Continuing Medical Education:

Visual outcomes of vitrectomy for polypoidal choroidal vasculopathy-related breakthrough vitreous haemorrhage

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Learning objectives

Upon completion of this activity, participants will be able to:

1. Describe visual outcomes of PPV and the effect of initial polyp location on visual outcomes of PPV for PCV-associated VH, based on a retrospective record review.
2. Identify factors triggering the development of breakthrough VH in patients with PCV and other factors affecting visual outcomes after PPV.
3. Distinguish potential advantages and complications of PPV for PCV-associated VH.

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Visual outcomes of vitrectomy for polypoidal choroidal vasculopathy-related breakthrough vitreous haemorrhage

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Abstract

Purpose To evaluate the long-term visual outcomes of pars plana vitrectomy (PPV) for polypoidal choroidal vasculopathy (PCV)-associated vitreous haemorrhage (VH).

Method We retrospectively reviewed the records of patients with PCV-related VH who underwent PPV. The main outcome measures were best-corrected visual acuity (BCVA) and fundus findings at 3 months postoperatively and final visit.

Results Seventeen eyes of 17 patients with massive subretinal haemorrhage (16.7 ± 7.1 disc size of mean subretinal haemorrhage area) were enrolled. The mean postoperative follow-up period was 25.2 months. Four eyes received intravitreal bevacizumab injections, and three eyes underwent photodynamic therapy before the onset of VH. The mean BCVA improved from logarithm of the minimum angle of resolution (LogMAR) of 2.63 ± 0.57 preoperatively to 1.43 ± 0.82 at final visit ($P < 0.001$). Among the eyes with initial polyps at subfoveal or juxtafoveal area, 16.70% achieved final BCVA $\geq 20/400$ (LogMAR 1.3), whereas 87.50% of eyes with initial polyps at extrafoveal area had final BCVA $\geq 20/400$ (Fisher's exact test, $P = 0.026$).

Conclusions PCV with massive subretinal haemorrhage is at risk for breakthrough VH. The visual prognosis in eyes with PCV-related breakthrough VH is variable after vitrectomy. Initial polyps at the extrafoveal area led to better functional outcomes. Early vitrectomy may be beneficial for visual recovery after PCV-related VH.

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Introduction

Polypoidal choroidal vasculopathy (PCV) is characterized by orange-reddish polypoidal lesions beneath the retinal pigment epithelium (RPE) that usually lead to recurrent serous leakage and haemorrhage.¹ PCV was previously described as 'posterior uveal bleeding syndrome'² and 'multiple recurrent retinal pigment epithelial detachments in black women'³ more than two decades ago. The representative findings, indicated by indocyanine green angiography (ICG), are branching choroidal networks with terminal polypoidal dilatation of the choroidal vessels.⁴ PCV is more commonly found in Asian populations.⁵ However, the pathogenesis of PCV is still not fully understood.

PCV lesions tend to bleed easily, with a rate of 30–63.6% for subretinal haemorrhage^{6–8} and 4.5–19.9% for vitreous haemorrhage (VH).^{7,8} In the clinical course of PCV, haemorrhage is usually acute, and visual acuity declines abruptly. Visual prognosis may be limited, with prolonged dense haemorrhages under the RPE or recurrent haemorrhages that lead to RPE and outer retina degeneration. Chan *et al*⁹ proposed a classification based on the clinical patterns at presentation, and each subgroup may have a different natural course or clinical outcome. The massive haemorrhagic group (group 4) was defined as a large subretinal or sub-RPE haemorrhage > 2 Macular Photocoagulation Study disc areas in the macular region. In addition, breakthrough VH may also be encountered after treatments such as intravitreal injections of anti-vascular endothelial growth

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factor (VEGF) agents,¹⁰ photodynamic therapy (PDT),^{11,12} and pneumatic displacements.¹³ The visual prognosis of PCV with VH is variable and is generally considered to be poor.^{10,12} However, in a case series reported by Jung *et al*,¹⁴ the visual outcome of vitrectomy for VH associated with PCV seemed to be better than that of the age-related macular degeneration (AMD) group. As there are few reports evaluating the outcomes of surgery for PCV-related VH,^{14,15} we aimed to evaluate the long-term visual outcomes of PCV with breakthrough VH managed by early pars plana vitrectomy (PPV).

Materials and methods

We conducted a retrospective study of patients with PCV-related breakthrough VH undergoing PPV from August 2008 to March 2012 in the Department of Ophthalmology, National Taiwan University Hospital, Taipei, Taiwan. This study was approved by the Institutional Review Board of National Taiwan University Hospital, Taipei, Taiwan. The study complied with the guidelines of the Declaration of Helsinki. The collected preoperative and postoperative records included a complete medical and ophthalmic history, best-corrected visual acuity (BCVA) with Snellen chart, intraocular pressure, slit lamp examination, dilated fundus examination, optical coherence tomography, fundus fluorescein angiography (FFA), ICG, preoperative treatments, and operation records. Diagnoses of PCV were made preoperatively or postoperatively, based on the results of fundus examination, FFA, and ICG. A branching vascular network with polypoidal structures dilatation demonstrated by ICG was crucial for the confirmation of PCV. The locations of polypoidal lesions were classified into subfoveal, juxtafoveal (within 200 μ m of the fovea), and extrafoveal.¹⁶

All patients underwent a standard 20-G system three-port PPV without subretinal manipulation. All operations were performed by a single retina surgeon (CH Yang). The intravitreal injection of bevacizumab was performed at the end of surgery if there was a fresh subretinal haemorrhage, serous retinal detachment (RD), serous RPE detachment, or cystoid macular oedema noted during operation. When an active PCV lesion with recurrent bleeding or leakage was found during the course of postoperative follow-up, an intravitreal bevacizumab injection was performed.

The main outcome measures were BCVA and fundus findings at 3 months postoperatively and at the final follow-up visit. Visual acuity values were converted into the logarithm of the minimal angle of resolution (LogMAR) for statistical analysis. Counting fingers (CFs) was converted to LogMAR 2.0, and hand motion (HM) was converted to LogMAR 3.0.¹⁷ Factors that might

influence the visual outcome, including age, gender, presence of systemic disease, size of subretinal haemorrhage, duration of subretinal haemorrhage, duration of VH, location of polypoidal lesions, preoperative treatment with intravitreal bevacizumab injection, or PDT, were evaluated for correlation with the final functional outcomes by a logistic regression test. Fisher's exact test was used to analyse categorical variables. Statistical analyses were conducted using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). $P < 0.05$ was considered to be statistically significant.

Results

Seventeen eyes of 17 consecutive patients (9 men and 8 women) were included in this study. All cases were followed up for at least 6 months. The basic characteristics of these patients were summarized in Table 1. The mean age of the patients was 60.1 ± 8.5 years (ranging from 45 to 81 years). The mean postoperative follow-up period was 25.18 ± 20.23 months (ranged from 6 to 72 months). Six patients had hypertension, three patients had diabetes mellitus, and one patient was under anticoagulant use. Three patients (17.6%) had PCV lesions in both eyes.

Among these eyes with PCV-related VH, VH was the initial presentation in two eyes, and seven eyes developed spontaneous breakthrough VH during the follow-up period. Four eyes received intravitreal bevacizumab injections, and three eyes underwent PDT before the occurrence of breakthrough VH. The one remaining eye received pneumatic displacement for the subretinal haemorrhage, but RD and VH occurred 10 days later. The average duration from subretinal haemorrhage to VH was 3.5 ± 1.2 weeks (ranging from 2 to 6 weeks). All of the eyes had massive subretinal haemorrhages (the mean subretinal haemorrhage area was 16.7 ± 7.1 in disc size).

Patients underwent PPV 1.3 ± 0.7 months (ranging from 0.1 to 2.5 months) after the onset of the VH. Bevacizumab was injected intravitreally into nine eyes during the operation. The eye with RD and VH after pneumatic displacement received PPV and gas tamponade, and the retina attached postoperatively. No eye developed any complication after PPV, except for cataracts. There was no recurrent VH during the postoperative follow-up. Active PCV lesions were found in five eyes, and bevacizumab was injected. One eye (patient no. 8) developed new PCV lesion with small subretinal haemorrhage at 1 year after vitrectomy. Bevacizumab was injected two times. The haemorrhage resolved and final BCVA was 20/100 (LogMAR 0.7).

Baseline visual acuity was LogMAR 0.95 ± 0.60 before VH (measured at the time of subretinal haemorrhage)

Table 1 Clinical characteristics and outcomes of patients with operation for polypoidal choroidal vasculopathy-related vitreous haemorrhage

No.	Age/ gender	Eye	Systemic disease	Fellow eye	Duration from subretinal haemorrhage to VH (weeks)	Duration of VH (months)	Initial polyp location	Subretinal haemorrhage area (disc size)	Pre-op Tx	BCVA before VH (LogMAR)	Pre-op BCVA (LogMAR)	Post-op 3 months BCVA (LogMAR)	Follow-up duration (month)	Final BCVA (LogMAR)	Final macular status
1	51M	OS	HTN	—	2	2.5	NA ^a	15	Nil	NA ^b	3.0	2.0	72	2.0	Scar
2	58M	OS	—	—	3	1	Sub	13	Nil	NA ^b	2.0	1.5	71	1.7	Scar
3	55F	OD	—	—	3	2	Extra	14	Px1	0.7	1.4	0.8	45	0.2	RPE change
4	60F	OD	—	PCV with RPED	2	1.5	Extra	22	Ax4	NA ^b	3.0	2.0	29	2.0	Scar
5	70M	OS	DM	—	2	2	NA ^a	18	Ax2	NA ^b	LP	3.0	29	2.0	Atrophy
6	56F	OD	—	—	6	0.4	Extra	5	Ax1	0.5	3.0	1.5	15	1.3	Fibrosis
7	70F	OS	HTN	—	4	1.5	Sub	26	Gas	1.0	3.0	2.0	27	2.0	Scar
8	54F	OS	—	PCV	4	0.1	Juxta	5	Px2	0.8	3.0	1.0	24	0.7	RPED
9	56F	OD	—	—	3	1	Juxta	16	Ax1	1.0	3.0	2.0	20	2.0	Scar
10	58M	OS	HTN, DM, anticoagulant use	Drusen	4	1	Juxta	32	Ax1	1.0	2.0	1.7	20	3.0	Scar
11	66M	OD	HTN	PCV	4	1.5	Extra	8	Nil	NA ^b	3.0	0.8	20	0.3	RPE change
12	56F	OD	—	—	5	0.5	Extra	16	Nil	0.3	2.0	2.0	19	1.3	RPE change
13	62M	OD	HTN	—	2	0.5	Juxta	18	Nil	2.0	3.0	2.0	12	2.0	Scar
14	66M	OS	—	—	3	0.5	Extra	18	Ax4	2.0	3.0	2.0	7	0.8	Scar
15	81M	OS	HTN, DM	—	5	2	NA ^a	17	Nil	NA ^b	LP	2.0	6	2.0	Scar
16	45M	OS	—	—	4	1	Extra	15	Px1	0.2	3.0	0.2	6	0.1	RPE change
17	58F	OD	—	—	3	2.5	Extra	25	Nil	1.0	2.0	1.0	6	1.0	Scar

Abbreviations: A, intravitreal bevacizumab injection; BCVA, best-corrected visual acuity; DM, diabetes mellitus; Gas, pneumatic displacement; HTN, hypertension; LP, light perception; NA, not applicable; OD, right eye; OS, left eye; P, photodynamic therapy; PCV, polypoidal choroidal vasculopathy; postop, postoperative; preop, preoperative; RPE, retinal pigment epithelium; RPED, retinal pigment epithelial detachment; Tx, treatment; VH, vitreous haemorrhage.

^aThe initial polyp location could not be identified by indocyanine green angiography images due to dense submacular haemorrhage.

^bBCVA before VH was not obtained since the VH was the initial presentation or the patient was referred from local clinics.

and dropped to 2.63 ± 0.57 before PPV. Visual acuity improved to LogMAR 1.62 ± 0.67 at 3 months postoperatively ($P < 0.001$) and LogMAR 1.43 ± 0.82 at the final visit ($P < 0.001$) (Figure 1a). All eyes showed improvement in visual acuity, except one eye that was limited by dense cataract and marked macular scarring (Figure 1b). Final BCVA ranged from HM (LogMAR 3.0) to 20/25 (LogMAR 0.1) and was not correlated with age, gender, systemic disease, subretinal haemorrhage size, duration from subretinal haemorrhage to VH, duration from VH to PPV, preoperative treatment with intravitreal bevacizumab injection, or PDT. In the six eyes with initial polyps at the subfoveal or juxtafoveal areas, one eye (16.70%) achieved final BCVA $\geq 20/400$ (LogMAR 1.3); in the other eight eyes with initial polyps at the extrafoveal area, seven eyes (87.50%) had final BCVA $\geq 20/400$ (Fisher's exact test, $P = 0.026$).

Case presentation

Patient No. 3 (Figure 2): A 55-year-old woman without any systemic disease, presented with blurred vision in the right eye for 3 days. Visual acuity was 20/100 (LogMAR 0.7), and fundus examination demonstrated massive subretinal haemorrhage. ICG showed extrafoveal polypoidal lesions. PDT with spot size $5000 \mu\text{m}$ and power $600 \text{ mW}/\text{cm}^2$ was performed for 83 s. VH occurred 1 week after PDT, and the visual acuity dropped to 20/500 (LogMAR 1.4). Ultrasonography demonstrated hypoechoic opacities in the vitreous cavity and subretinal space. PPV was performed for non-clearing VH 2 months later. The final BCVA (4 years postoperatively) was 20/30 (LogMAR 0.18) with retinal pigment epithelial changes at the lower part of macula.

Patient No. 10 (Figure 3): A 58-year-old man had a history of hypertension, diabetes mellitus, and valve replacement surgery with ongoing anticoagulant use. He presented with decreased vision in the left eye, and the visual acuity was 20/200 (LogMAR 1.0). Massive subretinal haemorrhage was noted. ICG revealed polypoidal lesions at the juxtafoveal area. Bevacizumab was injected intravitreally. Visual acuity declined suddenly to CF 2 days after the injection. A VH was discovered, and ultrasonography uncovered marked opacities in the vitreous and beneath the retina. PPV was performed 3 weeks after VH. The improvement of visual acuity was limited by extensive scarring, and VA decreased to HM at final visit (20 months postoperatively).

Discussion

PCV usually presents with recurrent serous and haemorrhagic detachments of the RPE, and massive haemorrhage occurs occasionally with sudden

deterioration of vision.^{18,19} The cluster type of PCV lesions, which was the most common formation of the PCV lesions, was found to be related to increased frequency of massive haemorrhage with poorer visual outcomes.^{7,16} Larger PCV size (lesion ≥ 1 disc area) is associated with severe vision-threatening complications, such as suprachoroidal haemorrhage and VH.²⁰ In some genotype-phenotype analysing studies, the risk genotypes of LOC387715 rs10490924 were correlated with larger lesion size, greater chance of VH, and worse therapeutic response.^{21–23}

VH associated with PCV can occur as the initial presentation or during the follow-up period.^{14,15,24,25} In this current study, VH was the initial presentation in two eyes, whereas seven eyes were found to have spontaneous breakthrough VH from subretinal haemorrhage during the follow-up period.

Ultrasonography was crucial in the setting of VH obscuring fundus detail and helped to exclude more urgent aetiologies. In a study describing the ultrasonographic features of PCV with VH, two characteristic types of ultrasonographic findings were reported that might represent the different stages of the haemorrhagic retinal elevations.¹⁵ The most important sign was the detection of hypoechoic opacities on both sides of a hyper-reflective membrane (Figure 2, top right and Figure 3, bottom left), indicating haemorrhages distributed both in the vitreous cavity and in the subretinal space. In contrast, the area under the retinal membrane would be echo free in rhegmatogenous RD. The other ultrasonographic feature of the PCV lesion depicted a dome-shaped elevation with hypoechoes inside and even a fluid level, representing haemorrhagic pigment epithelial detachment.¹⁵ Ultrasonography could also help to exclude other possible causes of VH, such as intraocular tumours or posterior vitreous detachment.

PCV-related breakthrough VH can also develop after manipulations, such as PDT,^{11,12,26} intravitreal injection of anti-VEGF agents,¹⁰ pneumatic displacement,¹³ or combined therapy with PDT and anti-VEGF agents.^{27–29} In the current study, three cases of VH developed after PDT. Four eyes received intravitreal bevacizumab injections, and one eye had pneumatic displacement before the onset of breakthrough VH. Postoperative bleeding is a known complication of PDT for PCV^{11,12} that results in subretinal haemorrhage in 31% of treated eyes and VH in 6.6–12.5% of treated eyes.^{12,26} The risk of massive VH after PDT was higher in PCV than in common AMD, and VH was indicative of poor visual prognosis.¹² Larger laser irradiation spot size (especially $> 3500 \mu\text{m}$) of PDT was considered to be a higher risk for postoperative VH.¹² Three cases in the current study received PDT in eyes with pre-existing subretinal haemorrhages and developed VH 1–6 weeks after the

Figure 1 (a) Change of VA: baseline VA was $\text{LogMAR } 0.95 \pm 0.60$ before VH and dropped to 2.63 ± 0.57 before vitrectomy. VA improved to $\text{LogMAR } 1.62 \pm 0.67$ at 3 months postoperatively and final VA was $\text{LogMAR } 1.43 \pm 0.82$. ($P < 0.001$ for preoperative LogMAR and final LogMAR). (results represent mean $\pm$ SD) (b) Final postoperative visual acuity plotted against preoperative visual acuity. All eyes had improved visual acuity at final visit compared with preoperative visual acuity, except for one eye with dense cataract and marked macular scarring. The color reproduction of this figure is available on the *Eye* journal online.

Figure 2 Patient No. 3. (Top left) Preoperative ICG showed extrafoveal polypoidal lesions. Visual acuity was 20/100 ($\text{LogMAR } 0.7$) at that time (top right) VH occurred 1 week after PDT and visual acuity dropped to 20/500 ($\text{LogMAR } 1.4$). Ultrasonography showed hypoechoic opacities in vitreous cavity and beneath temporal-lower retina. (Bottom left) Postoperative ICG revealed regression of polypoidal lesions. (Bottom right) Fundus picture at final visit (4 years postoperatively) demonstrated retinal pigment epithelial changes over lower part of macula. Visual acuity was 20/30 ($\text{LogMAR } 0.18$). The color reproduction of this figure is available on the *Eye* journal online.

Figure 3 Patient No. 10. (Top left) Fundus picture at the first visit showed massive subretinal haemorrhage. (Top right) ICG revealed juxtafoveal polypoidal lesions. (Bottom left) A VH occurred 2 days after intravitreal bevacizumab injection, and visual acuity declined to CFs. Ultrasonography found marked opacities in the vitreous and beneath the retina. (Bottom right) The fundus picture at 2 months postoperatively revealed extensive submacular haemorrhage and exudate. Visual acuity at that time was 20/2000 (LogMAR 2.0). The improvement of visual acuity was limited by extensive scarring, and visual acuity decreased to HM at the final visit (20 months postoperatively).

therapy. The laser spot sizes used in this study were 1500, 3500, and 5000 μm , respectively. The mechanism of haemorrhage might be related to the direct effects of laser exposure or to altered choroidal blood flow.¹² PDT would cause occlusion of both the abnormal and physiologic choroidal vessels within the treated area, resulting in increased blood flow in fragile vasculatures and leading to massive haemorrhage complications.¹²

Although it is controversial whether combination of intravitreal injection of anti-VEGF agents with PDT could decrease the risk of haemorrhage complication after PDT,^{26–29} intravitreal injection of anti-VEGF agents alone could also induce haemorrhage. Cho *et al*¹⁰ retrospectively reviewed 54 patients with PCV who had received intravitreal ranibizumab injection. They found postoperative subretinal haemorrhages in five (8.9%) eyes and VH in one (1.8%) eye. All subretinal

haemorrhages developed within 1 week after injection. Those with large PCV lesions (size $\geq 15 \text{ mm}^2$) carried a higher risk for bleeding. Visual acuity decreased significantly in the eye with postoperative VH. The mechanism of haemorrhagic complications after the intravitreal ranibizumab injection could be an RPE tear,³⁰ resulting from the contraction of choroidal vessels or changes in choroidal blood flow following ranibizumab injection.¹⁰ In the current study, VH occurred 1 to 4 days following the intravitreal bevacizumab injection in the eyes with pre-existing subretinal haemorrhage, suggesting that intravitreal injection might be a trigger factor for breakthrough VH. It could be postulated that intravitreal injection might cause intraocular pressure fluctuations within short durations of time and stretch of choroid and sclera in the eyes with a massive subretinal haemorrhage that might lead to breakthrough VH.

Wu and co-workers¹³ retrospectively evaluated 120 eyes that had undergone intravitreal tissue plasminogen activators and pneumatic displacements for submacular haemorrhages. Eighteen eyes (15%) reported complications with breakthrough VH, and two cases (1.67%) suffered from RD. They found a large area of submacular haemorrhage (≥ 10 disc areas) and PCV as the underlying aetiology were associated with a higher risk of VH after the procedure, and the occurrence of VH did not affect the visual prognosis of submacular haemorrhage. There was only one eye that received pneumatic displacement in our study, and RD accompanied with VH was found 10 days after the procedure. Although PPV and gas tamponade had anatomically successful results, the final VA was restricted by macular scarring and recurrent subretinal haemorrhage.

In the current study, VH occurred 2–6 weeks (3.5 weeks on average) after subretinal haemorrhage, which concurs with the observations of previous studies.^{14,31} Further, all of the eyes in this study had massive subretinal haemorrhages (average haemorrhage area: 16.7 disc size), which suggests that eyes with massive subretinal haemorrhages were at risk of breakthrough VH. Several common characteristics of breakthrough VH recognized in earlier reports, as well as in this study, helped to clarify the mechanism of spontaneous breakthrough VH. VH usually developed several weeks following subretinal haemorrhage, and turbid, thick, organized haemorrhages were seen even in newly developed VH.¹⁴ No breaks could be identified in such

cases. Lincoff *et al*³² demonstrated in a rabbit model that subretinal blood could cause necrosis of the overlying retina, except for the internal limiting membrane and that fragments of erythrocytes could migrate across the damaged retina into the vitreous cavity. Manipulations such as intravitreal injection of anti-VEGF agents, PDT, and pneumatic displacement may trigger the migration of the subretinal blood that clouds the vitreous.^{10–13,26}

Few studies have reported the visual outcomes of PPV for PCV with breakthrough VH (Table 2).^{10,12,14,15} Jalali *et al*¹⁵ reported 10 eyes receiving PPV combined with individualized procedures for VH associated with PCV. The mean follow-up duration was 19.5 months. PPV was performed 3.1 months after the onset of VH. Preoperative visual acuity measured light perception (LP) only, and the final visual acuity ranged from LP to 20/25 (LogMAR 0.1), including six eyes (60%) with BCVA $\geq 20/400$ (LogMAR 1.3). Surgically related complications consisted of rhegmatogenous RDs in three eyes. Jung *et al*¹⁴ investigated 12 eyes that underwent PPV for PCV with VH. The mean follow-up duration was 12.7 months. The preoperative BCVA was LP to 20/80 (LogMAR 0.6), and the final BCVA ranged from CFs to 20/25 (LogMAR 0.1), including BCVA $\geq 20/400$ (LogMAR 1.3) in seven eyes (54%). Surgical complications included one choroidal detachment. In our study, visual outcomes varied from HM to 20/25 (LogMAR 0.1). The percentage of eyes with final BCVA $\geq 20/400$ (LogMAR 1.3) was 47.1%, slightly lower than the results (54–60%) of previous studies.^{14,15} A longer follow-up duration with a higher rate of

Table 2 Study results describing visual outcomes of vitrectomy for polypoidal choroidal vasculopathy with breakthrough vitreous haemorrhage

Study	Case number	Mean follow-up duration (months) (range)	Surgery	Mean time to surgery (months)	BCVA	Complications after PPV (except cataract)
Jalali <i>et al</i> ¹⁵	10	19.5 (6–48)	PPV + individualized procedures	3.1	Preoperative: LP Final: LP ~20/25 (6 eyes $\geq 20/400$)	Three RRD
Jung <i>et al</i> ¹⁴	12	12.7 (6–29)	PPV $\pm$ IVB or IVTA	4.8	Preoperative: LP ~20/80 Final: CF ~20/25 (7 eyes $\geq 20/400$)	One CD
Cho <i>et al</i> ¹⁰	One eye (1.8%) had VH 4 days after intravitreal ranibizumab injection	7.4 (4–14)	PPV	—	Baseline: 20/100 Final: CF	—
Hirami <i>et al</i> ¹²	Six eyes (6.6%) developed VH after PDT	9.6 (5–15)	Two received PPV	—	Baseline: 20/650–20/20 Final: HM ~20/100 (3 eyes $\geq 20/400$)	—
Our study	17	25.2 (6–72)	PPV $\pm$ IVB	1.3	Preoperative: LP ~20/500 Final: HM ~20/25 (8 eyes $\geq 20/400$)	None

Abbreviations: BCVA, best-corrected visual acuity; CD, choroidal detachment; CF, counting fingers; HM, hand movements; IVB, intravitreal bevacizumab injection; IVTA, intravitreal triamcinolone injection; LP, light perception; PDT, photodynamic therapy; RRD, rhegmatogenous retinal detachment; VH, vitreous haemorrhage.

recurrence and cataract formation might account for this finding. PPV could facilitate earlier diagnosis and provide ambulatory vision even for those with macular lesions and central scotoma. With careful management, none of our cases experienced any of the possible surgical complications, such as retinal breaks, RDs, or choroidal detachments.

During postoperative follow-up, recurrent VH or new PCV lesions had been reported.^{14,15} Jung *et al*¹⁴ reported recurrent VH after PPV in four cases, which absorbed spontaneously in three eyes. Two eyes developed new PCV lesions within 1 year and was managed by laser photocoagulation in Jalali *et al*'s study.¹⁵

In the present study, there was no recurrent VH during the postoperative follow-up. New PCV lesion with small subretinal haemorrhage occurred in one eye at 1 year after PPV and was treated successfully with intravitreal bevacizumab injection. Long-term follow-up is necessary in cases with PCV-related breakthrough VH to recognize and manage the recurrent lesions earlier.

Several reports studying vitrectomy for AMD-related VH demonstrated poor functional outcomes, possibly due to severe inflammatory reactions, extensions of pre-existing subretinal haemorrhages, and surgical complications.^{33–35} However, our study and other studies^{14,15} reported more favourable visual outcomes of vitrectomy for PCV-related VH. Visual recovery was limited mainly by macular pathology, such as macular scarring, atrophy, or RPE changes. Subretinal blood can act as a barrier to block metabolic exchange, causing degenerative changes of the RPE and outer retina.³⁶ In this study, none of the following were shown to be related to visual outcomes: age, gender, subretinal haemorrhage size, duration from subretinal haemorrhage to VH, duration from VH to PPV, preoperative treatment with intravitreal bevacizumab injection, or PDT. Cases with systemic disease (DM or HTN) showed a borderline relationship (Fisher's exact test, $P = 0.05$) with poorer visual outcomes. Eyes with initial polyps at the extrafoveal area had better visual outcomes than those with polyps at the subfoveal or juxtafoveal areas. Foveal microstructures were more likely to be destroyed, as the polyps close to the fovea restricted visual recovery. In a recent study comparing the long-term results of PDT with or without intravitreal bevacizumab injection for PCV, the polyp location was more significantly associated with the final visual improvement rather than treatment modality itself.³⁷

The limitations of this study include its retrospective study design, small case numbers, and potential confounding factors. Nevertheless, our study has the largest sample size and the longest follow-up duration compared with other studies. These results still provide valuable information for clinical practice.

In summary, the visual prognosis in eyes with PCV-related breakthrough VH is variable after vitrectomy. Massive subretinal haemorrhage is at risk for breakthrough VH. Some treatment modalities, such as intravitreal injection, pneumatic displacement, and PDT, may trigger the development of breakthrough VH. Visual recovery after PPV may be limited by macular pathology, and initial polyps at the subfoveal or juxtafoveal areas may be linked to a poorer functional prognosis. Further prospective study is required for better understanding of the surgical outcomes of PCV-related breakthrough VH.

Summary

What was known before

- PCV lesions tend to bleed easily, with a rate of 30–63.6% for subretinal hemorrhage and 4.5–19.9% for VH.
- VH associated with PCV can occur as the initial presentation or during the follow-up period; breakthrough VH may also be encountered after treatments such as intravitreal injections of VEGF agents, PDT and pneumatic displacements.

What this study adds

- PCV with massive subretinal haemorrhage is at risk for breakthrough VH.
- The visual prognosis in eyes with PCV-related breakthrough VH is variable after vitrectomy. Initial polyps at the extrafoveal area led to better functional outcomes.
- Early vitrectomy may be beneficial for visual recovery after PCV-related VH.

Conflict of interest

The authors declare no conflict of interest.

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Visual outcomes of vitrectomy for polypoidal choroidal vasculopathy-related breakthrough vitreous haemorrhage

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1. Your patient is a 68-year-old man with polypoid choroidal vasculopathy (PCV)-associated vitreous haemorrhage (VH). According to the retrospective record review by Dr Yang and colleagues, which of the following statements about visual outcomes of pars plana vitrectomy (PPV) for PCV-associated VH is **correct**?

- A Mean best-corrected visual acuity (BCVA) improved from logarithm of the minimal angle of resolution (LogMAR) of 2.63 ± 0.57 before PPV to 1.43 ± 0.82 at final visit
- B The mean change in BCVA after PPV was not statistically significant
- C Patients with initial polyps at the subfoveal area had better visual outcomes
- D Patients with initial polyps at the juxtafoveal area had better visual outcomes

2. According to the retrospective record review by Dr Yang and colleagues, which of the following statements about factors triggering the development of breakthrough VH in patients with PCV is **correct**?

- A Massive subretinal haemorrhage does not appear to increase the risk for breakthrough VH
- B Some treatment modalities, such as intravitreal injection, pneumatic displacement, and photodynamic therapy (PDT) may trigger the development of breakthrough VH

- C Preoperative treatment with intravitreal bevacizumab injection or PDT affected final BCVA
- D Age, gender, and systemic disease affected final BCVA

3. According to the retrospective record review by Dr Yang and colleagues, which of the following statements about potential advantages and complications of PPV for PCV-associated VH would **most** likely be correct?

- A PPV could facilitate earlier diagnosis
- B Patients with macular lesions and central scotoma will not achieve ambulatory vision after PPV
- C Three eyes in this series experienced retinal breaks or detachments
- D Three eyes in this series experienced choroidal detachments

Activity evaluation

1. The activity supported the learning objectives.

Strongly disagree		Strongly agree
1	2 3	4 5

2. The material was organized clearly for learning to occur.

Strongly disagree		Strongly agree
1	2 3	4 5

3. The content learned from this activity will impact my practice.

Strongly disagree		Strongly agree
1	2 3	4 5

4. The activity was presented objectively and free of commercial bias.

Strongly disagree		Strongly agree
1	2 3	4 5