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Retinal detachment after open globe injury

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Abstract

Purpose—To characterize the development of retinal detachment after open globe trauma.

Design—Case-control study

Participants—892 patients comprising 893 open globe injuries, of which 255 were ultimately diagnosed with retinal detachment, with the remaining eyes serving as controls.

Methods—Retrospective chart review of open globe injuries presenting to the Massachusetts Eye and Ear Infirmary between 1999 and 2011. Kaplan-Meier analysis was used to estimate time to detachment and multivariable logistic regression was used to define clinical factors associated with retinal detachment after open globe injury.

Main Outcome Measures—Demographic and clinical characteristics at the time of presentation after open globe injury, date of retinal detachment diagnosis, and last date of follow-up.

Results—Primary repair of the open globe was typically undertaken within hours of presentation. 255 eyes were ultimately diagnosed with retinal detachment after open globe trauma, yielding an incidence of 29% (95% confidence interval: 26%-32%). For eyes that developed retinal detachment, 27% (69/255) detached within 24 hours of primary open globe repair, 47% (119/255) detached within one week, 72% (183/255) within one month. Multivariable regression analysis revealed presence of vitreous hemorrhage (odds ratio: 7.29, $p < 0.001$), higher zone of injury (odds ratio: 2.51 per integer increase in zone number, odds ratio: 1.00-6.30, $p < 0.001$), and poorer Logarithm of the Minimum Angle of Resolution visual acuity at the time of presentation after open globe injury (odds ratio: 2.41 per integer increase in Logarithm of the Minimum Angle of Resolution visual acuity, odds ratio: 1.00-81.30, $p < 0.001$) to be associated with retinal detachment. A screening tool, named herein the Retinal Detachment after Open Globe Injury (RD-OGI) score, was created.

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Conclusions—Retinal detachment is common after open globe trauma, though often not appearing until days to weeks after the initial traumatic event. Several clinical variables at the time of initial presentation can predict the future risk of detachment.

Introduction

More than 35 years have elapsed since Eagling's review of retinal detachment after open globe injury (OGI).¹ Decades later ocular trauma remains an important cause of visual loss with more than 200,000 open globe injuries occurring globally every year.² In many reports, retinal detachment has been shown to be associated with poor visual outcome after OGI.³⁻⁷ However, the clinical features that predict retinal detachment after OGI are incompletely understood. The paucity of data was demonstrated in a recent search on Pubmed with query terms "retinal detachment" and "open globe trauma" or "open globe injury." In addition, prior to the late 1990s there was no standardized terminology of ocular trauma. As a result, the ophthalmic literature contains terms that are not used uniformly, and there is considerable confusion when attempting to interpret the results of earlier studies. In light of improvements in diagnostic modalities and the adoption of more standardized terminology for traumatic eye injuries, we sought to review the experience of this institution in the diagnosis of retinal detachment after open globe trauma.⁸

Methods

A retrospective review of 1036 consecutive open globe injuries evaluated by the Eye Trauma Service of the Massachusetts Eye and Ear Infirmary (MEEI) from February 1, 1999 to November 30, 2011 was undertaken. 143 charts were either unavailable for review or were incomplete and so were excluded from analysis, yielding a total cohort of 893 eyes. Open globe injuries were treated urgently upon presentation.⁹⁻¹¹ After open globe primary repair, patients were admitted for 48 hours of intravenous antibiotics.

Demographic and clinical data from these 893 charts were entered into a database. Variables included were age, gender, date, time and place of injury, mechanism of injury, initial clinical findings, date and time of open globe repair, ocular trauma score (OTS), zone of injury, date of retinal detachment diagnosis, date of retinal detachment surgery, and last date of follow-up (censoring date).^{8,12} Clinical findings included were visual acuity at the time of presentation, presence of an afferent pupillary defect, and the presence of vitreous hemorrhage. In our database and throughout this manuscript, we have used the standardized terminology proposed by Kuhn et al to classify ocular injuries, where the globe is the tissue of reference. According to this classification system, an *open globe* injury is defined as a full-thickness defect of the cornea and/or sclera, and open globes are divided into *ruptures* or *lacerations* depending on the mechanism of injury (ruptures are caused by blunt objects and lacerations are caused by sharp ones). Lacerations are further subdivided into *penetrating* injury, *intraocular foreign body* (IOFB) injury, and *perforating* injury. A penetrating injury has an entrance wound, an IOFB injury has an entrance wound and a retained IOFB, and a perforating injury has an entrance and an exit wound.¹³

We have also used the definitions described by Pieramici et al. Specifically, a zone I injury is isolated to the cornea (including the limbus), a zone II injury involves the sclera no more than 5 mm posterior to the limbus, and a zone III injury involves the sclera more than 5 mm posterior to the limbus.¹⁴ In a few rare and unusual instances, IOFBs were found in perforated or ruptured globes, for example, in globes ruptured by impact with a tree.

All statistical analyses were performed using Stata 11.1. Visual acuity was assessed using Logarithm of the Minimum Angle of Resolution (logMAR) equivalents. An unpaired t test

was used to compare means between groups. The Mann-Whitney U test was used to compare differences in medians. The Chi-squared test and Fisher exact test were used to assess differences in categorical outcomes. Time to diagnosis of retinal detachment was calculated with the Kaplan-Meier method and was defined as time from open globe repair to the time of retinal detachment diagnosis by an attending physician. Because primary globe repair typically occurred within hours of the patients presenting to the hospital, the time to diagnosis calculations remained virtually unchanged if we used “time of presentation” or “time of repair” as the starting time.

Logistic regression analysis was undertaken to define clinical factors associated with retinal detachment.¹⁵ Missing variables were excluded from analysis and not imputed. A two-tailed, p value of less than 0.05 was considered statistically significant. The Hosmer-Lemeshow statistic was calculated to determine goodness-of-fit of the multivariable model. Testing for outliers was performed; exclusion of these outliers did not meaningfully change the regression coefficients and therefore the subjects were retained.

To internally validate the multivariable model, it was subjected to a bootstrap procedure with 10,000 repetitions to generate a final regression model with bias-corrected 95% confidence intervals. This study was completed in adherence to the tenets of the Declaration of Helsinki; the Institutional Review Board of Massachusetts Eye and Ear Infirmary approved this study.

Results

Of 893 eyes that presented to MEEI from February 1999 to November 2011 with open globe trauma, 255 were ultimately identified as having a retinal detachment (Table 1). At presentation, patients who developed retinal detachment were older (mean age 46 vs. 38 $p<0.0001$), had a poorer median visual acuity (light perception vs. 20/400, $p<0.001$), were less likely to have a visual acuity of 20/200 or better (1.6% vs. 43%, $p<0.001$), were more likely to have an APD (34% vs. 8%, $p<0.001$), and were more likely to have vitreous hemorrhage (85% vs. 32%, $p<0.001$) compared with patients who did not develop retinal detachment. In both groups, most patients were male (78% vs. 80%, $p=0.65$).

Location and mechanism of the traumatic wound are presented in Table 2. Patients who developed retinal detachment were more likely to have a Zone III injury than those without detachment (49% vs. 13%, $p<0.001$), Zone II injuries were equivocal (31% vs. 30%, $p=0.74$), Zone I injuries were less common (12% vs. 48%, $p<0.001$), and zone data was missing in similar proportions (7% vs. 8%, $p=0.67$). The mechanism of globe injury, as defined by the Ocular Trauma Score, for eyes that developed retinal detachment was rupture (62%) and laceration (38%), which consisted of penetration (34%) and perforation (2%). An intraocular foreign body was identified in 16% of eyes that developed retinal detachment and in 15% of eyes that did not develop retinal detachment ($p=0.51$).

The clinical characteristics that were associated with retinal detachment were calculated and are presented in Table 3. Eyes with vitreous hemorrhage (51%, 95% Confidence Interval (CI): 47%-56%) and zone III injury (60%, 95% CI: 53%-67%), as well light perception (57%, 95% CI: 50%-63%) and no light perception vision (79%, 95% CI: 65%-92%) were notably at a high risk of detaching.

The crude incidence rate of retinal detachment after open globe trauma was 29% (95% CI: 26%-32%). As shown in the Kaplan-Meier curve in Figure 1, the presentation of retinal detachment predominates in the early period after trauma. Of the 255 confirmed retinal detachments, 27% (69/255) were identified within 24 hours after open globe injury repair, 47% (119/255) within the first week, and 72% (183/255) within the first month. Of the 255

patients found to have retinal detachment, 5% (14/255) detached more than one year after the open globe injury. Due to partially missing records, the initial date of diagnosis was unavailable in 6% (16/255) of cases.

To determine the risk of detachment with multiple risk factors, logistic regression was employed. Age, gender, visual acuity at the time of presentation, presence of an afferent pupillary defect, vitreous hemorrhage, zone of injury, OTS mechanism, and presence of an intraocular foreign body (IOFB) were examined in univariable regression. Examined as ordinal variables were zone of injury (Zone I=0, Zone II=1, Zone III=2), ocular trauma score mechanism of injury (penetration=0, perforation=1, rupture=2), and visual acuity (using logMAR equivalents). Unadjusted odd ratios, confidence intervals, and p values are presented in Table 4. The univariate regressors whose p values were less than 0.25 were then subjected to a multivariable logistic analysis to calculate adjusted odds ratios (ORs). Age, presence of an afferent pupillary defect, retained intraocular foreign body, and mechanism of injury failed to show a significant likelihood to detach and were excluded. The multivariable regression was internally validated using the bootstrap method. The final regression model revealed presence of vitreous hemorrhage (Odds Ratio (OR): 7.29, $p<0.001$), poorer logMAR visual acuity at time of presentation after open globe injury (OR: 2.41 per integer increase in logMAR vision, $p<0.001$), and higher zone of injury (OR: 2.51 per integer increase in number, $p<0.001$) to be associated with future retinal detachment.

Because logMAR visual acuity and zone of injury were calculated as ordinal variables, the correct interpretation of the odds ratios is calculated by raising the odds ratio to the power of the independent variable. For example, poorer visual acuity is associated with an increase in retinal detachment risk (OR: 2.41 per logMAR integer). Therefore, a person with a visual acuity of hand motion (logMAR 3.0) has a 14.00 (2.41^3) greater odds of detaching than a patient with a visual acuity of 20/20 (logMAR 0, OR: 2.41^0 or 1) and a 5.81 greater odds than a person with 20/200 vision (logMAR 1, OR: $(2.41^3)/(2.41^1)$). Similarly, a patient with a Zone III injury has a 6.30 greater odds (OR 2.51^2) of detaching than a Zone I injury (OR 1.0) but only a 2.51 greater odds than a patient with a Zone II injury.

To create a simple method of predicting retinal detachment at the time of presentation after open globe injury, a multivariable logit model using dummy variables was also created, named herein the Retinal Detachment after Open Globe Injury (RD-OGI) score. The model is provided in Table 5. The area under the receiver operator characteristic (AUROC= 0.90) and the Hosmer-Lemeshow statistic ($p=0.56$) suggested adequate model fit. An example of the score's use in predicting risk of detachment is presented in the Discussion.

Discussion

Retinal detachment is a common event after open globe injury and several clinical factors can predict the future risk of detachment. Our study is unique for its description of the natural history of retinal detachment after open globe injury and to present a predictive model for estimating the probability of detachment based on initial clinical findings. Strengths of our study include its size and statistical design of using Kaplan-Meier survival analysis, which compensates for subjects whom are lost to follow-up and provides an accurate assessment of incidence and time-to-detachment. Nevertheless, follow-up in the first month after detachment, the period when 72% of detachments developed, was high at 91%.

In the literature, previous outcome studies of open globe injury have reported how many patients had retinal detachment at the time of presentation, with a range from 3.4% to 35%, but these smaller reports did not study how many subjects detached after their initial

presentation.^{4,16-23} Regarding studies examining risk factors for RD, three reports previously identified anatomic zone as being predictive of RD.^{22,24,25} Two other studies from Iran and Germany studied risk of RD after open globe trauma using multiple clinical variables, but their small cohort sizes, 116 and 52 open globe injuries respectively, limit the accuracy of their findings.^{5,26}

In most cases in our database, the diagnosis of retinal detachment was made by b-scan ultrasonography, as hemorrhage precluded a thorough funduscopic examination. The initial b-scan was typically performed one day after presentation, once primary closure of the globe had been completed. In a few cases, the initial b-scan was not made until several days later. Therefore, we cannot exclude the possibility that the findings of Figure 1, which report time to diagnosis of retinal detachment, may have a “lag time” of a few days from the true “detachment time,” although this difference in timing is likely irrelevant. In 24 eyes (9%), the diagnosis of RD was made in the operating room at the time of vitrectomy for another indication, such as nonclearing hemorrhage. Multiple prior b-scans performed in these eyes had not shown a detachment.

As shown in Figure 1, most retinal detachments (53%) were not diagnosed until a week after the traumatic incident. Given this latency in the presentation of retinal detachment, referral and observation by a retina specialist should be considered for patients who are at high risk of detaching after primary repair of the open globe. The clinical question therefore arises, which patients are at higher risk of detaching and in need of continued monitoring, if not earlier surgical intervention, by a retina specialist? To quantify this risk of detachment, the RD-OGI score was created and it awards points based on the presence of three clinical findings present at the time of presentation: visual acuity, zone of injury, and presence of vitreous hemorrhage (Table 5). For example, a patient may present to the emergency department after sustaining eye pain and vision loss after being struck with a glass shard. On examination, his visual acuity is found to be hand motion at two feet (2 points, Table 5). A penetrating wound 4-7 mm posterior to the limbus is identified and designated as zone III (the injury involves zones II and III but is defined by the highest zone, so 2 points are given, Table 5). Some vitreous hemorrhage is present (2 points, Table 5), a retained piece of glass is noted but no retinal detachment is identified on b-scan. The clinician consults Table 5 and finds that the patient’s total RD-OGI score, 6, suggests that he has approximately a 79% probability of having a retinal detachment in the future. A second patient may present following an assault, with a complaint of eye pain. His visual acuity is count fingers (1 point). A 2 mm penetrating wound in the central cornea is present and is designated zone I (0 points). No vitreous hemorrhage (0 points) is present. The second patient’s total RD-OGI score is 1, suggesting a 3% probability of detaching in the future.

Interestingly, several variables were present in univariate analysis that failed to show significance when other risk factors were controlled for in the multivariable model. For example, age was initially shown to be predictive for RD; patients with RD were on average 8 years older than patients without RD. Several hypotheses exist to explain the higher rate of RD in the elderly population in comparison to younger patients. As shown previously by Andreoli et al., 49% of elderly patients have had prior ocular surgery, which may weaken the integrity of the globe in addition to the scleral thinning associated with the aging process.¹¹ In addition, although penetration, perforation, and rupture were significant in univariate analysis, they failed to show predictive power when other variables were input into the model, suggesting that, like age, other factors when controlled are more important than the mechanism by which it occurred. Interestingly, presence of an intraocular foreign body was not found to be significant ($p=0.51$, Table 2 and Table 4). Given that most IOFBs are removed urgently with vitrectomy at the time presentation, it raises questions how early

vitrectomy and other surgical procedures may alter the risk of future detachment and warrant further investigation.

This study has several limitations. Most importantly is its retrospective nature, which can introduce potential bias due to variability in reporting clinical findings and missing data. As stated in the methods, 143 charts were excluded from review. The most common reason for exclusion was a prematurely terminated diagnostic evaluation. For example, the typical excluded case would be an elderly patient with multiple medical problems who had sustained a severe open globe injury after a fall and presented with light perception vision. After primary repair of the globe was completed, the patient would decline to receive further intervention, due to the poor visual prognosis and the risks associated with additional intervention, before a definitive diagnosis could even be established to account for the visual loss. For this reason, after consultation with an external bio-statistician, we elected to exclude these cases that had not received a complete work-up with the understanding that the true number of retinal detachments could be slightly greater or smaller than the estimate we identified here. In addition, though we are encouraged that our model remained stable after repeated resampling using the bootstrap method, the true diagnostic utility of any predictive tool can only be assessed in an independent, prospective cohort. Another limitation of this study is related its scope, which precludes the inclusion of additional analyses. This study was limited to examining the clinical variables at the time of presentation after trauma that could predict the risk of developing an RD. While such an approach gives insight into the risk of RD under general clinical practice, it does not inform the clinician what interventions may modify the incidence of RD, such as early vitrectomy, laser, or other surgical procedures. In addition, the question of how many RDs were amenable to surgical treatment, what techniques were utilized, and what outcomes were observed will be described in future reports. Finally, our model is intended to serve a different purpose from the popular and validated Ocular Trauma Score, which predicts final visual potential after open globe injury.⁸ However, because the presence of retinal detachment is an input into the Ocular Trauma Score, a separate model is still needed to estimate the risk of retinal detachment itself, a role the RD-OGI Score can fulfill.

In conclusion, in this study we reviewed the Massachusetts Eye and Ear Infirmary experience of treating nearly 900 open globes over the past decade. Retinal detachment is common after open globe trauma, with 255 patients in our cohort ultimately detaching yielding an incidence rate of 29%. Of the 255 confirmed retinal detachments, 27% (69/255) were identified within 24 hours after open globe injury repair, 47% (119/255) within the first week, and 72% (183/255) within the first month. Of the 255 patients found to have retinal detachment, 5% (14/255) detached more than one year after the open globe injury. Multivariable regression analysis revealed the presence of vitreous hemorrhage (OR: 7.29, $p<0.001$), a higher zone of injury (OR: 2.51 per integer increase in zone, $p<0.001$), and poorer logMAR visual acuity (OR: 2.41 per integer increase in logMAR, $p<0.001$) at the time of presentation to be associated with increased risk of retinal detachment. A predictive tool, the RD-OGI score, based on the presence of three clinical findings was created to predict retinal detachment. After prospective validation with independent cohorts, the Retinal Detachment after Open Globe Injury (RD-OGI) Score may be useful for helping the ophthalmologist predict which patients are at high risk for retinal detachment after open globe trauma.

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Figure 1.

Time to retinal detachment after open globe injury Of the 255 confirmed retinal detachments, 27% (69/255) were identified within 24 hours after open globe injury repair, 47% (119/255) within the first week, and 72% (183/255) within the first month. Of the 255 patients found to have retinal detachment, 5% (14/255) detached more than one year after the open globe injury.

Table 1

Demographics of patients presenting with open globe injury (OGI)

Variable	No retinal detachment (n=638)	Retinal detachment (n=255)	P value
Mean age	38 ± 23* (Range: 3 months-98 years old)	46 ± 23* (Range: 2-96 years old)	<0.0001*
Male	509/638 (80%)	198/255 (78%)	0.48
Median visual acuity at presentation after open globe injury	20/400	Light Perception	<0.001[‡]
20/40	113/638 (18%)	0/255 (0%)	<0.001 [‡]
20/80 and <20/40	96/638 (15%)	2/255 (1%)	<0.001 [‡]
20/200 and <20/80	68/638 (11%)	2/255 (1%)	<0.001 [‡]
20/400 and <20/200	26/638 (4%)	4/255 (2%)	0.07 [‡]
Count fingers (CF)	62/638 (10%)	9/255 (4%)	0.001 [‡]
Hand motion (HM)	117/638 (18%)	62/255 (24%)	0.04
Light perception (LP)	98/638 (15%)	129/255 (51%)	<0.001
No light perception (NLP)	9/638 (1%)	33/255 (13%)	<0.001
Missing	49/638 (8%)	14/255 (5%)	0.25
Afferent Pupillary Defect (APD)	52/638 (8%)	87/255 (34%)	<0.001
Vitreous hemorrhage	205/638 (32%)	217/255 (85%)	<0.001

P values calculated with the χ^2 test, unless otherwise specified

* Students' t test; Plus-minus values are means ± standard deviation (SD)

[‡] Fisher exact test[‡] Mann-Whitney U test

Table 2

Location and mechanism of the traumatic wound

Variable	No retinal detachment (n=638) Zone of Injury	Retinal detachment (n=255)	P value
Zone I (highest)	309/638 (48%)	31/255 (12%)	<0.001
Zone II injury (highest)	193/638 (30%)	80/255 (31%)	0.74
Zone I,II	75/638 (12%)	27/255 (11%)	0.62
Zone II only	118/638 (18%)	53/255 (21%)	0.43
Zone III injury (highest)	83/638 (13%)	125/255 (49%)	<0.001
Zone I,III	0/638 (0%)	2/255 (1%)	0.08 [†]
Zone II,III	9/638 (1%)	24/255 (9%)	<0.001
Zone I,II,III	23/638 (4%)	33/255 (13%)	<0.001
Zone III only	51/638 (8%)	66/255 (26%)	<0.001
Zone data missing	53/638 (8%)	19/255 (7%)	0.67
Ocular Trauma Score (OTS) mechanism:			
Rupture (all)	215/638 (34%)	157/255 (62%)	<0.001
Rupture only	211/638 (33%)	153/255 (60%)	<0.001
Rupture with retained			
Intraocular	4/638 (1%)	4/255 (2%)	0.24 [†]
Foreign Body (IOFB)			
OTS mechanism:			
Lacerations (all) (all penetrations, IOFBs, and perforations)	408/638 (64%)	96/255 (38%)	<0.001
Penetrating injuries (all)	398/638 (62%)	86/255 (34%)	<0.001
Penetrating only	309/638 (48%)	49/255 (19%)	<0.001
Penetrating with retained IOFB	89/638 (14%)	37/255 (15%)	0.83
Intraocular Foreign Body (IOFB) (all IOFBs, including eyes with missing OTS mechanism)	94/638 (15%)	42/255 (16%)	0.51
Perforating injuries (all)	5/638 (1%)	6/255 (2%)	0.09[†]
Perforating only	5/638 (1%)	5/255 (2%)	0.13 [†]
Perforating with retained IOFB	0/638 (0%)	1/255 (1%)	0.29 [†]
OTS mechanism missing	20/638 (3%)	6/255 (2%)	0.66[†]

P values calculated with the χ^2 test, unless otherwise specified[†] Fisher exact test

Table 3

Proportion of eyes with retinal detachment by presenting clinical sign

Clinical variable	Proportion of eyes that developed retinal detachment (95% confidence interval)
20/40	0% (0%)
20/80 and <20/40	2% (0%-5%)
20/200 and <20/80	3% (0%-7%)
20/400 and <20/200	13% (4%-26%)
Count fingers (CF)	13% (5%-21%)
Hand motion (HM)	35% (28%-42%)
Light perception (LP)	57% (50%-63%)
No light perception (NLP)	79% (66%-92%)
Vitreous hemorrhage	51% (47%-56%)
Zone I injury	9% (6%-12%)
Zone II injury	29% (24%-35%)
Zone III injury	60% (53%-67%)
Rupture injury	42% (37%-47%)
Laceration Injury	19% (16%-22%)
Penetrating injury	18% (14%-21%)
Intraocular Foreign Body	31% (23%-39%)
injury	
Perforating injury	55% (19%-89%)

Table 4

Multivariable logistic regression: Clinical variables associated with retinal detachment

Variable	Unadjusted Odds Ratio (OR)	95% confidence interval	P value		Adjusted Odds Ratio (OR)	95% confidence interval (bias-corrected)	P value
Age	1.01	1.01-1.02	<0.001	-	-	-	-
Visual Acuity at presentation	3.08	2.58-3.67	<0.001	Visual Acuity at presentation ^{*†}	2.41	2.01-2.89	<0.001
Snellen equivalent: 20/20	1	-	-	Snellen equivalent: 20/20	1	-	-
Snellen equivalent: 20/30	1.22	1.19-1.26	<0.001	Snellen equivalent: 20/30	1.17	1.13-1.21	<0.001
Snellen equivalent: 20/40	1.4	1.33-1.48	<0.001	Snellen equivalent: 20/40	1.3	1.23-1.37	<0.001
Snellen equivalent: 20/63	1.75	1.61-1.92	<0.001	Snellen equivalent: 20/63	1.55	1.42-1.70	<0.001
Snellen equivalent: 20/100	2.2	1.94-2.48	<0.001	Snellen equivalent: 20/100	1.85	1.63-2.10	<0.001
Snellen equivalent: 20/200	3.08	2.58-3.67	<0.001	Snellen equivalent: 20/200	2.41	2.01-2.89	<0.001
Snellen equivalent: 20/400	4.32	3.43-5.42	<0.001	Snellen equivalent: 20/400	3.14	2.48-3.97	<0.001
Snellen equivalent: Count fingers at 2 ft.	9.49	6.66-13.47	<0.001	Snellen equivalent: Count fingers at 2 ft.	5.81	4.04-8.35	<0.001
Snellen equivalent: Hand motion at 2 ft.	29.22	17.17-49.43	<0.001	Snellen equivalent: Hand motion at 2 ft.	14.00	8.12-24.14	<0.001
Snellen equivalent: Light Perception	89.99	44.31-181.41	<0.001	Snellen equivalent: Light Perception	33.73	16.32-69.76	<0.001
Snellen equivalent: No Light Perception	277.00	114.31-665.78	<0.001	Snellen equivalent: No Light Perception	81.30	32.80-201.60	<0.001
Afferent Pupillary Defect	5.83	3.97-8.57	<0.001	-	-	-	-
Ocular Trauma Score Mechanism (Penetration, Perforation, Rupture)	1.55	1.36-1.77	<0.001	-	-	-	-
Penetration	1.00	-	-	-	-	-	-
Perforation	1.55	1.36-1.77	<0.001	-	-	-	-
Rupture	2.40	1.85-3.13	<0.001	-	-	-	-
Zone of Injury (I, II, III)	3.85	3.07-4.82	<0.001	Zone of Injury [†] (I, II, III)	2.51	1.86-3.39	<0.001
Zone I injury	1.00	-	-	Zone I injury	1.00	-	-
Zone II injury	3.85	3.07-4.82	<0.001	Zone II injury	2.51	2.05-3.80	<0.001
Zone III injury	14.79	9.41-23.21	<0.001	Zone III injury	6.30	3.46-11.49	<0.001
Retained Intraocular Foreign Body (IOFB)	1.14	0.77-1.70	0.51	-	-	-	-
Vitreous hemorrhage	14.76	10.04-21.70	<0.001	Vitreous hemorrhage	7.29	4.42-12.05	<0.001

-logMAR 0, Snellen 20/20 = OR: 1 (2.41⁰); logMAR 1, Snellen 20/200 = OR: 2.41 (2.41¹); logMAR 2, Snellen Count Fingers = OR: 5.81 (2.41²), etc.

-Zone I= OR: 1 (2.51⁰); Zone II= OR: 2.51 (2.51¹); Zone III= OR: 6.3 (2.51²).

* Visual acuity is presented as the Snellen equivalent of Logarithm of the Minimum Angle of Resolution (logMAR)

[†] Odds increase with each increasing integer, e.g.:

Table 5

Probability of developing retinal detachment based on initial clinical findings

Clinical variable at presentation after open globe injury*	Retinal Detachment After Open Globe Injury (RD-OGI) pointst [†] :	β coefficient	p value
Visual acuity better than Count Fingers	0	-	-
Count Fingers (CF) at 2 ft.	1	1.02	0.03
Hand Motion (HM) at 2 ft.	2	2.04	<0.001
Light Perception	2.5	2.44	<0.001
No Light Perception	3.5	3.58	<0.001
Zone I injury*	0	-	-
Zone II injury*	0.5	0.62	0.023
Zone III injury*	2	1.83	<0.001
Vitreous Hemorrhage	2	2.04	<0.001
Sum of RD-OGI Points		Probability of developing retinal detachment	
0.0		1%	
0.5		2%	
1.0		3%	
1.5		4%	
2.0		7%	
2.5		10%	
3.0		16%	
3.5		24%	
4.0		34%	
4.5		46%	
5.0		58%	
5.5		69%	
6.0		79%	
6.5		86%	
7.5		95%	

* For zone of injury, only the highest zone is counted. For example, a Zone II-III injury would received 2 points.

[†] β coefficients for these dummy variables were rounded to the nearest half integer to create the RD-OGI points