Incidence of and Risk Factors for Postoperative Hyphema After 23-Gauge Pars Plana Vitrectomy for Proliferative Diabetic Retinopathy

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Purpose: We aim to investigate the incidence, clinical course, and risk factors for developing postoperative hyphema after 23-gauge pars plana vitrectomy (PPV) for patients with proliferative diabetic retinopathy (PDR) without neovascularization of the iris or angles and neovascular glaucoma (NVG).

Methods: This retrospective study included 155 consecutive eyes from 124 patients with at least three-month follow-up who underwent PPV for PDR without neovascularization of the iris or angles and NVG. Demographic data, surgery notes, postoperative hyphema assessment, intraocular pressure (IOP), and the surgical outcome were recorded.

Results: Postoperative hyphema occurred in 18 of 155 eyes (11.6%), with 14 of those having hyphema on day 1, and 4 having hyphema on days 7–20. Of the 18 eyes, only 3 (16.7%) had normal IOP, and immediate intraocular hypertension was observed in 15 (83.3%). Seven eyes required anterior chamber paracentesis and five needed anterior chamber irrigation. The average time for absorption of the hyphema was 13.1 days, and IOP was controlled in all cases. There was a significant correlation between membrane removal and the development of hyphema (OR = 5.65 and 95% CI: 1.190–25.203; p = 0.013). No recurrence of hyphema was observed. In patients with hyphema, the final best corrected visual acuity (BCVA) was 1.75 ± 0.84 logMAR, which improved significantly compared to the initial BCVA of 2.20 ± 0.65 logMAR (t = 3.893; p = 0.001), and the final anatomic success rate was 100%.

Conclusion: The development of hyphema is not uncommon after PPV for patients with PDR without neovascularization of the iris or angles and NVG, and membrane removal is a risk factor for postoperative hyphema. The timely management of hyphema ensures that hyphema does not affect the visual recovery or the final anatomical success.

Keywords: pars plana vitrectomy, hyphema, proliferative diabetic retinopathy, diabetes, membrane removal

Introduction

Hyphema is defined as the accumulation of blood cells in the anterior chamber of the eye. The most common cause is ocular trauma (blunt or penetrating); however, it can also develop as a result of non-trauma-related conditions, such as iris neovascularization, melanoma, juvenile xanthogranuloma, retinoblastoma, leukemia, and medication-induced anticoagulation. In addition, hyphema can develop after ocular surgery, including surgeries for glaucoma, severe infectious keratitis, cataract, macular hole, epiretinal membrane, and rhegmatogenous
retinal detachment. Hemorrhage in the anterior chamber blocks the angle of the chamber, inhibiting aqueous drainage and resulting in an increase in intraocular pressure (IOP). Hyphema is a common condition, and its prognosis is good if it is treated properly and timely. However, hyphema can significantly alter a patient’s visual prognosis through severe complications, such as corneal blood staining, amblyopia, secondary glaucoma, and optic atrophy. To our knowledge, postoperative hyphema in patients with proliferative diabetic retinopathy (PDR) who have undergone pars plana vitrectomy (PPV) is rarely documented in the literature. As patients with neovascularization of the iris or angles and neovascular glaucoma (NVG) have a higher risk of hyphema, we investigated the frequency, risks, and treatment regimens associated with hyphema after PPV for patients with PDR without neovascularization of the iris or angles and NVG. In this study, we reviewed the surgical records and postoperative course records of patients with PDR without neovascularization of the iris or angles and NVG after undergoing PPV and identified the patients with postoperative hyphema. We describe the incidence, risk factors, and management protocols of hyphema in these patients. The effect of hyphema on visual recovery and the final anatomical success is also analyzed and described here.

Methods
We performed a retrospective review of 155 consecutive eyes in 124 patients with PDR without neovascularization of the iris or angles and NVG who had undergone PPV in the Department of Ophthalmology on the East campus of the Renmin Hospital of the Wuhan University (Wuhan Optics Valley General Hospital) from October 2017 to December 2019. The university’s ethics committee and institutional review board approved the study protocol, which adhered to the tenets outlined in the Declaration of Helsinki. Informed consent was obtained from each patient before their procedure. The indications for patients with PDR who underwent PPV were vitreous hemorrhage (VH), recurrent VH, massive preretinal hemorrhage, extensive fibrovascular proliferation, tractional retinal detachment, and tractional-rhegmatogenous retinal detachment. Patients with NVG, neovascularization of the iris or angles and ocular trauma were excluded. All surgeries were performed by the same experienced physician (Dr. Zhen Chen). The patients’ clinical data, including age, gender, type and duration of diabetes mellitus (DM), coexisting systemic diseases (such as hypertension), use of oral anticoagulant/antiplatelet medications, recent surgical procedures, best corrected visual acuity (BCVA), IOP, slit-lamp biomicroscopy, dilated fundus examination, and fundus photographs (or B-scan ultrasonography) were collected prior to surgery. Postoperative examinations included BCVA, IOP, slit-lamp biomicroscopy, and dilated fundus examination.

BCVA was measured using a Snellen chart, and the values were converted to logarithm of the minimum angle of resolution (logMAR) scores for data analysis. The visual acuity levels of counting fingers, hand motion, and light perception were recorded as 2.0 logMAR, 3.0 logMAR, and 3.3 logMAR, respectively.

All cases were performed under either general anesthesia or local retrobulbar anesthesia. Some patients received an intravitreal ranibizumab (Lucentis; Novartis, Switzerland and Genentech, USA; 0.5 mg in 0.05 mL) 3–5 days before undergoing vitrectomy. In all cases, a 23-gauge vitrectomy (Bausch & Lomb, St Louis, MO, USA) with a wide-angle viewing system (Alcon Laboratories, Fort Worth, TX, USA) was used. After surgery, all patients were examined daily in the ward to assess BCVA and IOP and to undergo slit-lamp biomicroscopy and dilated fundus examination. All patients underwent PPV alone or in combination with phacoemulsification. During PPV, the cortical vitreous and/or hemorrhage was first removed. This was followed by vitreous base shaving (360°) under scleral depression to remove the peripheral vitreous, and then the fibrovascular membrane was removed using the bimanual or unimanual technique. Scissors segmentation and delamination were used to divide the thick fibrotic plaque from the retina, then fibrovascular membrane was removed by vitreous cutter. The bimanual technique such as membrane dissections and en bloc excision was primarily used in complicated situations during vitrectomy. Intraoperatively, bleeding was controlled by endodiathermy or increasing the infusion or air pressure. After fluid-air exchange, retinal breaks were treated with endolaser, complete panretinal photocoagulation (PRP) was performed on the anterior retina in all cases, and air or silicone oil (SO, Oxane 5700 centistokes, Bausch & Lomb Inc. Rochester, NY, USA) was used as a tamponade. The sclerotomy sites were routinely sutured with 8/0 polyglactin, and patients were instructed to maintain an appropriate head posture after surgery.

Clinicians generally grade hyphema based on the percentage of the anterior chamber that is filled with blood. Grade 0 (microhyphema) occurs when there are scattered red blood cells in the anterior chamber that do not form
Grade I hyphema occurs when <33% of the anterior chamber is filled with blood, grade II has 33–50% filling, grade III has >50% but <100% filling, and grade IV has 100% filling.1,13

The patients were divided into two groups based on whether they displayed hyphema in the anterior chamber postoperatively. Group 1 included eyes from patients with PDR who did not develop hyphema after PPV, and group 2 included eyes from patients with PDR who developed hyphema after PPV. These two groups were compared to identify and analyze the possible risk factors for postoperative hyphema.

The incidence and management of postoperative hyphema and the time of hemorrhage absorption were recorded. Patients with hyphema were treated with medical agents and/or surgical procedures. Conservative management options included bed rest, head elevation, the use of an eye shield, and the use of pharmacological agents (topical steroids and anti-glaucoma medications). We found that patients with hyphema also displayed a high IOP, which is defined as a pressure >21 mmHg as measured by non-contact tonometer (FT-1000; Tomey Corporation, Japan). High IOP was controlled using topical β-adrenergic antagonists, α-adrenergic agonists, and topical and oral carbonic anhydrase inhibitors. If no improvement was observed after using these medications, surgical intervention was required. The outcome measures used after absorption of hyphema were visual recovery, IOP, and retinal anatomical success, anatomical success was defined as retinal reattachment during follow up. We also recorded the postoperative complications in the hyphema group.

The preoperative and postoperative BCVA of patients with hyphema were analyzed using a paired t-test. Statistical comparison between groups 1 and 2 was performed using a chi-square test, Fisher’s test, or Mann–Whitney U-test, and categorical variables included sex, age, duration of DM, hypertension, use of oral anticoagulants, preoperative IOP, history of PRP, and indications for surgery. We assessed the potential risk factors for postoperative hyphema using mixed-effect logistic regression analysis. A p-value of <0.05 was used as the threshold to determine statistical significance. Statistical analyses were performed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) and R language version 3.6.2.

Results

A total of 155 consecutive eyes from 124 patients with PDR without neovascularization of the iris or angles and NVG who had undergone PPV were enrolled in this retrospective study. Of the 155 procedures, postoperative hyphema occurred in 18 eyes (11.6%) after PPV. The hyphema group (n = 18) included 10 males and 8 females, and the non-hyphema group (n = 106) included 60 males and 46 females. Table 1 compares the baseline data and preoperative characteristics between the hyphema and non-hyphema group and shows that there were no significant differences in terms of demographic and baseline data and preoperative characteristics including sex, age, duration of DM, hypertension, use of oral anticoagulants, preoperative IOP, history of PRP, and indications for surgery.

Table 1. Baseline Data and Preoperative Characteristics of PDR Patients for PPV

|                         | Hyphema (+) n=18 | Hyphema (-) n=106 | P value |
|-------------------------|------------------|-------------------|---------|
| No. of eyes             | 18               | 137               |         |
| Sex                     |                  |                   |         |
| Male                    | 10               | 60                | 1       |
| Female                  | 8                | 46                |         |
| Age                     |                  |                   |         |
| <40                     | 1                | 16                | 0.191   |
| 40–60                   | 12               | 58                |         |
| >60                     | 5                | 32                |         |
| Duration of DM          | 12.4±10.6        | 10.7±6.6          | 0.699   |
| Hypertension            | 9                | 42                | 0.276   |
| Oral anticoagulants     | 1                | 5                 | 0.572   |
| Preoperative IOP (mmHg) | 16.6±3.6         | 16.0±2.9          | 0.431   |
| PRP                     | 2                | 21                | 0.489   |
| Indications of the surgery |              |                   |         |
| VH                      | 12               | 104               | 1       |
| Recurrent VH            | 0                | 6                 | 0.798   |
| Massive preretinal hemorrhage | 0   | 2                 | 0.067   |
| FVP                     | 8                | 42                | 0.386   |
| TRD                     | 6                | 19                | 0.16    |
| TRD/RRD                 | 0                | 11                | 0.649   |

Note: P value was obtained by Chi-square test or Fisher exact test or t-test.

Abbreviations: DM, diabetes mellitus; IOP, intraocular pressure; PRP, panretinal photoocoagulation; VH, vitreous hemorrhage; FVP, fibrovascular proliferation; TRD, tractional retinal detachment; TRD/RRD, tractional-rhegmatogenous retinal detachment.
The surgical procedures of PPV used for patients with PDR are listed in Table 2. Of the 18 eyes, 7 (38.9%) received IVR before surgery, and 11 (61.1%) did not. Intraoperative fibrovascular membrane removal was performed on 15 eyes (83.3%), 10 (55.6%) underwent unimanual vitrectomy, 5 (27.8%) underwent bimanual vitrectomy, 5 (27.8%) received endodiathermy to stop bleeding, 5 (27.8%) had iatrogenic tears after membrane removal, fluid-air exchange was performed on all eyes, and all were filled with SO after surgery. The surgical time was 80 ± 15 min in the hyphema group and 65 ± 20 min in the non-hyphema group, and statistical analysis showed that the surgical time in the hyphema group was significantly longer than in the non-hyphema group (p < 0.001). In addition, the t-test indicated that the surgical time in the membrane removal group was significantly longer than in the non-membrane removal group (t = 10.7; p < 0.001), which shows that membrane removal increases the surgical time, resulting in the correlation between surgical time and hyphema. Statistical analysis revealed that the two groups did not differ significantly based on anesthesia, IVR pretreatment, endodiathermy, method of membrane removal, iatrogenic tears, fluid-air exchange, or postoperative head position. However, hyphema occurred more frequently in patients with PDR who underwent membrane removal during PPV (p = 0.021). In our study population, all eyes with postoperative hyphema were filled with SO. Using SO tamponade might influence the results, but we did not analyze the choice of tamponade as an influencing factor. Other postoperative complications after vitrectomy were recorded in the hyphema group. Early postoperative VH within 1 month after the surgery occurred in 3 eyes (16.7%), preretinal bleeding occurred in 15 eyes (66.7%), recurrent retinal detachment complicated by progressive fibrovascular proliferation developed in 1 eye (5.6%). Later postoperative VH, choroidal detachment, endophthalmitis and NVG were not observed in the hyphema group.

Table 3 shows the clinical features and outcomes of the postoperative hyphema cases in this cohort of patients. Of the 18 eyes, the mean age of the patients was 53.4 y, and the mean duration of DM was 12.4 y. Of these eyes, 14 had postoperative hyphema from the first postoperative day, and, in 4 cases, postoperative hyphema occurred 7–20 days after surgery. Of the 18 cases of hyphema, 12 (66.7%) were grade I, 2 (11.1%) were grade II, 2 (11.1%) were grade III, and 2 (11.1%) were grade IV.

Table 2 Surgical Procedures of PDR Patients for PPV

| Procedure                                      | Hyphema (+) n=18(Eyes) | Hyphema (-) N=137(Eyes) | P value |
|------------------------------------------------|------------------------|-------------------------|---------|
| Anesthesia                                     |                        |                         |         |
| General anesthesia                             | 0                      | 1(0.7%)                 |         |
| Local retrobulbar anesthesia                   | 18(100%)               | 136(99.3%)              |         |
| IVR pretreatment                               | 7(38.9%)               | 72(52.6%)               | 0.401   |
| Endodiathermy                                  | 5(27.8%)               | 35(25.5%)               | 0.584   |
| Membrane removal                               | 15(83.3%)              | 72(52.6%)               | 0.021   |
| Method of removing membrane                    |                        |                         |         |
| No membrane removal                            | 3(16.7%)               | 65(47.4%)               |         |
| Unimanual                                      | 10(55.6%)              | 49(35.8%)               |         |
| Bimanual                                       | 5(27.8%)               | 23(16.8%)               | 0.082   |
| Iatrogenic tears                               | 5(27.8%)               | 22(16.1%)               |         |
| Fluid-air exchange                             | 18(100%)               | 114(83.2%)              | 0.076   |
| Tamponade procedure                            |                        |                         |         |
| No tamponade                                   | 0                      | 23(16.8%)               | -       |
| Air tamponade                                  | 0                      | 44(32.1%)               |         |
| SO tamponade                                   | 18(100%)               | 70(51.1%)               |         |
| Postoperative head position                    |                        |                         |         |
| Prone                                          | 18(100%)               | 114(83.2%)              | 0.076   |
| Not prone                                      | 0                      | 23(16.8%)               |         |
| Surgical time (min)                            | 80±15                  | 65±20                   | <0.001  |

Note: P value was obtained by Chi-square test or Fisher exact test or t-test.
Abbreviations: IVR, intravitreal ranibizumab; SO, silicone oil.
| Patient | Age/ Sex | DM/ Year | Hypertension/ Years | Oral Anti-Coagulant/ Anti-Platelet | Indication of Surgery | Preoperative IVR | Postop Lens Status | Membrane Removal | Endodiathermy | Tamponade | Onset/ Grade | Postoperative Hypertension | Additional Intervention | Absorption Time |
|---------|---------|---------|--------------------|-----------------------------------|-----------------------|------------------|-------------------|-----------------|--------------|-----------|---------------|-----------------------------|----------------------|------------------|
| 1       | 50/M    | Yes/10  | Yes/2              | No                                | VH, FVP               | No               | Phakia            | Yes             | No           | SO        | 1 d grade 1 | Yes                          | —                    | 3 d              |
| 2       | 45/M    | Yes/1   | No                 | No                                | VH, FVP               | No               | Phakia            | Yes             | Yes          | SO        | 1 d grade 2 | Yes                          | ACP                  | 7 d              |
| 3       | 64/M    | Yes/9   | Yes/3              | No                                | FVP                  | No               | Phakia            | Yes             | No           | SO        | 20d grade 2 | Yes                          | ACI                  | 14 d             |
| 4       | 45/M    | Yes/8   | Yes/0.5            | No                                | VH, FVP               | No               | Phakia            | Yes             | No           | SO        | 1 d grade 1 | Yes                          | ACI                  | 30 d             |
| 5       | 39/M    | Yes/1   | No                 | No                                | VH, FVP               | No               | Phakia            | Yes             | No           | SO        | 1 d grade 1 | Yes                          | —                    | 8 d              |
| 6       | 74/M    | Yes/30  | Yes/4              | No                                | VH, FVP               | No               | Phakia            | Yes             | No           | SO        | 1 d grade 3 | Yes                          | ACI, IVR             | 30 d             |
| 7       | 50/M    | Yes/13  | No                 | No                                | VH                   | Yes              | Phakia            | No              | No           | SO        | 8 d grade 1 | Yes                          | ACP                  |                 |
| 8       | 40/M    | Yes/5   | Yes/1              | No                                | VH                   | Yes              | Phakia            | No              | Yes          | SO        | 9 d grade 1 | Yes                          | ACP                  |                 |
| 9       | 56/M    | Yes/20  | Yes/10             | No                                | VH                   | Yes              | Phakia            | Yes             | No           | SO        | 7 d grade 1 | Yes                          | ACP                  |                 |
| 10      | 49/M    | Yes/10  | No                 | No                                | FVP                  | Yes              | Pseudophakia      | Yes             | Yes          | SO        | 1 d grade 1 | Yes                          | ACP                  |                 |
| 11      | 62/F    | Yes/25  | No                 | No                                | TRD                  | Yes              | Phakia            | Yes             | No           | SO        | 1 d grade 1 | Yes                          | —                    |                 |
| 12      | 59/F    | Yes/15  | No                 | No                                | TRD                  | Yes              | Phakia            | Yes             | No           | SO        | 1 d grade 1 | Yes                          | —                    |                 |
| 13      | 38/F    | Yes/11  | No                 | No                                | VH, TRD              | Yes              | Aphiakia          | Yes             | No           | SO        | 1 d grade 1 | Yes                          | ACP                  |                 |
| 14      | 46/F    | Yes/11  | Yes/3              | No                                | VH, TRD              | No               | Phakia            | Yes             | Yes          | SO        | 1 d grade 1 | No                           | —                    |                 |
| 15      | 58/F    | Yes/10  | No                 | No                                | VH, FVP              | No               | Phakia            | Yes             | No           | SO        | 1 d grade 1 | No                           | —                    | 7 d              |
| 16      | 58/F    | Yes/10  | No                 | No                                | TRD                  | Yes              | Phakia            | Yes             | No           | SO        | 1 d grade 1 | No                           | —                    | 7 d              |
| 17      | 68/F    | Yes/40  | Yes/8              | Yes                              | TRD                  | Yes              | Phakia            | Yes             | No           | SO        | 1 d grade 1 | Yes                          | ACI                  | 30 d             |
| 18      | 61/F    | Yes/14  | Yes/14             | No                                | VH                   | No               | Phakia            | Yes             | No           | SO        | 1 d grade 3 | Yes                          | ACP and ACI          | 30 d             |

**Abbreviations:** M, male; DM, diabetes mellitus; IVR, intravitreal ranibizumab; VH, vitreous hemorrhage; FVP, fibrovascular proliferation; F, female; TRD, tractional retinal detachment; SO, silicone oil; ACP, anterior chamber paracentesis; ACI, anterior chamber irrigation.
grade II, 4 (22.2%) were grade III, 3 (16.7%) had normal 
IOP, and 15 (83.3%) had elevated IOP. Of the patients with 
high IOP, only 4 cases (22.2%) were normalized using 
IOP-lowering drugs alone. In addition to using IOP-
lowering drugs, six patients (33.3%) required anterior 
chamber paracentesis (ACP), one (5.6%) required anterior 
chamber irrigation (ACI) combined with ACP, four 
(22.2%) required only ACI, and one (5.6%) required ACI 
combined with IVR. We performed ACP as an outpatient 
procedure using a slit lamp. IOP was controlled by topical 
medications, ACP, or ACI in all patients with hyphema, 
extcept for one eye that required a glaucoma valve implant-
tion. The average time for absorption of the hyphema 
was 13.1 d (3–30 d). No recurrence of hyphema was 
observed.

During follow-up examinations, we found that all 18 
eyes with hyphema achieved anatomical success, the final 
anatomic success rate was 100%, and the final BCVA for 
each patient improved significantly when compared with 
their initial BCVA. The mean postoperative BCVA was 
1.75 ± 0.84 logMAR, which is a significant improvement 
over the preoperative BCVA of 2.20 ± 0.65 logMAR (t = 
3.893; p = 0.001).

We also analyzed the potential independent risk factors 
for the development of hyphema after PDR surgeries using 
mixed-effect logistic regression. The results indicated that 
membrane removal was a significant risk factor for the 
development of hyphema (OR = 5.65 and 95% CI: 1.190– 
25.203; p = 0.013).

Discussion

Diabetic retinopathy (DR) is the most common microvas-
cular complication of DM and is responsible for up to 
4.8% of cases of blindness globally. If left untreated, 
nearly half of the eyes that develop PDR will also develop 
severe vision loss due to related complications, including 
retinal detachment and vitreous hemorrhage. Over the 
past decade, rapid advancements in technology for retinal 
imaging and the development of new therapies have dra-
matically improved the visual outcomes for patients with 
DR. In cases of severe PDR, such as those with a dense 
and extensive fibrovascular membrane and tractional reti-
nal detachment, vitreoretinal surgery is necessary, which 
can restore vision and improve the patient’s quality of life.

However, this procedure can be associated with com-
lications, including recurrent vitreous hemorrhage, retinal 
detachment, cataract, neovascular glaucoma, and endophthalmitis. Although rare, hyphema can develop in certain cases after PPV for PDR. From the litera-
ture, it is clear that postoperative hyphema is a frequent 
complication of trabeculectomy in patients with NVG, and 
hyphema may be a surgical risk factor for the failure of 
trabeculectomy in these patients. In this group, the preo-
perative use of intravitreal bevacizumab (IVB) can reduce 
the risk of postoperative hyphema. In our study, there 
were no patients with neovascularization of the iris 
or angles and NVG in the hyphema or the non-hyphema 
group, and we believe that the mechanism of hyphema in 
patients with NVG is different from its mechanism in the 
group of patients we studied.

Among the hemorrhagic complications that can occur 
after PPV for PDR without neovascularization of the iris 
or angles and NVG, postoperative hyphema is relatively 
rare when compared with the development of a vitreous 
hemorrhage. Hyphema often develops from tears in the 
vessels of the ciliary body and iris following trauma or an 
iridectomy. In the present study, 11.6% of patients with 
PDR developed postoperative hyphema after undergoing 
PPV, and 2.3% (4 of 155 eyes) developed severe hyphema. 
However, other studies have observed occurrence rates of 
postoperative hyphema of 5.6%, 10%, 16.2%, and 8%. Patients with postoperative hyphema may be 
asymptomatic, may present with a transient vision block-
age, or may associate their symptoms with vitreous hemor-
rhage. Hyphema does not typically cause permanent loss 
of vision, but in some cases, it will inhibit the drainage 
of aqueous humor resulting in an acute rise in the IOP and 
optic neuropathy, which ultimately poses a serious threat 
to the patient’s vision. Of our cohort, 15 eyes (83.3%) 
exhibited elevated IOP. The management of hyphema 
seeks to accelerate the absorption of the blood and prevent 
possible complications. Conservative management 
options included bed rest, head elevation, the use of an 
eye shield, and the use of pharmacological agents, eg, 
topical steroids and anti-glaucoma drugs. If these methods 
failed and clinical indications for surgical treatment were 
met, including persistent elevated IOP, possible corneal 
bleeding, and non-resolving hyphema, surgery was 
performed, and the technique chosen was based on the 
severity and density of hyphema. In our study, 4 eyes 
(22.2%) were stabilized using only IOP-lowering drugs 
and 11 required ACP and/or ACI. ACP is the most com-
mon outpatient surgical approach, as it can be performed 
safely and repeatedly using a slit lamp with adequate 
aseptic precautions. If there is a small amount of 
hyphema or large blood cells in the anterior chamber,
ACP can be used. However, if the blood clots in the anterior chamber are not easily absorbed, ACI should be performed. Nearly all patients with elevated IOP were stabilized using topical medications, ACP, and/or ACI, and only one eye required a glaucoma valve implantation. No recurrence of hyphema was observed.

In all patients who developed postoperative hyphema in our study, SO was used for long-term tamponade to prevent recurrent retinal detachment, improve postoperative visual acuity, reduce the possibility of recurrent bleeding, and complement follow-up laser therapy. In three patients without fibrovascular membrane, SO was used because adequate hemostasis was not achieved at the end of the vitrectomy. Through the surgical records, we found that four patients with severe hyphema developed active bleeding after membrane removal during the surgery. Complete hemostasis could not be achieved by perfusion/air pressure increase or adequate endodiathermy. When using logistic regression analysis to study the potential risk factors in patients with PDR for developing postoperative hyphema after PPV, we found that membrane removal was a significant independent risk factor (OR = 5.65 and 95% CI: 1.190–25.203; p = 0.013). As membrane removal was strongly correlated with surgical time, it was not used in the regression model. Membrane dissection is an effective and important technique in the treatment of complex PDR, and bleeding can easily occur when performing this surgery. In addition, we discovered that most cases of hyphema that develop following intraocular surgery occur at the time of surgery or immediately thereafter. In this study, 83.3% of patients (15 eyes) that developed hyphema had undergone fibrovascular membrane removal. In addition, 14 eyes developed postoperative hyphema on the first day after surgery, and 4 cases developed hyphema 7–20 days after surgery. We postulate that early hyphema may be caused by blood that is able to break through the silicone oil and pass through the weakened zonules in pseudophakic or phakic eyes into the anterior chamber. However, late hyphema may be caused by rebleeding due to the dispersion of residual blood in the retina, or because the preretinal blood clot liquefaction time was 1–3 weeks (average 14 d). Remaining in the prone position after vitrectomy can easily cause the blood clot to dissolve into the anterior chamber. The liquefaction of preretinal bleeding can also cause the hyphema to undergo changes, which might require multiple ACPs and ACIs. Nonetheless, hyphema in the anterior chamber did not ultimately affect the patient’s vision or anatomical success.

Aside from membrane removal, we did not find any factors that were associated with the occurrence of hyphema including sex, age, duration of DM, hypertension, use of anticoagulant/antiplatelet medications, preoperative IOP, indications for surgery, anesthesia, preoperative IVR, endodiathermy, method of membrane removal, iatrogenic tears, fluid-air exchange, or postoperative head position. Previous studies have indicated that anticoagulants or antiplatelet agents do not increase the risk of ocular hemorrhagic events in cataract and macular surgery. However, IVR did not decrease the occurrence of postoperative hyphema in our study. We speculate that this is because only 38.9% of patients with hyphema received IVR, and the hyphema group may include more complicated patients with PDR with a high risk of postoperative bleeding.

While our work revealed important insights into the risks that can lead to hyphema, there are some potential limitations. First, it was a retrospective study. Second, the patients with PDR in our study were complex and may not accurately reflect all patients. Despite these limitations, we identified membrane removal as a risk factor for developing postoperative hyphema after PPV in patients with PDR. The incidence of postoperative hyphema was 11.6%, and neither the presence nor the degree of hyphema affected the visual recovery or final anatomical success of the patients. Our results indicate that surgeons should carefully remove the membrane in patients with complex PDR to reduce intraoperative and postoperative bleeding. However, if hyphema develops postoperatively, timely treatment will reduce complications and allow for complete recovery.

Disclosure

The authors report no conflicts of interest in this work.

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