

Pneumoretinopexy versus scleral buckling in retinal detachments with superior breaks: A comparative analysis of outcome and cost

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Purpose: The purpose of this study is to study single surgery reattachment rate, refractive shift, surgical time, cost, and complications of pneumoretinopexy (PR) compared to scleral buckling (SB) in rhegmatogenous retinal detachments (RRDs) with superior breaks. **Methods:** Data of RRD with superior breaks, from 2013 through 2016, treated either with PR or SB surgery at a tertiary eye-care center were retrospectively reviewed. Treatment outcomes, procedural costs, refractive shift, surgical time, and complications, namely, cataract and glaucoma, were analyzed. **Results:** Thirty-two cases treated by PR ($n = 15$) and SB surgery ($n = 17$) fulfilled the selection criteria. Macula off RRD (91%) was the commonest presentation. Baseline parameters like duration of vision loss, presenting vision, and ocular characteristics were comparable. Single surgery retinal reattachment (66.7% PR vs. 76.5% SB) was analogous ($P = 0.698$). Retinal reattachment with secondary intervention was achieved in all cases at the last follow-up. Average vision gain in logMAR of 0.8 in PR and 0.6 in SB was not significantly different ($P = 0.645$) between the two groups, with SB group having a 1.9 Dioptre myopic shift and PR group none. Surgical time was shorter in PR versus SB at 15 versus 85 min and surgical cost (including additional surgery) was 50% less in PR. Complications like cataract progression ($P > 0.99$) and glaucoma ($P = 0.71$) were analogous among the groups. Horse-shoe tears were associated with failed primary surgery in 60% of PR and 75% of SB procedures. **Conclusion:** In RRDs secondary to superior breaks, PR proved to be faster, more economical, and less tissue manipulative than scleral buckle surgery, with equivalent efficacy and safety profile.

Key words: Horse-shoe tears, pneumatic retinopexy, scleral buckling, single operation success, surgical cost, surgical time

Rhegmatogenous retinal detachment (RRD) is one of the most common ocular emergencies threatening vision, necessitating timely surgical treatment to prevent irreversible vision loss.^[1,2] Early surgical intervention results in superior visual outcomes but in a developing country like India, inequity of access to health-care services coupled with financial resource constraints result in delay in presentation to clinic. In a resource-limited milieu, safe, effective, minimally invasive, and economical surgical options like pneumoretinopexy (PR) could go a long way in reducing this blindness burden of treating simple RRDs.^[3] Despite its potential benefits, PR remains an underutilized surgery. Vitreoretinal surgeons prefer the more invasive and technically demanding scleral buckling (SB) or microincision vitrectomy surgery (MIVS), in the belief of their enhanced efficacy.^[4,5] Studies have questioned this belief and documented similar reattachment rates, better visual results, and reduced necessity of cataract surgery in PR versus MIVS or SB in RRD.^[6,7]

Ethnic variations have been documented that dictate both presentation and treatment response, thereby introducing another dimension to the surgical outcomes of retinal detachment.^[7-9] There is paucity of data comparing efficacy and safety of PR versus SB in brown races. This is partly responsible for poor

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adoption of relatively simple, rapid, cost-effective PR technique in developing countries, where it is probably most needed. The current study attempts to analyze the surgical outcome of PR over SB, in a tertiary eye-care facility of eastern India.

Methods

The case records of surgeries performed over 4 years (January 2013–December 2016) were reviewed to include consecutive patients with history of surgery (SB or PR) for RRD with breaks no greater than 1 clock hour in size within the superior two-thirds of the fundus (breaks within 10–2 O'clock). Combined SB with intraocular tamponade, prior history of trauma, patients younger than 18 years, proliferative vitreoretinopathy worse than grade B,^[10] follow-up less than 3 months, and records with inadequate data were excluded from analysis.

The demographic details, clinical presentation, mode of management, treatment cost, and surgical outcome were recorded. To compare the treatment outcome, the patients were divided into two groups based on the primary intervention,

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that is, PR or scleral buckle (SB). The data were compared for single surgery reattachment rate, surgical time, and refractive shift. The cost incurred for achieving retinal reattachment and possible additional postoperative procedures like vitrectomy, silicone oil removal, cataract extraction, and glaucoma filtering procedures was calculated and compared for the groups. The prevailing standard surgical cost for all the procedures was considered for analysis.

The surgeons who were exponents of scleral buckle surgery had preferred scleral buckle over PR. All the PR procedures were performed by a single surgeon (UCB). All the surgeons were trained vitreoretinal surgeons of at least a decade of clinical and surgical experience.

Surgical technique

Pneumoretinopexy

Under aseptic conditions, the breaks were localized by indirect ophthalmoscopy and transconjunctival cryopexy of break edges was done. Prior to intravitreal gas injection, the globe was softened by digital massage and anterior chamber paracentesis. Perfluoro propane (C_3F_8) gas (0.3–0.4 ml) was injected intravitreal, with a 30-ga hypodermic needle under direct visualization of needle tip. Slow injection was ensured to prevent *fish egging* (multiple small bubbles). Upon withdrawal of needle, a cotton-tipped applicator was pressed at the needle track, to prevent vitreous incarceration. Optic disc perfusion was then checked by indirect ophthalmoscopy and paracentesis was repeated if central retinal artery pulsation was noted.^[11] Eye was patched after instilling povidone iodine. Postoperative positioning was determined by the location of the break and was maintained for 16–18 h/day for 5–7 days. Perfluoro propane (C_3F_8) was preferred as its volume quadruples in 2 days and lasts for 30–45 days. This greater expansion permitted injection of a smaller volume.^[12]

Scleral buckling

A 360° conjunctival peritomy was followed by bridling of all recti with 2-0 Mersilk. The breaks were localized again, marked on sclera, and cryopexy of break edges was done. Solid silicone explant was secured with 5-0 polyester mattress sutures, followed by passing of an encircling band, which was then fastened with either Watzke sleeve or clove-hitch knot. The sector with highest retinal elevation was selected for transscleral subretinal fluid (SRF) drainage using a 26-G hypodermic needle. After raising the buckle height by tightening the buckle sutures, the globe was formed with balanced salt solution and disc perfusion ensured before closing the conjunctival peritomy with 7-0 vicryl sutures.

As per institutional policy, follow-up was done on day 1, 1 week, 1 month, 3 months, 6 months, and subsequently at yearly intervals, with adherence ensured by telephonic calls. Presence of residual SRF on first postoperative day mandated a tighter follow-up.

Surgical failure was defined as persistent postoperative SRF contiguous with the retinal break, requiring a secondary intervention to reattach the retina. Progression of cataract within 3 months of the primary procedure was attributed to the surgical intervention and was considered as a complication. Rise in intraocular pressure during the course of management was another complication that was considered.

Statistical analysis was performed using the InStat statistical software version 3.0 (GraphPad software Inc., CA, USA). The data were expressed as mean \pm standard deviation for continuous variables and comparisons were made using Student's unpaired *t*-test. Frequencies for categorical variables were compared through Fisher's exact test/Chi-square test.

The study was approved by the institutional review board (IEC code 2017-104-IM-18; date of approval 27-8-2017) and followed the tenets of the Declaration of Helsinki.

Results

During the 4-year study period, a total of 48 patients had undergone surgery for retinal detachments with superior retinal breaks. Out of them, 15 patients treated with PR and 17 with SB met the inclusion and exclusion criteria.

The demographic and preoperative characteristics are given in Table 1. Most cases had a *macula off* detachment, except three patients in PR group. The visual acuity in these three ranged from 20/20 to 20/30. Multiple breaks were seen in 3 out of 15 PR eyes and 2 out of 17 SB eyes.

The treatment outcome and complications are tabulated in Table 2. Retinal reattachment with primary surgery was achieved in 66.7% cases treated with PR and 76.5% with SB, the difference being statistically insignificant. Patients with failed primary surgery were managed by pars plana vitrectomy and silicone oil tamponade. One of the cases in PR group continued to have a peripheral detachment until last follow-up at 18 months postsurgery. Two of the others had persistent SRF beyond a week of surgery but showed complete resolution at 1-month follow-up visit. In contrast, in the SB group only one patient had persistent RD beyond a week which had resolved within a month. Five eyes in PR and four eyes in SB group had a failed primary procedure. Horse-shoe tears (HST) were associated with failed primary surgery in 60% of PR and 75% of SB procedures. The reasons for failure and the other known associations attributable to failure are listed in Table 3.

Visual outcomes were analyzed from surgery till last follow-up, both intragroup and intergroup. Final best corrected visual acuity was 0.3 logMAR and 0.75 logMAR in PR and SB group, respectively. The intergroup difference did not attain statistical significance ($P = 0.07$, Mann-Whitney *U* test).

Intragroup analysis of visual gain over time was highly significant in PR-treated patients ($P = 0.005$; Wilcoxon signed rank test) and significant in SB group ($P = 0.01$). Intergroup analysis of difference in vision gain (logMAR of 0.8 in PR and 0.6 in SB) by unpaired *t*-test, however, did not reveal any statistical significance ($P = 0.645$).

Comparison of surgical time and cost (inclusive of additional procedures) tilted the scales in favor of PR as being a significantly more economical and faster procedure (PR was 50% more economical than SB and was 6 times faster).

Occurrence of cataract was evenly distributed amid the two groups. Glaucoma occurrence was seen only at 1 month in PR group and was analogous in two groups.

Discussion

Surgical preferences for treatment of RRD vary between SB, microincision vitrectomy surgery, and PR. For simple

Table 1: Patient profile and RD characteristics at presentation

	Pneumoretinopexy group (n=15)	Scleral bucking group (n=17)	P
Age (mean±SD)	50±5.9	40±14	P=0.147*
Sex ratio:			
Males:females	2:1	7.5:1	P=0.209‡
Eye laterality			
Right: left	10:5	11:6	P>0.999‡
Median duration of vision loss (range)	7 days (0-90 days)	15 days (2-120 days)	P=0.056†
Median vision at presentation (Snellen's equivalent)	1.3 logMAR units (20/400)	1.3 logMAR units (20/400)	P=0.479†
Lens status—Phakic	14/15 (93%)	16/17 (94%)	P>0.999‡
Cataract presence	5/14 (36%)	5/16 (31%)	P>0.999‡
Intraocular pressure	12.2±2.2 mmHg	12.8±4.1 mmHg	P=0.643*
Detachment characteristics			
Macula off	12/15 (80%)	17/17 (100%)	P=0.092‡
Subtotal RD	15/15 (100%)	16/17 (94%)	P>0.999‡
Coexisting CD	1/15 (6.7%)	1/17 (5.9%)	P>0.999‡
>1 retinal break	3/15 (20%)	2/17 (11.8%)	P=0.645‡
Horseshoe tear	5/15 (33.3%)	6/17 (35.3%)	P>0.999‡

*Unpaired t-test. †Mann-Whitney U test. ‡Fisher's exact test

Table 2: Treatment outcomes of pneumoretinopexy (PR) and scleral bucking (SB)

	Pneumoretinopexy group (n=15)	Scleral bucking group (n=17)	P
Single-operation success	66.7%	76.5%	P=0.698‡
Days for retina to reattach (median)	1.5 days	1 day	P=0.055†
Refraction change of myopic shift (spherical equivalent) at 3 month FUP (median)	0 D	1.9 D	P=0.024§,†
Final visual acuity			
a. Without cataract complication (median)	0.3 logMAR	0.75 logMAR	P=0.074†
b. Inclusive of cataract surgery result	Better than 20/200 in 12/15 patients—80%	Better than 20/200 in 14/17 patients—82%	P>0.999‡
Complications			
a. Cataract progression	4/14 phakic eyes (28.6%)	4/16 phakic eyes (25%)	P>0.999‡
b. Glaucoma (IOP >21 mmHg requiring meds)	4/15 (27%) at 1 month All resolved by 3 months	6/75 (35%) at 1 month 2 persisted till last follow-up	P=0.712‡
Surgical time	Median 15 min Mean 56+68.5	Median 85 min Mean 97+62.8	P=0.015§†
Additional procedures	5/15 (33.3%)	5/17 (29.4%)	P>0.999‡
Cost including resurgery in rupees			
Median	7490	16,000	P=0.028§*
Mean±SD	18,962+17,596	23,518+13,324	
Mean follow-up	9.86±7.6 months	14.8±10.3 months	P=0.280†
Failed surgery associations	n=5	n=4	
Nuclear sclerosis LOCS >1	2/5	1/4	P>0.999‡
Multiple breaks	2/5	0/4	P=0.444‡
Horseshoe tears	3/5	—	P>0.999‡

*Unpaired t-test. †Mann-Whitney U test. ‡Fisher's exact test. §Statistically significant

rhegmatogenous detachments with superior breaks, as far as surgical success is concerned, the surgical choices swing mostly between SB and PR, although there is no clear superiority of one procedure over the other.^[7] As PR is quicker, less expensive than SB, and is easy to perform in an office setting, it is accepted well in developed countries.^[13-15] In early 1990s, 87% of vitreoretinal surgeons in North America recognized the procedure as the standard of care.^[16] In pigmented races, the acceptance was poorer and there are

very few studies comparing its efficacy with more time-tested treatment of SB.^[14,17-19]

Early presentation and phakic status lend themselves to improved success with PR^[4,14,19] and the same was corroborated in our study as most of our patients (93%) were phakic and had presented at a median of 7 days duration. This is in contravention to most studies, which report late presentation of greater than 1 month in almost half of their patients.^[16,18]

Table 3: The demographics and ocular characteristics of eyes that had a failed primary surgery

Surgery	Age (years)	vision loss (days)	Lens status	Break location (O'clock)	Break type	Causes attributed to failure
PR	47	90	Clear	1 and 2	HST	Associated CD and open break
PR	71	10	NS III	2	HST	Open HST flap
PR	45	1	NS I	10 and 12	Hole	Tamponade induced secondary break
PR	20	2	Clear	10	Hole	Missed inferior break
PR	54	8	Clear	1	HST	Open HST flap
SB	26	21	Clear	12	HST	CD
SB	40	4	Clear	10	HST	Residual SRF continuous with break
SB	62	15	PCIOL	2	Hole	Missed break
SB	58	20	NS II	1	HST	Break not supported on buckle indent

HST, Horse shoe tear; Hole, atrophic hole; CD, choroidal detachment; NS, nuclear sclerosis; PCIOL, posterior capsule intraocular lens

The SB cases in the current series had a relatively delayed presentation with median of 15 days; nevertheless, the choice of SB over PR in these eyes was dictated not by presentation lag, but by surgeon familiarity with the procedure. As regards to the age of presentation, it was similar to the range reported in literature^[2,11,12,16,19] and there was no significant age difference between groups.

The single surgery success rate of 66.7% for PR in this series is in the range of reported figures of 60–75% in Asian and Arabian ethnicity.^[2,17,19,20] Higher success rates of 75–80% have however been reported by extensive studies on white races.^[5,11,13]

Failure in PR invariably occurs during early postoperative period of first month,^[21,22] the commonest cause being poor patient compliance to positioning. Decision to perform PR thus should take into consideration patient's ability to adopt required positioning and willingness for stringent follow-up.^[14] The postoperative positioning in our cohort, unlike western countries, was not supervised (patients were expected to comply with instructions) which could be a reason for relatively lower single surgery success rate. The five cases which did fail had other associated reasons like multiple breaks (40%) and HST (60%).^[2,11,21,23,24]

A major benefit of PR is minimal tissue trauma leading to reduced morbidity and improved visual gain.^[25] This was confirmed in this series with significant visual gain in PR group coupled with median myopic shift of 0 versus 1.9 D myopic shift seen in scleral bucking cases. A Cochrane database review by Hatef *et al.* favored PR as causing a lesser myopic shift of less than 1 spherical equivalent over SB.^[23] The recently concluded PIVOT trial (PR vitrectomy outcome trial) also reported enhanced vision gain of 4.9 letters in eyes subjected to PR versus vitrectomy.^[6] This aspect of better visual gain and reduced tissue damage translates into enhanced patient productivity and the same has been confirmed by Ellakwa *et al.* over a long follow-up of 3 years.^[2] As none of the PR eyes were drained of the SRF and all the SB eyes were ensured a near total drainage of SRF, the slow reabsorption of SRF in PR must have resulted in a better VA recovery in our series. This aspect has been corroborated by Wilkinson *et al.* who hypothesize that slow reabsorption of SRF permits a slower settling of the delicate outer segments of photoreceptor elements against the pigment epithelium to result in improved visual recovery.^[26]

The occurrence of cataract progression in 29% cases of PR is a little more than 1–19% reported by previous studies.^[2,11,19]

The use of more long-lasting C_3F_8 in all our patients could be a factor potentiating progression of cataract. Glaucoma has been reported to occur in almost one-fourth cases of PR eyes, with the timing being immediate postoperative.^[20] Absence of this immediate spike in our cohort confirms the safety of using small volumes of C_3F_8 instead of SF_6 . However, the percentage (27%) of glaucoma over the first 1 month is higher than quoted by previous investigators.^[2] The expansile properties of C_3F_8 could be the causative factor for this and normalization of pressures in all eyes by 3rd month gives credence to this reason. The higher incidence of cataract (25%) and glaucoma (35%) in the eyes subjected to SB group too could also reflect the increased propensity for both ocular morbidities in the population presenting to our setup.

A significantly faster surgery at low cost could be an ideal surgical option in high-volume vitreoretinal surgical setups as well as in less equipped centers. In our study, PR was 6 times quicker and 50% less expensive than SB. PR being an ambulatory surgery is more economical than the infrastructure dependent scleral bucking procedure. Studies from developed countries of western hemisphere have documented a 50% reduction in cost by performing PR over SB or pars plana vitrectomy procedure.^[11,27] This economic benefit coupled with equivalent efficacy of PR has prompted advocates of the surgery to expand its' indications, with suggestions to include break extent of larger than 1 clock hour, more than 1 break, and presence of mild PVR cases.^[4,13] Keeping in mind the scenario of developing countries with abysmal coverage by health insurance, poor per-capita income with estimated 25% income shelled out for retinal detachment treatment options,^[27] a less costly, efficacious treatment modality could go a long way mitigating the economic burden on the patient.

Study limitations

The retrospective design, small sample size, short follow-up, and a single surgery success rate lower than reported in for Caucasian races.

Conclusion

A comparable single operation success rate with PR in simple RRDs at a 50% cost saving, with more optimal visual gain sans significant myopic shift in this series, reinforces the value of this underutilized surgery. In a developing country context where delay in retinal surgery due to economical and health-care

facility reasons leads to irreversible blindness,^[18] it is imperative that this quicker and ambulatory surgery with faster learning curve is attempted in selected cases as the primary treatment.

In case of failure, PR still succeeds in “turning back the clock”^[28] with no reduction in response to further definitive surgery. It is thus recommended that PR becomes part of retinal surgeons’ armamentarium with the only caveat being a careful case selection and even more careful indirect ophthalmoscopy examination combing the periphery for all breaks.^[5,28,29]

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Conflicts of interest

There are no conflicts of interest.

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