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ORIGINAL RESEARCH

Epidemiology of Ocular Trauma and Predictive Modeling of Visual Outcomes: A 12-Year Retrospective Study at a Tertiary Hospital in China

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Background: Ocular trauma is a visually and economically devastating cause of visual loss. This study investigated the prevalence and clinical characteristics of ocular trauma in central and northern China, and assessed prognostic factors.

Methods: Cases of ocular trauma that underwent surgical treatment in a tertiary hospital in China between January 1, 2012, and December 31, 2023, were reviewed. All patient data were collected, including demographic information, type of injury, cause of injury, overall condition, number of surgeries, structural damage, surgical complications, and initial and final visual acuity (VA). We constructed three models to explore the prognostic factors of final VA: linear regression, regression tree, and random forest.

Results: Over 12 years, 1019 patients (1019 eyes) with ocular trauma underwent surgery, of which 836 were open globe injuries. Patients were predominantly male (80.8%), with an average age of 31.1 years. The most at-risk age group was 41–50 years old. Farmers (33.3%) and students (20.9%) were the most common occupations. The most frequent complication was vitreous hemorrhage (95.7%). Most patients required three surgeries (42.2%). During vitrectomy, proliferative vitreoretinopathy and elevated intraocular pressure were observed in 735 patients (72.1%). The final VA ranged from 0 to 3.00 logMAR with a mean of 1.10±0.43 logMAR. Among the three models, the random forest performed the best. Ocular structural damage and surgical complications, along with the number of surgeries, were important factors affecting the visual prognosis.

Conclusion: Individuals at high risk should be given extra care, as traumatic and surgical complications are the main prognostic factors.

Keywords: eye injuries, visual acuity, prognosis, predictive learning models

Introduction

Eye trauma constitutes a significant cause of visual impairment, accounting for approximately 3% of all emergency department visits.[1] Globally, it ranks as the fourth leading cause of blindness, affecting an estimated 1.5–2 million individuals annually.[2] Blunt contusions are the predominant type of ocular trauma and are typically managed conservatively, whereas penetrating injuries from sharp objects often require hospitalization and surgical intervention.[3] Various incidents such as motor vehicle accidents, sports injuries, industrial mishaps, falls, and violent trauma contribute to these injuries. Moreover, ocular complications frequently accompany head injuries, affecting up to 84% of patients with such trauma.[4] Hence, comprehensive evaluation of ocular injuries is crucial in cases involving facial fractures or head trauma.

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Existing studies on ocular trauma in China are predominantly limited to the central and southern regions.[5–7] Given the country's population size, the burden of eye trauma in China may exceed that of certain developed countries, yet there is insufficient research on its etiology, severity, and treatment outcomes.[8] Therefore, there is an urgent need for a comprehensive analysis of epidemiological data on ocular injuries in China. Importantly, most eye injuries are preventable.[9] Evaluating the epidemiological and clinical characteristics of ocular trauma in our patient population is essential to identify prevention strategies and reduce associated costs. This present study aims to investigate the prevalence and clinical characteristics of eye trauma, evaluate prognostic factors influencing visual outcomes.

Materials and Methods

The First Affiliated Hospital of Zhengzhou University serves the central and northern regions of China, with an annual outpatient volume of 170,000 and approximately 10,000 eye disease patients. A retrospective study analyzed clinical data from patients with ocular injuries requiring surgical treatment at the First Affiliated Hospital of Zhengzhou University between January 1, 2012, and December 31, 2023. Approval was obtained from the Ethics Committee of the hospital (2023-KY-0244-001). Patients were classified using the International Classification of Diseases (ICD) 9th and 10th editions. The study excluded cases with pre-existing retinal detachment, glaucoma, severe eye infection or inflammation, diabetic retinopathy, type 1 diabetes, fundus diseases causing vision impairment, and significant visual acuity (VA) loss.

Data collected included patient demographics, injury characteristics, and initial and final best corrected visual acuity (BCVA), assessed using the Snellen format. VA was converted to logarithmic minimum resolution angle (logMAR) values for analysis. LogMAR values of 1.8, 2.3, 2.8, and 3 corresponded to visual outcomes categorized as counting fingers (CF), hand motion (HM), light perception (LP), and no light perception (NLP) in follow-up assessments involving BCVA.[10]

Patient and Public Involvement

It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting, or dissemination plans of our research.

Statistical Analysis

All statistical analyses were performed using R, employing appropriate packages and functions for linear regression, regression tree, and random forest models. Demographic and patient characteristics, including age, vision status, cause, and type of injury, were presented using descriptive statistics in R. Continuous variables were described using mean ± standard deviation (SD), while categorical variables were described using frequencies and percentages. Pairwise comparisons were performed using a non-parametric Mann–Whitney test. We first conducted univariate linear regression analyses on all variables to identify potential predictors of final BCVA. Variables with a p-value less than 0.1 in the univariate analyses were considered for inclusion in the multivariate linear regression model. The significance level for the multivariate linear regression was set at $p<0.05$, indicating statistical significance. To capture potential non-linear relationships and interactions among the predictors of BCVA, we utilized regression tree and random forest models. These models offer the advantage of handling complex interactions and non-linear effects, which may not be adequately captured by linear regression. All variables will be included in the nonlinear analyses. To evaluate the importance of each predictor variable in the random forest model, we used the concept of feature importance. Feature importance is measured by the mean decrease in node impurity, also known as IncNodePurity, which is calculated based on the Gini impurity or variance reduction. Variables with higher IncNodePurity values contribute more to the predictive power of the model, indicating their greater relevance in determining the outcome.

The efficacy of the linear regression, regression tree, and random forest models was assessed using mean squared error (MSE), root mean squared error (RMSE), mean absolute error (MAE), and R^2. MSE quantifies the average squared difference between observed and predicted BCVA values, providing a measure of the model's accuracy. RMSE, the square root of MSE, represents the average magnitude of the prediction error and is on the same scale as the BCVA measurements. MAE calculates the average absolute difference between observed and predicted BCVA values, offering another perspective on model accuracy.

Results

Characteristics of the Patients

From January 1, 2012, to December 31, 2023, a total of 1019 patients (1019 eyes) with eye injuries requiring surgical treatment were treated at the research center.

Table 1 provides the demographic details of the study population. Of the 1019 patients, 823 were male (80.8%) and 196 were female (19.2%), yielding a male-to-female ratio of 4:1. The patients' ages ranged from 1 to 88 years, with an average age of 31.1±19.2 years. Age distribution identified the 31–40 year (17.0%) and 41–50 year (18.6%) age groups as high-risk for eye injuries, followed by the 1–10 year (16.7%) and 51–60 year (15.1%) age groups.

Open ocular injuries were more prevalent than closed injuries (18.0%), with a mean logMAR VA of 2.3±0.4. At the time of injury, 16.3% of patients were under the influence of alcohol. The majority of patients did not have diabetes or hypertension. Farmers (33.3%) and students (20.9%) were the most common occupations among those injured. Work-related injuries were most frequent (48.1%), with metal objects being the primary cause of trauma (67.6%).

Ophthalmological examinations revealed that the most common complication was vitreous hemorrhage (95.7%), followed by retinal detachment (88.8%) and choroidal detachment (76.2%). Ciliary body detachment (9.6%) and endophthalmitis (2.0%) were relatively rare. This study focused exclusively on patients who underwent surgical treatment. Most patients required multiple surgeries, with 42.2% undergoing 3 surgeries and 9.4% undergoing up to 5 surgeries. During vitrectomy, surgical complications were observed in 735 patients (72.1%). The primary complications included proliferative vitreoretinopathy (PVR) and elevated intraocular pressure.

Visual Outcome and Prognostic Factors

The final VA in this study ranged from 0 to 3.00 logMAR (NPL), with a mean of 1.10±0.43 logMAR and a median of 1.09 logMAR (interquartile range = 0.38). Notably, 31.2% of patients achieved a final VA better than 1.00 logMAR, and 2.4% had vision better than 0.30 logMAR. There was no statistically significant difference in initial VA between closed and open globe injuries ($p=0.098$, Mann–Whitney test), nor in final visual acuity ($p=0.094$, Mann–Whitney test).

We constructed three models to explore the prognostic factors affecting final VA after ocular trauma surgery. Due to collinearity between the agent of trauma and the cause of injury, only the former was included in the linear regression analysis. The univariable linear regression results demonstrated that worse visual outcomes were significantly associated with open globe injury ($p=0.005$), worse initial VA ($p<0.001$), alcohol intake at injury ($p<0.001$), surgical complications ($p<0.001$), hypertension ($p=0.010$), diabetes ($p=0.029$), endophthalmitis ($p<0.001$), retinal detachment ($p<0.001$), choroidal detachment ($p<0.001$), ciliary detachment ($p<0.001$), vitreous hemorrhage ($p=0.007$), fireworks injury, and undergoing multiple surgeries (Table 2). However, in the multivariable analysis, only worse initial VA ($p=0.015$), surgical complications ($p<0.001$), endophthalmitis ($p<0.001$), retinal detachment ($p<0.001$), choroidal detachment ($p<0.001$), ciliary body detachment ($p=0.026$), and 4 ($p=0.007$) or more surgeries ($p<0.001$) remained significantly associated with worse final VA (Table 2). Among these, endophthalmitis had the greatest impact on visual prognosis (coefficient 0.58).

In the pruned regression tree, prognostic factors affecting visual outcomes included gender, occupation, diabetes, hypertension, and cause of injury, in addition to surgical complications, number of surgeries, retinal detachment, choroidal detachment, ciliary body detachment, and endophthalmitis (Figure 1A). Additionally, this model provided a segmented prediction of final VA. In the random forest model, the top five factors affecting prognostic VA were surgical complications, number of surgeries, retinal detachment, age, and endophthalmitis (Figure 1B). In all three models, surgical complications, number of surgeries, retinal detachment, and endophthalmitis emerged as significant factors influencing visual outcomes.

To evaluate the effectiveness of the models, we tested the MSE, RMSE, MAE, and R^2 values for all three models. While regression trees better capture complex nonlinear relationships compared to linear regression, their performance was similar (Supplementary Table 1). Random forest outperformed both ($R^2=0.790$), with its final VA predictions being closest to the actual values (Figure 2).

Table 1 Baseline Characteristics of Participants (1019 Participants, 1019 Eyes)

Variables	
Sex, n (%)	
Male	823 (80.8)
Female	196 (19.2)
Age, n (%)	
1–10	170 (16.7)
11–20	92 (9.0)
21–30	151 (14.8)
31–40	173 (17.0)
41–50	190 (18.6)
51–60	154 (15.1)
61–70	68 (6.7)
≥70	21 (2.1)
Trauma type, n (%)	
Open	836 (82.0)
Close	183 (18.0)
Visual acuity at injury, mean (SD)[#]	2.3 (0.4)
Occupations, n (%)	
Employees	128 (12.6)
Unemployed	36 (3.5)
Farmer	339 (33.3)
Student	213 (20.9)
Worker	120 (11.8)
Others	183 (18.0)
Causes of injury, n (%)	
Blast	145 (14.2)
Motion	41 (4.0)
Traffic accident	59 (5.8)
Work	490 (48.1)
Life accident	284 (27.9)
Agent of trauma, n (%)	
Firework	141 (13.8)
Fist	34 (3.3)
Metal	689 (67.6)
Glass	30 (2.9)
Plant	36 (3.5)
Stone	74 (7.3)
Others	15 (1.5)
Surgical complications, n (%)	
Yes	735 (72.1)
No	284 (27.9)
Alcohol intake at injury, n (%)	
Yes	166 (16.3)
No	853 (83.7)
Number of surgeries	
1	75 (7.4)
2	244 (23.9)
3	430 (42.2)
4	174 (17.1)
5	96 (9.4)

(*Continued*)

Table 1 (Continued).

Variables	
Hypertension, n (%)	
Yes	216 (21.2)
No	803 (78.8)
Diabetes, n (%)	
Yes	90 (8.8)
No	929 (91.2)
Endophthalmitis, n (%)	
Yes	20 (2.0)
No	999 (98.0)
Retinal detachment, n (%)	
Yes	905 (88.8)
No	114 (11.2)
Choroidal detachment, n (%)	
Yes	776 (76.2)
No	243 (23.8)
Ciliary detachment, n (%)	
Yes	98 (9.6)
No	921 (90.4)
Vitreous hemorrhage, n (%)	
Yes	975 (95.7)
No	44 (4.3)

Note: [#]Visual acuity at injury is presented in logMAR.

Discussion

This study conducts a retrospective analysis of risk factors and characteristics associated with ocular injuries in the central and northern regions of China. The results reveal a pattern of increasing prevalence followed by stabilization in the number of eye injury patients from 2012 and 2020, with a subsequent decline (data not shown). This trend may be linked to the implementation of work stoppages and home confinement measures during the COVID-19 pandemic, resulting in a decrease in accidental injuries. Our results showed a male-to-female prevalence ratio of approximately 4:1 in ocular injuries, consistent with previous research highlighting a preference for open globe injuries in children and young adults, particularly males.[11] Boys' heightened engagement in high-risk activities contributes to the highest trauma prevalence observed in boys aged 1–10 years, emphasizing the importance of family-centered preventive interventions.[12] An analysis of clinical data indicates that children's ocular injuries often occur in domestic environments, especially rural areas, and are commonly caused by sharp objects. Increasing adult supervision and reducing environments where children are left alone can reduce the likelihood of eye injuries.

Our results show that individuals aged 31 to 50 are more susceptible to eye injuries, except for preschool children. This demographic aligns with prior research suggesting the highest prevalence of eye trauma occurs within the 30–50 age group.[13] Middle-aged individuals who experience eye injuries commonly work in construction, whereas those injured at home often engage in activities such as chopping firewood.[14] The prevalence of eye injuries among elderly individuals in China is relatively low, possibly due to traditional family structures providing better care and support.[15] Given their heightened susceptibility to trauma, special attention should be paid to the elderly population. Research suggests that elderly women may face a higher risk of ocular injuries compared to elderly men, possibly due to the higher prevalence of osteoporosis and arthritis in this demographic, leading to an increased risk of falls.[16] Falls, especially within the home environment, are a leading cause of injury among the elderly and are often linked to severe eye injuries.[17] Poor vision is a significant fall risk factor, underscoring the need for ophthalmologists and optometrists to raise awareness among high-risk populations.[18] Previous data indicates that elderly individuals who experience sudden visual loss have higher rates of

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Table 2 Univariable and Multivariable Linear Regression Analysis of Visual Acuity at Last Follow-up

	Univariable		Multivariable	
	Coefficient (95% CI)	P value	Coefficient (95% CI)	P value
Trauma type				
Close	1 (Reference)		1 (Reference)	
Open	0.10 (0.03 to 0.17)	0.005	−0.04 (−0.10 to 0.02)	0.151
Visual acuity at injury#	0.11 (0.05 to 0.17)	<0.001	0.05 (0.01 to 0.10)	0.015
Alcohol intake at injury				
No	1 (Reference)		1 (Reference)	
Yes	0.16 (0.09 to 0.23)	<0.001	0.05 (−0.02 to 0.13)	0.158
Agent of trauma				
Fireworks	1 (Reference)		1 (Reference)	
Metal	−0.22 (−0.29 to −0.14)	<0.001	−0.02 (−0.10 to 0.06)	0.607
Fist	−0.04 (−0.19 to 0.12)	0.657	0.07 (−0.04 to 0.19)	0.219
Glass	−0.21 (−0.37 to −0.04)	0.014	−0.03 (−0.16 to 0.09)	0.589
Plant	−0.36 (−0.51 to −0.20)	<0.001	−0.06 (−0.18 to 0.06)	0.331
Stone	−0.19 (−0.31 to −0.07)	0.002	−0.01 (−0.11 to 0.09)	0.863
Others	−0.29 (−0.52 to −0.07)	0.011	−0.06 (−0.22 to 0.11)	0.494
Surgical complications				
No	1 (Reference)		1 (Reference)	
Yes	0.56 (0.51 to 0.61)	<0.001	0.29 (0.23 to 0.35)	<0.001
Number of surgeries				
1	1 (Reference)		1 (Reference)	
2	−0.10 (−0.19 to −0.00)	0.039	−0.06 (−0.14 to 0.03)	0.205
3	0.30 (0.21 to 0.38)	<0.001	0.09 (−0.00 to 0.18)	0.051
4	0.43 (0.34 to 0.53)	<0.001	0.14 (0.04 to 0.24)	0.007
5	0.72 (0.61 to 0.83)	<0.001	0.36 (0.24 to 0.47)	<0.001
Hypertension				
No	1 (Reference)		1 (Reference)	
Yes	0.08 (0.02 to 0.15)	0.010	0.01 (−0.04 to 0.06)	0.716
Diabetes				
No	1 (Reference)		1 (Reference)	
Yes	0.10 (0.01 to 0.20)	0.029	0.07 (−0.01 to 0.15)	0.069
Endophthalmitis				
No	1 (Reference)		1 (Reference)	
Yes	0.83 (0.65 to 1.02)	<0.001	0.58 (0.44 to 0.71)	<0.001
Retinal detachment				
No	1 (Reference)		1 (Reference)	
Yes	0.61 (0.53 to 0.68)	<0.001	0.27 (0.20 to 0.33)	<0.001
Choroidal detachment				
No	1 (Reference)		1 (Reference)	
Yes	0.34 (0.28 to 0.40)	<0.001	0.10 (0.05 to 0.15)	<0.001
Ciliary detachment				
No	1 (Reference)		1 (Reference)	
Yes	0.32 (0.23 to 0.41)	<0.001	0.08 (0.01 to 0.15)	0.026
Vitreous hemorrhage				
No	1 (Reference)		1 (Reference)	
Yes	0.18 (0.05 to 0.31)	0.007	0.02 (−0.08 to 0.11)	0.719
Sex				
Female	1 (Reference)			
Male	0.00 (−0.06 to 0.07)	0.904		

(*Continued*)

Table 2 (Continued).

	Univariable		Multivariable	
	Coefficient (95% CI)	**P value**	**Coefficient (95% CI)**	**P value**
Age				
>70	1 (Reference)			
1–10	−0.08 (−0.27 to 0.12)	0.434		
11–20	−0.02 (−0.23 to 0.18)	0.817		
21–30	−0.05 (−0.24 to 0.15)	0.637		
31–40	−0.08 (−0.27 to 0.12)	0.424		
41–50	−0.02 (−0.22 to 0.17)	0.815		
51–60	0.02 (−0.18 to 0.21)	0.863		
61–70	−0.01 (−0.22 to 0.20)	0.928		
Occupations				
Employees	1 (Reference)			
Unemployed	−0.13 (−0.29 to 0.03)	0.106		
Farmer	0.02 (−0.07 to 0.10)	0.708		
Student	−0.02 (−0.11 to 0.08)	0.737		
Worker	−0.01 (−0.12 to 0.10)	0.884		
Others	0.00 (−0.09 to 0.10)	0.952		

Note: [#]Visual acuity at injury is presented in logMAR.

hospitalization and mortality compared to those with normal vision, primarily due to the difficulties in carrying out daily tasks as a result of this loss.[19]

Occupational eye injuries are more pronounced in developing countries compared to developed nations, and are commonly observed in construction, manufacturing, and agricultural environments, often attributed to metal plates and iron nails. Up to 90% of workplace injuries could be avoided through educational initiatives and mandatory eye protection measures.[20] Therefore, offering training and education for workers and farmers, reinforcing regulations, and establishing consequences for non-adherence are crucial to reducing workplace risks. Our study revealed that farmers had the highest prevalence of ocular trauma, identifying them as a high-risk group. In addition to globe rupture and blunt trauma, contact with crops and soil significantly increases the risk of fungal keratitis.[21] However, this exposure history is often overlooked.

In our cohort, metal was the most common cause of injury, followed by fireworks. Metals are ubiquitous in both occupational and daily environments and are frequently implicated in injuries involving sharp or high-velocity objects.[22,23] Fireworks play a significant role in celebrations, especially during the Chinese Spring Festival, which has historical roots in ancient Chinese culture. Eye injuries from fireworks are a notable health issue, consistent with previous research findings.[24,25] Contributing factors include inadequate knowledge and skills for handling fireworks, and technological advancements enhancing the effectiveness of specific firecrackers. A systematic review showed that strict regulations on fireworks in some countries led to an 87% decrease in trauma incidents, primarily due to legal restrictions on individual use.[26] Therefore, enhancing public education and enacting suitable legislation are imperative to mitigate eye injuries from fireworks.

The visual outcomes for trauma patients in this study were suboptimal, with only 51 individuals achieving a final VA of 0.30 logMAR or higher. Interestingly, our analysis showed that both initial and final VA did not differ significantly between open globe and closed globe trauma. This result may be limited by the sample size and the unbalanced distribution of injury types. Additionally, optic nerve atrophy in patients with closed globe trauma can still lead to visual impairment, whereas simple peripheral corneal penetrating injuries tend to have a better visual prognosis.[27,28]

Alcohol consumption is linked to a significant proportion of attacks, with 76.5% of cases involving alcohol, similar to previous data from north Queensland.[29] Moreover, research reports that physical assault, often involving males,

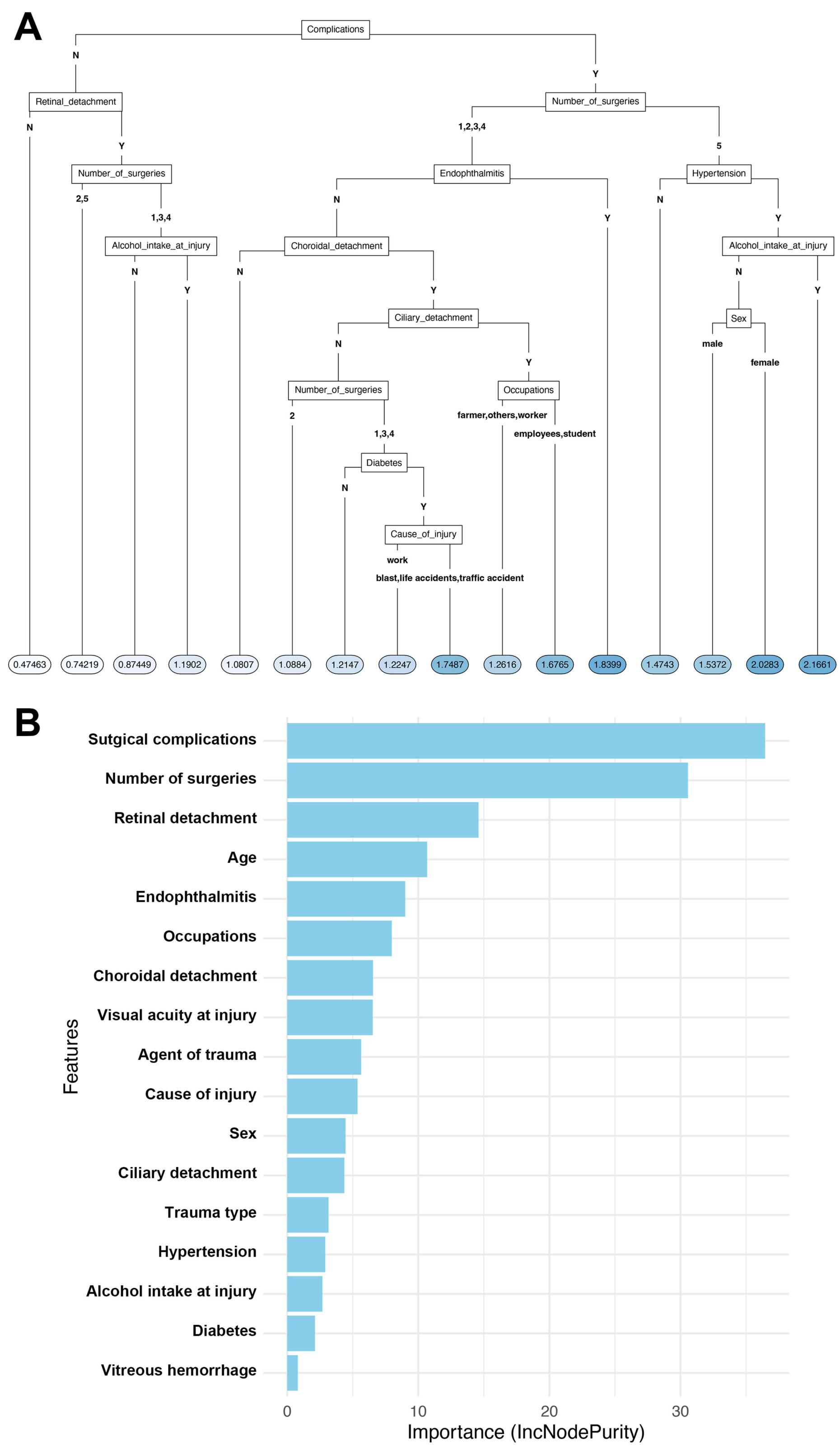

Figure 1 Regression tree diagram of the regression tree model (**A**) and feature importance plot of random forest model (**B**).

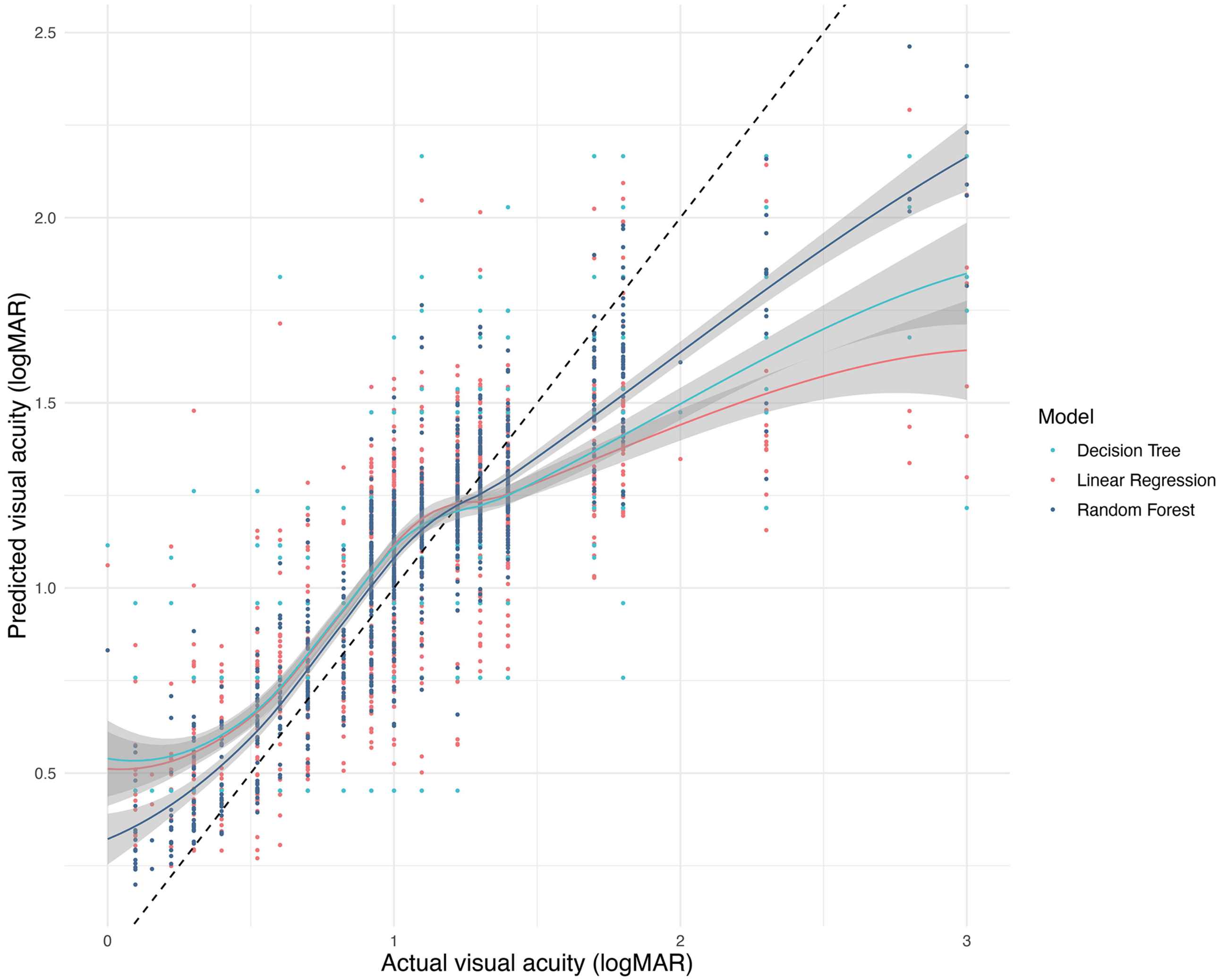

Figure 2 Comparison of predicted visual acuity by linear regression, regression tree, and random forest models against actual visual acuity.

contributes to 15.8% of eye rupture injuries.[30] Strategies to control alcohol consumption and improve public safety measures may reduce incidents of alcohol-related violence and eye injuries.[31,32]

Managing open globe trauma poses considerable challenges for ophthalmologists. Ocular trauma often requires expeditious surgical intervention, hospitalization, and multiple surgeries to maintain ocular integrity and restore visual function.[33] Depending on the nature of the injury, patients with ocular trauma receive various treatments including conservative, medical, surgical, or a combination thereof. This study specifically focuses on patients who underwent surgical intervention. Among these patients, the number of surgeries ranged from 1 to 5, with the majority undergoing 3 surgeries. Careful evaluation of ocular features is necessary to determine suitable surgical techniques, including the potential use of silicone oil during trauma surgery. After surgical intervention, individuals with substantial retinal fibrosis or scarring may face an increased risk of traction retinal detachment or difficulties in achieving retinal adherence, necessitating the retention of silicone oil within the eye. Recent research indicates minimal occurrence of sympathetic ophthalmitis, allowing extended retention of NLP eyes without enucleation.[34] Although sympathetic ophthalmia caused by trauma ultimately results in worse VA compared to that caused by surgery, prompt treatment with corticosteroids or immunosuppressants can still significantly improve visual outcomes.[35]

In this study, surgical complications primarily referred to elevated intraocular pressure and PVR. Other research also indicates that PVR is a significant negative predictor for poor visual outcomes in ocular trauma patients.[36] Early intravitreal triamcinolone acetonide injection has been shown to effectively reduces traumatic PVR, increases surgical success and improves visual prognosis.[37] Further investigation is needed to examine effective surgical methods and therapeutic approaches for ocular injuries. Endophthalmitis is a rare but severe ocular infection that can lead to irreversible vision loss. In our study, only 20 cases of endophthalmitis were identified, all associated with open globe injuries, and 19 of these cases experienced surgical complications. Earlier studies reported endophthalmitis rates as high as 30% in ocular trauma, while more recent studies have found incidences ranging from 0% to 16.5% following open-globe injuries.[38,39] In this present study, the endophthalmitis rate was 2%, likely reflecting timely medical intervention and improved patient care. Consistent with our findings, previous research has confirmed that endophthalmitis is a significant factor affecting post-traumatic vision.[40,41]

To investigate the factors that influence visual prognosis in ocular trauma, we utilized three models: linear regression, regression tree, and random forest, comparing their respective performances. Consistent with previous research,[42] our results highlighted several factors influencing final visual recovery, including VA at injury, number of surgeries, endophthalmitis, retinal detachment, choroidal detachment, ciliary detachment, and surgical complications. Lower initial VA and more surgeries may indicate the severity of accompanying lesions. It is worth noting that, contrary to findings in other studies, the type of injury showed statistical significance only in the univariate linear regression analysis, and vitreous hemorrhage was not identified as a significant influencing factor in any of the models.[36] This discrepancy may be due to the complexity of the injuries. For instance, an open globe with minor lacerations tends to have a good visual prognosis, while a closed globe with severe optic nerve damage results in a poor prognosis. Additionally, small amounts of vitreous hemorrhage, often caused by minor injuries, may have little impact on vision. However, vitreous hemorrhage is considered as a risk factor of retinal detachment after open globe injury.[43] Hemorrhage in the anterior chamber and vitreous cavity is also a contributing factor to the development of traumatic glaucoma. Among the three models, the random forest model performed the best, with its predictions of final VA being closest to the actual values. In contrast, linear regression analysis was less effective in handling nonlinear relationships and variables with collinearity, making it less suitable for predicting the final VA of ocular injuries influenced by complex factors.

Our prognostic models offer valuable clinical insights by estimating visual prognosis based on patient demographics and ocular trauma characteristics. By integrating crucial factors such as structural damage, and surgical complications, these models enhance early risk assessment, guide treatment strategies, and support informed decision-making. Their application may help optimize patient management, improve functional outcomes, and contribute to the development of standardized prognostic tools in ocular trauma care.

The authors acknowledge the limitation of our study. As this is a retrospective study, some patient information was missing, limiting the comprehensiveness of the sample size and the analysis of prognostic factors. Furthermore, the specific affected areas and subtypes of open globe injuries were not analyzed, therefore factors associated with injury severity (such as the number of surgeries) could not be accurately assessed. The number of cases of open and closed injuries was also unequal. Despite these limitations, we believe our results have enhanced the understanding of ocular trauma in central and northern China and explored the factors affecting the visual prognosis of surgical patients. This is beneficial for managing patients with ocular trauma and predicting visual outcomes.

In summary, eye trauma is a significant factor in causing visual impairment or loss, particularly among children and middle-aged males. Metal ejection is identified as the primary cause of these injuries. Open globe injuries exhibit a higher prevalence rate compared to closed globe injuries, with ocular rupture being the primary manifestation. The visual prognosis mainly depends on VA at injury and the presence of surgical complications, retinal detachment, choroidal detachment, ciliary detachment, and endophthalmitis. Our findings, in line with established consensus, highlight that many eye injuries are preventable through public awareness, parental supervision, workplace protective measures, and strict firework regulations.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article.

Ethics Approval

This study involves human participants. This study was approved by the Institutional Review Committee of the First Affiliated Hospital of Zhengzhou University (2023-KY-0244-001). All procedures were in compliance with the tenets of the Declaration of Helsinki. Participants gave informed consent to participate in the study before taking part.

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Disclosure

The authors declare no conflicts of interest in this work.

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