• Clinical Research •

Risk factors for postoperative blindness in primary rhegmatogenous retinal detachment: insights from first presentation to a tertiary center in China

Hai-Qin Zhu[1], Hui-Min Rao[2], Chun Xiao[2], Qin-Tuo Pan[1,3], Zhao-Liang Zhang[1,3], Zong-Duan Zhang[1,3], Ying Wang[2], Xu-Ting Hu[1,2,3]

[1]National Clinical Research Center for Ocular Diseases, Eye Hospital, Wenzhou Medical University, Wenzhou 325027, Zhejiang Province, China

[2]The First People's Hospital of Aksu District in Xinjiang, Aksu 843099, Xinjiang Uyghur Autonomous Region, China

[3]State Key Laboratory of Ophthalmology, Optometry and Visual Science, Eye Hospital, Wenzhou Medical University, Wenzhou 325027, Zhejiang Province, China

Correspondence to: Xu-Ting Hu. 270 Xueyuan Road, Wenzhou 325027, Zhejiang Province, China. hxt@wmu.edu.cn; Ying Wang. 26 Beijing West Road, Aksu 843099, Xinjiang Uyghur Autonomous Region, China. 982491110@qq.com

Received: 2024-09-23 Accepted: 2025-02-13

Abstract

● **AIM:** To identify risk factors for postoperative blindness in patients with primary rhegmatogenous retinal detachment (RRD) at their first presentation to a tertiary center, using a large clinical database to improve understanding of this adverse outcome.

● **METHODS:** Electronic health records of patients with primary RRD from the Eye Hospital of Wenzhou Medical University were retrospectively analyzed. Postoperative blindness was defined according to the World Health Organization (WHO) criteria for legal blindness. Potential risk factors included demographic characteristics, preoperative clinical features, and surgical variables. Univariable and multivariable logistic regression analyses were performed to calculate odds ratios (ORs) and 95% confidence intervals (CIs) for each risk factor.

● **RESULTS:** A total of 532 patients were included in the cohort, of whom 62 (12.0%; 28 males, 34 females) developed postoperative blindness at the final follow-up. Among these 62 patients, 30 had high myopia and 32 did not. The mean age of participants was 49.0±16.4y, with 275 subjects (52%) being male and 133 patients (25%) having the condition in the right eye. In the multivariable model for all patients, the following factors were associated with an increased risk of postoperative blindness: higher preoperative logarithm of the minimum angle of resolution visual acuity (logMAR VA; OR=1.09 per 0.1 logMAR unit increase, 95%CI 1.03-1.15); inferior or superior retinal breaks (OR=2.42, 95%CI 1.12-5.24); and macular holes or superior retinal breaks (OR=8.46, 95%CI 3.45-20.75). In the subgroup of patients with high myopia, risk factors for postoperative blindness included: pseudophakia/aphakia versus phakia (OR=6.33, 95%CI 1.41-28.31); macular holes or superior retinal breaks (OR=15.15, 95%CI 3.07-74.85); and proliferative vitreoretinopathy (PVR; OR=21.41, 95%CI 2.14-214.57). In the subgroup of patients without high myopia, increased risk of postoperative blindness was associated with: higher preoperative logMAR VA (OR=1.11 per 0.1 logMAR unit increase, 95%CI 1.04-1.18); and inferior or superior retinal breaks (OR=2.90, 95%CI 1.19-7.06).

● **CONCLUSION:** Using a large real-world clinical database, we identified distinct risk factors for postoperative blindness in patients with primary RRD-including differences between those with and without high myopia. These findings emphasize the need to target specific risk factors in clinical practice to mitigate and reduce the incidence of postoperative blindness in this patient population.

● **KEYWORDS:** postoperative blindness; primary rhegmatogenous retinal detachment; risk factors; high myopia; visual acuity

DOI:10.18240/ijo.2025.12.11

Citation: Zhu HQ, Rao HM, Xiao C, Pan QT, Zhang ZL, Zhang ZD, Wang Y, Hu XT. Risk factors for postoperative blindness in primary rhegmatogenous retinal detachment: insights from first presentation to a tertiary center in China. *Int J Ophthalmol* 2025;18(12):2304-2311

INTRODUCTION

Rhegmatogenous retinal detachment (RRD) is a severe ophthalmic condition with a significant risk of blindness if not treated promptly. Annually, it affects approximately 12.17 per 100 000 individuals[1]. While predominantly affecting

individuals aged 50-70y, RRD is also increasingly observed in younger myopic patients, a trend associated with the global rise in myopia[2]. Despite advancements in ophthalmic surgical techniques, postoperative visual acuity remains suboptimal, with 5% to 28% of patients unable to achieve a visual acuity better than 20/400[3-4].

Blindness represents a critical public health challenge with severe repercussions. Conditions such as RRD not only cause visual impairment but also lead to significant reductions in mobility and overall quality of life[5]. The associated visual impairments increase the risk of falls, fall-related injuries, and potentially traumatic events, which in turn increases the likelihood of developing post-traumatic stress disorder[6].

Timely surgical intervention is crucial for preventing vision loss in RRD patients. Although modern vitreoretinal surgery has achieved high anatomical success rates, visual outcomes can still be variable[3-4,7]. Factors affecting postoperative visual recovery include preoperative foveal status, proliferative vitreoretinopathy (PVR), the duration of vision loss before treatment, the duration of detachment, initial best-corrected visual acuity (BCVA), and the integrity of the ellipsoid zone and external limiting membrane[8-11].

The researches on the risk factors for postoperative blindness in patients with primary RRD are limited, particularly those initially diagnosed at a tertiary center. This study aims to address this critical question by analyzing a large cohort of such patients using electronic health records from the Eye Hospital of Wenzhou Medical University (WMU) in Wenzhou, China. Our study examined demographic, clinical, and operative data collected at the initial presentation to identify disparities in the risk of blindness following clinical intervention. Our results indicate that patients with lower preoperative BCVA, macular holes, and high myopia are at an increased risk for postoperative blindness.

PARTICIPANTS AND METHODS

Ethical Approval This retrospective study focuses on patients with primary RRD who were evaluated at the Eye Hospital of WMU (Wenzhou, China) between 2017 and 2022. The Institutional Review Board of the Eye Hospital of WMU approved the study and granted a waiver of informed consent due to its retrospective nature (approval number: 2023-144-K-118-01). Participant confidentiality and data protection are still strictly maintained. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Patients and Data Collection Patients who have been diagnosed with primary RRD, undergone surgical treatment, and completed at least six months of follow-up were included in this study. Exclusion criteria included significant corneal opacification, a history of ocular trauma, previous vitreoretinal surgery, severe ocular infections or inflammatory diseases, age-related macular degeneration, diabetic retinopathy, hereditary retinal diseases or vitreoretinal dystrophies, type 1 diabetes, and severe data loss.

Data collection encompassed a broad range of variables, including patient demographics (gender and age), clinical characteristics of RRD (laterality, duration of visual symptoms, location, size, number of retinal breaks, and foveal status), preoperative ophthalmic parameters [logarithm of the minimum angle of resolution visual acuity (logMAR VA), intraocular pressure (IOP), axial length (AL), and lens status], and surgical factors, includins surgeon's experience, type of surgery [pars plana vitrectomy (PPV) or PPV+scleral buckle (SB) *vs* SB alone], and time from diagnosis to surgery. Additionally, data were collected on the presence of comorbidities such as PVR, RRD with choroidal detachment (RRD-CD), and posterior scleral staphyloma (PSS).

The World Health Organization, along with the National Programme for Control of Blindness in India, defines blindness as a BCVA of less than 20/400 in the better eye[12]. In this study, postoperative legal blindness is defined as a final BCVA of less than 20/400 in the operated eye at the last follow-up visit.

High myopia is defined as an AL exceeding 26 mm, measured using the IOL-Master (Carl Zeiss Meditec AG, Jena, Germany). PVR is categorized as grade C or higher according to the 1983 International Retinal Association classification guidelines[13]. The diagnoses of RRD-CD and PSS were confirmed using B-scan ultrasonography preoperatively. To evaluate foveal status, all patients underwent optical coherence tomography scans focused on the fovea using the Spectralis HRA optical coherence tomography (Heidelberg Engineering, Heidelberg, Germany).

Risk Factors Demographic risk factors analyzed included gender (male *vs* female), age, and laterality of detachment (right eye *vs* left eye). Preoperative risk factors encompassed the duration of visual symptoms, preoperative logMAR VA, preoperative intraocular lens, AL, lens status (phakic *vs* pseudophakic or aphakic), location of retinal breaks (inferior or macular *vs* superior), foveal status (macular-off *vs* macular-on), presence of PVR (grade C/D *vs* no or grade A/B), RRD-CD, and PSS. Surgical risk factors assessed included the surgeon's experience, type of surgery performed (PPV or PPV+SB *vs* SB alone), and the interval between diagnosis and surgical intervention.

Statistical Analysis Analyses were performed using commercially available software: SPSS (version 22.0; SPSS, Inc., Chicago, IL, USA) and GraphPad Prism (version 7.00; GraphPad Software Inc., San Diego, CA, USA). Quantitative data are presented as means±standard deviations, while qualitative variables are expressed as percentages. The

Kolmogorov-Smirnov test was used to determine whether continuous variables followed a normal distribution. For univariate analysis of categorical variables, the χ^2 test or Fisher's exact test was applied, depending on the data characteristics. Continuous variables were analyzed using either the Wilcoxon rank-sum test or Student's *t*-test, based on their distribution.

Both univariate and multivariate logistic regressions were conducted with postoperative blindness following retinal detachment surgery as the outcome variable. Predictors with a $P<0.2$ in the univariate analysis were included in a multivariate logistic regression by applying a forward conditional procedure. The associations between risk factors and postoperative blindness were quantified using odds ratios (ORs) and 95% confidence intervals (CIs) for both univariate and multivariate models. These models were assessed overall and further stratified based on the presence or absence of high myopia. The performance of the models was evaluated using the receiver operating characteristic curve and the area under the curve (AUC). All statistical tests were two-sided, and a *P*-value of less than 0.05 was considered statistically significant.

RESULTS

Our cohort comprised 532 patients with primary RRD. Among these, 191 patients (36%) had high myopia, while 341 patients (64%) did not. At the final follow-up, 62 patients (12%) were diagnosed with legal blindness, compared to 219 patients (41%) who were diagnosed preoperatively. Of these, 30 patients (16%) had high myopia, a significantly larger proportion compared to the 32 patients (9%) without high myopia ($P=0.029$). Baseline demographic and clinical characteristics for this cohort are detailed in Table 1. The mean age of participants was 49.0±16.4y, with 275 subjects (52%) being male and 133 patients (25%) having the condition in the right eye. The average preoperative logMAR VA was 1.3±0.8, the preoperative IOP was 11.4±3.7 mm Hg, and 176 patients (33%) had a duration of visual symptoms of less than 7d. The mean axial length was 25.5±2.4 mm, and 191 patients (36%) were diagnosed with high myopia. Of the cohort, 483 patients (91%) were phakic, while 49 patients (9%) were pseudophakic or aphakic. In this study, 58 eyes (11%) had PVR grade C or higher, 18 eyes (3%) had RRD-CD, and 107 eyes (20%) had PSS. The characteristics of retinal breaks and holes are summarized in Table 1. Consultant surgeons performed 449 operations (84%), with primary RRD surgery treated with SB alone in 102 cases (19%). The mean time from diagnosis to surgery was 6.3±16.9d.

Compared to the patients who did not experience postoperative blindness, those in the blind cohort exhibited a higher prevalence of pseudophakic or aphakic status (19% *vs* 8%), high myopia (48% *vs* 34%), macular hole (42% *vs* 6%), PVR (23% *vs* 9%), RRD-CD (10% *vs* 3%), PSS (44% *vs* 17%), and macular-off RRD (89% *vs* 74%). Additionally, the blind cohort had a higher mean age (56.3±13.9y) compared to the non-blind cohort (48.1±16.5y; $P<0.001$). The blind cohort also had a lower average preoperative IOP (10.3±3.5 mm Hg) compared to the non-blind cohort (11.6±3.7 mm Hg; $P=0.01$), a higher preoperative logMAR VA (1.9±0.6) compared to (1.2±0.8; $P<0.001$), and a greater AL (26.6±3.2 mm) compared to 25.4±2.3 mm ($P=0.004$). Furthermore, the blind cohort had a higher proportion of patients undergoing PPV or PPV+SB (95% *vs* 79%).

Table 2 present the results of univariable and multivariable logistic regression analyses conducted on all patients. In the univariable models, all examined variables were found to be statistically significant predictors of postoperative blindness ($P<0.05$). Specifically, higher mean age (OR 1.38 per 10y older, 95%CI 1.14-1.66, $P=0.001$), higher preoperative logMAR VA (OR 1.12 per 0.1 logMAR unit increase, 95%CI 1.07-1.16, $P<0.001$), greater AL (OR 1.20 per 1 mm longer, 95%CI 1.09-1.32, $P<0.001$), pseudophakia or aphakia/phakia (OR 2.81, 95%CI 1.38-5.74, $P=0.005$), inferior/superior retinal breaks (OR 1.70, 95%CI 0.86-3.35, $P=0.129$), macular holes/superior retinal breaks (OR 14.34, 95%CI 7.01-29.34, $P<0.001$), PVR (OR 2.82, 95%CI 1.44-5.53, $P=0.002$), RRD-CD (OR 4.09, 95%CI 1.48-11.32, $P=0.007$), PSS (OR 3.76, 95%CI 2.16-6.56, $P<0.001$), macular-off RRD (OR 2.82, 95%CI 1.25-6.35, $P=0.013$), and PPV or PPV+SB/SB alone (OR 5.25, 95%CI 1.61-17.10, $P=0.006$) were all associated with an increased risk of postoperative blindness. Conversely, higher preoperative IOP (OR 0.91 per 1mm Hg higher, 95%CI 0.84-0.98, $P=0.011$) was associated with a decreased risk of postoperative blindness. The associations identified in the univariable models, particularly those related to higher preoperative logMAR VA and the location of retinal breaks, remained statistically significant and retained the same directionality in the multivariable logistic regression model. The AUC for the overall multivariable model was 0.80, as depicted in Figure 1.

Table 3 presents the results of univariable and multivariable logistic regression analyses for patients with high myopia. In the univariable models, all assessed risk factors were significantly associated with postoperative blindness, except for inferior/superior retinal breaks, RRD-CD, macular-off RRD, and PPV or PPV+SB/SB alone. These associations maintained the same directionality as observed in the models for all patients. In the multivariable logistic regression model, only three variables remained statistically significant: pseudophakia or aphakia/phakia (OR 6.33, 95%CI 1.41-28.31, $P=0.016$), macular holes/superior retinal breaks (OR 15.15,

Table 1 Summary statistics for the study cohort overall and stratified by postoperative blindness status *n* (%)

Variable	All (*n*=532)	Legal blindness (*n*=62; 12%)	Not blindness (*n*=470; 88%)	*P*
Gender, male	275 (52)	28 (45)	247 (53)	0.274
Age (y)	49.0±16.4	56.3±13.9	48.1±16.5	<0.001
Eye, right	133 (25)	12 (19)	121 (26)	0.275
Duration of visual symptoms<7d	176 (33)	18 (29)	158 (34)	0.471
Preoperative logMAR VA	1.3±0.8	1.9±0.6	1.2±0.8	<0.001
Preoperative IOP (mm Hg)	11.4±3.7	10.3±3.5	11.6±3.7	0.010
Axial length (mm)	25.5±2.4	26.6±3.2	25.4±2.3	0.004
High myopia	191 (36)	30 (48)	161 (34)	0.029
Lens status				
Phakia	483 (91)	50 (81)	433 (92)	
Pseudophakia or aphakia	49 (9)	12 (19)	37 (8)	0.003
Number of breaks				
1	220 (41)	32 (52)	188 (40)	
2-3	211 (40)	23 (37)	188 (40)	
≥4	101 (19)	7 (11)	94 (20)	0.129
Size of breaks (<1 clock hour)	474 (89)	53 (86)	421 (90)	0.331
Location of retinal breaks				
Superior	296 (56)	18 (29)	278 (59)	
Inferior	182 (34)	18 (29)	164 (35)	
Macular	54 (10)	26 (42)	28 (6)	<0.001
Proliferative vitreoretinopathy	58 (11)	14 (23)	44 (9)	0.002
Choroidal detachment	18 (3)	6 (10)	12 (3)	0.012
Posterior scleral staphyloma	107 (20)	27 (44)	80 (17)	<0.001
Macular-off RRD	401 (75)	55 (89)	346 (74)	0.010
Consultant surgeons	449 (84)	50 (81)	399 (85)	0.386
Time to initial repair (d)	6.3±16.9	5.7±5.8	6.4±17.8	0.778
Type of surgery				
SB	102 (19)	3 (5)	99 (21)	
PPV or PPV+SB	430 (81)	59 (95)	371 (79)	0.002

logMAR: Logarithm of the minimum angle of resolution; VA: Visual acuity; IOP: Intraocular pressure; RRD: Rhegmatogenous retinal detachment; SB: Scleral buckling; PPV: Pars plana vitrectomy.

Table 2 Univariable and multivariable logistic regression models for all patients

Variable	Univariable		Multivariable	
	OR (95%CI)	*P*	OR (95%CI)	*P*
Age (per 10y)	1.38 (1.14, 1.66)	0.001	1.15 (0.90, 1.48)	0.262
Preoperative BCVA (per 0.1 logMAR)	1.12 (1.07, 1.16)	<0.001	1.09 (1.03, 1.15)	0.001
Preoperative IOP (per 1 mm Hg)	0.91 (0.84, 0.98)	0.011	0.95 (0.87, 1.04)	0.259
Axial length (per 1 mm)	1.20 (1.09, 1.32)	<0.001	1.11 (0.93, 1.33)	0.236
Lens status (pseudophakia or aphakia/phakia)	2.81 (1.38, 5.74)	0.005	1.92 (0.82, 4.46)	0.132
Location of retinal breaks				
Superior	REF		REF	
Inferior	1.70 (0.86, 3.35)	0.129	2.42 (1.12, 5.24)	0.024
Macular	14.34 (7.01, 29.34)	<0.001	8.46 (3.45, 20.75)	<0.001
Proliferative vitreoretinopathy (yes/no)	2.82 (1.44, 5.53)	0.002	1.95 (0.83, 4.62)	0.127
Choroidal detachment (yes/no)	4.09 (1.48, 11.32)	0.007	1.42 (0.39, 5.17)	0.598
Posterior scleral staphyloma (yes/no)	3.76 (2.16, 6.56)	<0.001	1.03 (0.37, 2.89)	0.952
Macular-off RRD (yes/no)	2.82 (1.25, 6.35)	0.013	0.64 (0.22, 1.86)	0.414
Type of surgery (PPV or PPV+SB/SB)	5.25 (1.61, 17.10)	0.006	1.40 (0.34, 5.72)	0.637

OR: Odds ratio; CI: Confidence interval; BCVA: Best-corrected visual acuity; logMAR: Logarithm of the minimum angle of resolution; IOP: Intraocular pressure; RRD: Rhegmatogenous retinal detachment; PPV: Pars plana vitrectomy; SB: Scleral buckling.

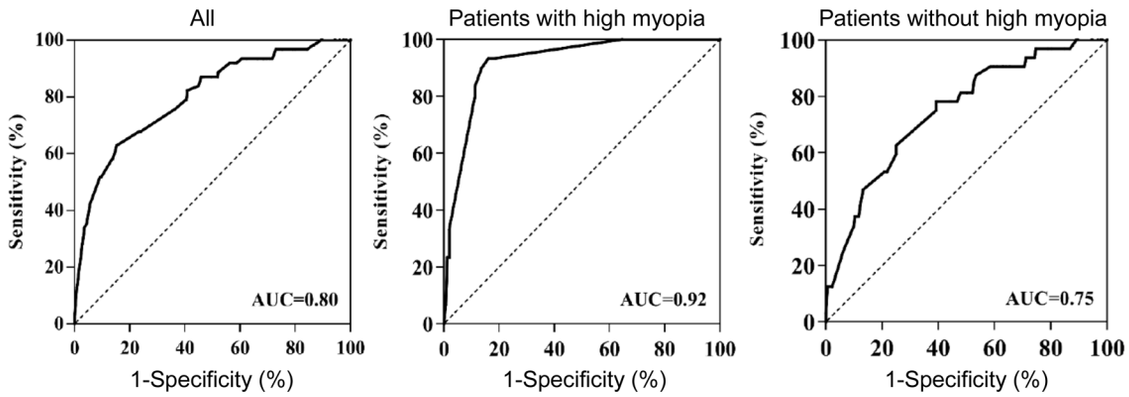

Figure 1 Receiver operating characteristic (ROC) curves showing the ability of the predicted probabilities of postoperative blindness derived from the multivariable logistic regression model The panel on the left is for all patients whereas on the right there are curves for patients with high myopia and patients without high myopia. The area under the ROC curve (AUC) for the 3 models is 0.80, 0.92, and 0.75, respectively.

Table 3 Univariable and multivariable logistic regression models for patients with high myopia

Variable	Univariable		Multivariable	
	OR (95%CI)	*P*	OR (95%CI)	*P*
Age (per 10y)	1.96 (1.47, 2.63)	<0.001	1.52 (0.95, 2.45)	0.084
Preoperative BCVA (per 0.1 logMAR)	1.13 (1.06, 1.19)	<0.001	1.04 (0.93, 1.17)	0.478
Preoperative IOP (per 1 mm Hg)	0.86 (0.76, 0.97)	0.013	0.93 (0.79, 1.10)	0.403
Axial length (per 1 mm)	1.39 (1.14, 1.69)	0.001	1.32 (0.90, 1.94)	0.162
Lens status (Pseudophakia or aphakia/phakia)	7.55 (2.80, 20.38)	<0.001	6.33 (1.41, 28.31)	0.016
Location of retinal breaks				
Superior	REF		REF	
Inferior	0.97 (0.25, 3.77)	0.968	0.68 (0.08, 5.86)	0.725
Macular	19.52 (6.45, 59.06)	<0.001	15.15 (3.07, 74.85)	0.001
Proliferative vitreoretinopathy (yes/no)	7.86 (2.43, 25.46)	0.001	21.41 (2.14, 214.57)	0.009
Choroidal detachment (yes/no)	5.68 (0.77, 41.99)	0.089	0.24 (0.01, 5.40)	0.366
Posterior scleral staphyloma (yes/no)	6.50 (2.37, 17.84)	<0.001	0.57 (0.10, 3.10)	0.514
Macular-off RRD (yes/no)	3.18 (0.92, 11.02)	0.069	0.53 (0.05, 5.54)	0.598
Type of surgery (PPV or PPV+SB/SB)	NA		NA	

OR: Odds ratio; CI: Confidence interval; BCVA: Best-corrected visual acuity; logMAR: Logarithm of the minimum angle of resolution; IOP: Intraocular pressure; RRD: Rhegmatogenous retinal detachment; PPV: Pars plana vitrectomy; SB: Scleral buckling.

95%CI 3.07-74.85, *P*=0.001), and PVR (OR 21.41, 95%CI 2.14-214.57, *P*=0.009).

Table 4 summarizes the results of univariable and multivariable logistic regression analyses for patients without high myopia. In the univariable models, a higher preoperative logMAR VA (OR 1.11 per 0.1 logMAR unit increase, 95%CI 1.05-1.17, *P*<0.001), macular holes/superior retinal breaks (OR 6.96, 95% CI 2.10-23.03, *P*=0.001), and RRD-CD (OR 4.27, 95%CI 1.26-14.51, *P*=0.020) were all associated with an increased risk of postoperative blindness. Among these factors, only a higher preoperative logMAR VA remained statistically significant in the multivariable logistic regression model. Additionally, the AUC for the multivariable model was 0.92 for patients with high myopia and 0.75 for patients without high myopia, as shown in Figure 1.

DISCUSSION

In this study, we identified demographic, clinical, and surgical risk factors for postoperative blindness in patients with primary RRD during their initial consultation at a tertiary center in China. Overall, the incidence of blindness at the final follow-up was relatively low, at 12%. However, this rate was significantly higher among patients with high myopia (16%) compared to those without high myopia (9%). In a multivariable model analysis involving all primary RRD patients, inferior retinal breaks and macular holes, compared to superior retinal breaks, along with higher preoperative logMAR VA, were identified as significant risk factors for postoperative blindness.

In our analysis of primary RRD stratified by high myopia status, we observed distinct differences in risk factors for postoperative blindness across the various diagnostic groups.

Table 4 Univariable and multivariable logistic regression models for patients without high myopia

Variable	Univariable		Multivariable	
	OR (95%CI)	*P*	OR (95%CI)	*P*
Age (per 10y)	1.12 (0.87, 1.44)	0.398	1.07 (0.77, 1.49)	0.673
Preoperative BCVA (per 0.1 logMAR)	1.11 (1.05, 1.17)	<0.001	1.11 (1.04, 1.18)	0.002
Preoperative IOP (per 1 mm Hg)	0.92 (0.83, 1.02)	0.100	0.95 (0.85, 1.07)	0.386
Axial length (per 1 mm)	1.10 (0.80, 1.51)	0.544	1.08 (0.77, 1.50)	0.658
Lens status (pseudophakia or aphakia/phakia)	0.70 (0.16, 3.07)	0.633	0.56 (0.12, 2.69)	0.464
Location of retinal breaks				
Superior	REF		REF	
Inferior	2.17 (0.98, 4.78)	0.056	2.90 (1.19, 7.06)	0.019
Macular	6.96 (2.10, 23.03)	0.001	3.55 (0.89, 14.17)	0.073
Proliferative vitreoretinopathy (yes/no)	2.00 (0.81, 4.93)	0.134	1.18 (0.40, 3.48)	0.762
Choroidal detachment (yes/no)	4.27 (1.26, 14.51)	0.020	2.11 (0.49, 9.02)	0.316
Posterior scleral staphyloma (yes/no)	1.99 (0.42, 9.52)	0.387	1.30 (0.21, 8.01)	0.781
Macular-off RRD (yes/no)	2.53 (0.86, 7.43)	0.092	0.66 (0.18, 2.47)	0.537
Type of surgery (PPV or PPV+SB/SB)	1.56 (0.46, 5.36)	0.477	0.89 (0.19, 4.15)	0.885

OR: Odds ratio; CI: Confidence interval; BCVA: Best-corrected visual acuity; logMAR: Logarithm of the minimum angle of resolution; IOP: Intraocular pressure; RRD: Rhegmatogenous retinal detachment; PPV: Pars plana vitrectomy; SB: Scleral buckling.

Specifically, while the location of retinal breaks significantly predicted blindness in both RRD with and without high myopia, certain predictors emerged as exclusive to each subgroup: macular holes were significant predictors solely for RRD associated with high myopia, whereas inferior retinal breaks specifically predicted blindness in cases without high myopia. This is expected, as macular hole retinal detachment is anticipated to be particularly prevalent among East Asian individuals with high myopia, and this subgroup's surgical outcomes are frequently suboptimal[2,14]. In patients without high myopia, the presence of inferior retinal tears is significantly linked to recurrent retinal detachment following initial surgery, which subsequently impacts postoperative visual recovery[15-18].

In our multivariable model, a higher preoperative logMAR VA was identified as a significant predictor of postoperative blindness in patients with primary RRD who did not have high myopia; however, this predictive value was not observed in patients with high myopia. Poor preoperative VA often reflects extensive macular detachment or chronic retinal changes, which impair photoreceptor recovery post-surgery. In non-high myopia, these factors are more critical than structural abnormalities, as the retina is typically less degenerated[19]. Despite high-level evidence indicating that better preoperative BCVA is generally associated with improved postoperative BCVA[10,20-21], which aligns with our findings for the overall population and the non-high myopia group, our model suggests that preoperative BCVA is a weaker predictor of postoperative outcomes in patients with high myopia. This discrepancy may be attributed to the exclusion of cases involving high myopia, macular holes, and other retinal pathologies that could influence macular function in the evaluation of the visual prognosis of RRD in many studies[17,22-23]. Conversely, our study observed a higher prevalence of macular holes and posterior scleral staphyloma among patients with high myopia. Although univariate models indicated a predictive value of preoperative BCVA for postoperative blindness, this association was not observed in the multivariate models.

Our research findings also indicate that a history of cataract surgery is not a significant predictor of postoperative blindness in patients without high myopia but becomes a significant factor in those with high myopia. The absence of the natural lens or its replacement in high myopia, as seen in pseudophakia or aphakia, alters vitreoretinal dynamics, increasing traction on the retina. This traction is exacerbated in high myopia due to preexisting retinal thinning and posterior staphyloma, which are common in highly myopic eyes[19]. These structural changes lead to higher rates of surgical failure and poor visual outcomes. Additionally, pseudophakic retinal detachment is reported to exhibit more severe clinical manifestations and a higher incidence of undetectable retinal breaks, particularly among patients with high myopia who have posterior scleral staphyloma[24].

Our study also indicates that PVR is a significant predictor of postoperative blindness in patients with high myopia but not in those without it. This may be attributable to the elevated reoperation rates and the increased use of silicone oil tamponade associated with retinal detachment complicated by PVR, particularly in cases involving macular holes[25]. High myopia is associated with chronic retinal inflammation and

glial cell proliferation, which promote the development of PVR[26]. The exaggerated vitreoretinal traction in these eyes further exacerbates PVR, leading to recurrent detachments and poor surgical outcomes. Additionally, the presence of PSS in patients with high myopia can delay silicone oil removal postoperatively, which may contribute to high postoperative IOP and optic atrophy[27]. Furthermore, complete macular atrophy is a significant risk factor for retinal redetachment after silicone oil removal[28].

While other studies have identified factors such as macular-off RRD and time to initial repair as being associated with postoperative VA, our multivariate analysis did not find these variables to be significant risk factors. Lee *et al*[22] reported that the average final VA in patients with macula-on RRD was not statistically different from that in individuals with macula-off RRD whose macular detachment duration was ≤3d, and was better than that in patients with macula-off RRD whose macular detachment duration was ≥4d. Chen *et al*[29] postulate that patients undergoing emergency surgical procedures for RRD exhibit better visual outcomes postoperatively compared to those receiving standard inpatient surgical treatment. However, our study did not reveal these differences. In our practice, the protocol for managing fresh RRD involves performing surgery within 3d if the macula is already detached. If the macula remains attached, retinal detachment close to the macula or detachment with elevation in the upper temporal quadrant is considered an emergency, and surgery should be scheduled within 24h.

Based on our findings, we recommend: 1) Early vitrectomy with internal limiting membrane peeling and silicone oil for high myopia with macular holes; 2) Scleral buckling±vitrectomy for non-myopic RRD with inferior breaks; 3) Enhanced monitoring for PVR and IOP in high-risk cases (*e.g.*, high myopia with PVR, delayed silicone oil removal).

However, our study has several limitations. First, the definition of legal blindness varies across countries. While the U.S. defines it as visual acuity of 20/200 or worse with specific visual field requirements[12], our study used corrected vision worse than 20/400 without considering visual fields, potentially impacting conclusions. Second, as a retrospective study using electronic medical data, selection bias may exist due to incomplete 6-month follow-ups. Additionally, visual acuity as an outcome measure is limited by confounding factors like cataracts. Third, the model did not account for intraoperative or postoperative variables, such as retinal redetachment, glaucoma, delayed oil removal, or surgical techniques like subretinal fluid drainage, internal limiting membrane peeling and tamponade use. These factors, which significantly influence visual outcomes, were not included. We emphasize the need for future prospective studies to systematically collect detailed intraoperative and postoperative data for a more comprehensive analysis.

In conclusion, our study highlights the influence of demographic, clinical, and surgical variables on postoperative blindness resulting from primary RRD at a tertiary eye center. Higher preoperative logMAR VA, inferior/superior retinal breaks, and macular holes were identified as significant risk factors for postoperative blindness in all RRD cases at first presentation. However, our study also indicates potential differences in risk factors for postoperative blindness between RRD cases with high myopia and those without. Specifically, pseudophakia or aphakia and PVR were found to be more significant risk factors for postoperative blindness in RRD cases with high myopia, whereas preoperative logMAR VA and inferior/superior retinal breaks were more significant in RRD cases without high myopia. These findings provide robust data to support clinical decision-making, enabling ophthalmologists to make more informed decisions when developing surgical plans and postoperative management strategies. This, in turn, enhances the precision of interventions and optimizes long-term visual outcomes for patients.

ACKNOWLEDGEMENTS

Conflicts of Interest: Zhu HQ, None; **Rao HM,** None; **Xiao C,** None; **Pan QT,** None; **Zhang ZL,** None; **Zhang ZD,** None; **Wang Y,** None; **Hu XT,** None.

REFERENCES

1 Ge JY, Teo ZL, Chee, *et al*. International incidence and temporal trends for rhegmatogenous retinal detachment: a systematic review and meta-analysis. *Surv Ophthalmol* 2024;69(3):330-336.

2 Ohno-Matsui K, Lai TYY, Lai CC, *et al*. Updates of pathologic myopia. *Prog Retin Eye Res* 2016;52:156-187.

3 Marques JH, Castro C, Malheiro L, *et al*. Dealing with rhegmatogenous retinal detachment in patients under 40 years old: a tertiary center results. *Int Ophthalmol* 2021;41(2):475-482.

4 Ross WH. Visual recovery after macula-off retinal detachment. *Eye (Lond)* 2002;16(4):440-446.

5 Ricci FS, Boldini A, Beheshti M, *et al*. A virtual reality platform to simulate orientation and mobility training for the visually impaired. *Virtual Real* 2023;27(2):797-814.

6 Bonsaksen T, Brunes A, Heir T. Post-traumatic stress disorder in people with visual impairment compared with the general population. *Int J Environ Res Public Health* 2022;19(2):619.

7 Garweg JG, Deiss M, Pfister IB, *et al*. Impact of inner limiting membrane peeling on visual recovery after vitrectomy for primary rhegmatogenous retinal detachment involving the fovea. *Retina* 2019;39(5):853-859.

8 Haq Z, Mittra RA, Parke DW, *et al*. Impact of foveal status and timing of surgery on visual outcome in rhegmatogenous retinal detachment. *Retina* 2024;44(1):88-94.

9 Cai LZ, Lin J, Starr MR, *et al*. PRO score: predictive scoring system for visual outcomes after rhegmatogenous retinal detachment repair. *Br J Ophthalmol* 2023;107(4):555-559.

10 Zaletel Benda P, Vratanar B, Petrovski G, *et al*. Prognostic factor analysis of visual outcome after vitrectomy for rhegmatogenous retinal detachment. *J Clin Med* 2020;9(10):3251.

11 Guan I, Gupta MP, Papakostas T, *et al*. Role of optical coherence tomography for predicting postoperative visual outcomes after repair of macula-off rhegmatogenous retinal detachment. *Retina* 2021;41(10):2017-2025.

12 Vashist P, Senjam SS, Gupta V, *et al*. Definition of blindness under National Programme for Control of Blindness: Do we need to revise it? *Indian J Ophthalmol* 2017;65(2):92-96.

13 Hilton G, Machemer R, Michels R, *et al*. The classification of retinal detachment with proliferative vitreoretinopathy. *Ophthalmology* 1983;90(2):121-125.

14 Ando F, Ohba N, Touura K, *et al*. Anatomical and visual outcomes after episcleral macular buckling compared with those after pars Plana vitrectomy for retinal detachment caused by macular hole in highly myopic eyes. *Retina* 2007;27(1):37-44.

15 Abu El-Asrar AM, Al-Kwikbi HF, Kangave D. Prognostic factors after primary vitrectomy and perfluorocarbon liquids for bullous rhegmatogenous retinal detachment. *Eur J Ophthalmol* 2009;19(1):107-117.

16 Martínez-Castillo VJ, García-Arumí J, Boixadera A. Pars Plana vitrectomy alone for the management of pseudophakic rhegmatogenous retinal detachment with only inferior breaks. *Ophthalmology* 2016;123(7):1563-1569.

17 Mancino R, Aiello F, Ciuffoletti E, *et al*. Inferior retinotomy and silicone oil tamponade for recurrent inferior retinal detachment and grade C PVR in eyes previously treated with pars Plana vitrectomy or scleral buckle. *BMC Ophthalmol* 2015;15:173.

18 Zhou CD, Qiu QH, Zheng Z. Air versus gas tamponade in rhegmatogenous retinal detachment with inferior breaks after 23-gauge pars Plana vitrectomy: a Prospective, Randomized Comparative Interventional Study. *Retina* 2015;35(5):886-891.

19 Nishimura S, Okuda T, Higashide T, *et al*. Preoperative retinal detachment variables causing macular detachment. *Clin Ophthalmol* 2025;19:11-18.

20 Baba T, Kawasaki R, Yamakiri K, *et al*. Visual outcomes after surgery for primary rhegmatogenous retinal detachment in era of microincision vitrectomy: Japan-Retinal Detachment Registry Report IV. *Br J Ophthalmol* 2021;105(2):227-232.

21 Suzuki N, Kunikata H, Aizawa N, *et al*. Predicting visual outcomes for macula-off rhegmatogenous retinal detachment with optical coherence tomography. *J Ophthalmol* 2014;2014:269837.

22 Lee CS, Shaver K, Yun SH, *et al*. Comparison of the visual outcome between macula-on and macula-off rhegmatogenous retinal detachment based on the duration of macular detachment. *BMJ Open Ophthalmol* 2021;6(1):e000615.

23 Gotzaridis S, Liazos E, Petrou P, *et al*. 25-gauge vitrectomy and incomplete drainage of subretinal fluid for the treatment of primary rhegmatogenous retinal detachment. *Ophthalmic Surg Lasers Imaging Retina* 2016;47(4):333-335.

24 Moussa G, Jalil A, Lippera M, *et al*. SF_6 compared with C2F6 for inferior rhegmatogenous retinal repair: The Manchester Pseudophakic Retinal Detachment Study. *Retina* 2024;44(5):791-798.

25 Grosinger AJ, Nicholson BP, Shah SM, *et al*. Time to unplanned return to the operating room and associated risk factors in patients with surgical retinal detachment repair. *Am J Ophthalmol* 2021;229:18-25.

26 Qiao X, Shah W, Gao XQ, *et al*. Understanding how the immune system environment is controlled in high myopia cases. *Int Immunopharmacol* 2024;143:113138.

27 Han L, Cairns JD, Campbell WG, *et al*. Use of silicone oil in the treatment of complicated retinal detachment: results from 1981 to 1994. *Aust N Z J Ophthalmol* 1998;26(4):299-304.

28 Li MY, Tang JY, Jia ZX, *et al*. Long-term follow-up of primary silicone oil tamponade for retinal detachment secondary to macular hole in highly myopic eyes: a prognostic factor analysis. *Eye (Lond)* 2021;35(2):625-631.

29 Chen ZY, Gao K, Lai KB, *et al*. Effects of the implementation of an emergency surgical pattern in patients with rhegmatogenous retinal detachment: a retrospective observational study. *J Ophthalmol* 2022;2022:4240225.