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# PREDICTORS OF VISUAL RECOVERY FOLLOWING PARS PLANA VITRECTOMY FOR NONCLEARING VITREOUS HEMORRHAGE IN PATIENTS WITH PROLIFERATIVE DIABETIC RETINOPATHY

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**ABSTRACT**

**Background: Objective:** To identify preoperative factors that predict visual recovery six months after pars plana vitrectomy for nonclearing vitreous hemorrhage in proliferative diabetic retinopathy.

**Material and Methods:** This retrospective cohort pooled 260 adults operated on at three tertiary ophthalmology units in Pakistan during 2024, with one eye studied per patient. Good recovery meant best-corrected visual acuity of 6/18 or better. Baseline ocular and systemic factors were assessed with multivariable logistic regression, and postoperative events were reported separately.

**Results:** Six-month outcomes were available for 246 patients, of whom 117 achieved good recovery (47.6%; 95% confidence interval, 41.4–53.8%). Complete previous photocoagulation was linked to higher odds of recovery (adjusted odds ratio, 2.46; 95% confidence interval, 1.33–4.54), whereas extramacular traction (0.28; 0.13–0.61) and hand-movement/light-perception vision (0.20; 0.08–0.47) were linked to lower odds. Older age and higher glycated hemoglobin were unfavorable; better renal function was favorable. Hemorrhage duration showed no independent association. Recurrent hemorrhage developed in 45 eyes (18.3%) and 31 (12.6%) needed repeat vitrectomy. Allowing for missing outcomes, full-cohort recovery lay between 45.0% and 50.4%.

**Conclusion:** Presenting vision, previous photocoagulation, retinal traction, age, glycemic control and renal function were associated with visual recovery. These findings can guide individual counselling, but they are observational, do not prove treatment effects, and need independent validation.

**Keywords:** Proliferative diabetic retinopathy, Vitreous hemorrhage, Pars plana vitrectomy.

## INTRODUCTION

Diabetic retinopathy is still a leading cause of avoidable visual disability in adults with diabetes. A global meta-analysis estimated that more than one in five people with diabetes have retinopathy, and a smaller but substantial share have sight-threatening disease, a burden expected to grow with rising diabetes prevalence.[1]

In Pakistan, a surgical series reported visual improvement after small-gauge vitrectomy for nonclearing diabetic vitreous hemorrhage, but also recurrent bleeding and raised intraocular pressure.[2] Patients with persistent hemorrhage therefore need

to hear about both the likely recovery and the chance of further treatment.

The DRCR Retina Network Protocol AB trial compared initial aflibercept with vitrectomy and panretinal photocoagulation. Mean visual acuity over 24 weeks did not differ significantly between groups, although the confidence interval could not exclude a clinically relevant difference.[3] A secondary analysis showed faster clearance of hemorrhage after surgery and underlined how strongly presenting vision shaped early recovery.[4] Another randomized trial likewise found faster early clearance with vitrectomy plus bevacizumab, with no significant difference in visual gain at 24 weeks.[5]

Surgical technique matters as well. In one randomized trial, internal limiting membrane peeling during vitrectomy for diabetic hemorrhage gave better six-month vision and fewer epiretinal membranes.[6] In another, sulfur hexafluoride tamponade reduced postoperative bleeding compared with balanced salt solution, yet final acuity was similar.[7] Freedom from rebleeding and final visual function are clearly separate outcomes.

A multicenter analysis of 1,504 operated eyes linked postoperative vision to presenting acuity, tractional membranes, tamponade and systemic factors.[8] A prospective study tied visual outcome to previous laser treatment and intraocular disease activity, although it mixed several manifestations of advanced retinopathy.[9] Another series identified preoperative macular tractional detachment as a key prognostic sign.[10] The state of the underlying retina, and not just the density of the hemorrhage, appears to drive the result.

More recent observational work associated recurrent hemorrhage and silicone oil use with worse final vision, though the choice of tamponade also reflects surgical complexity.[11] Earlier surgery was associated with better twelve-month vision in a retrospective comparison without randomized allocation.[12] Long-term studies have also documented later surgery in both the operated and fellow eyes, so counselling must look beyond the first postoperative months.[13]

Renal impairment has been studied as a possible modifier of surgical outcome, but its effect is hard to separate from ocular severity and coexisting systemic disease.[14] In a Pakistani multicenter setting, routinely recorded clinical variables offer a practical way to estimate prognosis without costly biomarker tests. Patients and families usually want to know whether useful sight for daily life will return, not merely whether the retina will be anatomically attached. A clear visual endpoint links surgical results to that conversation, which matters when extra visits and further treatment strain household budgets. This study therefore examined preoperative predictors of six-month visual recovery after vitrectomy for nonclearing hemorrhage, describing operative features and later complications separately.

## MATERIALS AND METHODS

This retrospective multicenter cohort included 260 adults who underwent primary pars plana vitrectomy for nonclearing vitreous hemorrhage due to proliferative diabetic retinopathy at three tertiary ophthalmology units in Pakistan between January and December 2024, with follow-up continuing until July 2025. This study followed the Declaration of Helsinki and was approved by the Ethics Committee of the institutions. Because the data were retrospective and anonymized, the committee waived informed consent for this analysis. All patients gave written consent for surgery. Data from the three units were pooled, with one eye per patient. All consecutive eligible operations were included, whether or not the patient attended the final visit. The analytical file held no personal identifiers.

Patients aged 18 years or older were eligible if visually significant hemorrhage had persisted for at least twelve weeks and prevented adequate retinal view or completion of photocoagulation. Exclusion criteria were macula-involving or macula-threatening tractional detachment, combined tractional–rhegmatogenous detachment, previous vitrectomy, traumatic hemorrhage, retinal vein occlusion, or another dominant cause of visual loss. Eyes with localized extramacular traction that did not threaten the macula were kept. When both eyes qualified, the first operated eye was used.

Baseline data comprised age, sex, diabetes duration, hypertension, glycated hemoglobin, estimated glomerular filtration rate, dialysis, antithrombotic use, hemorrhage duration, lens status, previous panretinal photocoagulation and visual acuity. Photocoagulation was classed as complete or incomplete/absent, and baseline vision as chart-measurable, counting fingers, or hand movements/light perception. Extramacular traction was identified on preoperative examination and ultrasonography; a macula that could not be seen was not assumed to be normal.

Operative data comprised instrument gauge, preoperative anti-vascular endothelial growth factor injection and its interval to surgery, membrane dissection, internal limiting membrane peeling, tamponade, combined cataract surgery and retinal breaks. Every vitrectomy included endolaser. Adjuncts were chosen clinically, not randomly. Vision was assessed at one, three and six months; the six-month window ran from day 150 to day 210, and the examination closest to day 180 was used. Definitions are given in Table 1.

**Table 1: Operational definitions and outcome assessment**

| Variable | Definition |
|---|---|
| Primary outcome | Best-corrected visual acuity of 6/18 or better at six months. |
| Hemorrhage duration | Weeks from onset of the qualifying episode to surgery; minimum twelve weeks. |
| Baseline visual categories | Chart-measurable acuity, counting fingers, or hand movements/light perception. |
| Baseline traction | Localized extramacular traction without macular involvement or threat. |
| Persistent hemorrhage | Postoperative bleeding without an intervening documented clear interval. |
| Recurrent hemorrhage | New bleeding after initial clearing; early within four weeks and late thereafter. |
| Secondary visual outcomes | Acuity of 6/60 or better and paired chart-measurable logMAR change. |
| Follow-up denominator | Available examinations for visual outcomes; complete six-month records for cumulative events. |

Postoperative events and surgical choices were excluded from the preoperative predictor analysis.

Snellen acuity was converted to logMAR as the base-10 logarithm of the Snellen denominator divided by the numerator. Counting fingers and worse were kept as clinical categories rather than given arbitrary numerical values, so paired logMAR change was limited to eyes with chart acuity at baseline and six months. Persistent bleeding, recurrent hemorrhage, pressure rise needing treatment, retinal detachment, neovascular glaucoma and repeat vitrectomy were recorded separately, with cumulative events summarized for the 246 eyes with complete six-month records.

Analyses were run in Python 3.12 with NumPy and SciPy. Continuous variables are given as mean ± standard deviation or median (interquartile range). Groups were compared with Welch's t-test, the Mann–Whitney U test or Pearson's chi-square test. The logistic model contained age, baseline vision, hemorrhage duration, previous photocoagulation, traction, glycated hemoglobin and renal function, together with a study-site term to account for case-mix differences in the pooled data. Adjusted odds ratios with Wald 95% confidence intervals and two-sided p-values are reported; $p<0.05$ was considered significant.

All predictors were entered together, without stepwise selection. Collinearity was checked with variance inflation factors, and linearity of continuous terms with a joint likelihood-ratio test of quadratic terms. Apparent discrimination, calibration and Brier score describe model fit without external validation. Eyes missing the six-month outcome were left out of the main regression; in sensitivity analysis every missing endpoint was counted first as recovery and then as nonrecovery. Baseline predictor data were complete.

Records were checked for duplicate identifiers, impossible operation dates, and agreement between visit attendance and recorded acuity. Recurrent bleeding required a documented clear interval, which separated it from persistent hemorrhage. When no examination fell within the six-month window, the endpoint was coded as missing rather than carried forward from an earlier visit. Every percentage is shown with its denominator. Regression estimates reflect association with the vision attained, not with the size of improvement. With 117 recovery events and ten fitted parameters, the model had roughly twelve events per parameter.

## RESULTS

Of the 260 patients, each contributing one eye, 246 (94.6%) had six-month acuity; eleven could not be contacted and three missed the visit because of illness. Baseline characteristics are shown in Table 2.

**Table 2: Baseline characteristics of the cohort**

| Characteristic | Observed value |
|---|---|
| Patients and study eyes, n | 260 |
| Age, years, mean ± SD | 57.4 ± 9.5 |
| Women, n/N (%) | 119/260 (45.8) |
| Diabetes duration, years, median (IQR) | 14.0 (11.1–18.0) |
| Hypertension, n/N (%) | 150/260 (57.7) |
| HbA1c, %, mean ± SD | 8.4 ± 1.3 |
| eGFR, mL/min/1.73 m², median (IQR) | 72.6 (52.8–92.7) |
| Dialysis, n/N (%) | 3/260 (1.2) |
| Antithrombotic treatment, n/N (%) | 62/260 (23.8) |
| Hemorrhage duration, weeks, median (IQR) | 18.6 (15.2–22.7) |
| Complete previous PRP, n/N (%) | 104/260 (40.0) |
| Extramacular traction, n/N (%) | 56/260 (21.5) |
| Phakic eyes, n/N (%) | 168/260 (64.6) |
| Chart / CF / HM-LP baseline vision, n | 83 / 120 / 57 |

PRP: panretinal photocoagulation; HbA1c: glycated hemoglobin; eGFR: estimated glomerular filtration rate; IQR: interquartile range; SD: standard deviation. Baseline denominators were 260.

Operative details and postoperative events appear in Table 3; persistent bleeding and recurrence after initial clearing were counted separately.

**Table 3: Operative characteristics and postoperative events**

| Characteristic or event | Observed value |
|---|---|
| 23-gauge / 25-gauge surgery, n | 162 / 98 |
| Preoperative anti-VEGF, n/N (%) | 195/260 (75.0) |
| Injection interval, days, median (IQR) | 5.0 (4.0–6.0) |
| Combined cataract surgery, n/N (%) | 65/260 (25.0) |
| Membrane dissection, n/N (%) | 65/260 (25.0) |
| Internal limiting membrane peeling, n/N (%) | 47/260 (18.1) |
| Fluid / air / gas / silicone oil tamponade, n | 94 / 81 / 65 / 20 |
| Intraoperative retinal break, n/N (%) | 18/260 (6.9) |
| Persistent postoperative hemorrhage, n/N (%) | 21/246 (8.5) |
| Early / late recurrent hemorrhage, n | 28 / 17 |
| Any recurrent hemorrhage, n/N (%) | 45/246 (18.3) |
| Pressure elevation requiring treatment, n/N (%) | 35/246 (14.2) |
| Retinal detachment / neovascular glaucoma, n | 8 / 3 |
| Repeat vitrectomy, n/N (%) | 31/246 (12.6) |

Operative denominators were 260; postoperative denominators were 246. Events overlapped. Silicone oil remained in 10/246 eyes (4.1%) at six months.

Visual outcomes are shown in Table 4. Good recovery occurred in 117/246 eyes (47.6%; 95% confidence interval, 41.4–53.8%). In 80 eyes with paired chart measurements, median improvement was 0.70 logMAR (IQR, 0.40–1.00), and 64 of the 80 gained at least 0.30 logMAR.

**Table 4: Visual status at baseline and follow-up**

| Assessment | Evaluated eyes n | BCVA ≥6/18 n/N (%) | BCVA ≥6/60 n/N (%) | Below chart n |
|---|---|---|---|---|
| Baseline | 260 | 0/260 (0.0) | 44/260 (16.9) | 177 |
| One month | 254 | 59/254 (23.2) | 189/254 (74.4) | 2 |
| Three months | 250 | 101/250 (40.4) | 218/250 (87.2) | 0 |
| Six months | 246 | 117/246 (47.6) | 224/246 (91.1) | 0 |

BCVA: best-corrected visual acuity. The 6/18 category was contained within 6/60. Below-chart vision included counting fingers or worse. Denominators reflected attendance.

Unadjusted comparisons are shown in Table 5. Hemorrhage duration did not differ significantly between groups.

**Table 5: Baseline comparisons by six-month recovery**

| Baseline factor | BCVA ≥6/18 | BCVA <6/18 | p-value |
|---|---|---|---|
| Patients, n | 117 | 129 | — |
| Age, years, mean ± SD | 55.2 ± 8.9 | 59.2 ± 9.9 | <0.001 |
| Hemorrhage duration, weeks, median (IQR) | 18.3 (15.3–22.0) | 18.7 (15.2–23.9) | 0.370 |
| Chart-measurable vision, n/N (%) | 43/117 (36.8) | 37/129 (28.7) | 0.002 |
| Counting-fingers vision, n/N (%) | 60/117 (51.3) | 53/129 (41.1) | — |
| Hand movements/light perception, n/N (%) | 14/117 (12.0) | 39/129 (30.2) | — |
| Complete previous PRP, n/N (%) | 58/117 (49.6) | 43/129 (33.3) | 0.010 |
| Extramacular traction, n/N (%) | 16/117 (13.7) | 37/129 (28.7) | 0.004 |
| HbA1c, %, mean ± SD | 8.1 ± 1.3 | 8.6 ± 1.3 | 0.002 |
| eGFR, mean ± SD | 80.7 ± 25.9 | 64.8 ± 27.8 | <0.001 |

Baseline vision used one overall chi-square test. Continuous comparisons used Welch's t-test, except hemorrhage duration: Mann–Whitney U. eGFR units: mL/min/1.73 m².

Adjusted associations are shown in Table 6. The largest variance inflation factor was 1.40, and the joint quadratic-term test gave p=0.581. Apparent area under the receiver operating characteristic curve was 0.790, Brier score 0.185, and Hosmer–Lemeshow p=0.942. Counting all fourteen missing outcomes as nonrecovery or as recovery placed full-cohort recovery between 45.0% and 50.4%.

**Table 6: Adjusted associations with six-month good visual recovery**

| Preoperative predictor | Adjusted OR | 95% CI | p-value |
|---|---|---|---|
| Age, per ten years | 0.65 | 0.46–0.91 | 0.012 |
| Counting fingers versus chart vision | 0.78 | 0.40–1.53 | 0.472 |
| Hand movements/light perception versus chart vision | 0.20 | 0.08–0.47 | <0.001 |
| Hemorrhage duration, per four weeks | 0.86 | 0.69–1.08 | 0.205 |
| Complete previous PRP versus other | 2.46 | 1.33–4.54 | 0.004 |
| Extramacular traction versus absent | 0.28 | 0.13–0.61 | 0.001 |
| HbA1c, per percentage point | 0.65 | 0.51–0.83 | <0.001 |
| eGFR, per ten units | 1.22 | 1.08–1.37 | 0.001 |

OR: odds ratio; CI: confidence interval. All covariates were entered in one pooled regression that also included a study-site term; the reference category for vision was chart-measurable acuity. Estimates describe associations.

## DISCUSSION

Nearly half of the eyes regained useful vision, and the baseline condition of the eye stayed important after systemic factors were taken into account. Poor presenting vision and extramacular traction were the strongest ocular markers of a lower chance of recovery.

With recurrence in 18.3% of eyes, the possibility of further treatment should be raised before surgery. Recent studies have linked recurrent hemorrhage with severe intraoperative bleeding and certain systemic features, although small event numbers allowed only unadjusted analysis.[15] A contemporary 25-gauge cohort also examined rebleeding after diabetic vitrectomy,[16] and another study associated it with anticoagulant use and glycated hemoglobin.[17] The present model, by contrast, used only preoperative information.

Higher glycated hemoglobin went with poorer recovery, but this does not show that lowering it just before surgery improves vision. Motoda and colleagues found that longer surgery predicted postoperative bleeding, that immediately preoperative glycated hemoglobin had a borderline association, and that earlier changes did not predict rebleeding.[18] An early-vitrectomy series similarly found higher glycated hemoglobin and more hypertension in patients who rebled.[19]

Better estimated glomerular filtration rate was independently associated with better recovery. Renal disease may mark a broader burden of microvascular damage, although this was not measured directly. A Japanese cohort reported more postoperative bleeding and neovascular glaucoma in advanced nondialysis chronic kidney disease,[20] while another study found more severe ischemic changes with renal impairment but similar rates of visual improvement.[21] Differences in endpoints and ocular severity make direct comparison difficult.

Complete previous photocoagulation was associated with better odds of recovery, whereas hemorrhage duration was not. Because only eyes with at least twelve weeks of hemorrhage were included, the range of timing was narrow and early surgery could not be assessed. Adjuncts must also be judged by indication: one randomized trial favored gas over silicone oil for vision in tractional detachment or extensive fibrosis,[22] and another found fewer epiretinal membranes and more eyes reaching 20/50 after internal limiting membrane peeling in tractional detachment.[23] Neither trial settles the best adjunct for eyes with hemorrhage alone.

Rebleeding does not necessarily mean permanent visual loss. A multicenter observational study found that many late postoperative hemorrhages cleared spontaneously, although management was not randomized.[24] Long-term follow-up from China also documented later complications and frequent fellow-eye surgery, which supports counselling beyond the six-month mark.[25]

The primary endpoint measured the acuity attained, not the change from baseline. An eye starting with very poor vision can improve a great deal and still fall short of 6/18. For this reason functional recovery and paired logMAR gain were reported separately and should be read together when counselling patients.

The multicenter design and routine clinical variables are strengths. Limitations include its retrospective design, incomplete attendance at the endpoint visit, unmeasured macular ischemia, and confounding by treatment choice. Limiting numerical acuity change to paired chart measurements avoided arbitrary conversions but reduced the sample for that analysis. The missing-outcome bounds were narrow but cannot rule out selection bias, and apparent model performance does not guarantee similar performance elsewhere. The findings can inform individual counselling, but any clinical prediction tool needs independent validation.

## CONCLUSION

Six months after vitrectomy, 47.6% of evaluated eyes reached best-corrected visual acuity of 6/18 or better. Better presenting vision, complete previous photocoagulation, absence of extramacular traction, younger age, lower glycated hemoglobin and higher estimated glomerular filtration rate were associated with recovery. These associations can support individual prognostic counselling but do not establish that any treatment causes better outcomes.

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