumatic endophthalmitis is especially dangerous, which develops when the purulent process spreads into the vitreous body and can lead to complete loss of vision or even loss of the eye.

The study of complications and outcomes of eye injuries is necessary to improve the effectiveness of specialized care, reduce the number of severe functional outcomes and scientifically substantiate approaches to the prevention, diagnosis and treatment of post-traumatic pathology in ophthalmology. Their timely diagnosis and treatment are key factors in preserving visual functions and preventing patient disability (Bohrani Sefidan et al. 2022). At the same time, in the modern scientific literature, data on the structure and frequency of secondary complications, especially of an infectious nature, arising at different times after eye injuries are not fully presented. This makes it difficult to develop universal clinical algorithms and preventive strategies. Thus, conducting this research appears to be relevant and justified both from a clinical and scientific-practical point of view.

The purpose of this work was to study secondary complications in patients with eye injuries hospitalized at the National Center of Ophthalmology named after Academician Z.A. Alieva.

MATERIAL AND METHODS

A retrospective analysis of the inpatient charts of patients with eye injuries, hospitalized at the National Center of Ophthalmology named after Academician Z.A. Alieva in 2019-2023, with various eye injuries was conducted. The criterion for inclusion in this study was the presence of open or closed globe injuries. The diagnosis of "eye injuries" was established according to clinical manifestations based on the classification of BETT and the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10), Class VII: "Eye injuries".

According to the recommendations of the international BETT classification, in this work the main object of analysis as a unit of observation of ophthalmic injuries was the eye. This approach allows for a more accurate reflection of the

frequency of occurrence, structure and nature of injuries, as well as their frequency of complications and outcomes. This, in turn, allows for comparability with world literature data (Kuhn et al., 2006; Wong et al. 2018).

A total of 2225 cases with various eye injuries were studied, including 1389 with open globe injuries and 662 with closed globe injuries. All patients had carefully collected data on the time, place, conditions of receiving trauma and the time it took to turn to a medical institution for help. The average age of patients was 34.5 ± 1.2 years. The largest proportion of ophthalmic injuries occurred in men of working age in the age group 30-44 years (32.9% of all patients).

When calculating the timeliness of patients' appeals, we were guided by the scale proposed by Academician L.K. Moshevota and co-authors (2018): timely referral (up to 24 hours after receiving an injury), delayed referral (2-5 days after receiving an injury), late referral (on the 6th day and later after receiving an injury).

Statistical analysis is performed using the Microsoft Office Excel 2007 software complex, using descriptive statistics methods. Pearson's χ^2 test was used to analyze the relationship between categorical variables. The results were considered statistically significant at a significance level of $p < 0.05$. All quantitative indicators are presented as mean and standard deviation ($M \pm SD$).

In the tabular data, the sum of the proportions of secondary complications cannot be 100% due to the combined occurrence in one eye.

RESULTS AND DISCUSSION

It was established that the frequency and nature of complications in eye injuries depended on the timeliness of the patient's referral for specialized help (Table 1). As can be seen from Table 1, the conducted analysis revealed a statistically significant relationship between the frequency of complications in eye injuries and the timeliness of patient treatment. Thus, such optical complications as post-traumatic cataracts and corneal opacity were found frequently, both among patients who promptly turned to the National Center of Ophthalmology named after Academician Z.A. Alieva, as well as in delayed and late referrals.

Table 1. The frequency and nature of complications from eye trauma in patients hospitalized at the National Center of Ophthalmology named after Academician Z.A. Aliyeva

Category of complications	Examples of complications	The timeliness of the patient's referral to the National Center of Ophthalmology named after Academician Z.A. Aliyeva		
		Timely n=1798	Delayed n=258	Late n=169
Optical	Cataract, corneal opacity	184 (10.23%)	46 (17.83%)	22 (13.02%)
Inflammatory	Uveitis, iridocyclitis	21 (1.11%)	4 (1.55%)	12 (7.1%)
Anatomical and functional	Iridodialysis, retinal detachment, choroid detachment, lens subluxation, increased IOP, glaucoma	42 (2.33%)	20 (7.75%)	20 (11.83%)
Bacterial complications	Keratitis, endophthalmitis, secondary bacterial contamination, corneal abscess	190 (10.57%)	67 (26.0%)	72 (42.6%)
Long-term secondary complications	Sympathetic inflammation, subatrophy of the eyeball	26 (1.44%)	3 (1.16%)	6 (3.55%)

The largest share of inflammatory complications (uveitis and iridocyclitis) was diagnosed during late referral (7.1% of all late patients). Perhaps, the presence of inflammatory complications at later referrals may be connected with their transition to more severe conditions, namely – secondary bacterial infections.

Among the anatomical and functional complications - iridodialysis, retinal detachment, choroid detachment, subluxation of the lens, increased intraocular pressure, glaucoma - a sharp increase was observed when the patient was referred very late (11.83%). This fact confirms the special importance of early diagnosis and treatment of such complications in order to preserve the anatomical integrity of the eye in the future.

Secondary bacterial complications showed a pronounced tendency to increase depending on the timeliness of referrals – from 10.57% with timely to 42.6% of all patients with eye injuries analyzed with late referrals for specialized care.

As for such long-term secondary complications of eye trauma, as subatrophy of the eyeball and sympathetic inflammation, as can be seen from Table 1, their share is the most important in patient with late referrals (3.55% of all late referrals). This is twice as much as with timely and delayed referrals ($p < 0.05$). Also, Watanachai et al. (2021) showed that a delay of more than 24 hours increases the risk of endophthalmitis by almost four times (OR 3.9; $p < 0.001$). It is noted that prevention of this

condition requires early diagnosis, stabilization of intraocular pressure and active anti-inflammatory treatment.

The analysis of the nature of post-traumatic complications among the studied population (Table 2) showed that superficial keratitis and reactive uveitis occurred in a statistically significant proportion of mild complications with closed globe injuries ($p < 0.05$). This, in turn, may indicate their more typical development in superficial injuries.

Among the moderate complications, the development of post-traumatic cataract was 7.4 times more likely to be diagnosed in the eyes with an open globe injury. This fact may indicate a high risk of lens damage in penetrating eye injuries.

Corneal opacity and development of secondary glaucoma, on the contrary, were more often registered with closed eye injuries.

As for severe complications, as can be seen from the table 2, the development of endophthalmitis was registered in eyes with closed and open globe injuries (1.57 and 4.67%, respectively, $p < 0.05$). Also, such complications as retinal detachment were registered with the same frequency. Thus, severe complications, especially infectious and degenerative, were more often observed with open globe injuries, which indicates their high risk of disability and requires aggressive anti-infective and anti-inflammatory therapy.

Table 2. Characteristics of post-traumatic eye complications by degree of severity among patients hospitalized at the National Center of Ophthalmology named after Academician Z.A.Aliyeva

Degree of severity	Complications	Closed globe injuries, n=662	Open globe injuries, n=1389	Total n=2051	P-value
		% of all closed globe injuries	% of all open globe injuries		
Mild complications	Superficial keratitis	3.47	0.07	1.52	p<0.05
	Reactive uveitis	3.47	0.14	1.12	
Moderate complications	Post-traumatic cataract	1.36	16.77	6.34	p<0.05
	Corneal opacity	1.21	0.22	0.49	
	Secondary bacterial keratitis	1.51	0.07	0.45	
	Secondary glaucoma	1.21	0.43	0.68	
Severe complications	Endophthalmitis	1.57	4.67	3.01	p<0.05
	Panophthalmitis	0.00	0.58	0.36	
	Retinal detachment	1.36	1.22	1.17	
	Subluxation of the lens	0.76	1.08	0.98	
	Optic nerve atrophy	0.00	0.07	0.04	
	Uncontrolled secondary glaucoma (refractory)	0.30	0.14	0.18	
	Subatrophy of the eyeball, sympathetic inflammation	0.30	2.02	1.35	

Table 3. Distribution of post-traumatic eye complications by types and age groups of patients hospitalized at the National Center of Ophthalmology named after Academician Z.A.Aliyeva

Age group	n	With complications, n (%)	Types of complications (in % of all in this age group)		p-value	Pearson χ^2
< 1 year	4	1 (25.0%)	Bacterial	1 (100)	>0.05	0.07
1-5 years	179	28 (15.6%)	Optical Bacterial Anatomical and Functional Inflammatory Long-term secondary	14 (50) 13 (46.4) 3 (10.7) 1 (3.6) 1 (3.6)	<0.05	5.99
6-16 years	334	70 (21.0%)	Optical Bacterial Anatomical and Functional Inflammatory	46 (65.7) 23 (32.8) 2 (2.9) 1 (1.5)	>0.05	0.58
17-29 years	347	94 (27.09%)	Optical Bacterial Anatomical and Functional Long-term secondary Inflammatory	42 (44.7) 28 (29.7) 13 (13.8) 6 (6.4) 5 (5.3)	>0.05	0.47
30-59 years	1026	306 (29.8%)	Bacterial Optical Anatomical and Functional Long-term secondary Inflammatory	153 (50) 120 (39.2) 33 (10.9) 23 (7.5) 20 (6.5)	>0.05	2.24
60 years and older	335	127 (37.9%)	Bacterial Optical Anatomical and Functional Inflammatory Long-term secondary	88 (69.3) 30 (23.6) 19 (15.0) 10 (7.9) 2 (1.6)	<0.05	8.26

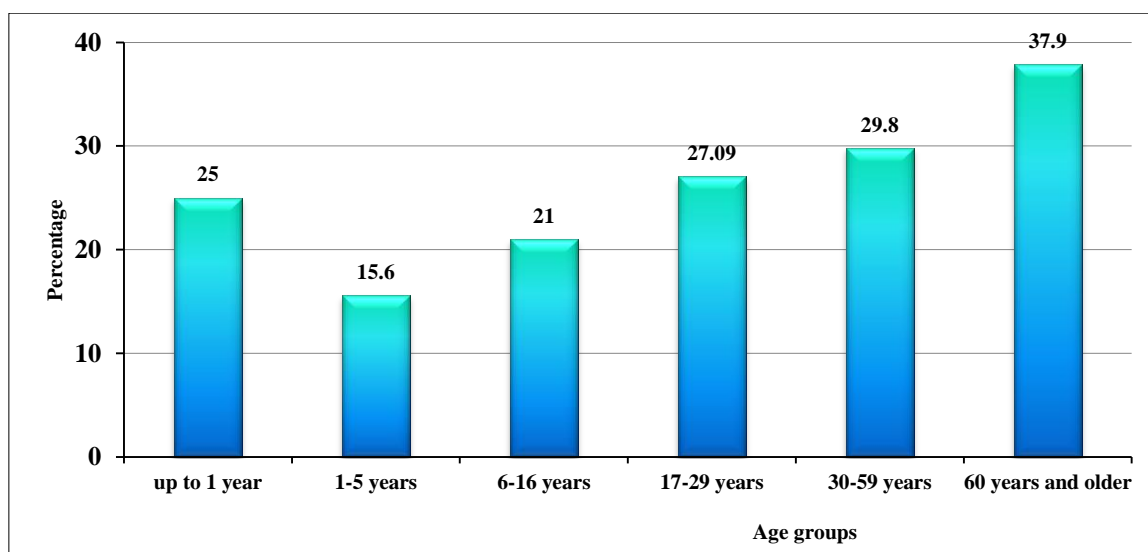


Figure. Frequency of post-traumatic secondary complications of the eye by age groups among patients hospitalized at the National Center of Ophthalmology named after Academician Z.A.Aliyeva (in % of the number of injuries in each age group)

As can be seen from graph 1, the highest frequency of post-traumatic complications in eye injuries was registered among patients in the age group "60 years and older" - 37.9% ($p < 0.005$), the lowest in the age group "1-5 years" (15.6%). Some authors explain this fact with the age-related features of tissue regeneration, the presence of background diseases and the delay in seeking medical help in elderly patients (Lee et al., 2022).

Table 3 presents the results of the assessment of the statistical significance of differences between age groups, calculated by χ^2 , as well as individual p-values in comparison of each group with the total share of complications among the studied population. The general statistic of the χ^2 criterion was 32.41, $p = 0.00002$, which indicates the existence of a significant relationship between the age of the patient and the probability of developing post-traumatic complications. As can be seen from table 3, the analysis of the distribution of complications among patients of different age categories revealed a tendency to increase the share of complicated cases with age. Thus, the frequency of complications ranged from 15.6% in children of the age group "1-5 years" to 37.9% in patients of the age group "60 years and older". In the age group "up to 1 year", complications were recorded in 25.0% of cases;

however, considering the extremely small sample size ($n=4$), these data do not have statistical significance.

In the age group "6-16 years", the occurrence of secondary complications of an optical nature was observed. Perhaps such a high share (65.7% of all detected complications in this age group) of optical disorders may indicate damage to the cornea and lens as a result of mechanical injuries typical of games or ophthalmic injuries that occurred in everyday life.

In the age group "17-29 years" there is a high proportion of optical and functional complications (44.7% and 19.1%, respectively), which in turn confirms the complex nature of trauma.

As can be seen from table 3, the dominance of secondary bacterial and optical complications is observed in the age group "30-59 years". This fact can be explained by high visual load and professional risks, as well as the heterogeneous structure of trauma (including penetrating wounds, foreign bodies). Among patients of the older age group "60 years and older", a high proportion of secondary bacterial complications prevailed (69.3% of all cases in this age group).

The nature of the foreign body (metallic, organic, inert, etc.), its size, localization (intraocular, superficial) and the time elapsed before its removal directly affect the outcome of

trauma and the frequency of secondary bacterial complications (Fekih et al., 2019). In our studies, no statistically significant relationship was found between the development of secondary

complications and the presence of a foreign body. And the greatest difference is seen for the optical and bacterial types of complications (Table 4).

Table 4. The distribution of complications depending on the presence of a foreign body in eye injuries in patients hospitalized at the National Center of Ophthalmology named after Academician Z.A.Aliyeva

Type of complication	A foreign body		Total	P-value
	present n=336	absent n=1889		
Bacterial	77 (22.9%)	229 (12.12%)	306	<0.001
Anatomical and Functional	3 (0.89%)	67 (3.54%)	70	<0.001
Inflammatory	3 (0.89%)	34 (1.8%)	37	<0.5
Optical	2 (0.6%)	250 (13.23%)	252	<0.001
Long-term secondary complications	2 (0.6%)	11 (0.6%)	13	<0.05

As can be seen from Table 4, the analysis of the distribution of complications in patients with eye trauma with the presence of a foreign body (n=336) compared to ophthalmic trauma without a foreign body (n=1889) suggested the presence of statistically significant differences in the nature of complications depending on this factor. Statistical calculations revealed a high degree of statistical significance of differences ($\chi^2=178.23$; $p<0.0001$). The marked differences in the frequency of secondary bacterial complications suggest a statistically significant relationship between the presence of a foreign body and the type of complications, in particular microbial ($p<0.001$). The obtained results once again emphasize the necessity of complex microbiological control upon admission of patients with intraocular foreign bodies.

A lower frequency of optical, anatomical and inflammatory complications in cases with the presence of foreign bodies may be due to the fact that such patients were more often subjected to earlier surgical intervention, including primary surgical treatment with removal of the foreign body and intravitreal antibiotic administration (Zhu et al., 2022).

CONCLUSION

Thus, the conducted study allowed to establish reliable predictors of the complicated course of the post-traumatic period, including the development of secondary bacterial,

inflammatory, optical, anatomical and functional complications, as well as long-term secondary complications.

Our studies have established a clear relationship between the timeliness of referral and the frequency of consequences, which emphasizes the critical importance of early diagnosis and timely treatment of eye injuries. It was also revealed that the nature of the trauma has a statistically significant influence on the type of complications that develop: superficial keratitis and reactive uveitis were more often diagnosed with closed globe injuries, while with open globe injuries, post-traumatic cataract, as well as endophthalmitis and sympathetic inflammation, which later lead to subatrophy of the eyeball. A higher frequency of severe complications was characteristic of open globe injuries, especially when combined with later referrals.

By the method of mathematical modeling, based on the interaction of various clinical and demographic factors, it is possible to estimate and predict the risk of developing various complications, outcomes and other conditions.

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CONFLICT OF INTEREST

The authors confirm the absence of a conflict

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