Contrast sensitivity measurements in acute and resolved optic neuritis

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SUMMARY We measured contrast sensitivity by means of Arden grating plates in 41 eyes with acute optic neuritis and in 51 eyes with resolved optic neuritis. The scores were abnormal in 93% of eyes in the acute phase and 78% in the resolved phase irrespective of visual acuity. Even when acuity improved to 6/7.5 or better with resolution of the neuritis, 67% of eyes still showed abnormal contrast sensitivity. Since Snellen acuity represents just one point at the high spatial frequency end of the contrast sensitivity function, a patient in whom acuity improves to 6/6 with resolution of optic neuritis may still have difficulty seeing objects of lower relative contrast or at lower spatial frequencies.

Contrast sensitivity is a measure of the ability of the eye to detect a luminance difference between dark and light bars over a range of spatial frequencies. It was first measured by Campbell and Green,¹ who generated sinusoidal grating patterns on an oscilloscope. More recently Arden² developed a technique for rapid assessment of contrast sensitivity using a booklet containing six plates each of which consists of a sinusoidal grating of a fixed spatial frequency with a subtended visual angle α from 0.2 to 6.4 cycles per degree.

Abnormal contrast sensitivity has been reported in optic nerve disorders—neuritis,³⁻⁷ compressive lesions,⁸ glaucoma,⁹ retinal disease,¹⁰ cerebral lesions,¹¹ and amblyopia.¹² In this report we describe the results of contrast sensitivity measurements in acute and resolved optic neuritis and compare the scores to Snellen acuities.

Materials and methods

Contrast sensitivity and visual acuity were measured in 66 patients with optic neuritis, mean age 30.8 years (range 11–53). There were 46 females and 20

males. The patients were divided into two groups depending on whether the optic neuritis was acute (group I, examination within one month of onset of symptoms) or inactive (group II, examination at least one month after onset and in most cases months to years later).

Twenty-four patients were examined in the acute phase, 28 in the inactive, and 14 in both. Three patients in group I and 9 in group II experienced bilateral optic neuritis. Thus group I comprised 41 eyes (38 patients) with acute optic neuritis, while group II had 51 eyes (42 patients with inactive optic neuritis).

Visual acuity measurements were recorded at distance for each eye with proper refractive correction.

Contrast sensitivity was measured in each eye with the Arden grating plates. The test was administered by a non-physician using the technique described by Arden,² and for each patient a total score consisting of a sum of the scores on each of the six plates was determined. In addition an interocular difference in scores was calculated for each of the 35 patients in group I and 33 patients in group II with monocular optic neuritis. Cases of bilateral optic neuritis were excluded in this computation since we wanted to compare impaired to normal eyes. A total score of 82 or an interocular difference of greater than 11 was considered abnormal.²

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Results

The mean total Arden grating score was 107.8 in group I (acute optic neuritis) and 93.6 in group II (resolved optic neuritis) ($t=2.78$, $p<0.01$). The average interocular difference was 36.8 in group I and 20.2 in group II ($t=3.02$, $p<0.01$) (Table 1).

Table 1 Mean Arden grating scores

	<i>n</i>	$\bar{x}$	<i>SD</i>	
<i>Group I (acute)</i>				
Involved eyes	41	107.8	26.7	<i>t</i> =7.95*
Normal fellow eyes	35	70.2	13.3	
Interocular difference†	35	36.8	25.5	
<i>Group II (resolved)</i>				
Involved eyes	51	93.6	22.5	<i>t</i> =6.09*
Normal fellow eyes	33	68.2	15.7	
Interocular difference†	33	20.2	19.2	

*Comparison of involved with normal fellow eyes, $p<0.001$.

†For this computation only patients with monocular optic neuritis are included.

In group I the scores ranged from 55 to 150 with 35 of the 41 eyes (85%) scoring in the abnormal range. In 89% of the cases of monocular neuritis there was a significant interocular difference (>11). As indicated in Figs. 1 and 2, abnormal total scores and interocular differences occurred throughout the entire range of Snellen acuities. Five of the seven eyes with acuity of 6/7.5 or better and 19 of the 23 with 6/12 or better showed abnormal contrast sensitivity. In three of the six eyes with a normal total score an abnormal interocular difference was present. Thus in only three of 41 eyes was both the total score and interocular difference normal.

In group II the scores ranged from 44 to 140 with 36 of the 51 eyes scoring abnormally. A significant interocular difference (>11) was present in 55% of the cases of monocular optic neuritis. As in group I, abnormal contrast sensitivity scores and interocular differences occurred throughout the range of Snellen acuities (Figs. 3, 4), with 18 of the 33 eyes having acuity of 6/7.5 or better being in the abnormal range. Four of the eyes with a normal total score had an abnormal interocular difference.

In the 17 eyes examined during both the acute and inactive phases the Arden scores averaged 103.4 acutely and 83.4 after resolution ($t=6.73$, $p<0.001$). A plot of visual acuity versus contrast sensitivity score is seen in Fig. 5. The Arden score improved in all but one eye with resolution of optic neuritis, though 10 of the 17 remained in the abnormal range and two others had interocular differences greater than 11.

Arden scores for the fellow eyes of the 35 cases of

Fig. 1 Arden grating scores for involved (solid circles) and fellow (open circles) eyes in 41 cases of acute optic neuritis.

Fig. 2 Interocular differences in Arden grating scores between involved and fellow eyes in 35 cases of unilateral acute optic neuritis.

Fig. 3 Arden grating scores for involved (solid circles) and fellow (open circles) eyes in 51 cases of resolved optic neuritis.

Fig. 5 Arden grating scores for 17 eyes examined during both the acute (solid circles) and resolved (open circles) phases of optic neuritis. Lines connect the two measurements for each eye.

Fig. 4 Interocular differences in Arden grating scores between involved and fellow eyes in 33 cases of unilateral resolved optic neuritis.

unilateral optic neuritis in group I and 33 cases in group II averaged 70.2 and 68.2 respectively (Table 1). Five asymptomatic eyes in group I and seven in group II had scores in the abnormal range (Figs. 1, 3).

Discussion

Contrast sensitivity has been previously measured in optic neuritis, but we are not aware of a report that has compared its measurement in acute to resolved optic neuritis. Arden and Gucukoglu¹ reported abnormal contrast sensitivity in 70% of 57 cases of resolved optic neuritis. Abnormal results were also found in the fellow eyes of 56% of those patients with signs and symptoms of multiple sclerosis and 19% of those without. Zimmern *et al.*⁴ studied eight patients with resolved optic neuritis and visual acuity of 6/6 and recorded abnormal contrast sensitivity in the involved eyes of eight and in the fellow eye of one. Hess and Plant⁵ studied nine eyes of eight patients with optic neuritis and found that impaired contrast sensitivity was dependent on both the spatial and temporal frequency of the stimulus. Two studies have measured contrast sensitivity in

patients with multiple sclerosis without clinically apparent optic neuritis. Kupersmith *et al.*⁶ found abnormal contrast sensitivity in 14 of 18 such patients, and Regan *et al.*⁷ demonstrated similar abnormalities in 20 of 48. All patients in the former and most in the latter study had visual acuity of 6/6.

In our study we measured contrast sensitivity with Arden grating plates and considered an eye to be abnormal if either its total score or interocular difference exceeded the standards set by Arden.² Contrast sensitivity was impaired in 93% of the eyes in patients with acute optic neuritis irrespective of visual acuity. Although the scores with resolved neuritis were significantly lower, they were still abnormal in 78% of eyes. Even when visual acuity improved to 6/7.5 or better, 67% of eyes still had impaired contrast sensitivity. In those patients examined in both the acute and resolved periods, contrast sensitivity improved with resolution of the neuritis in all but one eye, yet in 70% of eyes the measurement was still abnormal.

Arden² reported a normal population mean score of 69.8 for his test booklet. The mean score of the normal fellow eyes in our series is quite similar. Several of the fellow eyes in each of our groups did score in the abnormal range. Visual acuity was normal in each of these eyes, but the abnormal score is suggestive of a previous subclinical optic neuritis.

The measurement of contrast sensitivity represents an additional means for assessing visual function. In this study we found that, although contrast sensitivity improves with resolution of optic neuritis, it frequently remains abnormal. This may be the reason many patients after having recovered from optic neuritis report that vision is not normal, being 'washed out' or 'dull', despite acuity of 6/6. Snellen acuity represents just one point at the high spatial frequency end of the contrast sensitivity function. A patient could maintain normal Snellen acuity yet have difficulty seeing objects of lower relative contrast or at lower spatial frequencies. It is

important for the clinician to recognise that Snellen acuity measures only one facet of vision and that a recording of 6/6 acuity with a full visual field does not necessarily mean that visual function is normal. Often, indicating to a patient with a resolved optic neuritis that the visual symptoms he is experiencing are expected is enough to allay his concern about the residual impairment he suffers.

The work was supported in part by a fellowship grant from the Heed Ophthalmic Foundation (Dr Beck).

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