ORIGINAL ARTICLE

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Causes of failure of pneumatic retinopexy

ABSTRACT

Objective

To determine the causes of failure in eyes that underwent pneumatic retinopexy at the University of the Philippines-Philippine General Hospital (UP-PGH).

Methods

A retrospective review of pneumatic retinopexy procedures performed at the UP-PGH from January 1996 to December 2002 was undertaken. Seventeen cases were analyzed as to preoperative and intraoperative variables: age; sex; preoperative visual acuity; presence of proliferative vitreoretinopathy(PVR); extent of retinal detachment; presence of macular detachment; presence, number, and type of lattice degeneration; previous cataract surgery; surgeon factor; and intraoperative use of cryotherapy. Two-tailed Fisher's exact test and Chi square test were used in the analysis of statistical significance.

Results

The following variables were shown to be significantly correlated with failure: eyes with breaks outside the 11-1 o'clock meridians ($p = 0.02$), eyes with less than or equal to 3 quadrants of retinal detachment ($p = 0.05$), and preoperative visual acuity worse than 5/60 ($p < 0.100$).

Conclusion

Failure in eyes with retinal breaks outside the 11-1 o'clock meridians suggested poor patient compliance with regard to postoperative posture. In eyes with less than or equal to three quadrants of detachment, failure may ensue as a result of spillover of subretinal fluid to uninvolved quadrants. Future success with pneumatic retinopexy will rely ultimately on careful patient selection, surgeon familiarity with the technique, and patient cooperation.

Key words: Pneumatic retinopexy, Retinal detachment, Proliferative vitreoretinopathy

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INTRODUCED by Hilton and Grizzard[1] in 1986, pneumatic retinopexy uses intravitreal gas to temporarily tamponade retinal breaks in rhegmatogenous retinal detachments. The reported single-operation success rates in a series of at least 100 eyes performed between 1986 and 1990 ranged from 69% to 84%.[2] The study identified the following causes of failure: new or missed breaks (14.9%), reopened initial breaks (11.2%), and breaks that never closed (4.6%). Risk factors for failure were male gender, preoperative visual acuity worse than 20/50, four quadrants or total retinal detachment, aphakia or pseudophakia, and additional pathologic findings. Despite the relatively low success rates as initial intervention, pneumatic retinopexy remains a useful alternative to scleral buckling. It offers reduced tissue trauma, less complications related to surgical technique, and lower expense.[1,3] Disorders of muscle balance and changes in refraction are not experienced.[4] Overall morbidity with pneumatic retinopexy is likely to be lesser than that of scleral buckling.[5]

This study evaluated the causes of and determined the risks for failure of pneumatic retinopexy done at the University of the Philippines-Philippine General Hospital (UP-PGH).

METHODOLOGY

A retrospective review of pneumatic retinopexies performed at the UP-PGH from January 1996 to December 2002 was undertaken. Twenty-six cases of unilateral pneumatic retinopexy operations were identified. Data were extracted from patient charts and recorded in a computer database. These included patient characteristics (age, sex, and laterality) and preoperative and surgical variables.

Preoperative variables
- Duration of blurring of vision prior to surgery
- Time between consultation and surgery
- Visual acuity
- Intraocular pressure
- Refraction
- Proliferative vitreoretinopathy (PVR) classification
- Extent of retinal detachment
- Presence of macular detachment
- Presence, number, type, and location of breaks
- Approximate size of breaks (e.g. <1 clock-hour)
- Presence and location of lattice degeneration
- Previous cataract surgery
- History of trauma

Surgical variables
- Type of anesthesia
- Surgeon (consultant, fellow, resident)

- Amount and concentration of perfluoropropane (C_3F_8) injected
- Anterior chamber paracentesis
- Use of cryotherapy or postoperative laser photocoagulation
- Intraoperative complications

The types and number of surgeries required to attach the retina and the causes of failure were recorded. Preoperative and postoperative visual-acuity changes were computed using the logMAR scale.

Most of the data on preoperative variables like proliferative-vitreoretinopathy (PVR) classification and number and location of breaks were extrapolated from the preoperative drawings.

Case records analyzed were those of eyes with rhegmatogenous retinal detachment that had been treated with pneumatic retinopexy as a primary procedure. All cases fulfilled the indications for the use of pneumatic retinopexy, which were a single break no larger than 1 clock-hour located within the superior 8 clock-hours of the retina or a group of small breaks within 1 clock-hour and no PVR worse than Grade B.

Success was defined as anatomic reattachment achieved with a single operation and maintained for a minimum of 30 days. Patients with persistent detachment for 12 days or more were classified as failures.

Nine cases were excluded from the analysis for the following reasons: large breaks (> 1 clock-hour in size, 2 cases), 2 small holes that were 2 clock-hours apart (1 case), PVR Grade CP type 1 involving 2 clock-hours of the ocular fundus (2 cases), and short duration (< 2 weeks) of follow-up (4 cases).

The causes of failure of retinal attachment after a single pneumatic retinopexy procedure were determined. Two-tailed Fisher's exact test and Chi square test were used in the analysis of statistical significance.

RESULTS

Seventeen cases were analyzed, 11 (65%) right eyes and 6(35%) left eyes. There were 12 (71%) males and 5(29%) females with mean age of 45.6 ± 14.6 years. The mean duration of blurring of vision prior to consultation was 46.0 ± 56.0 days. The mean number of days from consultation to surgery was 6.5 ± 9.5.

Only 6 of 17 eyes were attached with a single operation, giving a success rate of 35%. This included one case that underwent a second C_3F_8 injection 2 days after the initial pneumatic retinopexy procedure. Out of the 11 eyes that failed the initial procedure, 9 were reoperated (5 by scleral buckling, 3 by combined pars plana vitrectomy with scleral buckling, and 1 by pars plana vitrectomy with lensectomy), of which 8 were reattached successfully for a success rate

of 88.9%. The lone failure underwent a combined pars plana vitrectomy with scleral buckling. Two of the scleral buckling surgeries used adjunctive C_3F_8. If the two cases that did not have subsequent surgery were excluded, the ultimate success rate would be 93.3% (14 of 15 eyes ultimately reattached).

The causes of failure were the inability of the primary break to close in 7 cases (41%) and new or missed breaks in 4 (24%).

The following preoperative and surgical variables were significantly correlated with failure: eyes with breaks outside the 11-1 o'clock meridians ($p = 0.02$), eyes with less than or equal to 3 quadrants of retinal detachment ($p = 0.05$) and preoperative visual acuity worse than 5/60 ($p < 0.100$) (Table 1). Five out of the six eyes where the initial operation was successful had preoperative macular detachment. All these had improvement in visual acuity, showing a logMAR difference of 0.37 to 1.30 (logMAR preop – logMAR final). The eye without macular detachment suffered visual loss (logMAR difference = –0.14) secondary to cystoid macular edema. All eyes that were subsequently reattached with a second surgery had improved vision. The logMAR difference ranged from 0.7 to 1.86.

DISCUSSION

In this study, the single operation attachment rate with pneumatic retinopexy of 35% is far below that reported in literature (60 to 84%).[2] Similarity, in a multicenter study comparing pneumatic retinopexy with scleral buckling, 2 centers each had a single-operation success rate for pneumatic retinopexy of 43% (3 of 7 eyes).[6] This underscores the effect of a small sample size on the outcome. Furthermore, a low success rate in the small series may imply less experience with the technique. The success in the larger series reported may reflect an increase in the success rate with familiarity of the procedure.

The ultimate success rate in this study, defined as successful reattachment of the retina after at least 2 surgeries, was 93.3%, comparable with those in other reports (92 to 100%).[2, 3, 6, 7] This finding validated the conclusion that eyes which fail the initial pneumatic retinopexy procedure can be reattached with subsequent surgery and that an initial attempt with pneumatic retinopexy does not lower the chances of ultimate anatomic success.[2, 6]

Failure in eyes with retinal breaks outside the 11-1 o'clock meridians was found to be statistically significant compared to eyes with breaks within the 11-1 o'clock meridians. Grizzard and associates found no similar correlation.[2] This finding in our study may suggest postural problems by the patients with retinal breaks outside the superior 2 clock-hours. These patients were required to tilt their head or lie on their side unlike those with breaks within the 11-1 o'clock meridians who maintained an upright posture most of the time.

In the 3 eyes with total retinal detachment, the retina was reattached with the initial procedure. Failure was significantly correlated in eyes with less than 4 quadrants of retinal detachment. A possible explanation is the spillover of subretinal fluid to the attached areas. This phenomenon has been observed by various authors.[8, 9, 10] Yeo et al.[8] first reported the extension of the detachment to the previously uninvolved macula. Poliner et al.[11] first documented the occurrence of new retinal detachment in previously uninvolved quadrants within 2 days of the pneumatic retinopexy procedure. Chen et al.[10] observed the shift of subretinal fluid leading to failure by opening a break in a previously attached area of the retina. According to Algvere et al.,[9] the most serious and only significant complication in their series was the development of rhegmatogenous or tractional detachments in previously uninvolved inferior retinal quadrants in 24% of cases. These were attributed to vitreous inflammation induced by the gas, ocular motion, patient posture, among other causes.

A preoperative visual acuity worse than 5/60 correlated with failure at $p < 0.10$. A vision of worse than 6/15 (20/50) was noted by other authors[2] and believed to be also a risk factor in scleral buckling.

Grizzard et al.[2] found that failure in eyes with PVR was statistically significant compared with failure in eyes without PVR, making them conclude that eyes with early signs of PVR, such as star folds or rolled posterior edges, should not be subjected to pneumatic retinopexy. We found no such correlation. A possible reason is that Grizzard, et al., included patients with stage C-1 PVR. In our study, the 2 eyes excluded from the analysis because of C-1 PVR had previous cataract surgery and failed the initial pneumatic retinopexy procedure. Both remained detached after 2 to 5 subsequent surgeries.

The success of the procedure was not correlated with age and sex. On the contrary, Grizzard et al.[2] found a significant failure correlation among male patients. This was attributed to patient's poor maintenance of correct postoperative posture or to differences in ocular pathology. There have been no reports regarding the effect of age on the outcome.

The possibility that the presence of lattice degeneration could affect the anatomic outcome has not been previously suggested. Although there was no statistically significant correlation of failure with the presence of lattice associated with the primary breaks in this study, the procedure failed in all 5 eyes with breaks associated with lattice. The failure could be related to inability to visualize the breaks within the lattice or the development of new breaks within the lattice.

Twenty-four percent of the eyes in our study had new

Table 1. **Eyes in which initial pneumatic retinopexy procedure failed.**

Variables	No. of eyes	% Failed	p value
Age			
19-35	6	50.0	0.35[3a]
41-66	11	72.7	
Sex			
Male	12	58.3	0.39[3a]
Female	5	80.0	
Pre-operative VA			
Worse than 5/60	13	76.9	0.06[3b*]
6/60 or better	4	25.0	
PVR Grade			
No PVR	6	50.0	0.35[3a]
PVR A, B	11	72.7	
Quadrants detached			
4 and total	3	0	0.05[4b]
1, 2, 3	14	78.6	
Macular status			
Macula attached	2	50.0	1.00[4a]
Macula detached	15	66.7	
No. of breaks			
1	16	68.8	0.35[4a]
2	1	0	
Location break			
11-1 o'clock	7	28.6	0.02[4b]
Elsewhere	10	90.0	
Location			
Anterior	13	69.2	0.58[4a]
Posterior	4	50.0	
Type of break			
Hole	11	63.6	1.00[4a]
Tear	6	66.7	
Break associated with lattice			
Yes	5	100.0	0.17[4a]
No	12	50.0	
Lattice found elsewhere			
Yes	3	66.7	1.00[4a]
No	14	64.3	
Previous cataract surgery			
Yes	3	100.0	0.61[4a]
No	14	57.1	
Surgeon[1]			
Consultant	4	75.0	0.45[4a]
Fellow	10	50.0	
Resident	2	100.0	
Intraoperative cryotherapy[2]			
Yes	9	55.6	0.33[4a]
No	4	100.0	

[1]One lacking entry for "surgeon"
[2]Eyes with posterior breaks excluded
[3]Chi-square test
[4]Two-tailed Fisher's exact test
[a]Not statistically significant
[b]Statistically significant
[*]Statistically significant at *p* < 0.100

or missed breaks. Other series reported 7 to 23%.[2-4, 6-7, 9-10] Some investigators believed that unrelieved vitreous traction was the major cause of new tears.[4, 7] Extension of the original tears had been noted after gas injection.[4] Others theorized it as the result of transmitted vitreous traction 180 degrees away from the gas bubble.[7]

In a review by Grizzard et al.,[2] out of 161 failures in 676 eyes, the immediate cause of failure was new or missed breaks in 12.8%, reopened breaks in 3.6% and breaks that never closed in 1.0%. In our series, inability to close the primary break was the most frequent cause of failure in 7 of 11 failures (41%). Nonclosure of the break was believed to be secondary to persistent vitreous traction (3 cases) and inadequate scar formation around the break (1 case). There were three other failures resulting from nonclosure of the break. Whether these failures were the result of delayed absorption of the subretinal fluid remains in question. However, delayed absorption of subretinal fluid should not be mistaken for failure of the procedure.[10]

Previous cataract surgery did not correlate with failure. In this study, the initial pneumatic retinopexy failed in all eyes with a history of cataract surgery, including the 2 excluded from the analysis. Of the 3 eyes included in the analysis, all had no posterior capsule, 2 were pseudophakic (PCIOL) and one was aphakic. The poor surgical outcome of pneumatic retinopexy for pseudophakic and aphakic eyes is well documented. Success rates in these cases are variable, ranging from 25% to 67%.[2, 4, 6, 9-10] Nevertheless, Tornambe and Hilton[6] still recommend pneumatic retinopexy in pseudophakic and aphakic patients regardless of whether the posterior capsule is intact or not, as most of these eyes that failed the procedure initially were ultimately reattached with good vision.

Surgeon experience was also evaluated as a possible factor but did not correlate with success.

Although the procedure failed in all eyes that were not treated with preoperative cryotherapy, our study failed to show any significant correlation. Similarly, Grizzard et al.[2] did not find any significant difference in eyes treated with cryotherapy, but these were compared to eyes treated with postinjection focal laser. In our study, the two groups were not compared.

Brinton and Hilton[12] outlined the indications for the use of cryopexy and laser. Cryopexy is generally recommended for eyes with small or hard-to-find breaks, media opacities, pigment atrophy, far peripheral tears, and 11 to 1 o'clock tears with no laser indirect ophthalmoscope available. Laser delivered through an indirect ophthalmoscope or by the slit-lamp is performed in a two-session procedure for very posterior and extensive or large breaks (to minimize retinal pigment epithelial dispersion). In our study, two eyes with posterior breaks were successfully treated with laser delivered by slit-lamp alone. Both

cryotherapy and laser were applied in four eyes. One eye was successfully attached and 3 failed. To our knowledge, there have been no reports on the use of a combination of cryotherapy and laser.

Potential complications of pneumatic retinopexy are cataract, glaucoma, vitreous inflammation, endophthalmitis,[1] subretinal gas,[13] and vitreous hemorrhage.[3] Cataract may be induced by direct trauma to the lens during injection or secondary to the cataractogenic effect of the gases.[14] Glaucoma may result from the expansion of perfluoropropane (C_3F_8) gas, which is most rapid in the first six hours after injection.[1] No intraoperative complications were noted in this series.

Postoperative PVR was documented in only one patient in this study. Other series reported 3 to 10%.[1, 3, 6-7, 9-10] In the randomized controlled clinical trial comparing pneumatic retinopexy and scleral buckling by Tornambe and Hilton,[6] PVR developed with similar frequency (3 and 5%) in both groups. They suggested that neither perfluoropropane nor sulfur hexafluoride stimulated the development of PVR in the human eye with RD. Pigments in the vitreous similar to "tobacco dust" were seen. These pigments were frequently seen with cryosurgery and not a specific feature of gas injection.[1]

Future success with pneumatic retinopexy will rely ultimately on careful patient selection, surgeon familiarity with the technique, and patient cooperation.

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