

# Ocular Trauma Pattern in the North Bund Area of Shanghai Pinpoints Risk Factors and Predicts Visual Outcomes

**Jian Zhang**

Shanghai Jiao Tong University School of Medicine

**Shimei Chen**

Shanghai Jiao Tong University School of Medicine

**Yan Suo**

Shanghai Jiao Tong University School of Medicine

**Xieyi Yao**

Shanghai Jiao Tong University School of Medicine

**Fang Wei**

Shanghai Jiao Tong University School of Medicine

**Fenge Chen** (✉ [FengE\\_2019@126.com](mailto:FengE_2019@126.com))

Shanghai Jiao Tong University <https://orcid.org/0000-0001-7329-2903>

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## Research article

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# Abstract

**Background:** To identify the ocular trauma pattern in the north Bund area of Shanghai.

**Methods:** This is a retrospective, cross-sectional study. Patients between January 2016 and December 2018 with trauma in one eye and being hospitalized for at least one day in Shanghai General Hospital were selected in this study. All patients received first evaluation at the emergency room, followed by careful eye examination by one of attending ophthalmologists and reevaluation by one of the authors. Demographics and related patient's clinical data at the time when trauma occurred were recorded, including age, gender, occupation, cause and type of trauma, location and size of injury, type of surgery, and hospitalization time.

**Results:** 206 patients were reviewed. We found that gender and age are two mutually correlated risk factors for ocular trauma. We also identified occupation as a major risk factor, which is closely associated with penetrating/ intraocular foreign body injuries. Moreover, season change adds an additional layer of risk factor for ocular trauma, showing a significantly higher peak of ocular trauma percentage in hot summer months. Furthermore, retinal detachment and vitreous hemorrhage were identified as two prevailed types of complications. Importantly, we found that complications, along with location and/or size of injuries, determine the visual outcomes.

**Conclusions:** We identified a clear ocular trauma pattern in the north Bund area of Shanghai. Importantly, complications, location and/or size of injuries determine the visual outcomes. Our findings pinpoint risk factors for ocular trauma, which predict visual outcomes and might be further applied in eye injury prevention.

## Background

Blindness is one of the top public health issues worldwide that has profound socioeconomic and psychological impacts on patients and their families. It is estimated that ocular trauma contributes to about 0.5 million new blind peoples every year. The number of blind peoples will increase to 76 million in 2020 if no effective preventive actions are taken, which could be worse in developing countries [1].

As the leading cause of blindness, ocular trauma accounts for the major event for patients' visits in ophthalmology emergency room and ocular out-patient office. Previous studies have shown that the percentage of hospitalized eye injury is between 6.5 and 27.7 per 100,000 populations annually in developing countries [2, 3]. One of the programs led by WHO aiming at blindness prevention indicates that about 55 million ocular injuries cause restricted activities for more than one day per year. Among these patients, 0.75 million need hospitalization every year, and 1.6 million become blind owing to the severity of ocular traumas. In total, nearly 19 million people become blind unilaterally or with low vision eventually [4]. In addition to the financial burden that ocular traumas cause, it severely affects a patient's life quality. For example, the risk of being blind and the possibility of ophthalmectomy always put the patients and their families under much inconvenience and huge stresses, and therefore inevitably lower

their life quality. Fortunately, ocular traumas are preventable in majority of cases, which could be further improved if the traumas pattern has been identified.

Shanghai, an international metropolis, has witnessed her own miracle at an amazing high-speed and high-efficiency growth in recent years, becoming an important global economic hub and financial center. As of June 2017, more than four and half million immigrant workers were registered in Shanghai, and about 65% of them didn't have college degree. The immigrant labor population was more than doubled and reached 9.7 million as of the end of 2018, according to the 2018 Census (published in [sohu.com](http://sohu.com)). Such a situation increases the risk of ocular trauma in an intensive laboring working environment. However, the ocular trauma pattern has rarely been investigated so far, resulting in a poor situation in eye injury prevention that fails to keep pace with the advancement in health care in Shanghai. Shanghai General Hospital, the largest health care center for ocular disease treatment in the north Bund area of Shanghai, is located in the central urban area of Shanghai, Houkou district, which has about 800,000 native residents, and about 150,000 immigrant workers. The hospital not only serves the residents in this area, but also serves patients in the whole city and elsewhere in the country, including millions of floating workers in the urban areas of Shanghai. In this study, we analyzed a cohort of 206 ocular traumas patients in Shanghai General Hospital between January 2016 and December 2018, aiming to identify the ocular trauma pattern in this area, which could be useful for visual outcome prediction and eye injury prevention.

## Methods

This is a retrospective, cross-sectional study to analyze the ocular trauma pattern in hospitalized patients between January 2016 and December 2018 in the department of ophthalmology at Shanghai General Hospital. All research activities were performed in adherence to the Declaration of Helsinki and approved by the Research Council and the Research Ethics Committee of Shanghai General Hospital

Patients who had traumas in one eye and being hospitalized for at least one day were selected in this study. None of the patients had a multi-system trauma. All enrolled patients received first evaluation at the emergency room, followed by careful eye examination by one of attending ophthalmologists and reevaluation by one of the authors. Demographics and related patient's clinical data at the time when trauma occurred were recorded, including age, gender, occupation related population, cause and type of traumas, type of globe injuries, location and size of injury, type of surgery, and hospitalization time. Pieramici's standard classification was adopted for classifying the types of ocular traumas [5]. The trauma details were further classified into three groups according to the wound size (in mm): group 1  $\leq 5$  mm, 5mm < group 2 10 mm, and group 3 10mm, with an additional blunt injury group.

The grade and condition of eyeball injury is based on the visual condition of the initial examination after the injury. All patients were examined using the standard logarithmic vision acuity (VA) chart, and the best VA for each patient was recorded. VA score was divided into the following four levels: level I  $\geq 0.3$ , 0.05  $\leq$  level II < 0.3, light perception (LP) level III < 0.05, and level IV = no light perception (NLP). The VA score of

each patient at the first visit at the emergency room was recorded as initial VA. After surgeries or treatments were conducted on the first visit, all the patients included in this study had three follow up visits: one week, one month, and three months. Because usually patient's visual function gets stable around three months after surgery, we chose three months as follow-up period after surgery to record final VA.

Wound locations were classified into three zones according to the Ocular Trauma Classification Group [6]: 1) Zone I, injuries involved only cornea and limbus; 2) Zone II, injuries were confined to the anterior 5 mm from the limbus (no retina involved); and 3) Zone III, injuries extended into the posterior by more than 5 mm from the limbus. In cases of multiple corneoscleral wounds, the zone was defined according to the most posterior openings. In cases of intraocular foreign bodies (IOFBs), the zone was defined at the specific entry spot. For perforating wounds caused by explosive accidents during firework display, however, the zone was defined by the most posterior spot, usually the exit site. Most of the injuries were classified into a specific zone at the time of the initial examination, unless in some cases, the wounds had to be more precisely determined during the surgical exploration.

Complications can be directly or indirectly caused by trauma. As previously reported, lens dislocation, vitreous hemorrhage (VH), retinal detachment (RD), and traumatic endophthalmitis are four common complications [6]. Thus, these four types of complications were also chosen in this study and were recorded and estimated as vital factors related to the visual outcomes.

*Statistical analysis:* The data were collected and analyzed basing on the influences of the gender, age, occupation, season, VA, mechanism of trauma, and the complications as well. Statistical analyses and graphs were carried out using GraphPad Prism 7 software. Chi-square test was used to compare the impact of categorical variables on the occurrence of ocular trauma and visual outcomes, including gender, occupation, location and size of eye injury. One-way ANOVA was used to compare the impact of seasonal change on the occurrence of ocular trauma. Descriptive statistics include case numbers, and percentage (%). In general, the percentage was calculated by the formula: % = (group case number/total case number 206)\*100, if it's not specified. For the percentage regarding gender within the same group, or the percentage of NLP in the same zone injury or wound size group, the percentage was calculated by the formula: % = (gender or NLP case number in the group/total group case number)\*100. P < 0.05 was considered significant.

## Results

# Gender and age are two mutually correlated major risk factors for ocular trauma

Totally, 206 patients were reviewed at Shanghai General Hospital between January 2016 and December 2018. Of 206 patients, 198 patients (96.12%) were admitted to hospital, and 168 patients (81.55%) received surgical treatment within the first 24 hours of trauma. We found that 182 out of 206 patients

(88.35%) were males (Table 1). In the category of blue-collar worker population, none of ocular trauma patients is female but all are males (Table 1, Fig.1A & B), indicating that gender is a risk factor for ocular trauma. Further analysis revealed that gender significantly affects the type of traumas, as male patients account for the majority of the ocular traumas caused by sharp objects: 69 cases with IOFBs, and 69 penetrating injury cases without IOFBs (Table 1&2). In contrast, only 1 female student had penetrating injury, and none of the females had IOFB injury (Table 1&2).

Next, we found that the gender difference in ocular trauma percentage is closely associated with age (Table 1, Fig. 1A). The mean age of the patients was  $49.32 \pm 19.00$  years old (y/o), with majority of patients (46.12%) falling into 40~60 y/o age group. However, in 40~60 y/o group, of 95 patients, 91 patients are males (95.8%), only 4 patients are females (4.2%) (Table 1). The gender difference also appeared in other age groups except for the child group, which only includes three cases (Table 1, Fig.1A). Thus, we identified gender and age as two mutually correlated major risk factors for ocular trauma.

## Occupation and penetrating/IOFB injuries

Of 206 patients, 121 cases (58.74%) in our study cohort were blue-collar workers (Table 1), which belongs to the population consisting of millions of immigrant workers in Shanghai. However, eye injuries were much less in those people whose occupation is not involving manual labor job, such as students, teachers, and retirees, etc., underscoring occupation as a risk factor for ocular trauma, although it does not apply to farmers who may rarely expose their eyes to the risk environment in this study (Table 1). Based on this observation, we assume that occupation, in particular manual labor job, might be associated with types of ocular trauma.

It came to our attention that the largest proportion of ocular traumas was penetrating (34.95%) and IOFB injuries (33.5%), followed by contusion (22.33%), perforating injuries (6.31%), and a small portion of rupture (2.91%) (Table 2). Further analysis showed that majority of the penetrating/IOFB injuries occurred in the category of blue-collar worker population, with 49 penetrating injury cases and 64 IOFB injury cases, respectively (Table 1). However, only few cases of penetrating/IOFB injuries occurred in other occupation related population, such as farmer and office clerk (Table 1). Our data suggest that penetrating/IOFB injuries are two major types of occupation related ocular traumas, which more frequently occur in the blue-collar population. Luckily, all patients with IOFB injury received surgeries to remove the IOFBs successfully for better visual outcomes.

## Season change adds an additional layer of risk factor to ocular trauma incidents

We also investigated the role of season change in ocular trauma pattern to determine if it also acts as a risk factor. Indeed, ocular trauma percentage exhibited a seasonal pattern, as hot summer months

between June and September reached the peak with a significantly higher average ocular trauma percentage compared to other seasons (Fig.1C). Totally there were 66 cases occurred in summer season between January 2016 and December 2018, which accounts for 32% of ocular trauma incidents in three years (Table 3).

## **RD and VH are two prevailed types of complications**

Complications of RD, VH, lens dislocation and endophthalmitis are closely associated with final visual acuity [6]. In this study we also chose to focus on these four types of ocular trauma related complications. We found that RD and VH are two major types of complications in our study cohort, which accounts for 10.19% and 8.74% of ocular trauma incidents, respectively, whereas both lens dislocation (3.88%) and traumatic endophthalmitis (1.46%) only occurred in a small portion of patients (Table 4). Extraction of dislocated lens was performed in all the 8 lens dislocation cases (3.88%) (Table 4). For patients with any type of RD, VH, and traumatic endophthalmitis, PPV had to be performed to obtain better visual outcomes either during the first hospitalization period or the follow-up period. None of the patients received enucleation as the primary procedure.

## **Location and/or size of injuries determine the vision outcomes**

To further understand how injuries may affect the visual outcomes, we analyzed the impact of the location and/or size of injuries on the visual outcomes. We found that most of the injuries are located in the zone I (38.83%), followed by 22.33% of the patients in zone II and 17.96% of the patients in zone III, which is also reflected in wound size with similar percentage, although some patients had overlapping in injury zones and wound sizes (Table 4, Fig. 1D&E). Patients with zones I and II injuries have relative benign visual outcomes and low NLP percentage (6.25% for zone 1 injury, and 6.52% for zone II injury, respectively), which is also true for patients with wound size smaller than 10mm (0% in group 1 patients, and 14.89% in group 2 patients, respectively)(Table 4). However, patients with zone III injury and/or wound size larger than 10mm exhibited poor prognosis with much higher NLP percentage. NLP percentage reached 83.78% in patients with zone III injury, and 72.5% in patients with group 3 injury (Table 4), suggesting that location and/or wound size significantly affect the visual outcomes, in particular NLP, which is a sign of blindness (Table 4).

The correlation between zone/wound size and visual outcomes was strongly supported by the patients' data in this study. VA is typically used for vision measurement in ocular trauma patients, with level I as the best, and level 4 as the worst. 51.46% of the patients were classified to Level III according to the initial VA, and all level IV patients exhibited either zone III injury or  $\geq 10$ mm wound size injury (Table 5). Corneal scarring is one of the reasons that causes low vision, depending on the size and location of the scarring. We found that 45 cases who had corneal scarring that caused low vision at different degrees. Among

them, 13 patients showed NLP as final VA. All 13 patients had severe corneal injuries with group 3 wound size (10 mm). The other 32 patients had less severe corneal scarring and showed slightly better final VA score, since they all had group 2 wound size (larger than 5mm, but less than 10mm) (Table 4 &5). In addition, one patient who had zone II injury with 7mm wound size converted to NLP at the end of third month, which was caused endophthalmitis due to infection (Table 5). For most other conditions, however, the visual outcomes were promising after treatment. All the IOFBs were successfully removed through surgeries according to the different segments involved. Three months later, most of the patients had a better final VA to varying degrees except for level IV patients (Table 5, Fig. 1F).

## Discussion

Over decades, Shanghai has witnessed her own rise as an international metropolis at an amazing growth speed, becoming one of the greatest global economic and financial centers in the world. A notable change is the quick increase of the immigrant labor population in Shanghai, from 4.5 million in 2017 to 9.7 million in 2018 within a year or so. Majority of the immigrant labors are engaged in manual work, which brings new challenges in public health service due to lack of higher education and safety consciousness. One such a challenge is an increased ocular trauma percentage in recent years. Similar to other trauma, ocular trauma imposes heavy health, economic, and social burdens on patients' families, communities and the government. However, majority of those injuries are preventable if the injury pattern is well recognized [7].

In this study, we were able to identify a clear ocular trauma pattern by analyzing a cohort containing 206 ocular trauma patients, which includes four risk factors, two major type of traumas, and two prevailed types of complications as well. We found that gender and age are two mutually correlated major risk factors for ocular trauma, since majority of the patients are young and middle-aged males. The male predominance exhibited in our study cohort is consistent with previous studies [8–12], which also indicates that males probably have more chances of being exposed to dangerous situations during work or outdoor activities [13, 14]. Meanwhile, as an inconceivable factor, age often determines an individual's response, judgment and safety consciousness when involving in physical activities. It has been shown that younger people tend to participate in risky activities with lack of supervision and coaching [15]. In line with this finding, we also found that youths are a high-risk population, which accounts for 25.72% of ocular trauma percentage in this study cohort. However, we found that the riskiest age group in our study falls into 40–60 y/o group. The discrepancy may reflect the lack of young people in the labor market nowadays. The higher prevalence of ocular trauma incidents among middle aged population is consistent with previous epidemiological studies on the eye injuries in both China and India [2, 16].

Occupation is another major risk factor for ocular trauma, in particular for those people whose job requires intensive manual labor in industrial fields. However, previous studies have suggested that the area where people live or work, and life style and social culture could either enhance or dampen the impact of occupation on ocular trauma percentage [8, 9, 17, 18]. A previous study reported that road traffic accidents in India account for the maximum cases of ocular trauma, followed by sports, games,

and other recreational activities [19]. In contrast, we found that majority eye injuries in our study cohort were happened at workplaces. Thus, our findings, along with others, suggest that lifestyle and culture may modulate the impact of occupation on ocular trauma occurrence differently.

Season change adds an additional risk factor to ocular trauma percentage. A previous study suggested that traumas were more likely to occur during warmer periods of a year, and that this effect was more significant in self-employed handicraft worker compared to nine-to-fiver.[20] Similarly, we found that the ocular trauma percentage is significantly increased in the summer months. We reasoned that number of factors could be attributable to increased ocular traumas during summer months, such as increased outdoor activities, overtime work, and quarrel or fight after alcohol consumption, and so on [21, 22].

Penetrating /IOFB injuries by sharp object are two major types of the ocular traumas in our study, which is consistent with previous studies showing that traumas are frequently caused by sharp objects following collisions [19, 20, 23, 24]. Importantly, we found that penetrating/IOFB injury are two major types of occupation related ocular traumas, as we observed a significant difference in several occupation groups regarding the types of ocular traumas. In patients whose occupation are blue-collar workers, most of the penetrating/IOFB injuries occurred in their workplaces. In contrast, in patients whose occupation are white-collar professionals, traumas mostly happened when engaged in sport activities or traffic accidents. This observation strongly suggests that blue-collar workers require high standard of self-protection.

Complications are closely associated with visual outcomes. It has been reported that RD, VH, lens dislocation and endophthalmitis are poor prognostic factors correlated with final visual acuity [6]. Therefore, complications have to be treated carefully. In this study, different surgeries were performed according to different situations of the patients. Meanwhile, antibiotics were applied appropriately to all the patients with open-globe injuries, especially to the patients with IOFBs. These personalized treatments provided best chances for our patients to achieve better final VA. Nevertheless, given the results of our study, traumatic endophthalmitis should also be considered as a poor prognostic factor, as one patient with less severe ocular trauma in our study cohort became blind due to bacterial toxic effect on the retina. For the patients who underwent extraction of dislocated lens, secondary intraocular lens implantation was strongly recommended for better VA achievement when the intraocular environment reached stabilization after three months.

Our study further revealed that location and/or wound size of injuries also determine the severity of ocular traumas. The VA outcomes of zone I and zone II injuries are significantly better than those zones III injuries ( $p < 0.0001$ ). Similarly, patients with wound size smaller than 10mm have better final VA compared to those with larger than 10mm openings in the globe. In addition, larger wound size may also give rise to severe corneal scarring that causes low vision. Thus, zone III and/or group 3 eye injuries are considered as significant poor prognostic factors for visual outcome [5]. Since our study revealed that majority of the ocular traumas is work related, safety precautions and wearing proper PPE are on the highest priority for

those high-risky populations. Further studies are necessary for better understanding the importance of compliance with eye protection regulations.

## Conclusions

We identified a clear ocular trauma pattern in the north Bund area of Shanghai. Importantly, complications, location and/or size of injuries determine the visual outcomes. Our findings pinpoint risk factors for ocular trauma, which predict visual outcomes and might be further applied in eye injury prevention.

## List Of Abbreviations

VA, vision acuity; LP, light perception; NLP, no light perception; IOFBs, intraocular foreign bodies; VH, vitreous hemorrhage; RD, retinal detachment; y/o, years old; PPV, Pars plana vitrectomy; PPE, personal protection equipment.

## Declarations

*Ethics approval and consent to participate:* This study was approved by the Research Council and the Research Ethics Committee of Shanghai General Hospital. All the patients consented to participate in this study. Written informed consent was obtained from all participants.

*Consent for publication:* Not applicable.

*Availability of data and materials:* The datasets generated and/or analyzed during the current study are available in the repository of Department of Ophthalmology, Shanghai general Hospital. The datasets and/or analyzed during the current study are available from the corresponding author upon reasonable request.

*Competing interests:* The authors confirm that this article content has no conflict of interest.

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*Authors' contribution:* J. Z., F. W. and F. C. conceived the project. J. Z. wrote the manuscript, J. Z. and S. C. analyzed the data. J. Z., S. C., Y. S., X. Y., F. W., and F. C. performed ocular trauma reevaluation.

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## Tables

**Table 1. Demographics of ocular trauma patients**

Category	Case number (n)	Percentage (%)
Male (M)	182	88.35
Female (F)	24	11.65
Hospitalized within the first 24 hours of trauma	198	96.12
Surgery received	168	81.55
Hospitalized after 24 hours of trauma	8	3.88
<b>Age (y/o)</b>		
0-7	3 (1 <sup>a</sup> , 2 <sup>b</sup> )	1.46 (33.3 <sup>a</sup> , 66.7 <sup>b</sup> )
8-18	5 (4 <sup>a</sup> , 1 <sup>b</sup> )	2.43 (80 <sup>a</sup> , 20 <sup>b</sup> )
19-39	53 (52 <sup>a</sup> , 1 <sup>b</sup> )	25.72 (98.1 <sup>a</sup> , 1.9 <sup>b</sup> )
40-60	95 (91 <sup>a</sup> , 4 <sup>b</sup> )	46.12 (95.8 <sup>a</sup> , 4.2 <sup>b</sup> )
≥60	50 (34 <sup>a</sup> , 16 <sup>b</sup> )	24.27 (68 <sup>a</sup> , 32 <sup>b</sup> )
<b>Population</b>		
Child	3 (1 <sup>a</sup> , 2 <sup>b</sup> )	1.46 (33.3 <sup>a</sup> , 66.7 <sup>b</sup> )
Student	5 (4 <sup>a</sup> , 1 <sup>bc</sup> , 2 <sup>ac</sup> , 2 <sup>ad</sup> )	2.43 (80 <sup>a</sup> , 20 <sup>b</sup> )
Blue-collar worker	121 (121 <sup>a</sup> , 0 <sup>b</sup> , 49 <sup>c</sup> , 64 <sup>d</sup> )	58.74 (100 <sup>a</sup> , 0 <sup>b</sup> , 34.95 <sup>c</sup> )
Farmer	8 (8 <sup>a</sup> , 0 <sup>b</sup> , 7 <sup>c</sup> , 1 <sup>d</sup> )	3.88
Retiree	58 (42 <sup>a</sup> , 16 <sup>b</sup> , 7 <sup>ac</sup> , 2 <sup>ad</sup> )	28.16 (72.4 <sup>a</sup> , 27.6 <sup>b</sup> )
Office clerk	11 (6 <sup>a</sup> , 5 <sup>b</sup> , 4 <sup>ac</sup> )	5.33 (54.5 <sup>a</sup> , 45.5 <sup>b</sup> )

a, male; b, female; c, penetrating injury; d, IOFB

**Table 2. Ocular trauma distribution by damaging means and ocular trauma type**

Damaging means		Cases	Percentage (%)
During work		111 (111 <sup>a</sup> , 0 <sup>b</sup> )	53.88
Road accident		34 (24 <sup>a</sup> , 10 <sup>b</sup> )	16.5
Explosive accident		13 (9 <sup>a</sup> , 4 <sup>b</sup> )	6.31
Quarrel and fight		40 (30 <sup>a</sup> , 10 <sup>b</sup> )	19.42
During a game or sport		8 (8 <sup>a</sup> , 0 <sup>b</sup> )	3.88
Type of trauma			
Open globe injuries	Penetrating (IOFB-free, caused by sharp object))	72 (69 <sup>a</sup> , 3 <sup>b</sup> )	34.95
	IOFB (Caused by sharp object)	69 (69 <sup>a</sup> , 0 <sup>b</sup> )	33.50
	Perforating (Caused by explosive accidents, such as firework)	13 (9 <sup>a</sup> , 4 <sup>b</sup> )	6.31
	Rupture	6 (3 <sup>a</sup> , 3 <sup>b</sup> )	2.91
Closed globe injuries	Contusion (Caused by blunt object)	46 (32 <sup>a</sup> , 14 <sup>b</sup> )	22.33

a: Male; b: Female

**Table 3. Seasonal pattern of ocular trauma**

Season	Month	Case number (n)	%*	%#
Winter	January	15	7.3	18.4
	February	15	7.3	
Spring	March	16	7.8	24.3
	April	20	9.71	
	May	14	6.81	
Summer	June	18	8.74	32
	July	26	12.62	
	August	22	10.68	
Fall	September	28	13.59	25.2
	October	14	6.81	
	November	10	4.85	
Winter	December	8	3.88	

\*percentage by month; #, percentage by season. Data were calculated from three years.

**Table 4. Ocular trauma complications, wound location and size**

	Case number (n)	Percentage (%)
<b>Complications</b>		
Lens dislocation	8	3.88
RD	21	10.19
VH	18	8.74
Endophthalmitis	3	1.46
<b>Locations</b>		
Zone I	80 (5 <sup>a</sup> )	38.83 (6.25 <sup>a</sup> )
Zone II	46 (3 <sup>a</sup> )	22.33 (6.52 <sup>a</sup> )
Zone III	37 (31 <sup>a#</sup> )	17.96 (83.78 <sup>a</sup> )
<b>Wound size</b>		
Group 1 ≤ 5mm	76 (0 <sup>a</sup> )	36.89 (0 <sup>a</sup> )
5 < Group 2 < 10 mm	47 (7 <sup>a</sup> , 32 <sup>b</sup> )	22.82 (14.89 <sup>a</sup> )
Group 3 ≥ 10 mm	40 (29 <sup>a#</sup> , 13 <sup>c</sup> )	19.42 (72.5 <sup>a</sup> )

a, NLP; #, 18 of the patients who have zone III trauma also have wound size larger than 10mm.

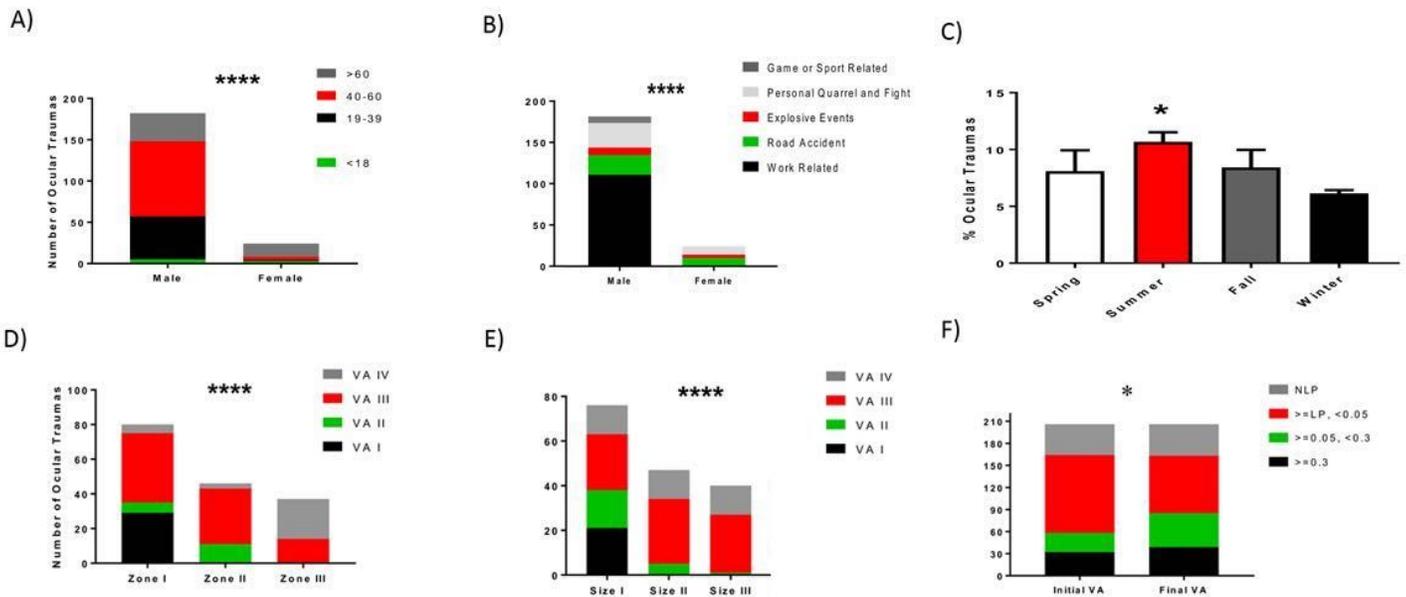
b, patients with minor corneal scarring showed slightly better final VA; c, patients have severe corneal scarring that causes low vision.

**Table 5. Percent vision acuity in ocular trauma patients**

VA score	Initial VA		Final VA	
	n	%	n	%
Level I $\geq 0.3$	32 (0 <sup>a</sup> )	15.53	39	18.93
$0.05 \leq$ Level II $< 0.3$	26 (1 <sup>a</sup> )	12.62	46	22.33
LP $\leq$ Level III $< 0.05$	106 (10 <sup>ab</sup> )	51.46	78	37.86
Level IV = NLP	42 (29 <sup>a</sup> , 3 <sup>b</sup> )	20.39	42+1 <sup>c</sup>	20.87

n: case number; %: Ocular trauma percentage; a, wound size  $\leq 10$ mm; b, patients have severe corneal scarring; c, this patient who had zone II injury with 7mm wound size developed NLP caused by endophthalmitis.

## Figures



**Figure 1**

Ocular trauma pattern in the North Bund Area of Shanghai. A) Ocular trauma percentage is related to both age and gender. B) Occupation and ocular trauma. C) Average yearly seasonal ocular trauma percentage comparison. Spring: March, April, and May; Summer: June, July, and August; Fall: September, October,

and November; Winter: January, February, and December. D) Ocular trauma location determines the vision outcomes. E) Injury size affects vision significantly. F) Comparison of vision before and after 3-month treatment. \*,  $p < 0.05$ , one-way ANOVA ( $n=3$ ) for C); \*\*\*\*,  $p < 0.0001$ , chi-square test for all other statistical analysis.