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Original Article

Conbercept combined with retinal photocoagulation significantly improves visual acuity and quality of life in patients with proliferative diabetic retinopathy

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Abstract: Objective: To evaluate the clinical efficacy of Conbercept combined with retinal photocoagulation in patients with proliferative diabetic retinopathy (PDR) and its effect on visual acuity and related outcomes. Methods: This retrospective study included 120 PDR patients treated between January 2019 and January 2021. Based on treatment modality, patients were assigned to a study group (SG, n=60; Conbercept combined with retinal photocoagulation) or a control group (CG, n=60; retinal photocoagulation alone). Surgical data, best-corrected visual acuity (BCVA), central macular thickness (CMT), frequency of Conbercept injections, incidence of postoperative complications, quality of life (QoL) scores, and the need for additional pan-retinal photocoagulation (PRP) were compared between the two groups. Multivariate logistic regression was performed to identify independent risk factors associated with surgical complications. Results: Compared to the CG, the SG demonstrated significantly reduced intraoperative bleeding and greater improvements in BCVA and CMT from 1-48 months postoperatively (P<0.05). The SG required fewer additional PRP sessions at 6 months postoperatively (P<0.05), and demonstrated significantly lower rates of vitreous hemorrhage and macular edema recurrence (P<0.05). QoL scores were significantly higher in the SG at the 48-month follow-up (P<0.05). Logistic regression analysis identified age ≥60 years, disease duration ≥15 years, baseline HbA1c ≥8.5%, surgical duration ≥90 minutes, intraoperative bleeding ≥2 mL, and lack of early anti-VEGF therapy as independent risk factors for postoperative complications (P<0.05). Conclusion: The combination of Conbercept with retinal photocoagulation significantly improved visual outcomes and reduced postoperative complications in PDR patients, particularly beneficial for patients with advanced age, prolonged disease duration, elevated HbA1c, extended surgical duration, or intraoperative bleeding.

Keywords: Conbercept, surgical treatment, proliferative diabetic retinopathy, visual outcomes, risk factors, retinal photocoagulation

Introduction

Diabetic retinopathy (DR) is among the most common and severe microvascular complications of diabetes mellitus, with proliferative diabetic retinopathy (PDR) representing its most advanced stage. As the global prevalence of diabetes continues to increase, the incidence of PDR is also rising annually, positioning it as a leading cause of vision loss and blindness worldwide [1, 2]. It has been reported that the prevalence of PDR may exceed 50% in individuals with a diabetes duration of over 20 years, often resulting in substantial visual impairment and a marked decline in quality of life [3].

Currently, the primary therapeutic options for PDR include vitrectomy, pan-retinal photocoagulation (PRP), and anti-vascular endothelial growth factor (anti-VEGF) therapy [4]. Among these, PRP remains a standard treatment modality. It achieves therapeutic effects by selectively ablating ischemic retinal tissue, thereby reducing VEGF production and suppressing abnormal neovascularization. Nevertheless, PRP has several inherent drawbacks, including delayed therapeutic response, the need for multiple treatment sessions, and a risk of peripheral visual field loss. In recent years, the advent and increasing use of anti-VEGF therapies, particularly PRP combined with

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anti-VEGF injections, has emerged as an increasingly important strategy for managing PDR.

Although conventional vitrectomy is effective in removing proliferative membranes and mitigating retinal ischemia, it is associated with considerable intraoperative risks - most notably hemorrhage - and a relatively high incidence of postoperative complications [5]. These challenges are particularly pronounced in PDR patients complicated by diabetic macular edema (DME), where surgical intervention alone often fails to yield optimal therapeutic outcomes. While PRP can suppress neovascularization, its therapeutic effects typically take time to manifest and may be accompanied by complications such as peripheral visual field loss [6, 7].

In recent years, anti-VEGF agents have attracted increasing attention for their role in PDR management. Conbercept, a next-generation anti-VEGF agent, functions by specifically binding multiple isoforms of VEGF, thereby effectively inhibiting pathologic neovascularization and reducing vascular permeability [8]. Emerging clinical evidence [9] suggests that preoperative administration of anti-VEGF drugs can significantly reduce intraoperative bleeding and improve the surgical field, potentially enhancing surgical safety and outcomes. Nevertheless, despite these promising findings, data on the long-term efficacy and safety of Conbercept, when used in conjunction with surgical intervention for PDR, remain limited - particularly concerning its effect on postoperative outcomes and the role of anti-VEGF therapy in the long-term management of the condition.

This study conducted a novel and comprehensive 4-year follow-up to systematically evaluate the clinical efficacy of Conbercept in combination with retinal photocoagulation in PDR patients. Key outcome measures included postoperative improvements in visual acuity, changes in central macular thickness (CMT), incidence of complications, and enhancement in quality of life. Moreover, multivariable logistic regression analysis was performed to identify risk factors associated with surgical complications. This provides a basis for the development of individualized treatment strategies and offers valuable guidance for optimizing clinical protocols and improving therapeutic outcomes in the management of PDR.

Materials and methods

Study design

This retrospective cohort study systematically collected comprehensive clinical data from the hospital's information system of PDR patients who underwent either surgical treatment alone or combined surgery with Conbercept. A comparative analysis was conducted between the two groups to evaluate the relative efficacy of the treatment modalities. The aim was to generate clinically meaningful evidence to inform and refine therapeutic strategies for PDR management. The study protocol was approved by the Ethics Committee of Ninghai First Hospital and was conducted in accordance with the ethical standards of the Declaration of Helsinki.

Case selection

Clinical data were retrieved from the hospital information system for patients diagnosed with PDR at Ninghai First Hospital between January 2019 and January 2021. Patients were included based on the following criteria: (1) diagnosis of PDR in accordance with the 2014 Chinese diabetic retinopathy guidelines [10]; (2) classification as stage IV to VI PDR; (3) meeting the surgical indications and undergoing surgery at our hospital; and (4) unilateral eye involvement only. Based on these criteria, 186 patients were initially identified.

Secondary screening was then conducted using the following exclusion criteria: (1) the presence of coagulation disorders; (2) coexisting ocular conditions; (3) cataracts that interfered with intraoperative fundus procedures and necessitated lens extraction; and (4) systemic health conditions contraindicating ophthalmic surgery. After applying these criteria, 120 eligible patients (120 eyes) were included in the final analysis. Participants were subsequently divided into two groups based on the treatment received: the study group (SG, n=60), which received Conbercept combined with surgery, and the control group (CG, n=60), which underwent surgery alone.

Intervention method

Patients in the study group received Conbercept combined with surgical treatment. A single intravitreal injection of Conbercept was administered 3-7 days prior to surgery. After standard

preoperative mydriasis and anesthesia, a conventional three-port 23-gauge pars plana vitrectomy was performed to remove fibrovascular proliferative membranes. Intraoperative photocoagulation was performed based on the extent of retinal ischemia. Intravitreal tamponade was applied as needed based on the patient's condition prior to the completion of surgery. Following surgery, patients received Conbercept injections on a *pro re nata* (PRN) basis. At the 1-month follow-up, an additional intravitreal injection of Conbercept was administered if optical coherence tomography (OCT) indicated a central macular thickness ≥300 μm or evidence of active neovascularization. Thereafter, monthly follow-up visits were scheduled, during which additional injections were given in cases of newly developed or recurrent neovascularization. In the control group, patients underwent retinal photocoagulation combined with surgical intervention.

Data collection and outcome measures

Preparatory work prior to data collection: To ensure data integrity and minimize bias, the processes of data collection and statistical analysis were performed independently by different personnel. A blinded data collection protocol was implemented, whereby patient identities were anonymized using a coded identifier system (e.g., Patient No. 1, Patient No. 2) following the recording of basic demographic information. Subsequently, a designated auditor reviewed the collected data for accuracy and completeness. Only after verification was, the dataset forwarded to the statistical team for analysis.

Throughout the entire process, strict confidentiality measures were upheld. No personally identifiable information was accessed or disclosed during any stage of the study. All procedures adhered to institutional data protection policies and relevant national regulations regarding the handling of patient data.

Primary outcome measures: (1) Improvement in visual acuity and CMT [11]: Best-corrected visual acuity (BCVA) and CMT were measured at admission, and at 1, 3, 6, 12, 24, 36, and 48 months postoperatively, followed by intergroup comparisons. (2) Perioperative complications and CMT changes: The incidence of perioperative complications, including vitreous hemorrhage, neovascular glaucoma, and other related complications, was recorded. Additionally, changes in CMT from admission to 1 month postoperatively were analyzed and compared between the two groups. (3) PRP treatment: The number and frequency of PRP sessions were documented, including preoperative PRP, intraoperative supplemental photocoagulation, and any additional photocoagulation required postoperatively. These data were compared between the groups to evaluate differences in treatment intensity and disease control. (4) Postoperative risk factor analysis: Potential risk factors for postoperative complications were analyzed, including a range of clinical data that may influence long-term outcomes.

Secondary outcome measures: (1) Baseline characteristics: Demographic and clinical characteristics, including age, sex, and disease duration, were compared between the two groups to identify potential confounding factors that might influence treatment outcomes. (2) Surgery-related parameters: Surgery-related variables, such as surgical duration and intraoperative blood loss were recorded and compared between groups to evaluate procedural differences and surgical complexity associated with each treatment modality. (3) Postoperative Conbercept injections: The number of Conbercept injections administered during the postoperative period was recorded and analyzed across defined intervals: 0-6 months, 7-12 months, 13-24 months, 25-36 months, and 37-48 months postoperatively [12]. (4) Quality of life assessment: Quality of life was assessed at the 48-month follow-up using the Visual Functioning Questionnaire-25 (VFQ-25) [13]. The VFQ-25 consists of 10 subscales - general vision, near activities, distance activities, social functioning, mental health, role difficulties, dependency, driving, color vision, and peripheral vision - each scored from 0 to 100, with higher scores indicating better visual function and overall quality of life.

Statistical methods

Data analysis was performed using SPSS version 22.0. Descriptive statistics were applied to summarize the data, with continuous variables presented as means ± standard deviation (means ± SD). Data normality was assessed using the Shapiro-Wilk test. Intergroup comparisons of continuous variables were performed using independent samples t-tests. Repeated

Table 1. Comparison of baseline characteristics between the two groups ($\bar{x} \pm s$)/[n (%)]

Item		Study group (n=60)	Control group (n=60)	t/χ^2	*P*
Sex	Male	35	33	0.135	0.714
	Female	25	27		
Mean age (years)		57.31±7.59	56.38±7.19	0.582	0.562
Mean duration of disease (years)		12.81±5.82	12.23±5.36	0.566	0.573
Glycated hemoglobin (%)		8.29±1.53	8.12±1.28	0.765	0.446
Presence of DME		40	38	0.149	0.699
Previous PRP treatment		45	47	0.188	0.665
Baseline BCVA (logMAR)		1.26±0.39	1.25±0.38	0.286	0.775
Baseline CRT (μm)		432.46±115.58	420.48±109.02	0.594	0.554

DME: diabetic macular edema; PRP: pan-retinal photocoagulation; BCVA: best-corrected visual acuity; CRT: central retinal thickness.

Table 2. Comparison of surgery-related parameters between the two groups

Surgery-related data	Study group (n=60)	Control group (n=60)	t/χ^2	*P*
Surgery duration (min)	70.19±16.13	66.78±14.68	1.213	0.228
Intraoperative bleeding (%)	5	10	3.956	0.047
Iatrogenic retinal breaks (%)	3	5	0.536	0.464
Intraoperative laser photocoagulation (%)	56	56	0.000	1.000
Gas tamponade (%)	48	50	0.223	0.637
Silicone oil tamponade (%)	12	10	0.223	0.637

measures analysis of variance (ANOVA) was employed to evaluate the effects of time and treatment on best-corrected visual acuity (BCVA) and central macular thickness across multiple time points. When significant differences were detected by the repeated measures ANOVA, Bonferroni correction was applied for *post hoc* multiple comparisons. Categorical variables were expressed as frequencies and percentages, with intergroup differences analyzed using the chi-square test or Fisher's exact test. Potential risk factors for postoperative complications were first examined by univariate logistic regression analysis, with variables demonstrating a *P*-value <0.10 selected for inclusion in a multivariable logistic regression model. This model estimated odds ratios (ORs) and 95% confidence intervals (CIs). A *P*-value of <0.05 was considered significant.

Results

Comparison of baseline characteristics between the two groups

Baseline characteristics, including sex, age, disease duration, and glycated hemoglobin levels, were compared between the two groups. No significant differences were observed in these variables ($P>0.05$) (**Table 1**).

Comparison of surgery-related data between the two groups

Analysis of surgical data showed that the study group experienced significantly less intraoperative bleeding compared to the control group ($P<0.05$). In contrast, no statistically significant differences were found between groups in terms of surgical duration, extent of intraoperative laser photocoagulation, or the use of gas or silicone oil tamponade ($P>0.05$) (**Table 2**).

Comparison of visual acuity improvement between the two groups

BCVA was assessed at admission and at 1 month, 3 months, 6 months, 12 months, 24 months, 36 months, and 48 months postoperatively. The study group consistently exhibited significantly greater improvement in BCVA compared to the control group at all postoperative time points from 1 month to 48 months ($P<0.05$) (**Figure 1**).

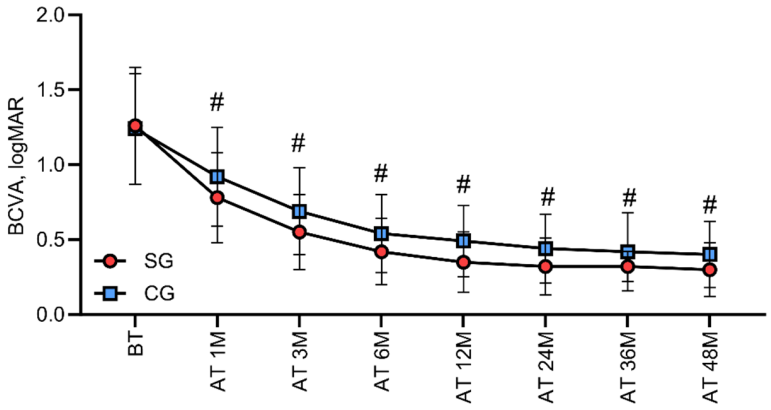

Figure 1. Comparison of visual acuity improvement between the two groups. BCVA in the SG was significantly lower than in the CG at 1 month, 3 months, 6 months, 12 months, 24 months, and 36 months postoperatively (P<0.05). Note: BCVA: best-corrected visual acuity; SG: study group; CG: control group; BT: baseline treatment; AT: after treatment. Compared to the control group, $^{\#}P$<0.05.

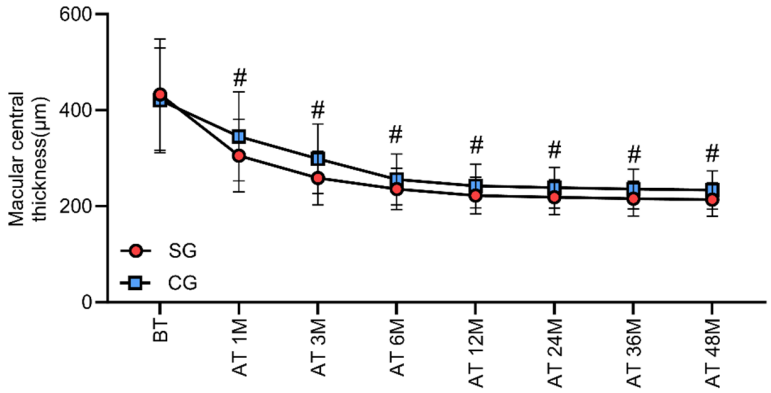

Figure 2. Comparison of changes in MCT between the two groups. The MCT in the SG was significantly lower than in the CG at all follow-up time points from 1 month to 48 months postoperatively (P<0.05). Note: MCT: macular center thickness; SG: study group; CG: control group; BT: baseline treatment; AT: after treatment. Compared to the control group, $^{\#}P$<0.05.

Comparison of MCT changes between the two groups

No significant difference was observed in baseline MCT between the two groups (P>0.05). However, from 1 month through 48 months postoperatively, the study group demonstrated significantly lower MCT values compared to the control group (P<0.05) (**Figure 2**).

Comparison of postoperative Conbercept injection frequency between the two groups

During the postoperative follow-up, patients in the study group received significantly more Conbercept injections than those in the control group across all evaluated intervals: 0-6 months, 7-12 months, 13-24 months, 25-36 months, and 37-48 months (P<0.05) (**Figure 3**).

Comparison of perioperative complications between the two groups

Follow-up analysis indicated that the study group experienced significantly lower incidences of perioperative peripheral vitreous hemorrhage, macular edema recurrence, and overall complication rates relative to the control group (P<0.05). No significant differences were observed between groups regarding other perioperative complications (P>0.05) (**Table 3**).

Comparison of quality of life at 48-month follow-up between the two groups

At the 48-month postoperative follow-up, the study group exhibited significantly higher scores across all domains of the VFQ-25 scale compared to the control group. These domains included general vision, near activities, distance activities, social functioning, mental health, role difficulties, dependence, driving, color vision, and peripheral vision (P<0.05) (**Figure 4**).

Comparison of PRP treatment between the two groups

Preoperatively, 45 patients (75.00%) in the study group received PRP, with an average of 3.21±1.12 photocoagulation sessions, while 47 patients (78.33%) in the control group underwent preoperative PRP, averaging 3.41±1.21 sessions. No significant difference was observed between the two groups (P>0.05). Postoperative supplemental photocoagulation was administered to 56 patients (93.33%) in

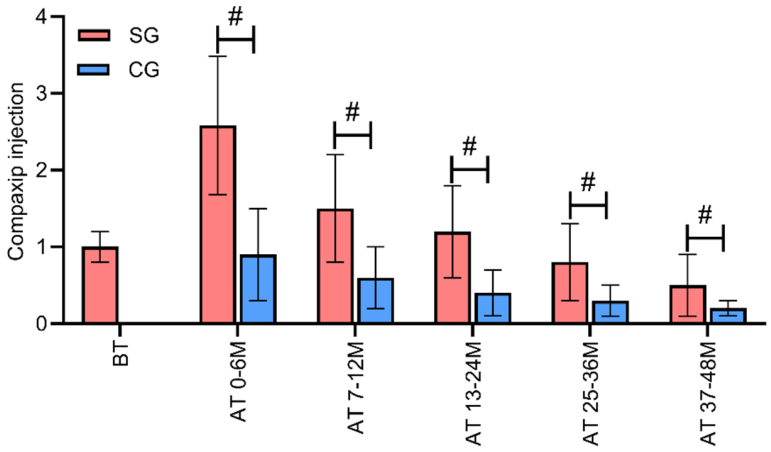

Figure 3. Comparison of postoperative Conbercept injections between the two groups. The amount of Conbercept injected in the SG was significantly higher than in the CG during the postoperative periods of 0-6 months, 7-12 months, 13-24 months, 25-36 months, and 37-48 months (P<0.05). Note: SG: study group; CG: control group; BT: baseline treatment; AT: after treatment. Compared to the control group, #P<0.05.

Table 3. Comparison of perioperative complications between the two groups [n (%)]

Complication	Study group (n=60)	Control group (n=60)	X^2	P
Vitreous hemorrhage	4 (6.67)	9 (15.00)	4.186	0.041
Neovascular glaucoma	1 (1.67)	3 (5.00)	1.034	0.309
Retinal detachment	1 (1.67)	2 (3.33)	0.342	0.559
Recurrent macular edema	6 (10.11)	12 (20.00)	4.502	0.034
Cataract progression	11 (18.33)	14 (23.33)	0.459	0.498
Elevated intraocular pressure	3 (5.00)	5 (8.33)	0.536	0.464
Total incidence	26 (43.33)	43 (71.67)	10.208	0.002

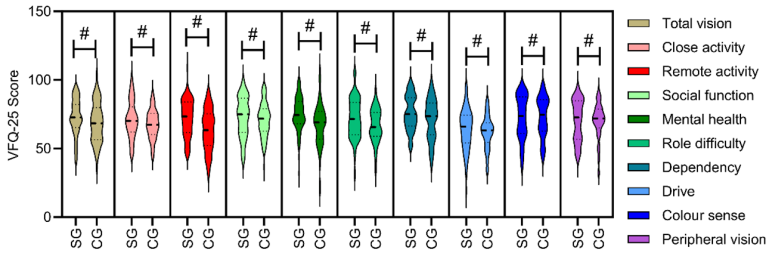

Figure 4. Comparison of quality of life scores between the two groups at 48-months postoperative follow-up. Postoperative scores in all dimensions of the VFQ-25 scale were significantly higher in the SG than in the CG (P<0.05). Note: VFQ-25: Visual Functioning Questionnaire-25; SG: study group; CG: control group. Compared to the control group, #P<0.05.

the study group and 54 patients (90.00%) in the control group, also without a significant difference (P>0.05). Notably, the incidence of additional photocoagulation within 6 months after surgery was significantly lower in the study group (25.00%, 15/60) compared to the control group (43.33%, 26/60) (P<0.05).

Univariate and multivariable analyses of surgical complications

To identify factors associated with the occurrence of surgical complications, univariate analysis was first conducted, followed by multivariable logistic regression. The univariate analysis revealed that age ≥60 years, disease duration ≥15 years, baseline HbA1c ≥8.5%, surgical duration ≥90 minutes, intraoperative bleeding ≥2 ml, and absence of early anti-VEGF treatment were potential predictors of postoperative complications (P<0.1) (**Table 4**).

Subsequent multivariable logistic regression incorporating these variables identified that all the above factors were strongly associated with an increased risk of postoperative complications (P<0.05) (**Table 5**; **Figure 5**).

Discussion

This study comprehensively assessed the long-term clinical outcomes of Conbercept combined with surgical treatment for PDR over a four-year follow-up. Our findings demonstrate that, compared to surgery alone, adjunctive Conbercept therapy significantly improved visual outcomes, decreased the incidence of postoperative complications, and enhanced patients' quality of life. Notably, the combined treatment was associated with reduced intraoperative bleeding, superior postoperative visual acuity gains, more pronounced decreases in MCT, and lower

Table 4. Univariate analysis of postoperative complications after PDR surgery

Item		Group with complications (n=31)	Group without complications (n=89)	χ^2	*P*
Sex	Male	18	50	0.032	0.858
	Female	13	39		
Age	≥60 years	19	34	4.904	0.027
	<60 years	12	55		
Disease duration	≥15 years	20	28	11.536	0.001
	<15 years	11	61		
Baseline HbA1c	≥8.5%	22	38	7.365	0.007
	<8.5%	9	51		
Presence of DME	Yes	23	55	1.532	0.216
	No	8	34		
Previous PRP treatment	Yes	18	27	7.508	0.006
	No	13	62		
Surgery time	≥90 minutes	16	18	10.943	0.001
	<90 minutes	15	71		
Intraoperative bleeding	≥2 ml	17	20	14.321	<0.001
	<2 ml	14	69		
Early anti-VEGF therapy	No	20	31	8.512	0.004
	Yes	11	58		
Baseline BCVA	≥1.3 logMAR	18	40	1.562	0.211
	<1.3 logMAR	13	49		
Baseline CRT	≥450 μm	19	42	1.872	0.171
	<450 μm	12	47		

DME: diabetic macular edema; PRP: pan-retinal photocoagulation; VEGF: vascular endothelial growth factor; BCVA: best-corrected visual acuity; CRT: central retinal thickness.

Table 5. Multivariable logistic regression analysis of postoperative complication incidence

Risk factor	B	S.E	Wald	*P*	OR	95% CI
Age ≥60 years	0.986	0.434	5.165	0.023	2.681	1.145-6.278
Disease duration ≥15 years	1.385	0.512	7.321	0.007	3.995	1.464-10.892
Baseline HbA1c ≥8.5%	1.242	0.487	6.512	0.011	3.462	1.333-8.995
Surgery duration ≥90 minutes	1.328	0.492	7.294	0.007	3.774	1.440-9.892
Intraoperative bleeding ≥2 mL	1.476	0.478	9.526	0.002	4.375	1.714-11.165
Absence of early anti-VEGF therapy	1.254	0.423	8.785	0.003	3.504	1.529-8.032

Note: VEGF: vascular endothelial growth factor.

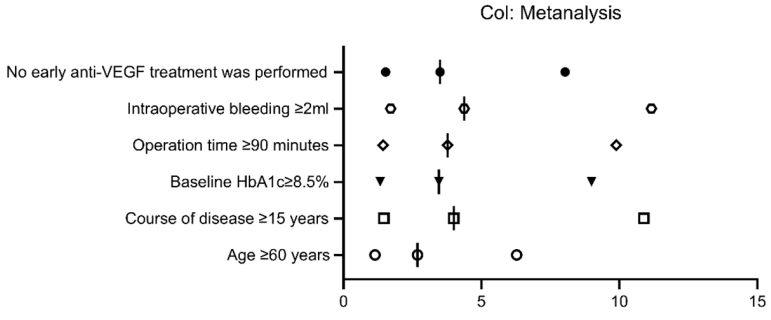

Figure 5. Multivariable logistic regression analysis of postoperative complications occurrence.

rates of perioperative complications, particularly vitreous hemorrhage and macular edema recurrence.

Intraoperative and early outcomes

In this study, the intraoperative hemorrhage rate was significantly lower in the study group compared to the control group, likely due to the

preoperative administration of Conbercept. As a next-generation anti-VEGF agent, Conbercept specifically binds to VEGF isoforms, effectively inhibiting their activity and thereby reducing the fragility and permeability of pathologic neovascular vessels [14]. This mechanism likely underlies the observed reduction in intraoperative bleeding risk.

These findings are consistent with the meta-analysis by Wang et al. [15], which included 18 studies with 1,149 patients and found that although Conbercept did not significantly enhance overall clinical outcomes, it was associated with a shorter operative duration and lower incidence of intraoperative hemorrhage and retinal tears, particularly within intermediate and short postoperative intervals. They also reported a significant reduction in postoperative vitreous hemorrhage. Additionally, Wang et al. [16] demonstrated that Conbercept improved intraoperative visualization and surgical ease in PDR patients, supported by *in vitro* fibroblast barrier models.

Our findings corroborate these observations, as no significant differences were detected between groups in terms of surgical duration or the incidence of iatrogenic retinal breaks. This indicates that the adjunctive Conbercept does not complicate the surgical procedure but rather optimizes the intraoperative environment without prolonging the operation duration [17].

Visual improvement and anatomical outcomes

Further analysis revealed that the study group achieved better visual outcomes, as evidenced by lower BCVA values, throughout the follow-up period from 1 month to 48 months postoperatively. These findings suggest that Conbercept not only facilitates immediate visual improvement but also plays a critical role in sustaining long-term visual function through ongoing maintenance therapy. Notably, patients in the study group showed superior control of MCT, consistent with the findings reported by Li et al. [18]. In their study involving 60 eyes with severe PDR and 20 eyes with combined proliferative vitreoretinopathy and macular detachment, Conbercept-treated patients exhibited significantly reduced MCT and VEGF levels compared to other pharmacological treatments. These results highlight Conbercept's efficacy in controlling macular edema through anti-VEGF mechanisms, thereby improving anatomical outcomes.

An in-depth analysis of visual acuity changes in our study revealed a characteristic pattern of rapid early improvement followed by sustained stabilization. This can be attributed to two main factors: (1) early Conbercept administration effectively suppresses inflammatory responses and vascular leakage, creating a favorable microenvironment for retinal recovery; (2) consistent maintenance therapy prevents neovascular regeneration and macular edema recurrence, thus consolidating the therapeutic benefits [19].

Injection strategy and long-term management

This study found that the frequency of Conbercept injections in the study group was higher than in the control group aross all follow-up intervals. This difference likely reflects the proactive, prophylactic treatment approach implemented in our protocol. Ding et al. [20] reported that preoperative Conbercept injections significantly reduced intraoperative hemorrhage rates in PDR patients, and postoperative injections effectively lowered the risk of early disease recurrence. Moreover, longitudinal analysis revealed a gradual decrease in injection frequency over time, which is likely due to the cumulative therapeutic effects of adjunctive interventions such as photocoagulation, alongside the progressive stabilization of disease activity.

Supporting this, Ortiz-Seller et al. [12], in a meta-analysis evaluated different anti-VEGF dosing regimens in PDR patients with retreatment rates as the primary outcome. They concluded that Conbercept offered superior refractive outcomes compared to laser therapy. Their findings suggest that lower-dose anti-VEGF regimens may reduce both ocular and systemic adverse effects. Based on these insights, we advocate for a PRN injection regimen, tailored to the patient's clinical status and disease activity. This individualized strategy not only maximizes therapeutic efficacy but also mitigates the risk of overtreatment. Nonetheless, the optimal clinical effectiveness of such a regimen warrants further validation through additional studies [21].

Analysis of perioperative complications and their prevention

The study group demonstrated a lower incidence of both vitreous hemorrhage and macular edema recurrence compared to controls. Multivariable logistic regression identified several independent risk factors for postoperative complications, including age ≥60 years, disease duration ≥15 years, baseline HbA1c ≥8.5%, surgery duration ≥90 minutes, intraoperative hemorrhage volume ≥2 mL, and absence of early anti-VEGF therapy. These findings align with prior reports. For instance, Perais et al. [22], through a comprehensive review of multiple databases, identified age, total cholesterol, gender, disease duration, and BMI as significant predictors of PDR progression. Similarly, Wang et al. [23] highlighted the critical role of preoperative glycemic control, particularly elevated HbA1c levels, in influencing surgical outcomes, supporting the findings of the present study.

Informed by these risk factors, we advocate for meticulous timing of surgical intervention. Preoperative Conbercept administration has been shown to suppress retinal neovascularization and enhance vascular stability, thereby reducing both intraoperative and postoperative hemorrhagic complications [24]. Therefore, scheduling surgery during the phase of relative disease quiescence may further minimize the risk of complications.

Comprehensive assessment of quality of life and visual functioning

This study is the first to systematically evaluate the long-term impact of Conbercept combination therapy on quality of life in patients with PDR. Patients in the study group exhibited higher scores across all dimensions of the VFQ-25 scale, indicating not only enhanced visual function but also substantial improvements in the overall quality of life. We propose that the quality of life in PDR patients is influenced by both the degree of visual recovery and the effective prevention of complications, as well as by the mitigation of psychological stress associated with the disease. Notably, the significant improvements observed in mental health and social functioning dimensions in the study group may be attributed to the reduced incidence of postoperative complications and more stable disease control. These findings provide critical insight into optimizing postoperative rehabilitation for patients with PDR.

Study limitations and future directions

Despite yielding significant findings, this study has several limitations. First, as a single-center retrospective analysis with a relatively small sample size, there was an inherent risk of selection bias, which may affect the generalizability of the results. Second, although patients were followed longitudinally, PDR is a chronic, progressive disease, and extended follow-up periods are needed to fully elucidate the sustained efficacy and safety of Conbercept combined therapy. Third, the administration of Conbercept in this study was based on a PRN regimen, reflecting real-world clinical practice; however, the lack of comparative analysis among different dosing strategies - such as fixed-interval or treat-and-extend regimens - limits the understanding of the optimal therapeutic approach.

To address these limitations, future research should focus on: (1) conducting multicenter, large-scale, randomized controlled clinical trials to further validate the findings of the present study; (2) evaluating the effect of various Conbercept dosing regimens, including dosage and injection frequency, on the long-term prognosis of PDR patients; (3) integrating genomics and metabolomics to identify biomarkers for Conbercept therapy, thereby enabling precision medicine approaches; (4) developing artificial intelligence-based risk prediction models that incorporate clinical parameters, imaging, and molecular data to improve individualized risk assessment and treatment planning; and (5) constructing and externally validating risk prediction models grounded in identified clinical risk factors to ensure broad applicability and generalizability.

Conclusion

Conbercept combined with surgery provides superior clinical benefits for patients with PDR, demonstrated by significant improvements in postoperative BCVA, reductions in MCT, and enhanced overall quality of life compared to surgical treatment alone. It is recommended to strengthen perioperative management for patients with advanced age, prolonged disease duration, elevated HbA1c levels, extended sur-

gery duration, or substantial intraoperative bleeding, in order to minimize the incidence of complications. The novelty of this study lies in its systematic, four-year longitudinal evaluation of Conbercept combination therapy in PDR, addressing a critical gap in long-term follow-up data in this field. Additionally, it provides a comprehensive analysis of postoperative complications and establishes a relatively complete risk prediction model, contributing valuable insights for clinical management.

Disclosure of conflict of interest

None.

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