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CLINICAL INVESTIGATION

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Visual field defects in optic neuritis and anterior ischemic optic neuropathy: distinctive features

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Abstract ● Background: We analyzed the value of visual field defects in the differential diagnosis of optic neuritis (ON) and non-arteritic anterior ischemic optic neuropathy (AION). ● Methods: Ninety-nine consecutive patients with acute-onset optic neuropathy formed the basis for this study. Compressive and vasculitic neuropathies were excluded. Eighty-six patients fulfilled the criteria for either ON (50 patients): ≤ 35 years, normal disk, recovery of visual function, or AION (36 patients): ≥ 60 years, swelling of the disk, no recovery of visual function. Without knowledge of other clinical data, visual fields obtained by Goldmann perimetry were classified into five types of defects (forced choice). With the correct diagnosis at hand, fields were reviewed for characteristic features. ● Results: Forced-choice classification into defect types [%]: Central scotoma ON 68, AION 18; superior altitudinal defect ON 13, AION 7; inferior altitudinal defect ON 8, AION 52; peripheral defect ON 1, AION 5; diffuse defect ON 10, AION 18. Search for pathognomonic defects: A scotoma centered on the fixation point with a sloping border occurred exclusively in ON (25 of 50 patients). An inferior altitudinal defect with a sharp border along the horizontal meridian, particularly in the nasal periphery, occurred only in AION (10 of 36 patients). A steep centrocecal scotoma occurred in 3 of the 36 AION cases and not at all in the ON cases. Scotomas in the center breaking through to the periphery, superior altitudinal defects (with a sloping border along the horizontal meridian) and diffuse depressions verging on blindness occurred in both ON and AION. ● Conclusion: A scotoma centered on the fixation point with a sloping border is highly characteristic of ON, while an inferior altitudinal defect with a sharp border along the horizontal meridian, particularly in the nasal periphery, is highly characteristic of AION. To identify these diagnostic criteria, it can be necessary to examine full fields. With restriction of perimetry to 30° a large central scotoma can be mistaken for a diffuse defect and the border in the nasal periphery can be missed.

Introduction

Demyelinating optic neuritis (ON) and non-arteritic anterior ischemic optic neuropathy (AION) are the two most common optic neuropathies with acute visual loss. The differentiation between ON and AION is not always straightforward since the two diseases share many signs and symptoms. Although a central scotoma has been regarded as the characteristic field defect of ON [2, 4, 5, 9, 11, 12, 13] and a sector scotoma as typical for AION [3, 8, 12, 15], Rizzo and Lessell [16] found a considerable overlap of the visual field defects in ON and AION. Moreover, Keltner et al. [10] concluded on the basis of 448 patients in the Optic Neuritis Treatment Trial: "Since

a wide variety of visual field defects can occur with an acute attack of optic neuritis, the pattern of visual field loss is of limited utility in distinguishing optic neuritis from ischemic optic neuropathy and other optic nerve disorders". Aiming to solve this seeming contradiction, we investigated whether the visual fields are helpful in differentiating diagnosis between ON and AION.

The diagnosis of ON and AION can be based on circumstantial evidence only. To get as close as possible to a "gold standard", we used three selection criteria for assigning patients to either ON or AION: age, presence or absence of disk swelling and recovery of visual function or persistence of the deficit:

1. *Age of the patient:* ON is generally thought to occur between the ages of 20 and 50 with a peak at 30–35 years [12], whereas AION is thought to occur between 40 and 80 with a peak at 56–70 years [12]. Although there is some overlap, ON mainly occurs in younger, AION in older persons. We utilized this age distribution by applying an age of ≤ 35 years as a selection criterion for ON and an age of ≥ 60 as a selection criterion for AION. To largely avoid the overlap zone we excluded all patients aged between 36 and 59 years of age.
2. *Presence or absence of disk swelling:* Although the disk can be swollen in both ON and AION, ON frequently occurs with a normal disk, whereas AION by definition is associated with a swollen disk. Using a normal disk as a selection criterion for ON, one avoids mistaking AION for ON. The presence of disk swelling, however, does not exclude ON.
3. *Recovery of visual function:* Since substantial recovery of visual function occurs in most cases of ON [1] and only rarely in AION [14], this criterion is also useful for discrimination, although if it were applied alone, some AION cases would be mistaken for ON and some ON cases for AION.

The application of all three criteria most probably allows correct assignment of cases to either ON or AION. Pain aggravated by eye movements occurs nearly exclusively in ON, but was not used for distinction here since it was the subject of another study in the same group of patients [6].

We pursued the following three questions: (1) Do the visual fields differ between ON and AION if classified by forced choice into predetermined defect patterns? (2) To what extent can the differential diagnosis between ON and AION be made solely from the visual fields? (3) Are there defect patterns pathognomonic for ON and AION?

Methods

Patients

Between September 1992 and August 1993, 99 patients with an acute non-compressive unilateral optic neuropathy came to our neuro-ophthalmological outpatient clinic. All patients underwent neuro-ophthalmological examination including visual acuity testing with projected numeral optotypes and 90°-kinetic Goldmann perimetry.

From the 99 patients we selected 86 who fulfilled the inclusion criteria for either ON [onset of visual loss during previous 2 weeks, age ≤ 35 years, disc normal, recovery of visual acuity by factor ≥ 1.59 (2 dB) during follow-up of ≤ 1 month] or AION [onset of visual loss during previous 2 weeks, age ≥ 60 years, disc swollen, no recovery of visual function (improvement < 1.59 or 2 dB) during follow-up of ≤ 1 month].

Excluded were six patients between 36 and 59 years of age, three with giant cell arteritis, one with borreliosis and one with toxoplasmosis. Two patients younger than 35 who may well have had ON were not eligible for the study because they had a swollen disk. The clinical data of the remaining 86 patients, 50 in the ON and 36 in the AION group, are summarized in Table 1.

Perimetry

Visual fields were examined with the Goldmann perimeter by experienced technicians who were not informed that their findings would be used for a comparative study. A series of targets (III/4e, I/4e, I/3e, I/2e, I/1e) was applied, up to the weakest that could be detected. Targets were advanced from the periphery at a constant speed. Scotomata were searched for inside the isopters, and their borders identified by centrifugal movement of the respective target. If a radial border emerged, targets were moved perpendicularly to it. Optical near correction was provided in most cases.

Evaluation of visual fields

Classification into defect types (forced choice)

The initial fields were presented in random order to two examiners (authors J.G. and G.K.). They had to classify, according to their general clinical experience and independently of each other, the field defects into one of five types: central, superior altitudinal, inferior

Table 1 Clinical data of 50 patients with ON and 36 patients with AION (range with mean or median, respectively, in parentheses). Visual acuity is not normally distributed, but the logarithm of visual acuity is. Therefore, the mean was calculated as follows: The original acuity values were converted to their logarithm, then the logarithms were averaged and finally the average was reconverted to an acuity value

	Age (years)	Visual acuity (initial)	Visual acuity (follow up)	Visual acuity change (factor)	Follow-up (days)
ON (*n*=50)	13–35 (mean 26.0)	0.01–0.8 (mean 0.04)	0.1–1.2 (mean 0.6)	1.7–120 (median 10)	6–30 (mean 21.3)
AION (*n*=36)	60–83 (mean 68.1)	0.01–1 (mean 0.06)	0.01–1 (mean 0.05)	0.05–1.3 (median 1)	17–31 (mean 25.3)

altitudinal, peripheral or diffuse. Specific criteria were not supplied, in order to make the procedure similar to previous studies in which the principal location of the visual field loss was not characterized in detail ("central, altitudinal, Bjerrum, nasal step, depression of peripheral isopter" in [10]; "central, superotemporal, superonasal, inferotemporal, inferonasal" in [16]). Only the visual field of the involved eye was available to the examiners; no other clinical findings were known.

Search for pathognomonic field defects

With the correct diagnosis at hand, two of the authors (J.G. and G.K.) reviewed the initial fields for pathognomonic features.

Results

Classification into defect types (forced choice)

The classification by the two examiners were closely similar and are averaged in Table 2.

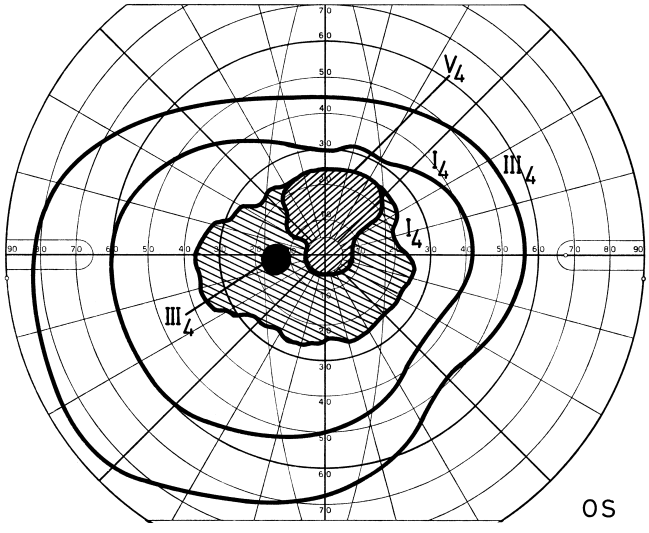

Fig. 1 Goldmann field of left eye in a patient with ON. Central scotoma for target V/4e, surrounded by a scotoma for I/4e

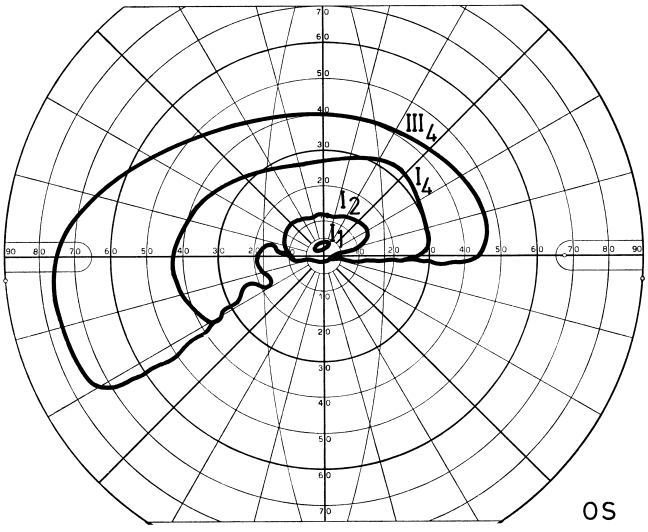

Fig. 2 Goldmann field of left eye in a patient with AION. Inferior altitudinal defect. Coincidence of several isopters indicates that the border along the horizontal meridian is sharp. In the upper half of the field targets III/4e, I/4e, I/2e and I/1e were seen although the respective isopters are narrowed

Search for pathognomonic field defects

Reviewing the fields for pathognomonic features with the correct diagnosis at hand, the two examiners found that a scotoma centered on the fixation point with a sloping border (Fig. 1) occurred exclusively in ON (25 of 50 cases). An inferior altitudinal defect with a sharp border along the horizontal meridian, particularly in the nasal periphery (Fig. 2) occurred only in AION (10 of 36 cases) A steep centrocecal scotoma (Fig. 3) occurred in 3 of the 36 AION cases and not at all in the ON cases (Table 3). Scotomata in the center breaking through to the periphery, superior altitudinal defects (with a sloping border along the horizontal meridian) and diffuse field defects verging on blindness occurred in both ON and AION.

Table 2 Visual field defects (%), classified without knowledge of clinical details (forced choice. Data of right and left eyes are combined (left eye mirror imaged)

	Central	Superior altitudinal	Inferior altitudinal	Peripheral	Diffuse
ON (*n*=50)	68	13	8	1	10
AION (*n*=36)	18	7	52	5	18

Table 3 Pathognomonic field defects (%)

	Scotoma centered on fixation point with sloping border	Inferior altitudinal defect with sharp border along horizontal meridian	Steep centrocecal scotoma
ON (*n*=50)	50	0	0
AION (*n*=36)	0	28	8

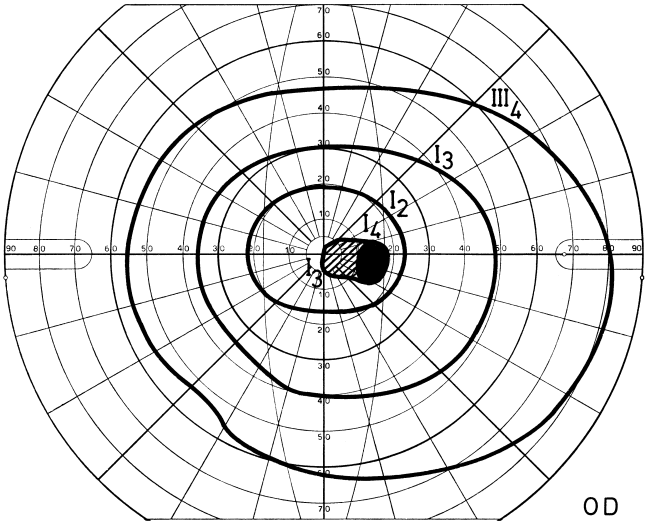

Fig. 3 Goldmann field of right eye in a patient with AION. Steep centrocecal scotoma (target I/3e). This type of defect was not seen in ON

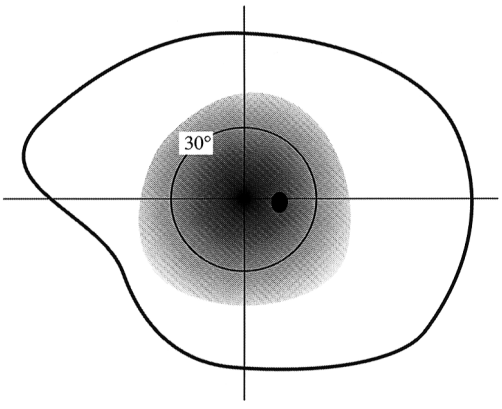

Fig. 4 Scotoma centered on the fixation point with a sloping border, pathognomonic of ON. If perimetry is limited to 30°, such a scotoma can be mistaken for a diffuse defect

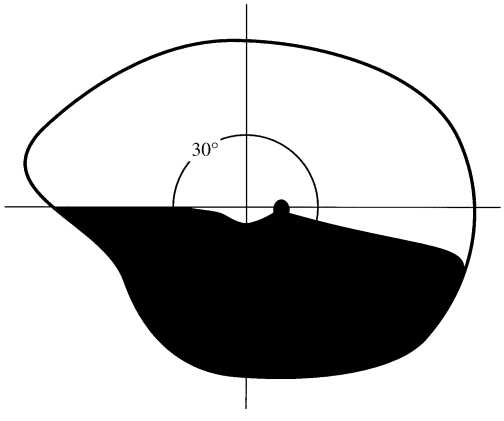

Fig. 5 Inferior altitudinal defect with a sharp border along the horizontal meridian, pathognomonic of AION. If perimetry is limited to 30°, the sharp border along the horizontal meridian can be missed

Discussion

We investigated the value of visual fields in the differential diagnosis of ON and AION. The impetus for our study originated from a seeming contradiction in the literature. Older sources suggested that a central scotoma is characteristic of ON [12], and a sector scotoma of AION [3, 8, 12], while more recent publications infer that the pattern of visual field loss is of limited utility in distinguishing ON from AION, since a wide variety of visual field defects occur in both [10, 16].

Our results support the traditional view, and we hold that later interpretations reflect differences in methods of data acquisition and analysis. Our search for pathognomonic field defects revealed that a scotoma centered on the fixation point with a sloping border (schematically drawn in Fig. 4) occurred exclusively in ON (25 of 50 patients), and an inferior altitudinal defect with a sharp border along the horizontal meridian, particularly in the nasal periphery (Fig. 5), occurred only in AION (10 of 36 cases).

Of special interest were three AION cases with a steep centrocecal scotoma. These defects clearly differed from the scotoma we regard as pathognomonic of ON in that they were not centered on the fixation point and their border was not sloping. Rather, a steep centrocecal scotoma seems to be fairly characteristic of AION. This view is supported by a study by Reuscher et al. [15], in which 14 of 83 AION cases showed a steep centrocecal scotoma. Moreover, in 8 of those 83 AION cases the centrocecal area was preserved in the midst of a combined superior and inferior altitudinal defect. The data of Reuscher et al. [15] suggest that the papillo-macular nerve fiber bundle has a separate vascular supply which can be affected or spared in isolation.

To identify the diagnostic criteria, it can be necessary to examine full fields. With a restriction to 30° or a separate evaluation of the central part [10], a large central scotoma can be mistaken for a diffuse defect (Fig. 4) and the border in the nasal periphery can be missed (Fig. 5). Another requirement is a method that indicates the steepness of the scotoma margin. In kinetic perimetry, as applied in our study, this requirement is met by testing with a series of targets which should be slowly advanced perpendicularly to the emerging border. Automated static threshold perimetry is not ideal for defining a border if measurements at different points are interpolated and if several threshold levels are lumped together to one and the same shade of gray.

Concerning data analysis, the more recent studies were not designed to identify pathognomonic features, since evaluators were forced to choose between predetermined

alternatives. In the study of Rizzo and Lessell [16] five alternatives were given: central, superior altitudinal, inferior altitudinal, peripheral and diffuse. When we replicated this mode of analysis in our cases, we reached similar results, i.e., a considerable overlap between ON and AION (Table 2). Although a central scotoma predominated with 68% in ON and an inferior altitudinal defect with 52% in AION, 18% of the AION defects were classified as central scotomas and 8% of the ON defects as inferior altitudinal. However, closer analysis of these defects revealed that they lacked certain characteristics: The scotomas were not centered on the fixation point and the inferior altitudinal defects were not sharply bordered in the nasal periphery. The reason why these defects were assigned to the respective groups in the forced-choice procedure was that the four other choices were inappropriate.

Likewise, the fields of the 448 patients taking part in the Optic Neuritis Treatment Trial [10] were analyzed by forced choice. In a first step, the defects were separated into diffuse and local, in a second step the most prominent pattern was characterized in severity, and in a third step the principal location of visual field loss was determined by a choice between central, superotemporal, superonasal, inferotemporal and inferonasal.

There is no doubt that the value of visual fields in the differential diagnosis between ON and AION is limited to cases with pathognomonic defects, i.e., to about 50% of the ON and 28% of the AION cases. In other cases non-specific defects occur, such as scotomata breaking through from the center to the periphery, superior altitudinal defects (with a sloping border along the horizontal meridian) and diffuse depressions.

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