ELSEVIER

Clinical Neurophysiology 117 (2006) 1158–1166

www.elsevier.com/locate/clinph

# Electrophysiological findings in patients with nonarteritic anterior ischemic optic neuropathy ☆

Márta Janáky [a,*], Zsuzsanna Fülöp [a], Andrea Pálffy [a], Krisztina Benedek [b], György Benedek [c]

[a] *Department of Ophthalmology, Faculty of Medicine, Albert Szent-Györgyi Medical and Pharmaceutical Center, University of Szeged, Koranyi rkpt 14, POB H-6701-427 Szeged, Hungary*

[b] *Department of Neurology, Faculty of Medicine, Albert Szent-Györgyi Medical and Pharmaceutical Center, University of Szeged, POB H-6701-427, Szeged, Hungary*

[c] *Department of Physiology, Faculty of Medicine, Albert Szent-Györgyi Medical and Pharmaceutical Center, University of Szeged, POB H-6701-427, Szeged, Hungary*

Accepted 24 January 2006

**Abstract**

*Objective*: Nonarteritic ischemic optic neuropathy (NAION) is one of the most frequent causes of sudden visual loss in middle-aged or elderly patients. Although several electrophysiological methods are available for an objective evaluation of the visual deficits, these are not generally used in the assessment of the clinical condition of NAION patients. To evaluate the severity of the optic nerve and retinal damage, electrophysiological tests were performed on 8 patients with NAION.

*Methods*: Visual evoked potentials (VEPs), scotopic, photopic and flicker electroretinograms (ERGs), multifocal ERGs and pattern ERGs were recorded.

*Results*: The results demonstrated that the VEPs fairly reliably reflected the visual loss caused by NAION. The VEPs were extinguished in cases with a serious visual acuity loss, while a decrease in amplitude and a lengthening of the P100 latency were observed in cases with good visual acuity and a severe visual field loss and in the nonattacked fellow eye of the patients with monocular involvement. The pattern ERGs failed to show signs of retrograde degeneration. The photopic, scotopic and flicker ERGs, and the oscillatory potentials (OPs) were close to normal in these NAION patients.

*Conclusions*: Our observations permit the conclusion that electrophysiological methods can provide an objective indication of the clinical condition of these patients. The new data obtained promote an understanding of the pathomechanism of the disease.

*Significance*: Electrophysiological tests are suitable for monitoring of the progression of the disease in NAION patients.



*Keywords:* Nonarteritic ischemic optic neuropathy; Visual evoked potentials; Retina; Electroretinography; Visual fields

## 1. Introduction

Nonarteritic anterior ischemic optic neuropathy (NAION) is one of the most frequent causes of sudden visual loss in middle-aged or elderly patients (Boone et al., 1996; Borchert and Lessell, 1988; Guyer et al., 1985; Lessell, 1999; Repka et al., 1983). Its annual incidence rate has been estimated as 10.3 per 100,000 individuals aged 50 years or older (Hattenhauer et al., 1997). The pathogenesis of the disease is still unclear (Arnold, 2003; Beck et al., 1987; Burde, 1993; Tesser et al., 2003). It may be presumed that an infarction of a blood vessel supplying the intrascleral portion of the optic nerve causes the sudden visual loss in NAION patients. Hayreh et al. (1994) postulated that the cause of the infarction could be defective autoregulation. Others have emphasized the importance of an anatomical

☆ The authors express their gratitude to Kati Mayer and Gabriella Dósai-Molnár for their valuable technical assistance and to Péter Liszli for all his kind help.

* Corresponding author. Tel.: +36 62 545101; fax: +36 62 545842.
*E-mail address:* janaky@opht.szote.u-szeged.hu (M. Janáky).

1388-2457/$30.00 
doi:10.1016/j.clinph.2006.01.013

variation of the optic disk (disk at risk) as the most important predisposing factor (Beck et al., 1987; Burde, 1993; Mansour et al., 1988).

Even establishment of the correct diagnosis can sometimes be difficult when the patient has good Snellen acuity with disk edema, while the other symptoms fit the criteria of NAION. Differential diagnostic problems similarly arise when the symptoms appear in relatively young patients. A thorough survey of the diagnostic criteria, and the exclusion of other pathologies causing visual loss, generally guarantees the validity and integrity of the NAION diagnosis (Janaky et al., 2005).

In clinical practice, the functional deficit in the visual system is generally tested during an estimation of the visual acuity and visual field defects. Some NAION patients have very poor visual acuity, while others have good visual acuity with serious visual field defects (Boone et al., 1996; Newman et al., 2002; WuDunn et al., 1997). The testing of visual acuity and visual fields, however, is subjective, and the reliability of the results of these examination methods is therefore questionable when the visual loss is severe, or the co-operation of elderly patients is not satisfactory. These considerations suggest the employment of objective, electrophysiological methods in the estimation of visual deterioration in this disease. Although various such methods are available for an objective evaluation of the visual deficits, these have not been generally used in the assessment of the clinical condition of NAION patients. Electrophysiological tests could also be useful in answering the crucial question relating to the pathomechanism of NAION, i.e. whether the damage in the eye is restricted to the optic nerve or other layers of the retina would be consecutively afflicted upon these special vascular defects. No systematic electrophysiological study has yet been reported concerning this aspect of the disease. To clarify these problems, we have performed a wide spectrum of electrophysiological tests according to the ISCEV standards on 8 NAION patients. Our observations are reported in the following.

## 2. Patients and methods

The study was approved by the Human Ethical Committee of Albert Szent-Györgyi Medical and Pharmaceutical Center and was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. Altogether 8 patients who satisfied the criteria of NAION described by Beri et al. (1987) were involved in the study. All of them had suffered a sudden visual loss or visual field loss, and they had experienced optic disk edema, followed by pallor of the disk, a relative afferent pupillary defect, and altitudinal, optic disk-related or concentric visual field defects.

Their case histories, clinical conditions and suspected predisposing factors are summarized in Table 1.

An intracranial cause of the visual loss was excluded by careful neurological examination, and intracranial and orbital MRI and CSF analysis. MRI revealed some small white matter lesions in two cases (Cases 1 and 2). However, this could not be linked to the visual loss. Other pathologies of disk edema such as vasculitis, syphilis, borelliosis, herpes simplex, etc. were excluded by serological and immunological tests. Color Doppler ultrasonography ruled out intracranial circulatory disturbances.

An age-matched group of 26 healthy individuals with good vision served as normal controls. After being informed as to the nature and possible consequences of the study, all the participants provided their written consent. Unpaired *t* tests were carried out for statistical comparison.

### 2.1. Electrophysiological recordings

All electrophysiological potentials were recorded with a RETI-Port 32 system (Roland Consult Gmbh, Wiesbaden, Germany). All of the procedures applied to record electroretinograms (ERGs) and visual evoked potentials (VEPs) were performed in accordance with International Society for Clinical Electrophysiology of Vision standards (Marmor and Zrenner, 1998–1999).

For electroretinography, the pupils were fully dilated with a combination of Mydrum (Chevin, Ankefarm) and Neosynephrin (10%, Ursaform) solutions. DTL electrodes (Dawson et al., 1979) were routinely used as active electrodes to record ERGs. Gold-cup electrodes 5 mm in diameter were used as reference and ground electrodes. The reference electrodes were pasted 1 cm laterally from the ipsilateral orbital rim. The ground electrodes were placed over the midline of the forehead (Fz). Impedance was maintained below 5 kΩ with the use of a conductive EEG paste (Adhesive gel TEN20). Sampling rate was 1000 Hz.

Before ERG recordings, dark adaptation was provided for at least 30 min. Binocular stimulation was used in all ERG recordings.

In accordance with the program of the RETI-PORT 32 system, which follows the ISCEV standards, scotopic ERGs were obtained by averaging 3 responses to −25-dB flashes of 0.5 Hz against a dark background of a Ganzfeld screen. The bandpass filter of the amplifier was set to 1–300 Hz.

To obtain maximal ERGs, the responses to 3 0-dB flashes of 0.5 Hz against a dark background were averaged. The bandpass of the amplifier was 1–300 Hz. Oscillatory potentials (OPs) were recorded under the same circumstances, except that the bandpass filters were set to 100–500 Hz.

Photopic ERGs were obtained by averaging 3 responses to a 0-dB standard flash stimulation of 0.5 Hz with the background light on. The bandpass filter was set to 1–300 Hz. Eight responses to 30-Hz flickering 0-dB flashes were averaged to obtain flicker ERGs.

For the recording of pattern ERGs (PERGs) and pattern VEPs, the patient was seated comfortably in front of a computer monitor with her/his pupils undilated. The