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CLINICAL INVESTIGATION

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Detection of choroidal aneurysms with indocyanine green videoangiography

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Abstract ● Background: Aneurysms of the choroidal vasculature have been described only in histopathological studies. ● Methods: Indocyanine green videoangiograms obtained with the scanning laser ophthalmoscope from 32 patients with geographic atrophy were reviewed. ● Results: In 8 of 32 patients indocyanine green videoangiography (ICGVA) showed hyperfluorescent aneurysms along choroidal arteries. The same aneurysmal formations were found in two of the eight patients on very early images of fluorescein videoangiography before dye leakage occurred. Seven of eight patients with choroidal aneurysms had a history of hypertension. ● Conclusions: ICGVA is a useful diagnostic tool in detecting choroidal aneurysms. Multiple mechanisms are probably involved in the pathogenesis of choroidal aneurysms, among them the higher hemodynamic stress in the macular region, hypertension and aging.

Introduction

Aneurysms are common angiographic findings in retinal vascular disorders due to circulatory or metabolic diseases, whereas aneurysms of the choroid have been described only in histopathologic studies [1, 5, 8, 9].

While performing indocyanine green (ICG) videoangiography (ICGVA) in patients with unilateral exudative age-related macular degeneration (AMD), we observed aneurysms of choroidal arteries in a fellow eye with geographic atrophy. Thereupon, we reviewed ICG angiograms of patients with geographic atrophy secondary to AMD.

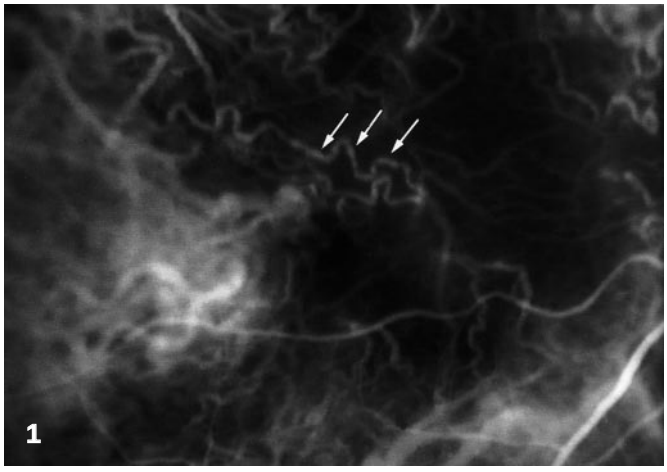
Materials and methods

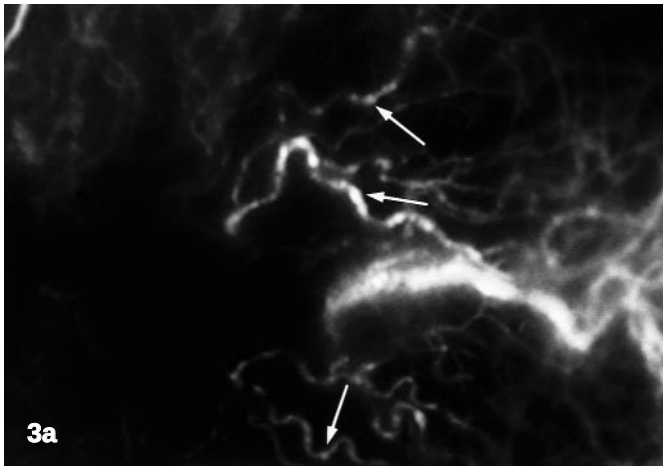
The ICG angiograms of 32 patients with unilateral geographic atrophy who had an ICG study for occult choroidal neovascularization secondary to AMD in their first eye were reviewed for aneurysmal formations. Geographic atrophy was defined as a well-defined area of retinal pigment epithelial atrophy of at least two disc diameters in extent. Aneurysms were defined as focal saccular or bulbous outpouchings of choroidal arteries. Eyes with any history or signs suspicious of choroidal neovascularization were excluded. There were 13 men and 19 women with an average age of 74.2 years (range 62–86 years).

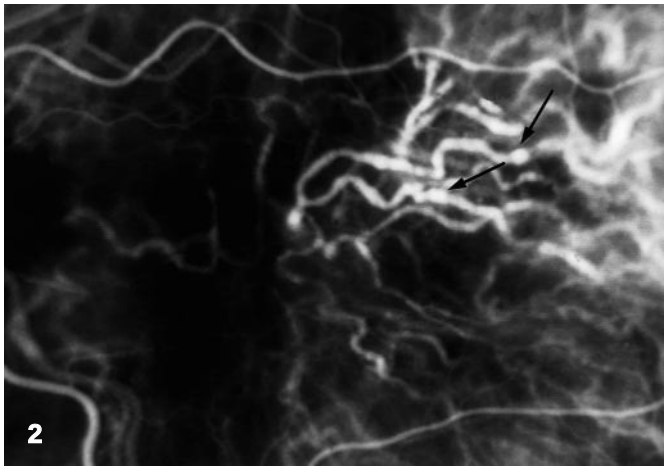
Each patient provided informed consent and underwent ophthalmologic examination including fluorescein videoangiography (FVA) and ICGVA. FVA and ICGVA were performed using the Rodenstock scanning laser ophthalmoscope SLO-101. For FVA, 5 ml of 10% fluorescein solution were injected into a cubital vein. For ICGVA, injections of 50 mg ICG dissolved in 2 ml of aqueous solvent were given. No image post-processing or enhancement was used.

Results

Early-phase ICGVA revealed hyperfluorescent aneurysms along choroidal arteries (Figs. 1, 2, 3a) in the area of geographic atrophy in 8 of 32 patients. No aneurysmal formations of choroidal veins were found. There was no leakage of the aneurysms on later frames. With the videoangiography system we were able to look half-frame to half-frame into the very early filling phase of the FVA in two of the eight patients and found the same aneurysmal outpouchings (Fig. 3b). The patients' charts were reviewed for a history of hypertension and diabetes. Thir-







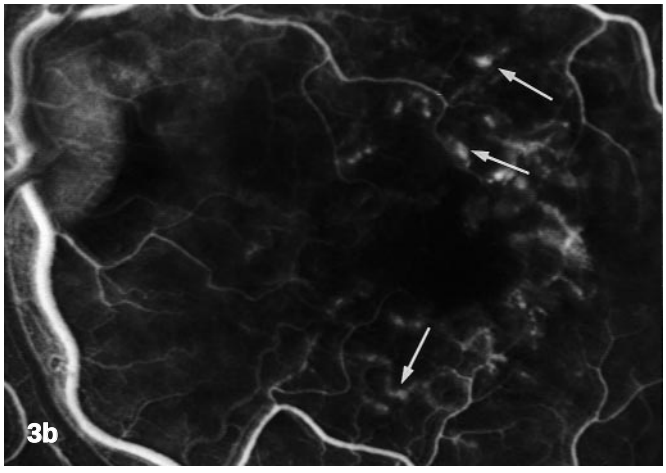


Fig. 1 SLO-ICG angiogram demonstrating aneurysmal formations of a choroidal artery (*arrows*)

Fig. 2 SLO-ICG angiogram demonstrating aneurysms of several choroidal arteries (*arrows*)

Fig. 3 a SLO-ICG angiogram demonstrating multiple aneurysms (*arrows*). *b* Very early picture of fluorescein videoangiography of the same eye, confirming the choroidal aneurysms (*arrow*)

teen of 32 patients had a history of hypertension, among them seven of the patients with aneurysmal formations. There was one patient with a 3-year history of insulin-independent diabetes mellitus, hypertension and choroidal aneurysms.

Discussion

Our study included 32 patients biomicroscopically characterized by an atrophic geographic lesion secondary to AMD, in whom FVA demonstrated the classical window defect with early hyperfluorescence that gradually fades. On ICGVA we noted aneurysmal formations of choroidal arteries.

FVA has not been helpful in delineating the choroidal circulation. A major advantage of ICGVA in imaging the choroidal pathology is its high conjugation to plasma proteins, reducing dye leakage through the fenestrations of the choriocapillaris. This provides better visualization of the finer vascular details of the choroid than with FVA, where the rapid leakage of the fluorescein molecule obscures subretinal details. The question arises of whether our ICG angiographic findings could be an artifact. Prominent hyperfluorescence is known from choroidal vessels oriented parallel to the optical axis and from additive fluorescence caused by superjacent vessels and arterial-venous crossings. However, with the SLO videoangiography we found the same vascular pattern on very early FVA images, before dye leakage from the choroidal vessels occurred, in two of eight patients. On biomicroscopy these patients did not have any retinal aneurysms or small drusen in this area – both hyperfluorescent on FVA – which could interfere with the angiographic interpretation.

In our study we noticed the aneurysms in areas of geographic atrophy with thinned choroidal vasculature [8, 9]. We never saw aneurysms outside the area of geographic atrophy or in eyes with a normal choroidal vasculature. Compared to the planar retinal vasculature, the choroidal

architecture is three dimensional. In other areas of normal choroidal thickness, choroidal aneurysms may be hidden by superjacent choroidal vessels or the hyperfluorescent veil of the choriocapillaris. Choroidal aneurysms also may be overlooked on ICGVA by loss of background contrast in comparison to conventional fluorescein angiography. The choroid in the macular region, a three-dimensional very dense vascular network, appears very hyperfluorescent on ICGVA, and the aneurysms may be missed because of lack of contrast. We noticed the aneurysms in areas of reduction choroidal vasculature (Figs. 1, 2, 3a) in front of a dark background and without superjacent vessels.

Multiple mechanisms probably are involved in the pathogenesis of aneurysms. Retinal arterial macroaneurysms are associated with hypertension, arteriosclerosis and aging [4, 6], conditions that were also found in our patients. Similar aneurysms develop in the cerebral circulation secondary to hypertension and embolization [7]. Studies of experimental aneurysms [10] have emphasized the role of both hypertension and increased hemodynamic stress. The choroidal vascular bed is unique in its angioarchitecture and predisposition to vascular stress. At the posterior pole the greater aggregation of arterial branches from the posterior ciliary arteries and the abrupt changes in vessel caliber [5] suggest a higher hemodynamic stress than elsewhere in the eye. Rapid blood flow and pressure changes of the macular area may cause loss of contractility of the aging choroidal vascular wall.

Retinal arterial macroaneurysms are frequently associated with intraretinal vascular abnormalities including complete or incomplete arterial occlusion, dilatation of the adjacent capillary bed, zones of capillary non-perfusion and capillary microaneurysms rimming avascular zones around the aneurysm [2]. This may be analogous to the choroidal system, where aneurysms were found in areas of geographic atrophy with thinned choroidal vasculature and reduced choriocapillaries perfusion and non-perfusion. Histopathologic findings of choroid vessels secondary to hypertension, including irregularity of the caliber of the arteries with focal narrowing and dilatations, aneurysms, teleangiectatic capillaris and choriocapillaries closure [1, 3, 5, 8, 9], support this notion.

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