Prognostic factors after primary vitrectomy and perfluorocarbon liquids for bullous rhegmatogenous retinal detachment

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PURPOSE. *To identify prognostic factors for visual acuity and anatomic outcomes associated with bullous rhegmatogenous retinal detachment (RRD) management using primary pars plana vitrectomy, intraoperative perfluorocarbon liquids (PFCLs), and internal gas tamponade.*
METHODS. *The authors studied a consecutive series of 115 eyes (115 patients) with a bullous RRD not complicated by proliferative vitreoretinopathy (PVR) associated with large, multiple, and/or posterior breaks in 58 (50.4%) eyes. All eyes underwent vitrectomy, injection of PFCL, and gas tamponade as the primary procedure. Encircling scleral bands were placed in all cases. The follow-up period ranged from 3 to 60 months (mean 16.6±14.1 months).*
RESULTS. *Retinal reattachment was achieved in 92.2% of eyes (106/115) with one operation and in all eyes after a second procedure. PVR was observed in 1 (0.87%) eye and preretinal membranes in 3 (2.6%) eyes. Progression of pre-existing cataract and development of new cataract occurred in 45 (58.4%) of the 77 phakic eyes. The presence of inferior retinal breaks was significantly associated with redetachment after the first procedure (p=0.0156). On univariate analysis, better preoperative visual acuity (p<0.001), macular sparing retinal detachment (p<0.001), and fewer quadrants involved by the detachment (p=0.0015) were significant positive prognostic factors for final visual acuity. Logistic regression analysis highlighted that macular sparing retinal detachment and absence of trauma were associated with better final visual acuity.*
CONCLUSIONS. *Redetachment was associated with the presence of inferior retinal breaks. Visual recovery was dependent on preoperative visual acuity, macular involvement, extent of retinal detachment, and trauma. (Eur J Ophthalmol 2009; 19: 107-17)*

KEY WORDS. *Pars plana vitrectomy, Perfluorocarbon liquids, Prognosis, Rhegmatogenous retinal detachment*

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INTRODUCTION

The term primary vitrectomy for rhegmatogenous retinal detachment (RRD) implies that pars plana vitrectomy is the first surgical intervention in the treatment of this disease. In recent years, primary pars plana vitrectomy (PPPV) is gaining widespread popularity and in some centers, is applied in numbers comparable to those of scleral buckling surgery or even in the majority of cases (1). The indications for PPPV has been expanded to include bullous detachment with flap tears, retinal detachment due to posterior, multiple, or tractional retinal breaks, pseudophakic/aphakic retinal detachment, unclear break situation (no break, or not all breaks could be identified on examination before surgery), combined rhegmatogenous retinal detachment and choroidal detachment, and inadequate view of the fundus (1-9).

Bullous RRDs are technically difficult to repair with scleral

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buckling. These detachments present substantial difficulties in the exact localization of the breaks, for application of retinopexy, and for proper placement of the scleral buckle. In addition, external drainage of subretinal fluid may result in drainage of liquid vitreous with associated failure of the retina to flatten (10). Sullivan et al (11) studied 153 consecutive patients undergoing surgery for primary retinal detachment. In their series, failure of primary surgery was significantly associated with presence of highly elevated breaks (defined as breaks not closeable on indentation). Vitrectomy offers potential advantages over scleral buckling in these cases. It eliminates vitreoretinal traction, provides better intraoperative control over the intraocular environment throughout surgery, allows internal drainage of subretinal fluid avoiding the possible complications of external drainage, facilitates more precise treatment of retinal breaks after the tears have flattened, and creates space for a large volume of nonexpansile gas concentrations for prolonged internal tamponade. It also avoids the risk of postoperative pain, anterior segment ischemia, strabismus, and anisometropia caused by complex buckling in cases with complex arrangement of breaks (12, 13).

The aim of the present study was to determine visual acuity and anatomic outcomes, as well as complications associated with RRD management using PPPV, intraoperative perfluorocarbon liquids (PFCLs), and internal gas tamponade, and to determine prognostic factors associated with outcomes.

METHODS

We retrospectively reviewed the medical records of all patients who had bullous RRD not complicated with proliferative vitreoretinopathy (PVR) or giant retinal tears managed by primary vitrectomy, intraoperative PFCLs, and internal gas tamponade. The detachment was defined as bullous if no part of the retinal break could be approximated to the underlying retinal pigment epithelium by scleral indentation either preoperatively or at the time of operation. All surgeries were performed by a single surgeon (A.M.A.) at King Abdulaziz University Hospital between May 1998 and December 2005. Among the 115 patients considered in the study, 3 had both eyes operated during this interval for primary retinal detachment by the same surgeon. Only the first operated eye for these 3 patients was considered as the involved eye and included in the analyses of the current study.

Data collected included patient age, gender, preoperative best-corrected visual acuity (BCVA), intraocular pressure (always measured by applanation tonometry), duration of symptoms, history of amblyopia, history of possibly etiologic trauma, previous eye surgery, lens status (phakic, cataract, pseudophakic, aphakic), fellow eye diseases, vitreous findings, macular status (on or off), extent and distribution of retinal detachment by quadrants, number, size, and location of retinal breaks, operation details, intraoperative findings, intraoperative complications, postoperative complications, reoperations, retinal attachment status, follow-up duration, and final BCVA.

Operation details

Patients were operated under general anesthesia. Solid silicone encircling bands 2.5 mm wide were placed (preequatorial) in all eyes to support the posterior margin of the vitreous base. Lensectomy was performed through the pars plana in eyes with dense cataract. All eyes underwent pars plana vitrectomy to remove the vitreous gel and posterior hyaloid. In pseudophakic eyes, posterior capsulectomies were created using the vitreous cutter to improve visualization. Perfluorocarbon liquid was injected over the posterior pole to drain subretinal fluid through retinal breaks. The level of PFCL was kept posterior to retinal breaks. The encircling band was then shortened only by the amount necessary to create a moderate buckle height based on visual assessment. Tightening the encircling band allowed easier removal of the vitreous base. Vitreous adherent to the margins of retinal breaks was carefully removed, and the flap of horseshoe breaks was excised to abolish vitreal traction. The PFCL bubble was enlarged, displacing the remaining anterior subretinal fluid through retinal breaks. Anterior retinotomy close to ora serrata was performed in 35 eyes where complete drainage via a posterior break could not be achieved. Chorioretinal adhesion was achieved by transscleral cryotherapy or indirect ophthalmoscope laser photocoagulation applied around all retinal breaks and retinal degenerative areas predisposing to break formation (i.e., lattice degeneration), and extended for 360° placed in the peripheral retina in the area of the vitreous base. The dispersed pigment and cells were aspirated around the PFCL bubble using the suction cutter. A meticulous 360° indirect ophthalmoscope with scleral indentation was performed to exclude the possibility of iatrogenic breaks posterior to the sclerotomies or elsewhere. Complete fluid-air exchange was performed. Once the fluid-air exchange was complete, a 25% sulfur hexafluoride (SF_6)–air mixture was flushed through the vitreous chamber for internal tamponade. Nitrous oxide anesthesia was discontinued 20 minutes before injection of SF_6. The operating time ranged from 70 to 115 minutes (mean 93.7±12.3 minutes). At the conclusion of the procedure, subconjunctival injection of triamcinolone 40 mg was given. The whole operation was monitored using the indirect ophthalmoscope and 20 D lens. Patients were nursed in the face-down position as soon as possible after surgery to achieve effective tamponade of retinal breaks and to keep the gas bubble away from the lens. Oral acetazolamide 500 mg twice daily was prescribed and was discontinued after normalization of the intraocular pressure.

Statistical methods

The association between two categorical variables was investigated using either the chi-square test or Fisher exact test as appropriate. Student *t*-test was used to compare the difference between two proportions from the same sample. A p value less than 0.05 indicated statistical significance. Kaplan-Meier survival analysis and a scatter graph were used to investigate the relationship between duration of follow-up and hazard rates for development of cataract. Stepwise logistic regression analysis was conducted to identify variables that were predictors of final visual acuity of 20/60 or better. In this analysis, all the variables from the univariate analysis that were investigated for association were included as the predictor variables. Programs 1L and LR from the BMDP 2007 Statistical Package were used for the Kaplan-Meier survival analysis, and for the logistic regression analysis, respectively. Chi-square test and Fisher exact test were conducted using StatsDirect Statistical Software. Two proportions from the same sample were compared using StatPac Gold statistical program.

RESULTS

There were 115 eyes of 115 patients included in this study. Ninety-three (84.5%) were males, and 17 (15.5%) were females. The age at presentation ranged from 16 to 80 years, with a mean of 46.6±10.9 years, and a median of 48 years. Patients were symptomatic for a mean of 13.9±30.1 days (range, 1 to 210 days), and a median of 4 days. The right eye was involved in 60 (52.2%) patients, and the left eye was involved in 55 (47.8%) patients. Six (5.2%) eyes had amblyopia, and 3 (2.6%) eyes had glaucoma. Eight (6.9%) patients gave a history of blunt trauma that was judged sufficient to have possibly been an etiologic or contributing factor. The follow-up period ranged from 3 to 60 months, with a mean of 16.6±14.1 months, and a median of 14 months.

Seventy-two (62.6%) eyes were phakic/clear, 15 (13.0%) were phakic/cataract, 25 (21.8%) were pseudophakic, and 3 (2.6%) were aphakic. The interval between the cataract operation and the diagnosis of retinal detachment ranged from 2 to 240 months, with a mean of 38.5±57.8 months, and a median of 12 months.

All eyes had preoperative posterior hyaloid detachment. Six (5.2%) eyes had mild vitreous hemorrhage not preventing detailed fundus examination, and 3 eyes had choroidal detachment associated with extreme hypotony. In 70 (60.9%) eyes, a single break was detected, and two breaks were detected in 31 (27%) eyes. Fourteen (12.1%) eyes had three or more breaks. Fifteen (13%) eyes had breaks posterior to the equator, and 7 (6.0%) eyes had large breaks (extending more than one clock hour). Overall, the bullous retinal detachment in 58 (50.4%) eyes was associated with complex breaks (large breaks, multiple breaks at different anteroposterior locations, and/or posterior to equator breaks). The retinal breaks were located in the superior quadrants in 74 (64.3%) eyes, in the inferior quadrants (between the 4 and 8 o'clock meridians) in 27 (23.5%) eyes, and in both superior and inferior quadrants in 14 (12.2%) eyes. Lattice degeneration was present in 9 (7.8%) eyes. The macula was attached at presentation in 35 (30.4%) eyes; in the remaining 80 (69.6%) eyes, the macula was detached. The detachment involved a single quadrant in 12 (10.4%) eyes, two quadrants in 54 (47.0%) eyes, and three quadrants in 29 (26.2%) eyes. The detachment was total in 20 (17.4%) eyes.

Chorioretinal adhesion was achieved by transscleral cryotherapy in 34 (29.5%) eyes, by indirect ophthalmoscope laser photocoagulation in 73 (63.5%) eyes, and by both in 8 (7.0%) eyes. In 10 (8.7%) eyes with dense cataract, lensectomy was performed during primary vitrectomy.

Intraoperative complications

In 5 (4.3%) cases, excision of the flap of the horseshoe tear was complicated by a mild self-limited hemorrhage.

In 1 (0.87%) case, suprachoroidal hemorrhage occurred during transscleral cryotherapy. In 4 (3.5%) cases, the ciliary epithelium was detached leading to incomplete penetration of the ciliary body by the 4-mm infusion cannula. The tissue in front of the cannula was incised using a 20 gauge blade from the other sclerotomy site. This procedure was complicated by accidental lenticular touch in 1 (0.87%) patient.

Reattachment

After one operation, the retina was reattached at the final follow-up in 106 (92.2%) eyes and in all eyes after a second procedure. Redetachment after the first procedure occurred in 9 eyes. Redetachment in 7 (77.8%) cases was due to reopening of inferior original breaks that were located posterior to the buckling effect of the encircling band. Retinopexy was achieved by indirect ophthalmoscope laser photocoagulation in these eyes. The redetachment was due to PVR in 1 (11.1%) eye, and suprachoroidal hemorrhage in 1 (11.1%) eye. Transscleral cryotherapy was used for retinopexy in these two eyes. The interval between initial repair and diagnosis of redetachment ranged from 1 to 20 weeks, with a mean of 5.67±5.7 weeks, and a median of 4 weeks. Univariate analysis demonstrated a significant association between redetachment after the first procedure and the presence of inferior retinal breaks (p=0.0156) (Tab. I).

These nine eyes were reattached with a second procedure. The operations for redetachment included revision of vitrectomy with silicone oil tamponade in eight eyes, and vitrectomy revision and SF_6 gas tamponade in one eye. Silicone oil removal without further redetachment could be performed during the follow-up period.

Postoperative complications

Proliferative vitreoretinopathy causing retinal redetachment occurred in 1 (0.87%) eye. Epiretinal membranes occurred in another 3 (2.6%) eyes, but only one of three was considered severe enough that surgical removal was performed. Glaucoma was diagnosed postoperatively in 10 (8.7%) eyes. Glaucoma was treated medically in nine eyes, and one eye required surgical intervention. One (0.87%) patient developed sympathetic ophthalmia 5 weeks after successful repair of retinal detachment. This case was described in a previous publication (14).

Progression of pre-existing cataract and the development of new posterior subcapsular and nucleosclerotic cataracts were observed in 45 (58.4%) of the 77 phakic eyes. The interval between vitrectomy and diagnosis of cataract ranged from 2 to 150 weeks, with a mean of 30.6±27.9 weeks, and a median of 24 weeks. Thirty of these underwent cataract extraction within the follow-up period because of the development of significant lens

TABLE I - FACTORS PREDICTING THE OCCURRENCE OF RECURRENT RETINAL DETACHMENT

Variable	Recurrent retinal detachment (%)	p value
Gender		
Female	2/17 (11.8)	0.6196
Male	7/98 (7.1)	
Age, yrs		
≤50	6/77 (7.8)	0.999
>50	3/38 (7.9)	
Initial visual acuity		
<20/200	6/61 (9.8)	0.6135
≥20/200	3/54 (5.6)	
Trauma		
Yes	1/8 (12.5)	0.4901
No	8/107 (7.5)	
Amblyopia		
Yes	0/6 (0.0)	0.9999
No	9/109 (8.3)	
Duration of symptoms, days		
≤7	7/82 (8.5)	0.9999
>7	2/33 (6.1)	
Status of macula		
Attached	1/35 (2.9)	0.2725
Detached	8/80 (10.0)	
Number of breaks		
1	3/70 (4.3)	0.1515
≥2	6/45 (13.3)	
Quadrants of breaks		
Superior	2/74 (2.7)	
Inferior	5/27 (18.5)	0.0156*
Both	2/14 (14.3)	
Size of breaks		
≤1 Clock hour	8/108 (7.4)	0.4438
>1 Clock hour	1/7 (14.3)	
Location of breaks		
Anterior to equator	8/100 (8.0)	0.9999
Posterior to equator	1/15 (6.7)	
Complex breaks		
No	3/57 (5.3)	0.5046
Yes	6/58 (10.3)	
Extent of detachment		
1 Quadrant	0/12 (0.0)	0.6909
2 Quadrants	4/54 (7.4)	
≥3 Quadrants	5/49 (10.2)	
Lensectomy		
Yes	1/10 (10.0)	0.5727
No	8/105 (7.6)	
Retinopexy		
Laser	7/73 (9.6)	0.8551
Cryo	2/34 (5.9)	
Both	0/8 (0.0)	

*Statistically significant at 5% level of significance.

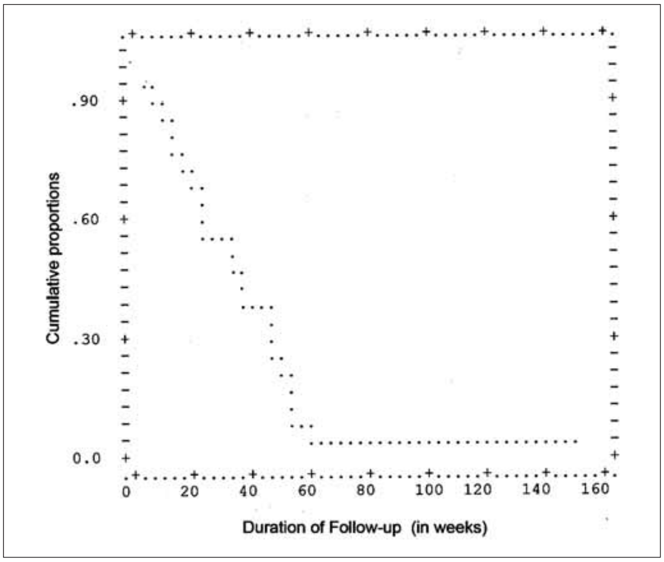

Fig. 1 - *Kaplan-Meier survival curve showing the cumulative proportions of eyes that were free of cataract formation by duration of follow-up.*

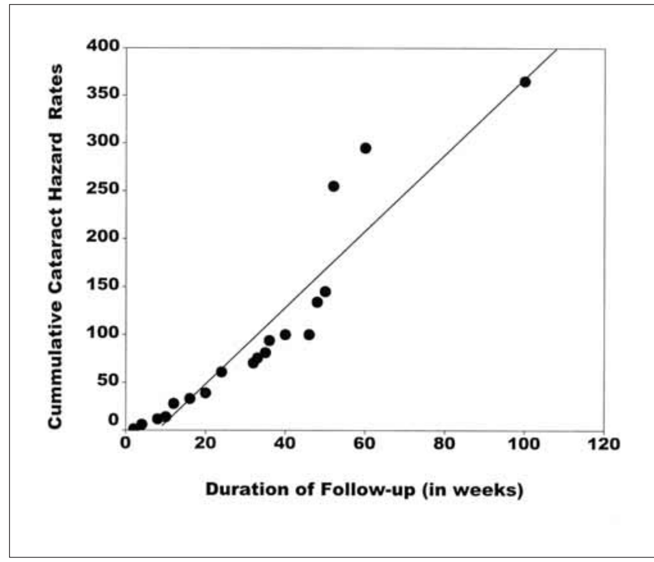

Fig. 2 - *Scattergraph showing the relationship between hazard rates for cataract formation and duration of follow-up.*

opacities. The interval between vitrectomy and cataract surgery ranged from 4 to 36 months, with a mean of 16.7±8.4 months, and a median of 14 months. At the final follow-up, 20 (17.4%) eyes were phakic/clear, 27 (23.5%) were phakic/cataract, 52 (45.2%) were pseudophakic, and 16 (13.9%) were aphakic.

We used Kaplan-Meier survival analysis to investigate the relationship between the duration of follow-up and development of cataract. The results from the analysis are presented in Table II. Kaplan-Meier survival curve for the cumulative proportions of eyes that remained free of cataract during follow-up is presented in Figure 1. When the cumulative hazard rates for cataract formation were plotted against duration of follow-up, the relationship between the two factors is shown in Figure 2. The scattergraph showed that successively longer durations of follow-up were associated with higher hazard rates for cataract development.

Visual acuity

The distribution of initial and final visual acuity is illustrated in Table III. Of the 115 eyes, 44 (38.3%) achieved visual acuity of 20/60 or better. The frequencies above the left to right diagonal line represent eyes that had improvement in visual acuity, those below the line experienced worsened vision, and those along the diagonal line had no change in visual acuity. Therefore, 68 (59.1%) eyes had improved vision, 12 (10.5%) had worsened vision, and there was no change in vision in 35 (30.4%) eyes. Sixty-one (53.0%) eyes had visual acuity of counting fingers or

TABLE II - RESULTS FROM KAPLAN-MEIER SURVIVAL ANALYSIS SHOWING THE CUMULATIVE PROPORTIONS OF EYES THAT EITHER SURVIVED OR DEVELOPED CATARACT FORMATION BY DURATION OF FOLLOW-UP

Follow-up time, wk	Cumulative proportion of eyes without cataract	Cumulative proportion of eyes developing cataract
2	0.9865	0.0136
4	0.9416	0.0601
8	0.8883	0.1184
10	0.8694	0.1399
12	0.7560	0.2797
16	0.7162	0.3337
20	0.6741	0.3944
24	0.5436	0.6095
32	0.4942	0.7048
33	0.4695	0.7561
35	0.4434	0.8132
36	0.3913	0.9384
40	0.3652	1.0074
48	0.2608	1.3439
52	0.0783	2.5478
60	0.0522	2.9533
100	0.0261	3.6464

TABLE III - RELATIONSHIP BETWEEN INITIAL VISUAL ACUITY AND FINAL VISUAL ACUITY FOR 115 EYES

Final visual acuity	**Initial visual acuity**				
	≤ Counting fingers	**20/200–20/100**	**20/80–20/50**	**≥20/40**	**Total**
≥20/40	8	3	6	9	26
20/50–20/80	15	13	4	5	37
20/100–20/200	23	7	3	2	35
≤ Counting fingers	15	1	1	0	17
Total	61	24	14	16	115

worse at presentation, and only 17 (14.8%) eyes had final visual acuity of counting fingers or worse. The difference between the two percentages was statistically significant (p<0.001; Student *t* test for two proportions from the same sample). Final visual acuity of counting fingers or less was due to dense cataract. Univariate analysis demonstrated a significant association between better final visual acuity of 20/60 or better and better initial visual acuity of 20/200 or better (p<0.001), attached macula (p<0.001), and fewer quadrants involved by the detachment (p=0.0015; p=0.0004; linear trend test) (Tab. IV). Multivariate stepwise logistic regression analysis was conducted to identify the variables that tended to be associated with final visual acuity of 20/60 or better after adjustment for all other confounding variables. Results from the analysis highlighted that final visual acuity of 20/60 or better was significantly associated with macular sparing retinal detachment (odds ratio [OR] = 4.88; 95% confidence interval [CI] = 1.29–18.5), and absence of trauma (OR = 20.6; 95% CI = 1.67–254).

Fellow eyes

Six (5.2%) fellow eyes were blind. The cause of blindness was not documented. Nineteen (16.5%) eyes had cataract, 15 (13.0%) eyes were pseudophakic, and 2 (1.7%) eyes were aphakic. Three (2.6%) eyes had already undergone successful retinal reattachment surgery before presentation, and 2 (1.7%) eyes had chronic unoperated retinal detachment. During the follow-up period, 3 (2.6%) fellow eyes experienced retinal detachment. Twenty-two (19.1%) fellow eyes underwent prophylactic treatment in the form of laser photocoagulation to treat lattice degeneration and extended for 360°. None of these eyes experienced retinal detachment during the follow-up period.

DISCUSSION

In this study of a homogenous group of 115 eyes with RRD without PVR operated by the same surgeon using PPPV and intraoperative PFCLs, the primary anatomic success rate was 92.2%. PVR occurred postoperatively in 1 (0.87%) eye. These results compare favorably with most other previously published studies in which PPPV in conjunction with intraoperative PFCLs were used as initial treatment of RRD (8, 15-24) (Tab. V). In the present series of 115 eyes, the bullous retinal detachment was associated with large breaks, multiple breaks at different anteroposterior locations, and/or posterior to the equator breaks in 58 eyes. The reattachment rate in these eyes was 89.7% (52/58) after one procedure. Previous studies have confirmed the advantages of PPPV in eyes with complex breaks (3, 8, 18). In eyes with multiple tears, Miki et al (3) reported primary reattachment rate of 96.9% (28/29) in the eyes that underwent PPPV compared to only 69.9% (16/23) in eyes that underwent scleral buckling.

The low rate of PVR in this series might be related to preoperative complete posterior hyaloid detachment allowing total removal of the vitreous scaffolding, the absence of PVR preoperatively, and meticulous treatment of all retinal breaks after retinal reattachment. Several studies found that incomplete posterior vitreous detachment without collapse of the vitreous gel and preoperative PVR were major predictors of postoperative PVR (25-28). In addition, redetachment due to avoidable factors such as incompletely closed retinal breaks involves a greater risk of PVR. The low incidence of PVR might also be related to removal of the vitreous with its chemotactic and mitogenic stimuli, and the washout of retinal pigment epithelial cells out of subretinal space and vitreous cavity (5).

The adjunctive use of PFCLs in the management of bullous RRD offers considerable advantages. These heavier-

TABLE IV - FACTORS PREDICTING FINAL VISUAL ACUITY

Variable	Final visual acuity of 20/60 or better (%)	p value
Gender		
Male	39/98 (39.8)	0.587
Female	5/17 (29.4)	
Age, yrs		
≤50	32/77 (41.6)	0.406
>50	12/38 (31.6)	
Initial visual acuity		
<20/200	13/61 (21.3)	<0.001*
≥20/200	31/54 (57.4)	
Trauma		
Yes	1/8 (12.4)	0.1515
No	43/107 (40.2))	
Amblyopia		
Yes	1/6 (16.7)	0.4043
No	43/109 (39.4)	
Duration of symptoms, days		
≤7	31/82 (37.8))	0.874
>7	13/33 (39.4)	
Status of macula		
Attached	23/35 (65.7)	<0.001*
Detached	21/80 (26.3)	
Number of breaks		
1	29/70 (41.4)	0.3834
≥2	15/45 (33.3)	
Quadrants of breaks		
Superior	29/74 (39.2)	0.3426
Inferior	12/27 (44.4)	
Both	3/14 (21.4)	
Size of breaks		
≤1 Clock hour	42/108 (38.9)	0.7063
>1 Clock hour	2/7 (28.6)	
Location of breaks		
Anterior to equator	39/100 (39.0)	0.6737
Posterior to equator	5/15 (33.3)	
Complex breaks		
Yes	20/58 (34.5)	0.5163
No	24/57 (42.1)	
Extent of detachment		
1 Quadrant	8/12 (66.7)	0.0015*
2 Quadrants	26/54 (48.1)	
≥ 3 Quadrants	10/49 (20.4)	
Linear trend test p value = 0.0004		
Lensectomy		
Yes	3/10 (30.0)	0.739
No	41/105 (39.0)	
Retinopexy		
Laser	32/73 (43.8)	0.3039
Cryo	10/34 (29.4)	
Both	2/8 (25.0)	
Recurrent detachment		
Yes	3/9 (33.3)	0.9999
No	41/106 (38.7)	

*Statistically significant at 5% level of significance.

than-water temporary vitreous substitutes stabilize and immobilize the bullously elevated mobile retina, converting a complicated situation into a relatively simple RRD. Initial injection of PFCLs during pars plana vitrectomy attaches the posterior retina and prevents the intraoperative extension of the detachment toward the macula in eyes with macular sparing retinal detachment. The PFCL bubble elevates the detached peripheral vitreous and stabilizes the anterior retina, facilitating the safe removal of the anterior vitreous. The optical clarity of PFCLs allows good visualization for meticulous 360° indirect ophthalmoscopy and more precise treatment of retinal breaks with the retina in apposition to the retinal pigment epithelium. This reduces dispersion of retinal pigment epithelial cells into the vitreous cavity and submacular pigment deposition. In addition, the risk of iatrogenic retinal injuries was minimized by the use of PFCLs in combination with the wide angle viewing system of the indirect ophthalmoscope. Vitrectomy by indirect ophthalmoscopy, a maneuver long advocated by John Scott (Cambridge, England), had the advantages of being quick and flexible, and enables visualization over a wide field of view of both the retinal periphery and central retina.

There is still much controversy regarding the advantages and disadvantages of additional encircling scleral buckle with PPPV. While some authors are of the opinion that additional encircling scleral buckle improves the results of the surgery (3, 20, 29), others argue that with modern vitrectomy techniques and a thorough cleaning of the vitreous base, additional buckling might not be necessary (19, 23, 30, 31). The rationale for the use of an encircling band in this series includes the desire to support the posterior margin of the vitreous base which may relieve traction of remnant vitreous that could lead to new break formation. Animal research supports the argument that residual cortical vitreous is present at the vitreous base, no matter how thorough the vitrectomy. Moreover, animal research has also shown that this residual vitreous provides the basis for cells to contract and cause a retinal detachment caused by foreshortening of the peripheral retina (32). In addition, retinal breaks developing along the posterior aspect of the vitreous base some time after vitrectomy was described. These breaks are caused by contraction of fibrovascular tissue ingrowth from the sclerotomy incisions and have visible vitreous strand connecting their flaps with the sclerotomy scars (33, 34). Therefore, the placement of an encircling band to support the posterior border of the vitreous base may reduce this tractional problem and can improve the rate of anatomic success. However, the potential disadvantage of encircling bands is increasing the axial length of the eye and induction of myopia (35).

Several studies reported that newly diagnosed retinal breaks, and not PVR, were the most common cause for retinal redetachment following PPPV (2, 3, 36). These postoperative breaks occurred mostly in previously normal-looking retina at the posterior edge of the vitreous base without apparent signs of retinal degeneration (2, 3, 36). It is believed that the new tear formation resulted from the posterior vitreous detachment progression into an apparently normal region but with strong vitreous adhesion (3, 36). Therefore, a 360° peripheral retinopexy to create a chorioretinal scar in the vitreous base region might be a possible way to further improve the anatomic results of PPPV for rhegmatogenous retinal detachment (23, 31).

Previous studies evaluated the effect of preoperative factors on final visual acuity after repair of RRD with scleral buckling. Factors associated with better final visual acuity included macular sparing retinal detachment, better preoperative visual acuity, less extent of retinal detachment, and lack of high myopia (37). Pastor et al (38) analyzed data from 546 phakic and pseudophakic RRDs treated by pars plana vitrectomy or scleral buckling. Characteristics associated with a worse functional result were macula-off, retinal detachment involving more than three quadrants, preoperative PVR, unsuccessful previous attempts to reattach the retinal detachment, long lapse of time between the development of retinal detachment and the surgical procedure, and older age of the patient. Few studies on PPPV have analyzed the possible predictors for postoperative outcomes. Oshima et al (39) compared scleral buckle surgery and PPPV in a retrospective study of patients with macula-off RRD. Overall, they found that preoperative visual acuity, preoperative ocular hypotony, and the duration of macular detachment were the three best predictors of postoperative visual recovery in both groups. Heimann et al (36) analyzed 512 cases to determine factors associated with anatomic and functional outcomes after PPPV for RRD. The factors identified included duration of symptoms, low preoperative visual acuity, myopia, amblyopia, hypotony, macular detachment, preoperative PVR, extent of detachment, involvement of inferior quadrants, no detectable breaks, large breaks, breaks posterior to the equator, surgeon level of surgical training, endocryotherapy, and combined scleral buckling surgery. In the current study, we identified a significant association between better final visual acuity and better initial visual acuity, macula-on retinal detachment, and fewer quadrants involved by the detachment in the univariate analysis. Results from the multivariate analysis highlighted that better final visual acuity was significantly associated with macular sparing retinal detachment and absence of trauma. The predictors of postoperative visual outcome identified in this series match to a large extent those following scleral buckling surgery. In this retrospective study, the predictive effect of myopic refractive error on postoperative visual and anatomic outcomes could not be evaluated as the measurements of the refractive error were missing in many patients.

The current study has identified a significant associa-

TABLE V - SUCCESS RATES AFTER PRIMARY VITRECTOMY FOR THE TREATMENT OF RHEGMATOGENOUS RETINAL DETACHMENT USING INTRAOPERATIVE PERFLUOROCARBON LIQUIDS

Author	Year	No. of eyes	Indications	Primary success, %	PVR, %
Bartz-Schmidt et al (15)	1996	33	Pseudophakic	94	3
Abu El-Asrar (8)	1997	22	Bullous with complex breaks	100	0
Brazitikos et al (16)	1999	14	Pseudophakic	100	0
Devenyi et al (17)	1999	94	Pseudophakic	100	0
Brazitikos et al (18)	2003	22	Multiple breaks	86.4	9
Stangos et al (19)	2004	71	Pseudophakic	95.7	1.4
Afrashi et al (20)	2004	22	Multiple breaks	90.9	9
Brazitikos et al (21)	2005	75	Pseudophakic	94	4
Ahmadieh et al (22)	2005	99	Pseudophakic	62.6	35.3
Weichel et al (23)	2006	152	Pseudophakic	93.4	5.2
Martínez-Castillo et al (24)	2007	60	Pseudophakic	98.3	0
Current study	2008	115	Bullous	92.2	0.9

PVR = proliferative vitreoretinopathy.

tion between the presence of inferior retinal breaks and redetachment after PPPV for bullous RRD. In the 74 eyes with superior breaks, 2 (2.7%) developed recurrent retinal detachment. In the 27 eyes with inferior breaks, 5 (18.5%) developed recurrent detachment. In the 14 eyes with both superior and inferior breaks, 2 (14.3%) developed recurrent retinal detachment. Similarly, Heimann et al (36) reported a higher rate of redetachment in patients with detachments involving the lower quadrants after PPPV. In another retrospective study of 53 patients, the primary attachment rate was 64%, but when these cases were subdivided according to position of the retinal breaks there was 50% redetachment rate in the group with inferior breaks (2). This result would suggest a poor outcome for these patients; however, the numbers were small (six patients). The higher rate of redetachments in patients with inferior retinal breaks is of significant importance if PPPV is employed. As a consequence of our analysis, a modification of our surgical technique is indicated. With relatively short-acting tamponade, e.g., SF6–air mixtures, as used in this study, breaks in the inferior quadrants are probably not sufficiently supported. A longer acting tamponade, e.g., perfluoropropane, and strict positioning of the patient might be needed to improve the success rates of PPPV in patients with inferior retinal breaks. However, Martinez-Castillo et al (40) achieved a primary success rate of 93.3% (14/15) in patients with pseudophakic RRD due to inferior breaks who underwent PPPV and air tamponade with only 24 hours of prone positioning postoperatively.

The major drawback of primary vitrectomy and intraocular gas tamponade in this series was the high incidence of postoperative cataract. Progression of pre-existing cataract and the development of new cataract occurred in 45 (58.4%) of the 77 phakic eyes. Thirty of these underwent cataract extraction within the follow-up period. Cataract formation after primary vitrectomy and intraocular gas tamponade for RRD has been noted by other authors in 21% to 86% of the cases (2, 29, 39). Our analysis showed that successively longer durations of follow-up were associated with higher hazard rates for cataract development. Therefore, the patient undergoing vitrectomy has to be informed of the probability of a second operation to improve postoperative visual acuity following primary vitrectomy.

In conclusion, primary vitrectomy with the help of PFCLs and a wide angle viewing system is effective for the management of uncomplicated, bullous RRD. The controlled intraocular environment of pars plana vitrectomy is an easier surgical option than complex conventional procedures with a low incidence of intraoperative complications and a high final anatomic success rate. However, the major disadvantage is the high incidence of postoperative cataract formation. The presence of inferior retinal breaks was significantly associated with redetachment after the first procedure. Better preoperative visual acuity, macular sparing retinal detachment, fewer quadrants involved by the detachment, and absence of trauma were significant positive prognostic factors for final visual acuity.

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