6. Published techniques, results and complications of primary vitrectomy

6.1. Introduction

One of the first five patients treated with pars plana vitrectomy suffered from a complicated type of retinal detachment [64]. These more complex forms of RRD, e.g. associated with PVR, giant retinal tears, vitreous haemorrhage or retinal redetachments, soon evolved to be one of the major indications for PPV [58]. Since 1984, the indications for PPPV have expanded to more uncomplicated situations that routinely would have been treated with SBS and more than 25 series of PPPV have been published until the year 2000. In this section, the published techniques and results of PPPV are reviewed. Parts of this review have been published by the applicant in the "Controversies in Ophthalmology" series in the British Journal of Ophthalmoloy [91] and as a book chapter in the 4th edition of "Retina" edited by Stephen J. Ryan [43].

6.2. Methods of literature review

The term "Primary vitrectomy for rhegmatogenous retinal detachment" implies that pars plana vitrectomy is the first surgical intervention in the treatment of this disease. When this term is used in the literature, however, its' definition is frequently widened: it often includes patients with RRD who have undergone either cryotherapy or photocoagulation for retinal breaks or small detachments prior to vitrectomy, although, strictly speaking, PPPV is not the first surgical intervention in these cases. To add to the confusion in terminology, there seems to be a general consensus that PPPV is the method of choice in some complicated forms of RRD, such as in patients with RRD associated with PVR grade C, penetrating eye injuries, proliferative retinopathy, giant retinal tears or macular holes. These cases are, however, not usually included in the series of- and discussions about PPPV. In order to achieve consistency, the term "Primary vitrectomy" (PPPV) in this article will include the two above-mentioned adjustments in definition.

To review the scientific literature about PPPV, a MEDLINE search was performed using the National Centre for Biotechnology`s “PubMed” Server (internet address: http://www.ncbi.nlm.nih.gov/PubMed/). All records filed until April 30th, 2001, that were identified by the search terms “vitrectomy” and “retinal detachment” were reviewed, and all articles published in either English, German or French relating to PPPV for RRD were obtained for further analysis. The studies not included in the analysis were those in which the major proportion of the study-population consisted of patients with RRD associated with preoperative PVR grade C, a history of penetrating or blunt eye injury, giant retinal tears, macular holes, proliferative retinopathy or a history of previous retinal detachment surgery. In addition, small series or brief reports, which consisted of abstracts only or which did not contain sufficient detail about indications, operating technique or rate and reasons for re-detachment, were also not considered in this review.

The methods applied in reports of surgery for RRD in general and, in particular, for PPPV differed in so many ways that a comparison of several studies is very problematical [105]. It is of importance that the reader keeps in mind that most studies differ in the following very important details: the follow-up period, which is of critical importance concerning the anatomical and functional success rates reported; the surgical method (e.g. the use of additional scleral buckling, choice of tamponade and use of 360° photocoagulation); the terminology and grading of preoperative characteristics (e.g. “large breaks” and “marked vitreous traction”); the measurement, notation and presentation of visual acuity; the preoperative anatomical and functional conditions; the analysis of intra- and postoperative complications; the classification of retinal breaks detected after the primary surgery being new or previously missed breaks; the classification of postoperative PVR; and, finally, the classification of significant lens opacities.

6.3. Published series of PPPV

Twenty-five publications reporting 1456 cases of PPPV, which contained sufficient information for analysis, were identified in the literature (Table 7) [8, 13, 14, 16, 23-26, 30, 31, 33, 36, 39, 46, 48, 68, 70, 74, 77, 87, 89, 94, 97, 109]. Series that concentrated on one specific indication for PPPV were, in decreasing order of frequency: pseudophakic / aphakic retinal detachments (7 series) [8, 14, 16, 24, 70, 77, 89]; unclear hole situations (3 series)[13, 23, 31]; choroidal detachment (2 series) [87, 109]; vitreous opacities (1 series) [46]; bullous retinal detachment (1 series) [25]; superior flap tears (1 series) [68]; multiple breaks (1 series) [14]; and inferior breaks (1 series) [94]. The remaining 8 series had a mixture of indications for PPPV [26, 30, 33, 36, 39, 48, 74, 97]. A further analysis of the anatomical characteristics examined in the series revealed the following features included in the studies of PPPV in decreasing order of frequency: multiple breaks (included in 18 studies); large breaks (13); unclear hole situations (10); central breaks (10); media opacities / impaired view of the retina (8); unusual breaks (6); bullous detachment (5); marked vitreous traction (3); and choroidal detachment (2 studies).

Regarding the preoperative lens status, 14 series contained information of PPPV in phakic and pseudophakic/aphakic patients, 9 series included pseudophakic/aphakic patients only, one series phakic patients only, and in one brief report of a series included in a review about PPPV, no details about the preoperative lens-status were provided.

Author	Year	Buckle	n	Primary Success	Final	PVR	VA ≥0.33	≥0.4	≥0.5
Escoffery[26]	1985	0%	29	79%	79%	7%		76%	
van Effenterre[97]	1987	0%	60	86%	92%	0%		76%	
Hakin[36]	1993	79%	124	64%	82%		34%		
Gartry[30]	1993	65%	114	74%	92%	8%	35%		
Girard[33]	1995	81%	103	74%	85%	16%			40%
Höing[48]	1995	0%	32	78%	94%	19%			44%
Bartz-Schmidt[8]	1996	100%	33	94%	100%	3%		79%	
Heimann[39]	1996	0%	53	64%	92%	6%		41%	
Yang[109]	1997	100%	9	89%	100%	0%		0%	
El-Asrar[25]	1997	100%	22	100%	100%	0%		32%	
Desai[23]	1997	100%	10	100%	100%	0%		70%	
Hoerauf[46]	1997	83%	37	87%		8%			
Sharma[87]	1998	100%	21	90%	90%	10%		19%	
Brazitikos[13]	1999	36%	14	100%	100%	0%		69%	
Campo[16]	1999	0%	275	88%	96%	6%		69%	
Devenyi[24]	1999	100%	94	100%	100%	0%			
Newman[70]	1999	48%	25	84%	96%	8%			48%
Oshima[74]	1999	51%	63	92%	100%	0%			
Brazitikos[14]	2000		103	93%	97%	4%			
Brazitikos[14]	2000	0%	20	85%	95%	10%			
Gastaud[31]	2000	58%	19	84%	100%	0%			
Pournaras[77]	2000	100%	23	92%	100%	4%		65%	
Speicher[89]	2000	0%	78	94%	96%	5%			
Miki[68]	2000		87	92%	100%	1%			
Tanner[94]	2001	0%	9	89%	100%	0%		67%	

Table 7: Published series and results of PPPV

6.4. Technical details of PPPV

The rate of additional scleral buckling could be calculated in 23 of the examined 25 studies (n=1266 patients). In total, scleral buckling was performed in 546/1266 (43%) of patients with PPPV.

Five different intraocular tamponades were used following PPPV for RRD. Sufficient detail about the frequency of tamponades could be obtained in 1169 patients out of 20 studies. SF_6 was used in 608/1169 cases (52%), air in 363/1169 (31%), and C_3F_8 in 158/1169 (14%). Less frequently applied tamponades were C_2F_6 in 23 patients of one series) [46], and silicone oil in 7 patients. The following technical details were usually not correlated to the numbers of patients but given only in a “yes/no” fashion per study and, sometimes, not asserted at all. The use of the following methods was mentioned: wide-angle viewing system (mentioned in 9 of 25 series); perfluorocarbon liquids (12/25); internal retinotomy in selected cases (7/25) or all cases (2/25); external drainage of subretinal fluid in few selected cases (3/25); transcleral cryopexy (18/25); photocoagulation using endolaser or indirect laser (16/25); and/or endocryopexy (1/25). Two studies provided mean operating times of 74 and 81 minutes for PPPV [24, 36]. In one series not included in the review of the results summarised here, the mean operating time for PPPV was 78 minutes compared to 56 minutes in scleral buckling surgery [75].

6.5. Results

6.5.1. Anatomical results

The primary reattachment rate of PPPV reported in the literature varies between 64% and 100% of cases in the different series Table 7. An analysis of the 25 series of PPPV reveals that reattachment was achieved with one procedure in 1230 of 1456 cases (85%). The final reattachment rate reported in the literature varies between 79% and 100%. Final reattachment was achieved in 1379 of 1456 cases (95%).

In addition to the series that focussed on pseudophakic / aphakic detachments, further information regarding the postoperative course of pseudophakic / aphakic patients could be taken from three other studies [13, 25, 94]. In total, details about the postoperative course of 670 pseudophakic / aphakic patients were extracted out of the 1446 cases described above. Primary success was accomplished in 612 of 670 pseudophakic / aphakic patients (91%). Final success was achieved in 656 of this subgroup of 670 patients (98%).

6.5.2. Reasons for failure

The reasons for failure after PPPV in 226 of 1446 cases, as judged by the authors of the individual articles, were: postoperative PVR in 91/226 (40%); new or missed retinal breaks in 90/226 (40%); and reopened old breaks in 31/226 (14%). In 9 cases, the exact cause of re-detachment could not be determined. Additional reasons for failure were choroidal haemorrhage (3/226)[16, 30], endophthalmitis (1/226)[33]and insufficient internal tamponade (1/226) [26].
The reasons for failure in 58 of 660 cases in the pseudophakic / aphakic subgroup were: postoperative PVR in 28/58 (48%); new or missed retinal breaks in 19/58 (33%); reopened old breaks in 10/58 (17%); and choroidal haemorrhage in one case.
The postoperative PVR-rates given in the articles vary between 0% and 19% and are based on different classifications. The numbers regarding only those cases in which postoperative PVR was made responsible for retinal re-detachment were 91/1446 cases (6%) for all patients and 28/660 (4%) in the pseudophakic / aphakic subgroup.

6.5.3. Functional results

The reported functional results of PPPV are presented in many different ways and an analysis of the reported results is almost impossible. The most common way of displaying visual results following surgery for RRD is the percentage of patients with a postoperative visual acuity of 0.4 or better. Sufficient information about this level of visual acuity could be identified in 13 series (526 out of 1446 patients) of PPV, and ranged from 0% to 90% in the individual series. In total, the proportion of patients with a

postoperative visual acuity of 0.4 or better was 332/526 (63%) in the cases that were available for analysis (Table 7).

6.5.4. Identification of previously unseen breaks

In eight series of PPPV, details about the intraoperative identification of previously unseen retinal breaks were examined [8, 13, 23, 24, 30, 31, 70, 77]. The authors report that in 77 of these combined 87 cases (89%) retinal holes could be identified during PPPV. Additional breaks combined with breaks that were seen previously were found in 22 other cases [8, 77, 87].

6.5.5. Intraoperative complications of PPPV

The most frequent intraoperative complication of PPPV were iatrogenic retinal breaks reported in 11 out of the 25 series analysed, where it occurred in 33 of 561 patients (6%) [13, 30, 36, 39, 46, 68, 70, 74, 77]. Iatrogenic damage to the lens was noted in 5 series with a frequency of 11/362 patients (3%) [30, 33, 46, 68, 87]. Further problems, which were encountered in single cases, were seven retinal incarcerations at retinotomy sites [30, 33, 36, 39, 68]; three cases of subretinal gas [30, 36]; six cases of choroidal haemorrhages during or after surgery[30, 33, 70]; and one case of subretinal infusion of fluid [26].

6.5.6. Postoperative complications of PPPV

Two studies have looked at the changes of refraction following PPPV without scleral buckling for pseudophakic / aphakic RRDs. The authors measured either a mean refractive change of –0.15 diopters [16] or found only “minor” changes with 2 of 78 patients having a change of refraction of more than 0.5 diopters [89]. A transient postoperative rise in the intraocular pressure was noted in seven studies in a total of 70 of 289 patients (24%) [8, 46, 70, 74, 77, 87, 89]. A persistent pressure rise was found in

27 out of 185 patients in 4 studies (15%) [23, 36, 46, 70]. The development of a nuclear cataract in phakic patients was examined in 9 studies. Only one group did not find any significant increase in lens-opacities in 20 phakic eyes with a mean follow-up of 9.5 months [48]. The other authors described what was classified as “significant” cataract-formation in 21% to 86% of phakic patients. Combining these studies, initiation or progression of nuclear cataracts was noted in 135 of 356 eyes (38%) [25, 33, 39, 46, 48, 68, 74, 97]. Other anterior segment problems, occurring in small numbers and mainly in pseudophakic / aphakic patients, included: subluxations of intraocular lenses (5 cases) [14, 16, 25, 89]; iris-capture (4) [8, 70] flattened anterior chamber (3) [87]; fibrinous iritis (2) [25, 26]; and single case reports of anterior chamber synechia necessitating revisional surgery [8], perfluorodecalin in the anterior chamber [8], anterior chamber haemorrhage [30] and corneal decompensation associated with a long-term silicone oil tamponade.[89].

Next to the problems of retinal redetachment and PVR summarised above, the most frequent posterior segment complication was macular pucker, which was investigated in 17 of the 25 series reviewed. Macular pucker occurred in 0% to 18% in the individual series and a total of 88 of 992 patients (9%) [8, 14, 16, 23-26, 31, 39, 46, 68, 70, 74, 77, 87, 89]. One series specifically looked at postoperative cystoid macular edema (CME) and described a high rate of this in 46 of 275 patients (17%) [16]; one more case of CME was described in another series [26]. Macular holes following PPPV were also found only in one series, occurring in 6 of 275 patients (2%) [16]. In one patient, residual perfluocarbon was noted in the macular area [14].
In addition to new/missed/reopened retinal breaks that caused re-detachments, four studies noted retinal breaks in attached retina in 27 of 464 patients (6%) [16, 39, 46, 87, 89]. Serous choroidal detachment was observed in 3 patients in 3 series [25, 30, 46]. A recurrent choroidal detachment was seen in one patient [109]. Postoperative haemorrhages in the vitreous cavity were noted in 6 patients in 3 series [23, 26, 46]. Visual field defects similar to those described after macular hole surgery were specifically looked for in one series, and were observed in 2 of 87 patients (2%) [68].

Three very serious complications were noted in single cases: one case of postoperative endophthalmitis [33]; one case of a central retinal artery occlusion associated with a rise in the intraocular pressure due to the internal tamponade [8]; and one case of a branch retinal artery occlusion.[46].

Other complications, which were linked to PPPV but which were documented outside the series reviewed above, included ocular motility restrictions with subsequent diplopia [108], posterior retinal folds following combined PPPV and SBS [60], new retinal breaks in attached retina[73] and sympathetic ophthalmia [76].

6.6. Summary

A systematic review of the literature identified 25 series with a total of 1456 cases of PPPV published between 1985 and 2001. The studies differ significantly regarding the inclusion criteria, operating techniques, recorded data and follow-up period which is an additional sign of the current confusion regarding indications and techniques of PPPV. Concerning published techniques and results of PPPV, it can be summarised that:

- In 43% of published cases (546/1266), additional scleral buckling was used in conjunction with PPPV
- SF_6-air mixtures (52%) and air (31%) were the tamponades that were used in the majority of cases
- Most recent series predominantly use wide-angle viewing systems, whereas earlier series were conducted using conventional contact lenses for vitrectomy
- Few intraoperative complications have been reported, the most important being iatrogenic retinal holes (about 6%) and lens touch in phakic patients (about 3%)
- The primary reattachment rates vary between 64% and 100%; overall, a primary reattachment was achieved in 85% (1230/1456) and final reattachment in 95% (1379/1456) of cases
- The anatomical success rates are higher in pseudophakic patients; primary reattachment in all series combined is 91% (612/670) and final reattachment was achieved in 98% (656/670)

- Postoperative PVR and new or missed retinal breaks were the major factors causing retinal redetachment; the fact that new / missed breaks are as important as PVR for failures following PPPV is in contrast to the reasons for failure following SBS and is a new finding elaborated in this work
- Although for less than half of all published cases functional results were provided, PPPV seems to achieve comparably good functional results with 63% (332/526) of patients achieving 0.4 or better visual acuity at final follow-up in a usually more complicated subset of patients
- The major popstoperative complications other than redetachment are cataract progression in about 40% of phakic patients, macular pucker in approximately 9% and temporary or persistent rises in IOP