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

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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 injury. Moreover, season change adds an additional layer of risk factor for ocular trauma, showing a significantly higher peak of ocular trauma incidence in hot summer months. Furthermore, RD and VH 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 incidence 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.

Unavoidably, millions of people lacking higher education and safety consciousness pour into this city for job opportunities. Such a situation increases the risk of ocular trauma in an intensive laboring working environment, leading to a strong demand for eye injury prevention. However, the ocular trauma pattern in this area remains unknown, which makes it difficult to have a better eye injury prevention strategy. In this study, we analyzed a cohort of 206 ocular traumas patients in Shanghai General Hospital, the largest health care center for ocular disease treatment in the north Bund area of Shanghai, 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 have traumas in one eye and being hospitalized for at least one day were selected in this study. 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, cause and type of trauma, location and size of injury, type of surgery, and hospitalization time. The trauma details were further classified into three groups according to the wound size (in mm): group 1 $\leq$ 5 mm, 5mm < group 2 $\leq$10 mm, and group 3 $\geq$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 and was recorded as final VA at the time of follow-up visit three months later.

Wound locations were classified into three zones according to the Ocular Trauma Classification Group [5]: 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, 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.

Compliments can be directly or indirectly caused by trauma. We focused on four most common ones: lens dislocation, vitreous hemorrhage (VH), retinal detachment (RD), and traumatic endophthalmitis. They 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. One-way ANOVA and chi-square test were performed. Descriptive statistics include means ± standard deviations, and incidence (%). Incidence was calculated by the formula: % = (group case number/total 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. 96.12% of the patients were admitted to hospital and took the surgical treatment within the first 24 hours of trauma. Interestingly, majority of the patients were males (88.35%) (Table 1). In the occupation category, we found that most of the male patients are workers; however, none of ocular trauma patients in this group is female (Table 1, Fig.1A & B). By analyzing the type of ocular traumas, we further found that gender significantly affects the trauma incidence. Male patients account for the majority of the ocular trauma incidence caused by penetrating injury (33.5% with IOFBs, and 34.95% without IOFBs). In contrast, only small portion of the female patients had such type of injury (Table 1).

Next, we found that the gender difference in ocular trauma incidence is closely associated with age (Table 1, Fig. 1A). The mean age of the patients was 49.32 ± 19.00 years old (y/o). Not surprisingly, majority of patients (46.12%) fell into 40~60 y/o age group. However, among 40~60 y/o group, male patients account for 44.2%, whereas female patients only account for 1.9% of total patients (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 injury

Of 206 patients, 58.74% of ocular trauma patients in our study cohort were workers engaged in the field of manual, industrial and decoration settings (Table 1). However, eye injuries were rarely seen in those people whose occupation does not require intensive manual labor, such as students, teachers, and retirees, etc., underscoring occupation as a remarkable 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).

Since occupation is closely linked to ocular trauma incidence, we then analyzed types of injuries that may contribute to occupation related ocular trauma. We found that more than half of patients who are workers had penetrating injuries (77 of 121 worker patients, Table 1), suggesting that penetrating injury is a major type of occupation related ocular traumas. Indeed, the largest proportion of ocular traumas was penetrating injury (71.36%), followed by blunt injury (22.33%) and explosive injury (11.17%), respectively (Table 1). This is also true for the kids and students, as the major type of traumas for this age group is also penetrating injury caused by pencil or scissors (5 of 8 cases) (Table 1, and data not shown). Of 147 penetrating cases, 69 patients with IOFBs (33.50%) underwent surgeries to remove all the IOFBs successfully for better visual outcomes (Table 2).

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 incidence exhibited a seasonal pattern, as hot summer months between June and September reached the peak with a significantly higher average ocular trauma incidence compared to other seasons (Fig.1C). Totally there were 94 cases (45.63%, p=0.0170) 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 often occur in ocular trauma patients, which is associated with visual outcomes. It also increases medical cost. In this study we chose to focus on four types of ocular trauma related complications. We found that RD and VH are two common types of complications in ocular trauma patients, which accounts for 10.19% and 8.74% of ocular trauma incidents, respectively, whereas both lens dislocation (3.88%) and traumatic endothphalmitis (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 endothphalmitis, PPV had to be performed to obtain better visual outcomes either during the first hospitalization or at the follow-up visit within 3 months for a second time surgery. 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 incidence, 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, which is also true for patients with wound size smaller than 10mm. However, patients with zone III injury and/or wound size larger than 10mm exhibited poor prognosis, suggesting that location and/or wound size significantly affect the visual outcomes. Most of the patients with zone III injuries and/or wound size larger than 10mm openings in the globe had NLP, 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 ≥10mm wound size injury (Table 5). Unfortunately, one patient who had zone II injury with 7mm wound size converted to NLP at the end of third month, which was caused by endophthalmitis (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. The dramatic change made in this city generates numerous opportunities in every aspects of people's life, in particular, job opportunities. Yet it also brings new challenges in public health service. One such a challenge is an increased ocular trauma incidence 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 [6].

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, a major type of trauma, 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 [7-11], which also indicates that males probably have more chances of being exposed to dangerous situations during work or outdoor activities [12, 13]. 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 [14]. In line with this finding, we also found that youths are a high-risk population, which accounts for 25.7% of ocular trauma incidence 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, 15].

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 incidence [7, 8, 16, 17]. 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 [18]. In contrast, we found that majority eye injuries in our study cohort were happened at workplaces. Thus, our findings, along with others, suggest that life style and culture may modulate the impact of occupation on ocular trauma occurrence differently.

Season change adds an additional risk factor to ocular trauma incidence. 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.[19] Similarly, we found that the ocular trauma incidence 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 [20, 21].

Penetrating injury by sharp tools is the major type of the ocular traumas in our study, which is consistent with previous studies showing that traumas are frequently caused by sharp objects following collisions [18, 19, 22, 23]. Importantly, we found that penetrating injury is a major type 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 injuries happened 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 both RD and VH were poor prognostic factors for visual outcomes, even if PPV was performed [5]. 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 (group 3 injuries, Table 5). Thus, zone III and/or group 3 eye injuries are considered as significant poor prognostic factors for visual outcome [24]. 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.

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.

Consent for publication: All the listed authors consented for publication.

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

Gender	**Case number (n)**	**Incidence (%)**	***p* value**
Male (M)	182	88.35	
Female (F)	24	11.65	
Hospitalized within first 24hrs			
Hospitalized	198	96.12	
Not hospitalized	8	3.88	
Age (y/o)			
0-7	3 (1[a], 2[b])	1.46 (0.48[a], 0.97[b])	
8-18	5 (4[a], 1[b])	2.43 (1.9[a], 0.48[b])	
19-39	53 (52[a], 1[b])	25.72 (25.2[a], 0.48[b])	
40-60	95 (91[a], 4[b])	46.12 (44.2[a], 1.9[b])	
▯60	50 (34[a], 16[b])	24.27 (16.5[a],7.8[b])	$p<0.0001$
Occupation			
Child	3 (1[a], 2[b])	1.46 (0.48[a], 0.97[b])	
Student	5 (4[a], 1[b])	2.43 (1.9[a], 0.48[b])	
Manual or industrial worker	121 (121[a], 0[b], 77[c])	58.74 (37.38[c])	
Farmer	8 (8[a], 0[b])	3.88	
Retiree	58 (42[a], 16[b])	28.16 (20.4[a], 7.8[b])	
Other	11 (6[a], 5[b])	5.33 (2.9[a], 2.4[b])	

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

Table 2. Ocular trauma incidence by damaging means and ocular trauma type

Damaging means			
During work	111	53.88	p=0.000 (all male)
Road accident	34	16.5	
Explosive events	13	6.31	
Quarrel and fight	40	19.42	
During a game or sport	8	3.88	
Type of trauma			
Penetrating	Total 147	71.36	
	IOFBs 69	IOFBs 33.50	
	Male: 69 Female: 0	Male: 33.5 Female: 0	
	IOFBs-free 78	IOFBs-free 37.86	
	Male: 72 Female: 6	Male: 34.95 Female: 2.01	
Blunt	Total 46	22.33	
	Male: 32 Female: 14	Male: 15.53 Female: 6.80	
Explosive	Total 13	11.17	
	Male: 9 Female: 4	Male: 4.37 Female: 1.94	

Table 3. Seasonal pattern of ocular trauma

Season	Month	Case number (n)	%*	%#	*p* value
Winter	January	15	7.3	18.4	p=0.0170
	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		

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

Table 4. Ocular trauma complications, wound location and size

	Case number (n)	Percent (%)	*p* value
Complications			
Lens dislocation	8	3.88	
RD	21	10.19	
VH	18	8.74	
Endophthalmitis	3	1.46	
Locations			
Zone I	80 (5[a])	38.83 (2.43[a])	$p<0.0001$
Zone II	46 (3[a])	22.33 (1.46[a])	
Zone III	37 (31[a#])	17.96 (15.05[a])	
Wound size			
Group 1 ≦ 5mm	76 (0[a])	36.89 (0[a])	$p<0.0001$
5< Group 2 <10 mm	47 (7[a])	22.82 (3.40[a])	
Group 3 ≧ 10 mm	40 (29[a#])	19.42 (14.08[a])	
Blunt (no open wound)	43 (6[a])	20.87 (2.91[a])	

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

Table 5. Percent vision acuity in ocular trauma patients

VA score	Initial VA		Final VA		*p* value
	n	%	n	%	
Level I ≧0.3	32 (0[a])	15.53	39	18.93	$p=0.0146$
0.05 ≤ Level II < 0.3	26 (1[a])	12.62	46	22.33	
LP < Level III <0.05	106 (10[a])	51.46	78	37.86	
Level IV = NLP	42 (29[a])	20.39	43 (42+1[b])	20.87	

n: case number; %: Ocular trauma incidence; a, wound size larger than 10mm; b, this patient who had zone II injury with 7mm wound size developed endophthaltitis due to severe infection

Figures

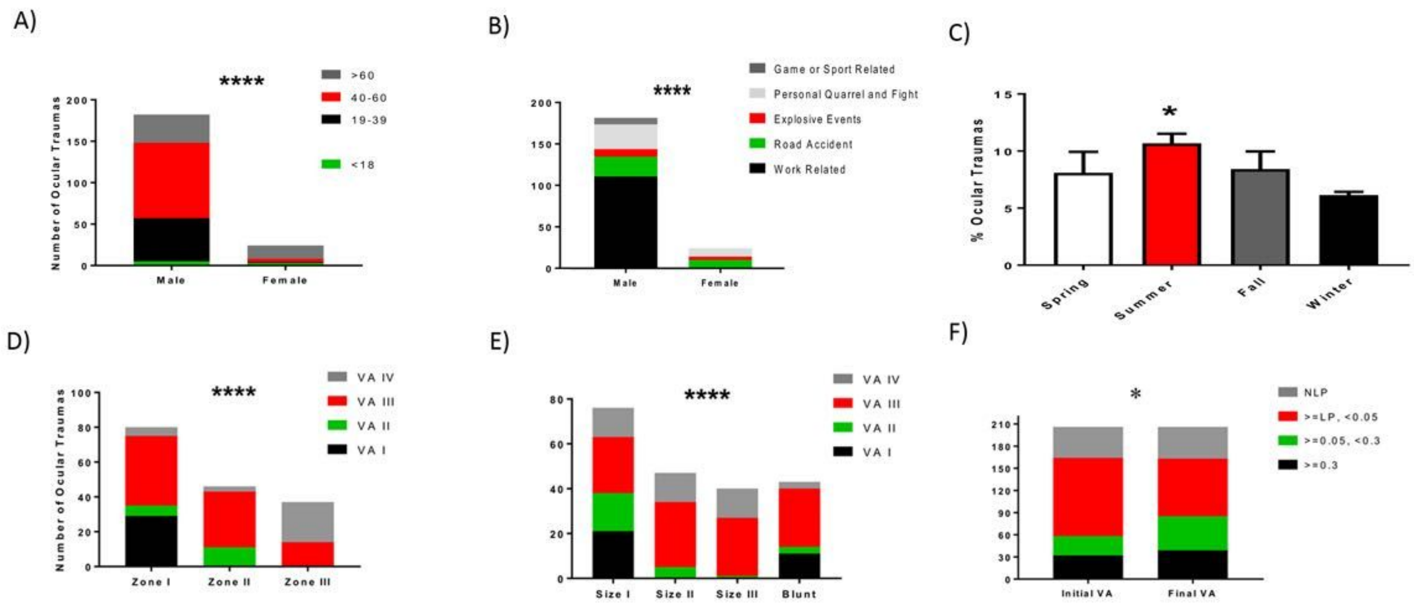

Figure 1

Ocular trauma pattern in the North Bund Area of Shanghai. A) Ocular trauma incidence is related to both age and gender. B) Occupation and ocular trauma. C) Average yearly seasonal ocular trauma incidence 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.