Vitrectomy with or without routine panretinal photocoagulation for proliferative diabetic retinopathy

Khusanbaev Kh. Sh., Yusupov A. F.

Republican Specialized Scientific and Practical Medical Center of Eye Microsurgery, Tashkent (Uzbekistan)

Вітректомія з рутинною панретинальною фотокоагуляцією або без неї при проліферативній діабетичній ретинопатії

Хусанбаев Х. Ш., Юсупов А. Ф.

Республіканський спеціалізований науково-практичний медичний центр мікрохірургії ока, Ташкент (Узбекистан)

Abstract

Purpose. *To perform a comprehensive comparative assessment of anatomical, functional, microvascular, and angiogenic outcomes of pars plana vitrectomy performed with and without panretinal endophotocoagulation (PRP) in patients with complications of proliferative diabetic retinopathy (PDR), with particular emphasis on retinal ischemia dynamics and vascular endothelial growth factor (VEGF) levels.*

Methods. *A total of 231 patients (231 eyes) with PDR were included. The main group (121 eyes) underwent vitrectomy without routine PRP, while the control group (110 eyes) underwent vitrectomy combined with PRP. All patients underwent best-corrected visual acuity (BCVA) assessment, intraocular pressure measurement, optical coherence tomography (OCT), optical coherence tomography angiography (OCTA, 12×12 mm), fluorescein angiography, and computer perimetry. VEGF levels in aqueous humor were analyzed in a subgroup of 80 patients (40 from each group) before vitrectomy and during subsequent phacoemulsification with intraocular lens implantation (Phaco+IOL). Follow-up duration was 12 months.*

Results. *Both groups demonstrated significant postoperative improvement in BCVA with no statistically significant intergroup differences. OCT angiography revealed stabilization or reduction of ischemic zones in the main group and a tendency toward enlargement of ischemic areas in the control group. VEGF concentration decreased significantly after vitrectomy in both groups, with no statistically significant difference between the groups.*

Conclusion. *Vitrectomy without routine PRP provides comparable functional outcomes and favorable stabilization of retinal ischemia and angiogenic activity. Wide-field OCT angiography and assessment of VEGF-related biomarkers provide objective information on retinal ischemia and angiogenic activity and may assist in individualized postoperative monitoring and treatment decision-making in selected patients with proliferative diabetic retinopathy.*

Keywords: *proliferative diabetic retinopathy, vitrectomy, OCT angiography, VEGF, panretinal photocoagulation.*

Резюме

Мета *– провести комплексну порівняльну оцінку анатомічних, функціональних, мікроваскулярних та ангіогенних результатів вітректомії pars plana, виконаної з панретинальною ендофотокоагуляцією (PRP) та без неї у пацієнтів з ускладненнями проліферативної діабетичної ретинопатії (PDR), з особливим акцентом на динаміку ішемії сітківки та рівні фактора росту судинного ендотелію (VEGF).*

Методи. *Загалом у дослідження було включено 231 пацієнта (231 око) з PDR. Основна група (121 око) пройшла вітректомію без рутинної PRP, тоді як контрольна група (110 очей) пройшла вітректомію в поєднанні з PRP. Усім пацієнтам було проведено оцінку гостроти зору з*

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Corresponding author: Khusanbaev Khasanjon Shavkatovich, Republican Specialized Scientific and Practical Medical Center of Eye Microsurgery, Tashkent, Uzbekistan.
E-mail: hasanjon77777@gmail.com.

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найкращою корекцією (BCVA), вимірювання внутрішньоочного тиску, оптичну когерентну томографію (ОСТ), оптичну когерентну томографію ангіографії (ОСТА, 12×12 мм), флуоресцеїнову ангіографію та комп'ютерну периметрію. Рівні VEGF у водянистій волозі ока були проаналізовані у підгрупі з 80 пацієнтів (по 40 з кожної групи) до вітректомії та під час подальшої факоемульсифікації з імплантацією інтраокулярної лінзи (Phaco+IOL). Тривалість спостереження становила 12 місяців.

Результати. *Обидві групи продемонстрували значне післяопераційне покращення BCVA без статистично значущих міжгрупових відмінностей. ОСТ-ангіографія виявила стабілізацію або зменшення ішемічних зон в основній групі та тенденцію до збільшення ішемічних ділянок у контрольній групі. Концентрація VEGF значно знизилася після вітректомії в обох групах без статистично значущої різниці між групами.*

Висновки. *Вітректомія без рутинної PRP забезпечує порівнянні функціональні результати та сприятливу стабілізацію ішемії сітківки та ангіогенної активності. Широкопольна ОСТ-ангіографія та оцінка біомаркерів, пов'язаних з VEGF, надають об'єктивну інформацію про ішемію сітківки та ангіогенну активність і можуть допомогти в індивідуалізованому післяопераційному моніторингу та прийнятті рішень щодо лікування у окремих пацієнтів з проліферативною діабетичною ретинопатією.*

Ключові слова: *проліферативна діабетична ретинопатія, вітректомія, ОСТ-ангіографія, VEGF, панретинальна фотокоагуляція*

Introduction

Proliferative diabetic retinopathy (PDR) represents the most advanced stage of diabetic retinal disease and remains one of the leading causes of irreversible visual impairment among working-age adults worldwide [1]. Chronic retinal ischemia is the primary driving force behind disease progression, triggering overexpression of vascular endothelial growth factor (VEGF) and subsequent pathological neovascularization, vitreous hemorrhage, and tractional retinal detachment [2, 3, 4].

Panretinal photocoagulation (PRP) has historically been considered the cornerstone of PDR management by reducing ischemic retinal drive and suppressing VEGF production [5, 6]. However, extensive laser ablation is associated with well-documented functional limitations, including peripheral visual field loss, reduced retinal sensitivity, and potential aggravation of macular ischemia, which may compromise postoperative visual rehabilitation [5, 7].

Advances in pars plana vitrectomy (PPV), enhanced intraoperative visualization, and refined membrane dissection techniques have significantly improved surgical outcomes in PDR [8, 9]. Vitrectomy itself has been shown to reduce intraocular VEGF concentration by eliminating the vitreous scaffold and improving intraocular oxygenation, thereby exerting an intrinsic antiangiogenic effect [2, 5]. These observations have raised questions regarding the necessity of routine PRP in all surgically treated cases.

The introduction of optical coherence tomography angiography (OCTA) has provided a non-invasive, layer-specific method for evaluating retinal microcirculation. Wide-field OCTA (12×12 mm) enables quantitative assessment of ischemic zones extending beyond the macula into parafoveal and mid-peripheral regions, which are critical in PDR progression [10, 11].

Recent studies have shown that intraocular VEGF levels are closely associated with the extent of retinal ischemia and angiogenic activity in proliferative diabetic retinopathy. However, the effect of panretinal photocoagulation on VEGF levels remains variable and may depend on disease severity and the timing of assessment. Some studies have reported that while PRP may influence inflammatory cytokine activity, intravitreal VEGF levels may not differ significantly between eyes treated with PRP and those without prior laser treatment [5].

Despite increasing interest in PRP-sparing strategies, comprehensive studies integrating functional outcomes, microvascular ischemia dynamics, and angiogenic biomarkers remain limited. The present study aims to address this gap by performing a detailed comparative analysis of vitrectomy with and without PRP, incorporating wide-field OCTA and longitudinal VEGF assessment.

Materials and Methods

Study design and patients

This retrospective comparative study included 231 patients (231 eyes) with proliferative diabetic retinopathy who underwent surgical treatment at the Republican Specialized Scientific and Practical Medical Center of Eye Microsurgery (Tashkent, Uzbekistan). Only one eye per patient was included in the analysis.

Patients were divided into two groups according to the surgical strategy:

• Main group: 121 eyes that underwent pars plana vitrectomy without routine panretinal photocoagulation

• Control group: 110 eyes that underwent pars plana vitrectomy combined with panretinal photocoagulation

Inclusion and Exclusion Criteria

Inclusion criteria. Patients were included in the study if they met the following criteria:

• confirmed diagnosis of proliferative diabetic retinopathy (PDR) based on clinical examination and imaging findings;

• compensated diabetes mellitus, defined as stable metabolic control under endocrinological supervision (HbA1c ≤ 8.5%);

• presence of PDR-related complications requiring pars plana vitrectomy, including:

- non-clearing vitreous hemorrhage
- tractional retinal detachment involving or threatening the macula
- combined tractional–rhegmatogenous retinal detachment
- dense fibrovascular proliferation causing significant vitreoretinal traction

• age ≥18 years;

• absence of previous vitreoretinal surgery in the study eye;

• ability to complete postoperative follow-up for at least 12 months.

Exclusion criteria. Patients were excluded if any of the following conditions were present:

• previous vitrectomy or major retinal surgery in the study eye;

• decompensated diabetes mellitus (HbA1c > 8.5% or unstable glycemic control);

• age < 18 years;

• presence of advanced glaucoma or optic nerve pathology that could significantly affect visual field assessment;

• ocular trauma or other retinal diseases unrelated to diabetic retinopathy (e.g., retinal vein occlusion, age-related macular degeneration);

• active intraocular inflammation or uveitis;

• incomplete clinical data or loss to follow-up before 12 months.

Baseline demographic and clinical characteristics did not differ significantly between the two groups ($p > 0.05$), indicating that the study populations were comparable before surgery (Tabl. 1).

The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent for surgical treatment and use of anonymized clinical data for research purposes was obtained from all patients.

Surgical technique

All patients underwent standard microincisional pars plana vitrectomy using a standardized surgical protocol. The procedure included removal of vitreous hemorrhage, dissection of fibrovascular membranes, and elimination of vitreoretinal traction. In the control group, panretinal photocoagulation was performed intraoperatively using an endolaser probe during pars plana vitrectomy. Laser treatment was delivered using a 532-nm diode-pumped solid-state laser. The following parameters were used: pulse duration: 0.1–0.2 s, power: 150–300 mW, adjusted to achieve moderate retinal whitening, spot size: variable, depending on the distance between the endolaser probe and the retinal surface (approximately 200–300 μm), total number of burns: approximately 1200–1600

Laser burns were applied to the mid-peripheral and peripheral retina, avoiding the macular area and major vascular arcades. In the main group, laser photocoagulation was not applied routinely and was reserved for selected cases during follow-up when clinically indicated.

Table 1. Baseline characteristics

Parameter	Main group (n=121)	Control group (n=110)	p
Age (years)	56.8 ± 8.4	57.3 ± 7.9	>0.05
Male/Female	68 / 53	61 / 49	>0.05
Duration of diabetes (years)	13.6 ± 4.2	13.9 ± 4.0	>0.05
HbA1c (%)	7.8 ± 1.1	8.0 ± 1.2	>0.05
Vitreous hemorrhage	72 (59.5%)	66 (60.0%)	>0.05
Tractional retinal detachment	39 (32.2%)	34 (30.9%)	>0.05
Combined TRD/ RRD	10 (8.3%)	10 (9.1%)	>0.05

Ophthalmic examination

All patients underwent a comprehensive ophthalmic examination preoperatively and during postoperative follow-up. The examination protocol included assessment of best-corrected visual acuity (BCVA), expressed in logMAR units, intraocular pressure measurement, slit-lamp biomicroscopy, and dilated fundus examination.

Structural retinal assessment was performed using spectral-domain optical coherence tomography (OCT), while retinal microcirculation was evaluated with wide-field optical coherence tomography angiography (OCTA). Preoperative OCT and OCTA were performed in eyes with sufficient media transparency and adequate visualization of the posterior segment.

In most eyes with advanced proliferative diabetic retinopathy, dense vitreous hemorrhage or extensive fibrovascular proliferation limited visualization of the retinal microvasculature and prevented reliable acquisition of baseline OCT angiography parameters.

Functional retinal assessment included standard automated computer perimetry. Reliable preoperative visual field testing was not feasible in a considerable number of eyes due to media opacity and markedly reduced visual acuity associated with vitreous hemorrhage or tractional retinal detachment. Therefore, visual field assessment was primarily performed during postoperative follow-up after restoration of optical media transparency.

Fluorescein angiography was performed when clinically indicated to further assess retinal perfusion and neovascular activity.

Follow-up examinations were conducted at 1, 3, 6, and 12 months depending on the parameters evaluated.

Optical coherence tomography and OCT angiography. Structural OCT and OCT angiography were performed using the Topcon DRI OCT Triton system. Wide-field OCT angiography scans of 12×12 mm were acquired to assess macular, parafoveal, and mid-peripheral retinal microcirculation.

The following OCT angiography parameters were analyzed:

• Retinal ischemia area (mm²), defined as regions of absent capillary perfusion

• Vessel density (VD, %) in the superficial and deep capillary plexuses

• Perfusion density (PD, %)

• Foveal avascular zone (FAZ) area (mm²)

• Non-perfusion index (NPI, %), calculated as the ratio of non-perfused area to total scanned area

Quantitative analysis was performed on en face images. When multiple ischemic zones were present, their areas were summed.

Fluorescein angiography. Fluorescein angiography was performed when indicated to assess retinal non-perfusion, vascular leakage, and neovascular activity, and to support clinical decision-making regarding additional treatment.

Computer perimetry. Visual field assessment was performed using a Tomey automated perimeter with a standard threshold strategy. The analysis included mean deviation (MD, dB) and pattern standard deviation (PSD, dB) as primary perimetric indices. Only reliable examinations were included in the analysis.

Computer perimetry was performed during postoperative follow-up at 3, 6, and 12 months to evaluate functional retinal outcomes and potential peripheral visual field changes associated with the selected surgical strategy.

VEGF assessment. Analysis of vascular endothelial growth factor (VEGF) concentration was performed in a subgroup of 80 patients (40 eyes in each group). Aqueous humor samples were collected at two time points:

1. At the beginning of vitrectomy, before any intraocular manipulation

2. During subsequent phacoemulsification with intraocular lens implantation, performed after stabilization of the vitreoretinal condition

VEGF concentration was measured using enzyme-linked immunosorbent assay (ELISA) according to the manufacturer's instructions.

Statistical analysis

Statistical analysis was performed using MedCalc statistical software. Quantitative data were tested for normality using the Shapiro–Wilk test. Normally distributed variables are presented as mean ± standard error (M ± m).

Intergroup comparisons were performed using the Student's t-test for normally distributed variables and the Mann–Whitney U test for non-normally distributed data. Changes over time were analyzed using paired statistical tests as appropriate. Correlation analysis between functional, microvascular, and biochemical parameters was conducted using Pearson's or Spearman's correlation coefficients, depending on data distribution.

All statistical tests were two-tailed, and a p value <0.05 was considered statistically significant.

Results

The results of the study are presented in a structured manner, reflecting functional, microvascular, and angiogenic outcomes following vitrectomy with and without panretinal photocoagulation. Comparative analysis was performed between the main and control groups at predefined postoperative time points using multimodal imaging and biochemical assessment.

The primary outcome measures included changes in best-corrected visual acuity, retinal ischemia dynamics assessed by wide-field OCT angiography, and vascular endothelial growth factor (VEGF) concentration in aqueous humor. Secondary analyses focused on the diagnostic performance of OCT angiography compared with fluorescein angiography and on the interrelationships between ischemia, VEGF levels, and visual outcomes.

Functional results are presented first, followed by microvascular and angiogenic findings.

To complement the graphical representation of postoperative visual acuity dynamics shown in Diagram 1, quantitative BCVA data are summarized in Table 2. The tabulated values provide exact mean logMAR measurements at each follow-up time point, enabling precise comparison between the main and control groups and supporting objective assessment of visual recovery after vitrectomy.

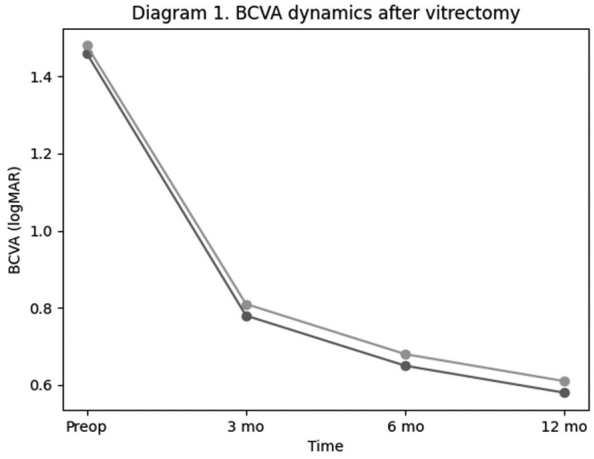

Diagram 1. Dynamics of best-corrected visual acuity (logMAR) during 12 months of follow-up.

Table 2. Dynamics of Best-Corrected Visual Acuity (logMAR)

Time point	Main group	Control group	p
Preoperative	1.46 ± 0.41	1.48 ± 0.40	>0.05
3 months	0.78 ± 0.39	0.81 ± 0.41	>0.05
6 months	0.65 ± 0.36	0.68 ± 0.38	>0.05
12 months	0.58 ± 0.34	0.61 ± 0.36	>0.05

Table 3. Visual field outcomes (Tomey computer perimetry) during follow-up (M ± m)

Time point	MD, dB (Main group)	MD, dB (Control group)	p	PSD, dB (Main group)	PSD, dB (Control group)	p
3 months	−14.9 ± 1.7	−16.1 ± 1.8	<0.05	6.5 ± 0.7	7.0 ± 0.8	<0.05
6 months	−13.8 ± 1.6	−15.8 ± 1.7	<0.01	6.2 ± 0.7	6.9 ± 0.8	<0.05
12 months	−12.9 ± 1.5	−15.6 ± 1.6	<0.001	6.0 ± 0.6	6.8 ± 0.7	<0.01

Notes: MD – mean deviation; PSD – pattern standard deviation; dB – decibels; M ± m – mean ± standard error.

Both groups demonstrated a statistically significant improvement in BCVA at all postoperative time points compared with baseline values ($p < 0.001$). The most pronounced visual gain occurred during the first three months after vitrectomy, followed by a more gradual improvement up to 12 months. At the final follow-up, clinically meaningful visual improvement (≥0.3 logMAR) was achieved in more than 70% of eyes in both groups.

Importantly, no statistically significant intergroup differences in BCVA were observed at any follow-up point. This indicates that omission of routine panretinal photocoagulation did not adversely affect visual recovery after vitrectomy. Visual outcomes appeared to be primarily determined by the extent of vitreoretinal traction removal and postoperative retinal stabilization rather than by the presence or absence of PRP.

Computer perimetry revealed progressive functional changes during postoperative follow-up at 3, 6, and 12 months. Comparative analysis demonstrated significantly better preservation of visual field function in the main group throughout the observation period.

Computer perimetry performed at 3, 6, and 12 months demonstrated a gradual improvement in visual field parameters in both groups. However, patients in the main group consistently showed less negative mean deviation (MD) values and lower pattern standard deviation (PSD) throughout the follow-up period. The increasing intergroup difference over time suggests better preservation of peripheral retinal function in eyes treated without routine panretinal photocoagulation.

Diagram 2 illustrates the trend in retinal ischemia area as assessed by wide-field OCT angiography. This combined visualization allows accurate evaluation of the magnitude and statistical significance of ischemic changes between groups over time.

In addition to ischemic area assessment, quantitative OCT angiography parameters were analyzed using 12×12 mm scans. Vessel density (VD, %) and perfusion density (PD, %) were calculated separately for the superficial capillary plexus (SCP) and deep capillary plexus (DCP). The foveal avascular zone (FAZ) area was measured manually on en face images. A non-perfusion index (NPI, %) was calculated as the ratio of non-perfused retinal area to the total scanned area. These parameters were used to assess microvascular integrity and its relationship with functional and biochemical outcomes.

Table 4. OCT angiography parameters in the postoperative period (12×12 mm, M ± m)

Parameter	Main group	Control group	P
SCP vessel density, %	42.6 ± 3.8	38.1 ± 4.1	<0.05
DCP vessel density, %	40.2 ± 3.5	35.7 ± 3.9	<0.01
Perfusion density, %	46.9 ± 4.2	41.3 ± 4.6	<0.05
FAZ area, mm²	0.42 ± 0.09	0.51 ± 0.11	<0.05
Non-perfusion index, %	14.8 ± 3.2	21.6 ± 3.9	<0.01

Notes: SCP – superficial capillary plexus; DCP – deep capillary plexus; FAZ – foveal avascular zone.

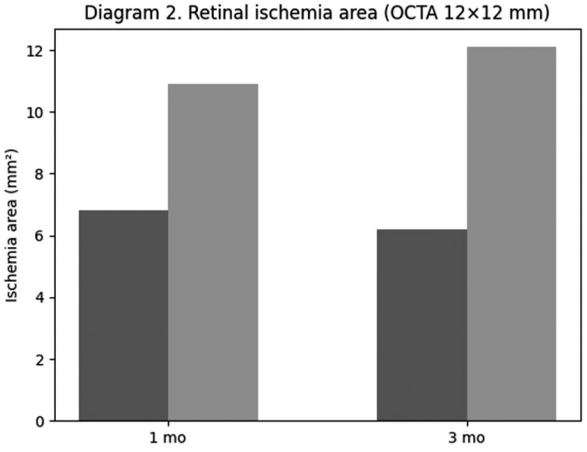

Diagram 2. Changes in retinal ischemia area according to OCT angiography 12×12 mm.

Quantitative OCT angiography analysis revealed significantly higher vessel and perfusion density in both superficial and deep capillary plexuses in the main group. The non-perfusion index was significantly lower, indicating better preservation of retinal microcirculation. FAZ enlargement was more pronounced in the control group, suggesting greater macular microvascular compromise.

Wide-field OCT angiography revealed fundamentally different ischemic patterns between the two treatment strategies. In the main group, the area of retinal ischemia demonstrated stabilization or mild regression during the postoperative period. In contrast, eyes treated with routine

Table 5. Comparative diagnostic informativeness of OCTA and FA

Criterion	OCTA	FA
Ischemia detection (mm²)	8.1 ± 1.3	8.6 ± 1.5
Repeatability	100%	54%
Quantitative assessment	Yes	No
SCP/DCP evaluation	Yes	No
Leakage detection	No	Yes

Notes: OCTA – optical coherence tomography angiography; FA – fluorescein angiography; SCP – superficial capillary plexus; DCP – deep capillary plexus.

PRP showed a tendency toward enlargement of ischemic areas, despite adequate anatomical retinal attachment.

These findings suggest that routine PRP does not necessarily prevent progression of retinal non-perfusion and may be associated with secondary microvascular compromise. The ability of OCT angiography 12×12 mm to visualize parafoveal and mid-peripheral ischemic zones was critical for detecting these changes, which would likely remain undetected using standard 6×6 mm scans.

Both imaging modalities demonstrated comparable ability to detect retinal ischemic zones. However, OCT angiography provided superior repeatability and enabled quantitative assessment of ischemia, allowing objective longitudinal monitoring. Fluorescein angiography retained value in detecting vascular leakage and neovascular activity but was limited by its invasive nature and reduced feasibility for repeated examinations.

From a clinical standpoint, OCT angiography proved to be the preferred method for postoperative monitoring and decision-making regarding additional laser treatment.

Baseline VEGF concentrations were comparable between the main and control groups, indicating similar levels of angiogenic activity prior to surgical intervention. After vitrectomy and subsequent cataract surgery, VEGF levels decreased markedly in both groups.

No statistically significant intergroup difference in VEGF concentration was observed at the time of phacoemulsification with intraocular lens implantation. This finding suggests that vitreous removal itself plays a dominant role in reducing intraocular angiogenic activity, regardless of the application of panretinal photocoagulation.

The timing of VEGF reassessment during cataract surgery allowed evaluation of longer-term biochemical changes, minimizing the influence of early postoperative fluctuations and providing a more stable estimate of postoperative angiogenic status.

Integrated outcome analysis

Taken together, the functional, microvascular, and biochemical results indicate that vitrectomy without routine PRP provides a favorable balance between anatomical stabilization and preservation of retinal microcirculation. Visual recovery was comparable between groups, while ischemic progression and VEGF activity were more effectively controlled in the PRP-free group.

Additional Results: Correlation Analysis

Correlation between VEGF levels, retinal ischemia, and visual acuity

To better understand the interrelationship between angiogenic activity, microvascular ischemia, and functional outcomes, a correlation analysis was performed in the VEGF subgroup (40 patients in each group).

VEGF and retinal ischemia (OCTA 12×12 mm)

A moderate positive correlation was identified between aqueous humor VEGF concentration and the area of retinal ischemia measured by OCT angiography:

• Main group: $r = 0.58$, $p < 0.01$

• Control group: $r = 0.64$, $p < 0.01$

This finding indicates that larger ischemic zones are associated with higher intraocular VEGF levels, confirming the role of ischemia-driven angiogenic stimulation in proliferative diabetic retinopathy.

VEGF and best-corrected visual acuity

An inverse correlation was observed between VEGF concentration and postoperative BCVA at 12 months:

• Main group: $r = –0.46$, $p < 0.05$

• Control group: $r = –0.42$, $p < 0.05$

Higher VEGF levels were associated with worse functional outcomes, suggesting that persistent angiogenic activity negatively affects visual recovery even after successful anatomical retinal stabilization.

Retinal ischemia and visual acuity

Correlation analysis demonstrated a moderate inverse relationship between ischemic area and BCVA:

• Main group: $r = –0.52$, $p < 0.01$

• Control group: $r = –0.55$, $p < 0.01$

Eyes with larger ischemic zones exhibited poorer visual outcomes, highlighting the functional relevance of microvascular perfusion beyond macular structural integrity.

Postoperative complications

Postoperative complications were carefully monitored during the 12-month follow-up period.

Recurrent vitreous hemorrhage occurred in 8 eyes (7.3%) in the main group and 7 eyes (5.8%) in the control group. Most cases resolved spontaneously or required only minor additional treatment.

Rubeosis iridis was observed in 4 eyes (3.3%) in the main group and 3 eyes (2.7%) in the control group.

Secondary neovascular glaucoma developed in 3 eyes (2.5%) in the main group and 2 eyes (1.8%) in the control group.

No statistically significant difference in the incidence of these complications was observed between the groups.

Discussion

The present study provides a comprehensive assessment of functional, microvascular, and angiogenic outcomes following vitrectomy performed with and without routine panretinal photocoagulation in patients with proliferative diabetic retinopathy. By integrating wide-field

OCT angiography, computer perimetry, and longitudinal VEGF analysis, the study offers a multidimensional perspective on postoperative retinal recovery beyond conventional anatomical endpoints.

Visual acuity improved significantly in both groups throughout the follow-up period, with no statistically significant intergroup differences at any time point. This finding is consistent with previous studies demonstrating that visual outcomes after vitrectomy in proliferative diabetic retinopathy are primarily determined by the removal of vitreoretinal traction and anatomical retinal stabilization rather than by the application of panretinal photocoagulation [8, 9].

In contrast, analysis of retinal microcirculation using wide-field OCT angiography revealed meaningful differences between treatment strategies. Patients managed without routine PRP demonstrated more favorable microvascular parameters, including stabilization of ischemic areas, higher vessel and perfusion density, lower non-perfusion index, and less pronounced FAZ enlargement. These findings are in agreement with recent OCT angiography studies suggesting that PRP does not necessarily prevent progression of retinal ischemia and may even contribute to secondary microvascular compromise [7, 10, 12].

Assessment of VEGF dynamics showed a marked reduction in intraocular VEGF concentration after vitrectomy in both groups, with no statistically significant intergroup differences at the time of subsequent phacoemulsification with intraocular lens implantation. This observation supports the concept of the intrinsic antiangiogenic effect of vitreous removal and is consistent with previous studies demonstrating that vitrectomy itself plays a dominant role in reducing intraocular VEGF levels regardless of PRP status [2, 3, 5].

Functional evaluation using computer perimetry further highlighted the clinical relevance of microvascular preservation. Patients in the main group demonstrated better preservation of visual field function throughout the follow-up period. These findings are particularly important, as peripheral visual field loss is a well-recognized adverse effect of panretinal photocoagulation and has been widely reported in the literature [7].

Correlation analysis supported a pathophysiological link between retinal microvascular impairment and functional outcomes. Larger ischemic areas and higher non-perfusion index values were associated with worse visual acuity and perimetric indices, underscoring the functional significance of retinal perfusion beyond macular structural integrity. These findings are consistent with previous studies demonstrating a close relationship between retinal ischemia and angiogenic activity in proliferative diabetic retinopathy [13].

Previous studies evaluating intraocular cytokine profiles in proliferative diabetic retinopathy have demonstrated that the effect of panretinal photocoagulation on angiogenic mediators is not uniform. In particular, Suzuki et al. reported that although inflammatory cytokine levels were higher in eyes without preoperative PRP, intravitreal VEGF levels did not differ significantly between groups [5]. These findings further support the hypothesis that vitrectomy itself plays a dominant role in reducing intraocular angiogenic activity.

Selective application of PRP during postoperative follow-up may have influenced the outcomes in the main group and should be considered a potential confounding factor when interpreting the results.

From a clinical perspective, the results support a more individualized approach to surgical management of proliferative diabetic retinopathy. Rather than routine application of panretinal photocoagulation, postoperative decision-making should be guided by objective assessment of retinal perfusion using wide-field OCT angiography, which has been shown to provide reliable and reproducible quantitative evaluation of retinal microcirculation [14].

Assessment of postoperative complications demonstrated that omission of routine panretinal photocoagulation did not increase the risk of neovascular complications such as rubeosis iridis, recurrent vitreous hemorrhage, or secondary neovascular glaucoma. These findings suggest that a PRP-sparing surgical strategy may be safe in carefully selected patients with proliferative diabetic retinopathy.

The main limitations of this study include its retrospective design and subgroup analysis of VEGF levels. Another important limitation is the limited availability of baseline OCT angiography and visual field data, which was due to media opacity and the severity of vitreoretinal pathology in eyes with advanced proliferative diabetic retinopathy. Nevertheless, the relatively large cohort, standardized surgical technique, and comprehensive multimodal evaluation strengthen the validity and clinical relevance of the findings.

Conclusion

Vitrectomy performed without routine panretinal photocoagulation provides functional outcomes comparable to conventional surgery while demonstrating favorable microvascular stabilization in patients with proliferative diabetic retinopathy.

Wide-field OCT angiography enables objective assessment of retinal ischemia and microvascular alterations, facilitating individualized postoperative monitoring and clinical decision-making. In the present study, VEGF levels decreased significantly after surgery in both groups, indicating that vitrectomy itself may contribute substantially to the reduction of intraocular angiogenic activity.

An individualized management approach guided by OCT angiography, with selective use of fluorescein angiography, may assist in evaluating retinal perfusion and neovascular activity and support postoperative monitoring and clinical decision-making in patients with complicated proliferative diabetic retinopathy.

Author Contributions

Khusanbaev Kh.Sh. contributed to the study design, data collection, quantitative analysis of OCT and OCT angiography parameters, statistical analysis, and drafting of the original manuscript. Yusupov A.F. contributed to data collection and analysis, including assessment of fluorescein angiography and computer perimetry data, performed statistical analysis, and participated in manuscript review and editing. All authors read and approved the final version of the manuscript.

Disclaimers

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Conflict of Interest

The author declare that they have no conflicts of interest related to this work.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Abbreviations

RSSPMCEM – Republican Specialized Scientific and Practical Medical Center of Eye Microsurgery; BCVA – Best Corrected Visual Acuity; OCT – Optical Coherence Tomography; OCTA – Optical Coherence Tomography Angiography; CP – Computer Perimetry; RPE – Retinal Pigment Epithelium; RNFL – Retinal Nerve Fiber Layer; IRF – Intraretinal Fluid; CRT – Central Retinal Thickness; MD – Mean Deviation; PD – Perfusion Density; PRP – Panretinal Photocoagulation; VEGF – Vascular Endothelial Growth Factor.

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