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Main Subject [Ophthalmology]

Original Article

Evaluation of Early Vitrectomy in Pre-macular Hemorrhage

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Article information

Received: 27-07-2025

Accepted: 22-09-2025

DOI: 10.21608/ijma.2025.408157.2231.

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Citation: Elkashef MH, Ghaly AAA, Ebrahim AM. Evaluation of Early Vitrectomy in Pre-macular Hemorrhage. IJMA 2025; XX-XX [Article in Press]. doi: 10.21608/ijma.2025.408157.2231.

Abstract

Background: Pre-macular hemorrhage (PMH) is a vision-threatening condition caused by the accumulation of blood in the subhyaloid or sub-internal limiting membrane space, often due to systemic or ocular vascular events. If not promptly managed, prolonged contact between blood and retinal tissue can lead to irreversible photoreceptor damage and poor visual outcomes. Early surgical intervention through pars plana vitrectomy (PPV) has been proposed as a means to rapidly restore the visual axis and improve prognosis.

The aim of the work: This work aimed To evaluate the efficacy and safety of early pars plana vitrectomy with hemorrhage evacuation and appropriate tamponade in patients presenting with premacular hemorrhage.

Patients and Methods: This prospective interventional study included 30 patients (30 eyes) with premacular hemorrhage treated at Al-Azhar University Hospitals. All patients underwent early 23- or 25-gauge PPV within two weeks of symptom onset. Data collected included demographic details, systemic comorbidities, ocular history, visual acuity (VA), type and location of hemorrhage, tamponade agent used, and postoperative outcomes. Best-corrected visual acuity (BCVA) was assessed preoperatively, and at one and three months postoperatively. Complications were recorded.

Results: The mean age was 51.5 ± 15.5 years; 60% were male. Diabetic retinopathy was the most common etiology (66.7%). Hemorrhages were predominantly subhyaloid (86.7%). Silicone oil was the most used tamponade (56.7%). Mean BCVA improved significantly from 0.0017 ± 0.0012 to 0.4 ± 0.2 at one month (p=0.001), with a slight decrease to 0.33 ± 0.2 at three months (p=0.001). Complications included cataract progression (26.7%), posterior capsule opacification (16.7%), and retinal tear (6.7%).

Conclusion: Early PPV is an effective and safe intervention for premacular hemorrhage, offering significant visual improvement and rapid recovery with an acceptable complication rate.

Keywords: Premacular Hemorrhage; Pars Plana; Vitrectomy; Visual Acuity; Diabetic Retinopathy; Subhyaloid Hemorrhage.

INTRODUCTION

Pre-macular hemorrhage is characterized by the accumulation of blood in the subhyaloid or sub-internal limiting membrane space directly over the macula, leading to acute visual impairment. This condition can significantly affect central vision and often presents with a sudden decrease in visual acuity, particularly when the hemorrhage is dense and centrally located. PMH is not a primary disease but rather a manifestation of various underlying systemic or ocular conditions such as diabetic retinopathy, retinal vein occlusion, Valsalva retinopathy, trauma, or hypertensive retinopathy [1–3]. The natural course of PMH varies depending on the etiology, size of the hemorrhage, and the location relative to the macula. In some cases, spontaneous resolution occurs over several weeks to months, particularly if the hemorrhage is small and there are no associated retinal complications. However, delayed clearance of blood can result in complications including hemosiderosis, epiretinal membrane formation, retinal traction, or even macular scarring, all of which may result in permanent visual loss [4,5].

Pars plana vitrectomy (PPV), a surgical procedure that removes the vitreous humor along with any associated hemorrhagic material, has become a widely accepted treatment for non-clearing vitreous and pre-macular hemorrhages. The timing of this intervention remains controversial. Historically, conservative observation was preferred, especially in cases with a reasonable expectation of spontaneous resolution. However, the paradigm has shifted with the evolution of surgical techniques and improved safety profiles of modern vitrectomy systems [6,7]. Recent studies have highlighted the potential benefits of early PPV in managing PMH. Early removal of the hemorrhage facilitates immediate visual rehabilitation, reduces the risk of iron toxicity, and prevents tractional complications [6, 8].

In patients with proliferative diabetic retinopathy, where recurrent hemorrhages and fibrovascular proliferation are common, early PPV may be even more critical [9]. A systematic review evaluated outcomes of early (<14 days) versus delayed vitrectomy in cases of dense vitreous or pre-macular hemorrhage. Their findings supported early intervention, associating it with higher rates of visual improvement and fewer postoperative complications such as epiretinal membrane formation and macular puckering [10]. **Shukla *et al.*** echoed these findings in diabetic patients, reporting that prompt vitrectomy minimized the duration of visual disability and led to a greater proportion of eyes achieving a final best-corrected visual acuity (BCVA) of 20/40 or better [11].

Retinal complications are not uncommon in delayed cases. The presence of blood in the vitreous cavity or on the macular surface can result in vitreoretinal traction, potentially causing retinal tears or detachments. Furthermore, persistent hemorrhage may serve as a scaffold for fibrotic proliferation, leading to long-term structural damage. Early surgical removal mitigates these risks by eliminating the pro-inflammatory and pro-fibrotic environment created by stagnant blood [12]. While the benefits of early PPV are increasingly recognized, the decision to operate must be individualized. **Confalonieri *et al.*** advised a balanced approach, considering the density and extent of hemorrhage, systemic comorbidities, and the surgeon's experience. In select cases with thin hemorrhages and stable retinal status, conservative observation may still be appropriate [13]. Nonetheless, the growing body of evidence favors early vitrectomy in dense or non-resolving PMH, particularly when vision is significantly impaired. The introduction of minimally invasive small-gauge vitrectomy (23-, 25-, and 27-gauge systems), enhanced intraoperative visualization, and improved fluidics has substantially reduced operative time and postoperative morbidity. **Ribeiro *et al.*** reported that these advances have made early vitrectomy more feasible in outpatient settings with reduced complications and faster visual recovery [14]. In light of these findings, early pars plana vitrectomy is gaining momentum as a proactive strategy in the management of pre-macular hemorrhages. It offers promising outcomes in terms of visual rehabilitation and complication prevention, especially when tailored to individual patient profiles and performed by experienced vitreoretinal surgeons.

This study aimed to evaluate the management of pre-macular hemorrhage by early pars plana vitrectomy and suction of hemorrhage with proper tamponade.

PATIENTS AND METHODS

Study Design and Ethical Considerations

This was a prospective interventional study conducted at the Department of Ophthalmology, Al-Azhar University Hospital, (Damietta, Egypt). The study adhered to the tenets of the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of the Faculty of Medicine, Al-Azhar University (Cairo, Egypt). Written informed consent was obtained from all participants prior to enrollment. The study included 30 consecutive patients presenting with pre-macular hemorrhage. The diagnosis of PMH was confirmed clinically using slit-lamp biomicroscopy and spectral-domain optical coherence tomography (OCT).

The **Inclusion Criteria were:** 1) A confirmed diagnosis of pre-macular hemorrhage on clinical examination and OCT. 2) Significant visual impairment attributable to the hemorrhage, with reduced best-corrected visual acuity (BCVA).

The Exclusion Criteria were: 1) Previous vitreoretinal surgery in the affected eye (excluding prior pan-retinal photocoagulation [PRP] or intravitreal injections [IVI]). 2) Presence of other significant ocular comorbidities (e.g., advanced glaucoma, uveitis) that could affect visual outcomes. 3) Inability to provide informed consent or comply with the postoperative follow-up schedule. 4) Systemic conditions that contraindicated surgery.

Preoperative Assessment: All patients underwent a thorough ophthalmologic and systemic evaluation including: Complete medical and ocular history: age, gender, history of trauma, comorbidities (e.g., diabetes mellitus, hypertension), anticoagulant use, and prior ocular interventions (e.g., PRP, IVI). Best-corrected visual acuity (BCVA) measured using a Snellen chart. Intraocular pressure measurement. Slit-lamp biomicroscopy for anterior segment evaluation. Dilated fundus examination using a +90D lens. Optical coherence tomography (OCT) to assess the location and extent of the hemorrhage. B-scan ultrasonography was performed when fundus visualization was obscured.

Surgical Technique: All patients underwent early pars plana vitrectomy (PPV), within two weeks of symptom onset. The procedures were performed by experienced vitreoretinal surgeons using either a 23- or 25-gauge three-port system, selected based on individual case characteristics.

Anesthesia and Preparation: The choice of anesthesia (local peribulbar or general) was based on patient age, medical fitness, cooperation, and preference. Local anesthesia was administered via an inferotemporal extraconal peribulbar injection (5 mL of a mixture of 2%

lignocaine and 0.5% bupivacaine with hyaluronidase). Sedation was used in selected cases as needed. Patients received topical nonsteroidal anti-inflammatory drops twice daily and moxifloxacin 0.5% eye drops four times daily for 2–5 days preoperatively. Systemic conditions such as hypertension and diabetes were optimized prior to surgery. Anticoagulants were temporarily discontinued as per the attending physician's recommendations.

Vitrectomy Procedure: Standard sterile draping and conjunctival antisepsis with 5% povidone-iodine were performed. A non-contact wide-angle viewing system (BIOM® 5 or Zeiss RESIGHT® 700) with a Zeiss OPMI Lumera microscope was used to visualize the posterior segment.

- **Phacoemulsification**: Combined phacoemulsification with foldable intraocular lens (IOL) implantation was performed in eyes with significant cataract to optimize visualization. Trypan blue-assisted capsulorhexis and a stop-and-chop or vertical chop technique were used, followed by posterior chamber IOL implantation.
- **Vitrectomy**: Core vitrectomy was performed using high-speed cutters (3500–5000 cpm) with vacuum levels ranging from 250 to 450 mmHg. Triamcinolone acetonide was injected to visualize residual vitreous. Posterior vitreous detachment (PVD) was induced where necessary; if unsuccessful, segmentation of the posterior hyaloid was performed. The pre-macular hemorrhage was carefully evacuated using active suction under high magnification, avoiding retinal surface trauma.
- **Tamponade**: Intraoperative tamponade choice was determined by hemorrhage severity and surgical judgment:
    - Silicone oil (56.7%) was used for eyes at risk of rebleeding or with intraoperative complications.
    - Air (33.3%) was employed for cases with lower risk.
    - Balanced salt solution (10%) was used when tamponade was not deemed necessary.
- **Adjunctive Procedures**: Endolaser photocoagulation was applied in cases with peripheral ischemia or intraoperative retinal breaks. In patients with cataracts, anterior segment procedures were combined as indicated.

Postoperative Care and Follow-up: Postoperatively, all patients were prescribed topical antibiotics and corticosteroids. Those with silicone oil tamponade were scheduled for oil removal depending on the clinical course. Follow-up visits occurred on postoperative day 1, week 1, month 1, and month 3. Each visit included BCVA assessment and a full ophthalmic examination. Postoperative complications such as cataract progression, posterior capsule opacification (PCO), retinal detachment, and elevated intraocular pressure were recorded and managed accordingly.

Outcome Measures: The primary outcome was the change in BCVA from baseline to 1 month and 3 months postoperatively. Secondary outcomes included; 1) Surgical success, defined as the restoration of a clear visual axis with improvement in BCVA. 2) Intraoperative and postoperative complications, including retinal tears, rebleeding, endophthalmitis, or need for reoperation.

Statistical Analysis: Data analysis was conducted using SPSS software (version 26.0, IBM Corp., Chicago, IL, USA). Normality of distribution was assessed using the Kolmogorov–Smirnov test. Continuous variables were presented as mean ± standard deviation (SD) and compared using paired t-tests. Categorical variables were expressed as frequencies and percentages, and analyzed using the Chi-square test or Fisher's exact test when appropriate. A *p*-value of <0.05 was considered statistically significant

RESULTS

A total number of 30 patients were included in our study. The mean age of them was 51.5 ± 15.5 with a range of 25 – 70 years. Male gender represents 60% of the patients and the female gender represents 40%. According to the patient's comorbidities, DM was found in 66.7%, HTN was found in 50%, heart diseases was found in 16.7%, and head trauma was found in 6.7%. As regards the previous ocular surgery, 23.3% underwent PRP, 16.7% underwent IVI, and 10% underwent both PRP and IVI **(Table 1).**

As regards the lens state of the patients, 13 patients (43.3%) were phakic, 10 patients (33.3%) were pseudo phakic, and 23.3% were cataractous. In terms of the characteristics of the pre macular hemorrhage, 86.7% were sub hyaloid, 10% were sub ERM, and 3.3% were sub ILM. Causes of the pre macular hemorrhage were, DM (66.7%), Valsalva (16.7%), BRVO (10%), and terson syndrome (6.7%) **(Table 2)**.

As regards the type of tamponade, the most common used tamponade in our study was silicon oil (56.7%), air (33.3%), and saline (10%). In terms of the BCVA, a statistically significant improvement was reported at one month postoperatively from 0.0017 ± 0.0012 at the base line to 0.4 ± 0.2 at one month postoperatively (P=0.001). However, at three months postoperatively, the BCVA was decreased to 0.33 ± 0.2 (P=0.001) **(Table 3).** The success rate in our study was 86.7%. The reported complications included, Aggravation of the cataract in 26.7%, Retinal tear in 6.7%, and PCO in 16.7% **(Table 4).**

Table [1]: Demographic data of the studied patients.

Variables		Mean ± SD or N (%) (n=30)
Age (years)	Mean ± SD (Min. - Max.).	51.5 ± 15.5 (25 – 70)
Gender (n,%)	Males	18 (60%)
	Females	12 (40%)
Associated comorbid conditions (n,%)	DM	20 (66.7%)
	HTN	15 (50%)
	Cardiac	5 (16.7%)
	Paraplegic	2 (6.7%)
	Head trauma	2 (6.7%)
Previous ocular surgery	PRP	7 (23.3%)
	IVI	5 (16.7%)
	PRP+IVI	3 (10%)

Table 2: Characteristics of the pre-macular hemorrhage

Variables	N (%) (n=30)
Type	
Sub hyaloid	26 (86.7%)
Sub ERM	3 (10%)
Sub ILM	1 (3.3%)
Cause	
DM	20 (66.7%)
Valsalva	5 (16.7%)
BRVO	3 (10%)
Terson syndrome	2 (6.7%)

Table 3: Visual outcomes of the patients.

BCVA (Decimal)	Mean ± SD	P value [b]
Preoperatively	0.0017 ± 0.0012	**P1= 0.001***
Post 1 month	0.4 ± 0.2	**P2= 0.001***
Post 3 months	0.33 ± 0.2	**P3= 0.**01*
P value [a]	**0.001***	

a: Friedman test. b: Wilcoxon test

Table 4: Success rate and complications of the studied patients

Variables	N (%) (n=30)
Success rate	
Successful	26 (86.7%)
Failed	4 (13.3%)
Complications	
Aggravation of the cataract	8 (26.7%)
Retinal tear	2 (6.7%)
PCO	5 (16.7%)

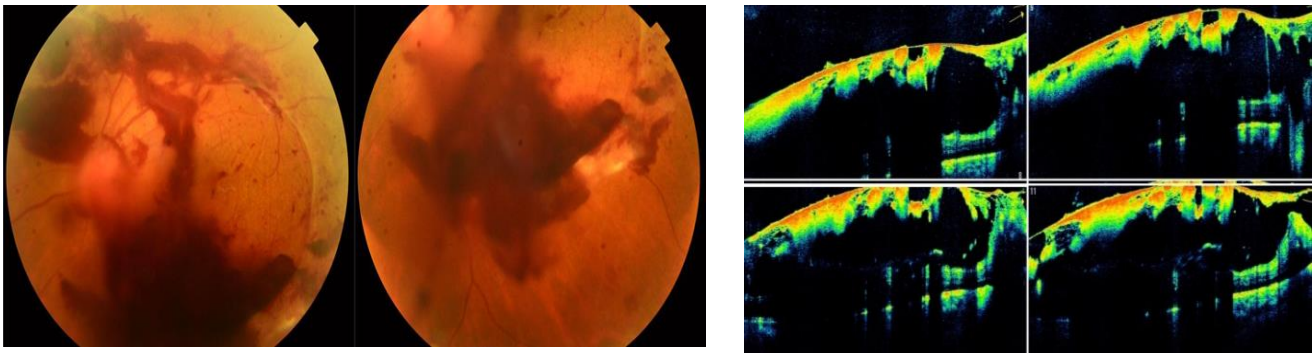

Figure (1): Case 1 shows pre-macular hemorrhage

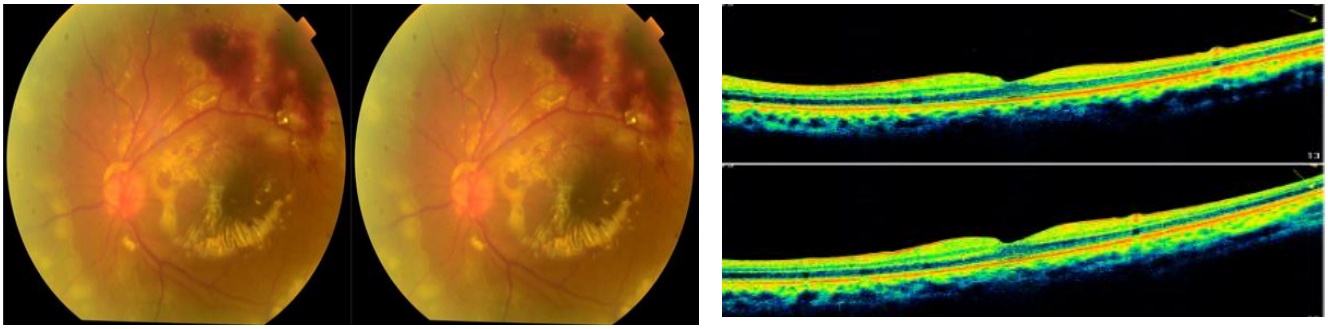

Figure (2): Case 1 shows an improvement after PPV.

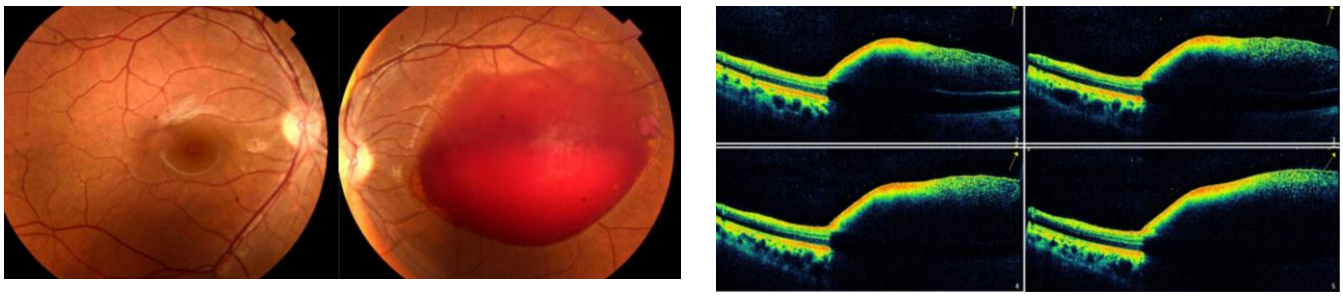

Figure (3): Case 2 shows pre-macular hemorrhage (Female patient 22 years old, pregnant, in the 3rd trimester, not diabetic)

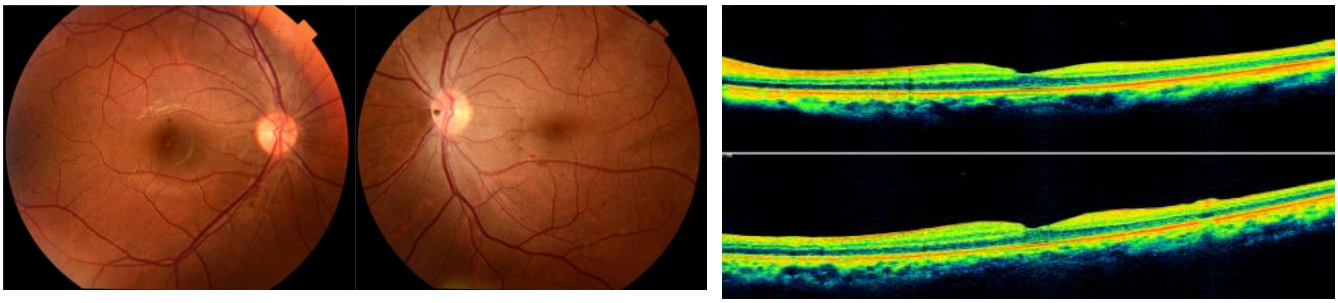

Figure (4): Case 2 shows an improvement after PPV

DISCUSSION

Pre-macular hemorrhage represents a significant cause of acute visual impairment and can result from various systemic and ocular pathologies, including diabetes mellitus, hypertension, Valsalva maneuvers, and traumatic injury [15]. The accumulation of blood in the subhyaloid or sub-internal limiting membrane (ILM) space obscures the macula and disrupts photoreceptor function. Prolonged contact with blood breakdown products, including iron and hemoglobin, can lead to retinal toxicity and permanent visual loss if not promptly managed [16].

Traditional approaches to PMH include conservative observation, Nd: YAG laser hyaloidotomy, and pars plana vitrectomy (PPV) [17,18].

While observation may be suitable for small hemorrhages with a likelihood of spontaneous resolution, dense or extensive PMH often requires active intervention. Nd: YAG laser can offer rapid clearance but carries risks such as retinal injury or incomplete drainage [19].

In contrast, PPV has gained favor in recent years for its ability to completely evacuate hemorrhagic material and restore the visual axis, especially when performed early in the disease course [20].

The primary rationale for this study was to assess the outcomes of early PPV in a diverse cohort of patients presenting with PMH of varying etiologies. While previous research has often emphasized long-term outcomes or compared conservative versus laser treatment [21], fewer studies have explored early vitrectomy with simultaneous suction evacuation and tailored tamponade application. Moreover, limited data are available from real-world clinical environments in which comorbidities like diabetes or hypertension are highly prevalent.

This study aimed to evaluate the effectiveness of early PPV in improving best-corrected visual acuity within the first three months, with secondary objectives of identifying postoperative complications and assessing the influence of factors such as lens status and tamponade choice on visual recovery.

Our results demonstrate a substantial improvement in BCVA from 0.0017 ± 0.0012 at baseline to 0.4 ± 0.2 at one month postoperatively (p=0.001). However, a slight decline to 0.33 ± 0.2 at three months was noted, though this remained statistically significant when compared to preoperative values. The overall surgical success rate, defined by improved BCVA and visual axis clearance, was 86.7%. Postoperative complications included cataract progression (26.7%), posterior capsule opacification (16.7%), retinal tears (6.7%), and optic atrophy (6.7%). These outcomes reflect a balance between the benefits of early hemorrhage clearance and the inherent risks of intraocular surgery.

The initial postoperative BCVA improvement can be attributed to the rapid restoration of the optical pathway and removal of toxic blood products, aligning with the findings of **Lee *et al.*** [22], who emphasized the importance of minimizing photoreceptor exposure to hemoglobin degradation products.

The subsequent decline in BCVA at three months may be partially explained by delayed-onset complications such as cataract formation or posterior capsule opacification, both of which are commonly reported following vitrectomy [23,24].

In our cohort, these were particularly prevalent among patients who received silicone oil tamponade, consistent with reports by **Titiyal *et al.*** [25] suggesting that oil may accelerate cataractogenesis and induce refractive changes.

Silicone oil was used in 56.7% of cases, primarily in eyes deemed at higher risk of rebleeding or with fragile vasculature. Although this agent offers long-term internal tamponade, its association with complications such as cataract progression, elevated intraocular pressure, and emulsification is well documented [25, 26]. In contrast, air and balanced salt solution (used in 33.3% and 10% of cases, respectively) are associated with fewer long-term complications. Our findings are in general agreement with studies advocating for early PPV in PMH.

Gupta *et al.* [26] reported that early vitrectomy leads to faster visual recovery and fewer structural complications compared to delayed intervention or non-surgical management. Similar to our results, their studies emphasized the benefit of early clearance in preserving macular architecture.

However, unlike studies by **Lee *et al.*** [22] that reported sustained visual gains beyond three months, our cohort showed a mild decline. This discrepancy may reflect differences in tamponade use, patient selection, or the prevalence of systemic comorbidities such as diabetes, which was present in 66.7% of our cohort and has been linked to poor retinal resilience.

Ghali *et al.* [27] retrospectively evaluated 17 patients undergoing PPV for PMH and reported varied BCVA outcomes ranging from counting fingers to 1.0 (logMAR). While their success rate was comparable, our prospective design and structured follow-up provide a more standardized assessment of functional outcomes.

De Maeyer *et al.* [28] similarly observed favorable results following PPV in five patients with sub-ILM hemorrhage, with no significant complications. Our study supports these findings in a larger cohort but adds new insights into complication rates and tamponade-specific outcomes.

In contrast, **Murtaza *et al.*** [29] and **Rennie *et al.*** [30] favored Nd: YAG hyaloidotomy as a less invasive alternative, achieving visual recovery in the majority of patients. However, this approach is limited by the need for clear media and the risk of laser-induced retinal damage. Furthermore, in cases of thick hemorrhage or sub-ILM location, laser may fail to achieve complete drainage.

A major strength of our study is its applicability to real-world clinical practice. By including patients with diverse etiologies and comorbidities, our findings reflect the complexity of routine ophthalmic care. The prospective design, consistent surgical technique, and use of objective outcome measures strengthen the reliability of the results. Additionally, by evaluating multiple tamponade agents and their impact on outcomes, this study offers valuable practical guidance on intra-operative decision-making. The statistically significant improvement in BCVA at one month reinforces the role of early intervention.

Nonetheless, the study has limitations. The sample size of 30 patients limits subgroup analysis and may restrict generalizability. The short follow-up period of three months precludes evaluation of long-term outcomes such as recurrent hemorrhage, late retinal complications, or permanent optic nerve changes. Furthermore, the absence of a non-surgical or laser-treated control group limits direct comparison with alternative management strategies. Future randomized trials comparing early PPV to Nd: YAG hyaloidotomy or conservative observation are needed. Lastly, while lens status and tamponade choice were recorded, a detailed analysis of their interaction with visual outcomes was not conducted due to the small sample size.

Our findings support the growing body of evidence that early vitrectomy is an effective and safe approach for managing PMH, especially in patients with significant visual impairment. However, the decision to proceed with surgery must be individualized, considering the hemorrhage's density, location, etiology, and the patient's systemic and ocular condition

Conclusion: Early pars plana vitrectomy offers a promising approach for the management of pre-macular hemorrhage, demonstrating significant early improvements in visual acuity. The slight decline in vision over the subsequent months, however, calls for ongoing vigilance and the development of strategies to mitigate postoperative complications. Continued research in this area will not only enhance our understanding of the optimal management of these hemorrhages but also pave the way for improved patient outcomes and quality of life.

Financial and non-financial activities and relationships of interest: None

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