Outcomes and Complications of Pneumatic Retinopexy Over a 12-Year Period

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BACKGROUND AND OBJECTIVE: To evaluate anatomic and clinical outcomes of pneumatic retinopexy for treatment of primary retinal detachment.

PATIENTS AND METHODS: Noncomparative, single-center, consecutive, interventional case series evaluating all patients treated between 2000 and 2012. Patients with less than 1 month of follow-up or coexisting neovascular age-related macular degeneration, uveitis, endophthalmitis, or prior posterior segment surgery were excluded.

RESULTS: Sixty-three eyes of 63 patients with primary retinal detachment treated with pneumatic retinopexy were included. Median follow-up was 10.3 months. Single-operation success (SOS), defined as anatomic reattachment with pneumatic retinopexy alone, occurred in 40 eyes (63%). The retina was successfully reattached in 21 of the other 23 eyes (91%) with one additional surgery. There was no difference in visual acuity outcomes between SOS and additional surgical intervention ($P = .85$). New or missed breaks were identified in 19 of 63 eyes (30%). Postoperative subretinal fluid was observed in 22 of 63 eyes (35%) and persisted at last follow-up in two of 63 eyes (3%). At final follow-up, the retina was fully attached in 97% of eyes.

CONCLUSION: Pneumatic retinopexy remains a reasonably successful option in the management of primary retinal detachment. No difference in best corrected visual acuity outcomes in eyes achieving SOS versus those requiring additional surgery was demonstrated.

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INTRODUCTION

Pneumatic retinopexy (PR) is a well-accepted technique for the repair of selected cases of rhegmatogenous retinal detachment (RD) since its original description by Hilton and Grizzard in 1985.[1,2] Historically, the criteria for considering pneumatic retinopexy include the presence of a single break (or multiple breaks all within 1 clock hour) located in the superior 8 clock hours of the retina. Necessarily, the media must be sufficiently clear to identify all breaks, and the patient must be able to position appropriately for gas tamponade of retinal breaks.[3,4] Eyes with substantial proliferative vitreoretinopathy, media opacities, or inferior breaks are typically excluded. Some have reported success with PR in conditions beyond these classic exclusion criteria, including breaks separated by greater than 1 clock hour,[5] limited proliferative vitreoretinopathy (PVR),[5] inferior retinal breaks,[6-8] giant retinal tears,[9] and mild vitreous hemorrhage or media opacities,[5,10,11] albeit with lower anatomic success rates. Reported anatomic success rates have varied from 43.7% to 93.5%, with complication rates similar to that of scleral buckling.[1-5,10-16]

Although PR generally has lower success rates compared to scleral buckling (SB) and pars plana vitrectomy (PPV),[3,17,18] it offers the opportunity to avoid an operating room procedure and its incumbent surgical and anesthesia risks. It has been reported to be at least as cost-effective, and some studies show no disadvantage to final visual outcomes even if additional surgeries are required.[3,10,11]

The purpose of the current study is to evaluate both anatomic and clinical outcomes in a population that underwent pneumatic retinopexy for primary retinal detachment in an academic referral center.

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TABLE 1

Clinical Characteristics in Patients Undergoing Pneumatic Retinopexy for Primary Retinal Detachment

Characteristics	All Patients, N (%)	Single-Operation Success, N (%)	Additional Surgery Required, N (%)	*P* Value
Location of retinal break(s)				
Superior	17 (27)	10 (16)	7 (11)	.35*
Superonasal/temporal	43 (68)	29 (46)	14 (22)	
Horizontal	3 (5)	1 (2)	2 (3)	
Inferior	0	0	0	
Number of Breaks				
One	54 (86)	32 (51)	22 (35)	.09*
Multiple	9 (14)	8 (13)	1 (2)	
Clock hours of retinal detachment				
0 – 3	41 (65)	27 (43)	14 (61)	.80*
4 – 6	18 (29)	11 (17)	7 (11)	
7 – 12	4 (6)	2 (3)	2 (3)	
Vitreous hemorrhage on presentation	7 (11)	6 (10)	1 (2)	.19*
Lattice degeneration	16 (25)	9 (14)	7 (11)	.49*
Macula attached	47 (75)	29 (46)	18 (29)	.61*
Retinopexy used				
Cryopexy	34 (54)	19 (30)	15 (24)	.08*
Laser	23 (37)	18 (29)	5 (8)	
Both	4 (6)	3 (5)	1 (2)	
None	2 (3)	0	2 (3)	
Gas used				
SF6	9 (14)	6 (10)	3 (5)	.83*
C3F8	54 (86)	34 (54)	20 (32)	
Lens status				
Phakic	49 (78)	31 (49)	18 (54)	.92*
Pseudophakic	14 (22)	9 (14)	5 (8)	
Number of additional surgeries required†				
1			21 (91**)	
2			1 (4**)	
3			1 (4**)	

**Chi-squared test*
*** Percentage based on 23 total eyes that required additional surgery.*
†Additional surgeries included pars plana vitrectomy, scleral buckling, or a combination of the two.

PATIENTS AND METHODS

The study protocol was approved by the institutional review board of the University of Miami Miller School of Medicine. This consecutive, noncomparative interventional case series included all patients who underwent PR for the management of primary rhegmatogenous RD at the Bascom Palmer Eye Institute between January 1, 2000, and December 31, 2012. Patients were excluded if there was prior posterior segment surgery, uveitis, endophthalmitis, or neovascular age-related macular degeneration (AMD), or follow-up less than 1 month.

PR was performed in the outpatient clinic by six attending retinal surgeons at the institute. The decision to proceed with pneumatic retinopexy was made by the individual treating physician and not by a standardized, prospective protocol. However, 56 of 63 eyes met the classic inclusion criteria previously described:[1,2] all eyes had breaks located within 1 clock hour in the superior 8 clock hours of the retina. In the seven eyes exceeding the classic criteria, there was mild vitreous hemorrhage that did not preclude a full peripheral examination.

PR technique was performed as previously described.[1] The decision to use cryotherapy, laser retinopexy, or both and the type of gas (C3F8 or SF6) for tamponade was made by the individual treating surgeon. If PR failed, patients typically underwent SB surgery, PPV, or both as a secondary procedure for RD.

PR single-operation success (SOS) was defined as retinal attachment at 6-month follow-up or last follow-up if less than 6 months, without additional

TABLE 2

Visual Acuity Outcomes in Patients Undergoing Pneumatic Retinopexy for Primary Retinal Detachment

	Preop BCVA, Median (Range)	BCVA at Last F/U, Median (Range)	No. (%) Eyes With ≥ 20/40 BCVA at Last F/U	No. (%) Eyes With <20/200 BCVA at Last F/U
All eyes	20/30 (20/15 - HM)	20/25 (20/20 - LP)	50 (81)	4 (6)
Macula-on eyes (n = 47)	20/25 (20/15 - 20/200)	20/25 (20/20 - 20/80)	39 (83)	0
Macula-off eyes (n = 16)	20/140 (20/20 - HM)	20/40 (20/20 - LP)	11 (67)	4 (25)
P value	< .001**	.08**	.22*	< .001*
Single-operation success eyes (n = 40)	20/30 (20/15 - HM)	20/25 (20/20 - LP)	33 (85)	2 (5)
Eyes requiring additional surgery (n = 23)	20/30 (20/20 - HM)	20/27.5 (20/20 - CF)	17 (71)	2 (8)
P value	.87**	.85**	.19*	.61*

BCVA = best corrected visual acuity; F/U = follow-up; HM = hand motion; LP = light perception; CF = counting fingers.
**Chi-squared test*
***Kolmogorov-Smirnov test; excludes cataract development*

surgery required. A new retinal break or RD after the first 6 months was considered an independent event and not included as a failure of PR.

Patient charts were retrospectively reviewed to obtain patient demographic information, clinical examination details, other procedures, and complications. Specific data collected included age, sex, affected eye, days since symptom onset, number and location of breaks, clock hours of RD, vitreous hemorrhage on presentation, lattice degeneration, status of the macula, retinal adhesive modality, gas used, lens status, visual acuity outcomes, reported complications, and number of additional surgeries required.

Statistical analysis was performed using SPSS version 21. Univariate comparisons between success and failure were performed using a two-sided Student's *t*-test or Kolmogorov-Smirnov test for continuous variables and the chi-squared test or Fisher's exact test for categorical variables. A *P* value of .05 or less was considered statistically significant in our analysis.

RESULTS

Patient Demographics

Over the 12-year study interval, 99 patients underwent PR for primary RD. Thirty-six eyes were excluded from the current study due to the following reasons: prior PPV (14), previous SB (seven), history of uveitis (six), neovascular AMD (four), prior endophthalmitis (one), and less than 1 month of follow-up information (four). Thus, 63 eyes of 63 patients were included in this study.

Median age was 60.3 years (standard deviation: 9.7), with a median follow-up time of 10.3 months (range: 1 to 97.1 months). Thirty-six (57%) patients were male, and 35 eyes (57%) were right eyes. Fifty-two patients (81%) underwent PR within 1 week of symptom onset.

Clinical Characteristics

A single break was present in 54 eyes (86%). Sixty-eight percent of breaks were located in the superotemporal (10:00 to 11:30) and superonasal (12:30 to 2:00) quadrants, and 24% were located superiorly (11:30 to 12:30). Forty-one eyes (65%) had less than 3 clock hours of RD; four eyes (6%) had greater than 7 clock hours of detachment. Vitreous hemorrhage was noted before PR in seven eyes (11%) but was sufficiently mild to allow uncompromised peripheral examination of the retina. Lattice degeneration was noted in 16 eyes (25%). At the presenting clinical examination, the macula was attached in 47 eyes (75%). Forty-nine eyes (78%) were phakic, and 14 eyes (22%) were pseudophakic.

The retinal breaks were treated with cryopexy (34 eyes; 54%), laser (23 eyes, 37%), or both (four eyes, 6%). The gas tamponade was with C3F8 (54 eyes; 86%) or SF6 (nine eyes; 14%).

Anatomic and Visual Outcomes

Comparing SOS eyes to those that underwent additional surgery, no preoperative characteristics were associated with better or poorer anatomic success rates (Table 1, page 133). SOS occurred in 40 eyes (63%); eight eyes (13%) never fully reattached after PR, and 15 eyes (24%) were initially attached but

subsequently re-detached. Median interval to re-detachment after initial PR was 20 days (range: 4 to 160). Of the 23 eyes undergoing additional surgery via PPV, SB, or both, 21 (91%) achieved successful reattachment with one surgery. The initial surgery after PR was SB in nine eyes (39%), PPV in three eyes (13%), and combined SB/PPV in 11 eyes (48%). One patient required two additional surgeries and one patient required three surgeries to attain retinal reattachment. Sixty-one eyes (97%) had complete retinal attachment at last follow-up. Two eyes (3%) had mild persistent inferior subretinal fluid, but the macula remained attached through last follow-up and no additional surgery was performed.

Two eyes had late retinal re-detachment at 460 and 3,325 days, respectively. Both of these detachments were considered to be independent events and not failures from initial PR and are included as SOS eyes.

Median best corrected visual acuity (BCVA) for all eyes on presentation was 20/30 (range: 20/15 to hand motion), which improved to a median BCVA of 20/25 (range: 20/20 to light perception) at last follow-up examination. Final BCVA of ≥ 20/40 occurred in 50 eyes (81%).

TABLE 3

Adverse Outcomes in Patients Undergoing Pneumatic Retinopexy for Primary Retinal Detachment

	All Patients, N (%)	Single-Operation Success, N (%)	Eyes Requiring Additional Surgery, N (%)	*P* Value
Subretinal fluid				
Persistent	2 (3)	2 (3)	0	< .001*
Resolved	20 (32)	4 (6)	16 (25)	
New or missed break	19 (30)	5 (8)	14 (22)	< .001*
Reopening of original break	1 (2)	0	1 (2)	.17
PVR	1 (2)	0	1 (2)	.18
Epiretinal membrane	10 (16)	4 (6)	6 (10)	.09*
Subretinal gas	1 (2)	0	1 (2)	.18*
Subsequent cataract surgery	12 (19)	3 (5)	9 (14)	.002*

**Chi-squared test*

Median preoperative BCVA was 20/30 for both the SOS and the additional surgery group. Median last follow-up BCVA was 20/25 in the SOS group and 20/27.5 for eyes requiring additional surgery at the last available examination (P = .85). BCVA ≥ 20/40 was attained in 85% in SOS eyes compared to 71% of eyes requiring additional surgery (P = .19).

Persistent or recurrent subretinal fluid occurred in 22 eyes (35%) and was the indication for additional surgery in 16 eyes. A new or missed break was identified in 19 eyes (30%). The breaks were noted 72 hours after initial treatment in five eyes, and additional cryotherapy or laser retinopexy was performed to prevent recurrent RD. A new or missed break resulted in re-detachment after initial PR in 14 eyes. In one eye, gas migrated into the subretinal space resulting in failure. Recurrent RD with PVR occurred in one eye. An epiretinal membrane occurred in 10 eyes (16%) (Table 3).

The anatomic success rates were similar during the first half (19 of 30 eyes [63%] between 2000 and 2006) and during the second half (21 of 33 eyes [64%] between 2007 and 2012) of the study interval (P = .98). Figures 1 to 3 illustrate successful management of a primary RD with PR alone.

DISCUSSION

The current longitudinal study demonstrates a 63% single-operation success rate with pneumatic retinopexy alone. All eyes achieved closure of the retinal breaks with macular reattachment, and two eyes had persistent subclinical inferior subretinal fluid. While on the lower range of reported success rates, this series concurs with the preponderance of the medical literature,[1,10,11,13-15] suggesting that PR success rates have converged to a fairly stable and uniform success rate. Thus, PR remains a useful element of the armamentarium of retinal reattachment tools.

The largest review evaluating anatomic success with PR reported 4,131 eyes from 81 independent studies in the world literature between 1986 and 2007.[15] The average SOS in that review was 74.4% but ranged from 43.7% to 93.5%. Final retinal reattachment was 96.1%. Additionally, the seminal randomized, controlled trial by Tornambe et al reported a 73% SOS rate with PR.[3] Two studies published in

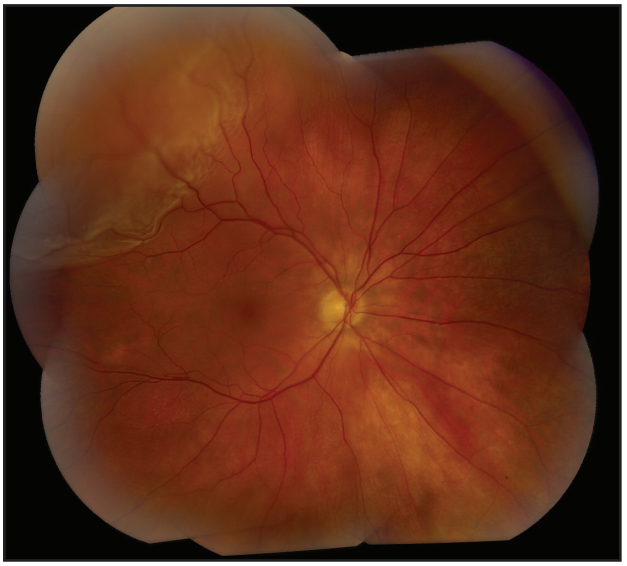

Figure 1. Montage posterior segment photo of a superotemporal retinal detachment from a horseshoe tear (not visualized in photo).

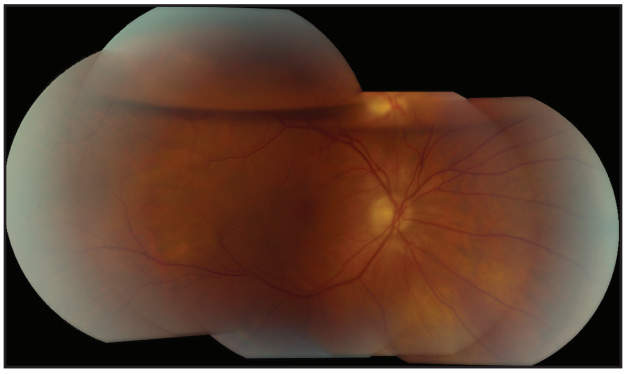

Figure 2. The retina is reattached, and a superior C3F8 bubble provides adequate tamponade prior to laser retinopexy.

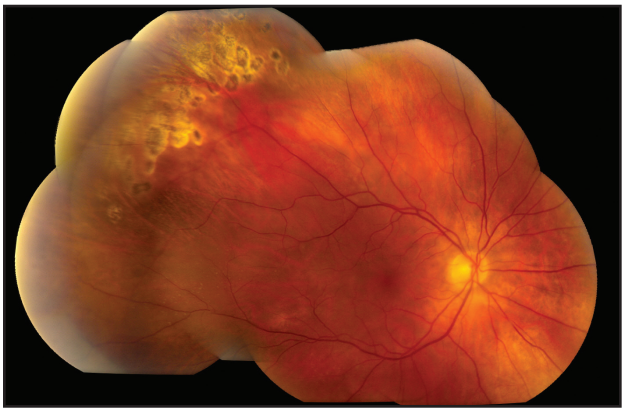

Figure 3. Three months after pneumatic retinopexy, the retina remains flat with superotemporal laser-induced chorioretinal scars.

2013 have reported SOS rates of 66.3%[19] and 60.7%,[20] respectively, which are consistent with the SOS from the current study.

There are some factors that may contribute to the variation of SOS rates in the literature. First, the definition of SOS varies among different studies. The definition of anatomic success in the current study was consistent with that of the randomized clinical trial by Tornambe and Hilton: retinal reattachment at 6 months after only pneumatic retinopexy and/or additional laser, cryopexy, or repeat gas injection within the first 72 hours. Some studies did not incorporate this 72-hour treatment window of additional procedures into their definition of SOS,[5,14] resulting in lower SOS, and others did not clarify what additional nonsurgical procedures were incorporated into their definition of SOS.[11]

A second possible confounding factor is subretinal fluid, which occurred after PR in 22 eyes (35%) in the current series. Four eyes had spontaneous resorption of the fluid, 16 eyes underwent definitive surgical intervention, and two eyes had persistent inferior subretinal fluid that did not require surgical intervention. While persistent inferior subretinal fluid can often be observed, especially if not encroaching on the macula, the decision to pursue early surgical intervention versus continued observation (with the anticipation of spontaneous resorption) can influence reported SOS rates.

A recent report from the European literature evaluated treatment outcomes in 4,179 patients with uncomplicated rhegmatogenous RD. Of these RDs, 115 (2.7%) were managed by PR.[16] Notably, the authors reported similar success rates to SB when a retinal hole was present but lower success rates in the setting of flap tears. In the current series, all tears were flap tears, which may partially account for the somewhat lower SOS rate.

It has been suggested that the success of PR is increased for some surgeons through a learning curve or case selection.[5] In the current study, the rate of SOS was remarkably similar throughout the study interval and was not overtly different among participating attending surgeons. In fact, the surgeons in the current study generally carried a bias against PR, using it only in selected patients and circumstances. Still, the success rates are fairly convergent, now 20 years after the introduction of PR.

Certain preoperative factors have previously been shown to influence the success of anatomic reattachment. Pseudophakia or aphakia,[3,5,10] larger extent of RD,[5,11] an increased number of breaks,[5] vitreous hemorrhage,[11] and use of cryotherapy[11] have all been associated with reduced SOS rates. There was a suggestion of lower SOS rates with cryotherapy, but the

current study was too small to meaningfully address these associations. The practitioners in the current series selected cases in accordance with a previously defined published standard. Thus, the majority of eyes were phakic, had only one retinal break, had less than 3 clock hours of RD, and had minimal or no vitreous hemorrhage.

Median BCVA was similar in the SOS versus additional surgery groups: 20/25 and 20/27.5, respectively. This finding is consistent with several prior reports and supports the consensus that initial PR does not disadvantage final BCVA if subsequent surgery is required.[1-5,10,12,13,15]

This study is limited by its retrospective design and heterogeneity in clinical practice from multiple surgeons who may have introduced slightly different techniques and case selection principles.

In conclusion, the current study supports the continued role for PR as an important option for the management of selected cases of RD adhering to the classic PR inclusion criteria but demonstrates an SOS rate that is somewhat below that of other surgical options. Its role in final reattachment success is contingent upon case selection, excellent patient compliance, and close surveillance during follow-up for recurrence.

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