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ORIGINAL PAPER

Risk factors for multiple retinal tears in patients with acute posterior vitreous detachment

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Abstract
Purpose To evaluate possible risk factors for multiple retinal tears in patients with acute posterior vitreous detachment.
Materials and methods Three hundred and seventy-six consecutive patients presenting with symptoms of floaters and/or flashes were examined. The associations of retinal tears with the duration of symptoms, multiple floaters, flashing, a family history of retinal detachment, peripheral retinal degeneration, lens status, myopia, tobacco dust, and retinal or vitreous hemorrhage were analyzed.
Results Fifty-four (14.4%) of the 376 patients had 71 initial retinal tears. Forty of the 54 eyes had one retinal tear, and 14 eyes had multiple retinal tears. The presence of retinal or vitreous hemorrhage increased the risk of multiple retinal tears 6.1 times using univariate analysis and 7.0 times using multivariate analysis.
Conclusion Unrecognized retinal tears in patients with acute posterior vitreous detachment can cause subsequent retinal detachment. It is therefore important to consider multiple retinal tears, especially in patients with retinal or vitreous hemorrhage.

Keywords Posterior vitreous detachment · Retinal tears · Vitreous hemorrhage

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Introduction

Posterior vitreous detachment (PVD) is a common age-related condition among patients 45 years or older [1]. The main complications associated with PVD are retinal detachment (RD) or tears, either at initial presentation or at a later date [2, 3]. In studies similar to the present one, the incidence of patients with retinal tears following acute PVD was reported to be 8–15% [3–7]. A meta-analysis of 1568 patients with acute, symptomatic PVD revealed an initial retinal tear percentage of 21.7%. This percentage varied from 47.6 to 8.2% [8]. The risk factors for a retinal tear with a symptomatic PVD include hemorrhage or retinal pigment epithelial cells in the anterior vitreous. Additional risk factors are myopia, trauma,

pseudophakia, aphakia, lattice degeneration, RD in the fellow eye, and a positive family history of RD [9–17]. It has also been suggested that patients with symptoms of light flashes or multiple floaters may have a higher risk of an associated retinal tear [3, 18].

Unrecognized retinal tears at the initial examination might predict serious subsequent complications in patients with acute PVD because it is well known that approximately half of the eyes with a symptomatic retinal tear and persistent vitreoretinal traction will progress to RD without treatment [19–21].

Risk factors for retinal tears in patients with acute PVD are well defined; however, it has been reported that as many as half of these patients have more than one tear, [19, 20] but to the best of our knowledge, there have been no studies that investigated risk factors for the development of multiple retinal tears in these patients. In this study, we therefore evaluated such risk factors in patients with acute PVD.

Materials and methods

This was a prospective study of 376 consecutive patients presenting with symptoms of floaters and/or flashes, who were examined by a retinal specialist (E.K.) at a private ophthalmic clinic in Izmir, Turkey, between June 2010 and April 2015. The history of a single floater as a black dot, line, or web, multiple floaters, or floaters with flashing was recorded, as well as the duration of symptoms, the family history of RD, and a detachment in the fellow eye. This study was conducted in accordance with the tenets of the Declaration of Helsinki, with local ethical approval from the Ethics Committee of Sifa University. Informed consent for participation in this study was obtained from each participant.

The eye examination included a visual acuity measurement, tonometry, a refractive error measurement, an examination of the anterior segment using biomicroscopy, an examination of the posterior segment using a slit lamp, indirect ophthalmoscopy, a +90 diopters (D) lens, and Goldmann 3-mirror contact lens biomicroscopy.

A diagnosis of vitreous separation involved the presence of a Weiss ring and/or the presence of a retinal tear. Patients without a Weiss ring were included in this diagnosis if there was clear evidence of a posterior vitreous separation on slit lamp biomicroscopy. This required that the examiner ensure that there was an optically empty region posterior to the vitreous gel, together with an undulating membranous sheet during either vertical or horizontal eye movements [22].

The following categories of patients were excluded from this study: prior ocular trauma (serious enough to cause disruption of intraocular structures, whether or not surgical repair was required); prior ocular diseases such as advanced glaucoma or diabetic retinopathy (very severe nonproliferative diabetic retinopathy or proliferative diabetic retinopathy with or without high-risk characteristics); prior intraocular inflammation; prior vitreous hemorrhage due to any cause; long-term use of topical pilocarpine; a history of prior treatment of retinal tears; or retinal detachment in the affected eye. Patients who had symptoms for >2 months and patients with any history of ocular surgery except uncomplicated phacoemulsification cataract extraction with in-the-bag intraocular lens insertion without posterior capsular rupture or vitreous loss were also excluded.

The associations of retinal tears with a variety of parameters such as the duration of symptoms, multiple floaters, flashing, a family history of retinal detachment, peripheral retinal degeneration, lens status, myopia, tobacco dust, and retinal or vitreous hemorrhage were analyzed.

All statistical analyses were performed using SPSS statistical software for Windows, version 11.5 (SPSS, Chicago, IL, USA). Demographic data were assessed using the mean, range, and standard deviation for continuous data or in number and percent for categorical data. Continuous data were compared using the Student's t test if the distribution of samples was normal or with the Mann–Whitney U test if the sample distribution was nonparametric. The χ^2 test was used for determining the difference between the control group and the retinal tear group for categorical data.

Possible risk factors for retinal tears were analyzed using the χ^2 test, Fisher's exact test, and logistic regression for univariate analyses. The strength of association was measured using the odds ratio and its 95% confidence interval. Multiple logistic regression was used to adjust for confounding factors using multivariate analyses. The results were considered statistically significant at a p value <0.05.

Results

Fifty-four (14.4%) of the 376 patients had 71 initial retinal tears with an average of 1.3 initial retinal tears per eye. Of the 71 initial retinal tears, 56 (78.8%) were flap tears while the remaining 15 (21.2%) were operculated tears. The majority (67.7%) of the initial retinal tears were present in the superotemporal position (Fig. 1). Of the 54 eyes, 40 eyes had one retinal tear, 14 eyes had multiple retinal tears, and of the 14 eyes having multiple retinal tears, 11 eyes had two tears and three eyes had three retinal tears. In eyes with multiple retinal tears, all of the retinal tears were flap tears. Subanalyses of multiple retinal tears showed that the tears usually did not occur near hemorrhages. In the 11 eyes with two retinal tears, both retinal tears were in the superior temporal quadrant. In the two eyes with one tear, one tear was in the superior temporal quadrant and one tear was in the superior nasal quadrant. In two of the eyes with three retinal tears, all of the retinal tears were in the superior temporal quadrant in one eye, two retinal tears were in the superior temporal quadrant, and one retinal tear was in the inferior temporal quadrant. All of the retinal tears were treated with laser photocoagulation.

The demographic data are shown in Table 1. Sex, age, duration of symptoms, mean spherical equivalent, and mean axial length did not differ between patients who had retinal tears and those who did not. There was no difference between patients with one retinal tear and multiple retinal tears with regard to sex, age, duration of symptoms, mean spherical equivalent, or mean axial length.

The univariate analyses showed that the presence of multiple floaters, flashing, a family history of RD, tobacco dust, and retinal or vitreous hemorrhage were associated with the occurrence of retinal tears (Tables 2, 3).

Univariate and multivariate analyses were also performed to analyze the association of risk factors with the occurrence of multiple retinal tears (Tables 4, 5). The only significant risk factor for the occurrence of multiple retinal tears was the presence of retinal or vitreous hemorrhage using univariate and multivariate regression analyses, with an increased risk of 6.1 times using univariate analysis and 7.0 times using multivariate analysis, relative to eyes without retinal or vitreous hemorrhage.

Discussion

In the current study, the presence of multiple floaters, flashing, a family history of RD, tobacco dust, and retinal or vitreous hemorrhage were risk factors for the occurrence of retinal tears. The duration of symptoms, the presence of peripheral retinal degeneration, pseudophakia, and myopia >3 D did not increase the chance of retinal tears.

It is important to be aware that some patients might have more than one tear at the initial examination, and misdiagnosis of these retinal tears can cause

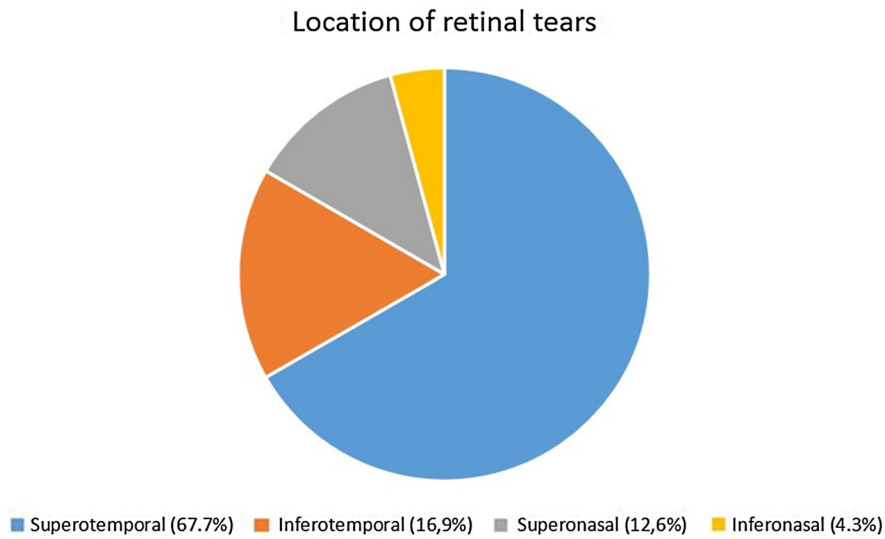

Fig. 1 Pie diagram showing location of initial retinal tears in different quadrants of retinal periphery

Table 1 Patient demographic data

Variable	Group (%) or mean ± SD		Total (%) or mean ± SD	*P* value
	Retinal tear (−)	Retinal tear (+)		
Sex				
Male	116 (33.3)	18 (36.0)	134 (35.6)	0.702
Female	206 (64.0)	36 (66.7)	242 (64.4)	
Age (years)				
Mean age ± SD	55.5 ± 13.2	50.8 ± 14.9	54.9 ± 13.5	0.019*
Range	36–89	34–89	34–89	
Duration of symptoms (days)				
Mean ± SD	11.8 ± 11.3	13.7 ± 10.1	12.1 ± 11.1	0.261
Range	1–28	1–29	1–29	
Spherical equivalent (D)				
Mean ± SD	−0.2 ± 1.7	−0.8 ± 2.1	−0.3 ± 1.8	0.035*
Range	−7.5 ± 4.5	−11	−7.5 ± 4.5	
Axial length (mm)				
Mean ± SD	23.3 ± 0.9	23.7 ± 1.5	23.2 ± 1.1	0.004*
Range	20.1 ± 28.8	21.2–28.7	20.1 ± 28.8	

* Statistically significant

subsequent RD. Risk factors for delayed or subsequent retinal tears have been well studied in these types of patients. In a prospective study of patients with acute symptomatic PVD, van Overdam et al. [23] reported that 3.7% of the patients developed new retinal tears within 6 weeks of follow-up. The predictive factors for the development of new retinal tears were multiple floaters, retinal or vitreous hemorrhage at the initial examination, and an increase in the number of floaters after the initial examination. Coffee et al. [9] reported that, in addition to vitreous hemorrhage and peripheral retinal hemorrhage at the initial examination, new symptoms were also factors for delayed-onset retinal tear in patients with symptomatic PVD.

Sharma et al. [24] reported subsequent retinal tears (SRT) in 12.2% of 155 eyes treated for acute PVD-related retinal tears during a median follow-up of 13 months. Of the 19 eyes that developed SRT, five eyes had associated RD. In one series, the development of retinal detachment following treatment of initial retinal tears was thought to result from SRT in 28% (five of 18) of the patients [25]. In another study, in the 7.6% of patients with SRT, 41.0% (12 of 29) developed RD [26]. Sharma et al. [24] emphasized that SRT may be asymptomatic or at least less symptomatic than initial retinal tears.

Uparkar and Natarjam [27] suggested that these delayed retinal tears could have been retinal tears present at the initial examination. Sharma et al. [24] also reported that it was possible that the SRT was present at the initial visit, but was undetected. We hypothesize that multiple retinal tears might be a reason for at least some of the undetected retinal tears.

In the present study, we found that 14 of 54 eyes with retinal tears had more than one tear. The only significant risk factor for multiple retinal tears was the presence of retinal or vitreous hemorrhage. Vitreous hemorrhage from a broken retinal blood vessel, with or without a retinal tear, occurred in 6–41% of patients with acute symptomatic PVD [28]. The majority of previous studies reported that between 50 and 75% of eyes with acute PVD and vitreous hemorrhage (VH) had a retinal tear [3, 29–32]. Byer [32] reported that retinal tears occurred in 30–90% of patients with acute symptomatic PVD with VH and in only 2–4% of patients with acute symptomatic PVD without VH. Based on our findings, retinal or vitreous hemorrhage should be a warning symptom for the clinician to consider not only retinal tears, but also possible multiple retinal tears. In our study, we found that retinal tears were not present near the hemorrhage, so fundoscopic examination in eyes with retinal or vitreous hemorrhage should be performed meticulously over 360°. It should be considered that as visualization of retinal tears might be obscured by hemorrhages B-mode ultrasonography is an essential part of examination in these patients. A more frequent follow-up for patients with a high risk of multiple

Table 2 Variables of the eyes with no retinal tear and eyes with retinal tear/tears

Variable	No. of eyes (%)		Total (%)
	Retinal tear (−)	Retinal tear (+)	
Duration of symptom			
≤2 weeks	225 (69.9)	29 (53.7)	254 (67.6)
>2 weeks	97 (30.1)	25 (46.3)	122 (32.4)
Multiple floater			
Yes	60 (18.6)	22 (40.7)	82 (21.8)
No	262 (81.4)	32 (59.3)	294 (78.2)
Flashing			
Yes	159 (49.4)	36 (66.7)	195 (51.9)
No	163 (50.6)	16 (33.3)	181 (48.1)
Family history of RD			
Yes	8 (2.5)	4 (7.4)	12 (3.2)
No	314 (97.5)	50 (92.6)	364 (96.8)
Peripheral retinal degeneration			
Yes	91 (28.3)	19 (35.2)	110 (29.3)
No	231 (71.7)	35 (64.8)	266 (70.7)
Lens status			
Phakic	257 (79.8)	45 (83.3)	302 (80.3)
Pseudophakic	65 (20.2)	9 (16.7)	74 (19.7)
Myopia			
≤3 D	294 (91.3)	46 (85.2)	339 (90.4)
>3 D	28 (8.7)	8 (14.8)	36 (9.6)
Tobacco dust			
Yes	17 (5.3)	32 (59.3)	49 (13.0)
No	305 (94.7)	22 (40.7)	327 (87.0)
Retinal and/or vitreous hemorrhage			
Yes	54 (16.8)	26 (48.1)	80 (21.3)
No	268 (83.2)	28 (51.9)	296 (78.7)

Table 3 Univariate analysis of the eyes with no retinal tear and eyes with retinal tear/tears

Variable	β	SE	Wald χ^2 ($df = 1$)	P value	Odds ratio	95% CI
Duration of symptoms	0.693	0.299	5.381	0.078	0.5	0.278, 0.898
Multiple floater	1.099	0.312	12.434	<0.001*	3.002	1.630, 5.531
Flashing	0.718	0.309	5.384	0.040*	2.05	1.118, 3.760
Family history of RD	1.144	0.631	3.288	0.020*	3.14	0.982, 10.816
Peripheral retinal degeneration	0.321	0.311	1.065	0.302	1.378	0.750, 2.533
Lens status	0.235	0.391	0.361	0.548	1.265	0.588, 2.719
Myopia	0.602	0.431	1.951	0.162	0.571	0.235, 1.275
Tobacco dust	3.262	0.373	76.648	<0.001*	26.096	12.573, 54.164
Retinal and/or vitreous hemorrhage	1.528	0.311	24.21	<0.001*	4.608	2.507, 8.470

* Statistically significant

Table 4 Univariate analysis of eyes with one retinal tear and eyes with multiple retinal tears

Variable	β	SE	Wald χ^2 ($df = 1$)	P value	Odds ratio	95% CI
Duration of symptoms	0.201	0.622	0.104	0.747	0.818	0.242, 2.768
Multiple floater	1.319	0.652	4.091	0.043	3.738	1.042, 13.417
Flashing	0.297	0.678	0.192	0.661	1.346	0.356, 5.086
Family history of RD	0.053	1.199	0.002	0.965	0.949	0.091, 9.945
Peripheral retinal degeneration	0.031	0.649	0.026	0.962	1.032	0.289, 3.680
Lens status	0.121	0.251	0.221	0.652	1.011	0.497, 2.122
Myopia	1.014	1.118	0.823	0.364	2.758	0.308, 24.674
Tobacco dust	1.199	0.724	2.742	0.098	3.317	0.802, 13.717
Retinal and/or vitreous hemorrhage	1.81	0.729	6.171	0.013*	6.111	1.465, 25.488

* Statistically significant

Table 5 Multivariate analysis of eyes with one retinal tear and eyes with multiple retinal tears

Variable	β	SE	Wald χ^2 ($df = 1$)	P value	Odds ratio	95% CI
Duration of symptoms	0.137	0.844	0.026	0.871	0.872	0.167, 4.558
Multiple floater	0.963	0.808	1.42	0.233	2.619	0.538, 12.756
Flashing	0.79	0.896	0.778	0.378	2.203	0.381, 12.747
Family history of RD	0.517	1.705	0.092	0.762	0.596	0.021, 16.857
Peripheral retinal degeneration	0.07	0.991	0.005	0.944	0.933	0.134, 6.511
Lens status	0.144	0.197	0.203	0.596	0.935	0.497, 2.122
Myopia	1.374	1.43	0.924	0.336	3.952	0.240, 65.112
Tobacco dust	1.51	0.995	2.304	0.129	4.528	0.644, 31.820
Retinal and/or vitreous hemorrhage	1.958	0.894	4.799	0.028*	7.085	1.229, 40.847

* Statistically significant

retinal tears can prevent misdiagnosis of retinal tears that were initially not detected.

This study has some limitations. First, we did not determine whether PVD was complete or incomplete. Optical coherence tomography and ultrasonography could have been helpful to evaluate the type of PVD. Second, we did not classify hemorrhages as retinal or vitreous ones, and it may be better to evaluate retinal and vitreous hemorrhages as separate risk factors.

In conclusion, unrecognized retinal tears in patients with acute PVD can cause serious complications, so a thorough examination is mandatory in all patients with symptomatic acute PVD, especially those who have retinal or vitreous hemorrhage.

Compliance with ethical standards

Conflict of interest The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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