Int Ophthalmol (2019) 39:2089–2095
https://doi.org/10.1007/s10792-018-1045-5

ORIGINAL PAPER

The impact of duration on the recurrence of rhegmatogenous retinal detachment: optimal cutoff value

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Received: 1 May 2018 / Accepted: 12 November 2018 / Published online: 23 November 2018

Abstract
Purpose To assess the impact of symptom duration on the recurrence of rhegmatogenous retinal detachment (RRD) and to determine the threshold symptom duration for recurrence.
Patient and methods In this non-comparative, observational case series, a retrospective evaluation was made of the records of patients with RRD at baseline and during the postoperative follow-up period, in respect of postoperative anatomic outcome, prognostic factors for recurrent retinal detachment and the cutoff value of symptom duration.
Results Recurrent retinal detachment was detected in 33 (17.8%) of 185 patients following primary retinal detachment surgery. The surgery type in phakic patients and preoperative symptom duration had a significantly high odds ratio for evidence of surgical failure. According to the ROC analysis, the threshold preoperative symptom duration was 20.5 days.
Conclusion Our results showed that early reattachment surgery is necessary to lower the risk of retinal redetachment. The threshold at which RRD recurrence significantly increases is 20.5 days.

Keywords Rhegmatogenous retinal detachment · Recurrent retinal detachment · Prognostic factors · Symptom duration · ROC analysis

Introduction

Rhegmatogenous retinal detachment (RRD) is one of the most common diseases of the retina that threatens vision and requires emergency treatment [1]. It has been reported that the incidence of detachment varies from 6.3 to 18.2/100,000 people per year [2, 3]. The aim of RRD treatment is to detect retinal tears, localization, closure of retinal breaks and elimination of any traction on the tear edges [4].

Proliferative vitreoretinopathy (PVR), involvement of inferior quadrants, undetectable retinal tear, high myopia and hypotonia are known to be risk factors for recurrence of detachment [5, 6]. In addition, risk factors associated with PVR development are aphakia, uveitis, vitreous hemorrhage, initial referral with PVR, high intraocular pressure and an older age [7]. Despite

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the progress in surgical technique and devices, PVR is frequently encountered and is the primary cause of failure in 75% of all cases of detachment surgery, with a cumulative risk of 5–10% [8]. Another important cause of RRD recurrence is the pre-surgery symptom duration. In many studies, the relationship between preoperative symptom duration and functional success was assessed [9–12]. But studies showing the relationship between preoperative symptom duration and RRD recurrence are not sufficient.

In this study, the causes of recurrence of RRD treated with primary vitrectomy were investigated. It was also aimed to assess the threshold value time of RRD symptom duration on RRD recurrence (defined as the time from onset of symptoms to surgical treatment).

Patients and methods

This single-center retrospective study was conducted between June 2013 and June 2017 in a tertiary referral center. The study protocol was approved by the Ethics Committee of Diskapi Research and Training Hospital, and all procedures followed the tenets of Declaration of Helsinki. Written informed consent was obtained from all participants prior to every surgical procedure. All the patients were Turkish Caucasians.

A total of 255 medical records were reviewed, and 185 patients were included in the study. Inclusion criteria were: patients treated with pars plana vitrectomy (PPV) with silicone oil or gas tamponade for primary RRD and followed up for at least 12 months after surgery, in silicone oil eyes, the follow-up period was started after the silicone was removed, duration of visual impairment such as a dense shadow in the peripheral vision or central visual loss, primary RRD successfully repaired with a single, uncomplicated pars plana vitrectomy. Cases with previous proliferative vitreoretinopathy were excluded. Other exclusion criteria were those with previous ocular surgery other than uncomplicated cataract surgery (cataract surgery must be at least 6 months before PPV) and those with preexisting ocular diseases such as glaucoma, uveitis, macular degeneration, or retinal vascular disorders.

All patients underwent a comprehensive ocular examination, including measurement of best-corrected visual acuity (BCVA) with the Early Treatment Diabetic Retinopathy Study (ETDRS) chart, detailed anterior segment, and dilated funduscopic examination using slit-lamp biomicroscopy with a 90-diopter non-contact lens and indirect ophthalmoscopy. Preoperative data included age, gender, BCVA, refractive error (RE), intraocular pressure, lens status, RD duration (defined as the time from onset of symptoms to surgical treatment), extent of retinal detachment, macular involvement, surgery type (PPV vs. Phaco + PPV), endotamponade type, number of retinal tears and detachment localization.

All the surgical procedures were performed under local anesthesia by the same surgeon (MC), using the 23-gauge Constellation Vision System (Alcon Laboratories, Fort Worth, TX, USA). In cases with mild and moderate cataract or aged > 60 years, phacoemulsification and intraocular lens implantation (IOL) were performed before PPV through a 2.2-mm superior clear corneal incision. Hydrophobic acrylic monofocal IOL was inserted to the capsular bag in all cases, and stromal hydration was applied to the corneal wound. After central and peripheral vitreous removal, a 360° scleral indentation was used to shave the vitreous base up to the ora serrata, followed by removal of all vitreous traction from retinal tears. Endolaser photocoagulation was applied to the surroundings of all retinal breaks. Complete fluid–air exchange was performed, and subretinal fluid was aspirated with a flute needle. Sclerotomy sites were sutured with 8-0 Vicryl sutures at the end of the operation. Perfluoropropane gas (C3F8, GOT C3F8 multi, Alchimia) was diluted at a rate of 16% before use. The silicone oil used in the study was 5000 cSt (centistokes) silicone oil (Oxane 5700). Silicone oil was preferred for patients who could not reliably maintain prone positioning and who had to travel by air. If silicone oil was selected as the tamponade agent, it was removed at subsequent surgery approximately 3 months after the initial vitrectomy. No scleral buckling was used in both groups.

Statistical analysis was performed using IBM SPSS 20.0 software (SPSS Inc, Chicago, IL). For the purposes of analysis, qualitative variables were categorized, whereas quantitative data were presented as mean $\pm$ standard deviation. Factors investigated for anatomic success were age, gender, lens status, quadrant of retinal detachment, myopia (< 6, ≥ 6D), macular involvement, the number of retinal tears, preoperative visual acuity (in logMAR), type of

surgery, preoperative symptom RD duration and detachment localization. The multivariate relationship between these factors and anatomic failure was evaluated using logistic regression analysis. The Mann–Whitney U or t test was used for numerical data, and the Chi-square or Fisher's exact test was used for categorical data in the investigation of the independent effects of these factors on anatomic success. Receiver operating characteristic (ROC) analysis was used to determine the critical point of symptom duration that caused recurrent retinal detachment. Based on the cutoff value, the patients were divided into two categories, and the preoperative parameters were compared. A value of $p \leq 0.05$ was considered statistically significant.

Results

Recurrent retinal detachment was detected in 33(17.8%) of 185 patients following primary retinal detachment surgery.

The epidemiological data, preoperative status and surgical approach are given in Table 1. The study included 185 patients comprising 134 males with a mean age of 61.24 ± 8.07 years and 51 females with a mean age of 63.14 ± 9.80 years. The mean follow-up period was 20.11 ± 9.11 months. The mean RD duration time from symptom onset to surgery was determined to be 14.26 ± 8.56 days.

There were no significant differences between silicone oil and perfluoropropane gas in terms of recurrent retinal detachment (15 patients (45.4%) with C3F8 endotamponade vs. 18 patients (54.5%) with silicone oil endotamponade) ($p = 0.52$). Recurrence occurred in 7 of 35 eyes (20%) with macula-on and 26 of 150 eyes (17.3%) with macula-off ($p = 0.71$). Missed and/or new retinal breaks (12 patients (36.3%)), inadequate tamponade of silicone oil or gas in the inferior part of the retina (4 patients (12.1%)) and PVR (17 (51.5%)) patients were detected as the main causes of failure. Recurrent retinal detachment occurred in 7 patients after silicone oil removal. The mean time to recurrence after silicone oil removal was 42 ± 28 days. Patients that developed recurrent retinal detachment underwent PPV and intraoperative endolaser treatment, and if necessary, epiretinal–subretinal membrane peeling, endodiathermy or retinotomy was performed and silicone oil was used as a tamponade. Finally, anatomic reattachment was achieved in all the patients.

Table 1 Preoperative characteristics of the studied patients including epidemiologic data, preoperative status and surgical approach

Patients	Number and percent
Number of patients	185
Age	61.76 ± 8.60
Symptom duration	14.26 ± 8.56
Follow-up	20.11 ± 9.11
Preoperative visual acuity	1.64 ± 0.63
Gender	
Female	51 (%27.6)
Male	134 (%72.4)
Endotamponade	
Silicon oil	99 (%53)
Gas	86 (%47)
Lens status	
Pseudophakic	89 (%49.1)
Phakic	96 (%51.9)
Retinal tear status	
Single	80 (%43.2)
Multiple	105 (%56.8)
Surgery type	
PPV/Phaco + PPV (phakic patients)	24 (%25)/72 (%75)
Macular involvement	
Macula-on	35 (%18.9)
Macula-off	150 (%81.1)
Retinal detachment	
Superior	67 (%36.2)
Midline	56 (%30.3)
Inferior	62 (%33.5)

Univariate logistic regression analysis showed that the number of detached retinal quadrants, surgical method (PPV or Phaco + PPV) and preoperative symptom duration had a significantly high odds ratio for evidence of surgical failure. The other factors were not seen to be a significant risk of recurrence (Table 2). In the multivariate logistic regression analysis, the three variables of "the number of detached retinal quadrants," "surgical method (PPV or Phaco + PPV)" and "preoperative symptom duration" showed that the surgical method (Phaco + PPV) and preoperative symptom duration were independent risk factors for recurrent detachment ($p = 0.016$, odds

Table 2 Univariate and multivariate logistic regression analyses of possible risk factors for redetachment

Study factors	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p* value	OR (95% CI)	*p* Value
Age (years)	0.988 (0.944–1.034)	0.607	NE	NE
Sex	0.768 (0.307–1.918)	0.571	NE	NE
Lens status (phakic vs. pseudophakic)	1.780 (0.783–4.051)	0.169	NE	NE
Quadrant of retinal detachment	0.257 (0.121–0.545)	**< 0.001**	0.574 (0.180–1.837)	0.350
Myopia (< 6 vs. > 6)	2.496 (0.715–8.707)	0.151	NE	NE
Number of retinal breaks	0.690 (0.442–1.076)	0.102	NE	NE
Macula on–off	1.432 (0.557–3.680)	0.456	NE	NE
Preoperative visual acuity	0.471 (0.085–2.620)	0.390	NE	NE
PPV versus Phaco + PPV (phakic patients)	4.000 (1.302–12.293)	**0.016**	0.127 (0.024–0.684)	**0.016**
Tamponade	1.066 (0.801–1.418)	0.663	NE	NE
Preoperative retinal detachment durations	0.699 (0.617–0.793)	**< 0.001**	0.682 (0.593–0.786)	**< 0.001**
Retinal detachment (superior vs. midline vs. inferior)	0.802 (0.504–1.275)	0.351	NE	NE

Bold values are siginificant

OR odds ratio, *CI* confidence interval, *NE* not entered into multivariable analysis

ratio 0.127; $p < 0.001$, odds ratio 0.682, respectively, Table 2). The recurrence rate was 16.6% (16/96) in phakic patients and 19.1% (17/89) in pseudophakic patients, and the difference was not significant ($p = 0.666$). A statistically significant difference was found between PPV and Phaco + PPV in phakic patients, and PPV showed a high recurrent RD rate ($p = 0.011$).

The threshold value of the RD duration, which would be a risk of recurrent retinal detachment, was assessed using ROC analysis (Table 3). According to the ROC analysis results, the threshold preoperative symptom duration was 20.5 days (Fig. 1). Based on this threshold value, patients undergoing surgery after 20.5 days were observed to have more detached areas

Table 3 Receiver operating characteristic (ROC) analysis of the preoperative symptom duration

Symptom duration	
CP = cutoff point (day)	20.5
AUC = area under the curve	0.961
95% CI	0.928–0.994
Sensitivity	%86.7
Specificity	%93.5
p value	< 0.001

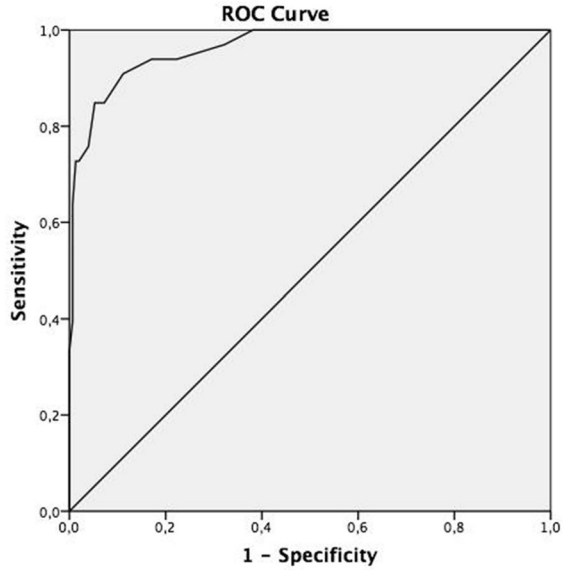

Fig. 1 Receiver operating characteristics curve for the symptom duration

($p = 0.004$) (Table 4). The recurrence rate was significantly higher in both macula-off and macula-on patients treated after 20.5 days ($p < 0.001$).

Table 4 Patients' preoperative characteristics, epidemiological data, preoperative status and surgical approach according to cutoff value

	< 20.5 days (n = 149)	> 20.5 days (n = 36)	p value
Recurrent retinal detachment	5 (%3.4)	28 (%77.7)	**< 0.001**
Surgery			
PPV	85 (%57)	28 (%77.8)	0.170
Phaco + PPV	64 (%43)	8 (%22.2)	
Tear(s)			
Single	73 (%48.9)	12 (%33.3)	0.124
Multiple	76 (%51.1)	24 (%66.7)	
Quadrants of retinal detachment			
1 Quadrant	16 (%10.7)	2 (%5.6)	**0.004**
2 Quadrant	97 (%65.1)	15 (%41.7)	
Total	36 (%24.2)	19 (%52.8)	
Lens			
Phakic	78 (%52.3)	18 (%50)	0.854
Pseudophakic	71 (%47.7)	18 (%50)	
Macula			
On	29 (%19.5)	6 (%16.7)	0.815
Off	120 (%80.5)	30 (%83.3)	
Tamponade			
Silicon oil	77 (%51.7)	22 (%61.1)	0.885
Gas	72 (%48.3)	14 (%38.9)	
Detachment localization			
Superior	55 (%36.9)	12 (%33.3)	0.886
Midline	44 (%29.5)	12 (%33.3)	
Inferior	50 (%33.5)	12 (%33.3)	

Bold values are siginificant

Discussion

This study included 185 eyes of 185 patients, and recurrent detachment was determined in 33 (17.8%) patients. According to the multivariate logistic regression analysis, the duration of preoperative symptom until surgery and the surgical method in phakic patients were found to be risk factors for recurrence.

Recent developments in instrumentation, surgical aids and techniques have resulted in final anatomic success rates of RRD repair of > 90% [13–17]. The anatomic success rate in the current study was 82.2%, and the recurrence rate was 17.8%. Similar anatomic success and recurrence rates have been reported in literature [15, 17].

Surgical intervention is more difficult in cases of inferior detachment because of the localization. Therefore, additional procedures such as scleral buckling can be used. However, with the advances in vitrectomy methods, such disadvantages have disappeared. Previous studies have indicated that inferior quadrant detachment is associated with a poor prognosis and risk of recurrent retinal detachment [18, 19]. However, other studies have reported that inferior detachment is not a risk factor for anatomic success and recurrence [20, 21]. In the current study, inferior quadrant detachment was not determined to be a risk factor for recurrence. The need for scleral buckling in the treatment of inferior quadrant detachments has also reduced with the developments in PPV and endotamponade technologies. In addition, scleral buckling can lead to complications such as choroidal hemorrhage, prolongation of operation, exposure, refractive defect, diplopia and anterior segment ischemia [22, 23]. Additional scleral buckling was not used in any of the current study patients with inferior quadrant detachment in the first surgery.

In this study, previous lens extraction was not seen to be a risk factor for anatomic success and recurrence. Wickham et al. [24] reported a similar result. Caiado

et al. [25] found the recurrence rate in phakic patients to be 28–29%, with an anatomic success rate of 71.4% in phakic patients, and approximately 95% in pseudophakic patients. In the current study, the recurrence rate in phakic patients was 16.6%, and in pseudophakic patients, 19.1%, and this difference was not statistically significant. However, in the current study, PPV alone was found to be a risk factor for recurrence in phakic patients compared to Phaco + PPV. The presence of the natural lens makes working in the area of the vitreous base challenging, and shaving of the vitreous base is more difficult in the presence of the natural lens.

Another important risk factor for recurrence has been reported to be the number of detached quadrant, and this was found to be a significant risk factor for recurrence in the current study. A similar result was obtained in the study by Wickham et al. [24]. A large number of detached quadrants can create surgical difficulties. Furthermore, a large number of detached quadrants may be related to a prolonged detachment period and may also facilitate the development of PVR.

The RD duration time between symptom and surgery is very important in terms of recurrence. Enders et al. [26] did not find any relationship in macula-on patients. However, in that study, patients with macular involvement showed a significant increase in recurrence rate after day 8 [26]. The current study showed an increased risk of recurrent RD after 20.5 days. The recurrence rate was significantly higher in both macula-off and macula-on patients treated after 20.5 days. The long RD duration was related to a higher risk of PVR. When the patients were separated into two groups based on 20.5 days, it was observed that the number of detached quadrants increased significantly in the patients in the longer than 20.5 days group. More extensive retinal detachment is a known risk factor for the development of PVR [27]. In the current study, PVR was not present in any patient preoperatively. PVR was observed after the first surgery. Therefore, it can be considered appropriate to plan a more aggressive treatment approach and more follow-up evaluation of patients who have been treated after 20.5 days postoperatively.

Endotamponade selection was not determined to have affected recurrence in the current study, which was in accordance with the literature [26]. Comparative studies have shown that eyes treated with silicone oil have been successfully reattached, achieved better visual acuity and had fewer postoperative complications [28, 29]. In a study by Caiado et al. [25], similar rates of recurrence were detected in patients using PPV + C3F8 and PPV + silicone (28–29%).

The retrospective design of this study was the most important limiting factor. The duration of the symptom depends on the patient correctly remembering the onset of the symptoms. For a future study, an ideal prospective study regimen would be needed with a structured assessment of the quality and duration of the symptom and self-assessment by the patient on the reliability of the recalled schedules. The relatively low number of patients may also affect the generalization of the results.

The main aim of this study was to measure the effect on recurrence rate of the RD duration between symptom onset and surgery. The results demonstrated that the RD duration is very important for recurrence. The optimal cutoff value, which significantly increases RRD recurrence, is 20.5 days.

Compliance with ethical standards

Conflict of interest The authors have no conflict of interests to declare. The authors alone are responsible for the content and writing of the paper.

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