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Intraocular Pressure Changes of Rhegmatogenous Retinal Detachment Patients Following Pars Plana Vitrectomy in Tertiary Hospital

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Abstract
Introduction: Rhegmatogenous retinal detachment (RRD) is one of the leading causes of vision loss worldwide. Retinal reattachment is the main target of RRD management. Pars plana vitrectomy (PPV) is one of the surgical approaches to reattach the retina by removing the vitreous gel and replacing it with tamponades. Several tamponades used in PPV may cause an alteration of intraocular pressure (IOP).
Purpose: To report the IOP changes of RRD patients who underwent pars plana vitrectomy surgery
Methods: A descriptive retrospective study was conducted on all RRD patients who underwent primary PPV with all tamponades at the National Eye Center, Cicendo Eye Hospital. This study has evaluated and observed the range of IOP across all the follow-up timelines post-surgery based on the endo tamponade used for the patients.
Result: A total of 90 patients met the inclusion criteria and received intravitreal tamponade. The median IOP at baseline was 12 (4-21) mmHg. Secondary glaucoma mostly occurred in 1st and 3rd months post-PPV, 37.78% and 36.67% respectively. 80% of patients who received silicon oil 1300 centistoke experienced IOP elevation which occurred highly during 1-week and 1-month post PPV. 2.2% of patients underwent glaucoma filtering surgery to further control the IOP elevation.
Conclusion: Pars plana vitrectomy procedure with several types of tamponades as vitreous substitution is one of the common approaches for patients with RRD. IOP elevation has been observed as one complication of PPV. Multiple factors may be attributable to IOP alteration. Monitoring of IOP before and after the surgery is mandatory to prevent secondary complications.
Keywords: Intraocular pressure, pars plana vitrectomy, retinal detachment, retinal tamponade, secondary glaucoma

INTRODUCTION

Rhegmatogenous retinal detachment (RRD) occurs when a full-thickness defect in the neurosensory retina (NSR) or an identified retinal break causes fluid accumulation in the subretinal space. RRD results in the separation of retinal pigment epithelium (RPE) and NSR. This is one of the leading causes of vision loss with a reported incidence of around 8–18 per 100,000 population. Males and patients of older age have higher incidence rates of having RRD. History of intraocular surgery congenital disease, myopia, and trauma are several predisposing identified factors. Retinal reattachment is the main target of RRD management that need to be achieved. There are several surgical options to manage RRD patients, including pneumatic retinopexy, scleral buckling, and primary vitrectomy with or without scleral buckling. Primary vitrectomy can be performed with an anterior approach or with a posterior approach as in Pars plana vitrectomy (PPV).[1-3]

Pars plana vitrectomy (PPV) releases vitreoretinal traction caused by retinal breaks by removing the vitreous to restore the anatomical structure of the retina and RPE. The main indication for PPV

includes posterior retinal breaks that are difficult to be reached by scleral buckle, eyes with a thin sclera, RRD with significant PVR grade, and vitreous opacity that may hamper the Visualization of giant retinal breaks. The vitreous gel is replaced with a variety of denominated tamponades, including gases [perfluoro propane (C3F8) or sulfur hexafluoride (SF6)], silicone oil (SO), and perfluorocarbon liquids. Vitreous removal and replacement by those tamponades may cause significant alteration of intraocular pressure (IOP). An increase of IOP over 30mmHg has been reported in more than 40% of eyes undergoing PPV.[2,4-6] Fakhri et al reported that 75.3% of patients from a total of 97 rhegmatogenous retinal detachment patients in Cicendo Eye Hospital in 2019 were in the range of 36-45 years old. Most of the patients were men (73.2%). A previous study also reported that 41% of patients following vitreoretinal surgery in Cicendo Eye Hospital experienced IOP elevation within the first 3 month post-surgery.[7,8]

The purpose of this study is to report the IOP changes of rhegmatogenous retinal detachment patients who underwent pars plana vitrectomy surgery in the Tertiary Hospital.

METHODS

This study was an observational descriptive retrospective study based on patient medical records data from a vitreoretinal unit from the National Eye Center in Cicendo Eye Hospital, Bandung. The Inclusion criteria in this study were all RRD patients who underwent primary PPV with all tamponades at National Eye Center, Cicendo Eye Hospital from 1st January 2022 to 30th June 2022, and patients who came for a followed-up visit minimum 3 months after surgery. The exclusion criteria were patients who had a history of surgery in the same eye, a history of congenital diseases, patients with a history of primary glaucoma, or patient who has other causes of secondary glaucoma such as lens-induced glaucoma, pseudoexfoliation syndrome, uveitis, and steroid-induced glaucoma.

Secondary glaucoma is defined as an increase of IOP above 22 mmHg using a tonometer. IOP data were gathered from the pre-surgical visit, day 1 after surgery, first and the third month of the follow-up period after surgery. The clinical information of the patients was collected from medical records, including age, sex, IOP before and after PPV surgery, lens status, grade of proliferative vitreoretinal (PVR), total quadrant of retinal detachment, types of retinal tamponades, SO emulsification, SO evacuation, the onset of secondary glaucoma, and antiglaucoma drugs. PVR classification in this study used the classification from the Retina Society Terminology Committee (1983) which divides the PVR into four stages (A, B, C, D) based on its severity. Data of all variables were analyzed descriptively using Microsoft Office Excel 2019 program and IBM SPSS Statistics 25.

RESULTS

There were 235 RRD patients from the vitreoretinal unit at Cicendo Eye Hospital Bandung undergoing primary PPV surgery during the period of 1st January 2022 to 30th June 2022. A total of 90 patients met the inclusion criteria of this study. Table 1 shows the baseline characteristics of patients in this study. Most of the patients (61.11%) were male. The patient's age range was 11-68 years old with 50.50 years of median age. Patients with an age range of 41-60 years old were 54 patients (60%). The most operated eye in this study was the right eye (56.67%).

Table 1. Baseline Characteristics of Patients

Characteristics	Number of patients (total 90)	Percentage (%)
Gender		
Man	55	61.11
Woman	35	38.89
Age (years old)		
Median (Range)	50.50 (11-68)	
Age Group		
1-20	1	1.11
21-40	19	21.11
41-60	54	60.00
>60	16	17.78
Operated Eye		
Right Eye	51	56.67
Left Eye	39	43.33

Table 2 shows the vitreoretinal surgery characteristics of the patients. Most of the patients (87.78%) were phakic. The highest proportion of patients had PVR grade B (51.1%), retinal detachment in all quadrants (36.67%), and 1 identified retinal break on examination (54.4%). Silicone oil 1300 centistokes (cSt) was the highest type of intravitreal tamponade used in 72 patients (80%).

Table 2. Vitreoretinal Surgery Characteristics

Characteristics	Number of patients (of total 90)	Percentage (%)
Lens Status		
Phakic	79	87.78
Pseudophakic	11	12.22
PVR		
No PVR	9	10.00
PVR grade A	23	25.6
PVR grade B	46	51.1
PVR grade C	12	13.3
Total Quadrant of Retinal Detachment		
1 Quadrant	9	10.00
2 Quadrant	28	31.11
3 Quadrant	20	22.22
All Quadrant	33	36.67
Identified Retinal Breaks on surgery		
1	49	54.40
2	32	35.60
3	6	6.70
>3	3	3.33
Intravitreal Tamponade		
SF6	1	1.11
C3F8	10	11.1
silicon Oil 5000 centistokes	5	5.6
Silicon Oil 2000 centistokes	1	1.11
silicon Oil 1300 centistokes	72	80.0
Heavy silicon	1	1.1
Tamponade complications of silicone oil	7	7.78
Emulsification		
Evacuation of Tamponade/ Silicon Oil		
No	10	11,11
Yes (≤ 3 Month)	4	4.44
(> 3 Month)	76	84.44
Median IOP (Range, mmHg)		
Baseline IOP (Before surgery)	12 (4-21)	
1 day after surgery		
1 week after surgery	13 (5-49)	
1 month after surgery	19 (5-64)	
3 months after surgery	17 (5-68)	
	16 (7-46)	
Secondary glaucoma after surgery	14	23.33
1 Day	34	37.78
1 Week	33	36.67
1 Month	15	16.67
3 Month		

Complications of silicone oil tamponade emulsification were found in 7 patients (7.78%). Patients undergoing evacuation of silicone oil over 3 months were 76 patients (84.4%). The median IOP at baseline before surgery was 12 (4-21) mmHg. This median of IOP remained within normal limit up to 3 months following surgical procedure. The onset of secondary glaucoma occurred highly in 1 week and 1 month after surgery in 34 patients (37.78%) and 33 patients (36.67%) respectively.

Table 3 describes the IOP characteristics of the patients throughout the follow-up period after the PPV. All of the patients had normal baseline IOP before surgery. There were 14 patients (15.6%) that experienced secondary glaucoma 1 day after surgery. The

proportion of patients who experienced secondary glaucoma in the range of 22-30 mmHg was 18.9% (17 patients) during 1-week post-PPV; 17.8% (16 patients) 1-month post-PPV; and 12.2% (11 patients) in 3 months post PPV. IOP measurement above 50 mmHg was detected in 1 patient during 1-week post-surgery and in 3 patients 1 month after surgery. The majority of patients who experienced secondary glaucoma in all followed-up periods received SO 1300 centistokes (cst) tamponade.

The management of secondary glaucoma, treated by both anti-glaucoma agents and glaucoma surgery, is ilustrated in the Table 4. Almost all patients with secondary glaucoma received 1 or 2 types of antiglaucoma drugs throughout all followed-up periods. Only a small proportion of patients received 3 antiglaucoma drugs. PPV, while the other one received it 6 months after surgery.

Table 3. IOP Characteristics Post Surgery

Characteritics	IOP Range (mmHg)				
	<22	**22–30**	**31–40**	**41–50**	**>50**
IOP 1-day post-surgery (n, %)	**76 (84.4%)**	**7 (7.8%)**	**6 (6.7%)**	**1 (1.1%)**	**0 (0%)**
Tamponade					
C3F8	8	2	0	0	0
SF6	1	0	0	0	0
SO 1300	61	4	6	1	0
SO 2000	1	0	0	0	0
SO 5500	4	1	0	0	0
Heavy Silicone	1	0	0	0	0
IOP 1-week post-surgery (n, %)	**56 (62.2%)**	**17 (18.9%)**	**9 (10%)**	**7 (7.8%)**	**1 (18.9%)**
Tamponade					
C3F8	6	2	1	1	0
SF6	1	0	0	0	0
SO 1300	43	14	8	6	1
SO 2000	1	0	0	0	0
SO 5500	4	1	0	0	0
Heavy Silicone	1	0	0	0	0
IOP 1-month post-surgery (n, %)	**57 (63.3%)**	**16 (17.8%)**	**8 (8.9%)**	**6 (6.7%)**	**3 (3.3%)**
Tamponade					
C3F8	7	3	0	0	0
SF6	0	0	1	0	0
SO 1300	44	12	7	6	3
SO 2000	1	0	0	0	0
SO 5500	4	1	0	0	0
Heavy Silicone	1	0	0	0	0
IOP 3-month post-surgery (n, %)	**75 (83.3%)**	**11 (12.2%)**	**2 (2.2%)**	**2 (2.2%)**	**0 (0%)**
Tamponade					
C3F8	10	0	0	0	0
SF6	1	0	0	0	0
SO 1300	58	10	2	2	0
SO 2000	1	0	0	0	0
SO 5500	4	1	0	0	0
Heavy Silicone	1	0	0	0	0

DISCUSSION

This study assigned a total of 90 RRD patients who underwent primary PPV surgery. The patient's age range was 11-68 years old. Baseline characteristics data from this study showed that male RRD patients are higher than females. The highest proportion of patients is in the age range of 41-60 years old. This finding is similar to the studies from Pillai et al (2020) who studied 635 vitrectomy patients from years 2013 to 2015 in South

India and Omidtabrizi et al (studied 225 eyes post vitrectomy surgery in 2020) which had reported higher incidence rates of RRD in males and older patients.[1,10,11]

It is important to note that the patients included in the study did not have elevated baseline pressure concerning the issue of mean baseline IOP being a risk factor for the development of glaucoma. The median of preoperative IOP baseline in this study was 12 mmHg (range 4-21 mmHg). This normal range of baseline IOP is similar to the baseline IOP from the studies conducted by Kovacic et al in 2019 [mean preoperative IOP 14.2 ± 4.9 mmHg] and Antoun et al in 2016 [mean preoperative IOP was 13.38 ± 6.8 mmHg].[12-14]

In this study, most patients had all quadrant retinal detachment in 33 patients (36.67%). Most patients who underwent PPV surgery in this study had PVR grade B (46 patients 51.1%). IOP elevation occurred in PVR gr < C2 (34.21%) and PVR grade ≥ C2 (55.56%) in the study conducted by Xu et al.[15] However, there is no current study to date that compares the PVR grade, total retinal detachment, and elevation of IOP in RRD patient underwent PPV.

Several surgical procedures, for instance, laser surgery, posterior capsulotomy, and cataract surgery may cause transient elevation of IOP. Even though the IOP level may reach 50 mmHg, it usually lasts from a few hours to a few days. A sustained increase in IOP level has been reported after vitrectomy. Vitreous gel substitution is used by a surgeon in the PPV procedure. Silicone oil tamponade has been used universally as a tamponade in RRD cases with PVR. C3F8 and SF6 gases are also commonly used in RRD cases. Secondary glaucoma following the PPV surgery may occur as a result of a pupillary block, migration of silicone oil droplets, or closure of peripheral iridocorneal angle by inflammatory cells, fibrins, blood, or anterior synechiae. Chronic IOP elevation after pars plana vitrectomy is associated with the development of open-angle glaucoma, prolonged inflammation, and the damage of trabecular meshwork. Several cytokines and inflammatory agents, such as Interleukin-6 (IL-6), IL-7, or Tumor Necrosis Factor alpha (TNF-α) may play role in this process.[3,6,8,16]

In this study, the onset of IOP elevation mostly occurred in 1 week (37.78%) and 1-month post-surgery (36.67%). A total of 15 patients (16.67%) had experienced high IOP in 3 months post PPV surgery. These findings are similar to what was reported by Ali Idrus et al in which 41% of patients had IOP elevation during the first week after surgery and 3 months after surgery.13 The high incidence of IOP elevation during the first-week post-surgery is associated with a high level of inflammations, red blood cells, debris, trabecular meshwork deformation, and oxidative damage.[3,6,8,15]

The majority of patients (80%) received SO 1300 cst as a vitreous substitute in this study. C3F8 gas tamponade was given to 10 patients, while SF6 gas was given to 1 patient. Secondary glaucoma in the SO 1300 cst group occurred in 11 patients at day one post-PPV, 29 patients at 1-week post-PPV, 28 patients at 1-month post-PPV, and 14 patients at 3 months post-PPV. Patients who received C3F8 gas tamponade experienced secondary IOP elevation in as many as 2 patients at 1-day post-PPV, 4 patients at 1weeks post-PPV, and 3 patients at 1-month post-PPV. Secondary glaucoma was observed in 1 patient who received SF6 gas tamponade a 1-month post-PPV. Previously, Ali Idrus et al (2017) observed the IOP at the same center from 2010 to 2011, but at that time there were no patients who received SF6 (Sulfur hexafluoride) gas tamponade. A retrospective study by Kovacic et al in 2019 examined 93 eyes with SF6 gas

tamponade out of a total of 139 eyes with retinal detachment, but this study did not analyze statistical correlation with the use of tamponade.

Antiglaucoma drugs can manage IOP elevation in almost all the patients with IOP elevation post-PPV in this study. It was reported by Antoun et al in 2016 that 88% of patients from his study responded well to antiglaucoma agents and 8.6% (3 patients) had normal IOP after the evacuation of SO. Only 2 patients in this study experienced sustained IOP elevation even when they were treated with antiglaucoma drugs. IOP remained high for more than 4 months of follow-up period even before silicone oil evacuation. Multiple factors may play a role in this persistent IOP elevation in this subject, such as inflammation status, preexistence systemic diseases, the length of surgery, and the integrity of the anterior chamber angle pre and post-surgery. The correlation among these factors needs to analyzed further in future study. This persistent elevation of IOP is an indication of performing filtering surgery. Glaucoma filtration surgery, specifically trabeculectomy, was conducted for those patients. The trabeculectomy for those two patients was suggested by glaucoma unit doctors in Cicendo Eye Hospital because the IOP elevation cannot be normalized for more than 3 months to target a 30% IOP reduction from the baseline.[3,6,8,12,13,16,17]

This study has several limitations. Due to the retrospective nature of the present study, some items, including the macular status, duration from RRD onset to PPV surgery, axial length status or biometric parameter of RRD patients before and after surgery, a standard measurement of IOP, and gonioscopy measurements in all patients with high IOP. Furthermore, the data in this study were not analyzed statistically. Future prospective analytical studies based on the results of the present data should be performed to provide further validation of the IOP profile in RRD patients who receive PPV surgery.

CONCLUSION

Pars plana vitrectomy procedure with several types of tamponades as vitreous substitution is one of the common approaches for patients with RRD. IOP elevation following PPV may be attributable to many factors. IOP elevation can be temporary or persistent following PPV surgery. We suggest that all RRD patients undergo comprehensive evaluation of systemic diseases, assessment of angle structures using gonioscopy before and after surgery to assess baseline integrity of the anterior chamber structures and baseline IOP, and biometric assessment to evaluate correlation among these risk factors. Monitoring of IOP before and after the surgery is mandatory to prevent secondary complications.

REFERENCES

1. Kurochkin P, Huang N, Petrela R, Rosenberg K, Brown J, Oellers P. Pars Plana Vitrectomy Outcomes for Rhegmatogenous Retinal Detachment Qualifying for Pneumatic Retinopexy. Clinical Ophthalmology. 2021;Volume 15:1207-14.
2. Sultan ZN, Agorogiannis EI, Iannetta D, Steel D, Sandinha T. Rhegmatogenous retinal detachment: a review of current practice in diagnosis and management. BMJ Open Ophthalmology. 2020;5(1):e000474.
3. Kim SJ, Fawzi A, Kovach JL, Patel S, Recchia FM, Sobrin L, et al. *Retina and Vitreous*. In: Rapuano CJ, Stout JT, McCannel CA, editors. *Basic and Clinical Science Course*. San Francisco: *American Academy of Ophthalmology*; 2022-2023.
4. Nakamura M, Nishi K, Nishitsuka K. Selection Criteria for Air Tamponade During Vitrectomy for Rhegmatogenous Retinal Detachment. Clin Ophthalmol. 2022;16:981-6.
5. Dhoot AS, Popovic MM, Nichani PAH, Eshtiaghi A, Mihalache A, Sayal AP, et al. Pars plana vitrectomy versus scleral buckle: A comprehensive meta-analysis of 15,947 eyes. Survey of Ophthalmology. 2022;67(4):932-49.

6. Rossi T, Ripandelli G. Pars Plana Vitrectomy and the Risk of Ocular Hypertension and Glaucoma: Where Are We? Journal of Clinical Medicine. 2020;9(12):3994.
7. Fakhri DM, Sutadiputra N, Putri M. *"Karakteristik Pasien Ablasio Retina Regmatogen di Rumah Sakit Mata Cicendo Bandung Tahun 2019"*. Prosiding Kedokteran. 2021;7(1).
8. Idrus EA, Gandasubrata A, Iskandar E. Characteristics of Secondary Glaucoma Post Vitreoretinal Surgery At National Eye Center Cicendo Eye Hospital from January 2010 to December 2011. Bali Journal of Ophthalmology. 2017;1:1.
9. Di Lauro S, Kadhim MR, Charteris DG, Pastor JC. Classifications for Proliferative Vitreoretinopathy (PVR): An Analysis of Their Use in Publications over the Last 15 Years. J Ophthalmol. 2016;2016:7807596
10. Pillai GS, Varkey R, Unnikrishnan UG, Radhakrishnan N. Incidence and risk factors for intraocular pressure rise after transconjunctival vitrectomy. Indian journal of ophthalmology. 2020;68(5):812-7.
11. Omidtabrizi A, Ghavami V, Shafiee M, Bayani R, Banaee T. Long-Term Intraocular Pressure Changes after Pars Plana Vitrectomy: An 8-Year Study. J Curr Ophthalmol. 2020;32(4):335-42.
12. Antoun J, Azar G, Jabbour E, Kourie HR, Slim E, Schakal A, et al. Vitreoretinal Surgery with Silicone Oil Tamponade in Primary Uncomplicated Rhegmatogenous Retinal Detachment: Clinical Outcomes and Complications. Retina (Philadelphia, Pa). 2016;36(10):1906-12.
13. Kovacic H, Wolfs RCW, Kılıç E, Ramdas WD. The effect of multiple vitrectomies and its indications on intraocular pressure. BMC ophthalmology. 2019;19(1):175.
14. Mansukhani S, Barkmeier A, Bakri S, Iezzi R, Pulido J, Khanna C, et al. The Risk of Primary Open-Angle Glaucoma Following Vitreoretinal Surgery—A Population-based Study. American journal of ophthalmology. 2019;201.
15. Xu P, Xia T, Chen J. Early Postoperative Intraocular Pressure Elevation after Vitreoretinal Surgery. J Clin Exp Ophthalmol. 2017;8:636.
16. Roa TM, Kanner EM, Netland PA. Glaucoma Associated with Disorders of the Retina, Vitreous, and Choroid. In: Albert D, Miller J, Azar D, Young LH, editors. Albert and Jakobiec's Principles and Practice of Ophthalmology. Cham: Springer International Publishing; 2020. p. 1-33.
17. Ge L, Su N, Fan W, Yuan S. Risk Factors and Management of Intraocular Pressure Elevation After Vitrectomy Combined with Silicone Oil Tamponade. Int J Gen Med. 2024;2024(17):447-56.