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Surgical outcomes of pars plana vitrectomy in proliferative diabetic retinopathy: A prospective study

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Abstract

Background: Proliferative diabetic retinopathy (PDR) remains a leading cause of blindness worldwide. Pars plana vitrectomy (PPV) is a standard surgical procedure for managing advanced PDR complications, such as vitreous hemorrhage, tractional retinal detachment (TRD), and diabetic macular edema (DME). This study aims to assess the outcomes of PPV in patients with PDR, focusing on visual and anatomical recovery post-surgery.

Materials and Methods: This prospective interventional study was conducted at the Department of Ophthalmology & General Medicine Kamineni Institute of Medical Sciences, between June 2017 and May 2018. Seventy-five patients with PDR undergoing PPV were included, with exclusion criteria involving other retinal vascular disorders or systemic contraindications. Baseline assessments included best-corrected visual acuity (BCVA), OCT, and fundus fluorescein angiography. Surgical procedures were performed under local anesthesia, with postoperative management including antibiotic and steroid eye drops. Patients were followed up at 1, 3, and 6 months.

Results: The most common indication for vitrectomy was vitreous hemorrhage (52%), followed by TRD (14.67%) and combined TRD and VH (17.33%). Postoperative visual acuity showed significant improvement in all groups, with the vitreous hemorrhage group achieving a BCVA of 0.19 (~6/36) at 3 months. The TRD group exhibited slower initial recovery but still showed statistically significant improvement in VA at 3 months.

Conclusion: PPV demonstrates significant potential in improving visual acuity and retinal outcomes in patients with diabetic retinopathy. While the vitreous hemorrhage group showed the most pronounced visual recovery, TRD cases require more individualized management due to slower postoperative recovery. These results underscore the importance of timely surgical intervention and tailored approaches for different PDR subtypes.

Keywords: Proliferative diabetic retinopathy, pars plana vitrectomy, vitreous hemorrhage, tractional retinal detachment, visual acuity, surgical outcomes

Introduction

Diabetic retinopathy (DR) is one of the leading causes of visual impairment and blindness worldwide, resulting from the chronic hyperglycemia-induced damage to retinal vasculature. As the disease progresses, patients may experience varying degrees of macular edema, retinal ischemia, and neovascularization, which can severely compromise visual function [1].

Pars plana vitrectomy (PPV) has emerged as a pivotal surgical intervention in the management of advanced stages of diabetic retinopathy, particularly in cases complicated by proliferative diabetic retinopathy (PDR), vitreous hemorrhage, retinal detachment, and tractional retinal detachment (TRD). PPV involves the removal of the vitreous gel and other pathological tissues, allowing for direct retinal visualization and improved access to the posterior segment of the eye. This procedure has demonstrated a substantial reduction in the incidence of severe visual impairment when performed at appropriate stages of the disease [2].

The indications for PPV in diabetic retinopathy are multifactorial, but the most common include persistent vitreous hemorrhage despite adequate laser treatment, TRD, and retinal detachment secondary to DR. In these advanced cases, the conventional treatment options, such as panretinal photocoagulation or anti-VEGF injections, often fail to yield satisfactory outcomes. PPV serves as a crucial adjunctive therapy by not only addressing the mechanical complications of DR but also enabling the removal of ischemic retina and fibrotic tissue that promote the pathogenesis of vitreoretinal traction [3].

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Numerous studies have validated the efficacy of PPV in managing DR-related complications, reporting improved visual acuity and retinal stability postoperatively. The surgical outcomes are influenced by factors such as the timing of intervention, the presence of coexisting systemic diseases like hypertension or nephropathy, and the extent of preoperative retinal damage [4]. In general, early intervention correlates with better postoperative visual prognosis, while delayed vitrectomy may result in poorer outcomes due to irreversible retinal damage and fibrosis. Nevertheless, despite its proven efficacy, PPV remains associated with risks, including cataract formation, retinal tears, and endophthalmitis, underscoring the need for careful patient selection and meticulous surgical technique [5].

This study aims to assess the efficacy of pars plana Vitrectomy in patients with diabetic retinopathy presenting to tertiary care hospital.

Materials and Methodology

This was a prospective interventional study conducted at the Department of Ophthalmology & General Medicine Kamineni Institute of Medical Sciences, over a one-year period, from June 2017 to May 2018. The study was approved by the Institutional Ethics Committee, and all participants provided written informed consent.

A total of 75 patients were recruited into the study, all of whom presented with complications of proliferative diabetic retinopathy (PDR) and were willing to undergo pars plana vitrectomy (PPV). Most of these patients were referred from the Department of General Medicine, as a part of their comprehensive screening profile for diabetic microvascular and macrovascular complications. The inclusion criteria were as follows: patients with PDR complicated by vitreous hemorrhage, tractional retinal detachment (TRD), or diabetic macular edema (DME), and those who had not received previous vitrectomy. Patients were excluded if they had any other retinal vascular disorders, epiretinal membranes, or macular holes unrelated to diabetes, or pre-existing conditions like age-related macular degeneration or advanced glaucoma that could affect visual outcomes. Additionally, patients with medical contraindications to PPV were excluded, as were those who failed to complete a three-month follow-up.

Upon enrollment, baseline data was collected, including detailed medical and ocular histories. Each patient underwent a comprehensive ophthalmic evaluation that included the following: best-corrected visual acuity (BCVA) using Snellen's chart for distance and near vision, slit-lamp biomicroscopy, indirect ophthalmoscopy, intraocular pressure measurement via Goldmannapplanation tonometry, and fundus photography. Optical coherence tomography (OCT) was used to assess macular edema, vitreomacular traction, epiretinal membranes, and posterior vitreous detachment, while fundus fluorescein angiography helped identify retinal ischemia and neovascularization. In cases where media opacities hindered fundus visualization, a B-scan ultrasonography was performed to evaluate the vitreous and retinal condition.

The indications for PPV included non-clearing vitreous hemorrhage lasting more than a month, vitreous hemorrhage resulting in visual acuity worse than 5/60 in one-eyed patients, TRD involving the fovea, combined rhegmatogenous and tractional retinal detachment, and persistent DME unresponsive to laser or intravitreal therapy.

Surgical procedures were carried out under local anesthesia, with intravitreal bevacizumab (2.5 mg/0.1 ml) administered in cases of active neovascularization. A standard 3-port 20-gauge vitrectomy was performed, involving core vitrectomy, membrane removal, and retinal stabilization using perfluorocarbon liquids (PFCL) if required. Postoperative management included antibiotic and steroid eye drops, and patients were followed at one week, one month, and three months for visual acuity, ocular health, and any complications.

Outcome measures included changes in BCVA, anatomical outcomes such as retinal reattachment and vitreous clearance, and the resolution of macular edema. Postoperative complications, including cataract formation, glaucoma, retinal detachment, and rebleeds, were also assessed.

Results

The study findings suggest a diverse patient profile, with a slightly higher proportion of male patients (53.3%) compared to females (46.67%), predominantly within the age range of 41-50 years (34.67%). The majority of patients had a duration of diabetes between 1-10 years (65.33%), which could be indicative of early diabetic retinopathy.

Table 1: Demographic characteristics of patients

Category	Number of Patients (n=75)	
Gender	Males	40 (53.3%)
	Females	35 (46.67%)
Age (in years)	41-50 years	26 (34.67%)
	51-60 years	20 (26.67%)
	61-70 years	18 (24%)
	>70 years	11 (14.67%)
Laterality	Right eye	39 (52%)
	Left eye	36 (48%)
Duration of diabetes	1-10 years	49 (65.33%)
	11-20 years	22 (29.33%)
	21-30 years	2 (2.67%)
	31-40 years	2 (2.67%)

Hypertension was the most common coexisting morbidity, affecting 44% of patients, which aligns with the known association between diabetes and cardiovascular conditions. A high percentage of patients were on oral hypoglycemic agents (86.67%), reflecting the widespread use of this treatment modality in managing diabetes.

Table 2: Coexisting Morbidity and Diabetes Treatment

Category	Frequency	
Coexisting morbidity	Hypertension	33 (44%)
	Ischemic heart disease	6 (8%)
	Only diabetes	36 (48%)
Diabetes treatment	On oral hypoglycemic drugs	65 (86.67%)
	Insulin	10 (13.33%)

The primary indication for vitrectomy was vitreous hemorrhage (52%), followed by tractional retinal detachment and a combination of both. These findings highlight the complexity of retinal pathologies in diabetic patients.

In terms of surgical procedures, the most common approach was vitrectomy combined with membrane peeling and endolaser (30.67%), suggesting its effectiveness for these conditions.

Table 3: Indications for Vitrectomy and Surgical Procedures

		Frequency
Indication	Vitreous Hemorrhage (VH)	39 (52%)
	Tractional Retinal Detachment (TRD)	11 (14.67%)
	TRD + VH	13 (17.33%)
	Macular Edema	3 (4%)
	Premacular Hemorrhage	3 (4%)
	Vitreomacular Traction (VMT)	2 (2.67%)
	VMT + VH	2 (2.67%)
Surgical Procedure	Vitrectomy + Membrane Peeling (MP) + Endolaser (EL)	23 (30.67%)
	Vitrectomy + Endolaser (EL)	15 (20%)
	Vitrectomy + Intraocular Lens (IOL)	10 (13.33%)
	Vitrectomy + MP + EL + Silicone Oil Injection (SOI)	19 (25.33%)
	Vitrectomy + MP + EL + IOL + SOI	8 (10.67%)

Postoperative visual acuity showed statistically significant improvements across all groups, with the most notable gains in the vitreous hemorrhage group, reaching a BCVA of 0.19 (Snellen ~6/36) at 3 months. These results underline the

positive surgical outcomes in diabetic retinopathy-related retinal surgeries, though the tractional retinal detachment group showed slower initial recovery, which warrants further investigation into individualized surgical approaches.

Table 4: Pre and Postoperative Visual Acuity (VA) Comparison

Postoperative Visit	Mean BCVA (± SD)	Snellen Equivalent	Statistical Analysis (p-value)
Vitreous Hemorrhage Group (n=39)	Preoperative	0.021 ± 0.0062	~1/60
	Immediate Postoperative	0.081 ± 0.034	~5/60
	1 Month Postoperative	0.12 ± 0.032	~6/60
	3 Months Postoperative	0.19 ± 0.045	~6/36
Tractional Retinal Detachment Group (n=16)	Preoperative	0.0610 ± 0.022	~4/60
	Immediate Postoperative	0.051 ± 0.019	~4/60
	1 Month Postoperative	0.091 ± 0.009	~5/60
	3 Months Postoperative	0.18 ± 0.052	~6/36

Table 5: Main Statistical Analysis Overview

Analysis Category	p-value	Statistical Test	Conclusion	
Overall	Preoperative vs Immediate Postoperative VA	0.0030	Student's t-test	Significant improvement in VA
	Preoperative vs 1 Month Postoperative VA	0.000041	Student's t-test	Significant improvement in VA
	Preoperative vs 3 Months Postoperative VA	0.000042	Student's t-test	Significant improvement in VA
Vitreous Hemorrhage Group (n=39)	Preoperative vs Immediate Postoperative VA	0.021	Student's t-test	Significant improvement in VA
	Preoperative vs 1 Month Postoperative VA	0.0011	Student's t-test	Significant improvement in VA
	Preoperative vs 3 Months Postoperative VA	0.0012	Student's t-test	Significant improvement in VA
Tractional Retinal Detachment Group (n=16)	Preoperative vs Immediate Postoperative VA	0.051	Student's t-test	Approaching significance
	Preoperative vs 1 Month Postoperative VA	0.042	Student's t-test	Significant improvement in VA
	Preoperative vs 3 Months Postoperative VA	0.012	Student's t-test	Significant improvement in VA

Discussion

This study was undertaken to evaluate the surgical outcomes of pars plana vitrectomy (PPV) in patients with proliferative diabetic retinopathy (PDR) and associated complications such as vitreous hemorrhage, tractional retinal detachment (TRD), and diabetic macular edema (DME). Diabetic retinopathy remains a leading cause of blindness, and while PPV has become a standard treatment for severe cases, its long-term efficacy, particularly in different subgroups of PDR, remains an area of active research. This study aimed to assess the visual and anatomical improvements following PPV, offering valuable insights into treatment efficacy and post-surgical recovery dynamics.

The study findings show a significant improvement in visual acuity (VA) across all patient groups, especially in those with vitreous hemorrhage (VH), who achieved the most substantial gain in BCVA, progressing from a preoperative value of 0.021 (~1/60) to 0.19 (~6/36) at 3 months post-surgery. These results are consistent with those reported by

Zhao *et al.* [6], who found significant improvements in VA following vitrectomy for diabetic vitreous hemorrhage. Similarly, Sahoo *et al.* [7] reported comparable outcomes in terms of retinal reattachment and functional recovery in patients with PDR-related vitreous hemorrhage, with most patients achieving visual acuity of 6/60 or better within 3 months post-surgery.

However, the tractional retinal detachment group in this study showed slower recovery, with less significant initial improvement in VA (p = 0.051 at immediate postoperative) compared to the vitreous hemorrhage group. This finding aligns with reports by Jang *et al.* [8], who highlighted that patients with combined TRD and VH have slower functional recovery due to the complexity of retinal detachment and the need for more extensive surgical intervention. In contrast, results from the study by Wang *et al.* [9] indicate that combined TRD and VH may lead to more substantial anatomical improvement after vitrectomy, though this is

often accompanied by prolonged postoperative management and rehabilitation.

Further supporting these observations, Lee *et al.* [10] found that patients with tractional retinal detachment required more complex and extended surgical techniques, which might contribute to the slower postoperative visual recovery in this subgroup. The combination of TRD with VH or macular edema was also linked to poorer baseline visual acuity, which can significantly influence the recovery trajectory.

Additionally, the high incidence of hypertension (44%) and diabetes duration of 1-10 years (65.33%) in this cohort mirrors the findings of previous studies that emphasize the overlap between cardiovascular comorbidities and diabetic retinopathy [11]. The use of oral hypoglycemic agents in the majority of patients (86.67%) reflects the prevailing therapeutic approach for diabetes management in the early stages of the disease. This finding is consistent with the study by Liu *et al.* [12], who demonstrated that long-term diabetes control with oral hypoglycemic agents was associated with reduced complications in diabetic retinopathy patients undergoing vitrectomy.

Conclusion

This study demonstrates that pars plana vitrectomy (PPV) provides significant visual improvement in patients with proliferative diabetic retinopathy (PDR), particularly in those with vitreous hemorrhage. Postoperative gains in visual acuity were statistically significant across all patient groups, with the most substantial improvement observed in the vitreous hemorrhage group. However, patients with tractional retinal detachment exhibited a slower recovery trajectory, necessitating further exploration of tailored surgical strategies. These findings support PPV as an effective intervention for diabetic retinopathy-related retinal complications, with the potential for improved patient outcomes when performed in a timely manner.

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Conflicts of Interest: None declared

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