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Functional Outcomes Following 23-Gauge Pars Plana Vitrectomy for Non-Diabetic Vitreous Hemorrhage: A Prospective Cohort Study

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ABSTRACT

Background: Non-diabetic vitreous hemorrhage is an important cause of sudden visual impairment and commonly results from retinal vein occlusion, ocular trauma, retinal vasculitis, choroidal neovascular membrane, and other retinal disorders. Persistent vitreous hemorrhage frequently requires pars plana vitrectomy to restore media clarity and improve visual function. However, postoperative visual recovery may be influenced by the underlying retinal pathology and macular status.

Objective: To evaluate the functional outcomes of 23-gauge pars plana vitrectomy in patients with non-diabetic vitreous hemorrhage.

Methods: A prospective cohort study was conducted at the Regional Institute of Ophthalmology, Minto Ophthalmic Hospital, Bangalore Medical College and Research Institute, Bengaluru, between May 2023 and October 2024. Forty-four eyes with non-diabetic vitreous hemorrhage undergoing 23-gauge pars plana vitrectomy were included. Baseline ophthalmic evaluation comprised visual acuity assessment, slit-lamp biomicroscopy, Goldmann applanation tonometry, indirect ophthalmoscopy, and B-scan ultrasonography where indicated. Patients were followed for six months after surgery. Functional outcomes were assessed by changes in uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA). Causes of restricted postoperative visual recovery were evaluated using clinical examination and spectral-domain optical coherence tomography when required.

Results: The mean age of the study population was 54.0 ± 10.7 years, with males accounting for 61.4% of patients. Mean UCVA improved significantly from 2.07 ± 0.41 logMAR preoperatively to 0.78 ± 0.36 logMAR at three months and 0.72 ± 0.39 logMAR at six months. Mean BCVA improved from 2.07 ± 0.41 to 0.53 ± 0.43 logMAR at six months (mean improvement 1.54 logMAR; $p < 0.001$). Epiretinal membrane was the most common cause of restricted visual recovery, followed by optic atrophy, vitreomacular traction, and macular scarring secondary to choroidal neovascular membrane.

Conclusion: Twenty-three-gauge pars plana vitrectomy provides excellent functional outcomes in patients with non-diabetic vitreous hemorrhage, resulting in significant improvement in visual acuity. Residual visual limitation is primarily related to underlying macular or optic nerve pathology rather than the surgical procedure itself.

Keywords: *Non-diabetic vitreous hemorrhage; 23-gauge pars plana vitrectomy; Functional outcome; Visual acuity; Best-corrected visual acuity; Optical coherence tomography.*

INTRODUCTION

Vitreous hemorrhage (VH), defined as the presence of blood within the vitreous cavity, is a significant cause of sudden, painless visual loss and accounts for a considerable proportion of vitreoretinal emergencies encountered in clinical practice [1]. The severity of visual impairment depends on the density of the hemorrhage and the underlying retinal pathology, ranging from mild floaters to complete loss of fundus visualization. Persistent vitreous hemorrhage not only causes profound visual disability but also obscures retinal examination, delaying the diagnosis and treatment of associated retinal disorders. If left untreated, prolonged vitreous hemorrhage may result in irreversible retinal damage, proliferative vitreoretinopathy, tractional retinal detachment, or secondary glaucoma, ultimately compromising visual prognosis [2,3].

Non-diabetic vitreous hemorrhage encompasses a heterogeneous group of disorders, with retinal vein occlusion, ocular trauma, retinal vasculitis, choroidal neovascular membrane, retinal tears, Valsalva retinopathy, and iatrogenic causes representing the principal etiologies [3]. Although these conditions differ in their pathophysiology, they share the common consequence of media opacity and significant deterioration in visual function. Restoration of useful vision therefore remains the primary therapeutic goal. While spontaneous resolution may occur in selected patients, persistent or recurrent hemorrhage frequently necessitates surgical intervention to clear the visual axis, identify the underlying pathology, and facilitate definitive retinal treatment [4].

Pars plana vitrectomy (PPV) has become the standard surgical treatment for non-resolving vitreous hemorrhage. The advent of microincision vitrectomy systems, particularly the 23-gauge technique, has transformed vitreoretinal surgery by reducing surgical trauma, shortening operative time, minimizing postoperative inflammation, and promoting faster visual rehabilitation. Beyond removing the hemorrhagic vitreous, 23-gauge pars plana vitrectomy enables management of associated retinal pathology through endolaser photocoagulation, membrane dissection, internal limiting membrane peeling, relief of vitreoretinal traction, and intraocular tamponade when indicated [5]. Consequently, the procedure restores optical media clarity and facilitates postoperative visual recovery.

Although numerous studies have demonstrated favorable visual outcomes following pars plana vitrectomy for diabetic vitreous hemorrhage, relatively few have specifically evaluated functional recovery in patients with non-diabetic vitreous hemorrhage. Moreover, the diversity of underlying etiologies and the presence of concurrent retinal abnormalities may influence postoperative visual outcomes despite restoration of a clear visual axis. Therefore, evaluating functional recovery following surgery is essential for assessing the overall effectiveness of treatment and for counselling patients regarding expected visual prognosis.

The present prospective study was undertaken to evaluate the functional outcomes of 23-gauge pars plana vitrectomy in patients with non-diabetic vitreous hemorrhage by assessing postoperative improvement in uncorrected and best-corrected visual acuity over a six-month follow-up period and identifying factors associated with suboptimal visual recovery.

MATERIALS AND METHODS

This prospective cohort study was conducted at the Regional Institute of Ophthalmology, Minto Ophthalmic Hospital, Bangalore Medical College and Research Institute (BMCRI), Bengaluru, between May 2023 and October 2024. Institutional Ethics Committee approval was obtained before commencement of the study, and written informed consent was obtained from all participants prior to enrolment. Consecutive patients presenting with non-diabetic vitreous hemorrhage who fulfilled the eligibility criteria and required surgical intervention were included in the study.

Patients aged >40 years with non-diabetic vitreous hemorrhage planned for 23-gauge three-port pars plana vitrectomy (23G PPV) were enrolled. Patients with proliferative diabetic retinopathy, those younger than 40 years, and individuals unwilling to participate were excluded. A total of 44 eyes from 44 patients constituted the final study population.

Baseline evaluation included a detailed clinical history followed by comprehensive ophthalmic examination. Uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA) were assessed using a logarithm of the minimum angle of resolution (logMAR) chart. Slit-lamp biomicroscopy was performed to examine the anterior segment, and intraocular pressure (IOP) was measured using Goldmann applanation tonometry. Posterior segment examination was carried out using indirect ophthalmoscopy with a +20 diopter lens whenever visualization was possible. B-scan ultrasonography was performed in eyes with dense vitreous hemorrhage to assess the posterior segment and detect retinal detachment or vitreoretinal traction. Gonioscopy was undertaken when clinically indicated to evaluate neovascularization of the angle, traumatic angle recession, or secondary glaucoma. Spectral-domain optical coherence tomography (SD-OCT) was performed postoperatively in selected patients after adequate media clarity was achieved to assess macular morphology and identify structural abnormalities responsible for limited visual recovery.

All patients underwent standard 23-gauge three-port pars plana vitrectomy. Sclerotomies were created 3–4 mm posterior to the limbus depending on the lens status. Following removal of the hemorrhagic vitreous, additional surgical procedures were performed whenever clinically indicated to manage the underlying retinal pathology.

Patients were followed postoperatively at one week, one month, three months, and six months. The primary outcome measure was functional recovery assessed by changes in UCVA and BCVA at three and six months after surgery. Secondary outcome measures included the identification of postoperative macular abnormalities responsible for restricted visual improvement, including epiretinal membrane, vitreomacular traction, optic atrophy, and macular scarring, as assessed by clinical examination and SD-OCT.

Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) version 20.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ±standard deviation, while categorical variables were presented as frequencies and percentages. Changes in postoperative visual acuity were analysed using the paired *t*-test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 44 eyes of 44 patients with non-diabetic vitreous hemorrhage who underwent 23-gauge pars plana vitrectomy were included in the study. The mean age of the study population was 54.0 ±10.7 years, with a male predominance (61.4%). Retinal vein occlusion was the most common etiology (26/44, 59.1%), followed by trauma (10/44, 22.7%), retinal vasculitis (6/44, 13.6%), and other etiologies (4/44, 9.1%). All patients completed the six-month follow-up and were included in the final functional outcome analysis.

The mean preoperative uncorrected visual acuity (UCVA) was 2.07 ±0.41 logMAR, which improved to 0.78 ±0.36 logMAR at three months and 0.72 ±0.39 logMAR at six months following surgery. Similarly, the mean best-corrected visual acuity (BCVA) improved from 2.07 ±0.41 logMAR preoperatively to 0.63 ±0.41 logMAR at three months and 0.53 ±0.43 logMAR at six months.

Table 1. Baseline demographic and clinical characteristics of the study population (n = 44)

Variable	Value
Age (years), mean ± SD	54.0 ± 10.7
Male	27 (61.4%)
Female	17 (38.6%)
Right eye	27 (61.4%)
Left eye	17 (38.6%)
Grade 4 vitreous hemorrhage	31 (70.5%)
Grade 3 vitreous hemorrhage	13 (29.5%)
Retinal vein occlusion	26 (59.1%)
Trauma	10 (22.7%)
Vasculitis	6 (13.6%)
Other etiologies*	4 (9.1%)

*Includes iatrogenic vitreous hemorrhage, choroidal neovascular membrane, and Valsalva retinopathy.

The improvement in both UCVA and BCVA was progressive throughout the follow-up period. Mean UCVA improved by 1.29 logMAR between baseline and 3 months and by 1.35 logMAR at 6 months. Mean BCVA improved by 1.44 logMAR at 3 months and 1.54 logMAR at 6 months.

Table 2. Changes in UCVA and BCVA following 23-gauge pars plana vitrectomy

Time point	UCVA (logMAR), Mean ± SD	BCVA (logMAR), Mean ± SD
Preoperative	2.07 ± 0.41	2.07 ± 0.41
3 months	0.78 ± 0.36	0.63 ± 0.41
6 months	0.72 ± 0.39	0.53 ± 0.43

Paired t-test analysis demonstrated statistically significant improvement in both UCVA and BCVA. Preoperative UCVA improved significantly at 3 months ($t = 16.22$, $p < 0.001$) and 6 months ($t = 16.75$, $p < 0.001$). Similarly, BCVA improved significantly at 3 months ($t = 16.79$, $p < 0.001$) and 6 months ($t = 17.67$, $p < 0.001$). Additional improvement between 3 and 6 months was also significant for UCVA ($t = 2.81$, $p = 0.0075$) and BCVA ($t = 2.25$, $p = 0.0299$).

Comparison	*t* value	*p* value
Preoperative UCVA vs 3-month UCVA	16.22	<0.001
Preoperative UCVA vs 6-month UCVA	16.75	<0.001
3-month UCVA vs 6-month UCVA	2.81	0.0075
Preoperative BCVA vs 3-month BCVA	16.79	<0.001
Preoperative BCVA vs 6-month BCVA	17.67	<0.001
3-month BCVA vs 6-month BCVA	2.25	0.0299

Table 3. Paired *t*-test analysis of postoperative visual outcomes

The primary study outcome was achieved, with statistically significant improvement in both UCVA and BCVA from baseline to six months. Although the majority of patients experienced substantial visual recovery following surgery, a small proportion demonstrated limited functional improvement despite adequate clearance of vitreous hemorrhage. Epiretinal membrane was the most frequent cause of restricted postoperative vision, followed by optic atrophy, macular scar secondary to choroidal neovascular membrane, and vitreomacular traction.

Table 4. Causes of restricted postoperative visual recovery (n=44)

Cause	n (%)
Epiretinal membrane	6 (13.6)
Optic atrophy	2 (4.5)
Macular scar (CNVM)	1 (2.3)
Vitreomacular traction	1 (2.3)

Postoperative spectral-domain optical coherence tomography and fundus evaluation identified structural macular abnormalities in eyes with suboptimal visual recovery. Representative findings included epiretinal membrane with foveal distortion, vitreomacular traction, and macular scarring secondary to choroidal neovascular membrane, indicating that residual macular pathology rather than persistent vitreous hemorrhage accounted for the limited functional outcome in these patients.

DISCUSSION

The present prospective study evaluated the functional outcomes of 23-gauge pars plana vitrectomy (23G PPV) in patients with non-diabetic vitreous hemorrhage and demonstrated significant improvement in visual acuity following surgical intervention. Both uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA) showed marked improvement from the preoperative period to three and six months postoperatively. These findings indicate that 23G PPV results in substantial improvement in postoperative visual function.

The principal objective of vitrectomy in vitreous hemorrhage is to remove the opaque vitreous, restore the optical pathway, and facilitate treatment of the underlying retinal pathology. However, the final visual outcome depends not only on successful clearance of hemorrhage but also on the integrity of the macula and optic nerve. In the present study, both UCVA and BCVA improved significantly after surgery, with further improvement observed between the third and sixth postoperative months. This gradual recovery may reflect continued resolution of postoperative inflammation, stabilization of the retinal recovery, and progressive recovery of retinal function following treatment of the underlying pathology.

The significant improvement in postoperative visual acuity observed in this study is comparable to the findings reported by Meinert et al. who demonstrated excellent visual recovery following pars plana vitrectomy for non-diabetic vitreous hemorrhage, with the majority of patients achieving useful postoperative vision.[6] Similar observations have been reported in previous studies evaluating vitrectomy for vitreous hemorrhage, where removal of the hemorrhagic vitreous combined with appropriate management of associated retinal lesions resulted in substantial functional improvement.[4,7] The present findings therefore support the role of early surgical intervention in selected patients with persistent vitreous hemorrhage to optimize visual rehabilitation.

Retinal vein occlusion constituted the most common etiology of vitreous hemorrhage in the present series, followed by trauma and retinal vasculitis. Visual recovery in these patients depends largely on the severity of the underlying retinal disease and macular involvement rather than the vitreous hemorrhage itself. Additional procedures were performed whenever clinically indicated to manage the underlying retinal pathology.[5]

Despite successful surgery, complete visual recovery was not achieved in every patient. Epiretinal membrane was the most common cause of restricted postoperative visual improvement, followed by optic atrophy, vitreomacular traction, and macular scarring secondary to choroidal neovascular membrane. These findings highlight that postoperative visual acuity is strongly influenced by pre-existing or residual macular pathology. Spectral-domain optical coherence tomography performed during follow-up proved valuable in identifying these structural abnormalities and explaining persistent visual limitation despite successful clearance of vitreous hemorrhage. Similar observations have been described in previous studies, which have demonstrated that macular structural damage remains one of the strongest determinants of postoperative visual prognosis following vitrectomy.[8]

An important observation in the present study was the continued improvement in visual acuity between the third and sixth postoperative months. This suggests that functional recovery extends beyond the early postoperative period and emphasizes the importance of adequate long-term follow-up before determining the final visual outcome. Patients should therefore be counselled that although removal of the vitreous hemorrhage is achieved immediately after surgery, maximal visual recovery may continue for several months depending on retinal healing and the underlying disease process.

The strengths of the present study include its prospective design, standardized surgical technique using a single 23-gauge microincision vitrectomy platform, and uniform six-month postoperative follow-up. Nevertheless, certain limitations should be acknowledged. The study was conducted at a single tertiary care center with a relatively small sample size, and the heterogeneous etiological profile limited disease-specific subgroup analysis. The relatively small sample size also precluded multivariable analysis of predictors of postoperative visual recovery. Additionally, the absence of a comparative treatment group precluded direct comparison with alternative surgical techniques or conservative management.

The present prospective study demonstrates that 23-gauge pars plana vitrectomy is an effective surgical procedure for achieving significant functional visual recovery in patients with non-diabetic vitreous hemorrhage. Both uncorrected and best-corrected visual acuity improved markedly following surgery, with statistically significant gains observed at three and six months of follow-up. Progressive visual improvement during the postoperative period highlights the importance of continued retinal healing and rehabilitation after successful vitrectomy. Although a small proportion of patients experienced limited visual recovery, this was primarily attributable to underlying macular or optic nerve pathology, including epiretinal membrane, optic atrophy, vitreomacular traction, and macular scarring, rather than failure of the surgical procedure itself. These findings support the use of 23-gauge pars plana vitrectomy as a safe and reliable treatment for restoring visual function in persistent non-diabetic vitreous hemorrhage. Larger multicentric studies with longer follow-up are warranted to further validate these outcomes and identify predictors of long-term visual prognosis.

DECLARATIONS

Ethics approval: Approved by the Institutional Ethics Committee, Bangalore Medical College and Research Institute, Bengaluru.

Consent to participate: Written informed consent was obtained from all participants before enrolment.

Availability of data and materials: The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: All authors contributed to the study conception and design. Data collection, analysis, manuscript preparation, and critical revision were performed by the authors. All authors read and approved the final manuscript.

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