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Research Article

Short-Term Visual Outcomes and Associated Factors After Retinal Laser Photocoagulation in Diabetic Retinopathy

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Background: Retinal laser photocoagulation remains an established treatment for sight-threatening diabetic retinopathy (DR), with its principal benefit often being preservation of existing vision rather than substantial visual acuity gain. However, short-term visual trajectories may vary according to baseline ocular and systemic characteristics. This study evaluated visual outcomes following retinal laser photocoagulation over a 6-week follow-up period and assessed associations between visual outcomes and baseline visual acuity, DR severity, glycemic status, maculopathy, diabetes duration, age, and sex.

Methods: This study included 60 patients with DR involving 100 treated eyes who underwent retinal laser photocoagulation. Best-corrected distance visual acuity (BCDVA) was assessed at baseline and at 1, 3, and 6 weeks after treatment. At 6 weeks, visual outcomes were categorized as improvement (≥2 Snellen lines), stable vision, or worsening (≥2 Snellen lines). Outcomes were evaluated according to baseline BCDVA, DR severity, HbA1c category, maculopathy status, diabetes duration, age, and sex. Longitudinal changes in BCDVA were assessed using Tukey HSD pairwise comparisons, and associations between clinical characteristics and visual outcomes were examined using appropriate statistical analyses.

Results: At 6 weeks, 17 (17.0%) of 100 treated eyes demonstrated improvement of ≥2 Snellen lines, 81 (81.0%) remained stable, and 2 (2.0%) worsened by ≥2 Snellen lines. No statistically significant differences were observed between baseline and Week 1 (mean difference, 0.03; Q = 0.64; p = 0.9698), Week 3 (mean difference, 0.05; Q = 1.37; p = 0.7664), or Week 6 (mean difference, 0.05; Q = 1.37; p = 0.7664) BCDVA. Visual outcomes varied across baseline BCDVA and DR severity categories. Diabetes duration was significantly associated with post-laser visual outcome (p = 0.02636).

Conclusion: Retinal laser photocoagulation was predominantly associated with short-term preservation of visual acuity, with 81.0% of treated eyes maintaining stable vision at 6 weeks and 17.0% demonstrating clinically meaningful improvement. Baseline visual acuity, DR severity, and diabetes duration were associated with variation in post-treatment visual outcomes. These findings emphasize the importance of baseline clinical characteristics in prognostic counseling and individualized follow-up following retinal laser photocoagulation. Further prospective studies with larger samples and longer follow-up are warranted to determine the durability of these visual outcomes.

Keywords: *Diabetic retinopathy, Retinal laser photocoagulation, Panretinal photocoagulation, Best-corrected visual acuity, Visual outcomes, Diabetes mellitus*

Introduction

Diabetes mellitus is a rapidly expanding global health challenge, with diabetic retinopathy (DR) representing one of its most important microvascular complications and a major cause of vision impairment among working-age adults. The 11th edition of the International Diabetes Federation Diabetes Atlas estimated that 589 million adults aged 20–79 years were living with diabetes globally in 2024, equivalent to approximately one in nine adults, while more than 250 million people were unaware of their condition (Genitsaridi et al., 2026; *Over 250 Million People Worldwide Unaware of Their Diabetes*, 2025). The increasing prevalence of diabetes, together with longer survival and prolonged disease duration, is consequently expanding the population at risk of retinal complications and vision-threatening visual loss. Globally, DR affects approximately one in five people with diabetes. A systematic review and meta-analysis estimated the prevalence of any DR at 22.27%, with 6.17% having vision-threatening diabetic retinopathy (VTDR) and 4.07% having diabetic macular edema (DME). The global burden is projected to increase substantially, with the number of adults with DR expected to rise from approximately 103 million in 2020 to 160.5 million by 2045, while the number with VTDR may increase from 28.5 million to 44.8 million over the same period (Teo et al., 2021). These projections underscore the growing need for early detection, appropriate treatment, and effective strategies to prevent irreversible visual loss. The burden of DR is particularly relevant in India, which has one of the world's largest populations of people living with diabetes. The risk and progression of DR are influenced by systemic and metabolic factors, particularly the duration of diabetes and glycemic control. A recent systematic review and meta-analysis of the Indian population reported that higher glycated hemoglobin (HbA1c) and blood glucose levels were associated with an increased risk of DR, emphasizing the importance of metabolic control in reducing retinal disease progression (Favas et al., 2025). The clinical spectrum of DR ranges from non-proliferative diabetic retinopathy (NPDR) to proliferative diabetic retinopathy (PDR), while DME can cause significant visual impairment at different stages of disease. Advanced DR may result in retinal ischemia, neovascularization, vitreous hemorrhage, tractional retinal detachment, and irreversible visual loss, making timely retinal assessment and intervention essential. Retinal laser photocoagulation has historically been a cornerstone in the management of sight-threatening DR. Panretinal photocoagulation (PRP) remains an established treatment for PDR, whereas focal or grid laser photocoagulation has been used for selected forms of DME. The principal therapeutic benefit of laser treatment is often better characterized as preservation of useful vision and prevention of severe visual deterioration rather than restoration of lost visual acuity. Evidence from landmark clinical trials and systematic reviews demonstrates that PRP substantially reduces the risk of severe visual loss and limits the progression and complications of PDR, although substantial improvement in central visual acuity is not consistently observed (Chew et al., 2003; Evans et al., 2014; Wang et al., 2024). Therefore, maintenance of visual acuity or prevention of further deterioration may itself represent an important indicator of treatment success. However, visual outcomes following retinal laser photocoagulation are heterogeneous. The response may vary according to baseline visual acuity, severity of DR, macular involvement, duration of diabetes, and systemic glycemic status (Reid et al., 2022; Rema et al., 2005; Sheth & Popat, 2026). Previous observational studies have reported varying degrees of visual improvement and stabilization following laser treatment, suggesting that the functional response cannot be predicted solely by the application of laser therapy itself (Sheth & Popat, 2016; Shrestha et al., 2007). Characterizing factors associated with visual improvement, stabilization, or deterioration may therefore assist clinicians in establishing realistic expectations, providing individualized prognostic counseling, and identifying patients who may require closer post-treatment monitoring. Importantly, preservation of central visual acuity does not necessarily indicate preservation of overall visual function. PRP may be associated with peripheral visual field changes and alterations in other aspects of visual performance, potentially affecting mobility, driving, and vision-related quality of life (Lee et al., 2025; Vasilijević et al., 2022). Nevertheless, the ability of laser photocoagulation to prevent severe, sight-threatening complications remains its principal clinical value. The introduction of intravitreal anti-vascular endothelial growth factor (anti-VEGF) therapy has expanded treatment options for PDR and DME, with evidence suggesting potential advantages in visual outcomes for selected patients. However, laser photocoagulation continues to have an important role because of its established efficacy in reducing severe visual loss and its durable therapeutic effect (Everett & Paulus, 2021; Simmonds et al., 2024). Despite the established role of retinal laser photocoagulation in the management of sight-threatening DR, considerable variability remains in reported visual outcomes following treatment, and the extent to which early visual response is influenced by baseline visual acuity, DR severity, and glycemic status remains insufficiently characterized in routine clinical practice. Understanding these relationships may help clinicians establish realistic expectations, provide individualized prognostic counseling, and identify patients who may benefit from closer post-treatment monitoring. Therefore, the present study aimed to evaluate visual outcomes following retinal laser photocoagulation in patients with DR over a 6-week follow-up period and to assess changes in best-corrected distance visual acuity (BCDVA) according to baseline visual acuity, DR severity, and glycemic status.

Materials and Methods

Study Design and Settings

This prospective clinical study evaluated short-term visual outcomes following retinal laser photocoagulation in patients with diabetic retinopathy (DR). The study included 60 patients involving 100 eligible eyes with DR who underwent retinal laser photocoagulation and were followed for 6 weeks after treatment. The study was designed to evaluate changes in best-corrected distance visual acuity (BCDVA) following retinal laser treatment and to examine the association of visual outcomes with baseline visual acuity, severity of DR, glycemic status, and duration of diabetes mellitus.

Study Population and Participant Selection

Patients diagnosed with DR who were clinically indicated for retinal laser photocoagulation were screened for eligibility. Eligible participants were enrolled following clinical assessment and informed consent. A total of 60 patients contributing 100 eyes were included in the final analysis. Both eyes were included when they met the study eligibility criteria. Participants underwent baseline assessment before retinal laser photocoagulation and were subsequently evaluated at 1, 3, and 6 weeks following treatment. The study pathway comprised participant screening and enrollment, baseline clinical and systemic assessment, retinal laser photocoagulation, and standardized post-treatment follow-up.

Eligibility Criteria

Patients with clinically diagnosed DR who required retinal laser photocoagulation and had documented baseline BCDVA were eligible for inclusion. Participants were required to attend the scheduled follow-up assessments during the 6-week study period. Eyes with incomplete baseline or follow-up visual acuity data were excluded from the relevant analysis. Eyes with ocular conditions or other clinical factors that could independently influence visual acuity were excluded according to the study protocol.

Baseline Clinical and Systemic Assessment

Demographic and clinical information was recorded at baseline. Patient-level variables included age, sex, duration of diabetes mellitus, and glycemic status, whereas eye-level variables included baseline BCDVA, severity of DR, macular involvement, and the type of retinal laser treatment performed.

Glycemic status was assessed using glycated hemoglobin (HbA1c) and was evaluated as a potential factor associated with post-treatment visual outcome. The duration of diabetes mellitus was also recorded because longer disease duration may be associated with more advanced retinal disease and may influence visual prognosis.

Baseline clinical characteristics were subsequently evaluated in relation to visual outcomes following retinal laser photocoagulation.

Classification of Diabetic Retinopathy

The severity of DR was assessed clinically and classified according to the Early Treatment Diabetic Retinopathy Study (ETDRS) classification. Eyes were categorized according to the severity of retinopathy and the presence of clinically relevant macular involvement, where applicable.

DR severity was subsequently evaluated as a potential determinant of visual outcome following laser photocoagulation. Baseline macular status was also considered because macular involvement may independently affect visual acuity and treatment response.

Retinal Laser Photocoagulation

Retinal laser photocoagulation was performed according to the clinical characteristics and retinal findings of each treated eye. The treatment modality was selected according to the underlying retinal pathology and clinical indication.

Panretinal photocoagulation (PRP) was performed for eyes with proliferative or advanced retinal disease requiring treatment of peripheral retinal ischemia. Focal or grid laser photocoagulation was performed when indicated for macular involvement or diabetic macular edema. Where clinically indicated, combined treatment approaches were used in eyes with coexisting proliferative disease and macular pathology.

The laser treatment modality administered to each eye was documented and evaluated as a potential factor influencing post-treatment visual outcome.

Visual Acuity Assessment

The principal functional outcome was best-corrected distance visual acuity (BCDVA). BCDVA was assessed at baseline before retinal laser photocoagulation and at 1, 3, and 6 weeks after treatment.
For subgroup analysis, baseline visual acuity was categorized into three groups:

- Group 1: ≤6/60
- Group 2: 6/36 to 6/18
- Group 3: 6/12 to 6/6

Changes in BCDVA at each follow-up visit were compared with baseline measurements to characterize the short-term trajectory of visual recovery or deterioration following retinal laser photocoagulation.
Where applicable, visual acuity measurements were converted to logMAR values for statistical analysis.

Follow-up Protocol

Participants were evaluated at baseline before laser treatment and subsequently at 1 week, 3 weeks, and 6 weeks after retinal laser photocoagulation.
At each follow-up visit, BCDVA was assessed and the treated eye was clinically evaluated for post-treatment status and any documented ocular complications or adverse events. Any additional treatment or retreatment performed during the follow-up period was recorded where applicable.
The 6-week follow-up assessment was considered the primary endpoint, while the 1- and 3-week assessments were used to characterize the early temporal trajectory of visual outcomes.
The study timeline was:
Baseline assessment → Retinal laser photocoagulation → Week 1 → Week 3 → Week 6

Study Outcomes

Primary Outcome

The primary outcome was the change in BCDVA from baseline to 6 weeks following retinal laser photocoagulation.

Secondary Outcomes

Secondary outcomes included:

1. Change in BCDVA from baseline at 1, 3, and 6 weeks.
2. Longitudinal trajectory of BCDVA during the 6-week follow-up period.
3. Proportion of eyes demonstrating visual improvement, stability, or deterioration at 6 weeks.
4. Association between baseline BCDVA category and post-treatment visual outcome.
5. Association between DR severity and post-treatment visual outcome.
6. Association between HbA1c and visual outcome.
7. Association between duration of diabetes mellitus and visual outcome.
8. Association between laser treatment modality and visual outcome.
9. Occurrence of documented ocular complications or adverse events during follow-up.

Definition of Visual Outcome

Visual outcomes at 6 weeks were categorized according to the change in BCDVA from baseline as improved, stable, or worsened.

An improved outcome indicated an increase in visual acuity compared with baseline, a stable outcome indicated no clinically meaningful change, and a worsened outcome indicated a reduction in visual acuity compared with baseline.
For the final statistical analysis, the predefined visual acuity criteria specified in the original study protocol were used to classify eyes according to their visual outcome.

Statistical Analysis

Data were analysed using descriptive and inferential statistical methods. Continuous variables were summarized using appropriate measures of central tendency and dispersion, while categorical variables were presented as frequencies and percentages.

The distribution of continuous variables was assessed before statistical analysis, and parametric or non-parametric tests were selected according to the distribution and characteristics of the data.

Changes in BCDVA across the four-assessment points baseline, 1 week, 3 weeks, and 6 weeks were evaluated using an appropriate repeated-measures statistical approach to assess longitudinal changes in visual acuity following retinal laser photocoagulation.

Because the study included 100 eyes from 60 patients, with some participants contributing both eyes, the potential correlation between fellow eyes was considered in the interpretation of eye-level analyses. Where appropriate, longitudinal analyses accounted for repeated observations and patient-level clustering.

Baseline BCDVA, DR severity, HbA1c, duration of diabetes mellitus, and laser treatment modality were evaluated as potential factors associated with visual outcome. Where appropriate, multivariable analyses were considered to identify factors independently associated with post-treatment visual outcomes.

Effect estimates were reported with corresponding 95% confidence intervals (CIs) where applicable. All statistical tests were two-sided, and a p-value <0.05 was considered statistically significant.

Ethical Considerations

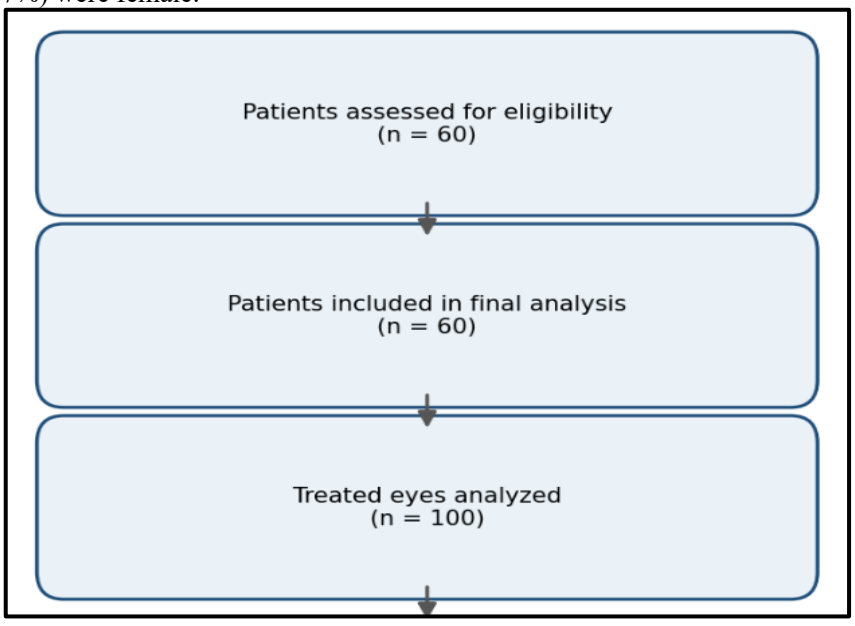
The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and applicable ethical standards for research involving human participants. Ethical approval was obtained from the relevant Institutional Ethics Committee before commencement of the study.

Written informed consent was obtained from all participants before enrollment and treatment. Participant confidentiality was maintained throughout the study, and data were anonymized for analysis and reporting.

Results

Study Population and Baseline Characteristics

The study included 60 patients with diabetic retinopathy involving 100 treated eyes. Of the 60 participants, 38 (63.3%) were male and 22 (36.7%) were female.



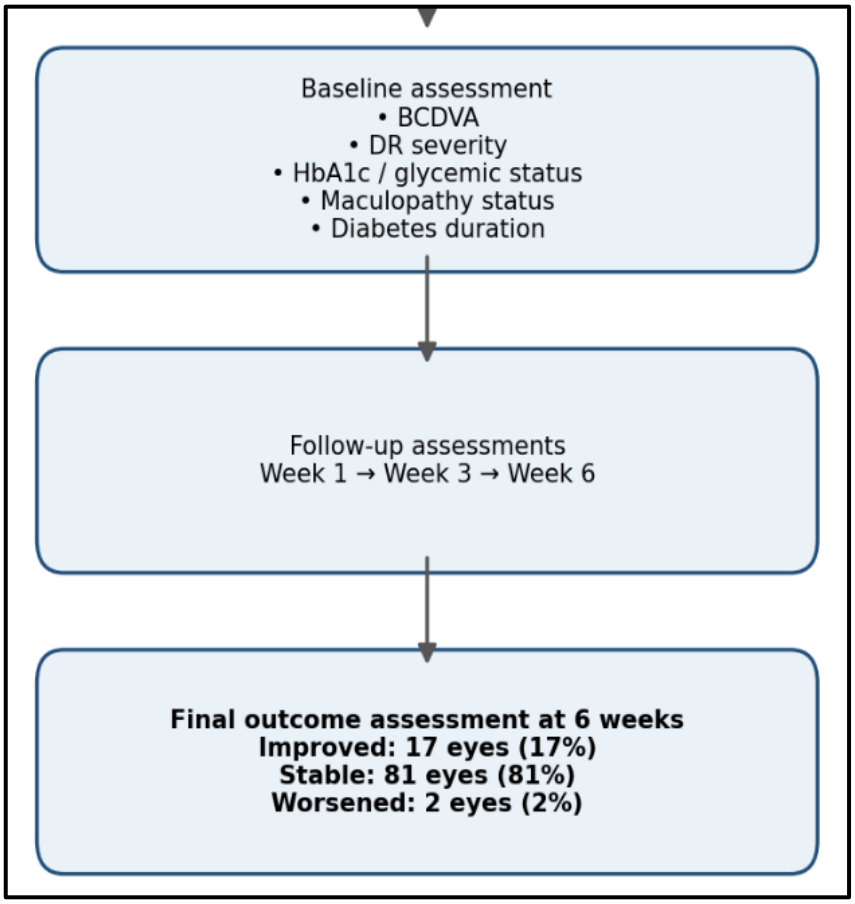


Figure 1. Study flow diagram of patients undergoing retinal laser photocoagulation for diabetic retinopathy.

The mean age was 59.08 ± 1.96 years among male participants and 58.82 ± 1.40 years among female participants. The mean duration of diabetes was 9.85 ± 3.42 years in males and 9.73 ± 3.96 years in females. The highest frequency of patients requiring retinal laser photocoagulation was observed in the 55-68-year age range. Of the 60 participants, 38 (63.3%) were aged 50-59 years and 22 (36.7%) were aged 60-70 years, while no participants were recorded in the 40-49-year age category. At the eye level, the duration of diabetes was ≤5 years in 9 eyes (9.0%), 6-10 years in 55 eyes (55.0%), 11-15 years in 34 eyes (34.0%), and >15 years in 2 eyes (2.0%). A χ^2 goodness-of-fit test against an assumed equal sex distribution yielded $\chi^2 = 4.27$, df = 1, $p < 0.05$. The baseline demographic and clinical characteristics of the study population are summarized in Table 1, and the overall study flow is presented in Figure 1.

Table 1. Baseline demographic and clinical characteristics of the study population

Characteristic	**n**	**%**
Patients	**60**	**100.0**
Male	38	63.3
Female	22	36.7
Age group (years)		
40–49	0	0.0
50–59	38	63.3
60–70	22	36.7
Treated eyes	**100**	**100.0**
Duration of diabetes (years)		
≤5	9	9.0
6–10	55	55.0
11–15	34	34.0
>15	2	2.0

Overall Visual Outcomes Following Retinal Laser Photocoagulation

At 6 weeks following retinal laser photocoagulation, visual outcomes were assessed according to changes in BCDVA from baseline. Among the 100 treated eyes, 17 (17.0%) demonstrated improvement of ≥2 Snellen lines, 81 (81.0%) remained stable, and 2 (2.0%) demonstrated deterioration of ≥2 Snellen lines. The overall distribution of visual outcomes at 6 weeks is presented in Table 2 and illustrated in Figure 2.

Table 2. Overall visual outcomes at 6 weeks following retinal laser photocoagulation

Visual outcome	Eyes, n	%
Improved (≥2 Snellen lines)	17	17.0
Stable	81	81.0
Worsened (≥2 Snellen lines)	2	2.0
Total	100	100.0

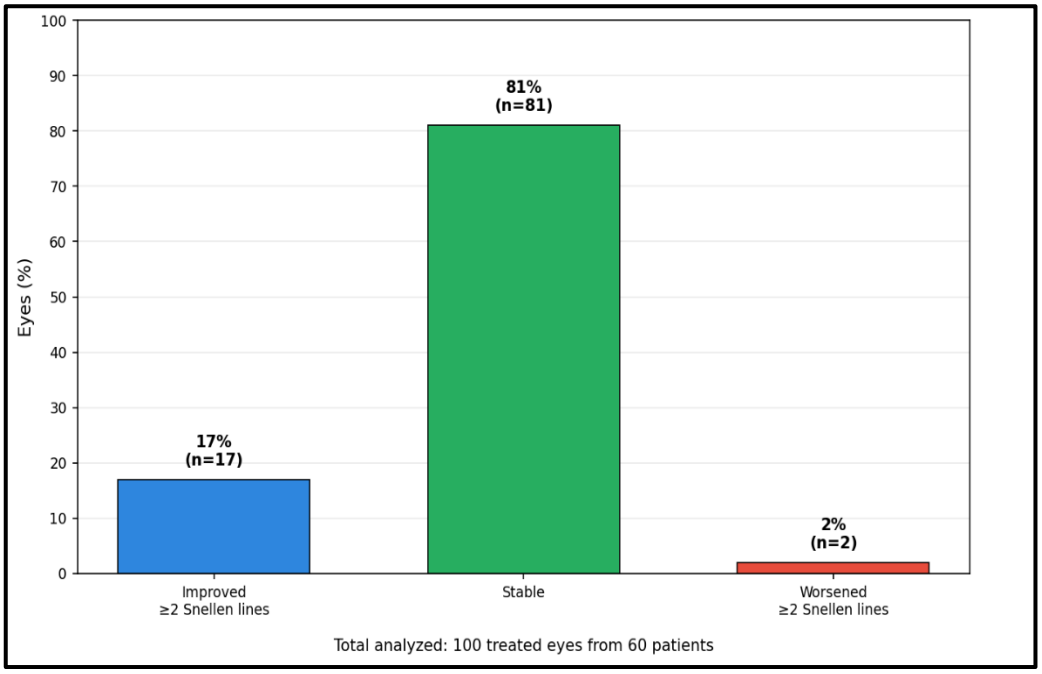


Figure 2. Overall visual outcomes 6 weeks after retinal laser photocoagulation.

Longitudinal Changes in BCDVA

BCDVA was assessed at baseline and at 1, 3, and 6 weeks following retinal laser photocoagulation. The reported mean differences from baseline were 0.03 at Week 1 and 0.05 at Weeks 3 and 6.

Tukey HSD pairwise comparisons showed no statistically significant differences between baseline and subsequent follow-up assessments. The baseline-to-Week 1 comparison yielded a mean difference of 0.03 ($Q = 0.64$, $p = 0.9698$), while the baseline-to-Week 3 comparison yielded a mean difference of 0.05 ($Q = 1.37$, $p = 0.7664$). The baseline-to-Week 6 comparison also yielded a mean difference of 0.05 ($Q = 1.37$, $p = 0.7664$). The critical Q value was 3.6486. The pairwise comparisons are presented in **Table 3**, and longitudinal changes in BCDVA from baseline through 6 weeks are illustrated in **Figure 3**.

Table 3. Tukey HSD pairwise comparisons of BCDVA between baseline and follow-up visits

Comparison	Mean difference	Q value	p-value
Baseline vs. Week 1	0.03	0.64	0.9698
Baseline vs. Week 3	0.05	1.37	0.7664
Baseline vs. Week 6	0.05	1.37	0.7664

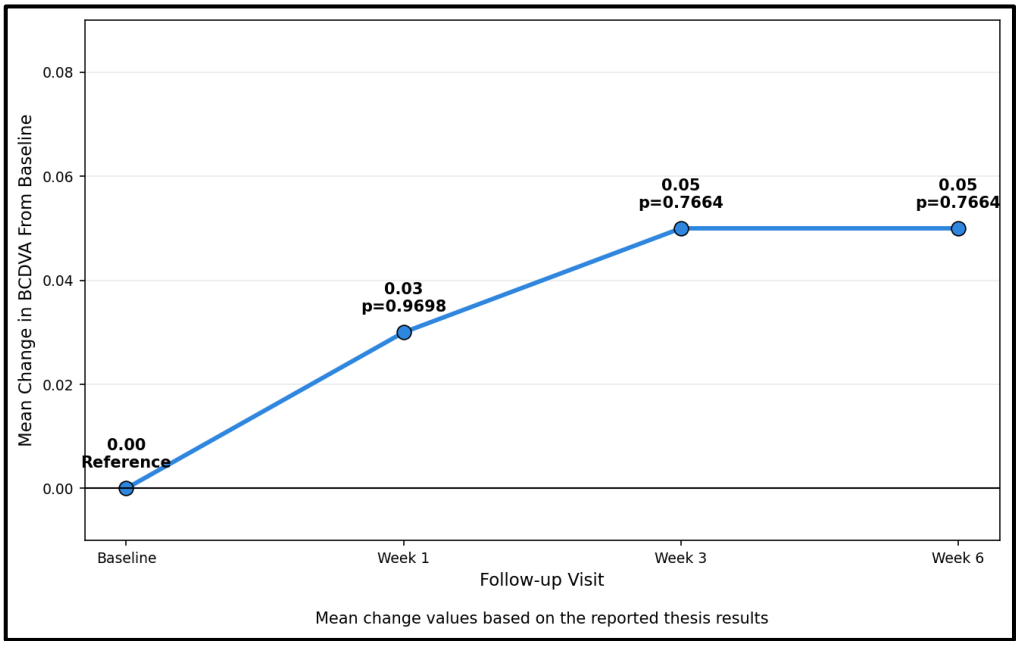


Figure 3. Longitudinal changes in best-corrected distance visual acuity (BCDVA) from baseline to 6 weeks after retinal laser photocoagulation

Visual Outcomes According to Baseline BCDVA

Baseline BCDVA was categorized into three groups: ≤6/60, 6/36–6/18, and 6/12–6/6. Of the 100 treated eyes, 57 (57.0%) had baseline BCDVA ≤6/60, 39 (39.0%) had BCDVA between 6/36 and 6/18, and 4 (4.0%) had BCDVA between 6/12 and 6/6.

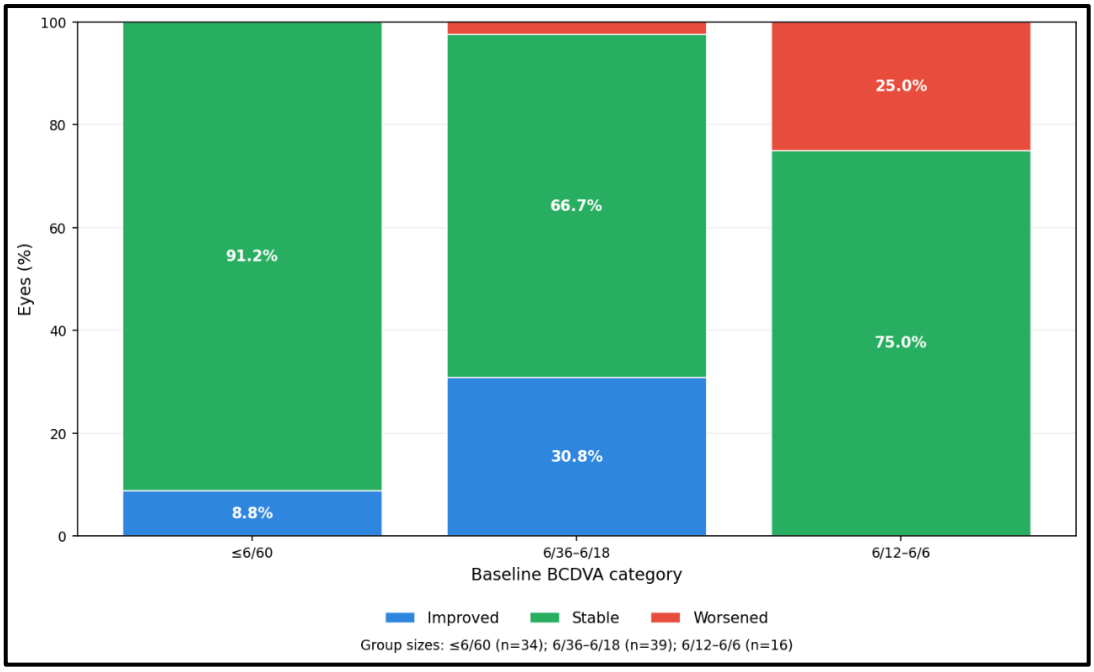


Figure 4. Six-week visual outcomes according to baseline best-corrected distance visual acuity (BCDVA).

Visual Outcomes According to Diabetic Retinopathy Severity

Among the 57 eyes with baseline BCDVA ≤6/60, 5 (8.8%) improved and 52 (91.2%) remained stable. Among the 39 eyes with baseline BCDVA of 6/36–6/18, 12 (30.8%) improved, 26 (66.7%) remained stable, and 1 (2.6%) worsened. Among the four eyes with baseline BCDVA of 6/12–6/6, 3 (75.0%) remained stable and 1 (25.0%) worsened. The distribution of visual outcomes according to baseline BCDVA is presented in Table 4 and illustrated in Figure 4. The analysis reported a statistically significant association between baseline BCDVA category and visual outcome, as well as a significant time-by-baseline BCDVA interaction.

Table 4. Visual outcomes according to baseline BCDVA

Baseline BCDVA	Total eyes, n	Improved, n (%)	Stable, n (%)	Worsened, n (%)
≤6/60	57	5 (8.8)	52 (91.2)	0 (0.0)
6/36–6/18	39	12 (30.8)	26 (66.7)	1 (2.6)
6/12–6/6	4	0 (0.0)	3 (75.0)	1 (25.0)
Total	100	17 (17.0)	81 (81.0)	2 (2.0)

Among the 100 treated eyes, 4 (4.0%) had mild NPDR, 48 (48.0%) had moderate NPDR, 30 (30.0%) had severe NPDR, and 18 (18.0%) had PDR. Among eyes with mild NPDR, 3 (75.0%) improved and 1 (25.0%) remained stable. Among eyes with moderate NPDR, 6 (12.5%) improved, 40 (83.3%) remained stable, and 2 (4.2%) worsened. In the severe NPDR group, 7 (23.3%) improved and 23 (76.7%) remained stable. Among eyes with PDR, 1 (5.6%) improved and 17 (94.4%) remained stable. The distribution of visual outcomes according to diabetic retinopathy severity is presented in Table 5 and illustrated in Figure 5. The analysis reported a statistically significant association between diabetic retinopathy severity and visual outcome.

Table 5. Visual outcomes according to diabetic retinopathy severity

DR severity	Total eyes, n	Improved, n (%)	Stable, n (%)	Worsened, n (%)
Mild NPDR	4	3 (75.0)	1 (25.0)	0 (0.0)
Moderate NPDR	48	6 (12.5)	40 (83.3)	2 (4.2)
Severe NPDR	30	7 (23.3)	23 (76.7)	0 (0.0)
PDR	18	1 (5.6)	17 (94.4)	0 (0.0)
Total	100	17 (17.0)	81 (81.0)	2 (2.0)

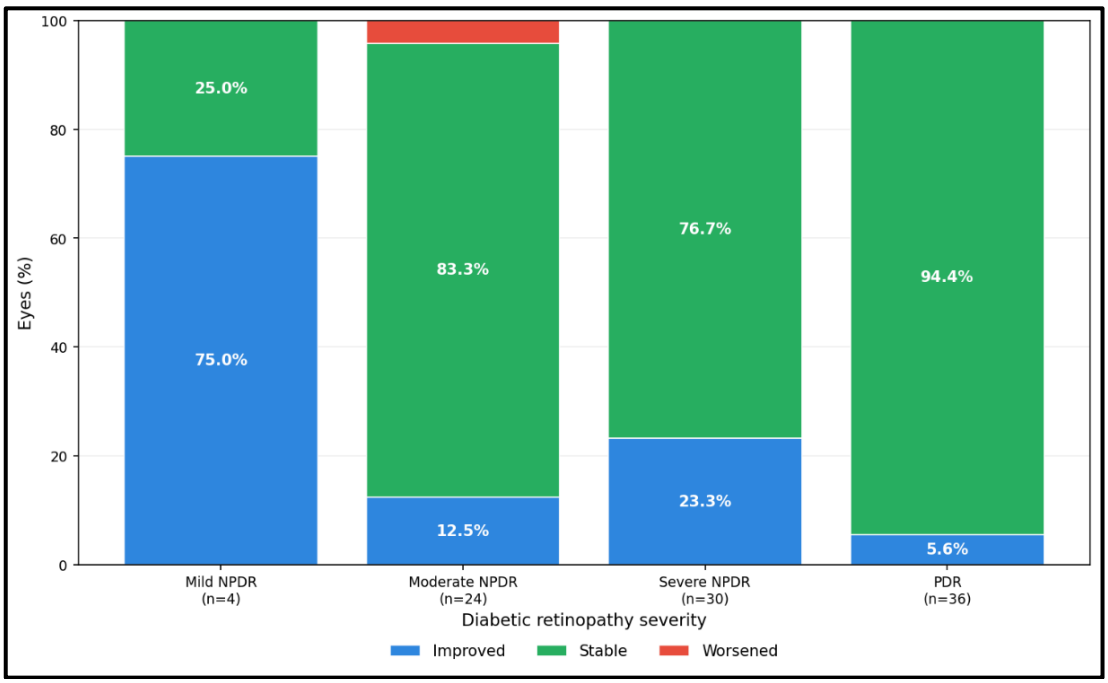


Figure 5. Six-week visual outcomes according to diabetic retinopathy severity.

Visual Outcomes According to Glycemic Control

HbA1c was categorized as ≤7.0% or >7.0%. Of the 100 treated eyes, 33 (33.0%) belonged to the HbA1c ≤7.0% group and 67 (67.0%) belonged to the HbA1c >7.0% group. Among eyes with HbA1c ≤7.0%, 5 (15.2%) improved, 27 (81.8%) remained stable, and 1 (3.0%) worsened. Among eyes with HbA1c >7.0%, 12 (17.9%) improved, 54 (80.6%) remained stable, and 1 (1.5%) worsened. The distribution of visual outcomes according to HbA1c category is presented in **Table 6** and included in the combined graphical analysis in Figure 6.

The analysis further reported that the visual outcome varied according to HbA1c category over the 6-week follow-up period, with the corresponding longitudinal relationship represented in Figure 6.

Table 6. Visual outcomes according to HbA1c category

HbA1c category	Total eyes, n	Improved, n (%)	Stable, n (%)	Worsened, n (%)
≤7.0%	33	5 (15.2)	27 (81.8)	1 (3.0)
>7.0%	67	12 (17.9)	54 (80.6)	1 (1.5)
Total	100	17 (17.0)	81 (81.0)	2 (2.0)

Visual Outcomes According to Maculopathy Status

Maculopathy was present in 37 eyes (37.0%), whereas 63 eyes (63.0%) had no maculopathy. Among eyes with maculopathy, 4 (10.8%) improved and 33 (89.2%) remained stable. Among eyes without maculopathy, 13 (20.6%) improved, 48 (76.2%) remained stable, and 2 (3.2%) worsened. The distribution of visual outcomes according to maculopathy status is presented in Table 7 and included in the combined graphical analysis in Figure 6. The analysis reported a statistically significant association between maculopathy status and visual outcome, together with a significant time-by-maculopathy interaction.

Table 7. Visual outcomes according to maculopathy status

Maculopathy status	Total eyes, n	Improved, n (%)	Stable, n (%)	Worsened, n (%)
Present	37	4 (10.8)	33 (89.2)	0 (0.0)
Absent	63	13 (20.6)	48 (76.2)	2 (3.2)
Total	100	17 (17.0)	81 (81.0)	2 (2.0)

Visual Outcomes According to Diabetes Duration

The distribution of treated eyes according to diabetes duration was 9 eyes (9.0%) with ≤5 years, 55 eyes (55.0%) with 6-10 years, 34 eyes (34.0%) with 11-15 years, and 2 eyes (2.0%) with >15 years of diabetes duration. The study reported improvement rates of 88.89% in the ≤5-year group, 9.09% in the 6-10-year group, 11.76% in the 11-15-year group, and 0% in the >15-year group, with a reported association between diabetes duration and post-laser BCVA (p = 0.02636). The relationship between diabetes duration and visual outcome is presented in **Figure 6**.

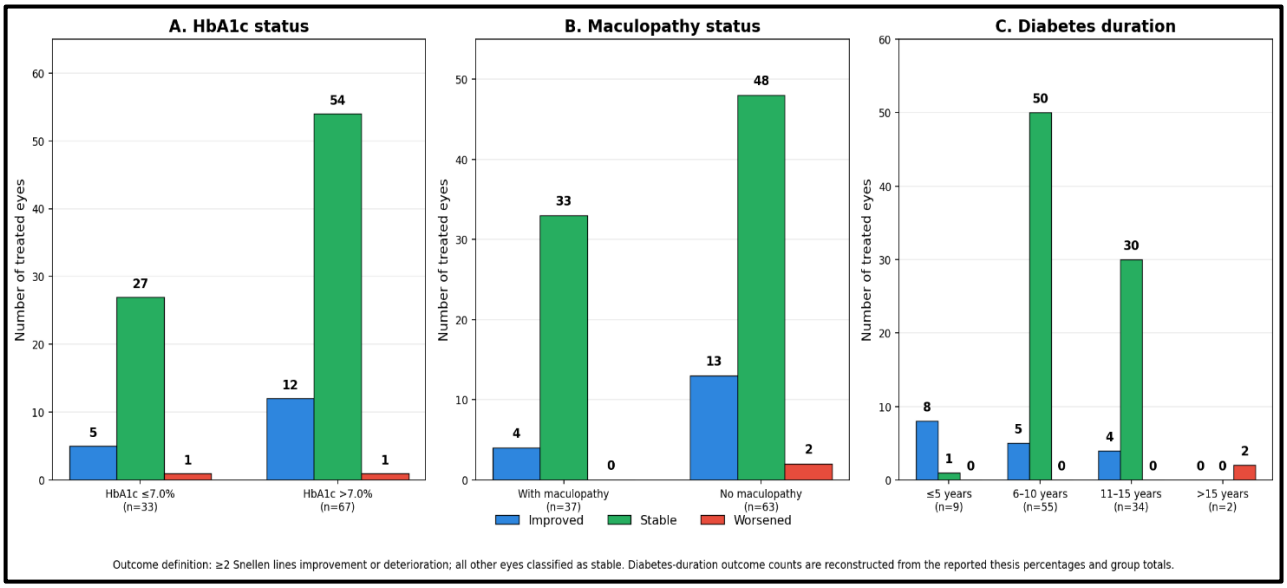


Figure 6. Visual outcomes at 6 weeks according to glycemic status, maculopathy, and duration of diabetes.

Visual Outcomes According to Sex

The study reported that 11.32% of male eyes improved compared with 23.4% of female eyes. Visual stabilization was the predominant outcome in both groups. The reported sex-specific improvement outcomes are presented in **Table 8**.

Table 8. Visual outcomes according to sex

Sex	Improvement (%)	Stable (%)	Worsening (%)
Male	11.32	Not reported	Not reported
Female	23.40	Not reported	Not reported

Visual Outcomes According to Age

The study reported that participants younger than 55 years had 30.43% improvement and 65.21% stable visual outcomes. In the 55–65-year age group, approximately 90% remained stable, while approximately 70% remained stable among participants aged ≥66 years.

Discussion

The present study demonstrates that visual stabilization was the predominant short-term outcome following retinal laser photocoagulation in diabetic retinopathy. Over the 6-week follow-up, 81.0% of treated eyes remained stable, 17.0% improved by ≥2 Snellen lines, and only 2.0% deteriorated. Consistent with this distribution, longitudinal analysis showed no statistically significant change in mean BCDVA during follow-up. These findings support the central therapeutic role of retinal laser photocoagulation as a vision-preserving rather than primarily vision-restorative intervention. In sight-threatening diabetic retinopathy, particularly PDR, treatment success is often reflected by prevention of clinically important visual deterioration rather than substantial gain in central visual acuity (Chew et al., 2003; Evans et al., 2014; Everett & Paulus, 2021; Wang et al., 2024). The predominance of stable vision in this cohort is consistent with the established evidence for PRP. The Early Treatment Diabetic Retinopathy Study demonstrated the long-term benefit of laser treatment in reducing the risk of severe visual loss, while the Cochrane review by Evans et al. (2014) confirmed the protective effect of PRP against severe vision loss in PDR. Importantly, these benefits do not necessarily translate into large improvements in average visual acuity. Rather, laser reduces the ischemic drive underlying neovascularization and thereby limits progression to sight-threatening complications (Chew et al., 2003; Evans et al., 2014; Wang et al., 2024). Accordingly, the 81% rate of visual stability observed in the present study should be interpreted as a clinically meaningful outcome rather than treatment failure. The relatively limited proportion of eyes demonstrating substantial visual improvement is also biologically plausible. Laser photocoagulation primarily addresses the pathological retinal ischemic stimulus and does not reverse established neuronal loss, chronic macular dysfunction, or irreversible retinal damage. Consequently, the potential for visual recovery is inherently constrained once significant structural damage has occurred (Everett & Paulus, 2021; Wang et al., 2024). This distinction is critical for patient counseling: the expected benefit of laser is often to preserve useful vision and prevent catastrophic deterioration, not to restore previously lost vision. The present findings are broadly consistent with previous clinical studies reporting stable or improved vision after retinal laser treatment. Sheth and Popat (2016) and Shrestha et al. (2007) reported favorable visual outcomes following laser photocoagulation, although differences in baseline disease severity, treatment indications, laser protocols, and follow-up duration limit direct numerical comparisons. Rema et al. (2005) similarly demonstrated that visual outcomes after PRP are influenced by baseline and systemic risk factors. The present study extends these observations by evaluating visual response in relation to baseline BCDVA, retinopathy severity, macular involvement, glycemic status, and diabetes duration.

Baseline visual acuity as a determinant of outcome

Baseline BCDVA appeared to influence the pattern of post-treatment visual response. Eyes with intermediate baseline impairment showed greater potential for measurable improvement, whereas eyes with relatively good baseline vision were predominantly stable and those with severe baseline impairment demonstrated limited recovery. This pattern may reflect a combination of ceiling and floor effects. Eyes with preserved baseline acuity have limited scope for measurable improvement, whereas severely impaired eyes may have irreversible retinal or macular damage that restricts functional recovery. Eyes with moderate impairment may retain sufficient viable retinal function to demonstrate clinically detectable improvement following treatment. This finding has practical implications for prognostic counseling. Baseline visual acuity should be considered when establishing realistic expectations after laser treatment, rather than assuming a uniform response across all treated eyes. Reid et al. (2022) similarly demonstrated that baseline clinical characteristics contribute to functional and anatomical outcomes following PRP, while Rema et al. (2005) identified baseline and systemic factors associated with visual outcomes after treatment. However, the present association should be interpreted cautiously because subgroup sizes were limited and the 6-week follow-up captures only early visual trajectories. Larger studies with longer follow-up and multivariable adjustment are required to establish whether baseline BCDVA independently predicts long-term visual outcomes.

Retinopathy severity and treatment response

Visual response also varied according to diabetic retinopathy severity, although stability remained the predominant outcome across clinically important disease stages. This finding is particularly relevant for PDR, where the primary

objective of PRP is prevention of severe visual loss and neovascular complications rather than immediate improvement in central acuity. Thus, stable BCDVA following treatment may represent an important therapeutic endpoint even in eyes with advanced disease. The lower potential for visual improvement in advanced retinopathy may reflect the cumulative effects of retinal ischemia, macular dysfunction, vascular pathology, and irreversible structural damage. These findings are consistent with evidence that baseline disease characteristics influence functional outcomes after PRP (Reid et al., 2022). More broadly, they reinforce the need to distinguish control of retinal disease from recovery of visual function. An eye may achieve effective disease stabilization without a corresponding gain in central acuity (Chew et al., 2003; Evans et al., 2014).

Glycemic control and visual outcome

The present study did not demonstrate a clear short-term difference in visual outcome according to HbA1c category. The proportions of improved, stable, and deteriorated eyes were broadly comparable between patients with HbA1c ≤7.0% and >7.0%. This finding suggests that a single measure of glycemic control may have limited ability to predict visual change over a 6-week post-laser interval. This observation should not, however, be interpreted as evidence that glycemic control is clinically unimportant. The effect of chronic hyperglycemia on diabetic retinopathy is cumulative, and its influence may be more apparent in disease development and progression than in immediate post-treatment changes in BCDVA. Favas et al. (2025) identified systemic metabolic factors as important contributors to diabetic retinopathy risk in the Indian population. Similarly, Thakkar et al. (2025) demonstrated associations between glycemic status and diabetes-related ocular structural parameters, while Varshney et al. (2024) reported differences in ocular functional parameters, including contrast sensitivity, according to diabetic control. Therefore, HbA1c should be considered a component of a broader prognostic profile rather than an isolated determinant of short-term visual response. A single HbA1c measurement also does not capture cumulative glycemic exposure, glycemic variability, or the duration of previous metabolic dysregulation. Future studies should therefore assess longitudinal glycemic control together with diabetes duration, retinopathy severity, macular status, and other systemic risk factors.

Maculopathy and visual prognosis

Macular involvement appeared to be an important modifier of visual outcome. Eyes with maculopathy were predominantly stable and showed less potential for visual improvement than eyes without macular involvement. This finding is clinically plausible because macular pathology directly compromises central visual function and may limit visual recovery even when laser effectively controls peripheral retinal disease. The presence of maculopathy therefore highlights the distinction between retinal disease stabilization and restoration of central vision. This distinction is increasingly important in contemporary diabetic retinopathy management, where macular disease may require pharmacological intervention in addition to laser. Everett and Paulus (2021) emphasized the complementary roles of laser and intravitreal therapy, while Simmonds et al. (2024) demonstrated the evolving evidence base comparing anti-VEGF agents with laser photocoagulation. Combination treatment may be particularly relevant in patients with concomitant macular involvement. Zhou et al. (2023) reported the efficacy of laser photocoagulation combined with ranibizumab in diabetic retinopathy, supporting a multimodal approach in selected patients. Thus, maculopathy should be incorporated into prognostic assessment and treatment planning rather than considering laser treatment in isolation.

Diabetes duration and cumulative retinal damage

The relationship between diabetes duration and visual outcome in the present study suggests that cumulative metabolic exposure may contribute to treatment response, although the subgroup findings should be interpreted cautiously because of limited numbers in some duration categories. Longer diabetes duration is biologically relevant because it represents prolonged exposure to hyperglycemia and cumulative microvascular injury, potentially resulting in more advanced retinopathy and reduced retinal functional reserve. This interpretation is consistent with Sheth and Popat (2026), who examined the association between diabetes duration, retinopathy stage, and visual outcome following laser photocoagulation. Favas et al. (2025) likewise emphasized the contribution of systemic risk factors to diabetic retinopathy in the Indian population. However, diabetes duration may function primarily as a marker of cumulative disease burden rather than an independent predictor of visual outcome. Its independent prognostic value should therefore be assessed alongside HbA1c, baseline BCDVA, retinopathy severity, maculopathy, age, and other systemic variables using appropriately adjusted multivariable models.

BCDVA does not fully represent visual function

An important implication of the present findings is that stable BCDVA should not be equated with complete preservation of visual function. PRP may affect peripheral visual function even when central acuity remains unchanged. Lee et al.

(2025), using data from the Diabetic Retinopathy Study and ETDRS, demonstrated the relevance of visual field changes following PRP. Consequently, assessment based exclusively on BCDVA may underestimate the functional consequences of treatment. Similarly, Vasilijević et al. (2022) reported changes in vision-related quality of life and treatment satisfaction following PRP, while Dastgir et al. (2025) evaluated broader visual function before and after argon laser treatment. These findings support a multidimensional approach to outcome assessment. The 81% rate of BCDVA stability observed in the present study therefore indicates preservation of central acuity but does not establish preservation of peripheral field, contrast sensitivity, color discrimination, or patient-perceived visual function. This distinction is particularly relevant because diabetes itself can affect visual performance beyond conventional acuity. Varshney et al. (2024) demonstrated differences in contrast sensitivity in relation to diabetic control, while Thakkar et al. (2025) highlighted broader diabetes-related ocular structural changes. Future investigations should therefore incorporate visual field assessment, contrast sensitivity, low-luminance testing, retinal imaging, and validated patient-reported outcome measures to provide a more comprehensive evaluation of the functional consequences of laser treatment.

Clinical relevance in the era of anti-VEGF therapy

The role of laser photocoagulation must now be considered within the context of contemporary anti-VEGF therapy. Anti-VEGF agents may offer visual advantages in selected patients, particularly those with PDR and concomitant macular involvement, but often require repeated injections and sustained clinical monitoring (Simmonds et al., 2024). PRP retains important advantages related to durability and its established ability to reduce severe visual loss (Chew et al., 2003; Evans et al., 2014). The present findings therefore support a complementary rather than exclusively competitive view of laser and anti-VEGF therapy. Treatment selection should be individualized according to retinopathy phenotype, macular involvement, systemic status, follow-up reliability, treatment burden, and healthcare resources. Combination approaches may be particularly appropriate in selected eyes with coexisting macular disease (Zhou et al., 2023). This consideration is especially important in the context of the expanding global diabetes burden. The number of individuals at risk of diabetic retinopathy is projected to increase substantially with the continuing rise in diabetes prevalence (Genitsaridi et al., 2026; Teo et al., 2021). The problem is compounded by the large number of individuals who remain undiagnosed with diabetes, reinforcing the need for early detection and systematic screening (Over 250 million people worldwide unaware they have diabetes, according to new research from the International Diabetes Federation [IDF], 2025). In settings where access to specialist eye care is constrained by geographic, economic, or social barriers, timely and durable treatment remains critical (Bhattacharjee & Varshney, 2026).

Clinical Implications

The findings have direct implications for clinical counseling and management. Patients undergoing retinal laser photocoagulation should be informed that maintenance of existing vision may be the most realistic short-term treatment goal. Baseline BCDVA, retinopathy severity, and macular status may help clinicians individualize expectations, while diabetes duration and glycemic control remain important components of long-term systemic and retinal disease management. Importantly, treatment success should not be judged solely by visual gain. In advanced diabetic retinopathy, preventing further deterioration may represent the most clinically meaningful outcome. This perspective is particularly relevant when communicating treatment expectations and evaluating the effectiveness of laser therapy in routine practice.

Strengths and Limitations

The principal strengths of this study include the prospective evaluation of post-laser visual outcomes and serial BCDVA assessment over a defined 6-week period, together with evaluation of clinically relevant baseline factors. However, several limitations warrant consideration. First, the short follow-up limits conclusions regarding long-term visual preservation and disease progression. Second, the single-center design may restrict generalizability. Third, inclusion of both eyes from some participants introduces within-patient correlation; analyses that treat eyes as independent observations may underestimate statistical uncertainty unless appropriate clustered or mixed-effects methods are applied. Fourth, subgroup sizes were limited for some clinical categories, reducing statistical power. Fifth, BCDVA alone does not capture visual field, contrast sensitivity, quality of life, or patient-reported functional outcomes, which may change independently of central acuity (Dastgir et al., 2025; Lee et al., 2025; Vasilijević et al., 2022). Finally, the independent contribution of baseline BCDVA, retinopathy severity, maculopathy, HbA1c, and diabetes duration should be evaluated using appropriately adjusted multivariable models.

Future Directions

Future prospective studies should extend follow-up beyond 6 weeks and evaluate whether early visual stability predicts long-term preservation of useful vision. Larger cohorts should incorporate multimodal retinal imaging, visual field testing,

contrast sensitivity, and patient-reported outcomes. Multivariable or mixed-effects models should account for inter-eye correlation and identify independent predictors of visual response. Comparative studies evaluating PRP, anti-VEGF monotherapy, and combination therapy are also warranted, particularly in patients with concurrent macular disease (Simmonds et al., 2024; Zhou et al., 2023). Given the increasing global burden of diabetes and persistent disparities in access to eye care, future research should additionally examine how screening pathways, treatment accessibility, systemic disease control, and continuity of follow-up influence real-world visual outcomes (Bhattacharjee & Varshney, 2026; Genitsaridi et al., 2026; Teo et al., 2021).

Conclusion

In conclusion, retinal laser photocoagulation in this cohort was associated predominantly with short-term preservation of visual acuity, with most treated eyes remaining stable over 6 weeks and a smaller proportion demonstrating clinically meaningful improvement. The findings reinforce the established role of laser as a vision-preserving intervention, particularly in sight-threatening diabetic retinopathy, rather than as a treatment expected to consistently restore lost visual function. Visual response appeared to vary according to baseline visual acuity, retinopathy severity, and macular involvement, whereas the short-term relationship between HbA1c and visual outcome was less evident. These findings emphasize the importance of individualized prognostic counseling and recognition that successful treatment may be reflected by prevention of deterioration rather than visual gain. Finally, BCDVA should not be considered a complete surrogate for visual function following laser photocoagulation. Future studies incorporating visual fields, contrast sensitivity, patient-reported outcomes, multimodal imaging, and longer follow-up are required to define the full functional impact of treatment and identify independent predictors of visual response. In the contemporary era of anti-VEGF therapy, retinal laser photocoagulation remains an important, durable component of diabetic retinopathy management, with its optimal use determined by disease phenotype, macular involvement, systemic status, patient factors, and the realities of healthcare access.

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Conflict of interest

The author declared no conflict of interest.

Ethics approval

The study protocol was reviewed and approved by the Institutional Ethics Committee (Approval No. IEC/BMCOP/2025/018). The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

AI tool usage declaration

No AI tool was used in manuscript preparation.

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