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ORIGINAL PAPER

Recurrent retinal detachment after diabetic vitrectomy

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Abstract

Purpose To investigate the characteristics of recurrent retinal detachment (RD) after diabetic vitrectomy (DV).

Methods Consecutive cases underwent vitrectomy for recurrent RD after DV was collected and separated into the following four groups for analysis: rhegmatogenous RD (RRD), pure tractional RD (Proliferative Subgroup 1), combined RD with proliferative tissue within the equator (Proliferative Subgroup 2), and combined RD with both posterior and peripheral proliferations (Proliferative Subgroup 3).

Results Of the 41 cases enrolled, retinal reattachment was achieved in 73.2%. Over all, visual acuity was statistically better after operation ($p = 0.001$). All cases in the RRD group (four cases) had reattachment and a better final vision ($p = 0.008$). In the proliferative subgroups, those with pure tractional RD (Subgroup 1, seven cases) had the best visual acuity at the time of recurrent RD ($p = 0.002$). Subgroups 2 and 3 showed statistically significant better final visual acuity ($p = 0.045$ and 0.019, respectively). Poor preoperative vision ($p = 0.001$), non-attachment ($p = 0.004$), and neovascular glaucoma ($p = 0.001$) were associated with poor prognosis.

Conclusions Visual acuity may improve after operation for recurrent RD after diabetic vitrectomy. Visual prognosis was better in cases with pure RRD. In the proliferative subgroups, vision was impaired by the development of neovascular glaucoma and retinal non-attachment.

Keywords Retinal detachment · Diabetic vitrectomy · Pars plana vitrectomy · Proliferative diabetic retinopathy · Recurrent retinal detachment

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Introduction

Around 1 to 20% of the cases developed retinal detachment (RD) after diabetic vitrectomy (DV) for fibrovascular proliferation (FVP) [1–7]. The risk was high for severe proliferation because of surgical difficulties and the excessive manipulations required [4, 5, 8]. New breaks, missed breaks, or proliferation

from residual fibrovascular tissue or newly developed preretinal tissue may be the underlying causes [2, 5, 9]. Because of the preproliferative microenvironment, compromised choroidal and retinal circulation, recurrent RD after vitrectomy for proliferative diabetic retinopathy usually had poor anatomical and functional prognosis [6, 8]. Previous reports on the surgical results of recurrent RD have been limited in the literature, and the reported prognosis was generally poor [8, 10]. It remains to be seen whether recent advancement in the instrument and techniques [11–13], specifically the use of small gauged instrument, frequent adaptation of bimanual techniques, and the use of anti-vascular endothelial growth factors, may enhance the surgical outcome. Further, risk factors affecting the anatomical and functional results have not been reported in the literature.

In the present cases series, we collected cases presenting with recurrent RD after DV and classified the cases based on the severity of detachment and preretinal proliferation. We aimed to describe the clinical characteristics and surgical prognosis of the cases treated for recurrent RD after DV.

Methods

Clinical charts of patients who were diagnosed as recurrent RD after DV and were operated by a single surgeon from 2008 to 2018 at the National Taiwan University Hospital were reviewed retrospectively. Those cases which had multiple large retinal breaks with retinal tissue shortening and insufficiency resulted from severe traction were excluded. Cases with opacified cornea, severe neovascular glaucoma (NVG), or without light perception vision were also excluded. The study adhered to the tenets of the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of National Taiwan University Hospital. All of the enrolled cases received regular follow-up, monthly for the first 3 months and 2–3 months afterward, for more than 6 months after operation. The demographic and ophthalmological data on the day of admission for second operation were collected, including age, sex, hypertension (HTN), renal function, interval between the primary operation and recurrence, best-corrected visual acuity (BCVA), intraocular pressure (IOP), severity of proliferation, RD severity and extent, and fellow eye status. The ophthalmological data at the first DV were also collected retrospectively, including BCVA, IOP, and the presence of traction retinal detachment (TRD) or combined tractional and rhegmatogenous detachment. We collected postoperative data including BCVA at 6 months after operation, final BCVA, fundus status, and the presence of NVG until the end of follow-up.

Patient classification

We classified these cases into two major categories: the pure RRD (RRD) group and the proliferative tissue-related group (Proliferative group). The proliferative group was further divided into pure TRD (Proliferative Subgroup 1), combined RD with proliferative vitreoretinopathy (PVR) and minor FVP (Proliferative Subgroup 2), combined RD with PVR and severe FVP (Proliferative Subgroup 3). PVR was defined as the presence of avascular preretinal membrane in the posterior or anterior retina, causing fixed retinal folds or anterior retinal contraction. Minor FVP was defined as FVP distributed within the equator, and severe FVP was defined as FVP growing beyond the equator. The grouping was done before the surgery and was readjusted during surgery. The fundus photograph of representative cases for the four groups is shown in Fig. 1.

Surgical techniques for proliferative cases:

A standard three-port pars plana vitrectomy was performed. A 23-gauged system was used for a more efficient suction if silicone oil removal was planned at the beginning of the surgery. Otherwise, a 25-gauged system was set up. After removing the vitreous strands and the residual peripheral vitreous with vitreous cutter, the preretinal membrane was carefully lifted with microforceps. The avascular epiretinal membrane was peeled directly with microforceps, with caution to avoid inducing breaks. Microscissors and microforceps were used alternatively for the delamination of thick fibrotic or fibrovascular tissue that was adherent to the retinal vessel. Bimanual techniques were frequently adopted for the removal of extensive proliferation on the detached retina. Retinectomy of a limited area was done posterior to the equator to remove the highly adherent, contracted thick membrane difficult to separate from the retina; circumferential peripheral retinectomy was performed

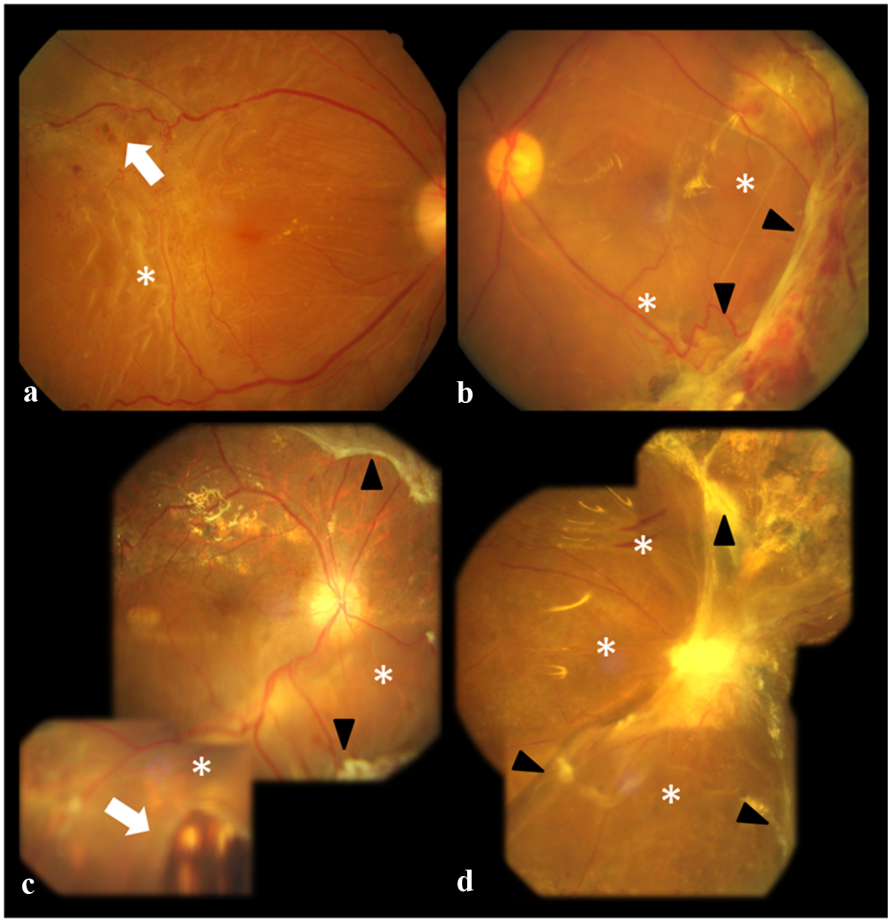

Fig. 1 Fundus photograph of representative cases for the four groups. **a** RRD group: The fundus photograph revealed retinal breaks at the temporal upper macula (arrow), which induced retinal detachment (asterisk). Proliferative tissue was not presented in this case. **b** Proliferative Subgroup 1: The fundus photograph revealed proliferative tissue along temporal macula (arrowhead) with tractional retinal detachment (asterisk). Retinal break was not presented in this case. **c** Proliferative Subgroup 2: The fundus photograph revealed minor proliferative tissue distributed within equator (arrowhead) and large retinal break (arrow) at inferior part, which resulted in combined RD (asterisk). **d** Proliferative Subgroup 3: The fundus photograph revealed extensive proliferative tissue extends to periphery at upper and nasal lower quadrants (arrowhead), with subtotal RD (asterisk). Retinal breaks were noted at periphery during operation

commonly for significant vitreous base traction unreleasable by other manipulations. Direct fluid–air exchange or perfluorocarbon liquid injection followed by fluid–air exchange was done to reattach the retina. Laser photocoagulation around the breaks and the peripheral retina was done subsequently. Silicone oil infusion was then performed after an intravitreal injection of bevacizumab (about 1.25 mg).

Statistical analysis

Among the categories studied, continuous variables were analyzed by the analysis of variance (ANOVA) tests and the Scheffer tests, and categorical variables were analyzed by the Chi-squared tests or Fisher's exact tests. Wilcoxon signed-rank tests were performed for the logMAR BCVA change before the second operation and the final follow-up. Logistic and linear regressions were used to analyze the risk factors for poor visual outcome. The statistical analysis was performed using SPSS software (version 21; SPSS, Chicago, Illinois, USA), and statistical significance was set at $p < 0.05$. For statistical analysis, the vision of counting finger was set as LogMAR 2.0 and hand motion or worse as 3.0 [14].

Results

There were 41 cases in the study. The demographic and ophthalmologic data are presented in Table 1. The mean age was 48.39 ± 10.95 years old, and 34.1% of them were male. At the first DV, mean BCVA logMAR was 1.773 ± 0.888, and 78.0% had TRD. The mean time interval from first DV to recurrence was 6.17 ± 6.12 months with 34.1% for more than 6 months. The mean BCVA logMAR was 2.213 ± 0.871 at the second operation, 1.801 ± 0.924 at 6 months after operation, and 1.842 ± 0.982 at the end of follow-up, respectively. Significant long-term visual improvement from preoperative vision was achieved after reoperation ($p = 0.001$, by Wilcoxon signed-rank test). Silicone oil was used in 38 cases. The lens status of all the study cases were summarized as follows: 16 cases (39.02%) were pseudophakic before the second surgery, 20 cases (48.78%) received phacoemulsification with intraocular lens implantation during the second surgery, 3 (7.32%) cases received phacoemulsification and intraocular lens implantation after the second surgery. There were only two cases (4.88%) that remained phakic at the end of follow-up. Overall, retinal reattachment was achieved in 73.2%. NVG developed in 29.3% of the cases. Among the cases with NVG, 75% of the cases had a final visual acuity of hand motion or worse.

Four cases had simple RRD as shown in Table 1. All of them had recurrence within the first 6 months after the initial operation. Three cases had open breaks within the equator and one at the vitreous base. All had reattachment and visual improvement after reoperation. None in this group developed NVG. Patients in this group also had better final vision after operation compared with those in other subgroups ($p = 0.008$). In the proliferative group, there were seven cases in Proliferative Subgroup 1, 11 cases in Proliferative Subgroup 2, and 19 cases in Proliferative Subgroup 3. Detailed information of each patient is given in Table 2.

In Proliferative Subgroup 1, BCVA at the time of recurrent RD was around 20/800 to 20/200, and 71.4% of cases had the final BCVA of 20/400 or better after the second operation. Retinal reattachment was achieved in five cases (71.4%), and NVG developed in two cases (28.6%). In Proliferative Subgroup 2, nine of the 11 cases had vision less than 20/400 at the time before the second operation. Postoperative BCVA was better than 20/400 in four cases. Retinal reattachment was achieved in 10 cases (90.9%), and NVG developed in three cases (27.3%). In Proliferative Subgroup 3, 16 of 19 cases had BCVA less than 20/400 at the time before the second operation. Postoperative BCVA was better than 20/400 in five cases. Retinal reattachment was achieved in 11 of the 19 cases (57.9%), the lowest among the three subgroups. NVG developed in seven cases (36.8%). Three cases in

Table 1 Demographic and clinical data for recurrent RD cases and comparison between RRD and proliferative groups

	Overall	RRD (4)	Proliferative (37)	*p* value
Age (first OP)	48.39 ± 10.95	43.00 ± 10.81	48.97 ± 12.36	0.660
Gender (M)	34.1%	25.0%	35.1%	1.000
HTN	56.1%	25.0%	59.5%	0.303
CKD	34.1%	25.0%	35.1%	1.000
LogMAR (first OP)	1.773 ± 0.888	2.000 ± 0.817	1.741 ± 0.907	0.273
Recur > 6 mos	34.1%	0%[a]	40.5%	0.278
LogMAR (second OP)	2.213 ± 0.871	1.850 ± 0.870	2.252 ± 0.874	0.348
LogMAR (final)	1.842 ± 0.987	0.625 ± 0.377	1.957 ± 0.941	0.008
Attachment	73.2%	100%	70.3%	0.559
NVG	29.3%	0%	32.4%	0.302

OP operation, *RRD* rhegmatogenous retinal detachment, *M* male, *HTN* hypertension, *CKD* chronic kidney disease, *logMAR* visual acuity in logMAR, *NVG* neovascular glaucoma

[a]All case in RRD group recurred within 6 months

Table 2 Cases summary, categorized by RRD and Proliferative Subgroups 1 to 3

	Age	Sex	R/L	VA1	FVP	TRD	Recur interval	VA2	VA6m	Final VA	f/u	Attach	NVG
Case													
RRD													
1	48	F	L	ND	2	P	5	20/500	20/25	20/25	> 5 years	P	N
2	35	F	R	HM	4	P	1	HM	20/400	20/200	12 months	P	N
3	31	M	R	20/200	4	P	1	20/300	20/100	20/100	8 months	P	N
4	57	F	L	ND	1	P	2	ND	20/400	20/100	> 5 years	P	N
Case													
Sub 1													
1	39	M	R	20/200	2	P	2	20/200	20/50	20/60	24 months	P	N
2	56	M	R	20/400	2	N	12	20/400	HM	HM	24 months	N	P
3	65	F	L	20/200	4	P	5	20/400	20/400	20/400	6 months	P	N
4	54	F	R	20/400	4	N	27	20/160	20/200	20/400	12 months	P	P
5	55	F	L	20/800	4	P	5	20/800	20/400	20/125	24 months	P	N
6	28	F	R	20/60	4	P	3	20/800	20/60	20/100	10 months	P	N
7	50	F	L	ND	2	N	4	20/250	20/400	HM	10 months	N	N
Case													
Sub 2													
1	47	F	L	HM	2	P	1	HM	20/400	LS	12 months	P	P
2	55	M	R	20/60	2	N	1	HM	20/200	20/200	29 months	P	N
3	51	M	L	HM	4	P	2	LS	HM	HM	9 months	P	N
4	57	F	L	ND	4	P	1	ND	20/800	20/800	38 months	P	N
5	31	M	R	20/400	4	N	2	20/100	20/200	20/125	45 months	P	P
6	51	F	R	N/A	4	P	13	HM	ND	ND	> 5 years	P	N
7	51	F	L	20/60	3	N	2	ND	20/800	20/800	68 months	P	N
8	52	F	R	LS	4	P	5	LS	NLP	NLP	32 months	N	N
9	51	M	L	20/500	2	P	4	LS	LS	NLP	38 months	P	P
10	45	F	L	20/400	3	P	12	ND	20/200	20/200	12 months	P	N
11	62	F	L	N/A	3	P	8	20/200	20/200	20/200	6 months	P	N
Case													
Sub 3													
1	41	M	R	N/A	4	P	12	HM	HM	HM	6 months	P	P
2	51	F	L	N/A	4	P	8	20/800	ND	ND	9 months	P	P
3	49	F	L	20/400	3	P	15	20/160	20/125	20/125	12 months	P	N
4	59	F	R	20/400	2	P	3	HM	HM	HM	20 months	P	P
5	53	F	R	HM	4	P	16	LS	LS	LS	29 months	N	N
6	64	M	R	N/A	3	P	15	20/200	20/125	20/100	22 months	P	N
7	43	F	R	ND	4	P	21	HM	LS	LS	26 months	P	P
8	41	F	L	N/A	3	P	3	HM	HM	HM	> 5 years	N	P
9	56	M	L	20/500	2	P	1	HM	20/800	20/800	8 months	N	N
10	20	F	R	HM	3	N	7	HM	HM	HM	> 5 years	P	N
11	60	M	L	ND	4	P	1	HM	LS	LS	13 months	N	P
12	53	F	R	N/A	4	P	10	HM	20/500	20/200	20 months	P	N
13	45	M	R	HM	4	P	12	20/400	20/800	20/125	48 months	P	N
14	61	M	L	20/60	2	N	2	HM	20/400	ND	> 5 years	N	N
15	43	M	R	HM	1	P	1	ND	ND	20/800	12 months	N	N

Table 2 continued

	Age	Sex	R/L	VA1	FVP	TRD	Recur interval	VA2	VA6m	Final VA	f/u	Attach	NVG
16	36	F	R	N/A	3	P	12	HM	HM	LS	> 5 years	N	P
17	54	F	L	20/600	3	P	2	HM	LS	LS	> 5 years	N	N
18	34	F	L	20/160	3	P	2	HM	20/400	20/400	20 months	P	N
19	27	F	L	HM	2	P	1	HM	ND	ND	6 months	P	N

M male, *F* female, *R/L* right/left, *VA1* visual acuity at first operation, *N/A* no available, *FVP* fibrovascular proliferation, *TRD* tractional retinal detachment, *VA2* visual acuity at second operation, *VA6m* visual acuity at 6 months after operation, *VA final* visual acuity at last follow-up, *f/u* follow-up, *NVG* neovascular glaucoma, *P* positive, *N* negative, *ND* number of digit, *HM* hand motion, *LS* light sense, *NLP* no light perception

Subgroup 3 gradually developed fibrosis around the PCIOL with poor vision despite attached retina.

The demographic and ophthalmological data between the three proliferative subgroups were compared, and the results are listed in Table 3. There were no significant differences in age, HTN, or renal function at the second operation. BCVA logMAR before the second operation was significantly better in Subgroup 1 than in the other two subgroups ($p = 0.002$). At 6 months after operation, there was a trend of better visual outcome in Subgroup 1 when compared with Subgroup 3 ($p = 0.069$, by post hoc Scheffer test). The final BCVA, however, did not have significant difference among the three subgroups. Only two cases in Subgroup 1 had final BCVA worse than 20/400 (28.6%), while 7 (63.6%) in Subgroup 2 and 14 (73.7%) in Subgroup 3 ($p = 0.135$) did. The Proliferative Subgroups 2 and 3 showed significance in visual improvement. ($p = 0.045$ and 0.019, respectively). The prognostic factors for poor final vision included BCVA logMAR at first and second operations ($p = 0.015$, 0.001, respectively), presence of recurrent detachment ($p = 0.004$), and development of NVG ($p = 0.001$). There was no significance correlation with the general conditions including HTN, kidney disease, gender, and age.

Discussion

The number of studies on recurrent RD after DV had been limited in the literature. Browns GA et al. reported a cases series (41 cases) of reoperation after DV in 1992, where 18 of the 41 cases were reoperated

Table 3 Demographic and clinical data for proliferative subgroups with statistical analysis

Proliferative group	Group 1 (7)	Group 2 (11)	Group 3 (19)	*p* value
Age (first OP)	50.43 ± 12.87	50.46 ± 8.04	47.58 ± 11.79	0.734
Gender (M)	28.6%	36.4%	36.8%	1.000
HTN	57.1%	72.7%	52.6%	0.611
CKD	28.6%	27.3%	42.1%	0.658
VA log (first op)	1.261 ± 0.487	1.756 ± 1.084	1.990 ± 0.919	0.236
TRD at first OP	57.1%	63.6%	89.5%	0.129
Recur > 6 mos	28.6%	27.3%	52.6%	0.185
LogMAR (second OP)	1.272 ± 0.298	2.336 ± 0.863	2.565 ± 0.777	0.002
LogMAR (6 m post)	1.288 ± 0.878	1.791 ± 0.848	2.196 ± 0.854	0.061
LogMAR (final)	1.599 ± 1.000	1.927 ± 0.925	2.143 ± 0.922	0.422
VA final > 1.3[a]	28.6%	63.6%	73.7%	0.135
Attachment	71.4%	90.9%	57.9%	0.197
NVG	28.6%	27.3%	36.8%	0.899

OP operation, *M* male, *HTN* hypertension, *CKD* chronic kidney disease, *logMAR* Visual acuity in logMAR, *TRD* tractional retinal detachment, *NVG* neovascular glaucoma

[a]Visual acuity presented as logMAR, equivalent to 20/400 as Snellen

because of recurrent RD. In these 18 cases, 83% had a final vision no better than counting fingers, and only 22% achieved retinal reattachment after the second operation [10]. No other update studies on this entity using modern instruments, techniques, and pharmacological agents were reported. In the present study, we reported better visual outcome and higher anatomical success rate than the previous study. Moreover, we analyzed our results by further dividing our cases based on the severity of presentation and found different subgroups may be associated with different surgical outcomes.

In the present study, we classified the recurrent RD cases into two major categories. The first is pure rhegmatogenous RD (RRD group). In such condition, all preretinal membrane and FVP tissue have been removed during the first operation. The detachment came mainly from missed breaks created during intraoperative manipulation (three cases in our series) or breaks formed by vitreous traction after surgery (one case in this series). Sternfeld et al. [9] reported a risk of induced break in DV of as high as 41.7%. Based on the authors' observation and literature review, iatrogenic breaks most commonly occur within a lattice degeneration adjacent to prior FVP stumps, from one or more heavy laser scars, or close to the ora serrata corresponding to the instrument insertion sites [2, 10]. The recurrence of RD in this type developed rapidly after the first operation and was correlated with better visual outcome without NVG complications.

The second category was proliferative tissue-related recurrent detachment. The proliferative tissue may come from PVR-related avascular tissue or diabetic retinopathy-related residual or newly formed fibrovascular proliferation. Organized blood clot under silicone oil is a unique and important source of thick preretinal tissue [15]. The proliferative group were further divided into three subgroups. Proliferative Subgroup 1 presented with the development of thick fibrotic bands or membranes causing retinal traction. Traction macular thickening, schisis, lamellar macular hole, full thickness macular hole, or frank traction macular detachment may develop. Extensive surgery may be required as the tractional membrane may be widespread; in our series, periphery retinectomy were needed in four cases. Proliferative Subgroup 2 featured combined rhegmatogenous and tractional retinal detachment with the presence of minor fibrotic membranes localized within the equator complicated by retinal breaks. There were both avascular membrane from proliferative vitreoretinopathy and vascular membrane from fibrovascular proliferation. Because the FVP membranes were limited, the removal of traction could usually be attainable. In our series, 10 of the 11 cases had reattachment as well as overall significant visual improvement. However, peripheral retinectomy was still needed in most cases because of the presence of PVR. Proliferative Subgroup 3 featured combined RD with extensive proliferative fibrotic membrane extending beyond the equator. It was the largest group in our study and was the most challenging to the surgeon. Anterior PVR was universally present in these eyes, and subretinal gas or subretinal silicone oil was not uncommon. The extensive proliferative tissue beyond the equator made complete removal more difficult, and the surgery was often complicated with bleeding and breaks even under bimanual techniques [16]. Only 11 of the 19 cases (57.9%) had final reattachment. We noticed three cases with attached retina gradually developed fibrosis around the PCIOL and had poor vision. This evolution indicates persistent low-grade inflammation long after surgery. Despite these difficulties, significant VA improvement was achieved. This was because the visual acuity markedly decreased at the time of recurrent detachment, and any anatomical and functional improvement may contribute to the average visual gain. In the proliferative subgroups, bimanual technique and peripheral retinectomy were frequently applied for releasing traction [17, 18]. The appliance of silicone oil tamponade was widely used in this situation, which has the advantage of early visual rehabilitation and a better opportunity to prevent recurrent detachment [6, 18].

Our classification was clinically relevant and useful not only for assessing the degree of surgical difficulties, but might also for predicting the anatomical and short-term functional outcome. Comparison among the three proliferative subgroups, we found better vision preoperatively in Subgroup 1; also, Subgroup 1 showed a trend of reduced chance to have BCVA less than 20/400. There was only two (28.6%) patients experienced recurrent RD after the second operation with a final BCVA worse than 20/400 in Proliferative Subgroup 1. Subgroup 3 had the least reattachment achieved. There was a significant difference in VA before the second operation between Subgroups 1 and

3, and a borderline significance of VA at 6 months. The relatively better prognosis in Subgroup 1 (TRD group) may have resulted from better vision before the second operation due to limited areas of retinal detachment, or less macular elevation and ischemia. Abunajma et al. [19] reported visual improvement after DV for chronic TRD, and the favorable prognostic factors included younger age and less degree of macula ischemia. Despite the aforementioned differences, the three subgroups were similar in many aspects. Visual improvement was achieved in around 50% of cases in each group. The rate of NVG and long-term visual prognosis were similar. These results indicated severe retina pathology once recurrent RD had developed. It is unknown whether the use of SO and anti-VEGF at the end of primary operation can decrease the dreadful complication of recurrent RD. To prevent recurrent RD, one should avoid missed breaks or vitreous traction induced breaks, and remove FVP tissue likely to cause traction as completely as possible. If there was unresolved extensive and thick preretinal blood under SO, early removal of the thick clot is suggested.

In summary, we reported a case series with recurrent RD after DV. The study was limited by the retrospective nature and a small cases number. However, the vitreoretinal changes and clinical conditions before and after repeated surgeries in each included case had been carefully documented. We found, with modern instrument and techniques, even though not a small proportion of cases had grave visual prognosis, significant visual improvement was achievable in many cases after operation. Cases with pure RRD had better visual and anatomical outcomes when compared with the proliferative group. Among the three proliferative subgroups, we found that a better visual prognosis was associated with better vision before operation, absence of NVG, and a reattached retina.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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