Analysis of Risk Factors for the Outcome of Primary Retinal Reattachment Surgery in Phakic and Pseudophakic Eyes

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Risikofaktoren für den Erfolg der primären Amotiochirurgie an phaken und pseudophaken Augen

Zusammenfassung

Hintergrund: Ziel der vorliegenden Studie war der Vergleich der prä-, intra- und postoperativen Situation in phaken und pseudophaken Augen mit frischer Amotio retinae, um ein Risikoprofil für den Operationserfolg nach primärer Amotiochirurgie zu erstellen. **Patienten und Methoden:** 220 konsekutive Patienten mit primärer Amotio retinae, 165 phake und 55 pseudophake Augen wurden einer Buckelchirurgie (Plombe/Cerklage) allein oder in Kombination mit einer Vitrektomie unterzogen. Prä-, intra- und postoperative Risikofaktoren wurden erfasst und deren Einfluss auf das anatomische und funktionelle Resultat mittels einer multivariaten Regressionsanalyse verglichen. **Ergebnisse:** Die kumulativen anatomischen Erfolgsraten nach 6 Monaten waren in phaken (88,5%) und pseudophaken (86,3%) Augen gleich (log rank = 0,340). Die Amotioausdehnung erwies sich in pseudophaken Augen als ein stärkerer Risikofaktor für die Beeinträchtigung des operativen Erfolges als in phaken Augen (p = 0,035). Bei phaken Augen zeigte sich kein Einfluss der Amotioausdehnung auf das chirurgische Resultat (1 Quadrant vs. 4 Quadranten; log rank = 0,135); während bei Pseudophakie eine Beeinträchtigung der Amotioausdehnung auf das chirurgische Resultat nachweisbar war (1 Quadrant vs. > 4 Quadranten; log rank < 0,001). Das relative Risiko einer Reamotio nach operativer Versorgung einer Amotio retinae ab 3 Quadranten betrug bei Normophakie 1,22 (CI: 0,71 – 1,70) und bei Pseudophakie 1,81 (CI: 0.88 – 2,59). **Schlussfolgerungen:** Bis zu einer Amotioausdehnung von 3 Quadranten weisen phake und pseudophake Augen ähnliche chirurgische Erfolgsraten auf. Ab einer Ausdehnung der Amotio retinae größer als neun Stunden findet sich im pseu-

Abstract

Background: To compare the preoperative risk profiles of phakic and pseudophakic eyes with primary retinal detachment and to assess their impact on the outcome of primary reattachment surgery. **Patients and methods:** 220 consecutive patients with primary retinal detachment, 165 phakic and 55 pseudophakic eyes were operated with scleral buckling alone or additional vitrectomy and followed up for 6 months. Pre-, intra- and postoperative risk factors were recorded and their impact on anatomical outcome after primary surgery in phakic and pseudophakic eyes was then compared in a multivariate regression analysis. **Results:** The cumulative probability of anatomical success 6 months after surgery was similar in phakic (88.5%) and pseudophakic eyes (86.3%; log rank = 0.340). The most important risk factor for a different surgical outcome between phakic and pseudophakic eyes was the size of retinal detachment (p = 0.035). In phakic eyes the size of retinal detachment had no significant impact on surgical outcome (1 vs. 4 quadrants; log rank = 0.135); whereas in pseudophakic eyes a significant impairment on surgical outcome was found (1 vs. 4 quadrants; log rank < 0.001). The relative risk for failure of primary surgery due to retinal detachment of at least 3 quadrants was in phakic eyes 1.22 (CI: 0.71 – 1.70), in pseudophakic ones 1.81 (CI: 0.88 – 2.59). **Conclusions:** The outcome of primary retinal reattachment surgery in phakic and pseudophakic eyes is similar for retinal detachments up to 3 quadrants. In retinal detachments of more than 9 clock times, the size of retinal detachment impairs the surgical outcome in pseudophakic eyes more than in phakic ones. The combination of extraocular surgery with vitrectomy in pseudophakic eyes

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dophaken Auge, im Gegensatz zum phaken Auge, bei alleiniger eindellender Operation ein negativer Einfluss der Amotioausdehnung auf den Operationserfolg. Dieser kann durch ein kombiniertes extra- und intraokulares Vorgehen mit Vitrektomie reduziert werden.

Schlüsselwörter
Netzhautablösung · Normophakie · Pseudophakie · Risikofaktoren

with retinal detachment of more than 9 clock times contributes to a better outcome.

Key words
Retinal detachment · surgical procedures · phakia, pseudophakia · risk factor, outcome assessment

Background

The incidence of retinal detachment (RD) in the general population lies within the range of 0.006 – 0.02 % , and nearly one quarter of the patients presenting with this condition are pseudophakic [1 – 4]. Eyes after posterior chamber lens implantation are still more prone to RD than are phakic ones, and the risk may increase after surgical or YAG-laser posterior capsulotomy [4, 8 – 11].

The characteristics of RD in phakic and pseudophakic eyes differ, and specific risk factors are thus considered to be predictive for the condition after cataract surgery [9 – 13]. In pseudophakic retinal detachment, preoperative evaluation and surgical treatment are rendered more difficult by a restricted view of the peripheral fundus (due to capsular fibrosis), by reflections of the intraocular lens itself or by insufficient pupillary dilatation. This situation may be exacerbated by the presence of numerous retinal breaks located far anteriorly [14 – 16]. The outcome of retinal reattachment surgery is thus deemed to be poorer in pseudophakic than in phakic eyes [17 – 19]. The identification of a specific risk factor bearing on surgical outcome in pseudophakic RD would undoubtedly enhance our understanding of the pathophysiological situation, simplify decision making [20, 21] and improve the result in high-risk patients.

In the present study, we compared the pre-, intra- and postoperative risk profiles in phakic and pseudophakic eyes and assessed their relative influence on the surgical outcome.

Patients and Methods

220 consecutive cases with primary RD, 165 phakic and 55 pseudophakic eyes, which had undergone scleral buckling either alone or in combination with pars plana vitrectomy were followed up for 6 months. Surgery was performed by two experienced surgeons (JGG, FK) between July 1994 and April 1999 at the Department of Ophthalmology, University of Bern, Switzerland. Phakic and pseudophakic eyes which had developed primary RD after uneventful intraocular lens implantation within the posterior chamber without incurring posterior capsule defects or undergoing zonular dialysis were included. The follow-up time had to be at least 6 months. Further exclusion criteria were: blunt trauma within a 6-month period prior to surgery, previous posterior segment trauma or surgery, proliferative retinopathy of any origin, antiproliferative therapy, uveitis, giant retinal breaks, and PVR stage B or more advanced [22].

A full medical and ophthalmological history of each patient was recorded, with particular attention being paid to the following risk factors: age, gender, trauma, lens and capsule status, duration of symptoms, preoperative PVR, vitreal haemorrhage, presence of pigment in the vitreous cavity, size of RD, and the location of vitreoretinal tractions, with (number) and without breaks.

Surgery and perioperative management followed a standardised protocol, the procedure adopted, the duration of surgery, the number and location of exodrainage created, the number of cryocoagulation spots, and intraoperative problems. Complications such as an impaired view of the fundus and the number of newly-detected retinal breaks being also recorded (Table **1**).

In our department, all patients undergoing retinal reattachment surgery are routinely monitored 1 week, 1 month and 6 months postoperatively, and data were available on this basis. The follow-up period had to be at least 6 months. The main primary outcome parameter was the status of the retina (complete or partial reattachment; persisting detachment). Treatment success was defined as complete retinal reattachment 6 months after primary surgery. Surgery was deemed to have failed if reoperation on the posterior segment (including laser retinopexy on an outpatient base) was required to stabilise or reattach the retina.

Surgical procedures

Scleral Buckling

Generally, surgery aimed to include all breaks within a single buckle. To this end, a radial or circumferential silicone sponge with a diameter of 3–4 mm and a length in accord with that of the break, and/or a silicone encircling band (2.0 mm in diameter) were employed. Retinal breaks were treated by exocryotherapy. If necessary, subretinal fluid was drained following sclerotomy, either after needle-puncture or by electrolysis. At the end of surgery IOP of approximately 12 mm Hg Schiötz was achieved by injecting either air or SF_6 after buckling or PPV.

Vitrectomy

Indications for primary vitrectomy

1. poor fundus view due to vitreal opacities;
2. difficult arrangement of breaks:
   – multiple breaks in more than one quadrant and at different anterior and posterior locations;
   – central breaks far posterior to the equator;

– insufficient tamponade despite adequate buckling or substantial quantities of remaining subretinal fluid;

3. proliferative vitreoretinopathy, stage A;
   insufficient reduction of tractional forces after buckling.

Vitrectomy was performed using a standard two- or three-port pars-plana access and retinopexy using either endolaser, cryotherapy or both. An internal tamponade was achieved using air or a 20%/80% SF_6/air mixture. Silicone oil (5000 CS) was injected only in the case of non-relievable tractional forces being operative in conjunction with an unstable retinal situation. An encircling silicone band (2.0 mm) was always applied during vitrectomy. Simultaneous implantation of an intraocular lens was never required.

The statistical analysis was performed using SPSS for Windows version 9.0 (Chicago, Illinois; USA). Student's t test (quantitative data), the χ^2 test or the Kruskal-Wallis test (qualitative data) and Wilcoxon's rank test (quantitative, non-parametric data) were applied. Distribution profiles were described in terms of skewness and kurtosis. The absence of pre-, intra- or postoperative data of the 6 months control lead to the exclusion of the case. The cumulative probability of failure of primary surgery during the 6-month follow-up period was calculated for each group according to the Kaplan-Meier product-limit method and data compared using the Mantel log-rank test. Cox's proportional hazard model was used to evaluate the effects of possible risk factors for adverse outcomes in phakic and pseudophakic eyes up to 6 months while adjusting for other covariates. The relative risk (odds ratio) of surgical failure for each value of the factor was compared to the risk for a specified reference value. Specific correlations were calculated using Spearman's rho (r) factor. Differences between sets of data were considered to be statistically significant if p values were ≤ 0.05 (on the basis of two-tailed tests).

Table **1** Frequency data respecting clinical risk factors

Factors	*phakic (n = 165)*	*pseudophakic (n = 55)*	*p-value*
1 Age (years, mean [SD])	55.7 ± 14.9	65.7 ± 8.3	< 0.001*
2 Gender (male, n [%])	97 (58.8)	43 (78.2%)	< 0.001°
3 Preoperative PVR A (n [%])	10 (6.1%)	10 (18.2%)	< 0.001°
	m.v.: 2	m.v.: 1	
4 Pigment in the vitreous cavity (n [%])			n.s.°
none	81 (49.1%)	26 (47.3%)	
little	29 (17.6%)	14 (25.5%)	
moderate	43 (26.1%)	10 (18.2%)	
massive	11 (6.1%)	3 (5.5%)	
	m.v.: 1	m.v.: 2	
5 vitreous haemorrhage (n [%])	26 (15.8%)	8 (14.5%)	n.s.°
		m.v.: 1	
6 Size of RD (clock segments, mean [SD])	4.86 ± 2.36	5.9 ± 2.83	0.003+
7 Traction without break (n [%])	11 (6.7%)	13 (23.6)	< 0.001°
8 Traction with break (n [%])	156 (94.5%)	42 (76.4%)	< 0.001°
9 Number of breaks (mean [SD])	1.88 ± 1.68	1.11 ± 0.91	n.s.*
10 Impaired fundus view (n [%])	12 (7.3%)	4 (7.3%)	n.s.°
11 Intraop. detected breaks (patients, n [%])	24 (14.5%)	15 (27.3%)	< 0.001°
12 surgical procedure (n [%])			n.s.°
only buckle	132 (80%)	42 (76.4%)	
additional vitrectomy	33 (20%)	13 (23.6%)	
13 Duration of surgery (min, mean [SD])	59.3 ± 22.8	58.2 ± 24	n.s.*
14 Exodrainage (n, mean [SD])	0.86 ± 0.65	0.98 ± 0.58	0.012+
15 cryocoagulation spots (n; mean [SD])	6.29 ± 6.37	6.54 ± 3.89	n.s.*
16 postoperative development of PVR	16 (12.4%)	9 (19.6%)	n.s.°
(patients n; [%])	m.v.: 36	m.v.: 9	

*t test; +Wilcoxon's rank test; °χ^2-test or Kruskal-Wallis-H; m.v.: missing values; n.s.: no significance

Results

Demographic and surgical data relating to the phakic and pseudophakic group are presented in Table **1**. Pseudophakic individuals were on average older ($p < 0.001$) and more often male ($p < 0.001$) than phakic ones. With regard to the duration of symptoms, no differences between the two groups was revealed.

Regarding the characteristics of RD, pseudophakic eyes more frequently showed preoperative PVR ($p < 0.001$) and vitreoretinal tractions without breaks ($p < 0.001$). The size of the RD was, however, greater in pseudophakic than in phakic eyes ($p < 0.003$) (Table **1**).

A comparison of the intraoperative characteristics of each group revealed similar frequencies in the number of cases requiring vitrectomy, the number of eyes in which fundus view was impaired, the number of exodrainages created and the number of cryocoagulation spots generated. Significantly more breaks were newly detected intraoperatively in pseudophakic eyes ($p < 0.001$). In the phakic group, primary vitrectomy was performed in 33/165 (20%) of cases (Table **1**). Silicone oil was used as an internal tamponade in 5/33 (15.2%), an SF_6/air mixture in 20/33 (60.6%) and air was used in 8/33 (24.2%). In the pseudophakic group, vitrectomy was performed in 13/55 cases (23.6%), silicone oil being employed in 2/13 individuals (15.4%), an SF_6/air mixture in 6/13 (46.2%) and air in 5/13 (38.5%).

PVR developed after scleral buckling in 16 (12.4%) of the phakic eyes and in 9 (19.6%) of the pseudophakic ones ($p = 0.075$). The development of PVR correlated fairly well with the size of the RD in pseudophakic eyes ($r = 0.379$), but only weakly so with that in phakic ones ($r = 0.165$).

The cumulative probability of anatomical success 6 months after surgery was similar in phakic (88.5%) and pseudophakic (86.3%) eyes ([log rank = 0.340]; Fig. **1**).

Cox's proportional hazards model revealed for the risk factors gender ($p = 0.035$) and size of RD ($p = 0.002$) to have a higher negative impact on anatomical outcome in pseudophakic than in phakic eyes.

Further analysis of the gender factor revealed women to have a significantly poorer anatomical outcome after vitrectomy than did their male counterparts (73.96% vs. 89.97%; log rank = 0.027). A more discriminative evaluation of these characteristics (women and vitrectomy) was not possible, due to the low number of cases (n = 17). In phakic eyes, an increase in the size of RD did not significantly lower anatomical success (96.8% [1 quadrant affected] vs. 70.6% [4 quadrants affected]; log rank = 0.135), in contrast to pseudophakic eyes (89.3% [1 quadrant affected] vs. 57,4% [4 quadrants affected]; log rank < 0.001 [Fig. **2**]). A comparison of the outcomes for RD involving four quadrants with one quadrant as reference yielded odds ratios of 1.22 (CI: 0.71 – 1.70) and 1.81 (CI: 0.88 – 2.59) for phakic and pseudophakic eyes, respectively.

Discussion

The present study has revealed the existence of several important differences in the preoperative characteristics of phakic and pseudophakic RD. Patients with pseudophakia tended to be older and more often male, had larger RDs, more frequently manifested preoperative PVR and vitreoretinal traction without breaks, exhibited a higher incidence of intraoperatively newly-detected vitreoretinal breaks, and more frequent exodrainages. Similar findings have been reported by other investigators [14 – 18,23]. Of the recorded risk factors, only gender and the size of the RD had, when considered independently, a significantly greater negative impact on the outcome of primary reattachment surgery in pseudophakic than in phakic eyes.

With respect to gender, the finding that women had a significantly poorer anatomical outcome after vitrectomy than did males is possibly due to the rather small number of qualifying cases involved, rendering a further multifactorial analysis of this putative association impossible. But the size of the RD does indeed appear to be a major prognostic risk factor for surgical failure in pseudophakic eyes. During cataract surgery, traumatisation of the vitreous body [24] and liquefaction of its gel phase [25] may heighten vitreoretinal traction within an already detached retinal zone, thereby promoting further separation peripherally and an enlargement of the affected area. In the present study vitrectomy was routinely combined with a cerclage. Although this undertaking has been reported to lower the detachment rate due to unavoidable remnants and new breaks [26], investigators are not of one mind as to the benefits it confers [20,27].

Previous studies [28,29] have shown that in RDs (with breaks) involving an area of more than nine clock segments, the success rate of reattachment surgery is significantly reduced. The present study revealed that the size of RD to have a significantly greater negative impact on the outcome of primary reattachment surgery in pseudophakic than in phakic eyes. One reason for this finding might be, that in pseudophakic eyes the size of the RD was significantly larger and correlated stronger with the postoperative development of PVR than in phakic eyes. The rates of PVR development after scleral buckling in phakic (12.4%) and pseudophakic (19.6%) eyes correspond to those already documented [16,29 – 34].

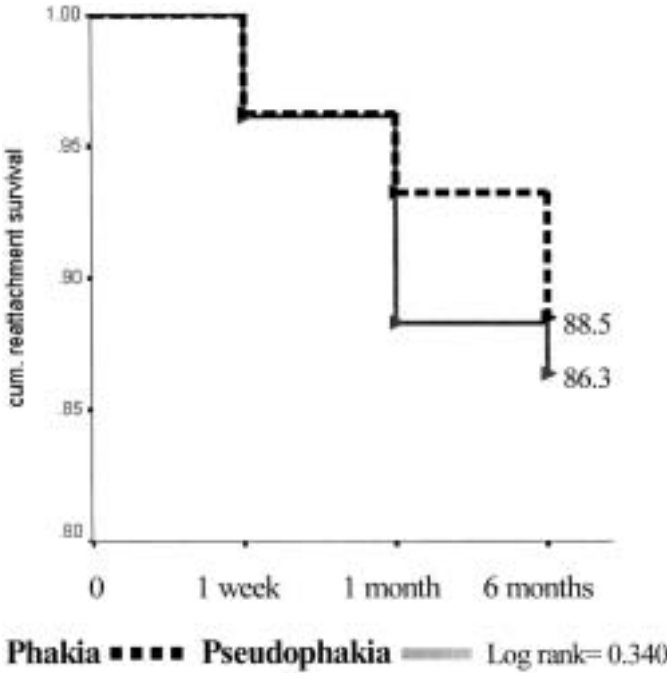

Fig. **1** Retinal reattachment survival curve: phakic vs pseudophakic eyes.

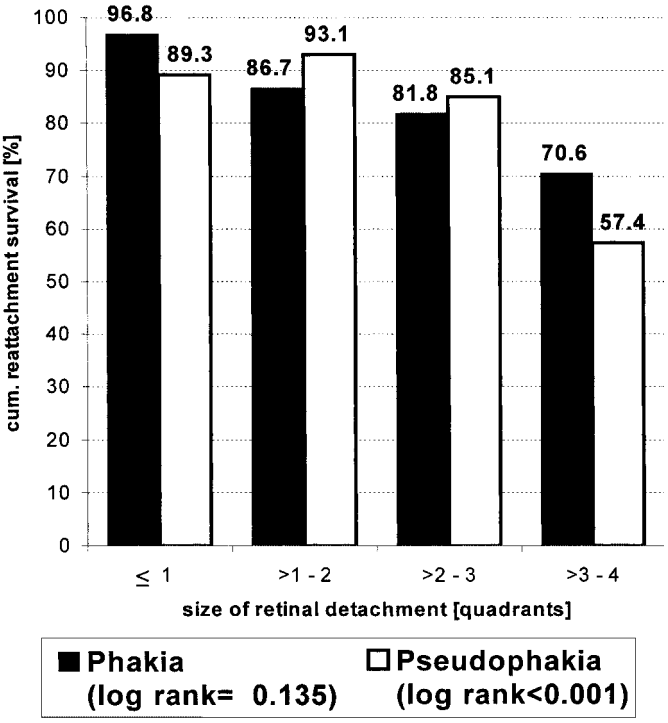

Fig. **2** Retinal reattachment survival rates 6 months postoperative as a function of the size of retinal detachment.

Using older cataract extraction techniques, pseudophakic subjects were supposed to be more prone to failure after reattachment surgery than where phakic ones [16,32,33,36,37]. In the present study, anatomical success rates for phakic and pseudophakic eyes were 88.5% and 86.3%, respectively, the outcomes being similar after reattachment surgery. The differences between phakic and pseudophakic eyes is somewhat smaller than that reported by other investigators [3,19,33,38–41]. One reason for this could be that previous studies included mainly eyes which were either aphakic or had received an anterior chamber lens. The situation of the implant has already been shown to have an impact on the anatomical and functional outcome of reattachment surgery [16,33]. This influence was believed to be related to the clarity of fundus view, which was more often compromised in eyes with an anterior chamber lens, thereby resulting in a higher incidence of undetected retinal breaks [11,18]. Although individuals with anterior chamber implants were excluded from the present study, pseudophakic eyes still manifested a higher incidence of intraoperatively newly-detected retinal breaks. Their discovery did not, however, have a bearing on outcome of reattachment surgery. This finding may reflect recent advancements in vitrectomy techniques, including indirect wide-angle optics and a means of removing capsular opacities. The removal of fundus-obscuring vitreal haemorrhages is also now feasible and desirable, since blood proteins are recognized to promote the development of PVR [29]. However, it cannot be inferred that vitrectomy offers advantages in the detection of these breaks; indeed, the procedure itself may even produce some of these. The present study cannot therefore assess the assets of vitrectomy in treating uncertain hole situations. But one important conclusion that can be drawn from our data is that the most important risk factor for different outcome after primary retinal reattachment surgery in phakic and pseudophakic eyes is the size of RD. In pseudophakic eyes the size of RD stronger impairs the outcome than in phakic ones. Its stronger impact in pseudophakic eyes reaches significance after primary reattachment surgery due to RD of more than 9 clock segments involved.

References

[1] Haimann MH, Burton TC, Brown CK. Epidemiology of retinal breaks. Arch Ophthalmol 1982; 100: 289–292
[2] Minihan M, Tanner V, Williamson TH. Primary rhegmatogenous retinal detachment. Br J Ophthalmol 2001; 85: 546–548
[3] Ah-Fat FG, Sharma M, Majid MA, McGalliard JN, Wong D. Trends in vitreoretinal surgery at a tertiary referral centre: 1987 to 1996. Br J Ophthalmol 1999; 83: 396–398
[4] Gray RH, Evans AR, Constable IJ, McAllister IL. Retinal detachment and its relation to cataract surgery. Br J Ophthalmol 1989; 73: 775–780
[5] Pervical SP, Anand V, Das SK. Prevalence of aphakic retinal detachment. Br J Ophthalmol 1983; 7: 43–45
[6] Claymann HM, Jaffe NS, Light DS, Jaffe MS, Cassady JC. Intraocular lenses, axial length, and retinal detachment. Am J Ophthalmol 1981; 92: 778–780
[7] Stark WJ, Maumenee AE, Fagadau WR, Hirst LH, Datiles MB. Intraocular lenses: experience at the Wilmer Institute. Austr J Ophthalmol 1983; 11: 95–102
[8] Kratz RP, Mazzocco TR, Davidson BD. A comparative analysis of anterior chamber, iris supported, capsule-fixated, and posterior chamber intraocular lenses following cataract extraction by phacoemulsification. Ophthalmology 1981; 88: 56–58
[9] Javitt JC, Vitale S, Canner JK, Krakauer H, McBean AM, Sommer A. National outcomes of cataract extraction I. Retinal detachment after inpatient surgery. Ophthalmology 1991; 98: 895–902
[10] Leff SR, Welch CJ, Tasman W. Rhegmatogenous retinal detachment after YAG laser capsulotomy. Ophthalmology 1987; 94: 1222–1225
[11] Yoshida A, Ogasawara H, Jalkh AE, Sanders RJ, McMeel JW, Schepens CL. Retinal detachment after cataract surgery. Predisposing factors. Ophthalmology 1992; 99: 453–459
[12] Yoshida A, Ogasawara H, Jalkh AE, Sanders RJ, McMeel JW, Schepens CL. Retinal detachment after cataract surgery. Surgical results. Ophthalmology 1992; 99: 460–465
[13] Bovey EH, Gonvers M, Sahli O. Traitement chirurgical du décollement de rétine chez le pseudophaque: comparison entre la vitrectomie et la compression épisclérale. Klin Monatsbl Augenheilkd 1998; 212: 314–317
[14] Bradford JD, Wilkinson CP, Fransen SP. Pseudophakic retinal detachments. Retina 1989; 3: 181–186
[15] Wilkinson CP. Retinal detachments following intraocular lens implantation. Ophthalmology 1981; 88: 410–413
[16] Wilkinson CP. Pseudophakic retinal detachments. Retina 1985; 5: 1–4
[17] Törnquist R, Bodin L, Törnquist P. Retinal detachment: a study of a population-based patient material in Sweden 1971–1981. IV. Prediction of surgical outcome. Acta Ophthalmol 1988; 66: 637–642
[18] Törnquist R, Törnquist P. Retinal detachment: a study of a population-based patient material in Sweden 1971–1981. III. Surgical results. Acta Ophthalmol 1988; 66: 630–636
[19] American Academy of Ophthalmology. The repair of rhegmatogenous retinal detachments. Ophthalmology 1990; 97: 1562–1572
[20] Heimann H, Hellmich M, Bornfeld N, Bartz-Schmidt KU, Hilgers RD, Foerster MH. Scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment (SPR Study): Design issues and implications. SPR Study Report No. 1. Graefe's Arch Clin Exp Ophthalmol 2001; 239: 567–574
[21] Newmann DR, Burton RL. Primary vitrectomy for pseudophakic and aphakic retinal detachments. Eye 1999; 13: 635–639
[22] The Retina Society Terminology Committee. The classification of retinal detachment with proliferative vitreoretinopathy. Ophthalmology 1983; 90: 121–125
[23] Törnquist R, Stenkula S, Törnquist P. Retinal detachment. A study of a population-based patient material in Sweden 1971–1981. I. Epidemiology. Acta Ophthalmol 1987; 65: 223–230
[24] Heimann H, Bornfeld N, Friedrichs W, Helbig H, Kellner U, Korra A, Foerster MH. Primary vitrectomy without scleral buckling for rhegmatogenous retinal detachment. Graefe's Arch Clin Exp Ophthalmol 1996; 234: 561–568
[25] Binkhorst CD. Corneal and retinal complications after cataract extraction. Ophthalmology 1980; 87: 609–617
[26] Rachal WF, Burton TC. Changing concepts of failures after retinal detachment surgery. Arch Ophthalmol 1979; 97: 480–483
[27] Yusuke O, Kazuyuki E, Masanobo M, Yamanishi S. Survey of surgical indications and results of primary pars plana vitrectomy for rhegmatogenous retinal detachment. Jpn J Ophthalmol 1999; 43: 120–126
[28] Cowley M, Conway BP, Camochiaro PA, Kaiser D, Gaskin H. Clinical risk factors for proliferative vitreoretinopathy. Arch Ophthalmol 1989; 107: 1147–1151
[29] Girard P, Mimoun G, Karpouzas I, Montefiore G. Clinical risk factors for proliferative vitreoretinopathy after retinal detachment surgery. Retina 1994; 14: 417–424
[30] Devenyi RG, de Carvalho Nakamura H. Combined scleral buckle and pars plana vitrectomy as primary procedure for pseudophakic retinal detachments. Ophthalmic Surg Lasers 1999; 30: 615–618
[31] Oshima Y, Emi K, Motokura M, Yamanishi S. Survey of surgical indications and results of primary pars plana vitrectomy for rheghmatogenous retinal detachments. Jpn J Ophthalmol 1999; 43: 120–126
[32] Bartz-Schmidt KU, Kirchhof B, Heimann K. Primary vitrectomy for pseudophakic retinal detachment. Br J Ophthalmol 1996; 80: 346–349
[33] Ho PC, Tolentino FI. Pseudophakic retinal detachment. Surgical success rate with various types of IOLs. Ophthalmology 1984; 91: 847–852
[34] Vatane HO, Syrdalen P. Retinal detachment after intraocular lens implantation. Acta Ophthalmol 1986; 64: 544–546
[35] Schwartz SG, Kuhl DP, McPherson AR, Holz ER, Mieler WF. Twenty-year follow-up for scleral buckling. Arch Ophthalmol 2002; 120: 325–329

[36] Chignell AH, Fison LG, Davies EW, Hartley RE, Gundry MF. Failure in retinal detachment surgery. Mod Probl Ophthalmol 1974; 12: 20 – 28
[37] Wong D, Billington BM, Chignell AH. Pars plana vitrectomy for retinal detachment with unseen retinal holes. Graefe's Arch Clin Exp Ophthalmol 1987; 225: 269 – 271
[38] Sullivan PM, Luff AJ, Aylward GW. Results of primary retinal reattachment surgery: a prospective audit. Eye 1997; 11: 869 – 871
[39] Hakin KN, Lavin MJ, Leaver PK. Primary vitrectomy for rhegmatogenous retinal detachment. Graefe's Arch Clin Exp Ophthalmol 1993; 231: 344 – 346
[40] Cousins S, Boniuk I, Okun E, Johnston GP, Arribas NP, Escoffery RF, Burgess DB, Grand MG, Olk RJ, Schoch LH. Pseudophakic retinal detachments in the presence of various IOL types. Ophthalmology 1986; 93: 1198 – 1208
[41] Hagler WS. Pseudophakic retinal detachment. Trans Am Ophthalmol Soc 1982; 80: 45 – 63