

Reassessment of pneumatic retinopexy for primary treatment of rhegmatogenous retinal detachment

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Background: Pneumatic retinopexy (PR) remains a popular technique for the treatment of rhegmatogenous retinal detachment (RRD).

Objective: To evaluate the single operation and final success rate of PR for primary treatment of RRD and to determine factors associated with anatomical and visual outcomes.

Methods: This retrospective case review study analyzed the data of patients who underwent PR for primary treatment of RRD. Patients with a follow-up period of <2 months were excluded. Single operation success was defined as successful retinal reattachment following a single PR throughout 2 months of follow-up.

Results: Eighty-four eyes met the inclusion criteria. Single operation success was achieved in 50 eyes (59.5%), while 82 obtained anatomical success at the final follow-up visit (97.6%). An average of 0.702±1.095 additional retinal detachment operations was necessary to achieve final anatomical success in the entire cohort (n=84) and 1.4±1.3 in the single operation failure group (n=34). Both groups (single operation success vs failure) did not differ significantly in any of the preoperative variables. Multivariate analysis of pseudophakic patients (n=22) revealed that 52.65% of the variation in single operation outcome was explained by the number of clock-hours detached (partial $R^2=43.76\%$, $P=0.001$). The final best-corrected visual acuity was significantly better in the single operation success group (logarithm of minimum angle [logMAR] 0.229±0.249 vs logMAR 0.747±0.567, $P<0.001$).

Conclusion: Careful patient selection is warranted before performing PR in RRD, particularly in pseudophakic patients with large detachments. Ultimately 60% of the cases will attach after the procedure with the rest requiring on average 1.4 additional procedures to achieve final anatomical success.

Keywords: pneumatic retinopexy, rhegmatogenous retinal detachment

Introduction

Retinal detachment is the separation of multilayer neurosensory retina from the underlying retinal pigment epithelium. The incidence of rhegmatogenous retinal detachment (RRD) has significant geographic variations ranging between 6.3 and 17.9 per 100,000 people per year.¹ In current clinical practice, scleral buckling, pars plana vitrectomy (PPV), and pneumatic retinopexy (PR) are used to treat RRD² with reported primary success rates of 95%, 71%–92%, and 64%, respectively.³ PR is both safe⁴ and cost-effective.⁵ It is used in 14%–17% of cases of RRD making it the second most popular primary modality after PPV.⁶ The classic indications for PR are retinal breaks confined to the superior clock-hours, retinal break or breaks within 1–2 clock-hours, absence of proliferative retinopathy grade C or D, a cooperative patient who can be positioned, and clear media.⁷ In addition, in cases with other relative indications, PR was shown to have satisfactory results.⁷ In spite

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of the fact that the immediate anatomical success rate of PR has been reported to be lower than that of other techniques, the final best-corrected visual acuity (BCVA) has been shown to be similar.^{8–10} It seems that though the success rate reported by studies investigating PR in the past 3 decades is declining,^{10–12} it remains a popular technique.⁶ Two recent large retrospective studies that investigated the risk factors for failure of PR reported an initial anatomical success rate of 61%–63.3% with a final rate of 96.1%–99.2%.^{13,14}

The aim of this article was to 1) evaluate the initial and final success rate (both anatomically and functionally) of PR surgery for primary treatment of RRD; 2) characterize the complications directly related to this procedure; and 3) identify the subset of patients who are most likely to benefit from this procedure as a primary modality.

Methods

All necessary authorizations were obtained from the Institutional Review Board of the Tel Aviv Medical Center.

Subjects

The medical records of patients who underwent PR between the years 2009 and 2012 at the Department of Ophthalmology of the Tel Aviv Medical Center, a tertiary care hospital in Tel Aviv, Israel, were reviewed.

In our department, PR is used to repair RRD with retinal breaks located between 8 o'clock and 4 o'clock. The procedure is not performed in cases with inferior breaks or lattice between the 4 o'clock and 8 o'clock positions, retinal break >1 hour, inability to detect retinal breaks in detached retina, clinically significant media opacity preventing identification of breaks, proliferative vitreoretinopathy grade C, previous retinal surgery, or poor patient compliance.

Inclusion criteria were a minimum follow-up period of 2 months. Patients who underwent ocular surgery (except cataract surgery) in the same eye prior to PR were excluded from this study. The demographic and preoperative characteristics extracted from each patient's medical record are depicted in Table 1.

Surgical technique

All patients were treated with a similar PR technique, adapted from Hilton et al by one of the three surgeons (LA, BA, or SS).¹⁵ After attempting to identify all the retinal breaks via fundal examination, the necessity, alternatives, and potential complications of the procedure were explained to the patient by the physician before obtaining consent. The PR was performed under retrobulbar or subconjunctival combined with topical anesthesia. In the first stage, transconjunctival

Table 1 Preoperative characteristics of success versus failed cases

| Variable | Single operation success (n=50) | Single operation failure (n=34) | P-value |
|--------------------------------------|---------------------------------|---------------------------------|---------|
| Male (%) | 58 | 67.6 | 0.371 |
| Age (years) | 61.6±11 | 58.2±12.9 | 0.214 |
| Hypertension (%) | 40 | 32.35 | 0.476 |
| Diabetes (%) | 16 | 17.65 | 0.842 |
| Axial length (mm) | 24.86±1.95 | 24.75±2.06 | 0.868 |
| Spherical equivalence | -3.90±4.16 | -3.07±3.73 | 0.443 |
| Preoperative BCVA (logMAR) | 0.773±0.830 | 1.059±0.901 | 0.145 |
| Preoperative IOP (mmHg) | 13.23±3.22 | 12.84±4.60 | 0.682 |
| Pseudophakia (%) | 26 | 26.4 | 0.962 |
| Glaucoma (%) | 8.16 | 11.76 | 0.585 |
| Amblyopic (%) | 8 | 8.82 | 0.893 |
| Time after cataract surgery (months) | 33±29.3 | 70.7±89.9 | 0.254 |
| Prior posterior capsular tear (%) | 12.5 | 20 | 1 |
| History of retinal tears (%) | 8 | 8.82 | 0.893 |
| Duration of symptoms (days) | 4.90±5.92 | 5.1±10.3 | 0.923 |
| Macula involved in detachment (%) | 46 | 41.1 | 0.823 |
| Clock-hours detached | 4.18±2.44 | 5.07±2.60 | 0.121 |
| VH at time of PR (%) | 12 | 11.76 | 0.974 |

Note: Data presented as mean ± standard deviation.

Abbreviations: BCVA, best-corrected visual acuity; IOP, intraocular pressure; VH, vitreous hemorrhage; PR, pneumatic retinopathy.

cryopexy was applied around each of the retinal breaks. Afterward, 0.5 mL of SF₆ or 0.3 mL of C₃F₈ was injected into the vitreous. Paracentesis was performed in selected patients who required lowering of intraocular pressure. All patients were postoperatively positioned in order to correctly apply pressure to the area of detached retina. When necessary, patients underwent additional laser retinopexy.

Definitions

Single operation success: successful retinal reattachment following a single PR throughout 2 months of follow-up.¹³ This group included patients who received additional laser or cryotherapy in the postoperative period. Additional retinal detachment repair procedures performed in this group were the result of re-detachment occurring after a period of 2 months.

Final anatomical success: eyes in which the retina remained attached throughout the follow-up period.

Statistical analysis

Statistical analyses were performed using SPSS 21.0 (IBM Corporation, Armonk, NY, USA). We compared both baseline and follow-up characteristics of primary success patients and failure patients by using, whenever appropriate, Student's *t*-test for normally distributed variables or Kruskal–Wallis for nonparametric variables. We used χ^2 or Fisher's

exact test as indicated for the analysis of categorical variables. We then performed stepwise backward multivariate logistic regression analysis that attempted to determine the baseline variables that enabled to predict success or failure introducing as independent variables those that reached a significant level of <0.3 in univariate analysis. Snellen BCVA values were converted to logMAR units. A P -value of <0.05 was considered significant.

Results

Out of a total of 102 eyes of 102 patients that underwent PR between the years 2009 and 2012, 84 patients fulfilled the inclusion criteria. Reasons for exclusion were a follow-up period of <2 months ($n=15$) and incomplete procedure or lack of data in medical records ($n=3$). There were 52 men and 32 women with a mean age of 60.25 ± 11.82 years (median, 60.50 years; range, 34–87) who were followed for a mean duration of 11.8 ± 9.1 months (median, 9.5 months; range, 2–58 months). The mean interval between appearance of visual symptoms and patient arrival was 5 ± 7.9 days (median, 3 days; range, 0–60 days). In 56% of the patients, the right eye was involved. All retinal tears were located in the superior half of the retina, while 61.9% were located specifically in the superotemporal quadrant. Retinal tears were limited to ≤ 1 hour in 90.5% of the patients, and the size of the retinal detachment was limited to one quadrant or less in 56% of the patients with macular sparing detected in 56% as well. Vitreous hemorrhage at the time of PR was documented in 11.9% of the cases. The follow-up time lasted >3 months in 82% of the patients, >12 months in 39%, and >24 months in 9.5%.

Single operation success

Out of 84 eyes, 50 reached single operation success (59.5%; 95% confidence interval [CI], 48.81–70.24), while 82 obtained final anatomical success (97.6%; 95% CI, 94.33–100.87). Out of the 34 patients from the single operation failure group, 79.4% underwent a single additional reattachment procedure. The mean interval between the primary PR and additional reattachment procedure was 15.4 days (median, 17 days; range, 1–570 days). An overall average of 0.702 ± 1.095 additional retinal detachment operations was necessary to achieve final anatomical success.

Table 1 depicts the clinical characteristics at baseline and after follow-up of the 50 (59.5%) single operation success patients versus the 34 (40.5%) single operation failure patients. Briefly, patients from both groups did not differ significantly in any of the variables examined.

We used stepwise backward multivariate analysis to determine the effect of the variables that were associated with single

Table 2 Comparison of outcomes in primary success versus primary failure

| Variable | Single operation success (n=50) | Single operation failure (n=34) | P-value |
|---|---------------------------------|---------------------------------|---------|
| Final BCVA (logMAR) | 0.229±0.249 | 0.747±0.567 | <0.001 |
| Glaucoma development (%) | 6 | 14.71 | 0.259 |
| Macular hole (%) | 2 | 2.94 | 1 |
| Epiretinal membrane (%) | 34 | 29.41 | 0.659 |
| SRF development (%) | 46 | 32.35 | 0.211 |
| CME development (%) | 8 | 17.65 | 0.180 |
| PVR development (%) | 12.24 | 26.47 | 0.098 |
| Cataract development (%) | 12.5 | 30.3 | 0.048 |
| Cataract operations (%) | 6.12 | 48.48 | <0.001 |
| Additional nonretinal detachment operations (%) | 12 | 15.15 | 0.747 |

Abbreviations: BCVA, best-corrected visual acuity; PVR, proliferative vitreoretinopathy; SRF, subretinal fluid; CME, cystoid macular edema.

operation success at a P -value of <0.3 (age, preoperative logMAR, time after cataract surgery, and clock-hours detached). When examining the subgroup of pseudophakic patients ($n=22$), 52.65% of the variation in single operation outcome was explained by the number of clock-hours detached (partial $R^2=43.76\%$, $P=0.001$) and to a lesser extent by time after cataract surgery (partial $R^2=8.89\%$, $P=0.074$).

Table 2 depicts the outcomes of the single operation success group versus the single operation failure group. There was a significant difference between both groups in terms of final BCVA (logMAR 0.229 ± 0.249 and logMAR 0.747 ± 0.567 , $P<0.001$). The difference in delta (final BCVA preoperative BCVA), however, was not significant (logMAR 0.544 ± 0.816 and logMAR 0.31 ± 1.15 , $P=0.314$). The single operation failure group had higher rates of cataract development and cataract surgery than the single operation success group (12.5% vs 30.3%, $P=0.048$, and 6.12% vs 48.48%, $P<0.001$, respectively). The single operation success group required less additional retinal detachment operations to achieve final anatomical success (0.2 ± 0.5 vs 1.4 ± 1.3 , $P<0.001$).

No intraoperative complications occurred. Table 3 lists the rates of post-PR complications.

Table 3 Post-PR complication rates in the entire cohort in descending order

| Complication | Rate (%) |
|---------------------------------|----------|
| Subretinal fluid | 40.5 |
| Epiretinal membrane | 32.1 |
| Cataract | 19 |
| Proliferative vitreoretinopathy | 17.9 |
| Cystoid macular edema | 11.9 |
| Glaucoma | 9.5 |
| Macular hemorrhage | 2.4 |
| Pigment epithelial detachment | 1.2 |

Abbreviation: PR, pneumatic retinopathy.

Discussion

In this retrospective study, single operation success via PR was achieved in 59.5% of the cases. These rates are consistent with the lower part of the wide spectrum of rates reported in the literature with reported success rates ranging from 44% to 94%.¹⁶ The relatively low single operation success rate may be the result of including RRD cases that have, by classic definition, lower primary success rates (multiple breaks in multiple quadrants). Vitreous hemorrhage, which coexisted in 11.9% of the RRD cases, may have prevented full identification of all the retinal tears. It is worth mentioning that the nine initial studies between 1986 and 1988 reported single operation success rates that ranged from 84% to 93.55%.¹⁶ This is in sharp contrast to the findings of this study and the lower rates reported by three recent studies that demonstrated a range of 60.7%–69.6%.^{13,14,17}

No statistically significant differences were found when comparing the baseline characteristics of the single operation success versus single operation failure groups. Previous studies have reported substantially higher success rates for phakic RRDs in comparison to pseudophakic or aphakic RRDs.¹⁶ Our findings are similar to those of a recent study by Fabian et al¹³ who came to the conclusion that the anatomical outcome is similar in both groups. The main theory for the reported lower success rate is the presence of multiple missed breaks in pseudophakic and aphakic eyes. Therefore, before performing PR in pseudophakic RRD, an in-depth examination of the peripheral retina is warranted.¹⁵

Multivariate analysis of the subgroup of pseudophakic patients revealed that 43.76% of the variation in single operation outcome was explained by the number of clock-hours detached ($R^2=43.76\%$, $P=0.001$). The odds ratio for each clock-hour detached in this group was 3.83 (95% CI, 1.04–14.12). This in fact means that the size of detachment in pseudophakic patients predicted an increased risk of single operation failure. A study by Tornambe et al⁴ on 302 eyes concluded that more extensive detachments are associated with lower single operation success. We speculate that larger detachments could potentially harbor numerous breaks that are more likely to go undetected in pseudophakic patients.

The mean BCVA at the final follow-up for single operation success was statistically significantly better for single operation success patients when compared to single operation failure (logMAR 0.229±0.249 and logMAR 0.747±0.567, $P<0.001$, respectively). These findings are supported by previous studies that reported better visual outcomes in the single operation success groups.^{13,14,16} In this study, the difference

in delta (final BCVA – preoperative BCVA) between both groups was not statistically significant. We speculate that this may be a result of a relatively low amount of additional retinal detachment procedures required in the single operation failure group (1.4±1.3). These findings are supported by those of Ambler et al¹⁸ who demonstrated that initial failure of PR does not adversely affect the visual outcome. As there was a substantial difference in the final BCVA of both groups, perhaps the initial BCVA should be considered when deciding which procedure to perform.

Cataract is one of the leading causes of blindness in Israel.¹⁹ In this study, the single operation failure group had higher rates of cataract development and cataract surgery than the single operation success group (12.5% vs 30.3%, $P=0.048$, and 6.12% vs 48.48%, $P<0.001$, respectively). No statistically significant differences in rates were found for all other complications. The higher rate of cataract development and cataract surgery in the single operation failure group may have been the result of additional retinal detachment operations performed, such as PPV, which increase the likelihood of developing clinically significant cataract.^{20,21} Therefore, combined surgery by phacoemulsification and vitrectomy in one session may be considered in cases with a significant cataract.²² The retrospective nature of this study in itself is a limitation as there may be several additional factors that were not studied, which may influence the outcomes. As part of the methodology of this study, a relatively large number of parameters that may have affected the outcomes were collected and studied in order to minimize the influence of such factors.

Conclusion

In summary, PR as demonstrated in this study carries a lower single operation success rate than initially published 3 decades ago. Careful patient selection is warranted before performing PR in RRD, particularly in pseudophakic patients with large detachments. Ultimately 60% of the cases will attach after the procedure. Those in which the procedure does not succeed the first time will require on average 1.4 additional procedures to achieve final anatomical success.

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Disclosure

The authors report no conflicts of interest in this work.

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