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Anatomical 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 may result from retinal vein occlusion, ocular trauma, retinal vasculitis, choroidal neovascular membrane, and other retinal disorders. Persistent vitreous hemorrhage often necessitates pars plana vitrectomy to restore media clarity, identify the underlying retinal pathology, and achieve favorable anatomical outcomes.

Objective: To evaluate the anatomical 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. Comprehensive preoperative ophthalmic evaluation was performed, including slit-lamp biomicroscopy, intraocular pressure measurement, indirect ophthalmoscopy, and B-scan ultrasonography whenever indicated. Additional intraoperative procedures, including endolaser photocoagulation, membrane peeling, internal limiting membrane peeling, and intraocular tamponade, were performed based on the underlying pathology. Patients were followed for six months. Primary outcome measures included resolution of vitreous hemorrhage, retinal attachment, postoperative rebleeding, and final anatomical success.

Results: The mean age of the study population was 54.0 ± 10.7 years, with males constituting 61.4% of patients. Retinal vein occlusion was the most common etiology (59.1%), followed by trauma (22.7%) and vasculitis (13.6%). Complete resolution of vitreous hemorrhage was achieved in all 42 eyes with isolated vitreous hemorrhage, while both eyes with associated tractional retinal detachment achieved successful retinal reattachment. Postoperative rebleeding occurred in two eyes (4.5%) and was successfully managed with vitreous lavage. At the end of six months, anatomical success was achieved in all 44 eyes.

Conclusion: Twenty-three-gauge pars plana vitrectomy provides excellent anatomical outcomes in patients with non-diabetic vitreous hemorrhage, with complete hemorrhage clearance, successful retinal stabilization, and a low incidence of postoperative complications, supporting its role as a safe and effective surgical treatment.

Keywords: *Vitreous hemorrhage; Pars plana vitrectomy; 23-gauge vitrectomy; Anatomical outcome; Retinal vein occlusion; Retinal detachment; Microincision vitrectomy.*

INTRODUCTION

Vitreous hemorrhage (VH) is defined as the presence of blood within the vitreous cavity and represents one of the important causes of sudden, painless visual loss encountered in ophthalmic practice.[1] The clinical presentation ranges from mild floaters and blurred vision to profound visual impairment depending on the extent of hemorrhage and the underlying retinal pathology. Although spontaneous resolution may occur in selected patients, persistent or recurrent vitreous hemorrhage frequently obscures visualization of the fundus, delays definitive diagnosis, and increases the risk of vision-threatening complications, including tractional retinal detachment, proliferative vitreoretinopathy, and neovascular glaucoma.[2,3] Prompt identification of the underlying etiology and timely intervention are therefore essential to preserve visual function and retinal integrity.

While proliferative diabetic retinopathy remains the most common cause of vitreous hemorrhage worldwide, a substantial proportion of patients present with non-diabetic vitreous hemorrhage resulting from retinal vein occlusion, ocular trauma, retinal vasculitis, choroidal neovascular membrane, retinal tears, Valsalva retinopathy, and iatrogenic causes.[3] These conditions differ considerably in their pathogenesis, prognosis, and management strategies, making individualized treatment planning essential. Persistent vitreous hemorrhage in such patients not only compromises vision but also prevents adequate retinal examination and timely treatment of the underlying pathology.

Pars plana vitrectomy (PPV) has become the standard surgical procedure for managing non-resolving vitreous hemorrhage. The introduction of microincision vitrectomy systems, particularly the 23-gauge technique, has significantly improved the safety and efficacy of vitreoretinal surgery by allowing smaller self-sealing sclerotomies, reduced surgical trauma, shorter operative times, faster postoperative recovery, and improved patient comfort. In addition to clearing the hemorrhagic vitreous, 23-gauge pars plana vitrectomy facilitates identification and treatment of associated retinal pathology through membrane dissection, endolaser photocoagulation, internal limiting membrane peeling, and intraocular tamponade when indicated.[4] Consequently, the procedure aims not only to restore media clarity but also to achieve stable retinal anatomy and prevent recurrent hemorrhage.

Although several studies have evaluated vitrectomy outcomes in diabetic vitreous hemorrhage, evidence focusing exclusively on non-diabetic vitreous hemorrhage remains comparatively limited. Furthermore, the diverse etiological spectrum of non-diabetic vitreous hemorrhage necessitates dedicated evaluation of surgical outcomes in this subgroup. The present prospective study was therefore undertaken to evaluate the anatomical outcomes of 23-gauge pars plana vitrectomy in patients with non-diabetic vitreous hemorrhage, with particular emphasis on vitreous hemorrhage clearance, retinal reattachment where applicable, recurrence of hemorrhage, and overall anatomical success following surgery.

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. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants before enrolment. Consecutive patients with non-diabetic vitreous hemorrhage who fulfilled the eligibility criteria and required surgical intervention were included in the study.

Patients aged more than 40 years with non-diabetic vitreous hemorrhage scheduled 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 provide informed consent were excluded. A total of 44 eyes were included in the final analysis.

A detailed demographic and clinical history was obtained for all patients, followed by a comprehensive ophthalmic examination. Preoperative evaluation included slit-lamp biomicroscopy for anterior segment assessment, intraocular pressure (IOP) measurement using Goldmann applanation tonometry, and posterior segment examination by indirect ophthalmoscopy with a +20 diopter lens whenever fundus visualization was possible. B-scan ultrasonography was performed in eyes with dense vitreous hemorrhage to confirm the diagnosis and identify associated retinal detachment or tractional retinal pathology. Gonioscopy was performed whenever clinically indicated to evaluate neovascularization of the angle, traumatic angle recession, or secondary glaucoma.

All surgeries were performed using a standard 23-gauge three-port pars plana vitrectomy technique. Sclerotomies were created 3–4 mm posterior to the limbus according to the lens status. Core vitrectomy was followed by removal of the hemorrhagic vitreous and careful examination of the peripheral retina. Additional procedures, including endolaser photocoagulation, membrane peeling, internal limiting membrane peeling, lens extraction, secondary intraocular lens implantation, scleral buckling, and internal tamponade with sulfur hexafluoride (SF_6), perfluoropropane (C_3F_8), or silicone oil, were performed whenever indicated based on the underlying retinal pathology.

Patients were examined postoperatively at one week, one month, three months, and six months. The primary outcome was anatomical success, defined as complete resolution of vitreous hemorrhage with successful retinal attachment at the final follow-up. Secondary anatomical outcomes included retinal reattachment in eyes with tractional retinal detachment,

occurrence of postoperative rebleeding, requirement for repeat vitreous lavage, and silicone oil removal in eyes that underwent silicone oil tamponade.

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 20.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean ±standard deviation, while categorical variables were expressed as frequencies and percentages. Descriptive statistics were used to summarize baseline characteristics, intraoperative findings, and postoperative anatomical outcomes.

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%). The right eye was affected more frequently than the left eye (61.4% vs. 38.6%). Most eyes were phakic (70.5%), and hypertension was the most common systemic comorbidity (50.0%). Dense vitreous hemorrhage (Grade 4) was present in 70.5% of eyes, while 29.5% had Grade 3 hemorrhage. The majority of patients underwent surgery after 3–6 months of symptom onset (54.5%).

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

Variable	n (%) / Mean ± SD
Age (years)	54.0 ± 10.7
Male sex	27 (61.4)
Female sex	17 (38.6)
Right eye	27 (61.4)
Left eye	17 (38.6)
Phakic	31 (70.5)
Pseudophakic	8 (18.2)
Aphakic	4 (9.1)
Traumatic cataract	1 (2.3)
Hypertension	22 (50.0)
Diabetes mellitus	7 (15.9)
Ischemic heart disease	7 (15.9)
Pulmonary tuberculosis	1 (2.3)
Raised IOP (>21 mmHg)	3 (6.8)
Grade 4 vitreous hemorrhage	31 (70.5)
Grade 3 vitreous hemorrhage	13 (29.5)

Retinal vein occlusion was the predominant etiology of vitreous hemorrhage (59.1%), followed by ocular trauma (22.7%) and retinal vasculitis (13.6%). Most patients had not received any prior ocular intervention before surgery (81.8%), while anti-vascular endothelial growth factor injections and laser photocoagulation had each been administered in 9.1% of eyes. Twelve eyes (27.3%) required an intraocular tamponade, of which silicone oil was the most frequently used agent.

Table 2. Etiology, disease characteristics, and intraoperative interventions

Variable	n (%)
Duration of vitreous hemorrhage	
<1 month	2 (4.5)
1–<3 months	5 (11.4)
3–6 months	24 (54.5)
>6 months	13 (29.5)

Etiology	
Retinal vein occlusion	26 (59.1)
Trauma	10 (22.7)
Vasculitis	6 (13.6)
Iatrogenic	2 (4.5)
Valsalva retinopathy	1 (2.3)
Choroidal neovascular membrane	1 (2.3)
Previous intervention	
None	36 (81.8)
Anti-VEGF	4 (9.1)
Laser photocoagulation	4 (9.1)
Additional surgical procedures*	
Endolaser photocoagulation	35
Membrane peeling	12
ILM peeling	8

*Multiple procedures were performed in individual eyes

Tamponade was used in 12 eyes (27.3%). Silicone oil was employed in seven eyes (58.3% of tamponade cases), SF_6 gas in four (33.3%), and C_3F_8 gas in one (8.3%). Silicone oil removal was successfully performed in five of the seven eyes (71.4%) during follow-up.

Table 3. Tamponade characteristics

Variable	**n (%)**
Eyes receiving tamponade	12 (27.3)
Silicone oil	7 (58.3)
SF_6 gas	4 (33.3)
C_3F_8 gas	1 (8.3)
Silicone oil removed	5/7 (71.4)
Silicone oil in situ	2/7 (28.6)

Preoperatively, 42 eyes presented with isolated vitreous hemorrhage and two eyes had vitreous hemorrhage associated with tractional retinal detachment. Complete anatomical success was achieved in all eyes by the end of the 6-month follow-up. Vitreous hemorrhage resolved in all 42 eyes with isolated hemorrhage, and both eyes with associated tractional retinal detachment achieved complete retinal reattachment with hemorrhage clearance. Two patients (4.5%) developed postoperative rebleeding, both of whom underwent vitreous lavage with subsequent complete anatomical recovery.

Table 4. Anatomical outcomes following 23-gauge pars plana vitrectomy

Outcome	**n (%)**
Total eyes	44
Isolated vitreous hemorrhage	42 (95.5)
Vitreous hemorrhage with TRD	2 (4.5)
Complete vitreous hemorrhage resolution	42/42 (100)
TRD resolution with retinal attachment	2/2 (100)
Postoperative rebleeding	2 (4.5)

Repeat vitreous lavage	2 (4.5)
Final anatomical success at 6 months	44/44 (100)

Representative postoperative fundus photographs demonstrated complete vitreous hemorrhage clearance with successful retinal stabilization following endolaser photocoagulation, internal limiting membrane peeling, and other adjunctive procedures where indicated. OCT performed in selected patients documented postoperative macular status and identified structural abnormalities in eyes with limited visual recovery.

DISCUSSION

The present prospective study evaluated the anatomical outcomes of 23-gauge pars plana vitrectomy (23G PPV) in patients with non-diabetic vitreous hemorrhage. The findings demonstrate that 23G PPV is a highly effective surgical intervention, achieving complete anatomical success in all eyes at the end of six months of follow-up. Complete clearance of vitreous hemorrhage was achieved in all patients, successful retinal reattachment was obtained in eyes with associated tractional retinal detachment (TRD), and postoperative rebleeding was infrequent and successfully managed without adversely affecting the final anatomical outcome.

Retinal vein occlusion was the most common etiology of non-diabetic vitreous hemorrhage in the present study, accounting for more than half of the cases, followed by ocular trauma and retinal vasculitis. This distribution reflects the changing spectrum of non-diabetic vitreous hemorrhage encountered in tertiary vitreoretinal practice, where retinal vascular occlusive disorders and trauma remain major indications for vitrectomy. Similar etiological patterns have been reported in previous studies evaluating surgical management of non-diabetic vitreous hemorrhage, with retinal vein occlusion representing one of the leading causes requiring operative intervention.[5,6] The predominance of dense Grade 4 vitreous hemorrhage in the present series also explains the need for surgical management, as fundus visualization was significantly compromised in the majority of patients.

The evolution of microincision vitrectomy systems has substantially improved the safety profile of vitreoretinal surgery. Compared with conventional 20-gauge surgery, the 23-gauge system provides smaller self-sealing sclerotomies, reduced conjunctival trauma, improved postoperative comfort, and faster recovery while maintaining adequate instrument rigidity for complex posterior segment procedures.[7] In the present study, additional procedures such as endolaser photocoagulation, membrane peeling, internal limiting membrane peeling, lens extraction, and intraocular tamponade were performed whenever indicated according to the underlying pathology. This highlights the versatility of 23G PPV, allowing definitive management of both the vitreous hemorrhage and its associated retinal pathology during the same surgical sitting.

An important finding of the present study was the excellent anatomical success rate. All 42 eyes with isolated vitreous hemorrhage demonstrated complete postoperative clearance of hemorrhage, while both eyes with associated tractional retinal detachment achieved successful retinal reattachment following vitrectomy. Only two patients experienced postoperative rebleeding, both of whom underwent vitreous lavage with subsequent complete anatomical recovery. These findings are comparable with the study by Shrestha et al., who also reported high anatomical success and favorable postoperative outcomes following pars plana vitrectomy for non-diabetic vitreous hemorrhage.[8] Similarly, previous studies have shown that timely vitrectomy facilitates removal of hemorrhagic vitreous, relief of vitreoretinal traction, identification of occult retinal breaks, and application of endolaser photocoagulation, thereby reducing the risk of recurrent hemorrhage and retinal complications.[9,10]

Internal tamponade was required in approximately one-quarter of the study population, with silicone oil being the most frequently utilized tamponade agent. The choice of tamponade depended on the underlying retinal pathology and intraoperative findings rather than the vitreous hemorrhage itself. Silicone oil removal was successfully performed in most of these eyes during follow-up, indicating satisfactory retinal stabilization after surgery. Previous studies have similarly emphasized the importance of individualized tamponade selection in achieving optimal anatomical outcomes in complex vitreoretinal disorders.[11,12]

The strengths of the present study include its prospective design, standardized surgical technique using a single microincision vitrectomy platform, and uniform postoperative follow-up over six months. 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 spectrum limited subgroup analysis according to individual disease entities. Furthermore, the absence of a comparison group precluded direct evaluation against alternative management strategies or different vitrectomy systems.

CONCLUSION

The present prospective study demonstrates that 23-gauge pars plana vitrectomy is a safe and highly effective surgical modality for the management of non-diabetic vitreous hemorrhage. Excellent anatomical outcomes were achieved, with complete resolution of vitreous hemorrhage in all eyes and successful retinal reattachment in patients with associated

tractional retinal detachment. Postoperative rebleeding was uncommon and was effectively managed without compromising the final anatomical outcome. The versatility of 23-gauge vitrectomy also allowed simultaneous treatment of associated retinal pathology through adjunctive procedures such as endolaser photocoagulation, membrane peeling, internal limiting membrane peeling, and intraocular tamponade when required. These findings highlight the role of early and appropriately planned vitrectomy in restoring normal retinal anatomy and preventing vision-threatening sequelae. Although larger multicentric studies with longer follow-up are warranted, the present study supports 23-gauge pars plana vitrectomy as a reliable surgical approach for achieving favorable anatomical outcomes in patients with persistent non-diabetic vitreous hemorrhage.

DECLARATIONS

- **Ethics approval:** Approved by the Institutional Ethics Committee of Bangalore Medical College and Research Institute, Bengaluru.
- **Consent to participate:** Written informed consent was obtained from all participants.
- **Availability of data and materials:** Available from the corresponding author on reasonable request.
- **Competing interests:** The authors declare no competing interests.
- **Funding:** No external funding was received for this study.
- **Authors' contributions:** All authors contributed to study conception, data collection, analysis, manuscript preparation, and approved the final manuscript.
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