Pars plana Vitrectomy for the Treatment of Rhegmatogenous Retinal Detachments: Overview of Anatomical/Functional Success Rates and Drivers of Failure

Descolamentos de Retina Regmatogéneos: Taxas de Sucesso Anatómico/Funcional e Causas de Falência de Vitrectomia Via *Pars Plana*

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ABSTRACT

INTRODUCTION: This study aims to investigate the anatomical and functional success rate of *pars plana* vitrectomy (PPV) for the treatment of primary rhegmatogenous retinal detachment.

METHODS: Retrospective, consecutive series, single-centre study of vitrectomy naïve patients that underwent PPV for primary rhegmatogenous retinal detachment between 2021 and 2023. Recorded preoperative data included lens status, retinal defects, extent of the detachment (total versus subtotal), macula status, presence of proliferative vitreoretinopathy and best corrected visual acuity (BCVA, in logmar). Inferior detachments were defined based on the presence of a retinal break in the detached retina between 5-7 clock hours. Intraocular tamponade was performed with either C3F8 gas or silicone oil and a low threshold for retinectomy was adopted. Anatomical success was defined as complete retinal reattachment 3 months after oil removal or gas absorption; functional success was defined as BCVA equal or better than 1.00.

RESULTS: This study included 104 eyes from 104 patients (59% male) with a mean age of 61.9±12.5 years; 17 (16.2%) were high myopes and 34 (32.4%) had already undergone cataract surgery. Most (56; 53.8%) presented with multiple retinal defects; 43 (41.3%) had inferior retinal detachments. Tamponade was performed with C3F8 gas in 84.8% of cases. Single-surgery reattachment success was 86.5%; final anatomical success was 100% after a median of 2 surgeries (only 1 patient required 4 surgeries for final reattachment). Surgery in inferior defects had an overall single surgery success rate of 81.4% *versus* 90% in the remaining patients (x^2=1.75, p=0.42); moreover, in a binary logistic model, no single included variable independently predicted anatomical success. Only 30.5% of patients had a preoperative BCVA equal or less than 1.0. Postoperative visual acuity improved from 1.71±0.09 to 0.58±0.05, with overall better final BCVA in macula-on patients (0.64 *vs* 0.22, p<0.001). Functional success was achieved in 84.8% of patients, a relevant increase from baseline (x^2=7.2, p=0.007).

CONCLUSION: *Pars plana* vitrectomy is increasingly considered the gold standard for the treatment of rhegmatogenous retinal detachments. Our success rate closely resembles the available published data, with high overall success rates in achieving anatomical reattachment and preserving or restoring visual function.

KEYWORDS: Retinal Detachment; Scleral Buckling; Visual Acuity; Vitrectomy.

RESUMO

INTRODUÇÃO: Este estudo tem como objetivo investigar a taxa de sucesso anatómico e funcional da vitrectomia via *pars plana* (VPP) nos descolamentos de retina regmatogéneos primários (DRR).

MÉTODOS: Estudo retrospetivo, consecutivo, envolvendo todos os doentes submetidos a VPP por DRR entre 2021 e 2023 no nosso centro. Os dados pré-operatórios registados incluíram o estado do cristalino, características dos defeitos retinianos, extensão do descolamento, envolvimento da mácula, presença de vitreorretinopatia proliferativa (VRP) e acuidade visual corrigida para longe (AVCL, LogMar). Consideraram-se descolamentos inferiores aqueles com defeito retiniano na retina descolada entre as 5 e as 7 horas. O tamponamento intraocular foi realizado com gás C3F8 ou óleo de silicone. O sucesso anatómico foi definido como a presença de retina aplicada 6 meses após a absorção do gás ou remoção do óleo de silicone

RESULTADOS: Foram incluídos 104 olhos de 104 doentes (59% do sexo masculino), com idade média de 61,9±12,5 anos; 56 olhos apresentavam múltiplos defeitos retinianos e 43 tinham descolamentos inferiores. A taxa de sucesso com uma única cirurgia (TSUC) foi de 86,5%; o sucesso final foi de 100% após uma mediana de 2 cirurgias. A cirurgia em descolamentos inferiores teve uma TSUC de 81,4% *vs* 90% nos restantes doentes (χ^2=1,75; p=0,42). Em 12 dos 14 doentes com redescolamento, esta ocorreu nos primeiros 45 dias pós-operatórios e em 7 casos foi devido a VRP com tração sobre defeitos inferiores. A AVCL pós-operatória melhorou de 1,71±0,09 para 0,58±0,05, com melhores acuidade finais nos doentes mácula-on (0,64 *vs* 0,22; p<0,001).

CONCLUSÃO: A VPP é o *gold-standard* no tratamento dos DRR. As taxas de sucesso são elevadas, mas sugere-se tratamento exaustivo das zonas de VRP e vigilância apertada nos primeiros 2 meses, especialmente nos descolamentos inferiores.

PALAVRAS-CHAVE: Acuidade Visual; Descolamento Retina; Recurvamento da Esclera; Visual Vitrectomia.

INTRODUCTION

Rhegmatogenous retinal detachment (RRD) refers to the separation of the neural retina from the underlying retinal pigment epithelium (RPE), due to the presence of a full-thickness retinal break. These breaks are caused by vitreoretinal traction and allow the infiltration and accumulation of liquified vitreous under the retina, creating a cleavage plane in the subretinal space.[1] This disease has an incidence of roughly 25 cases per 100 000 people per year and is a major cause of vision loss and burden in health care departments, requiring urgent intervention by a skilled ophthalmologist.[2] *Pars plana* vitrectomy (PPV), first introduced in the 1970's, allows for the removal of the vitreous gel and direct manipulation of the retina, therefore treating the underlying cause of the retinal detachment and achieving retinal attachment. Recent advancements, including higher rate cuts, smaller gauge instrumentation, stable intraocular pressure systems, and better visualization devices have minimised surgical trauma and reduced recovery time,[3-5] all while achieving high rates of functional and anatomical success. However, to this date, there is still scarce literature available regarding the influence of the different baseline clinical and demographic characteristics in the final anatomical and visual outcomes. We therefore aim to evaluate the results of PPV for the treatment of primary RRD and the main drivers of anatomical and functional success.

METHODS

STUDY DESIGN

Retrospective, consecutive series, single-centre study of vitrectomy naïve patients that underwent PPV for primary rhegmatogenous retinal detachment between 2021 and 2023 in the Department of Ophthalmology of Unidade Local de Saúde de Gaia/Espinho. Participants were briefed on the purpose and methodology of the study and provided their informed consent, according to the tenets of the Declaration of Helsinki for biomedical research.[6]

EXCLUSION CRITERIA, DATA COLLECTION AND ENDPOINTS

Exclusion criteria included prior PPV or scleral buckling and a previous history of trauma. We collected the complete pre, intra and post-operative data for all patients, based on a comprehensive ophthalmic history, slit lamp exam, di-

lated fundus examination, intraoperative surgeon observations, and detailed follow-up visits. The preoperative data recorded included the age, gender, lens status, presence of high myopia (≥ -6D of spherical equivalent), number and location of the retinal defects, extent of the detachment (total *vs* subtotal), macula status (defined per the clinical evaluation, or, in case of doubt, by macular Optical Coherence Tomography), presence and classification of proliferative vitreoretinopathy (PVR) and best corrected visual acuity (BCVA, in logmar). For statistical purposes and according to the available literature, visual acuity (VA) not measurable in the Snellen VA chart was defined as follows: counting fingers – 1.9; hand motion – 2.3; light perception – 2.7.[7]

Regarding the location of the RRD, inferior detachments were defined based on the presence of a retinal break in the detached retina between 5-7 clock hours.

Main endpoints included post-operative retina status, BCVA and anatomical/functional success, defined as complete retinal reattachment 5 months after oil removal or complete gas absorption and BCVA equal or better than 1.00, respectively.

SURGICAL TECHNIQUE

All surgeries were performed by two vitreoretinal surgeons (M.B. and F.N.) following the same technique. The procedure was performed under peribulbar block or general anaesthesia. The Constellation Vision System (Alcon Laboratories, Inc., Fort Worth, TX, USA) was used to perform 23 or 25-gauge three-port PPV with a wide-angle non-contact viewing system OCULUS BIOM 5, Oculus Surgical®). In phakic patients, cataract phacoemulsification was performed prior to PPV due to the risk of subsequent cataract formation and to allow better visualization of the retinal periphery. Complete PPV was performed under scleral indentation to improve access to the periphery. Epiretinal membrane peeling was carried out whenever such membranes were present. Peeling of the inner limiting membrane (and epiretinal membrane, if appropriate) was performed in all cases of PVR grade C, regardless of macular status, to reduce the risk of secondary epiretinal proliferation or PVR recurrence; a low threshold for retinectomy was adopted to eliminate residual tractions or retinal shortening. Retinal attachment was achieved using perfluorocarbon liquid; endolaser was then performed 360º and tamponade was achieved with C3F8 gas at 12% or silicon oil (SO), at the attending surgeon's discretion; in cases of redetachment tamponade was performed exclusively with silicon oil.

STATISTICAL ANALYSIS

Statistical analysis was conducted using the software IBM SPSS Statistics 27 (IBM Corp, Armonk, New York). Descriptive statistics were computed for all variables. Continuous variables were described using means and pattern deviations when normally distributed, or with medians and interquartile amplitudes. Categorical variables were described using absolute and relative frequencies. Data was compared between groups using chi-square analysis, the Wilcoxon signed-rank or Mann-Whitney U tests; binary logistic regression analysis was used to evaluate the impact of independent variables on the anatomical success rate. The resulting *p*-value significance level was set at p=0.05.

RESULTS

During the inclusion period, 104 patients were treated for primary RRD with PPV, with the above-described technique. Sixty-one (59%) were male, with a mean age of 61.9±12.5 (range 24-85) years. Seventeen (16.2%) were classified as high-myopes and 34 (32.4%) had already undergone cataract surgery. Most patients (56; 53.8%) presented with multiple retinal defects (median=2, range 1-8); 43 (41.3%) had inferior retinal detachments. The majority of patients (53, 50.5%) did not present significant PVR; 38 (36.2%) were classified as PVR grade B and 13 (12.4%) as PVR grade C, which was higher in the redetachment group (28.6 *vs* 10%, X^2=3.82, p=0.051). A significant proportion of patients had foveal involvement (85 patients, 81%) and 27 (25.7%) had total retinal detachment by the time of surgery. The preoperative patient characteristics are summarized in Table 1.

Table 1. Demographic and clinical characteristics of included patients with rhegmatogenous retinal detachment.

Clinical characteristics	
Male, n (%)	61 (59)
Age, mean (SD), years	61.9±12.5
Duration of symptoms, median (range), days	10 (1-500)
Pseudophakic, n (%)	34 (32.4)
High myopes, n (%)	17 (16.2)
Number of tears, median (range)	2 (1-8)
Inferior RRD, n (%)	43 (41.3)
PVR grade C, n (%)	13 (12.4)
Macula-off, n (%)	85 (81)
Total RRD, n (%)	27 (25.7)

PVR – proliferative vitreoretinopathy, RRD – rhegmatogenous retinal detachment, SD – standard deviation.

Median time from the onset of symptoms to surgery was 10 (1-500 days), as some patients did not seek immediate evaluation by an ophthalmologist after the onset of symptoms; median time to surgery after diagnosis was 3 days. Macula-on patients had their surgery performed at a median of less than 24 hours after diagnosis, with a mean time to surgery of 2.42 days; most (64.7%) macula-off patients had surgery in less than 5 days.

The majority of surgeries were performed under general anesthesia (97; 93.3%), with the remainder performed under peribulbar (6; 5.8%) or sub Tenon (1; 0.96%) block; 23G instrumentation was used in most cases (100; 96.2%). Tamponade was performed with C3F8 gas in 84.8% of patients. Oil tamponade was mostly used in challenging cas-

es, with all patients being classified as macula-off, 67% presenting with total retinal detachment, 47% with PVR grade C and 12/15 patients with VA less than 1.0 LogMar.

Single-surgery attachment success (SSAS) was 86.5%; final anatomical success was 100% after a median of 2 surgeries (only 1 patient required 4 surgeries for final reattachment), with silicon oil being removed at an average of 4.54±2.3 months after surgery – the characteristics of said patients can be observed in Table 2. Most (13/14) patients were classified as macula-off and only 1 of the redetachments was initially proposed for SO – a patient with a two-month history of total retinal detachment and grade C PVR more pronounced in the inferotemporal region, where a choroidal detachment was detected on preoperative echography. The remaining tamponade was performed with C3F8; SO was used in all subsequent redetachments. In 12/14 patients, redetachment occurred in the first 45 days post-op, and was caused by PVR with traction on inferior breaks/retina/retinectomy in 7 of the known 11 cases.

Surgery in inferior defects had an overall SSAS rate of 81.4% *vs* 90% in the remaining patients (X^2=1.75, p=0.42). In a binary logistic model, no single included variable (macula status, high myopia, total *vs* subtotal RRD, PVR, inferior *vs* superior) independently predicted anatomical success. Only a fraction of patients had a preoperative BCVA equal or less than 1.0 Logmar (30.5%). Postoperative visual acuity improved from 1.71±0.09 to 0.58±0.05 LogMar. Macula-on patients observed the best post-operative BCVA (0.22±0.18 [mean difference to baseline -0.23], *vs* 0.64±0.54 [mean difference to baseline -1.33] in macula-off patients – p<0.001). Functional success was achieved in 84.8% of patients, a relevant increase from baseline (X^2=7.2, p=0.007).

DISCUSSION

This study provides valuable insights into the outcomes of PPV for the treatment of primary RRD, a condition that still warrants significant visual loss and for which the best

Table 2. Clinical characteristics of patients with redetachment after PPV for RRD.

Characteristics / Cases	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gender	F	F	F	M	F	M	M	F	F	M	F	M	M	M
Age	66	56	75	62	77	58	61	67	54	76	79	83	64	72
Inferior detachment	Y	Y	N	N	N	Y	N	N	Y	Y	Y	Y	N	Y
Macula status	off	off	off	off	off	off	off	off	off	off	off	off	on	off
PVR C	Y	Y	N	N	N	N	Y	Y	N	N	N	N	N	N
Tamponade	C3F8	C3F8	C3F8	C3F8	C3F8	C3F8	SO	C3F8	C3F8	C3F8	C3F8	C3F8	C3F8	C3F8
Time from first surgery to redetachment, days	60	9	2	14	20	45	17	13	15	17	28	150	40	28
Tamponade used in redetachment	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO
Time to removal of silicon oil, months	8	3	6	6	2	2	10	4	5	3	3	6	UK	5
Additional surgeries	0	0	0	0	2	0	0	0	0	0	0	0	0	0

	Cause and location of redetachment
1	UK
2	PVR with traction on inferior retinectomy
3	PVR with traction on inferior retina
4	PVR with traction on inferior retina
5	PVR with traction on previous inferior break
6	PVR (total retinal detachment)
7	PVR with peripheral and temporal traction upon location of previous choroidal detachment
8	New inferior break
9	UK
10	PVR with traction on previous inferior break
11	PVR with traction on inferior retinectomy
12	UK
13	PVR traction on macula and temporal retina
14	PVR with traction on inferior retinectomy

F – female; M – male; N – No; PVR – proliferative vitreoretinopathy; SO – silicon oil; UK – unknown; Y – yes.

management strategy is yet to be established. The overall SSAS rate was 86.5%, and complete anatomical success was achieved in 100% of patients. The available published literature reports primary reattachment rates ranging from 80% to 90% for single-surgery PPV.[8-11] For example, Ong *et al*[12] report a single-surgery attachment success of 70.3% following PPV in a study involving 290 patients; Dhoot *et al*,[13] in a systematic review/metanalysis involving 10 546 patients, report a primary success rate of 86.5% and a final success rate of 96.7%. In a retrospective review of 1540 eyes, Wong *et al*[14] found a SSAS of 78.6% and an overall reattachment success of 95.2%. Haugstad *et al*[15] also found a SSAS of 89%; it is important to note, however, that approximately 50% of patients in this series presented with macula-on and no information regarding symptom duration or prevalence of significant PVR is mentioned, so results may not be of direct comparison with our sample. Our study falls in line with the current literature, with overall high success rates for primary reattachment and 100% efficacy even after redetachment in challenging cases, usually following a second PPV with silicon oil tamponade; only 1 patient needed an additional 3 surgeries for complete reattachment.

Although lower success rates were found in inferior retinal detachments (81.4% *vs* 90%, respectively), no statistically significant differences were found among groups (p=0.42). Traditionally, inferior retinal detachments are considered to be more challenging due to the gravitational effect (and less efficacy of post-operative tamponade), intraoperative access to the retinal periphery and likely longer duration of symptoms to surgery.[16,17] Also, the presence of PVR, a known risk factor for poor surgical outcomes, is considered the main driver of surgical failure,[18] and was responsible for 9/14 cases of redetachment in our study. 48.6% of patients had some degree of PVR, with 12.4% being grade C, higher in the redetached group (28.6 *vs* 10%, p=0.051). In spite of these issues, meticulous PVR and membrane removal with judicious use of peripheral retinectomies and 360º endolaser may allow for a high attachment rate in most cases. As discussed, and despite some trends regarding higher rate of failure in older, inferior, macula-off, and PVR grade C detachments, no significant predictors of redetachment were found in a binary logistic model. This may be due to the relatively low study sample and to the overall high rates of primary attachment in PPV with the above-described technique. It is also remarkable that most redetachments seem to appear early in the postoperative period, with 12/14 cases in our study appearing in less than 45 days post-op, which falls in line with a recently published paper by Cicinelli *et al*.[19]

The functional outcomes of this study are also noteworthy. Postoperative visual acuity improved significantly from 1.71±0.09 to 0.58±0.05 LogMAR. Macula-off patients presented with very poor baseline VA, at an average of 1.97±0.67, worse, on average, than counting fingers. Despite being the group with the greatest improvement in VA (average ΔBCVA of -1.33 *vs* -0.23 in macula-on patients), final BCVA was significantly higher in macula-on patients (0.22±0.18 *vs* 0.64±0.54, p<0.001). This is comparable to the existing literature[20] and strengthens the profound detrimental effect of foveal involvement on the functional outcomes of RRD.[21,22] It is therefore of key importance for the public to be informed about the symptoms and consequences of a late-diagnosed RRD.

This study involved all consecutive cases operated by the same surgeons with the same technique over a period of 2 years, with the same data collection protocol and approach to redetachment cases. However, some limitations arise. Its retrospective design and small sample may hinder the generalization of our results. Also, we did not account for other variables such as compliance with post-op positioning and therapeutic regimen, which could have an impact on the surgical success rate. Due to the short follow-up period of 5 months, there is a chance of missed redetachments if patients did not visit our department past the 5-month of follow-up. Lastly, this study focused on the impact of PPV in primary retinal detachments. Although the role of scleral buckle in today's vitreoretinal surgery is controversial, some authors have reported slightly better SSAS with scleral buckle in complex, primary RRDs; its use in our setting could, therefore, have influenced the anatomical and functional success rates.[23,24]

CONCLUSION

Pars plana vitrectomy has become the most commonly performed treatment in the surgical management of RRD, and new techniques have allowed for higher safety, success rates and reduced surgical time.[25,26] This study reinforces the efficacy of pars plana vitrectomy in achieving high anatomical and functional success rates for RRD, even in challenging cases such as inferior detachments and those with advanced PVR. The findings also underscore the importance of meticulous addressing of PVR with appropriate retinectomies and membrane peeling, in initial and redetached cases, the latter also benefiting from silicon oil tamponade, and warrants close follow-up in the early post-operative period, especially in cases of inferior detachments, due to its lower SSAS.

CONTRIBUTORSHIP STATEMENT / DECLARAÇÃO DE CONTRIBUIÇÃO

PMM, JC and FSN: Responsible for gathering data, presenting results, conducting literature searches, and writing the manuscript.

PS, MB and FSN: Responsible for performing clinical evaluations of the patients.

PMM, PS, MB and FSN: Responsible for formal analysis, review and supervision of the manuscript.

All authors approved the final version to be published.

PMM, JC e FSN: Responsáveis pela recolha de dados, apresentação dos resultados, realização das pesquisas bibliográficas e redação do manuscrito.

PS, MB e FSN: Responsáveis pela avaliação clínica dos doentes.

PMM, PS, MB e FSN: Responsáveis pela análise formal, revisão e supervisão do manuscrito.

Todos os autores aprovaram a versão final a ser publicada.

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