Objective: To assess the outcome and risk factors for failure of pneumatic retinopexy (PR) in eyes with primary rhegmatogenous retinal detachment (RRD).

Methods: Data of patients who underwent PR for the repair of primary RRD, from January 1, 2000, through June 30, 2011, were retrieved from medical records and retrospectively analyzed. Patients with a follow-up time of less than 4 months were contacted and invited for examination. Patients with less than 2 months of follow-up were excluded. Successful cases (attached retina at 2 months after the PR) were compared with failures. A subgroup analysis was performed comparing successful and failed cases of RRD that were reattached with only 1 additional operation.

Results: Two hundred seventy-six eyes (271 patients) underwent PR during the study period, of which 258 eyes (93.5%) were included in the study. Mean (SD) follow-up time was 36.1 (39.4) months; only 23 eyes (8.9%) had a follow-up of less than 4 months. Successful reattachment at 2 months was achieved in 171 eyes (66.3%). Sixty-seven eyes (77.0% of the failed cases) were reattached with only 1 additional operation and final anatomical success was achieved in 256 eyes (99.2%). Successful cases had significantly better final vision (P= .002) and fewer postoperative complications (P=.026). However, nonsignificant differences were found between the primary failure PR cases that underwent only 1 additional operation and the successful cases (P=.073).

Conclusions: Pneumatic retinopexy is a good surgical option for primary RRD. Most cases of primary failure are reattached with 1 additional procedure and have excellent final vision.


Pneumatic retinopexy (PR) was first introduced in the mid-1980s, independently by Dominguez1 and by Hilton and Grizzard,2 for the repair of rhegmatogenous retinal detachment (RRD). It consists of retinopexy of retinal breaks with intravitreal injection of gas into the vitreous cavity followed by postoperative positioning. Indications for PR, as described by Tornambe and Hilton3 in the multicenter, randomized, controlled clinical trial comparing PR with scleral buckling, included the presence of 1 or more retinal breaks within 1 clock-hour of the retinal arc in the upper two-thirds of the retina and sufficiently clear media to rule out the presence of other retinal breaks. Later on, indications for surgery have expanded to include multiple breaks in multiple quadrants, larger retinal breaks, and moderate proliferative vitreoretinopathy (PVR).4-5 With time, owing to its minimally invasive nature, cost-effectiveness, and relatively technical simplicity, PR has become commonly used in clinical practice. However, alongside its widespread popularity, the reported complications associated with PR have also grown.6-13 In addition, PR was reported to be less efficient in specific conditions, including in nonphakic eyes, in eyes with poor preoperative visual acuity (VA), in large detachments, and in cases with multiple retinal breaks.7,13-15 Furthermore, a broad range of anatomical success rates of 53% to 100% after a single PR procedure were reported.12 Together these reservations gave rise to a heated debate between those in favor and those against PR for RRD. The objective of this study was to investigate, in a relatively large case-series, the risk factors for failure and outcomes of PR surgery for the repair of primary RRD, with special attention to differences in out-
comes between successful cases and failed cases that underwent only 1 additional reattachment operation.

METHODS

STUDY DESIGN

The medical records of patients who underwent PR for primary RRD in The Goldschleger Eye Institute, The Sheba Medical Center, Tel Aviv, Israel, were reviewed retrospectively. The review period extended from January 1, 2000, through June 30, 2011. Inclusion criteria were primary RRD, PR as the primary procedure, and a follow-up period of at least 2 months. Two months’ limit was chosen because by this time the gas bubble is fully absorbed.

These data retrieved from the medical records included the following: age, sex, ocular history, laterality, duration of symptoms, axial length, spherical equivalence, preoperative clinical examinations, intraoperative data, and follow-up examination results, additional surgical procedures needed, and complications. The extent of the detachment was marked in clock-hours, the number and location of breaks and the involvement of the macula were also noted. Retinal breaks were defined as inferior if located between 4- and 8-o’clock positions (via the 6-o’clock position). All other breaks were defined as upper temporal or upper nasal.

Patients with less than 4 months’ follow up were contacted and invited for examination to obtain longer follow up. At this examination, the ocular history since his or her last visit was obtained, and he or she underwent a full ophthalmic examination. Patients who could not come or refused to be reexamined were asked to provide details of their follow up. In case they did not have a detailed medical report, we asked permission to contact the clinic at which they were followed up and retrieve their data. All telephone calls were executed by 2 investigators (I.D.F. and M.E.). The study protocol was approved by the local institutional review board and in concordance with the Declaration of Helsinki.

STUDY DEFINITIONS

Success: Attached retina at least 2 months after the PR without additional procedures.

Primary failure: Retinal redetachment within 2 months from PR or persistent retinal detachment after PR, which required an additional reattachment procedure.

Late retinal redetachment: Retinal redetachment after successful reattachment, observed at least 2 months after the PR.

Single surgery anatomical success (SSAS): Reattachment of the retina with PR, not requiring any additional retinal procedures until the end of the follow-up period.

Final anatomical success: attached retina at the final follow-up visit.

SURGICAL TECHNIQUE

All procedures were executed under subconjunctival anesthesia. Pneumatic retinopexy was performed using a technique similar to that previously described by Hilton and Grizzard. After transconjunctival cryopexy to the retinal breaks, 0.3 to 0.4 mL of perfluoropropane gas was injected intravitreally. Drainage of aqueous from the anterior chamber was performed either before or after the gas injection by some of the surgeons. Postoperatively, the patients were positioned so that the gas bubble adequately covered the retinal breaks. In addition, selected patients underwent postoperative laser retinopexy to the retinal breaks.

STATISTICAL ANALYSIS

The operations were performed by 7 vitreoretinal surgeons. Three surgeons (A.A., H.D., and J.M.) performed most of the procedures (85, 73, and 49), and together the other 4 performed the remaining 49 procedures. A comparison between surgeons regarding success rates and outcomes was performed, but the 4 surgeons with the lower volume were grouped and were considered as a single group.

All calculations were performed and presented using commercially available software (Microsoft Excel 2007; Microsoft Corporation) and SPSS software, version 17.0 (SPSS, Inc.). The t test was used to compare parametric data. Nonparametric data were analyzed with χ² testing unless an expected cell count was less than 5, in which case the Fisher exact test was used.

Snellen VA was converted to a logarithm of the minimum angle of resolution (logMAR) equivalent. Approximations for VA worse than 20/400 were as follows: counting fingers, 20/2000; hand motions, 20/4000; light perception, 20/8000; and no light perception, 20/16000. Statistical significance was set at P < .05. Data are presented with 1 SD throughout the article.

RESULTS

Two hundred seventy-six eyes of 271 patients underwent PR during the study period. Of these, full data was obtained on 258 eyes (93.5%) of 253 patients, and they were included in the study series. Only 18 eyes (6.5%) of 18 patients were excluded from analysis because of short follow-up or lack of data.

Of the 253 patients, 60.9% were males and 39.1% were females. The mean (SD) age was 57.3 (12.2) years (age range, 16.0-83.0 years), with a mean (SD) follow-up time of 36.1 (39.4) months (range, 2.0-141.0 months). One hundred forty-eight eyes (57.4%) were followed up for at least 1 year. Only 23 eyes (8.9%) had a follow-up shorter than 4 months. In all eyes, retinal breaks were detected in the superior two-thirds of the fundus. In 72.4% of eyes, a break was found in the upper temporal retina and in the upper nasal retina in 27.6% of eyes. The mean (SD) number of breaks was 1.2 (0.5) (range, 1-5 breaks) in a total mean (SD) area of 1.1 (0.3) clock-hours (range, 1.0-2.0 clock-hours). None of the eyes had a significant vitreous hemorrhage.

Successful reattachment at 2 months was achieved in 171 (66.3%) of 258 eyes with only 1 additional operation. The other 87 eyes (33.7%) underwent additional operations for a new or persistent RRD. A single surgery anatomical success was achieved in 158 eyes (61.2%); final anatomical success was achieved in 256 eyes (99.2%).

Of the 87 eyes with primary failure, 67 eyes (77.0%) were reattached with 1 additional operation only: PPV with gas injection (31 eyes), scleral buckle (30 eyes), PR (2 eyes), and PPV with silicone oil injection (4 eyes). Seventeen eyes (19.5%) underwent 2 additional operations, and 3 eyes (3.4%) underwent 4 additional reattachment operations. The type and order of surgical procedures for patients who underwent more than 1 additional operation are shown in the Figure. The second reattaching operation was performed within a mean time of 22.8 (19.9) days (range, 1-83 days) after the primary PR. Three of the failed cases were reoperated on beyond the 60 days limit (70, 80, and 83 days); however, they
were considered primary failure because they had a persistent local RRD from the primary PR. Five eyes (2.0%) have developed PVR and subsequently underwent PPV with retinectomy and silicone oil injection.

Late redetachment occurred in 12 eyes (4.7%). Of these, 10 eyes (83.3%) underwent only 1 additional reattachment operation (2 PPV with perfluoropropane gas injections, 4 scleral buckles, and 4 PRs) and 2 eyes (16.7%) underwent 2 additional reattachment operations (Figure). In the late redetachment group, the mean time of reoperation was 301.5 (343.1) days (range, 68-1250 days) after the primary PR. In all cases but 1, a new retinal break was diagnosed. In most cases, the new break was found within 90/11034 from the original break. Only 1 patient with PVR underwent PPV and retinectomy.

Comparison of the outcome of PR procedures performed by the 3 higher volume surgeons (A.A., H.D., and J.M.) and the group including the combined results of the surgeons with the lower volume revealed no statistically significant difference between surgeons for the rate of PR failure, the rate of postoperative complications, or final VA (P = .975).

SUCCESS VS PRIMARY FAILURE

Preoperative characteristics of the successful and failed PR cases are summarized in Table 1. Patients with failed PR were, on average, 3.7 years younger compared with the successful PR group (54.9 vs 58.6 years for the primary failure PR and successful cases, respectively; P = .02). Approximately one-fifth of both groups were pseudo-

Table 1. Comparison of Preoperative Characteristics in Patients Undergoing PR for the Repair of Primary RRD: Successful vs Failed Cases

<table>
<thead>
<tr>
<th>Variable</th>
<th>Successful PR (n = 171)</th>
<th>Primary Failure (n = 87)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>60.5 (39.5)</td>
<td>63.6 (33.4)</td>
<td>.70</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>58.6 (11.0)</td>
<td>54.9 (14.0)</td>
<td>.02</td>
</tr>
<tr>
<td>Axial length, mm</td>
<td>25.3 (1.7)</td>
<td>25.5 (1.6)</td>
<td>.498</td>
</tr>
<tr>
<td>Spherical equivalence, D</td>
<td>-3.3 (2.3)</td>
<td>-4.2 (5.4)</td>
<td>.26</td>
</tr>
<tr>
<td>LogMAR at presentation</td>
<td>0.7 (0.8)</td>
<td>0.7 (0.8)</td>
<td>.72</td>
</tr>
<tr>
<td>Snellen VA</td>
<td>20/100</td>
<td>20/100</td>
<td></td>
</tr>
<tr>
<td>IOP at presentation, mm Hg</td>
<td>13.6 (3.2)</td>
<td>13.4 (3.2)</td>
<td>.60</td>
</tr>
<tr>
<td>Pseudophakia, %</td>
<td>21.4 (17.1)</td>
<td>23.9 (16.8)</td>
<td>.38</td>
</tr>
<tr>
<td>Time after cataract surgery, mo</td>
<td>25.4 (21.8)</td>
<td>47.1 (35.2)</td>
<td>.04</td>
</tr>
<tr>
<td>Intact posterior capsule, %</td>
<td>88.8 (76.2)</td>
<td></td>
<td>.18</td>
</tr>
<tr>
<td>Duration of symptoms, d</td>
<td>7.9 (10.9)</td>
<td>8.9 (21.7)</td>
<td>.65</td>
</tr>
<tr>
<td>Macula attached, %</td>
<td>38.5 (44.2)</td>
<td></td>
<td>.23</td>
</tr>
<tr>
<td>Total size of breaks,</td>
<td>1.2 (0.4)</td>
<td>1.1 (0.2)</td>
<td>.03</td>
</tr>
<tr>
<td>Clock-hours detached</td>
<td>3.7 (1.3)</td>
<td>3.8 (1.8)</td>
<td>.65</td>
</tr>
</tbody>
</table>

Abbreviations: IOP, intraocular pressure; logMAR, logarithm of the minimum angle of resolution; PR, pneumatic retinopexy; RRD, rhegmatogenous retinal detachment; VA, visual acuity.

aData are given as mean (SD) unless otherwise indicated.

Figure. Type and order of surgical procedures for patients who underwent more than 1 additional reattachment operation. PPV gas indicates pars plana vitrectomy with perfluoropropane gas injection; PPV SO, pars plana vitrectomy with silicone oil injection; PR, pneumatic retinopexy; and SB, scleral buckle.
succes and primary failure PR cases, respectively; logMAR 0.2 and 0.3 for the successful and primary failure PR cases, respectively. The final logMAR for this group was only slightly worse than that of the successful group (logMAR 0.22 and 0.25 for patients who developed epiretinal membrane (11.3% and 11.3% of the cohort. Success rates reported in the published literature are found in a very wide range. Hilton et al12 and Tornambe17 reviewed data of nearly 1300 PR procedures to reattach the retina. Specifically, the patients who had a significantly worse outcome (Table 2) than the successful group. There were more cases of epiretinal membrane in this group (11.3% and 23.5% for the successful and primary failure PR cases with only 1 additional operation, respectively; P = .03); however, it had an insignificant impact on final VA (final logMAR 0.22 and 0.25 for patients who developed epiretinal membrane in the successful and primary failure PR groups with only 1 additional reattachment procedure, respectively; P = .11).

SUCCESS VS PRIMARY FAILURE WITH 2 OR MORE ADDITIONAL REATTACHMENT OPERATIONS

Patients who required 2 or more additional operations had a significantly worse outcome (Table 2) than the successful cases or those that required only 1 additional procedure to reattach the retina. Specifically, the patients who required 2 or more additional operations had worse final VA (final logMAR 0.67 and 0.20 for the failed group with ≥2 additional operations and successful group, respectively; P = .015), and significantly more cases of epiretinal membrane, cystoid macular edema, PVR, cataract, and vitrectomy for vitreous hemorrhage.

In this retrospective analysis, successful retinal reattachment after PR surgery for primary RRD was achieved in 66.3% of the cohort. Success rates reported in the published literature are found in a very wide range. Hilton et al12 and Tornambe17 reviewed data of nearly 1300 PR procedures to reattach the retina. Specifically, the patients who had a significantly worse outcome (Table 2) than the successful group. There were more cases of epiretinal membrane in this group (11.3% and 23.5% for the successful and primary failure PR cases with only 1 additional operation, respectively; P = .03); however, it had an insignificant impact on final VA (final logMAR 0.22 and 0.25 for patients who developed epiretinal membrane in the successful and primary failure PR groups with only 1 additional reattachment procedure, respectively; P = .11).

SUCCESS VS PRIMARY FAILURE WITH ONLY ONE ADDITIONAL REATTACHMENT OPERATION

Table 2 compares the outcomes of the successful PR group and the primary failure group which underwent only 1 additional retinal reattachment procedure (n = 67). In contrast to the significantly worse outcome and high complication rate of the whole primary failure group (n = 87), this group had a better outcome. The final logMAR for this group was only slightly worse than that of the successful group (logMAR 0.2 and 0.3 for the successful and primary failure PR cases, respectively; P = .03).

Moreover, no statistical differences were noted in the delta logMAR (difference between logMAR at presentation and final logMAR) between the 2 groups (0.46 vs 0.35 for the successful and primary failure PR cases, respectively; P = .30). The data in Table 2 indicate that there was no difference in the rate of development of macular hole, cystoid macular edema, PVR, and cataract, in this group compared with the successful group. There were more cases of epiretinal membrane in this group (11.3% and 23.5% for the successful and primary failure PR cases with only 1 additional operation, respectively; P = .03); however, it had an insignificant impact on final VA (final logMAR 0.22 and 0.25 for patients who developed epiretinal membrane in the successful and primary failure PR groups with only 1 additional reattachment procedure, respectively; P = .11).

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cases from 26 articles and reported a rate of 53% to 100% with a calculated average of 80%. Some of the articles included in their analysis are anecdotal (eg, a series of 4 eyes that underwent PR with success rate of 100%), whereas our case series is a large-scale cohort (258 eyes) operated on in a single medical center. Grizzard and colleagues performed a retrospective analysis on 107 consecutive eyes that underwent PR in their practice together with a literature review of 25 series on PR with primary attention to failures, and reported 69% single successes. Other publications reported success rates ranging from 62% to 68%, which are also in the range of our results. It is likely that pseudophakic status is not a contraindication for PR, and that the anatomical outcome is as good in these eyes as in phakic eyes. A meticulous search for retinal breaks should be performed in all eyes, and especially in pseudophakic ones. In our case series absence of intact posterior capsule did not correlate with failure. These findings correspond with some published series, but differ from others. In contrast to published articles, we found no associations between sex, worse initial VA, total area of detachment, macular status (detached or attached), and failure of PR.

Mudvari et al reported 50 cases of redetachment after primary PR. Most of their clinical descriptive data are similar to that of the failed cases in our cohort, but they included in their analysis cases of both early and late redetachment (redetachment up to 161 days after PR). It is our belief that cases of primary failure should be analyzed separately from cases of late redetachment, which are actually successful PR cases that redetached later. Most patients in their cohort (76%) redetached in the first month, thus, according to our criteria are defined as primary failure.

As mentioned earlier, when compared with the success group, the primary failure group had significantly more postoperative complications and worse final VA. These differences, however, became indistinct when a subanalysis was performed, comparing the success group with the primary failure cases that underwent only 1 additional retachment procedure (77.0% of the failed eyes).

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Conflict of Interest Disclosures: None reported.

Online-Only Material: This article is featured in the JAMA Ophthalmology Journal Club. Go to http://www.jamaophth.com to download teaching PowerPoint slides.
REFERENCES


Web Quiz Winner

Congratulations to the winner of our September quiz, Aditi Gupta, MS, DNB, Department of Vitreo-Retina, EyeQ Superspeciality Eye Institute, Gurgaon, India. The correct answer to our September challenge was grade 4 familial (autosomal recessive) isolated foveal hypoplasia. For a complete discussion of this case, see the Small Case Series section in the October issue (Saffra N, Agarwal S, Chiang JPW, Masini R, Bertolucci A. Spectral-domain optical coherence tomographic characteristics of autosomal recessive isolated foveal hypoplasia. Arch Ophthalmol. 2012;130(10):1324-1327).