3. Materials and Methods

3.1 Patients

This study reviewed a consecutive series of 591eyes of 569 patients undergoing pars plana vitrectomy (PPV) as the initial surgery for primary rhegmatogenous retinal detachment (RRD). All operations were performed by 10 surgeons between June 1994 and July 2003 at the Charité, Campus Benjamin Franklin, Berlin.

In all cases, the diagnosis of a RRD was confirmed before or during surgery. Patients with a history of uveitis, diabetic retinopathy and RRD secondary to ocular trauma were excluded from the study. Seventy-nine eyes with a follow-up period of less than 3 months were also excluded. There were a total of 512 eyes in study for data analysis.

3.2 Surgical Technique

In all cases, a standard three-port system pars plana vitrectomy was performed under general anesthesia. The infusion cannula was placed in the inferotemporal quadrant. The surgical technique consisted of a central and peripheral vitrectomy that released the vitreous traction around the breaks, and removal of the flap of the retinal tear to reduce persistent traction on the break. The vitreous base was removed as far as possible using external indentation. Drainage types of subretinal fluid were internal drainage, external drainage, acombination of both, or a retinotomy for internal drainage of subretinal fluid if necessary; a 20% -40% SF6-air mixture or silicone oil were used for internal tamponade. Exo-, endocryopexy or endolaser-photocoagulation were used to create chorioretinal adhesions. An encircling band or local buckle were used in some cases. Perfluordecalin or perfluoroctan could be used to unfold the detached retina. In addition to the basic vitrectomy technique, combined cataract surgery was also performed in the patients with significant cataract.

The indication for primary vitrectomy, the choice of tamponade, the use of additional scleral buckling and the type of coagulation method were based on the surgeons' individual preferences. In 33 (6.4%) eyes, scleral buckling procedures were chosen as the initial

operating method, however, the operation was converted to primary vitrectomy due to insufficient intraoperative retinal reattachment and/or occurrence of its complications, e.g. retinal incarceration and scleral perforation.

All patients who were treated with gas tamponade were instructed to maintain the proper position to encourage tamponade of the retinal breaks during the first two postoperative weeks.

3.3 Ocular examinations

All 512 cases were done according to the sequence of clinical examination, including external examination, measurement of best-corrected visual acuity and IOP, slit-lamp examination of the anterior segment, examination of the posterior segment by binocular indirect ophthalmoscopy with or without scleral indentation, and non-contact lens biomicroscopy. The features of retinal detachment and size, shape, number and position of retinal breaks were recorded on retinal charts in all patients except 12 patients with no view of the fundus due to opaque media. Ultrasound examinations were performed to determine the retinal detachment in 36 patients with impaired view of the retina (vitreous haemorrhage with or without cataract) and in 5 patients with intraocular lenses or lens fragments in the vitreous. Two patients with macular hole were examined with fluorescein angiography to differentiate from cystoid macular oedema or holes in epimacular membranes, and macular pucker of one patient was detected with it.

3.4 Preoperative assessment

The preoperative variables which were recorded included age, sex, symptoms, best-corrected visual acuity (VA), refractive error, intraocular pressure (IOP), lens status (phakia, aphakia/pseudophakia), extent location of retinal detachment (4 quadrants), macular status (macular on/off), macular diseases (macular pucker, hole /degeneration and submacular blood), retinal breaks (location, number and size, breaks not seen), proliferative vitreoretinopathy (PVR), vitreous haemorrhage (VH), retinal tear, a history of laser photocoagulation or cryocoagulation and other eye diseases (table 3-1).

3.5 Intraoperative assessment

Intraoperative variables recorded included surgeon, intravitreal tamponade (20% ~40% SF6-air mixture or silicone oil), placement of an encircling buckle or a local buckle, situation of retinal breaks, use of endo-/exocryopexy, endolaserphotocoagulation and perfluordecalin, removal of the flap of the retinal break, drainage of subretinal fluid (internal, external or both), retinotomy, combined lens surgery, complications (iatrogenic holes, lens touch, subretinal, vitreous or choroidal bleeding), change of operating method and causes of it (table 3-2).

3.6 Postoperative assessment

The postoperative variables were follow-up time, initial and final anatomic success rate, best-corrected visual acuity, changes in refractive errors, presumed causes of postoperative visual acuity below 0.4, intraocular pressure (IOP), complications (cataract progression, macular pucker, PVR, vitreous hemorrhage), number and causes of retinal redetachment and subsequent surgical interventions for recurrence of retinal detachment or retinal breaks, additional cataract surgery, and other ocular surgery (table 3-3).

3.7 Data collection

Case notes were identified and original notes of patients were reviewed. All clinical and surgical data were retrieved and recorded into a computer database (Filemaker 4.1). At first, only 410 and 353 of 591 cases had a follow-up of 3 and 6 months or more at our hospital. In order to retrieve information about the additional 238 cases with a follow-up period of less than 6 months, standard letters and questionnaires were sent to the patients' ophthalmologists. If the patients changed their ophthalmologists or the ophthalmologists could not be contacted, the letters and questionnaires were sent to the patients and the ophthalmologists filled in the questionnaires. A total of 292 letters and questionnaires were sent, 189 (65%) questionnaires were returned and 132 (70%) of them, including 30 of 410 cases, were followed up 3 months or more. 79 (13.4%) of 591 cases with a follow-up period less 3 months were not included

into the analysis. Finally, a total of 512 (86.6%) cases with a follow-up period of more than 3 months were included into the study (Fig. 3).

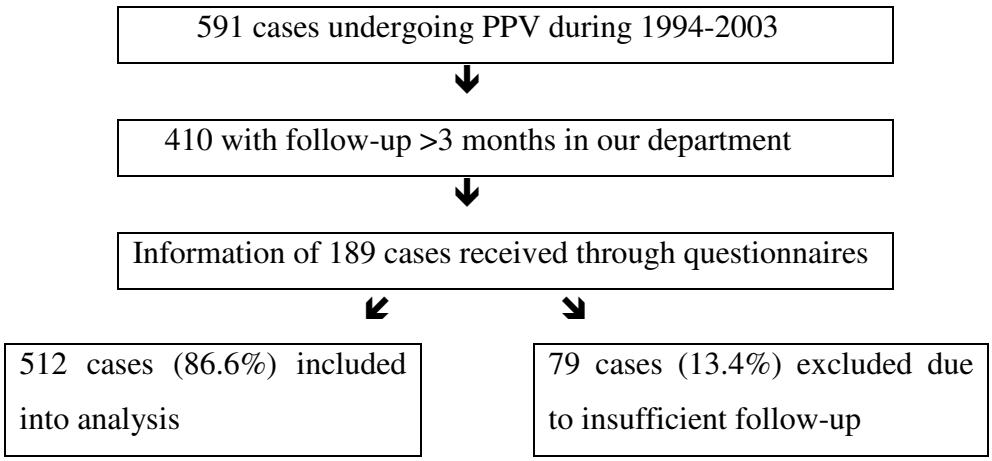

Fig. 3. Flow chart for inclusion of eyes into the study. PPV = pars plana vitrectomy.

3.8 Main outcome measures

The outcomes of rhegmatogenous retinal detachment surgery were evaluated using six main points: (1) best visual acuity during the follow-up period; (2) final visual acuity, best-corrected visual acuity at the last follow-up time, both of them irrespective of any intermediate cataract surgery; (3) initial anatomic success rate, irrespective of any prophylactic manipulation that reattaches the retina or ensures its attachment e. g. laser- or cryocoagulation for retinal break; (4) final anatomic success rate, any kind of reoperation permitted; (5) postoperative occurrence of PVR, irrespective of any reoperation; (6) postoperative occurrence of macular pucker.

3.9 Statistical analysis

Statistical analysis was performed using the SPSS software 10.0 (SPSS Inc, USA). Complete data retrieval was only possible in 503 (98.2%) out of the total of 512 eyes because of missing IOP-recordings note in 9 eyes. Data relating to 46 pre-, per-, and postoperative variables were studied. Descriptive statistics are given as mean and standard deviation, median and range for

continuous data. Univariate and multivariate analyses were accomplished on all 512 and 503 eyes respectively. In addition, because 22 of 503 eyes had no detectable breaks, two variables (location and size of breaks) do not exist in these eyes, to evaluate their value, a multivariate analysis was performed in 481 eyes with break detected. All items were analyzed as categorical variables. Survival time of retina was calculated from the date of the operation to the date of retinal redetachment or last follow-up, and survival curves were constructed using Kaplan-Meier method.

The risk factors of postoperative PVR, macular pucker, initial and final retinal reattachment, best and final visual acuity were analyzed with univariate analysis by Pearson chi-square test or Fisher exact test and multivariate analysis using a logistic regression model. After a forward stepwise fashion was used, with variables being added to the model according to a partial likelihood ratio test using an entry criterion of $p<0.10$. A ***P*** value of ≤ 0.05 was considered to be significant.

Statistical analysis of visual functional outcome, PVR, macular pucker and retinal reattachment status was carried based on the data obtained from patients with clinical visits up to the last follow-up examination (from 3 to 108 months).

Visual acuity was measured with a Snellen visual acuity chart. For purposes of statistical analysis, visual acuity were divided into three groups: Group 1: VA range from no light perception (NLP) to 0.05, Group 2: VA from 0.1 to 0.3, Group 3: VA from 0.4 to 1.0 (Table 1).

Intraocular pressure (IOP) was most often measured with the Goldmann applanation tonometer, or occasionally with the Schiøtz tonometer. IOPs were divided into 5 groups (Table 1).

Unusual breaks were defined as any break other than round holes or horseshoe tears. Retinal tears referred to retinal tear one quadrant or larger. The presence of PVR was defined as PVR grade B or greater according to Machemer et al. [113] Macular diseases included macular hole, macular pucker, macular degeneration and submacular haemorrhage. Cataract surgery

included phakoemulsification and intraocular lens implantation, lensectomy, posterior capsulotomy, intraocular lens removal and intraocular reposition.

Surgeons were firstly divided into two groups depending on their experience, specialist and non-specialist. Specialist had operated more than 100 PPV before contributing a patient to this study. All operations of non-specialists were further divided into two subgroups, the first 30 PPV of all beginning surgeons were coded as "beginners' surgeries". All further PPVs from the 31st onward were coded as "non-beginners' surgeries".

Table 3-1. Preoperative items and codes in statistic analysis

Items	Codes
Age (years)	12~39 (1) 40~59 (2) 60~79 (3) 80~94 (4)
Sex	Male (0) female (1)
Eyes	Right (1) left (2)
Symptoms	1day (1) 2~7days (2) 8~30days (3) >30days (4)
Visual acuity	NLP~0.05 (1) 0.1~0.3 (2) 0.4~1.0 (3)
Amblyopia	No (0) Yes (1)
Refractive errors	Emmetropia/Hyperopia (1)
	–1.0~<-5D (2) -5.0~-10D (3) >-10D (4)
Astigmatism	Astigmatism ≤ 1D (0) Astigmatism > 1D (1)
IOP (mm Hg)	<22 without drug treatment (1)
	<22 with drug treatment (2)
	≥ 22 without drug treatment (3)
	≥ 22 with drug treatment (4)
	>30mmHg with or without drug treatment (5)
Lens status	Phakia (1) Aphakia/pseudophakia (2)
Retinal detachment	
Extent (quadrant)	1 (1) 2 (2) 3 (3) 4 (4)
Location	
Superotemporal	No (0) Yes (1)
Inferotemporal	No (0) Yes (1)
Superonasal	No (0) Yes (1)

Inferonasal	No (0) Yes (1)
Bullous detachment	No (0) Yes (1)
Macular status	On (1) Part/general off (2)
Macular diseases	No (0) Yes (1)
Retinal breaks	
Number	No break (0) 1 break (1) 2 breaks (2) 3 breaks (3) >3 breaks (4)
Location	Peripheral (1) [Superotemporal, inferotemporal, Superonasal, inferonasal] Central (2)
Size	Small or normal (0) large/giant breaks (1) unusual breaks (2) (1)+(2) = (3)
No break seen	No (0) Yes (1)
PVR	No (0) Yes (1)
Vitreous haemorrhage	No (0) Minor (1) Moderate (2) No fundus view (3)
Retinal tear	No (0) Yes (1)
History of coagulation	No (0) Yes (1)
Other eye diseases	No (0) Strabismus (1) Glaucoma (2)

PVR = proliferative vitreoretinopathy

Table 3-2. Intraoperative items and codes in statistic analysis

Items	Codes
Specialists	beginners (1) non-beginners (2) specialists (3)
Tamponade	SF6 (1) Silicone oil (2)
SF6	20% (1) 25% (2) 30% (3) 35% (4) 40% (5)
Scleral buckling	No(0) Segmental buckle(1) Encircling buckle(2)
Cryopexy	Endo- (1) Exo-(2) Both (3)
Drainage	Internal (1) External (2) Both (3)
Use of PFCL	No (0) Yes (1)
Removal of flap	No (0) Yes (1)
Retinotomy	No (0) Yes (1)
Cataract surgery	No (0) Yes (1~5)

Complications	No (0)	Yes (1)
Iatrogenic holes	No (0)	Yes (1)
Lens touch	No (0)	Yes (1)
Subretinal bleeding	No (0)	Yes (1)
Choroidal bleeding	No (0)	Yes (1)
Retinal breaks	Same as preoperative break (1)	
	Different to preoperative (2) No break seen(3)	

SF6 = sulfur hexafluoride; PFCL = perfluorocarbon liquid

Table 3-3. Postoperative items and codes in statistic analysis

Items	Codes
Follow-up time (No.)	3 ~108 months
Initial anatomic success rate	Attachment (0) Redetachment (1)
Final anatomic success rate	Attachment (0) Redetachment (1)
Time of retinal redetachment (No.)	From 0.1 to 28.1 months
Survival time of retina (No.)	from 0.1 to 108 months
Time of cataract surgery (No.)	from 0.1 to 91.4 months
Postoperative best VA	NLP~0.05 (1) 0.1~0.3 (2) 0.4~1.0 (3)
VA at last follow-up time	NLP~0.05 (1) 0.1~0.3 (2) 0.4~1.0 (3)
PVR	No(0) Yes(1)
Macular pucker	No(0) Yes(1)
IOP	The same as preoperative codings
Causes of redetachment	New break (1) PVR (2)
	Old break reopened (3) Persistent break (4)
	Unclear (5) (1)+(2) (6) (2)+(3) (7)
Reasons for final VA (< 0.1)	Retinal redetachment (1)
	Presumed macular dysfunction (MDF)(2)
	Dense cataract (3)
	Combination of cataract and MDF (4)
	Pre-existing amblyopia (5)

	Optic nerve head atrophy (6) Macular pucker (7) Keratopathy (8) Endophthalmitis (9) Macular hole (10) Age-related maculaopathy (11) unknown (12) Myopia ≥ 20D (13)

PVR = proliferative vitreoretinopathy; VA = visual acuity; IOP = intraocular pressure; MDF = macular dysfunction