Artigo Original

Pars Plana Vitrectomy in Proliferative Diabetic Retinopathy – Retrospective Analysis of Results and Complications

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RESUMO

Objetivos: Analisar os resultados e as complicações da vitrectomia via pars plana (VVPP) no tratamento de pacientes com retinopatia diabética proliferativa (RDP).
Métodos: Estudo retrospectivo de todos os doentes submetidos a VVPP por RDP no período de Abril de 2012 a Junho de 2014, com um follow-up mínimo de 2 meses. Os dados recolhidos incluíram dados demográficos, melhor acuidade visual corrigida (MAVC), indicação para VVPP, complicações, sucesso funcional e sucesso anatómico.
Resultados: 108 olhos de 85 doentes foram submetidos a VVPP por RDP no período referido. A idade média dos doentes era de 62.45±10.89 anos, com um predomínio do sexo feminino (55.3%). O follow-up médio foi de 12.24 meses. A MAVC pré-operatória média era de 1.37±0.69 logaritmo de ângulo mínimo de resolução (logMAR). As 3 principais indicações para cirurgia foram: hemovítreo (HV), 68 olhos, descolamento de retina tracional (DRT), 9 olhos e DRT associado a HV (11 olhos). Em 59 olhos foi efetuado no mesmo tempo operatório cirurgia de facoemulsificação do cristalino. Na última consulta de follow-up, a MAVC média foi superior à registada no pré-operatório (0.87±0.76 logMAR, p <0.001). A taxa de sucesso funcional global foi de 80.6%, sendo superior no grupo de doentes com HV (89.7%). A taxa de sucesso anatómico foi de 98.1%.
Conclusões: O nosso estudo sugere que a VVPP pode ser usada com sucesso para tratar as complicações da RDP e frequentemente resulta em melhoria da acuidade visual do paciente.

Palavras-chave
Vitrectomia via pars plana, retinopatia diabética proliferativa, hemovítreo, descolamento de retina tracional, estudo retrospetivo.

ABSTRACT

Purpose: To analyze the results and complications of pars plana vitrectomy (PPV) in the treatment of patients with proliferative diabetic retinopathy (PDR).
Methods: Retrospective study of all patients that underwent PPV for PDR in the period between April 2012 and June 2014 and with a minimum follow-up of 2 months. Data collected included baseline demographics, best-corrected visual acuity (BCVA), indications for surgery, complications, anatomic and functional success.

Results: One hundred and eight eyes of 85 patients underwent PPV for PDR in the referred period. Patient's mean age was 62.45±10.89 years, with female predominance (55.3%). Mean follow-up time was 12.24 months. Preoperative mean BCVA was 1.37±0.69 logarithm of the minimum angle of resolutions (logMAR). The three main indications for surgery were: vitreous haemorrhage (VH) in 68 eyes, tractional retinal detachment (TRD) in 9 eyes and VH associated with TRD (11 eyes). Fifty-nine eyes underwent phacoemulsification in the same surgery. In the last follow-up appointment, mean BCVA was superior to that registered preoperatively (0.87±0.76 logMAR, p <0.001). Global functional success rate was 80.6%, and it was superior in the HV group (89.7%). Anatomic success rate was 98.1%.
Conclusions: Our study suggests PPV can be used successfully to treat PDR complications and often results in patient's visual acuity improvement.

Key-words
Pars plana vitrectomy, proliferative diabetic retinopathy, vitreous haemorrhage, tractional retinal detachment, retrospective study.

INTRODUCTION

Diabetes mellitus (DM) is a global epidemic affecting nowadays 382 million people worldwide.[14] Proliferative diabetic retinopathy (PDR) is an important cause of visual acuity loss in working age population.[38] Tractional retinal detachment (TRD) and vitreous haemorrhage (VH) are two frequent complications of PDR.[10] In the last decades, pars plana vitrectomy (PPV) surgical technique and instrumentation has evolved significantly, which contributed to the enlargement of surgical indications and to improve patients' prognosis.[2,18,21,31,34,37] In addition to classic surgical indications – persistent VH, TRD with macular involvement and combined TRD-rhegmatogenous retinal detachment, new conditions that may benefit with PPV have emerged, namely: severe neovascular proliferation[8], dense premacular subhyaloid haemorrhage[19], macular or optic disc traction[20,26], anterior hyaloidal fibrovascular proliferation[16] and severe macular edema.[13]

The purpose of this study is to report and analyze the visual and anatomical outcomes of our patients submitted to PPV for complications due to PDR.

MATERIALS AND METHODS

A retrospective observational study was conducted. Medical records of all patients with PDR submitted to PPV from April 2012 through June 2014 at Ophthalmology Department of Pedro Hispano Hospital were reviewed (110 eyes of 87 patients). All surgeries were done by one of three surgeons (CT, RC or JNM). Patients with less than 2 months follow-up were excluded (2 eyes of 2 patients), remaining for analysis 108 eyes of 85 patients.

Data collected included baseline demographics, previous ophthalmologic procedures (laser photocoagulation, phacoemulsification surgery, intravitreous injections), indication for surgery, best-corrected visual acuity (BCVA) preoperative and postoperative (2-3 months after surgery and last follow-up available), perioperative and postoperative complications, anatomical and visual outcome, and duration of follow-up.

BCVA was evaluated at 6 meters using decimal scale and was converted to logarithm of the minimum angle of resolution (logMAR) for statistical analysis. Patients with failure to read any letters were tested using counting fingers (CF), hand movements (HM) and light perceptions (LP), for which the following logMAR BCVA values were ascribed, as previously described[25]: CF = 1,85 logMAR; HM = 2,30 logMAR; LP = 2,80 logMAR; no LP = 2,90 logMAR.

The primary outcome measure was functional success rate that was evaluated at 2-3 months and at last follow-up available. BCVA improvement from baseline was considered a functional success. Secondary outcomes included complications and anatomical success (defined as completely attached retina at last follow-up).

Post-vitrectomy vitreous cavity haemorrhage (PVVCH) was classified into three groups: persistent (if present in day 1 after surgery), early (if arises in first month after surgery) or late (if arises more than 1 month after surgery).

All surgeries were done under general anesthesia (105 eyes) or peribulbar and subtenon's block (3 eyes). All patients underwent standard three-port 23 gauge PPV

using the procedures adequate to each case. An injection of intraocular gas - sulfur hexafluoride (SF6) or perfluoropropane (C3F8), or silicone oil as endotamponade was done in appropriate cases. At the end of surgery, subconjuntival injections of cefuroxime and triamcinolone acetonide were administered.

IBM Statistical Package for Social Sciences (SPSS) 20.0 was used for statistical analysis. Paired samples t test or Wilcoxon signed-rank test were used to compare BCVA (or alternatively repeated measures ANOVA for comparison of more than 2 groups). Independent samples t test was used to compare results between the group of combined surgery (phacovitrectomy) and the group only submitted to PPV. Fisher's exact test or chi-square test were used to compare proportions between qualitative variables. Statistical significance was set at $p<0.05$ for all analysis.

RESULTS

A total of 108 eyes of 85 patients with PDR underwent PPV during the study period. The mean age was 62.45±10.89 (range 34-87) years, with female predominance (55.3%). Mean follow-up was 12.24 months. Seventy six patients had type 2 DM and 9 patients type 1 DM.

Mean duration of DM at surgery was 27,8 ± 10,7 years for type 1 DM patients and 20,2 ± 9,2 years for type 2 DM patients. Twenty three patients (27.1%) underwent PPV in both eyes in different periods of the study. In this study, main systemic comorbidities were hypertension (72 patients) and dyslipidemia (44 patients) (Table 1).

Before PPV, 91 eyes have been previously submitted to panretinal photocoagulation and 72 eyes to macular focal/grid laser, 41 eyes to previous anti-vascular endothelial growth factor (VEGF) intravitreous injection, 4 eyes to previous intravitreal triamcinolone acetonide injection and 7 eyes to previous PPV.

On preoperative evaluation, 18 eyes presented rubeosis iridis and 7 eyes presented neovascular glaucoma. In respect to lens state, 37 eyes were pseudophakic and 59 presented cataracts. (Table 1)

Thirty six eyes (33.3%) received intravitreal ranibizumab injection before surgery, at a median of 5 days (range 1-12) before PPV. There was no statistically significant difference in development of PVVCH between those who did the injection (6 cases in 66 eyes) and those who didn't (13 cases in 72 eyes), with an incidence of 16.7% and 18.0%, respectively (χ^2 (1) = 0.032; p=1.00; n=108).

The indications for surgery were: VH, 68 eyes (63,0%), TRD, 9 eyes (8,3%), TRD associated with VH, 11 eyes (10,2%), tractional diabetic macular edema/epiretinal membrane (TDME), 7 eyes (6,5%) and other causes: 13 eyes (12.0%), includes: extensive neovascular proliferation, 12 eyes (11,1%) and 1 case of dense premacular haemorrhage (0,9%). During this study, no case was submitted to surgery due to combined retinal detachment. Simultaneous phacoemulsification surgery was done in 59 eyes (54,6%) and in 3 eyes (2,8%) simultaneous implantation of Ahmed glaucoma valve. Laser endophotocoagulation was

Table 1 | Baseline demographics.

Variable	Mean ±SD (minimum and maximum) or n (%)
Gender (female, %)	47 (55.3%)
Age, years	62.45±10.89 (34-87)
Type 2 Diabetes	76 (89.4%)
Duration of Diabetes, years	20.96±9.56 (2-47)
Insulin	62 (72.9%)
Hypertension	72 (84.7%)
Dyslipidemia	44 (51.8%)
Ischaemic heart disease	10 (11.8%)
Diabetic nephropathy	32 (37.6%)
Cerebrovascular disease	17 (20.0%)
Follow-up, months	12.24±7.22 (2-30)
Preoperative BCVA, logMAR	1.37±0.69 (0.3-2.8)
Previous macular focal/grid laser	72 (66.6%)
Previous panretinal photocoagulation	91 (84.3%)
Previous intravitreal anti-VEGF injection	41 (38.0%)
Previous intravitreal triamcinolona acetonide injection	4 (3.8%)
Previous pars plana vitrectomy	7 (6.5%)
Rubeosis iridis	18 (16.7%)
Neovascular Glaucoma	7 (6.5%)
Lens State	
Pseudophakic	37 (34.3%)
Aphakic	0 (0%)
Clear lens	12 (11.1%)
Cataract	59 (54.6%)

Abbreviations: BCVA – best-corrected visual acuity; logMAR – logarithm of the minimum angle of resolution; VEGF – vascular endothelial growth factor.

Table 2 | Surgical Indications, Additional Surgical Procedures and Type of Tamponade.

Variable	n (%)
Surgical Indication	
VH	68 (63.0%)
TRD	9 (8.3%)
TRD+VH	11 (10.2%)
TDME	7 (6.5%)
Others	13 (12.0%)
Additional Surgical Procedures	
Phacoemulsification	59 (54.6%)
Implantation of Ahmed glaucoma Valve	3 (2.8%)
Laser endophotocoagulation	100 (92.6%)
Intravitreal injection of triamcinolone acetonide at the end of surgery	3 (2.8%)
Type of Tamponade	
SF6	38 (35.2%)
C3F8	3 (2.8%)
Silicone Oil	4 (3.7%)

Abbreviations: VH – vitreous haemorrhage; TRD – Tractional retinal detachment; TDME – tractional diabetic macular edema/epiretinal membrane; SF_6 – sulfur hexafluoride; C3F8 – perfluoropropane

done in 100 eyes (92.6%). For tamponade, SF_6 was used in 38 eyes, C_3F_8 was used in 3 eyes and silicone oil was used in 4 eyes. (Table 2)

Mean preoperative BCVA was 1.37±0.69 logMAR, which improved to 0.87±0.76 logMAR at last follow-up (p<0.001) Functional success rate in last follow-up was 80.6%. At last follow-up, BCVA improved in 87 eyes (80.6%), was similar in 10 eyes (9.3%) and decreased in 11 eyes (10.2%). Seventeen eyes had final BCVA equal or less than +1.85 logMAR, 38 eyes between +1.30 and +0.70 logMAR, 27 eyes between +0.52 and +0.30 logMAR and 26 eyes superior to +0.30 logMAR. (Table 3). Three eyes had no LP (2.8%): 2 because of neovascular glaucoma in patients with poor metabolic control (with glycated hemoglobin above 10%) and 1 case in a patient with bilateral TRD with poor surgical prognosis where despite the poor prognosis after discussing the clinical situation with the patient surgery was performed (eye with total funnel-shaped TRD that was impossible to surgically solve).

At 2-3 months after surgery, functional success rate was 74.1% (80 eyes), in other words, slightly inferior to that of last follow-up.

In patients with follow-up equal or superior to 12 months (n = 64), we compared the latest postoperative BCVA to the BCVA recorded at 2-3 months postoperative in order to determine the long-term functional stability after PPV. We found that mean BCVA in those patients at 2-3 months postoperatively (0.97±0.75 logMAR) and at last follow-up available (1.00±0.75 logMAR) was similar and statistically superior to that registered preoperatively (repeated measures ANOVA test, p<0.001) (Figure 1). In 26 eyes (40.6%), final BCVA compared to 2-3 months postoperative was unchanged, in 23 eyes (35.9%) improved and in 15 eyes (23.5%) it

Table 3 | Visual outcomes in last follow-up (global and by surgical indication).

		BCVA (logMAR)						
		≤ +1.85	Entre +1.30 e +0.70	Entre +0.52 e +0.30	> +0.30	Mean ± SD	p-value (versus preop.)	Functional Success Rate
Global	Preop.	49	42	17	0	1.37±0.69	<0.001 *	80.6%
	Postop.	17	38	27	26	0.87±0.76		
VH	Preop.	35	24	9	0	1.44±0.69	<0.001 *	89.7%
	Postop.	9	21	17	21	0.76±0.72		
TRD	Preop.	5	4	0	0	1.80±0.75	0.06 &	55.6%
	Postop.	2	5	2	0	1.35±0.68		
TRD+VH	Preop.	2	7	2	0	1.04±0.52	0.11 &	72.7%
	Postop.	1	4	2	4	0.81±0.83		
TDME	Preop.	0	4	3	0	0.91±0.41	0.49 &	57.1%
	Postop.	1	4	2	0	0.95±0.51		
Others	Preop.	7	3	3	0	1.29±0.72	0.21 &	69.2%
	Postop.	4	4	4	1	1.04±0.93		

Abbreviations: BCVA – best-corrected visual acuity; logMAR – logarithm of the minimum angle of resolution; VH – vitreous haemorrhage; TRD – Tractional retinal detachment; TDME – tractional diabetic macular edema/epiretinal membrane; preop. – preoperative; postop. – postoperative; SD – standard deviation; * paired samples t test; & - Wilcoxon signed-rank test.

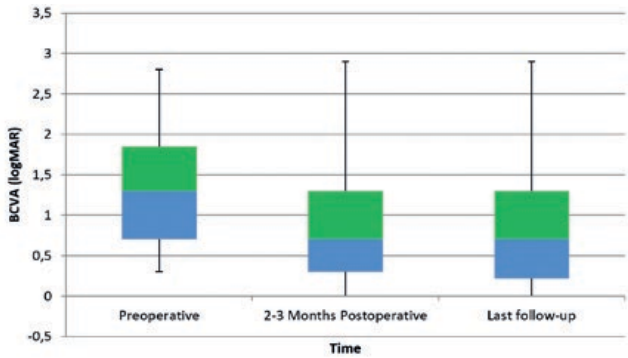

Fig. 1 | Boxplot showing BCVA evolution in patients with > 12 months follow-up (n = 64).

became worse. The main causes of BCVA deterioration in these 15 eyes were: neovascular glaucoma (5 eyes), macular edema (3 eyes), ischaemic maculopathy (2 eyes), posterior subcapsular cataract (2 eyes), macular atrophy (1 eye), posterior capsule opacification (1 eye) and 1 case of terminal glaucoma after surgery refractory to medical treatment.

Analyzing the functional results accordingly to surgical indication, there is a statistically significant relation between surgical indication and the functional success at last follow-up (χ^2 (4) = 11,170; p = 0,025; n=108), with the groups "VH", "TRD associated with VH" and "other indications" being strongly associated with success. Table 3 shows the visual outcomes for each indication for surgery, which was superior in VH group (functional success rate of 89.7%), where 59 eyes (86.8%) showed a final BCVA equal to or better than +1.30 logMAR and 21 eyes (30.9%) superior to +0.30 logMAR. The groups with worst results were TRD group (functional success rate of 55.6%, no eyes with final BCVA superior to +0.30 logMAR) and TDME group (functional success rate of 57.1%, no eyes with final BCVA superior to +0.30 logMAR).

It is also important to analyze the change in BCVA at last postoperative follow-up relatively to preoperative BCVA: 68.5% of eyes showed an improvement ≥0,3 logMAR, 22.2% an improvement or decrease inferior to 0.3 logMAR and only 9.2% showed a decrease ≥0.3 logMAR. The group of patients with VH showed again the best results (Table 4).

There were no statistically significant differences between genders in the incidence of failures in the last postoperative evaluation (χ^2 (1) = 1.969; p=0.220; n=108; men: 12 failures in 47 eyes: functional success rate 74.5%; women: 9 failures in 61 eyes: functional success rate 85.2%).

Mean BCVA at last follow-up was statistically superior compared to preoperative BCVA both in patients submitted to combined surgery (phacoemulsification and PPV) and in patients submitted only to PPV. In PPV group, the mean preoperative BCVA was 1.50±0.68 logMAR and improved to 0.76±0.69 logMAR (p<0.001). In combined surgery group, the mean preoperative BCVA was 1.27±0.69 logMAR and improved to 0.94±0.80 logMAR (p<0.001).

The overall anatomic success was 98.1% (106 eyes).

Intraoperative complications included iatrogenic retinal tears in 14 eyes (13.0%), 1 case of choroidal detachment, 1 case of choroidal trauma with vitrectome with choroidal hemorrhage and 1 case of serous retinal detachment caused by inadequate positioning of infusion line. Postoperative complications included 19 eyes (17.6%) with PVVCH: persistent in 7 eyes (6,5%), early in 7 eyes (6,5%) and late in 5 eyes (4,6%). Among other complications described in Table 5, we underline 12 cases of ocular hypertension (11 transient and 1 persistent) and 10 cases of *rubeosis iridis* (7 with neovascular glaucoma), of which 6 were already present preoperatively and only 4 appeared postoperatively. Of 7 eyes with postoperative neovascular glaucoma, 5 cases were already present preoperatively and only 2 appeared postoperatively.

In 63 eyes (58.3%) no additional procedures were needed after surgery. In the remaining 45 eyes (41.7%), the procedures done were: second PPV in 8 eyes (7.4%), phacoemulsification surgery in 2 eyes (1.9%), retinal photocoagulation

Table 4 | Change in best-corrected visual acuity (last follow-up versus preoperative).

	≥0.3 logMAR gain, n (%)	+- 0.3logMAR, n (%)	≥ 0,3 logMAR loss, n (%)
Global	74 (68.5%)	24 (22.2%)	10 (9.3%)
VH	52 (76.5%)	13 (19.1%)	3 (4.4%)
TRD	5 (55.6%)	2 (22.2%)	2 (22.2%)
TRD+VH	8 (72.7%)	1 (9.1%)	2 (18.2%)
TDME	3 (42.9%)	3 (42.9%)	1 (14.3%)
Others	6 (46.2%)	5 (38.5%)	2 (15.4%)

Abbreviations: VH – vitreous haemorrhage; TRD – Tractional retinal detachment; TDME – tractional diabetic macular edema/epiretinal membrane; logMAR – logarithm of the minimum angle of resolution

Table 5 | Intraoperative and postoperative complications (percentage of total eyes).

Variable	n (%)
Intraoperative Complications	
Iatrogenic retinal tears	14 (13.0%)
Choroidal detachment	1 (0.9%)
Others	2 (1.9%)
Postoperative Complications	
Post-vitrectomy vitreous cavity hemorrhage	19 (17.6%)
Hyphema	5 (4.6%)
Moderate anterior chamber reaction	4 (3.7%)
Corneal epithelial defects	5 (4.6%)
Choroidal detachment	1 (0.9%)
Rhegmatogenous retinal detachment	1 (0.9%)
Ocular Hypertension	12 (11.1%)
Rubeosis iridis	10 (9.3%)
Neovascular Glaucoma	7 (6.5%)
Cataract	4 (3.7%)

(focal and/or panretinal) in 28 eyes (25.9%), intravitreal injections of anti-VEGF in 25 eyes (23.1%) and glaucoma surgery in 5 eyes (4.6%). The reasons for underwent second PPV were: non-resorbing post-vitrectomy vitreous cavity hemorrhage in 6 eyes (5.5%), silicone oil removal in 1 eye and 1 case of rhegmatogenous retinal detachment 6 weeks after first surgery (0.9%).

DISCUSSION

Surgical management of late complications of PDR remains nowadays one of the most challenging vitreoretinal procedures. It's difficult to compare results from different studies owing to the presence of numerous confounding factors and important systemic comorbidities in these patients. However, we should highlight that anatomic and visual outcomes have continued to improve since the study *Diabetic Retinopathy Vitrectomy Study* (DRVS), with the progress of surgical techniques and instrumentation.[7,17,30] Our study showed positive results: 108 eyes underwent PPV with an anatomical success rate of 98.1% and a functional success rate of 80.9% and 34 eyes (31.48%) had a final BCVA ≥+0,3 logMAR, representing a significant improvement comparing with a recent study of Yorston et al[37] and older studies of Thompson et al[32], Sima et al[29] and DRVS.[7,8,9] Our success rate was were very similar to that of DRIVE UK study. [11] (Table 6) Anatomical success rate in our study was similar to the study of Sima et al[29] and higher than other published studies[11], and this is probably explained by the lower percentage of cases with TRD (only 18.5%) in our study.

The overall improved surgical results observed in our study probably could be multi-factorial: improved health-care services, better awareness of both primary health-care service providers and patients to improve diabetic control and other systemic comorbidities and the great evolution in PPV instrumentation and surgical technique.

The main indication for surgery in our study was VH. Previous studies differ in this respect, with some studies showing TRD as the main indication for surgery[11,35] and other studies pointing VH.[27] DRVS study showed benefits of early PPV in VH[7,9], with greater probability of visual acuity improvement or stabilization. Nowadays, with the significant improvement in surgical techniques and instrumentation, we consider that surgery is safer and early PPV makes even more sense (patients are frequently in working-age and need fast visual recovery). Thus, earlier intervention in VH could be one of the reasons of greater incidence of VH comparing with previous studies. On the other hand, a better understanding of the importance of good metabolic control by the patients and the improved access to health-care services may have contributed to the lower incidence of TRD in

Table 6 | Comparative visual outcomes following vitrectomy for proliferative diabetic retinopathy.

	Thompson et al (n=1007)	Sima et al (n= 260)	Yorston et al (n=174)	DRIVE UK (n=185)	Our study (n=108)
Vitrectomy years	1975-1983	1987-1990	2004-2005	2007-2009	2012-2014
TRD	36%	31.5%	37%	63%	8,3%
VH	35%	26.2%	49%	32.4%	63%
TRD+VH	NE	32.3%	NS	*	10.2%
Visual Acuity	17%≥6/12	15%≥6/12	11% >6/12	38% ≥6/12	3,5% ≥6/12
Follow-up	Minimum 6 months	Minimum 12 months	Median 8 months (4-15)	12 months	Mean 12.24 months (2-30)

Abbreviations: VH – vitreous haemorrhage; TRD – Tractional retinal detachment; NS – not specified; * Included in TRD group

our study. Additionally, the use of intravitreal injections of anti-VEGF as an adjunct to retinal photocoagulation induces an effective regression of retinal neovascularization, contributing to a better control of PDR in these patients (and hence a lower incidence of TRD).[2]

Among the various indications for PPV in PDR, VH presented the best prognosis, similarly to results of previous studies.[9,11,35] On the other hand, TRD presented the worst prognosis, with a functional success rate of 55.6%. Previous studies showed that TRD with macular involvement cause significant visual loss and have worst visual results compared with VH, as occurred in our study (because macular ischemia and atrophy occasionally prevent visual acuity improvement after a surgery with anatomical success).[11,29,35]

In our study, the TDME group presented a functional success rate of only 57.1%. The rational for the use of PPV in TDME is to promote release of anteroposterior and tangential macular tractions, clean retinal surface mediators that favor diabetic macular edema (DME) and increase oxygen levels in vitreous cavity.[5] Published studies showed structural improvement with PPV but functional results are more limited.[5,6] The Diabetic Retinopathy Clinical Research Network (DRCR.net) study evaluated the role of PPV in DME treatment. Of 241 patients, 71% presented changes of vitreoretinal interface or macular traction and epiretinal membrane peeling was done in 146 eyes (61%).6 Despite the surgery, mean visual acuity was unchanged throughout the study.

In a subgroup of this study, 87 eyes presented DME and vitreomacular traction and in these patients, at 6 months after surgery, visual acuity improved by ≥ 10 letters in 38% and deteriorated by ≥ 10 letters in 22% and mean visual acuity was similar to baseline (20/100).[5] Median central subfield thickness decreased by 160 microns at 6 months. Within the first 6 months, no eye had panretinal photocoagulation performed, 4 eyes had macular laser performed, 2 eyes had intravitreal injections of corticosteroid and 2 eyes received injections of anti-VEGF.[5] Few changes in results were noted between 6 months and 1 year and the majority of eyes (74%) did not receive some form of treatment for DME in this period.[5]

Thus, often these patients present a chronic macular edema with long evolution in which despite structural improvement no significant functional improvement occurs after surgery and this may explain the functional success rate observed in our study. Perhaps an earlier intervention in these eyes could have improved visual results. However, PPV in these eyes frequently allows stabilization of visual acuity and reduces the need of further treatments of DME.[5] In our study, the majority of patients with TDME achieved BCVA stabilization and only 1 eye presented a decrease in BCVA equal or superior to 0.3 logMAR.

Intravitreal anti-VEGF therapy can induce rapid regression of retinal neovascularization in PDR[2] and may be used as adjunctive pharmacotherapy in these patients. Growing evidence reports that intravitreal bevacizumab administered 1-2 weeks preoperatively may facilitate surgical dissection of fibrovascular membranes[4,23] and reduce the risk of recurrent vitreous cavity hemorrhage.[36] Another study reported that intravitreal ranibizumab administered 1 week preoperatively reduces the risk of intraoperative haemorrhage in patients with PDR and TRD.[22] However, there is a potential adverse effect because rapid fibrovascular membrane contraction can lead to rapid development or progression of TRD.[1] The timing of PVV is therefore critical to avoid this complication.

In our study, PVVCH occurred in 19 eyes (17.6%), and only 6 eyes (5.5%) needed a second PPV to clean the haemorrhage. However, there were no statistically significant differences in the occurrence of PVVCH between eyes that were submitted to ranibizumab injection preoperatively and those who didn't do the injection. In our study preoperative ranibizumab injection was done mainly in those more difficult cases and with more likelihood of hemorrhage, so the fact that there were no differences between the 2 groups is already a good result in our opinion. Nevertheless, these results need further validation by larger randomized controlled trials.

Iatrogenic retinal tears were the most common intraoperative complications, in 14 eyes (13.0%), similarly to what is described in literature (up to 29% of cases).[15]

The most important postoperative complications are PVVCH, increased intraocular pressure, rhegmatogenous retinal detachment, rubeosis iridis and neovascular glaucoma.

PVVCH is usually the most common postoperative complication, occurring in up to 22% of cases.[37] In our study occurred in 17.6% of cases. Early PVVCH is frequent and typically resolves spontaneously after a few weeks. Late PVVCH occurs in only 10% of eyes and can be related to neovascular proliferation in vitreous base, normally in sclerotomy entry sites.[24]

Increased intraocular pressure is a common complication and occurred in 12 eyes in our study (11.1%), due to obstruction of trabecular meshwork with erythrocytes and/or effects of ocular tamponade with gas or silicone oil, that generally can be controlled with medical treatment.[12]

Rhegmatogenous retinal detachment usually occurs in retinal tears not found intraoperatively and demands urgent surgical treatment. The incidence of 0.9% in our study is

lower than previous studies (incidences around 5%).[28] The risk of rhegmatogenous retinal detachment after PPV in PDR seems to be declining, probably due to the use of large angle visualization systems that allow more accurate peripheral retina evaluation[33] and due to the new 23-gauge and 25-gauge vitrectomy systems.[27]

Our study reports epidemiological data, surgical indications, results and complications of PPV in PDR. The strengths of our study include the substantial number of studied patients and the involvement of a single surgical center. The study is limited by its retrospective design, however, our results are similar to previous studies,[11,37] supporting its validity. Another limitation is that 54.6% of eyes underwent combined phacoemulsification surgery, which could be a bias in the conclusions regarding the functional success. However, there were no statistically significant differences in functional success rate in last follow-up (χ^2 (1) = 0.557; p=0.477; n=108) between eyes that only underwent PPV (8 failures in 49 eyes: success rate 85.6%) and eyes that underwent combined PPV and phacoemulsification (13 failures in 59 eyes: success rate 78.0%) and this fact mitigates the importance of this limitation and shows the relevance of the obtained results. A further limitation is the great variability in disease severity (typical of this pathology) that makes it difficult to generalize the results and to compare with other reported studies.

In conclusion, we can say that anatomical and visual results of PPV in PDR have been steadily improving. Our study suggests that PPV is an efficient procedure in the treatment of PDR and most patients frequently regain or retain useful vision, although the visual outcome remains unpredictable. Since long term stability after initial treatment is good, PPV represents an essential surgery in the treatment of severe complications of diabetic retinopathy.

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