Fluorescein Angiographic Features of Choroidal Insufficiency in Anterior Ischemic Optic Neuropathy

Sun-Young Shin, M.D., Dong-Seob Kim, M.D., and Myung-Kyoo Ko, M.D.

Department of Ophthalmology, School of Medicine, Hanyang University, Seoul, Korea

Anterior ischemic optic neuropathy (AION) is known to be caused by circulatory disturbance in the anterior optic nerve (AON). Because the AON shares blood supply from the paraoptic short posterior ciliary artery with peripapillary choroid, the authors investigated the angiographic evidences of combined choroidal insufficiency in patients with acute AION. Fundus fluorescein angiograms from 30 eyes from 28 patients with acute AION were enrolled in this study. The diagnosis of acute AION was based primarily on angiographic evidences of filling delay of optic nerve head and the various clinical features, such as decreased visual acuity, visual field defects, afferent pupillary defect, and optic disc swelling. Angiographic evidences of combined choroidal filling delay were as follows: 1) circular or localized filling delay of peripapillary choroid in 15 eyes (50%), 2) generalized filling delay of posterior pole in 11 eyes (36.7%), 3) filling delay of unilateral choroid divided by watershed zone in 5 eyes (16.7%), and 4) choriocapillary filling delay in 10 eyes (33.3%). In this study, various types of choroidal insufficiency in patients with AION were observed, which helped us to differentiate AION from the other various diseases of the anterior optic nerve.

Key words: anterior ischemic optic neuropathy (AION), fundus fluorescein angiography, posterior ciliary artery, choroidal circulation

INTRODUCTION

A complete knowledge of the anatomy and blood supply of the anterior optic nerve (AON) is essential to the understanding of the pathogenesis of anterior ischemic optic neuropathy (AION). The AON is composed of 4 layers as follows: superficial nerve fiber layer, prelaminar area, lamina cribrosa, and retrolaminar area. The branches of the central retinal artery (CRA) has been the main supplier to the superficial nerve fiber layer; the posterior ciliary artery (PCA), after forming the circle of Zinn-Haller (CZH) in the level of sclera, has supplied the prelaminar area and the lamina cribrosa; and both the CRA and PCA has supplied the the retrolaminar area. PCA, a major branch of the ophthalmic artery, has an important role in the blood supply to the optic nerve head and the adjacent retrolaminar optic nerve. Because PCA supplies most of the blood to AON and the CZH has supply branches not only to AON but also to peripapillary choroid, we assumed that some abnormalities on the posterior choroidal circulation would be detected in the fundus fluorescein angiogram of AION. In this study, therefore, a retrospective investigation of the fundus

Reprint requests to Myung-Kyoo Ko, M.D., Department of Ophthalmology, School of Medicine, Hanyang University, 17 Haengdang-Dong, Sungdong-Ku, Seoul 133-792, Korea.
fluorescein angiographic findings of patients with AION was conducted to observe the various features of combined choroidal insufficiency in AION.

**MATERIAL AND METHODS**

Twenty-eight patients with AION participated in this study. Of these, 15 were male and 13 were female. Ages ranged from 26 to 87 years with the average age being 53 years. The following criteria were used for diagnosing AION: (1) decreased visual acuity or visual field defect, (2) abnormal optic disc findings such as disc edema and hemorrhage, and (3) generalized or localized filling delay of optic disc in fundus fluorescein angiograms. Fundus fluorescein angiographies were performed within the first 4 weeks after the manifestations of the symptoms. Angiographies focused on the posterior pole were taken, of which the early phase angiograms were considered important. The fluorescein angiographic findings from 30 eyes in 28 patients were analyzed retrospectively, and the choroidal filling delay, which were found in combination with the optic disc filling delay, were defined as that having no fluorescein filling in the choroid until the arteriovenous phase. The findings were categorized as follows: (1) circular or localized filling delay in peripapillary choroid, (2) generalized filling delay in posterior pole, (3) filling delay of ipsilateral choroid divided by watershed zone, and (4) choriocapillary filling delay. By doing this, we were able to obtain results about the features and incidences of combined choroidal insufficiency in AION.

**RESULTS**

Fifteen male and 13 female patients participated in this study, and 30 eyes from the 28 patients including 2 patients who had both eyes involved in the study were examined. The mean age of the patients was about 53 years (range, 26 to 87 years). All the patients complained of decreased visual acuity and/or visual field defect. The eyes of all the patients had abnormal disc findings such as disc edema and peripapillary hemorrhage. We included fundus fluorescein angiograms that showed definite evidence of generalized or localized filling delay of the optic disc (Fig. 1 A, B). The various choroidal fluorescein filling delay were observed in combination with the optic disc filling delay. The features and incidences of choroidal insufficiency in AION are as follows: circular or localized filling delay of peripapillary choroid in 15 eyes (50%) (Fig. 2), generalized filling delay of posterior pole in 11 eyes (36.7%) (Fig. 3), filling delay of ipsilateral choroid divided by watershed zone in 5 eyes (16.7%) (Fig. 4), and choriocapillary filling delay in 10 eyes (33.3%) (Fig. 5).

**DISCUSSION**

AION is a clinical diagnosis based on a history of sudden painless visual loss and findings of optic disc edema and a visual field defect. It is one of the most common causes of impaired vision in middle-age and older patients. Visual loss in AION
As arcuate scotoma and central scotoma, can be manifested.\textsuperscript{8,9} Each branches of PCA have their own supply area. Therefore the various clinical features of AION are presented depending on the PCA degree and extent of PCA obliteration.

The causes of AION are generally unknown.
 Nowadays AION is understood as a vascular disorder and multifactorial disorder; this means that systemic disorders such as hypertension and diabetes mellitus act as precursors. Moreover, local factors such as glaucoma aggravate the ischemic condition of AON. The fact that PCAs do not have to be completely occluded to produce AION is an important point to note. The blood supply to the optic disc, peripapillary choroid, and choroid depends on the difference between the intraocular pressure and perfusion pressure in the PCAs. Even if no actual occlusion of posterior ciliary artery exists, AION can be produced when the perfusion pressure toward the optic disc and the choroid decreases. All the following conditions can decrease perfusion pressure: hypertension accompanying atherosclerosis, diabetes mellitus, vasculitis, heart failure and shock causing hypotension, hematologic disorders such as pernicious anemia and leukemia, and increased intraocular pressure in glaucoma.

Fundus fluorescein angiography was performed on patients with AION to demonstrate the circulatory condition of the optic disc and choroid in AION. The results which were categorized also included those that showed generalized or localized filling delay in optic disc. Moreover patients with AION had combined circulatory insufficiency of choroid. According to other previous reports, typical angiographic findings of AION are filling delay and leakage of optic disc and filling delay of the peripapillary choroid and, when AION is due to arteritis, profound choroidal filling delay could be observed. Combined choroidal insufficiency is difficult to find only by through fluorescein fundus angiography, especially when there is retrolaminar lesion or temporary decrease in perfusion pressure. Therefore with fluorescein fundus angiography, we could misinterpret an existence of AION without a filling delay of the optic disc. Among the various types of choroidal filling delay, circular and localized filling delay of peripapillary choroid is the most commonly observed feature. The vessels in the prelaminar part of the optic disc are most susceptible to obliteration. The peripapillary choroid is either equally or slightly less susceptible to obliteration, and the rest of the choroidal circulation is also susceptible to obliteration but much less so than the prelaminar part of the optic disc and peripapillary choroid.

In this study, circular or localized filling delay of peripapillary choroid was found in 15 eyes (50% of cases); generalized filling delay of posterior pole was found in 11 eyes (36.7%); filling delay of unilateral choroid divided by watershed zone was found in 5 eyes (16.7%); and choriocapillary filling delay was found in 10 eyes (33.3%). These various features and incidences may depend on the location and extent of the PCA obliteration. The importance of the CZH in the pathogenesis of AION was described by several authors. CZH branches to the AON, to the pial arterial system, and to the peripapillary choroid, so the circular or localized filling delay of peripapillary choroid is related to the arterial CZH, formed by short posterior ciliary artery within sclera. Complete or partial obliteration of CZH could produce circular or localized filling defect in the peripapillary choroid depending on the extent of the obliteration. Generalized filling delay of posterior pole occurs when short PCA is generally involved. The obliteration of the more proximal part of main short PCA may produce this generalized filling delay of the posterior pole. And because there is no anastomosis between medial and lateral PCAs exists, the obliteration of the medial PCA may produce the filling delay in the medial half of the choroid, and the obliteration of the lateral PCA may produce the filling delay in the lateral half of the choroid. If some of the branches of the medial or lateral PCAs have been obliterated, sectoral filling delay of the choroidal fluorescence may exist. In our study, watershed zone vertically dividing the posterior pole is was observed in 10 cases (33.3%), and it crosses between the optic disc and macular area. If the extreme peripheral branches of the PCAs have been obliterated, lobular shaped filling defect of choriocapillaris could exist. This choriocapillary filling delay indicates the microvascular insufficiency of PCA. Our study explain that there is definitely combined vascular insufficiency of choroid and anterior optic nerve.

AION is probably caused by vascular insufficiency in the posterior ciliary and peripapillary choroidal circulation, whether it be due to hypoperfusion or actual occlusion. For diagnosis as AION, clinical features, fundoscopic findings, and angiographic findings may be helpful. Angiographically the filling delay of optic disc and various types of
combined choroidal filling delay may be observed, which we can assume are caused by the typical vascular structures of posterior ciliary artery around the optic disc.

REFERENCES


