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The Value of Fundoscopic Examination for Retinal Artery Spasm in the Correlation of Cerebral Vasospasm

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During cerebral vasospasm (CVS) due to ruptured aneurysm the retinal arteries were photographed and evaluated with angiographic studies at various stages to study any correlation between them. Among 60 cases with angiographic CVS, ophthalmoscopic retinal artery spasm (RAS) was detected in 29 cases. Photographic demonstration of the RAS was possible in 7 cases. In general, in a series of cases, the degree of RAS seems to correspond to the severity of CVS.

Key Words: retinal artery spasm . cerebral vasospasm . subarachnoid hemorrhage . ruptured cerebral aneurysm

Early detection of cerebral vasospasm (CVS) following subarachnoid hemorrhage due to ruptured aneurysm is mandatory not only for the determination of the timing of surgery but also for prevention and treatment of ischemic cerebral damage. The most direct evidence of CVS can be obtained by cerebral angiography. However cerebral angiography still remains as an invasive study. Up to now in the investigative methods for ruptured cerebral aneurysm, ophthalmoscopy has been used to detect subhyloid hemorrhage and the development of papilledema. By close observation, some cases of ruptured cerebral aneurysm which showed neurological deterioration, the authors noticed the development of retinal artery spasm (RAS) which corresponded with the angiographic CVS. Therefore the authors attempted to correlate angiographic CVS with the ophthalmoscopic RAS.

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MATERIALS AND METHODS

During the time of CVS due to ruptured aneurysm, the fundoscopic finings of the retinal arteries were photographed (Olympus Retinal Camera, GRC*) and evaluated with the angiographic studies and the clinical features at various stages to study any correlation between them.

Among 95 cases of ruptured cerebral aneurysm treated surgically, 60 cases demonstrated various degrees of angiographic CVS. Fundoscopic findings of these cases were evaluated carefully. Cases with retinal artery narrowing

associated with hypertension and cerebral arteriosclerosis were excluded. The main limitations in this study were a failure to get successful fundus photographs in many uncooperative patients, and the avoidance of the sitting position for photography in order to protect the brain from further ischemia. Therefore, photographic demonstration of RAS was essentially limited to cooperative cases and to those cases with more or less neurologically stable conditions. Even though good correlation was observed with the ophthalmoscope in many cases, the correlation between the angiographic CVS and the ophthalmoscopic RAS could be documented only by retinal photography in a limited number of cases. The funds photographs were projected, and the diameter of the retinal arteries was measured with a millimeter ruler.

RESULTS

During the last two years, 95 cases of ruptured cerebral aneurysm were treated surgically. Among these, 60 cases demonstrated various degrees of angiographic CVS. Of all the cases with angiographic spasm, ophthalmoscopic RAS was detected in 29 of the 60 cases. However, photographic demonstration of the RAS was possible in only 7 cases because of the aforementioned limitations.

Case 1: Angiogram showed marked vasospasm in the middle cerebral artery due to the ruptured middle cerebral artery aneurysm (Fig. 1a). The fundus photograph taken at that time demonstrated RAS (Fig. 1b). Three weeks later, the middle cerebral artery spasm had resolved (Fig. 1c). Also the caliber of the retinal artery had increased and the vascularity of the retina was almost back to normal (Fig. 1d). Case 2: Angiogram showed vasospasm mainly in the anterior cerebral artery due to the ruptured anterior communicating artery aneurysm (Fig. 2a) and the fundus photograph showed RAS (Fig. 2b). The postoperative angiogram showed resolved CVS (Fig, 2c) and the retinal artery also revealed no spasm (Fig. 2d). Case 3: In this case, the funds photograph showed hemorrhage and RAS after the ruptured anterior communicating artery aneurysm (Fig. 3a). Two weeks later, the RAS was no longer present (Fig. 3b). Case 4: The angiogram showed diffuse CVS due to the ruptured anterior communicating artery aneurysm (Fig. 4a). Fundus photograph taken at that time showed marked RAS before the aneurysm surgery was done (Fig. 4b). The postoperative angiogram showed resolved vasospasm (Fig. 4c). Also the postoperative fundus photograph showed increase in the caliber of the retinal artery almost back to normal (Fig. 4d).

The results obtained were grouped as follows: Group 1 is the cases with bilateral diffuse CVS and showing bilateral RAS also; among 28 cases with bilateral diffuse CVS, 17 cases demonstrated bilateral RAS. Group 2 is the cases with unilateral diffuse CVS along with ipsilateral RAS: 9 of 27 cases with unilateral CVS showed ipsilateral RAS. And group 3 is the cases with unilateral localized CVS in the ophthalmic artery and its nearby internal carotid artery along with ipsilateral RAS: in five cases, there was unilateral regional CVS and among these, 3 cases demonstrated ipsilateral RAS (Table 1).

DISCUSSION

Spasm of the cerebral vessels is regularly observed arteriographically following subarachnoid hemorrhage due to rupture of a congenital saccular aneurysm. "The spasm is occasionally seen in the retinal vessels on the side of the ruptured aneurysm, and if accompanied by subhyloid hemorrhage, may be considered

* Manufactured by Olympus Optical Co., Ltd., Tokyo

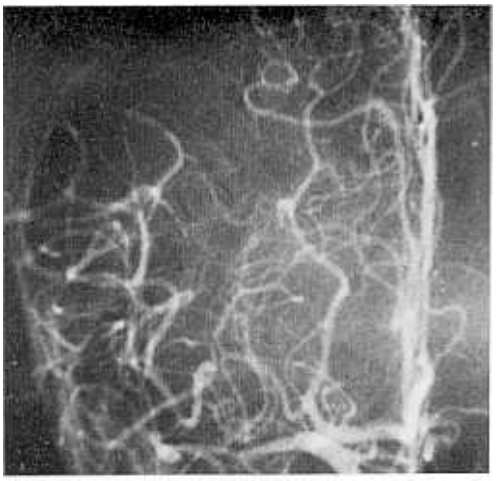

Fig. 1a.

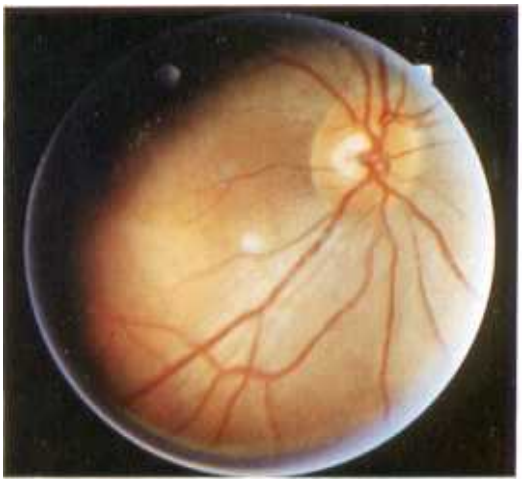

Fig. 1b.

Fig. 1c.

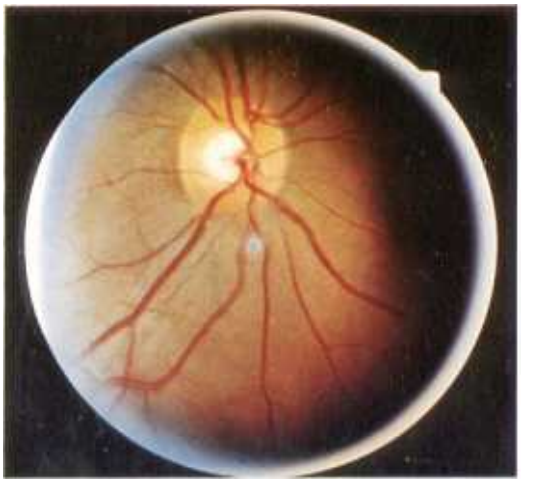

Fig. 1d.

Fig. 1. Case 1. (a) Initial right internal carotid arteriogram (anteroposterior view). There is an aneurysm of the middle cerebral artery. The middle cerebral artery shows marked vasospasm. (b) Initial fundus photograph (right) shows retinal artery spasm. (c) Right internal carotid arteriogram (anteroposterior view). Three weeks later, the middle cerebral artery spasm is resolved. (d) Fundus photograph (right). Three weeks later, the caliber of the retinal artery is increased and the vascularity of the retina seems to be increased.

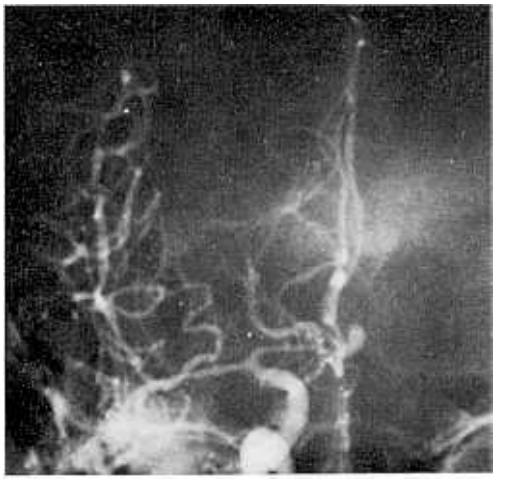

Fig. 2a.

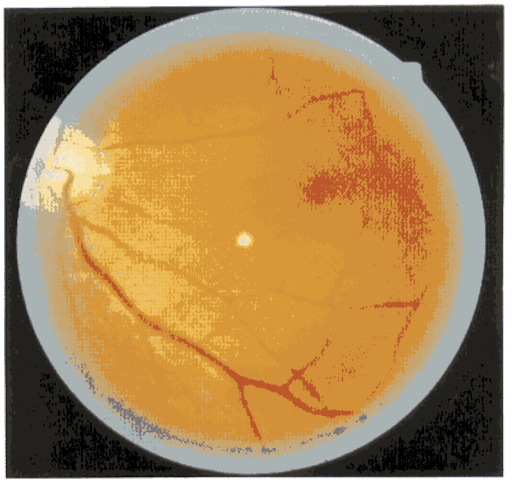

Fig. 2b.

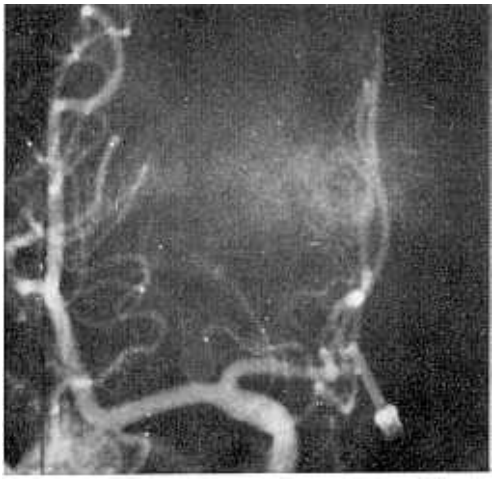

Fig. 2c.

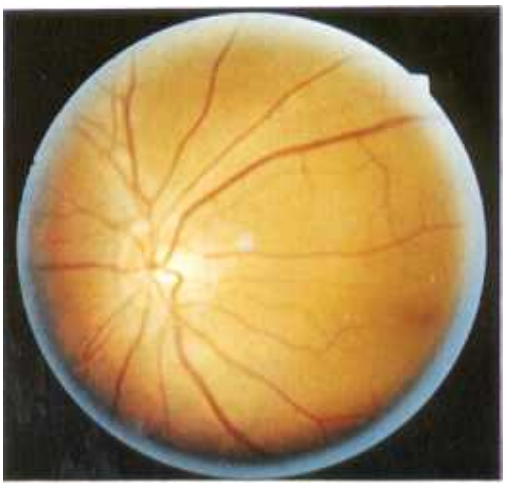

Fig. 2d.

Fig. 2. Case 2. (a) Initial right internal carotid arteriogram (anteroposterior view). There is an aneurysm of the anterior communicating artery. Shows vasospasm mainly in the anterior cerebral artery. (b) Initial fundus photograph (left) shows retinal artery spasm. (c) Postoperative right internal carotid arteriogram shows resolved cerebral vasospasm. (d) Postoperative fundus photograph, left. The retinal artery also reveals no spasm.

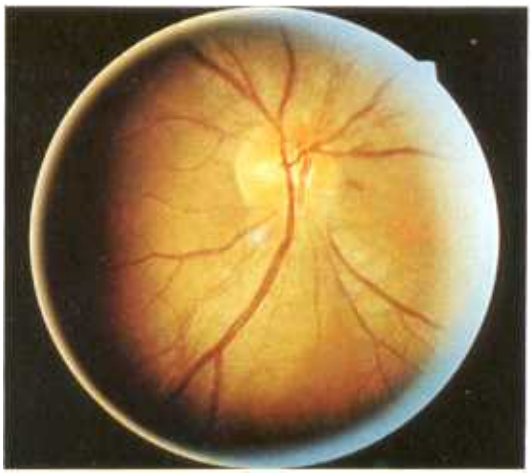

Fig. 3a.

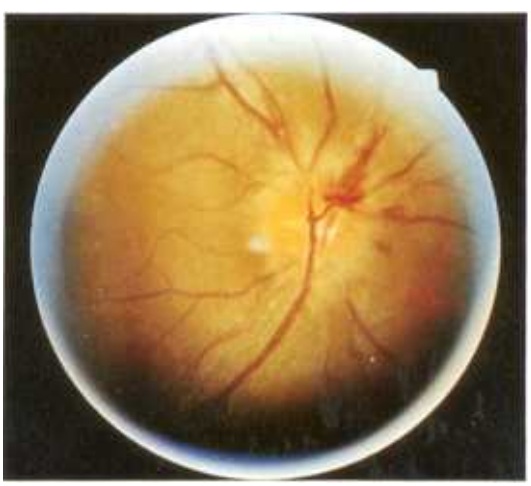

Fig. 3b.

Fig. 3. Case 3. (a) Preoperative fundus photograph, right, shows hemorrhage and retinal artery spasm after rupture of the anterior communicating artery aneurysm. (b) Two weeks later, postoperative fundus photograph, right, shows no retinal artery spasm.

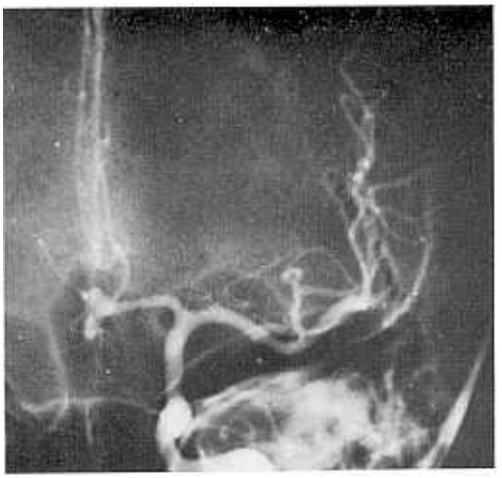

Fig. 4a.

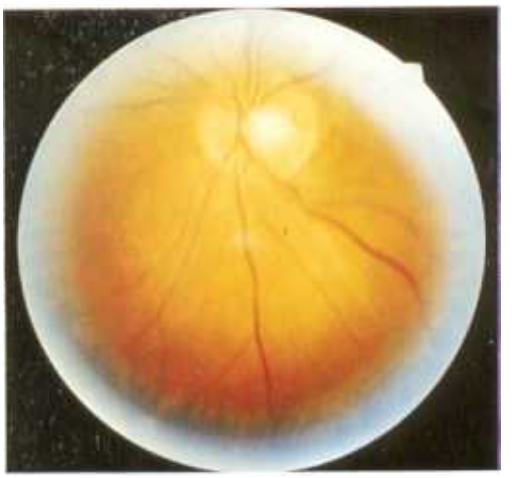

Fig. 4b.

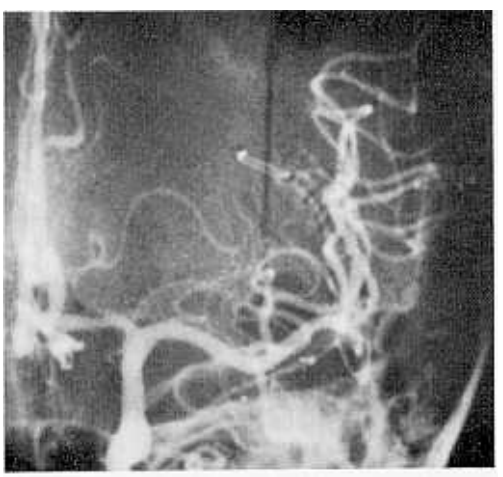

Fig. 4c.

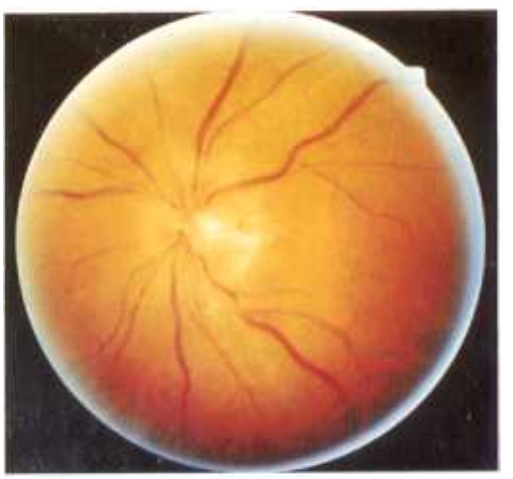

Fig. 3d.

Fig. 4. Case 4. (a) Preoperative left internal carotid arteriogram. The arteriogram shows diffuse cerebral vasospasm and an aneurysm in the anterior communicating artery. (b) Preoperative right fundus photograph shows marked retinal artery spasm. (c) Postoperative right internal carotid arteriogram (anteroposterior view) shows resolved vasospasm. (d) Postoperative left fundus photograph. The caliber of the retinal artery is increased.

Table 1. Correlation between the angiographic and the ophthalmoscopic findings

	Angiographic cerebral vasospasm (CVS)	No. of cases	Ophthalmoscopic retinal artery spasm (RAS)	No. of cases
Group 1	Bilateral, diffuse CVS	28	Bilateral RAS	17
Group 2	Unilateral diffuse CVS	27	Ipsilateral RAS	9
Group 3	Unilateral regional CVS (Ophthalmic a. & nearby internal carotid a.)	5	Ipsilateral RAS	3

diagnostic of that condition.[2"]

Early detection of cerebral vasospasm following ruptured cerebral aneurysm is necessary not only for protection of the brain from infarction but also for determination of the timing of surgical intervention. Even though development of the angiographic CVS and neurological manifestation of the cerebral ischemia do not always coincide, the appearance of the ischemic symptoms are preceded by angiographic CVS in many cases. Therefore prompt detection of CVS and protection of the brain are necessary. The most direct evidence of cerebral vasospasm can be obtained by cerebral angiography, though cerebral angiography still remains an invasive study.

During the close observation of the patients with ruptured cerebral aneurysm, the authors noticed that among the patients with clinical manifestation of CVS, RAS was also detected ophthalmoscopically. Furthermore, the RAS disappeared when the period of the CVS was over. Under the assumption that the CVS is closely related with the RAS, the authors tried to evaluate the correlation between the angiographic vasospasm and the ophthalmoscopic findings. In this study, of all the cases with angiographic vasospasm, various degrees of ophthalmoscopic RAS was detected in half of the cases. Most of the cases (17 out of 28) showed bilateral RAS along with bilateral diffuse angiographic CVS (Group 1). In the remainder of the cases, some patients had ipsilateral RAS along with unilateral angiographic CVS (Group 2). In 3 cases (Group 3), ipsilateral RAS was observed associated with localized vasospasm in the ophthalmic artery and its nearby internal carotid artery.

In some respects, the retinal blood supply resembles that of the brain and the retinal arterial system is composed of endarteries and no arteriovenous anastomoses occur.[5] It is also known that the central artery of the retina is surrounded by a sympathetic nerve plexus (nerve of Tiedemann).[5] The earlier literature on nerve supply to the retinal arteries has been reviewed extensively by Duke-Elder and Wybar and the general consensus was then that both sympathetic and parasympathetic nerve fibers innervate the retinal arteries.[1] Ruskell has described a parasympathetic supply to the central retinal artery, derived from the facial nerve, and he also considers that the sympathetic axons do in fact reach this artery.[3,4] If the CVS is related to the neural mechanism, it could be speculated that the retinal artery also has the similar innervation with that of the cerebral arteries and it results analogous spasm in the retinal artery.

Development of the CVS can be detected by neurological manifestation, cerebral angiography, regional cerebral blood flow study and dynamic CT scan. However, if it could be detected by fundus examination in its early

phase, it would be a convinient and useful tool for the diagnosis of the CVS. In general in a series of evaluated cases, the degree of RAS seemed to correspond to the severity of CVS even though there may be variation in some cases. It is author's opinion that the simple non-invasive ophthalmoscopic examination for the detection of RAS has value in the early detection of CVS and its progress.

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REFERENCES

Duke-Elder S, Wybar KC: *System of Ophthalmology, Vol II, The anatomy of visual system: The blood vessels and nerves of the eye. London: Kimpton, 1961, pp 380-381*

Gilroy GL, Meyer JS: *Medical Neurology: The Nrurological examination and functional neuroanatomy. New York: Macmillan, 1979, pp. 13-14*

Ruskell GL: *An ocular parasympathetic nerve pathway of facial nerve origin and its influence on intraocular pressure. Exp Eye Res 10:319-330, 1970*

Ruskell GL: *Facial parasympathetic innervation of the choroidal blood vessels in monkeys. Exp Eye Res 12:166-172, 1971*

Warwick R: *Eugene Wolff's Anatomy of the Eye and Orbit - including the central connexions, development, and comparative anatomy of the visual apparatus: The eye ball, the blood supply of the retina. Philadelphia and Toronto: Saunders, 1976, pp 145-147*