European Journal of Ophthalmology / Vol. 19 no. 3, 2009 / pp. 460-465

Fundus findings in spontaneous subarachnoid hemorrhage and their correlation with neurologic characteristics

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PURPOSE. *To determine the incidence of fundus findings in spontaneous subarachnoid hemorrhage (SAH) and their correlation with neurologic characteristics.*
METHODS. *In a prospective case series, 202 eyes of 101 patients with SAH were evaluated from September 2003 to September 2006. The incidence of fundus findings was detected and correlated with gender, age, consciousness state, Fisher score, site and number of aneurysms, laterality of aneurysms, aneurysmal rebleeding, and mortality rate.*
RESULTS. *Fifty (49.5%) patients had normal and 51 (50.5%) patients had abnormal funduscopic examination. Of all eyes, disc swelling in 85 (42.1%), retinal hemorrhage in 51 (25.2%), subhyaloid hemorrhage in 6 (3%), and vitreous hemorrhage in 3 (1.5%) eyes were detected. No relation was found between gender, age, Fisher score, number of aneurysms, laterality of aneurysms, aneurysmal rebleeding, and mortality rate and fundus findings. However, a correlation was observed between consciousness state and retinal hemorrhage (p=0.002) and disc swelling (p=0.002), and also between the anterior communicating artery location of aneurysm and retinal hemorrhage (p=0.017) and any kind of fundus findings (p=0.007).*
CONCLUSIONS. *Fundus findings including hemorrhage and disc swelling are common in patients with SAH and are related to the consciousness state and anterior communicating artery location of aneurysm. (Eur J Ophthalmol 2009; 19: 460-5)*

KEY WORDS. *Subarachnoid hemorrhage, Vitreous hemorrhage, Terson syndrome*

Accepted: October 23, 2008

INTRODUCTION

Spontaneous subarachnoid hemorrhage (SAH), a common and serious complication of cerebral aneurysm, can be accompanied by intraocular bleeding. The first description of intraocular hemorrhage in association with SAH was presented by Litten in 1881. Terson subsequently described vitreous hemorrhage accompanying a subarachnoid bleed in 1900 (1).

Various incidences of ophthalmic pathologies following SAH have been reported by different authors. Intraocular hemorrhage has been reported to occur in up to 40% of patients with ruptured cerebral aneurysms (1). Vitreous hemorrhage was associated in 3–5% of cases presenting with SAH (2). In another report, intraocular hemorrhage that did not initially involve the vitreous was observed in 20–40% of such patients (3).

A correlation has been detected to some extent between clinical characteristics of SAH and ocular findings. Ness et al showed the patients with higher Hunt and Hess grades exhibited a higher frequency of intraocular involvement (4). This association was also described by some other authors (5, 6). Shaw and Landers found the mortality rate to be twice as high for SAH in the presence of intraocular hemorrhage than for patients with SAH alone (7). Most of these studies, however, were ret-

1120-6721/460-06$25.00/0

Presented at the Joint Congress of European Society of Ophthalmology/American Academy of Ophthalmology; June 9–12, 2007; Vienna, Austria.

rospective and evaluated a limited number of cases.
To have further information regarding the incidences of various fundus pathologies in patients with spontaneous SAH and to determine the probable correlations between cerebral and fundus characteristics in a larger number of cases, we conducted this prospective case series.

METHODS

All patients with the diagnosis of SAH who were admitted to the Neurosurgery Department of Imam Hossein Hospital from September 2003 to September 2006 were included in this prospective descriptive case series. Informed consent was obtained from all patients or their relatives. Patients with any fundus pathology which interferes with the findings of this study and cases who were unable or refused to consent were excluded. Inability to perform fundus examination for any reason was also among the exclusion criteria. This trial was approved by the review board/ethics committee of the ophthalmic research center of the university.
Diagnosis of SAH was established by neurosurgeons and confirmed by brain computerized tomography (CT) scan. Cerebral angiography and/or CT angiography were performed for all cases to detect the site and number of cerebral aneurysms. Consciousness state was graded according to the Hunt and Hess grades by neurosurgeons (Tab. I) (5). The severity of SAH based on CT scan was scaled by Fisher score (Tab. II) (6). Site, laterality, and number of cerebral aneurysms as well as occurrence of intracranial rebleeding and death were recorded.
Indirect ophthalmoscopy was performed for all patients by a vitreoretinal specialist at presentation and repeated before any neurosurgical intervention and at time of discharge from hospital. Fundus examination was done with full dilated pupil after instillation of one drop of tropicamide 1% three times, 5 minutes apart. The patients were evaluated for the presence of optic disc swelling and any kind of posterior segment bleeding including retinal (i.e., dot, blot, and flame-shaped), subhyaloid, and vitreous hemorrhages. In cases with peripapillary retinal hemorrhage in association with disc swelling, the hemorrhage was not considered as an isolated posterior segment bleeding.

Statistical analysis

Categorical and continuous variables are presented, respectively, by percentages and means. The correlation of ocular findings with sex, consciousness state, Fisher score, site and number of cerebral aneurysms, rebleeding, and mortality rate were evaluated separately by chi-square test and expressed by confidence interval and odds ratio. Ocular findings correlation with age was assessed by *t* test. We also evaluated the association of

TABLE I - HUNT AND HESS CLASSIFICATION OF SUBARACHNOID HEMORRHAGE

Grade	Description
0	Unruptured aneurysm
1	Asymptomatic, or mild headache and slight nuchal rigidity
2	Cranial nerve palsy, moderate to severe headache, nuchal rigidity
3	Mild focal deficit, lethargy, or confusion
4	Stupor, moderate to sever hemiparesis, early decerebrate rigidity
5	Deep coma, decerebrate rigidity, moribund appearance

TABLE II - GRADING SYSTEM OF FISHER

Group	Blood on computerized tomography
1	No blood detected
2	Diffuse or vertical layer <1 mm thick
3	Localized clot and/or vertical layer 1 mm
4	Intracerebral or intraventricular clot with diffuse or no subarachnoid hemorrhage

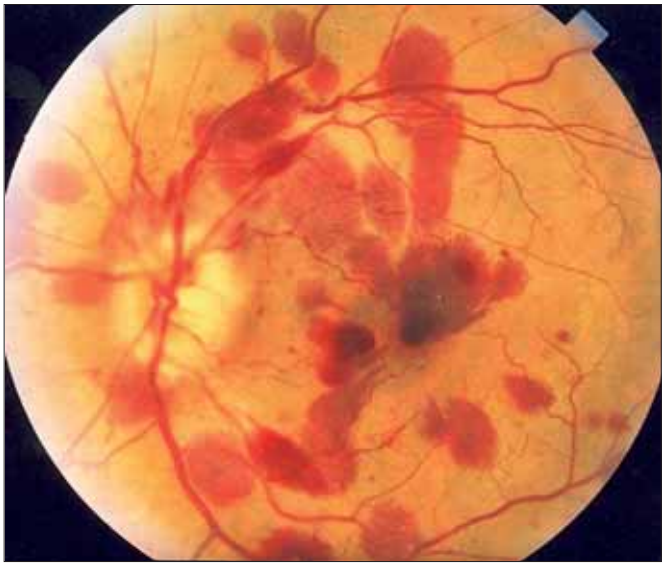

Fig. 1 - *Fundus picture of a patient with spontaneous subarachnoid hemorrhage demonstrating severe disc swelling as well as multiple retinal and preretinal hemorrhages in different sizes and shapes scattered over the posterior pole.*

cerebral aneurysms localization with ocular findings laterality by chi-square test. Statistical level of significance was preset at 0.05.

RESULTS

In this study, 202 eyes of 101 patients with diagnosis of spontaneous SAH met the inclusion criteria and entered into the study. There were 39 (39%) men and 62 (61%) women with mean age of 50±12 years (range, 20–85 years).

The consciousness state according to the Hunt and Hess grade and the severity of SAH based on the Fisher score as stated by CT imaging are shown in Tables III and IV, respectively.

Cerebral aneurysm was not visualized by angiography in 30 (29.7%) patients. The sites and the number of found cerebral aneurysms in each site are presented in Table V. One, two, and three cerebral aneurysms were detected in 59 (58.4%), 11 (10.9%), and 1 (1%) patients, respectively.

The incidences of fundus findings according to the patient, eye, and laterality are presented in Table VI. As shown, 50.5% of all patients with spontaneous SAH developed at least one fundus pathology and the most common was optic disc swelling (43.6%). Among the three different types of hemorrhages found in fundus examination, i.e., retinal, subhyaloid, and vitreous, retinal hemorrhage was the most frequent (25.2% of eyes) (Fig. 1). Other forms were detected in few eyes: subhyaloid hemorrhage in 6 (3%) and vitreous hemorrhage in 3 (1.5%). All eyes with either subhyaloid or vitreous hemorrhage had retinal hemorrhage simultaneously. Forty eyes (19.6%) had optic disc swelling without hemorrhage; however, only 10 eyes (4.8%) developed fundus hemorrhage with no disc swelling.

Most cases had bilateral fundus findings (41 to 3) and the difference between right and left eye involvement was not significant.

Most of the patients (84%) underwent two fundus examinations. In the repeated evaluations, however, neither new lesion nor progression of a previous lesion was detected.

Intracranial rebleeding occurred in 8 (7.9%) cases; in 6 patients it happened before and in 2 after cranial operation. During the study, 6 (5.9%) patients died, 4 before and 2 after surgery. Death occurred in 12.5% of patients having retinal hemorrhage and 25% of patients with vitreous and/or subhyaloid hemorrhages.

TABLE III - CONSCIOUSNESS STATE GRADING ACCORDING TO THE HUNT AND HESS SCALE IN PATIENTS WITH SPONTANEOUS SUBARACHNOID HEMORRHAGE AT DAYS 1, 7, AND 14 OF ADMISSION (%)

Hunt and Hess scale	Day 1	Day 7	Day 14
0	1 (1.1)	8 (8.2)	26 (26.8)
1	27 (28.7)	30 (30.6)	41 (42.3)
2	52 (55.3)	41 (41.8)	21 (21.6)
3	12 (12.8)	15 (15.3)	1 (1.0)
4	2 (2.1)	4 (4.1)	8 (8.2)
Total	94 (100)	98 (100)	97 (100)
Missed data	7	3	4

TABLE IV - SEVERITY OF SUBARACHNOID HEMORRHAGE ACCORDING TO FISHER SCORE IN PATIENTS WITH SPONTANEOUS SUBARACHNOID HEMORRHAGE

Fisher	No. (%)
1.00	9 (9.6)
2.00	56 (59.6)
3.00	25 (26.6)
4.00	2 (4.3)
Total	92 (100)
Missed data	9

TABLE V - FREQUENCY OF THE CEREBRAL MICROANEURYSM SITES IN PATIENTS WITH SPONTANEOUS SUBARACHNOID HEMORRHAGE (%)

Site	Frequency
ACOA	32 (31.7)
MCA	16 (15.8)
Post CA	4 (4.0)
MCA + ACOA	3 (3.0)
MCA + PCOA	2 (2.0)
ACOA + MCA + pericallosal	1 (1.0)
Carotid cavernous + PICA	1 (1.0)
PICA	1 (1.0)
Internal carotid	1 (1.0)
Carotid bifurcation	(1.0)
Pericallosal	4 (4.0)
Carotid bifurcation + PCOA	2 (2.0)
MCA + PICA	1 (1.0)
Ophthalmic + carotid	1 (1.0)
PCOA + basilar A	1 (1.0)
Positive angiography	71 (70.3)
Negative angiography	30 (29.7)
Total	101 (100)

ACOA = anterior communicating artery; MCA = middle communicating artery; Post CA = posterior cerebral artery; PCOA = posterior communicating artery; PICA = posterior inferior cerebellar artery.

The correlations of fundus findings including disc swelling, retinal hemorrhage, vitreous and/or subhyaloid hemorrhage, and any type of fundus finding (hemorrhage and/or disc swelling) with age, sex, consciousness state at 1, 7, and 14 days, Fisher score, site and number of cerebral aneurysms, aneurysmal rebleeding, and mortality rate were evaluated separately. Regarding the correlation for site of aneurysm, we considered only four common locations, including anterior communicating artery, middle cerebral artery, posterior cerebral artery, and pericallosal artery. No correlation was found except between the following parameters: 1) retinal hemorrhage and consciousness state at 7 days (p=0.002); 2) optic disc swelling and consciousness state at 1, 7, and 14 days (p=0.029, p=0.002, and p=0.0019, respectively); 3) retinal hemorrhage and anterior communicating artery aneurysm (p=0.017); and 4) any fundus finding (hemorrhage and/or disc swelling) and anterior communicating artery aneurysm (p=0.007). In other words, consciousness state correlated with both retinal hemorrhage and optic disc swelling, and anterior localization of aneurysm correlated with retinal hemorrhages and presence of either retinal hemorrhage or disc swelling. The statistically significant correlations between consciousness state and fundus findings are shown in Table VII. No correlation could be established between aneurysm anatomic localization and fundus findings laterality.

DISCUSSION

This study demonstrated that nearly half of the patients with spontaneous SAH developed fundus signs including optic disc swelling and/or hemorrhages. Although vitreous or subhyaloid hemorrhages were observed only in a few patients, retinal hemorrhage was detected in nearly one third of such cases. The appearance of retinal hemorrhages and optic disc swelling was associated with lower degrees of consciousness state; therefore, it might be concluded that fundus findings in cases with spontaneous SAH had some prognostic values regarding the patient's cerebral condition.

Terson syndrome was defined initially as the occurrence of vitreous hemorrhage in association with SAH. However, it has been applied to any type of intraocular hemorrhage by many authors, although each may have a different prognosis (1). Fundus hemorrhage was found in 27.2% of the eyes in our study, which was in accordance with the two prospective series presented by Garfinkle et al (3) and Pfausler et al (8), which reported incidences of 16.7% and 27.3%, respectively. However, in another prospective study conducted by Frizzell et al (9), this incidence was 8%. The reason for this low reported incidence in the latter study was assumed to be the exclusion of many critically ill patients with ruptured intracranial aneurysms who did not undergo ophthalmologic consultation (10). Sub-

TABLE VI - THE DISTRIBUTION (%) OF DIFFERENT FUNDUS FINDINGS IN PATIENTS WITH SPONTANEOUS SUBARACHNOID HEMORRHAGE

	Patient	Eye	Right eye	Left eye	Bilateral
Retinal hemorrhage	32 (31.7)	51 (25.2)	27 (26.8)	24 (23.8)	19 (18.8)
Subhyaloid hemorrhage	4 (4)	6 (3)	3 (3)	3 (3)	2 (2)
Vitreous hemorrhage	3 (3)	3 (1.5)	2 (2)	1 (1)	—
Any kind of hemorrhage	32 (31.7)	51 (25.2)	27 (26.7)	24 (23.8)	19 (18.8)
Disc swelling	44 (43.6)	85 (42.1)	44 (43.6)	41 (40.6)	41 (40.6)
Any kind of hemorrhage and/or disc swelling	51 (50.5)	93 (46)	51 (50.5)	42 (41.6)	42 (41.6)

TABLE VII - CORRELATION OF CONSCIOUSNESS SCALE (BASED ON HUNT AND HESS) CLASSIFICATION OF SUBARACHNOID HEMORRHAGE WITH DISC SWELLING AND RETINAL HEMORRHAGE IN PATIENTS WITH SPONTANEOUS SUBARACHNOID HEMORRHAGE (CHI-SQUARE ANALYSIS)

Consciousness scale		Disc swelling		95% CI	p Value	Retinal hemorrhage		95% CI	p value
		%	Odds ratio			%	Odds ratio		
Day 1*	2.00	46.2	2.5	0.9-6.8	0.029	37.5	3.600	0.3-37.6	0.080
	3.00	66.7	5.7	1.3-25.0		100.0	-	-	
	4.00	100	13.7	0.6-304.1		100.0	-	-	
Day 7†	1.00	26.7	2.5	0.3-24.1	0.002	23.3	2.1	0.2-20.4	0.002
	2.00	46.3	6	0.7-53.7		24.4	2.3	0.2-20.6	
	3.00	80	28	2.4-323.7		60	10.5	1.0-108.6	
	4.00	75	21	0.9-458.8		100	45	1.5-339.4	
Day 14†	1.00	43.9	3.3	1.0-10.4	0.019	26.8	2.811	0.7-11.2	0.058
	2.00	61.9	6.8	1.8-25.4		42.9	5.750	1.3-25.3	
	3.00	100	11.7	0.4-31.2		-		0.000	-
	4.00	50	4.2	0.8-22.9		37.5	0.130	0.7-29.8	

*Consciousness scale of 1 was considered as base of statistics (no patient with scale 0 had disc swelling).
†Consciousness scale of 0 was considered as base of statistics.

hyaloid and/or vitreous hemorrhage was detected only in 3% of our patients, which was lower than the rates (8 to 27.3%) stated by the previous studies (6, 8, 10, 11). This low incidence might be due to the fact that the patients were referred to our center; therefore, patients with more severe cases, who had more chance of having such hemorrhages, might have died before reaching our hospital for evaluation.

The association of fundus hemorrhage with the severity of SAH based on consciousness state has been shown by other authors (1, 6, 8, 12). In our study, such a correlation with consciousness state was found with both fundus hemorrhage and disc swelling.

Similar to Fahmy's study (2), we showed an association between retinal hemorrhage and anterior communicating artery aneurysm. This correlation in our study was detected with both retinal hemorrhage and disc swelling. Anatomic proximity of the cerebral aneurysm to the eye or increased level of intracranial pressure seems to be associated with higher frequency of fundus findings. Nevertheless, such correlation was not found in some other studies (5, 6, 8, 13). Comparing the laterality of cerebral aneurysm with the side of fundus involvement, we could not find any correlation that was compatible to other studies (8, 13).

Subarachnoid rebleeding occurred in 7.9% of our patients; however, it was not associated with more frequent ocular findings. This was not similar to Pfausler et al's

study, in which 7 of 10 patients with Terson syndrome had subarachnoid rebleeding (8). Mashiyama et al have also addressed such a possible connection, reporting subarachnoid rebleeding in 3 of 8 patients with Terson syndrome (13).

The reported mortality rates were 23.3%, 26.3%, and 54% in various studies (8, 14, 15). In the present study, this rate was 5.9% (6 of 101 patients). However, no correlation was detected between any kind of hemorrhage and mortality rate, which might be a result of the low number of deceased cases. Decreased mortality in our patients may express the improvement of intensive care systems in recent years. However, since our hospital was a referral center, severely ill patients might have died before admission.

Serial ophthalmologic examinations were seldom performed in previous prospective studies. We did not notice any significant alteration of fundus findings in repeated examinations. Therefore, we would not recommend routine repeated eye examinations in patients with spontaneous SAH, unless in the case of new symptoms.

In summary, the occurrence of ocular findings including optic disc swelling and fundus hemorrhages in patients with SAH is frequent. The existence of these findings reflects a poorer cerebral condition. Fundus examination in patients with SAH may be useful for prediction of visual outcome and for determining future probable ophthalmologic intervention.

None of the authors has a financial interest in the subject matter of the presentation.

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