Prognostic Factors in Eyes with Severe Proliferative Diabetic Retinopathy Managed with Pars Plana Vitrectomy*

Pars Plana Vitrektomi ile Tedavi Edilen Ciddi Proliferatif Diabetik Retinopatili Gözlerde Prognostik Faktörler

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ABSTRACT

Purpose: To determine the prognostic factors of functional outcomes in eyes with severe proliferative diabetic retinopathy (PDR) managed with pars plana vitrectomy (PPV).

Materials and Methods: A series of 136 consecutive eyes with severe PDR and non-clearing vitreous hemorrhage (VH) or retinal detachment (RD) that underwent PPV were retrospectively reviewed for prognostic risk factors of surgical outcomes and post-operative vision. Chi-square and logistic regression analysis were used for statistical analysis.

Results: Average follow-up was 35 months (range 6-56). A functional outcome (VA>5/200) was achieved in 109 eyes (80.1%) and in 51 of 66 eyes (77.3%) with traction retinal detachment. The VA was improved two lines or more in 79 eyes (58.1%), unchanged in 37 (27.2%), and was worse by 2 lines or more in 20 eyes (14.7%). Complete retinal attachment was observed at the final visit in 122 eyes (89.7%). Predictors of a poor visual outcome were found to be preoperative neovascularization severity (p=0.02), presence of iris neovascularization (RI) (p=0.04), absence of prior pan-retinal photocoagulation (p=0.03), intraoperative fluid/gas exchange (p=0.003), iatrogenic retinotomy (p=0.04), postoperative RI (p=0.0001), recurrent VH (p=0.003), RD requiring PPV and/or buckle surgery (p=0.0001). Logistic regression analysis demonsrated that the significant factors responsible for poor functional outcome to be post-operative RI and RD.

Conclusion: Vitreoretinal surgery has been demonstrated to preserve and improve vision in eyes with severe proliferative diabetic retinopathy. Counselling of patients who are to undergo surgery can be performed with a better understanding of the risks of major complications and the likely outcomes.

Key Words: Pars plana vitrectomy, proliferative diabetic retinopathy, visual acuity, visual function.

ÖZ

Amaç: Pars Plana Vitrektomi (PPV) ile tedavi edilen ciddi Proliferatif Diabetik Retinopatili (PDR) gözlerde görme prognozuna etki eden faktörleri belirlemek.

Gereç ve Yöntem: Ciddi PDR'lı ve temizlenmeyen vitreus kanaması veya retina dekolmanı nedeniyle PPV uygulanan ardışık 136 göz serisi, cerrahi sonuçlar ve ameliyat sonrası görmenin prognostik faktörleri yönünden geriye dönük olarak incelendi. İstatistiksel analiz için ki-kare ve logistik regresyon analizi kullanıldı.

Bulgular: Ortalama takip süresi 35 ay (6-56 ay) idi. 136 gözün 109'ünde (%80.1), traksiyonel dekolman olan 66 gözün 51'inde (%77.3) fonksiyonel sonuç (VA>5/200) elde edildi. Görme 79 gözde (%58.1) iki sıra veya daha fazla artarken, 37 gözde (%27.2) değişmeden kaldı, 20 gözde (%14.7) iki sıra veya daha fazla görme kaybı oldu. Son muayenede 122 gözde (%89.7) retina tamamen yatışık olarak bulundu. Ameliyat öncesi neovaskülarizasyon şiddeti (p=0.02), iris neovaskülarizyon varlığı (RI) (p=0.04), önceki pan-retinal fotokoagülasyonun yokluğu (p=0.03), ameliyat sırasında gaz/sıvı değişimi (p=0.003), iatrojenik retinotomi (p=0.04), ameliyat sonrası RI (p=0.0001), tekrarlayan vitreus kanaması (p=0.003), PPV ve/veya serklaj gerektiren retina dekolmanının (RD)varlığı (p=0.0001) kötü görme için ön görülen faktörler olarak bulundu. Logistik regresyon analizinde ise ameliyat sonrası RI ve RD varlığı kötü fonksiyonel sonuçtan sorumlu önemli faktörler olarak bulundu.

Sonuç: Ciddi PDR'lı gözlerde vitreoretinal cerrahi ile görmenin korunduğu ve artırıldığı gösterilmektedir. Başlıca komplikasyonların risklerini ve muhtemel sonuçlarını daha iyi anlayarak, cerrahi uygulanacak hastalara danışmanlık yapılabilir.

Anahtar Kelimeler: Pars plana vitrektomi, proliferatif diabetik retinopati, görme keskinliği, görme fonksiyonu.

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INTRODUCTION

Proliferative diabetic retinopathy (PDR) is one of the most common causes of blindness in industrialized countries.[1] producing severe visual loss from retinal macular detachment, macular edema with ischemia, vitreous hemorrhage (VH) and neovascular glaucoma (NVG). Pars plana vitrectomy (PPV) has been demonstrated to be effective in preserving and restoring visual function in patients with proliferative diabetic retinopathy,[2-6] but inspite of modifications in the technique, such as endolaser photocoagulation,[7-8] wide angle, non-contact visualization systems[9] and bimanual delamination of epi-retinal fibro-vascular proliferation[10,11] that have reduced the risk of severe complications, visual outcomes remain unpredictable.[12,13]

The purpose of this study was to evaluate the prognostic indicators of functional outcomes in eyes with severe PDR managed with pars plana vitrectomy.

MATERIALS AND METHODS

We have retrospectively reviewed the charts of 136 consecutive eyes that underwent pars plana vitrectomy by one surgeon for severe PDR with non-clearing VH and/or retinal detachment (RD). For all eyes, the following systemic preoperative variables were recorded: age, sex, type and duration of diabetes. For this study the criterion for type 2 diabetes was an onset after the age of 30 years although some were documented as requiring insulin.[14] The following preoperative ophthalmic variables were collected: previous ocular history including laser treatments and surgeries performed; the pre and post-operative variables that were recorded at each visit included visual acuity, measured by Snellen acuity with best refraction (BCVA) and converted to the logMAR equivalent.[15] The pre-operative lens clarity was classified (LOCS III)[16] and iris and angle neovascularization evaluated along with measurement of the intraocular pressure. On funduscopy with biomicroscopy and indirect ophthalmoscopy, the degree of fibrovascular proliferation (NVC classification)[2] as well as area of RD was noted, along with the proximity to or involvement of the fovea and whether there were any accompanying holes or tears. VH was defined as sufficient blood in the vitreous cavity to cause a visual acuity of less than 5/200.

Surgical Technique: 20 gauge PPV was performed by a single surgeon using a wide-angle, non-contact viewing system (SDI/BIOM, Oculus, Wetzlar, Germany). Pars plana lensectomy (PPL) was performed with the technique of Kokame et al.[17] In some cases visco-dissection was employed to facilitate the delamination of broad-based fibrous adhesions from the retinal surface.[18] Laser endo-photocoagulation (PRP) was applied around all retinal breaks. Silicone oil (SO) was not utilized in any of these eyes undergoing primary vitrectomy, but a scleral buckle was performed if there was residual traction on peripheral retinal breaks that could not be removed.

Post-operatively a change in vision was defined to be a two line improvement or loss from that measured pre-opeatively.[19] A functional success was defined as a post-operative final BCVA equal or greater than 5/200. An anatomic succes was defined as complete retinal attachment at the last post-operative visit. Post-operative persistent VH was defined as sufficient hemorrhage to cause a visual acuity less than 5/200 within the first week after surgery and recurrent VH as a new occurrence of bleeding after the first week.

The effects of the following risk factors were evaluated on the final visual outcome;

1- Preoperative: BCVA, history of cataract surgery, severity of posterior neovascularization (combined neovascularization/fibrosis grade 2), presence and type of RD, macular detachment, presence of VH, absence of prior PRP, presence of iris or angle neovascularization (RIA)

2- Intraoperative: Retinal breaks or retinotomies, lensectomy, fluid/gas exchange, scleral buckling.

3- Postoperative: Recurrent VH, recurrent tractional or rhegmatogenous RD, postoperative RIA.

Statistical Analysis

All data was analyzed by Stata statistical software. The data initially were examined in a univariate manner using chi-square analysis of discrete data and the Student *t*-test for continuous variables. In addition, variables that were observed to be associated with visual outcomes on univariate analysis were entered into a model using stepwise logistic regression to identify independent predictors of final vision. Statistical significance was considered to be $p<0.05$.

RESULTS

The study population consisted of 136 consecutive eyes of 126 patients. The mean age was 65.5 years (ranged 21-89 years) of which 72 (66%) were male and 64 (34%) female. Type 1 diabetes was noted in 34%, while 100 (74%) of them were insulin users. Post-operatively all eyes were followed more than six months (mean 35 months). The follow-up period was more than two years in 120 eyes (88.2%) and more than three years in 86 eyes (63.2%) .

In 98 eyes (72%) PRP was performed preoperatively in one quadrant or more of the retina. Fourteen eyes (10.3%) had previous cataract extraction; 10 of them had posterior-chamber and one had an anterior chamber- intraocular lens (IOL) implantation, three of them were aphakic. Thirty-eight eyes had a clear lens pre-operatively, 27 had mild lens opacity, while 57 eyes (41.9%) had moderate or severe lens opasity. The cross

Table 1: Pre-operative Characteristics.

	No-RD (n=55 eyes)	Traction RD (n=66 eyes)	Combined RD (n=15 eyes)	Total (n= 136 eyes)
NVC characteristics				
NVC-1	18	2	1	21 (15.4%)
NVC-2	13	13	5	31 (22.8%)
NVC-3	16	25	2	43 (30.6%)
NVC-4	8	26	7	41 (30.1%)
BCVA				
20/20-20/40	1	4	3	8 (5.9%)
20/50-20/200	12	24	7	43 (31.6%)
20/300-5/200	11	14	2	27 (19.9%)
4/200-0.5/200	13	14	2	29 (21.3%)
HM-LP	18	10	1	29 (21.3%)
Macula detached	--	28	11	39 (28.7%)
VH	49	46	9	104 (76.5%)
PRP	40	47	11	98 (72.1%)

BCVA: Best Corrected Visual Acuity, HM: Hand Motion, LP: Light Perception, n; number of eye, NVC: Severtiy of Neovascularization, PRP: Pan Retinal Photocoagulation, RD: Retinal Detachment, Traction RD: Tractional Retinal Detachment, Combined RD: Combined Retinal Detachment , VH: Vitreous Hemorrhage.

Table 2: Adjunctive Procedures performed during primary vitrectomy.

Lensectomy	52 (38.2%)
Phacoemulsification	2 (1.5%)
Posterior chamber lens implantation	43 (30.1%)
Endo pan-retinal photocoagulation	120 (88.2%)
Fluid/air/gas exchange	43 (31.6%)
Scleral buckle	10 (7.4%)
Peripheral cryopexy	5 (3.7%)

tabulation of the preoperative visual acuity and severity of neovascularization along with the detachment status, presence of VH and PRP were detailed in Table 1.

Adjunctive procedures that were performed at the time of vitrectomy surgery were shown in Table 2. In all eyes, all observable epi-retinal proliferation was removed with delamination. A fluid/air/gas exchange was performed in 43 eyes (31.6%), scleral buckling was performed in 10 eyes (7.4%). The eyes with moderate or severe lens opacification underwent cataract surgery (54 of 121 phakic eyes). Lens removal was performed via PPL in 52 eyes (96%) and by limbal phacoemulsification in 2 eyes (4%). In 41 of the 54 eyes (75.9%) that underwent cataract removal and in 2 of the 3 aphakic eyes, a posterior chamber IOL was implanted.

Post-operatively 20 of 136 eyes (14.7%) had at least one episode of moderate to severe persistent or recurrent VA (VA less than 5/200); of these eyes, eight (6%) required reoperation. Six eyes had recurrent tractional RD (TRD) (but without VH) after the primary vitrectomy. Among these, repeated surgery was performed in four (50%), two of them had severe combined RDs while the other two had tractional detachment with severe preoperative neovascularization (NVC-3 or 4). Repeated surgery in four eyes resulted in visual acuities of 20/40, 20/80, hand motion (HM) and no light perception (NLP) with phthisis bulbi respectively. Regmatogen RD (rrd) occurred after the primary vitrectomy in 12 eyes (8.8%). Four of the 12 eyes did not undergo further surgery, and all of them had NLP vision at the final visit. Of the eight eyes that underwent reoperation, six had significant degrees of proliferative vitreoretinopathy (PVR) equal to or greater than C-3. Three of the six eyes with PVR failed to reattach with repeat surgery and developed phthisis bulbi and/or anterior hyaloid fibrovascular proliferation (AHFP). Two of the remaining three eyes had complete reattachment with VA 20/100 and HM respectively; the other had stable extramacular traction detachment with HM vision due to optic atrophy.

RIA was observed in 11 eyes postoperatively, NVG was developed in four of them. In most of the eyes, the RI was associated with recurrent RD. Three of the four eyes with NVG and one eye with RI underwent repeated vitrectomy, while one eye recieved panretinal cryopexy and cyclocryopexy. Anterior hyaloid fibrovascular proliferation and phthisis developed in two of the four eyes, while the other two had extramacular traction detachments with HM and light perception (LP) vision.

Eight eyes (5.9%) required intraoperative corneal epithelial debridment during the surgery because of insufficient visualization; a persistent corneal epithelial defect remained in one of these eyes for six months which required tarsorrhaphy.

Functional succes;

Preoperative retinal status and postoperative visual acuities at the final visit were demonstrated in Table 3. Of all eyes 37.5% achieved a visual acuity of 20/40 or better while two-thirds of eyes achieved a visual acuity of 20/200 or better at final visit. A functional outcome (visual acuity of 5/200 or better -ambulatory vision) at the final visit was achieved in 109 of the entire group (80.1%), in

Table 3: Post-operative visual outcome and retinal attachment compared with pre-operative retina status

	Preoperative Retinal Status			
	No-RD	**Traction RD**	**Combined RD**	**Total**
	(n=53 eyes)	**(n=66 eyes)**	**(n=15 eyes)**	**(n=136 eyes)**
Post-op BCVA*				
20/20-20/40	22	23	6	51 (37.5%)
20/50-20/200	17	18	3	38 (27.9%)
20/300-5/200	8	10	2	20 (14.7%)
4/200-0.5/200	1	1	0	2 (1.5%)
HM-LP	5	7	1	13 (9.6%)
NLP	2	7	3	12 (8.8%)
Post-op macula attached*	53	59	12	124 (91.2%)
Post-op retina totally attached	52	58	12	122 (89.7%)

*at final visit
Post-op: Postoperative, BCVA: Best Corrected Visual Acuity, HM: Hand Motion, LP: Light Perception, NLP: No Light Perception, n: number of eye, RD: Retinal Detachment, Traction RD: Tractional Retinal Detachment, Combined RD: Combined Retinal Detachment.

Table 4: Post-operative complications compared with pre-operative detachment status.

	Preoperative Retinal Status			
	No-RD	**Traction RD**	**Combined RD**	**Total**
	(n=53 eyes)	**(n=66 eyes)**	**(n=15 eyes)**	**(n=136 eyes)**
Post-Op complications				
Persistent VH*	3	7	0	10 (7.4%)
Recurrent VH*	3	7	0	10 (7.4%)
Recurrent TRD	1	3	2	6 (4.4%)
Recurrent Combined RD	1	7	4	12 (8.8%)
Post-op RI	3	6	2	11 (8.1%)
Post-op AHNV	1	3	2	6 (4.4%)
Repeat Surgery	6	9	3	18 (13.2%)**

*Sufficient to produce VA <5/200, **total 20 procedures.
n; number of eye, RD: Retinal Detachment, Traction RD: Tractional Retinal Detachment, Recurrent Combined RD: Combine Retinal detachment, Persistent VH: Persistent Vitreous Hemorrhage, Post-op: Postoperative, Post-op RI: Post-opereative iris neovascularization, Post-op AHNV: Post-opereative anterior hyaloid neovascularization.

51 of 66 eyes (77.3%) with a pre-operative TRD, and in 11 of 15 eyes (73.3 %) with a pre-operative combined RRD and TRD. The visual acuity was improved two lines or more in 79 of the eyes (58.1%), was unchanged in 37 eyes (27.2%), and was decreased 2 lines or more in 20 eyes (14.7%).

Anatomic success;

122 of the 136 eyes (89.7%) that underwent surgery, had complete retinal attachment at the final visit, while 124 of them (91.2%) had at least macular attachment (Table 3). Retinal breaks were created or observed during epiretinal membrane dissection in 39 eyes (28.7%) These retinal breaks were found at the posterior of the equator in 25 eyes and at the anterior of the equator in 16 eyes. This occurred in 10.9% of eyes with no pre-operative detachment, in 33% of eyes with tractional detachment, and in 60% of eyes with combined mechanism detachments ($p<0.001$). Post-operative complications compared with pre-operative detachment status were listed in Table 4. Repeat vitrectomy was performed with or without scleral buckling for 18 eyes.

Predictors for poor visual outcome:

The following risk factors were determined through Chi-square analysis to be univariate predictors of a poor visual outcome (final visual acuity of <5/200):

A) Preoperative: severity of NVC ($p=0.02$) , presence of RI ($p=0.04$), absence of prior PRP ($p=0.03$),

B) Intraoperative: fluid/gas exchange ($p=0.003$), iatrogenic retinotomy ($p=0.04$),

C)Postoperative: recurrent VH ($p=0.003$), recurrent RRD ($p=0.0001$), recurrent TRD ($p=0.02$), need for repeated surgery ($p=0.0001$), postoperative RI ($p=0.0001$). No statistically significant correlation was found between the other predictors ($p> 0.05$). The significant factors were listed in Table 5.

From a multivariate model of all factors evaluated by univariate analysis, the significant factors responsible for a final VA of less than 5/200 were post-operative RIA which was absolutely predictive, and recurrent RRD which produced a relative risk of 64.8 ($p<0.0001$).

Table 5: Risk Factors for postoperative vision less than 5/200.

Variables	*No. of Eyes*	*% having final VA <5/200*	*P*
NVC			
1&2*	52	5 (9.6%)	0.02
3&4	84	22 (26.2%)	
Preoperative RI			
N*	129	23 (17.8)	0.04[a]
Y	7	4 (57.1%	
Absence of previous PRP			
N*	38	12 (31.6%)	0.03
Y	98	15 (15.3%)	
Intraoperative gas used			
N*	93	12 (12.9%)	0.003
Y	43	15 (34.9%)	
Iatrogenic retinotomies			
N*	97	15 (15.5%)	0.04
Y	39	12 (30.8%)	
Postoperative Recurrent VH.			
N*	117	18 (15.4%)	0.003[a]
Y	19	9 (47.4%)	
Recurrent RRD			
N*	124	16 (12.9%)	0.000[a]
Y	12	11 (91.7%)	
Recurrent TRD			
N*	130	23 (17.7%)	0.02[a]
Y	6	4 (66.7%)	
Repeat PPV and/or buckle			
N*	118	15 (12.7%)	0.000[a]
Y	18	12 (66.7%)	
Postoperative RI			
N*	125	16 (12.8%)	0.000[a]
Y	11	11 (100%)	

* reference variable
[a] Yate's correction is used for small expected frequency.
NVC: Neovascularization Severity, Preoperative RI: Preoperative iris Neovascularization, Absence of Previous PRP: Absence of previous Pan-retinal Photocoagulation, Postoperative Recurrent VH: Postoperative Recurrent Vitreous Hemorrhage, Recurrent RRD: Recurrent Rhegmatogenous Retinal Detachment, Recurrent TRD: Recurrent Tractional Detachment, Repeat PPV and/or Buckle: Repeated Pars Plana Vitrectomy and/or Buckle. Postoperative RI: Postoperative Rubeosis iridis, VH:Vitreous Hemorrhage.

DISCUSSION

The study is representative of outcomes from vitrectomy surgery performed by a single, experienced surgeon for such difficult cases of advanced PDR. In this study, the retina was completely attached at the final visit in 122 eyes (89.7%) with the macula attached in 124 (91.2%) and compares favorably with reported, a 70-93% complete reattachment[8,14,20-23] and a 75-91% macular reattachment rates.[8,11,14,20,21] Final anatomic outcomes were reported in previous series, 33 to 100% in eyes with central diabetic TRD over the past 25 years. [8,11,22,24-40] However, it is difficult to make accurate comparisons, as we included all diabetic vitrectomies, whereas some other studies only included those with TRD.[8,13.]

In this series a visual acuity of 5/200 or better at the final visit was achieved in 109 of the entire group of 136 eyes (80.1%) and in 51 of 66 eyes with TRD (77.3%), which is similar to 71-77% of the eyes in two prior studies [8,14,22] of equivalent cases and better than the 64-68% reported for cases performed earlier.[3,20,22,41] In our series 65.4% of all eyes and 60% of the eyes with TRD had final visual acuity of 20/200 or better which compares with 16 % to 57%[8,11,21,23,42,43] achieving in prior series. A final acuity postoperatively of 20/40 or better was observed in 35.5% of all eyes and in 34.8% of eyes with TRD in this series, compared with prior studies ranging from 13% to 22%.[8,11,20] We realize that in our series only 28 of the 66 eyes with TRD had a macular detachment preoperatively, which may have been the reason for the improved post-operative vision, although we did not observe that pre-operative macular detachment was a predictor for poorer visual outcome compared with no detachment or with no macular detachment. It is also possible that the reduced numbers of eyes with acuities $\geq$20/40 in the other series may have been due to greater numbers of eyes having significant lens opacity, since in those series 77-81% [8,11] were left phakic compared with 60% of the eyes remaining phakic in this study.

By univariate analysis the following pre-operative ophthalmic variables were determined to be significantly associated with a poor visual outcome post-operatively: the severity score of NVC , presence of RI, and absence of prior PRP. Other studies[1,20,24,44-49] as well have attempted to identify the risk factors for poor visual outcome. While the majority in those studies resulted directly from post-vitrectomy complications.[24,45-46] Preoperative ophthalmic predictors that were identified included pre-operative RIA,[24] NVG,[45,48-49] and pre-operative severe fibrovascular proliferation[1], similar to our studies. However, dense cataract or pre-operative aphakia, was not associated with a poor outcome in this study.

Intraoperative use of gas tamponade, such as air, SF_6 or C_3F_8, was associated with a worse visual prognosis in the univariate analysis. This probably reflects the complexity of the dissection rather than a direct effect of the tamponade.[21] In this series a fluid/gas exchange was performed in 31.6% of all eyes, compared with a 40% to 51% in prior studies.[8,11,21,24] The frequency of fluid/gas exchange, similar to the frequency of retinotomies, was greater in those eyes with more severe neovascularization but was not associated with a greater incidence of recurrent post-operative hemorrhage.

In this series, most all of the eyes with moderate or severe lens opacification underwent lens removal with the vitrectomy (44.6% of the phakic eyes). While this rate is significantly greater than that reported in previous series (3%-29%),[11,20,24] only 5.1% of all eyes in this series had an increase in opacification post-operatively sufficient to warrant lens extraction by the time of the last visit. In this series primary lensectomy did not significantly prolong the surgery and was not a risk factor for post-operative poor visual outcome unlike that reported by Williams.[8] In addition, lensectomy in this series was not a risk factor for iris neovascularization,[25] mainly we believe, because of the aggressive application of peripheral PRP.

Therefore, a substantial number of secondary cataract procedures was obviated by this approach with few observed complications. Phacoemulsification combined with PPV and PC-IOL implantation are both effective surgical methods to achieve better and more rapid visual rehabilitation for patients with combined cataract and vitreoretinal disease. [50-55] Combined vitreoretinal surgery and PC-IOL implantation resulted in greater improvement in vision, less astigmatism change, and fewer postoperative complications.[50]

The aggressive approach to delamination of epiretinal membranes at the peripheral vitreous base that was enabled with the wide-angle viewing system, we believe obviated the need for scleral buckling with a minimal incidence of resultant post-operative RD (13.2%). In the majority of cases buckling was performed during the first surgery only in eyes with combined mechanism detachments associated with significant PVR. The frequency of scleral buckling among all of the cases in this report is less than a rate of 9-17% [8,11,23, 24] reported previously.

Post-operative ophthalmic variables associated with a poor outcome in this study included persistent or recurrent VH, recurrent RD, repeated PPV and/or buckling surgery, postoperative RIA. In this series, a postoperative persistent or recurrent vitreous hemorrhage was significantly lower than reported previously of 25%-45% severe VH postoperatively for severe PDR and comparable or slightly lower than the 17%-19% reported in more recent series[20,25,56] utilizing delamination surgery. Persistent or recurrent VH may likely be the result of retained fibrovascular tissue at the vitreous base.[46,57] Before the development of the wide-angle visualization systems, a relatively large and often hemorrhagic vitreous skirt was left at the end of the procedure that would prevent observation of such peripheral neovascularization or make its dissection extremely difficult. Such neovascularization may be associated with delayed VH caused by contraction of the adherent peripheral gel from fibrocyte proliferation stimulated by the retained hematogenous components.[58] If stimulated to grow by peripheral retinal ischemia, such anterior neovascularization, lying at or close to the posterior margin of the vitreous base, if not delaminated, with ongoing, untreated peripheral retinal ischemia, may also lead to AHFP. Therefore, the low rates of both recurrent VH and AHFP in this series, we believe, are in part also due to the aggressive application of peripheral pan-retinal endolaser which was facilitated by the shaving of the vitreous gel to a minimal skirt, removing the hemorrhage and delaminating all peripheral neovascularization.

Eighteen eyes (13.2%) overall developed a recurrent detachment after the initial vitrectomy, among which six eyes (4.4%) had postoperative TRD or macular distortion and 12 eyes (8.8%) that had RRD. The incidence of recurrent TRD reported here is similar to the 12% incidence reported previously for delamination[8] and less than the post-operative detachment rate of 20%-36% for vitrectomy with membrane segmentation.[20,24] Among the 12 eyes with recurrent RD, in three eyes peripheral detachments were observed early after the vitrectomy and were successfully repaired with scleral buckling in the post-operative period. Nine of the 12 eyes (6.6% of all eyes) had severe PVR associated with the recurrent RD that occurred in eyes in which the original vitrectomy was for severe neovascularization, often associated with TRD or RRD. The 8.8% rate of post-operative RRD in this study compares with a 7% rate reported by Williams et al.[8]

Eleven eyes in this series (8.1%) were noted postoperatively to develop RI, among which four eyes also developed NVG. Eight out of the eyes that developed post-operative RI had recurrent RRD, as also reported by Aaberg.[25] In those eyes without RD, RI was associated with co-existent carotid or ophthalmic artery significant stenosis. The 3% rate of postoperative NVG in this series appears significantly better than the 4.4 %-23% reported previously in segmentation series [20,22-25] and similar to the 3%-7% reported in a small series of eyes undergoing similar delamination. The low rate observed in this series was in spite of a high frequency of lensectomy that has been reported previously to be associated with increased risk of RI and appears to be due to the low rate of recurrent RD and to the extensive application of PRR. At final visit, all of the eyes with significant RI had VA between HM and NLP. We found that postoperative RI was the strongest risk factor for poor visual outcome.

In our series, SOI tamponade was not used because, intraocular gas tamponade has greater surface tension and spontane reabsorbsion. SO tamponade have been advocated for treatment of the severe PDR [59-63] when extended intraocular tamponade was needed. The rational for using SO on the management of anterior segment neovascularisation is that SO compartmentalises the eye and confines angiogenic substance to the posterior segment.[64,65] SO tamponade is useful in severely diseased eyes with PDR, even in the presence of RI and NVG, FS, or in cases with previously failed vitrectomy, especially in the presence of RI.[66] But, SO does not always prevent the development of neovascuarization.[60,67] Recently, intravitreal bevacuzimab has become popular as a preoperative coadjuant in cases of severe PDR.[68-72] Preoperative suppresion of the intraocular bevacuzimab should reduce intraopertive hemorrhage during membrane dissection facilitating the surgery.

The retrospective, non-randomized nature of the study, small number of patients, no SO and no bevacuzimab useage comprise the limitations of our study.

In conclusion, in this consecutive cases series, post-operative RI and recurrent RD were the strongest

predictors for poor visual outcome. The current study confirmed the importance of pre-operative ophthalmic variables that signify poor visual outome such as global ischemia or more severe or extensive detachment that may limit visual return in spite of successful surgery. While the presence of more severe combined fibrous and neovascular epiretinal membnanes is associated with poorer vision outcomes, in this series, similar to others, the primary causes are those associated with surgical complications that may result in repeat detachment. With these outcomes in mind, counselling of patients who are to undergo surgery can be performed with a better understanding of the risks of major complications and the likely outcomes with the great majority of patients regaining or retaining useful vision.

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