Clinical outcomes and preoperative predictive factors of success in single pneumatic retinopexy for primary rhegmatogenous retinal detachment at a tertiary care center.

Paiboon Bowornwattanadilok[1], Pattawee Pongpisitkul[1], Pulthip Charoenphol[1]

[1]Department of Ophthalmology, Thammasat University, Thailand

Purpose: To evaluate the success rate of pneumatic retinopexy (PR) for treatment of primary rhegmatogenous retinal detachment (RRD) and to explore preoperative factors associated with the success rate of PR.

Methods: We conducted a retrospective study, having reviewed medical records of all patients diagnosed with primary RRD that underwent a single PR in Thammasat university hospital, Thailand, during 2016 to 2018. Preoperative ocular characteristics, postoperative anatomical and visual outcomes were collected.

Results: 68 eyes of 68 patients were enrolled. Success rate of a single PR was 42.6%. The significant predictors were location of lowest retinal breaks ($P < 0.001$) and extension of retinal detachment ($P < 0.002$). In multivariate logistic regression analysis for the group with successful outcome, the patients whose lowest retinal breaks were located within the superior 2 clock hours were found to be 13.55 times more likely to respond successfully to PR (OR=13.55, 95%Cl 3.82-48.01, $P<0.001$). The success rate of PR was 0.722 times when the extension of retinal detachment increased for 1 clock hour (OR=0.722, 95%Cl 0.535-0.974, P=0.033). Out of the 29 patients from the success group, 27 (93%) patients had improvement of BCVA. Postoperative complications included new or missed break (12%), subconjunctival gas (10%), raised IOP (4%), vitreous haemorrhage (3%) and subretinal gas (1%).

Conclusion: The success rate of a single PR in primary RRD was 42.6%. The location of lowest retinal breaks and extension of retinal detachment were significant preoperative predictors of success in single PR for RRD. Final BCVA was improved in most patients with successful PR.

Keywords: pneumatic retinopexy; rhegmatogenous retinal detachment; success; factors; complication

EyeSEA 2020;15(1):17-24

DOI: https://doi.org/10.36281/2020010201

Introduction

Rhegmatogenous retinal detachment (RRD) is a condition in which the neurosensory retina is separated from the retinal pigment epithelium. RRD is the sight threatening ocular disease as well as one of considerable causes of blindness in Thailand. Nowadays, there are several treatments of this condition, which have different strengths and weaknesses, for instance, scleral buckling, pars plana vitrectomy (PPV) and pneumatic retinopexy (PR).

PR is a minimally invasive, non-incisional procedure which comprises of 2 steps; The first step is injecting an expandable gas such as perfluoropropane (C_3F_8) or sulfur hexafluoride (SF_6) into vitreous cavity, then the second step is applying laser retinopexy or transconjunctival cryopexy to induce a chorioretinal adhesion around all retinal breaks. The benefits of this procedure, is that it is cost-effective, faster

Correspondence to:
Paiboon Bowornwattanadilok, *Thammasat University*
E-mail: pb19999@gmail.com
Received : March 4,2020
Accepted: March 9,2020
Published: June 30,2020

postoperative recovery and safe. It is effective for RRD with breaks at the superior clock-hours, which is the majority of RRD cases, without the need for a vitrectomy system. However, the reasons for underutilization are that this procedure does not relieve vitreoretinal traction, and also need for skillful ophthalmologist to take more preoperative time in order to find all retinal breaks. The most common complication of PR is redetachment secondary to missed break or new break. Moreover, The other complications are cataract formation, raised IOP, suprachoroidal gas, subconjunctival gas, subretinal gas, macular hole, cystoid macular edema.[1] Many studies reported the factors affecting the success rate of PR including pseudophakic/aphakic status, extension of retinal detachment, location of retinal break and vitreous hemorrhage.[2-4]

Currently, recent reports suggest a variety of success rates and predictive factors. The overall objective of this study was to evaluate the success rate of PR, in terms of anatomic and functional outcome, for treatment of primary RRD. The other purpose of this study was to define the preoperative factors which predict the success rate of PR. The complications related to this procedure were also analyzed.

Methods

Subjects

This retrospective analysis was approved by the Institutional Review Board of Thammasat University hospital in 2018. We reviewed the medical records of all patients who were diagnosed with primary RRD and underwent PR in Thammasat University Hospital, Thailand, during 2016 to 2018. The inclusion criteria were retinal breaks that are confined to the superior 8 clock-hours, a single retinal break or multiple breaks within 1–2 clock-hours, the absence of proliferative vitreoretinopathy (PVR) grade C or D, the cooperative patients who can maintain proper positioning and clear media. We excluded the patients who were diagnosed with glaucoma, history of previous retinal surgery, other ocular disease affecting visual function and the patients who lost follow-up before 6 months.

Surgical techniques

A similar PR technique was performed in all patients. The ophthalmologists examined and identified all the retinal breaks. The risk, benefit and complications were explained to the patients. The patients signed an informed consent. The PR was performed at operating room. Topical anesthesia (0.5%Tetracaine hydrochloride) was applied. Anterior chamber paracentesis was performed. Then, 0.3 ml of C_3F_8 was injected into vitreous cavity, in other words, 3.5 millimeters peripherally from limbus for pseudophakic/aphakic patients and 4 millimeters distant from limbus for phakic patients. We used C_3F_8 instead of SF_6, because C_3F_8 has a longer duration of action (30-45 days) and more expansile than SF6.[5] Zero-point-three ml of C_3F_8 was used, because the gas bubble will slowly expand over days to a volume of 1.2 ml allowing for slow equilibration of intraocular pressure. Afterwards, patients were assigned to position individually in order to apply gas on the detached retina. Lastly, laser retinopexy was performed on postoperative day 1 or day 2 if the retina around the retinal holes were considered sufficiently flat to perform an effective laser retinopexy.

Data collection

The data collected included age, gender, duration of symptoms, history of trauma, side of RRD. Clinical examination data were collected containing best corrected visual acuity (BCVA) by Snellen chart, intraocular pressure (IOP), lens status, number of retinal breaks, location of lowest retinal breaks, RRD extension, PVR grade, macular status. Postoperative data were collected including BCVA, IOP, area of retinal detachment and complications (such as raised IOP, new or missed break subconjunctival gas, subretinal gas, macular hole, cystoid macular edema, suprachoroidal gas and cataract progression) at 1 day, 7 days, 1 month, 3 months and 6 months. The definitions used in this study are as follows: 1) a single PR success was defined as the accomplishment of anatomically attached retina after a single PR. 2) VA improvement was defined as a gain of one or more lines or final VA equal 20/30 or better.

Statistical analysis

The data was collected in a standardized form, and stored in an electronic datasheet (Microsoft Excel). Descriptive statistics were shown as mean +/- standard deviation for continuous variables. Mann-Whitney U test was chosen for comparison. Furthermore, we used frequency and percentage for categorical variables. Chi-square or Fisher's exact test was chosen for comparison. We performed multiple logistic regression analysis to determine the association between factors and success of PR. The significance level was set at $P < 0.05$. Statistical analysis was conducted using SPSS software version 22.

Result

Our study sample comprised of 68 eyes of 68 patients with primary RRD that met the inclusion criteria. Patient demographic features were summarized in Table 1. The mean age at presentation was 58.18 ± 8.79 years. The proportion of gender was not different (male 48.5%, female 51.5%). The retinal detachment was located in the right eye 51.7% of cases. The mean duration of symptoms was 19.01 ± 17.77 days. The majority of patients had no history of trauma (89.7%) and had a single retinal break (77.9%). All lowest retinal breaks were located in the superior half of the retina, while 39.7% of the lowest retinal breaks were located in the superior 2 clock hours (11-1 o' clock). The mean extension of retinal detachment was 5.18 ± 2.44 clock hours. Most patients had PVR grade B (88.2%) and phakic lens (89.7%).

The rate of a single PR success was 42.6%. Preoperative characteristics were analysed to determine if any were predictors of pneumatic retinopexy outcome (Table 2). From all of these characteristics, only location of lowest retinal breaks and extension of retinal detachment were statistically significant predictors of pneumatic retinopexy outcome. In success group, majority of retinal breaks were detected at superior 2 clock hours. (72.4% vs 15.4%, *P < 0.001*). The extension of retinal detachment in success group was less than that in failure group (4.21 vs 5.90, P < 0.002). Most patients who were pseudophakic or aphakic group tended to fail (86%) for PR, however, it was not statistically significant (*P=0.225*).

In multivariate logistic regression analysis for the successful outcome group as shown in Table 3, these predictor variables maintained statistically significance (*P <0.05*). The patients whose lowest retinal breaks were located at superior 2 clock hour were found to be 13.55 times more likely respond successfully to PR (OR=13.55, 95%Cl 3.82-48.01, *P<0.001*). Moreover, the success rate of PR was 0.722 times when the extension of retinal detachment increased for 1 clock hour (OR=0.722, 95%Cl 0.535-0.974, *P=0.033*).

Mean BCVA at 6 months was logMAR 0.391 compared to preoperative BCVA, that was logMAR1.255 (Figure 1). Out of the 29 patients from the success group, 27 (93%) patients had improvement of BCVA. There are several postoperative complications, which are new or missed break (12%), subconjunctival gas (10%), raised IOP (4%), Vitreous haemorrhage (3%) and subretinal gas (1%).

Discussion

PR is the treatment of choice for primary RRD, because it is more cost-effective than scleral buckling procedure and PPV.[6] The success rate of PR is high, ranging from 43.75% to 93.55%.[7] In this study, the success rate for a single PR was 42.6% of the cases. The lower success percentage may be due to small sample size or lesser experience of the technique.

This study showed that patients with pseudophakic/aphakic eyes were not significantly associated with PR failure. This was different from a previous study[7-9] which demonstrated that PR was less successful in pseudophakic/aphakic eyes compared to phakic eye because of multiple tiny retinal break in periphery which may be missed.[5]

Regarding the location of the lowest retinal breaks, superior 2 clock hours (11-1 o' clock) tended to achieve success PR significantly according to the study.[3] It may be due to the postoperative positioning problem that patients with superior breaks can be easily postured than those with retinal breaks outside of 11-1 o' clock. Furthermore, the extension of retinal detachment was associated with success of PR. Larger extents of retinal detachment were more likely to result in failure of PR, consistent with previous literature.[2, 10]

In our study, mean BCVA at 6 months postoperative was logMAR 0.391 (Snellen equivalent ~20/50), which was consistent with literature[11], suggesting 80% of PR cases have 20/50 or better visual acuity. Several studies have discussed complications of PR. Some of them showed that cataracts was the most complication.[12] The present study found that the most complication was new or missed retinal breaks (12%), which was also suggested in

Table 1: Demographic Features

Demographic Features	n (%)
Mean age (years)	58.18 ± 8.79
Gender	
Male	33 (48.5%)
Female	35 (51.5%)
Side of eye	
Right	39 (57.4%)
Left	29 (42.6%)
Mean duration of symptoms (days)	19.01 ± 17.77
<7	6 (8.8%)
7-27	45 (66.2%)
≥ 28	17 (25.0%)
History of trauma	
Yes	7 (10.3%)
No	61 (89.7%)
Number of retinal breaks	
Single	53 (77.9%)
Multiple	15 (22.1%)
Location of lowest retinal breaks	
12,11,1	27 (39.7%)
10,2,9,3	41 (60.3%)
Mean RRD extension (clock-hour)	5.18 ± 2.44
PVR grade	
A	8 (11.8%)
B	60 (88.2%)
Macular status	
Macular on	21 (30.9%)
Macular off	47 (69.1%)
Lens status	
Phakic	61 (89.7%)
Pseudophakic/Aphakic	7 (10.3%)

Table 2: Ocular characteristics of successful versus failed cases

Characteristics	**success (n=29)**		**failure (n=39)**		***P-VALUE***
	n	%	n	%	
Age (y)					0.095
≤60	20	69.0%	19	48.7%	
>60	9	31.0%	20	51.3%	
Mean ± S.D.	55.83 ± 10.03		59.92 ± 7.40		0.101^{M}
Gender					0.132
Male	11	37.9%	22	56.4%	
Female	18	62.1%	17	43.6%	
Side of eye					0.418
Right	15	51.7%	24	61.5%	
Left	14	48.3%	15	38.5%	
Mean duration of symptoms (days)					0.630^{F}
<7	2	6.9%	4	10.3%	
7 - 27	18	62.1%	27	69.2%	
≥ 28	9	31.0%	8	20.5%	
History of trauma					0.721
Yes	2	6.9%	5	12.8%	
No	27	93.1%	34	87.2%	
Number of retinal breaks					<0.001*
Single	22	75.9%	31	79.5%	
multiple	7	24.1%	8	20.5%	
Location of lowest retinal breaks					
12,11,1	21	72.4%	6	15.4%	
10,2,9,3	8	27.6%	33	84.6%	
RRD extension (clock-hour)					
Mean ± S.D.	4.21 ± 2.01		5.90 ± 2.51		0.002*^{M}
PVR grade					
A	4	13.8%	4	10.3%	
B	25	86.2%	35	89.7%	
Macular status					0.278
Macula on	11	37.9%	10	25.6%	
Macula off	18	62.1%	29	74.4%	
Lens status					0.225^{F}
Phakic	28	96.6%	33	84.6%	
Pseudophakic/Aphakic	1	3.4%	6	15.4%	
Pre-op BCVA (log MAR)					
Mean ± S.D.	1.26 ± 1.01		1.62 ± 1.13		0.162^{M}
Pre-op Tension					
Mean ± S.D.	11.28 ± 3.32		11.26 ± 4.09		0.896^{M}

p-value from Chi-Square test, F = p-value from Fisher's Exact Test, M= p-value from Mann-Whitney U test, * Significant at the 0.05 level

Table 3: Multivariate logistic regression analysis for successful group

Characteristics	Adjusted Odds ratio	95%CI	*P-VALUE*
Location of the lowest retinal break		3.82- 48.01	<0.001*
12,11,1	13.55		
10,2,9,3	Reference		
RRD extension (clock hour)	0.722	0.535 -0.974	0.033*

Table 4: Correlation of visual outcome with risk factors

Characteristics	Success (n=29)		VA			
			Improved (n=27)		Not improved (n=2)	
	n	%	n	%	n	%
Age (y)						
≤60	20	69.0%	20	74.1%		
>60	9	31.0%	7	25.9%	2	100%
Mean ± S.D.	55.83	± 10.03	54.93	± 9.74	68.00	± 5.66
Gender						
Male	11	37.9%	9	33.3%	2	100%
Female	18	62.1%	18	66.7%		
Mean duration of symptoms (days)						
<7	2	6.9%	2	7.4%		
7 - 27	18	62.1%	17	63.0%	1	50.0%
≥ 28	9	31.0%	8	29.6%	1	50.0%
History of trauma						
Yes	2	6.9%	2	7.4%		
No	27	93.1%	25	92.6%	2	100%
Number of retinal breaks						
Single	22	75.9%	21	77.8%	1	50.0%
Multiple	7	24.1%	6	22.2%	1	50.0%
Location of lowest retinal breaks						
12,11,1	21	72.4%	19	70.4%	2	100%
10,2,9,3	8	27.6%	8	29.6%		
RRD extension (clock hour)						
Mean ± S.D.	4.21	± 2.01	4.00	± 1.33	7.00	± 7.07
PVR grade						
A	4	13.8%	3	11.1%	1	50.0%
B	25	86.2%	24	88.9%	1	50.0%
Macular status						
Macula on	11	37.9%	10	37.0%	1	50.0%
Macula off	18	62.1%	17	63.0%	1	50.0%

Lens status						
Phakic	28	96.6%	27	100%	1	50.0%
Aphakic	1	3.4%			1	50.0%
Preop BCVA (log MAR)						
Mean ± S.D.	1.26	± 1.01	1.24	± 0.96	1.50	± 2.12
Preop Tn						
Mean ± S.D.	11.28	± 3.32	11.67	± 3.04	6.00	± 2.83

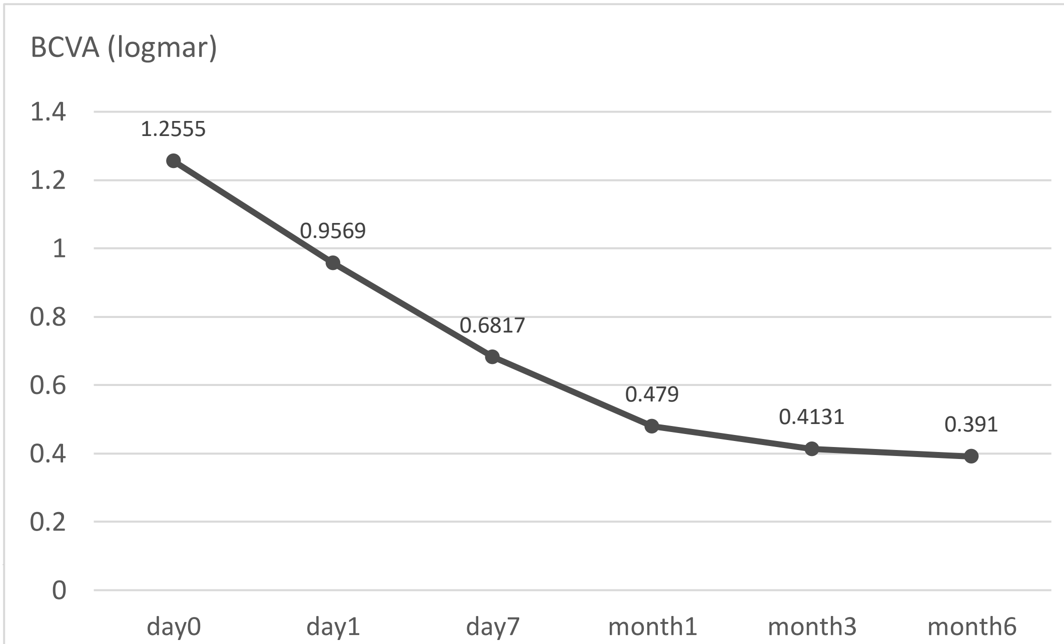

Figure 1: Functional outcomes of eyes in successful pneumatic retinopexy group

previous study.[7] They proposed that early new retinal breaks and RD developed due to traction on condensed vitreous distal to the sites of the original breaks following intraocular gas injections. Approximately 76% of new or missed breaks are located in the superior[8] clock hours of the retina, and 52% are found within 3 clock hours of the pre-existing causative breaks. Giant retinal tears rarely develop following pneumatic retinopexy.

Nonetheless, there were some limitations to our study. The retrospective design did not yield additional information which can influence the outcomes. The sample size was insufficient to define the associated factors between improved visual outcome and maintained visual outcome group. Moreover, different surgeons may have different levels of capabilities which may influence outcomes.

Conclusion

PR is a minimally invasive, low-cost and well tolerated treatment modality. PR offers distinct advantage for primary RRD over scleral buckling procedure and PPV, provided there is adequate patient selection. The rate of a single PR success in this study was 42.6% of patients. Our study results suggested that characteristics which were most likely to have benefit from PR were retinal breaks located in the superior 2 clock hours and smaller extensions of retinal detachment. Final BCVA was improved in most patients with successful PR.

References

1. Stewart S, Chan W. Pneumatic retinopexy: patient selection and specific factors. Clinical ophthalmology (Auckland, NZ). 2018;12:493.
2. Davis MJ, Mudvari SS, Shott S, Rezaei KA. Clinical characteristics affecting the outcome of pneumatic retinopexy. Archives of Ophthalmology. 2011;129(2):163-6.
3. Flaminiano RE, Sy RT, Arroyo MH, Tamesis-Villalon P. Causes of failure of pneumatic retinopexy. Philippine Journal of Ophthalmology. 2004;29(3):122-6.
4. Cohen E, Zerach A, Mimouni M, Barak A. Reassessment of pneumatic retinopexy for primary treatment of rhegmatogenous retinal detachment. Clinical ophthalmology (Auckland, NZ). 2015;9:2033.
5. Hilton GF, Das T, Majji AB, Jalali S. Pneumatic retinopexy: principles and practice. Indian journal of ophthalmology. 1996;44(3):131.
6. Goldman DR, Shah CP, Heier JS. Expanded criteria for pneumatic retinopexy and potential cost savings. Ophthalmology. 2014;121(1):318-26.
7. Chan CK, Lin SG, Nuthi AS, Salib DM. Pneumatic retinopexy for the repair of retinal detachments: a comprehensive review (1986–2007). Survey of ophthalmology. 2008;53(5):443-78.
8. Ling J, Noori J, Safi F, Eller AW, editors. Pneumatic retinopexy for rhegmatogenous retinal detachment in pseudophakia. Seminars in ophthalmology; 2018: Taylor & Francis.
9. Jung JJ, Cheng J, Pan JY, Brinton DA, Hoang QV. Anatomic, visual, and financial outcomes for traditional and nontraditional primary pneumatic retinopexy for retinal detachment. American journal of ophthalmology. 2019;200:187-200.
10. Grizzard WS, Hilton GF, Hammer ME, Taren D, Brinton DA. Pneumatic retinopexy failures: cause, prevention, timing, and management. Ophthalmology. 1995;102(6):929-36.
11. Tornambe PE, Hilton GF, Poliner LS, Brinton DA, Flood TP, Orth DH, et al. Pneumatic retinopexy: a multicenter randomized controlled clinical trial comparing pneumatic retinopexy with scleral buckling. Ophthalmology. 1989;96(6):772-84.
12. Hazzazi MA, Al Rashaed S. Outcomes of pneumatic retinopexy for the management of rhegmatogenous retinal detachment at a tertiary care center. Middle East African journal of ophthalmology. 2017;24(3):143.