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Original Article

Analysis of the causes affecting postoperative visual acuity recovery of open eye injury and its prevention measures

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Abstract: Open eye injury has become one of the three monocular blindness diseases in ophthalmology and the main reason of monocular blindness among children and young adults. This paper aimed to analyze the causes of open eye injury in northern China and its influence factors of visual acuity recovery postoperation and put forward the corresponding and adaptable preventive measures. A random sampling was conducted in 2014 on 60,000 urban and rural residents in North China about the open eye injury investigation and analysis. The self-designed and pre-test calibrated epidemiological characteristics of open eye injury questionnaire, and statistical analysis were used to explore the relevant factors affecting visual acuity recovery post operation in patients with open eye injury. There were 51,813 subjects in this survey, with a total of 483 patients with open eye injury. The injury causes and extents were closely related to their occupation, living environment and medical consciousness after injury. The recovery of visual acuity after seeing the doctor was closely related to patient's age, operation time, the injured area, nursing intervention, preoperative visual acuity, preoperative retinal conditions and the type of injury ($P<0.01$). Patients with open eye injury were mostly workers, peasants and students, whose protection awareness was weak. Age, operation time, the injured area, nursing intervention, preoperative visual acuity, preoperative retinal conditions and the type of injury were significant factors affecting visual acuity recovery. Local governments should work together with relevant hospitals to popularize public safety awareness and scientific knowledge, improve the personalized and humanistic nursing skills of medical workers and supplement or amend the existing policies and programs.

Keywords: Open eye injury, postoperative recovery, influencing factor, preventive measures

Introduction

Open eye injury is defined as changes in the structure and function of the eye directly owing to various mechanical, physical and chemical factors. It is a serious blind-causing eye disease, which has great damage to vision. The severity of the disease will not only cause disability, but even loss of ability to work, seriously affecting the quality of life of patients [1]. Opportunities of people reaching to different types of tools, chemicals and explosives in recent years have increased with the rapid development of industry, agriculture and the construction industry, so the incidence of open eye injury was also raised.

At present, open eye injury has become one of the three monocular blindness diseases in ophthalmology and the main reason of monocular blindness among children and young adults [2]. Statistically, millions of people suffer eye trauma every year in China, largely affecting people's physical and mental health. In eye injuries, open eye injury is more common [3]. Open eye injury has brought a heavy social and economic burden and become one of the major public health problems [4, 5]. Visual prognosis of eye injury patients is closely related to injury factors, the injured area, infection and retained foreign bodies. Timely understanding the clinical features of eye injury patients and correctly taking corresponding measures have positive effects on the patients, especially those with open eye injury. Therefore, taking positive and effective measures to eye trauma patients to implement targeted prevention, evaluate the

Table 1. Causes of open eye injury

Causes	Occupation					
	Worker	Farmer	Student	Preschool children	Housewife	No occupation
Case number	128 (26.50%)	117 (24.22%)	95 (19.67%)	73 (15.11%)	52 (10.77%)	18 (3.73%)
Injury factor	Causes of injury			Treatment time		
	Sharp tools	Explosives	Blunt objects	24 h	After 24 h	After 1 week
Case number	149 (30.85%)	146 (30.23%)	188 (38.92%)	263 (54.45%)	125 (25.88%)	95 (19.67%)
Injury factor	Injury time					
	Monday	Tuesday	Wednesday	Thursday	Friday	Weekend
Case number	49 (10.20%)	71 (14.67%)	54 (11.19%)	66 (13.57%)	62 (12.85%)	181 (37.47%)
Injury factor	Injury month					
	1	2	3	4	5	6	7	8	9	10	11	12
Case number	69	75	46	41	37	26	25	23	26	54	20	41
Percent (%)	14.3	15.5	9.5	8.5	7.7	5.4	5.2	4.8	5.4	11.2	4.1	8.5

effect of prevention and minimize the incidence of ocular trauma as much as possible are of great significance in promoting vision recovery [6, 7]. To this end, this study conducted an investigation on open eye injury among 60,000 urban and rural residents in northern China in 2014 using random sampling method to analyze factors resulting in open eye injury and factors affecting visual acuity recovery of patients, make appropriate preventive measures and give timely and correct treatment. Thus, the study has important clinical and social significance.

Materials and methods

Statement of ethics

We certify that this study has followed the Declaration of Helsinki (2008). All subjects have given their written informed consent. The ethical committee in our hospital has approved the experiment.

Study subjects

Permanent residents in North China were selected as subjects of the survey. Random sampling method was used to select 60,000 permanent residents from 20 villages and towns in 2014, 3,000 residents from each town for open eye injury investigation and analysis.

Methods

The self-designed and pre-test corrected open eye injury questionnaire on epidemiological characteristics was used (see **Addendum**). The questionnaire includes patient name, sex, age, occupation, injury time, treatment time, the type of material injury, causes of injury, type of injury, injury area, operation time, preoperative vision and postoperative vision recovery and so on. Details can be found in the Attached file. The questionnaires were filled out by the specially trained researchers by asking patients or their families term by term to confirm no empty or missing items. The test-retest reliability was 0.92 and the actual measurement was 51,813 cases.

Statistical analysis

The data were input to Excel file, and then SPSS17.0 was used for descriptive analysis. The enumeration data were performed chi-square test and the test level was $P<0.05$.

Results

Open eye injury investigation report analysis

A total sample of 60,000 people was included in the investigation. 51,813 people received examination and the examination rate was 86.36%. There were 483 patients with open eye injury among 51,813 subjects, so the total prevalence rate was 0.93%. The age of those patients ranged from 3 to 79 years old, with 367 males (75.8%) and 116 females (24.2%). The male/female ration was 3.16:1.

Causes of open eye injury

According to the survey (**Table 1**), the majority of the occupation of 483 open eye injury was

Table 2. Postoperative factors affecting open eye injury

Relevant factors		Case number (case)	Improved number (case)	Improvement rate	χ^2	*P*
Age	<30 years old	174	121	69.54%	27.050	0.000
	30-50 years old	160	108	67.50%		
	≥50 years old	149	65	43.62%		
Operation time	<7 d	164	107	65.24%	13.013	0.001
	7-14 d	194	159	81.96%		
	≥14 d	125	93	74.40%		
Eye injury symptoms	Merger endophthalmitis	139	76	54.68%	0.511	0.917
	Vitreous hemorrhage	147	84	57.14%		
	Foreign body and vitreous hemorrhage	98	58	59.18%		
	Merge eye contents prolapse	99	57	57.58%		
Injured area	I and II zone	277	169	61.01%	22.261	0.000
	III zone	206	81	39.32%		
Nursing intervention	Intervention group	262	197	75.19%	27.088	0.000
	Control group	221	116	52.49%		
Preoperative visual acuity	≥0.1	175	151	86.29%	114.367	0.000
	<0.1	206	125	60.68%		
	NLP-HM	102	22	21.57%		
Preoperative retinal condition	No detachment	270	217	80.16%	14.031	0.000
	Detachment	213	139	65.26%		
Type of injury	Penetrating injury	132	89	67.42%	28.890	0.000
	Foreign bodies injury	181	111	61.33%		
	Contusion	96	61	63.54%		
	Rupture	74	23	31.08%		

workers and peasants, in which there were 128 workers, accounting for 26.50%; and 117 farmers, accounting for 24.22%, followed by students and preschool children. Open eye injury was mainly caused by sharp tools, explosives and blunt objects. After eye injury, 263 patients received treatment within 24 h; 125 patients saw the doctor after 24 h; and 95 patients consulted the doctor after one week of the injury. Additionally, open eye injury mostly occurred at the weekend and the occurrence rate reached 37.47%, while at other times it was substantially flat. Open eye injury occurred mostly in January and February, the ratio was 14.2% and 15.8%, followed by October, with a ration of 11.2%. This may have a great relationship with China's traditional festivals. The results showed that the reasons of the majority of open eye injury patients were related to their occupations and living environments. About one-fifth of the population of the region had a poor sense of treatment or restricted by medical conditions after eye injuries. Nearly 40% of the open eye injury resulted from the accidents in the leisure and entertainment or from staff involved in the service during holidays.

Factors affecting the postoperative visual acuity recovery of open eye injury patients

We analyzed related factors of open eye injury patients before and after surgery. As is shown in **Table 2**, effects of patient's age, operation time, the injured area, nursing intervention, preoperative visual acuity, as well as preoperative retinal condition and injury type on the recovery of postoperative visual acuity of open eye injury patients were more significant ($P<0.01$), while the impact of eye trauma symptoms on the recovery of postoperative visual acuity of open eye injury patients was not significant ($P>0.05$).

Problems and recommendations in the epidemiological analysis of open eye injury

Open eye injury survey in North China indicated that the main problems attributing to the high morbidity rate of open eye injury in this area were late hospitalization time, delayed treatment and weak awareness of medical treatment. In regard to these problems, we proposed corresponding recommendations. Details can be found in **Table 3**.

Table 3. Problems and related recommendations of open eye injury in North China

Main problems	Recommendations
Late treatment; delayed treatment, poor sense of medical treatment.	Local governments should be combined with hospitals to popularize the public safety knowledge, improve safety awareness, provide appropriate medical preferential policies and conduct liquid charity clinics or propagandas.
Workers occupy most among patients with open eye injury.	Government should guide all walks of life to carefully study vocational skills, be proficiency in equipment operating procedures and safety management, improve and perfect the system of labor protection.
Open eye injury occurs most in weekend.	Local government should be combined with higher authorities' policies and local characteristics, regulates security order, put into medical monitoring during the holidays; popularizes safety knowledge daily or before the holiday, propagates self knowledge of eye injury and improve the public awareness of self-protection.
Preoperative visual acuity, preoperative retinal conditions and the type of injury are factors affecting postoperative visual acuity recovery.	We should pay attention to vision protection in daily life. Local government and hospitals should do vision screening and guidance and enhance the enthusiasm of people to protect their eyesight. At the same time, hospitals should enhance training, improve skills in quick and exact determination of patient eye injury. People should correct their attitudes and actively cooperate with benefiting policies of the government.
About 1/2 of open eye injury patients are not received nursing intervention during the treatment, which affects the postoperative visual acuity recovery.	Hospitals should strengthen training and improve the understanding of the mental state of open eye injury patients, in order to develop both individualized and humane health care programs and deepen patients' correct understanding of their conditions, and comfort and encourage patients to establish the confidence to overcome the disease.

Discussion

Open eye injury has great impairment on vision, severe conditions of which will not only cause disability, but even lose the ability of work. Open eye injury is not just a medical problem, but also a serious social problem [8]. The study found that in North China the prevalence rate of open eye injury was 0.93%, which was much higher than the global annual prevalence rate of open eye injury ($810/10^5$) [9]. Therefore, the relevant departments need to be actively carried out appropriate policies and measures to improve the health status of the region. The study found that the injured reasons of patients were related to their occupations and living environments. Because of the poor sense of treatment or limited medical conditions after eye injuries, about one-fifth of the population of the region missed the best treatment period. The injury time of nearly 40% of open eye injury occurred at the weekend or during festival. The survey found that factors affecting the postoperative visual acuity recovery of open eye injury were patient's age, operation time, the injured area, nursing intervention, preoperative visual acuity, preoperative retinal conditions and the type of injury. Therefore, for these risk factors, appropriate preventive and treatment measures should be given to reduce the occurrence of open eye injury and accelerate postoperative recovery of visual acuity.

Health education

Carried out by nurses, health education is nursing profession characteristic activities to suit patients or healthy people. The core of health education is to help people establish the concept of health education and encourage people to consciously take measures in favor of health education [10]. Thus, we should vigorously propagate knowledge of open eye injury and make people understand the common causes and harms of eye injuries, master self knowledge so as to learn to protect themselves. This study found that the proportion of men and women with open eye injury was 3.16:1. Workers and peasants had a high incidence rate, followed by students and preschool children. In addition, eye injury occurred mostly on weekends or holidays, which coincided with Schmidseder E and Kanoff JM's findings [11, 12]. The reason for workers occupied a larger number in open eye injury may be the inadequate safety measures in some companies, coupled with the worker's own weak safety awareness and illegal operations, so that workers have become the high risk group of open eye injury [13, 14]. Most open eye injury can be prevented. According to the distribution of gender, occupation, time of onset of eye injury patients, we concluded that we should strengthen education on focus groups, popularize safe knowledge, disseminate eye injury hazards, enhance the safety production facilities and security protection awareness, improve and perfect the system of labor protection, prevent violence to minimize open eye injuries, reduce the assault incidents, and strictly manage hazardous goods, which requires the joint efforts of all sectors of society.

Psychological care

Open eye injury patients are usually unprepared for injuries, but after an injury patients often suffer fear, anxiety and other emotions due to the injured side of the visual impairment, loss of vision or facial appearance damage [15]. Therefore, hospitals should strengthen training and improve the understanding of the mental state of open eye injury patients, in order to develop both individualized and humane health care programs and deepen patients' correct understanding of their conditions. Nurses should quickly and actively make emergency measures, take the initiative to communicate with the patient, eliminate the fear of patients and help them build confidence in struggling with the disease. Psychological counseling should be performed according to patient age, education level and personality characteristics. The key to improve the quality of care is attaching importance to and carrying out good psychological care in clinical process [16]. The study also found that the improvement rate of nursing intervention group was 75.19%, significantly higher than that (52.49%) of the controls ($P<0.01$). Nurses should carry out psychological counseling depending on the patient's different psychological problems, comfort and encourage patients to build confidence in overcoming the disease to coordinate treatment and nursing. They can also guide patients to maintain optimistic mood, adhere to medication, maintain adequate sleep, eat light food with high vitamin content and avoid eating spicy food. Patients should adhere to a subsequent visit monthly. If a visual disturbance, eye swelling, eye pain and other conditions occurs, they should receive timely treatment to reduce the incidence of blindness.

Early diagnosis and timely surgery to recover the vision of open eye injury patients

Since the natural barrier cornea and eyelid are damaged, it is easy to cause infection. Early diagnosis is important in order to avoid serious consequences [17-19]. The results of this study indicated that patient age, operation time, the injured area, nursing intervention, preoperative visual acuity, preoperative retinal conditions and the type of injury were factors affecting the visual acuity recovery of open eye injury, which is agreed with reports from Gupta A [20], Farr AK [21] and Cardillo JA [22].

In rural areas, there are more eye injury patients, who receive treatment late, so timely treatment is the key to prevent eye injury. We should take advantage of the gradually established primary network of health care. Rural doctors should play the role in eye care, eye trauma prevention, preliminary diagnosis and transference. After eye injury occurs, in addition to patients' timely treatment, doctors should give meticulous treatment. Doctors should conduct close follow-up observations and timely treatment of complications to reduce sequelae according to the type, nature and extent of eye injury. Local governments should be combined with hospitals to popularize the public safety knowledge, improve safety awareness, provide appropriate medical preferential policies and conduct liquid charity clinics or propagandas.

To sum up, the causes and extents of open eye injury were closely related to their occupation, living environment and medical awareness after injury. Factors affecting visual acuity recovery of open eye injury were patient's age, operation time, the injured area, nursing intervention, preoperative visual acuity, preoperative retinal conditions and the type of injury. Therefore, according to the risk factors, related hospitals in North China should increase safety awareness and promote professional skills of health care workers under guidelines of the government, in order to reduce open eye injury, speed up the recovery of visual acuity of patients in the area and provide theoretical basis for the social and public health management to some extent.

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Disclosure of conflict of interest

None.

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Addendum

Open eye injury epidemiological questionnaire

No. _____ Investigator: _____ Investigation time:_____

Name _____ Gender _____ Age_____

Home add_____County (District)_____Town____Village

Occupation: □ Worker □ Farmer □ Student □ Preschool child □ Housewife □ No occupation

Open eye injury prevalence: □ Yes □ No

Sick time: _____

Injury time: □ Monday □ Tuesday □ Wednesday □ Thursday □ Friday □ Saturday □ Sunday

Injury month: □ January □ February □ March □ April □ May □ June □ July □ August □ September □ October □ November □ December

Visiting time: □ Within 24 h □ After 24 h □ After one week

Causes of illness: □ Sharp tools □ Explosives □ Blunt objects

Operation time: □ <7 d □ 7-14 d □ ≥14 d

Preoperative visual acuity: □ ≥0.1 □ <0.1 □ NLP-HM

Preoperative retina: □ Ablatio □ No ablatio

The injured area: □ I zone □ II zone □ III zone

Injury type: □ Penetrating injury □ Foreign bodies injury □ Contusion □ Rupture

Eye injury symptoms: □ Merger endophthalmitis □ Vitreous hemorrhage □ Foreign body and vitreous hemorrhage □ Merge eye contents prolapse

Nursing intervention: □ Yes □ No

Postoperative visual acuity recovery situation: □ Better □ Not improved