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Research

*Corresponding author
Rohit Saxena, MD
Dr. Rajendra Prasad Centre for Ophthalmic Sciences
All India Institute of Medical Sciences
New Delhi 110029, India
Tel. 91-011-26593185; 91-011-26593182
Fax: 91-011-26588919
E-mail: rohitsaxena80@yahoo.com

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Microperimetry in Optic Neuritis

Indrish Bhatia, MD[1]; Shveta Lukhmana, MD[2]; Digvijay Singh, MD[1]; Vimala Menon, MS[3]; Pradeep Sharma, MD[3]; Rohit Saxena, MD[3*]

[1]Division of Ophthalmology, Medanta-The Medicity, Gurgaon, Haryana, India
[2]ESIC Medical College, Faridabad, Haryana, India
[3]Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, India

ABSTRACT

Aim: To evaluate microperimetry as a tool for visual field assessment in optic neuritis and compare it with standard automated perimetry.
Methods: A case-control study was conducted at a tertiary eye care centre in India. Ten cases of unilateral optic neuritis and 10 healthy controls underwent a detailed ophthalmic evaluation and visual field testing at presentation and 1 month and 3 months follow-up. Visual fields were charted using both the standard automated perimeter (10-2 and 30-2 programs) and microperimeter (central 20 degree program) at each visit.
Results: The visual acuity at presentation of the affected eye, fellow eye and control eyes was 0.27±0.19, 0.93±0.14 and 0.94±0.17 respectively. The affected eye visual acuity improved significantly to 0.89±0.24 (p<0.001) at the 3 months follow-up visit. The mean sensitivity thresholds of 10-2 visual field test at presentation were 14.16±11.51, 30.40±1.98 and 31.04±1.95 respectively of which the affected eye showed a significant improvement over 3 months to 28.90±8.36 (p<0.001). The mean sensitivity thresholds of 30-2 visual field test at presentation were 12.88±10.32, 26.03±2.59 and 27.99±2.31 respectively of which the affected eye and fellow eye showed a significant improvement over 3 months to 26.02±7.54 (p<0.001) and 27.86±1.77 (p<0.03) respectively. The mean sensitivity thresholds of microperimetry 20 degree visual fields at presentation were 5.60±7.32, 16.54±1.46 and 17.30±1.64 respectively of which the affected eye showed a significant improvement over 3 months to 16.41±4.87 (p<0.001). Microperimetry fields did not improve completely at 1 month unlike the 10-2 fields and correlated strongly with visual recovery. The 30-2 fields were the most sensitive to determine subclinical affliction of the fellow eyes in optic neuritis.
Conclusion: Microperimetry is a sensitive test to evaluate visual fields in optic neuritis and corresponds with visual recovery. The larger 30 degree module is still indispensible for visual field assessment in optic neuritis.

KEYWORDS: Microperimetry; Optic neuritis; Visual fields; Perimetry; Microperimeter.

ABBREVIATIONS: IEC: Institutional Ethics Committee; ANOVA: Analysis of variance; HVF: Humphrey Visual Field.

INTRODUCTION

Optic neuritis negatively impacts various visual functions including visual fields. Varying patterns of field loss have been reported, ranging from altitudinal, arcuate and centrocaecal to diffuse and even unilateral hemianopic field defects.[1-8]

Nearly all studies on visual fields in optic neuritis have been done using the standard automated perimetry, which has inadequate compensation for eye movements and this is particularly important in cases of poor vision and central scotomas such as those seen in optic neuritis. Microperimetry is a novel diagnostic modality that overcomes this limitation by continuously tracking the patient's fundus during stimulus projection. Eye movement detected by the machine either causes a pause in stimulus projection, or alteration the position of stimulus

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projection to match the amount of eye excursion. Additionally, the microperimeter also overlays the sensitivity map on the fundus image providing a visually appealing result with good structural correlation.[9-23]

There are limited studies of microperimetry in optic neuritis and only one comparing it to the standard perimetry.[24,25] This study evaluates microperimetry as tool for visual field assessment in optic neuritis and compares it with the standard automated perimetry.

METHODS

A prospective case control study was conducted at a tertiary eye care hospital in India after prior approval from the Institutional Ethics Committee (IEC). Ten consecutive cases of optic neuritis and 10 controls were enrolled into the study after written informed consent. The inclusion criteria for cases was the presence of acute unilateral optic neuritis diagnosed clinically (sudden onset diminution of vision in one eye of less than 2 weeks duration with or without optic nerve head changes and/or pain on eye movements preceding the vision loss in the presence of relative afferent papillary defect) in the absence of any other ocular or neurological pathology likely to affect fields. Cases were excluded if they were bilateral, had a previous episode of optic neuritis, were aged less than 18 years and/or had a Snellen's visual acuity worse than 6/60. Controls recruited were healthy individuals aged above 18 years with no known ocular or neurological disease. Cases or controls were excluded if they did not consent to the study or were lost to follow-up.

The subjects underwent a comprehensive evaluation including a detailed clinical history and examination (neurological and ophthalmic) followed by visual fields and microperimetry. Visual acuity was assessed using the Snellen's chart, visual fields by the 10-2 and 30-2 protocols on the Humphrey visual field analyzer (Carl Zeiss Meditec AG, Germany) as well as the central 20 degrees algorithm on the MP-1 microperimeter (Nidek, Japan). The order of these field tests was selected randomly. Visual fields on the microperimeter were performed using a 4-2 threshold strategy with an initial attenuation of 10 decibel-milliwatt (Dbm) and Goldmann III sized stimulus of white color, projected for 200 ms with a red cross fixation target of 7 degrees diameter.

To negate the effect of learning curve on visual field assessment, visual fields were repeated daily in both eyes till two identical fields on two consecutive days were obtained. These fields were then chosen for the study.

Patients were followed at 1 and 3 months after the initial presentation for visual parameters and field testing. Controls also underwent the Humphrey 10-2 and 30-2 field tests and microperimetry using the same settings as cases.

Statistical analysis was performed using SPSS 13.0 software (IBM Corporation, Armonk, NY, USA). For the purpose of analysis, the study population was divided into 3 groups; A (Eyes clinically diagnosed to be affected by optic neuritis n=10), B (Fellow, apparently unaffected eyes in unilateral cases, n=10) and C (Eyes of normal healthy controls; n=20). Comparison of variables was done at all hospital visits between the three groups, and over time for each group. Independent and paired samples *t*-test, Analysis of variance (ANOVA), Pearson's chi square test, Mann-Whitney test and the Friedman test were used as appropriate. A $p<0.05$ was considered statistically significant.

RESULTS

The demographic details of the cases and control groups are summarized in Table 1. There was no statistically significant difference with regard to demography between cases and controls. The duration of optic neuritis at presentation was 6±2.6 days with a range of 1-10 days.

	Patients (n=10)	Controls (n=10)	*p*-value
Age (years) (Mean±SD) (Range)	25.7±2.8 (18-38)	27.8±2.4 (25-32)	0.48 (independent sample *t*-test)
Sex Male Female	4 (40%) 6 (60%)	7 (70%) 3 (30%)	0.134 (Pearson chi square test)

Table 1: Demographic profile of cases and controls.

Mean visual acuity was reduced in affected eyes at presentation, being significantly lower than that of fellow eyes and controls. Statistically significant improvement occurred at both 1 month and 3 month follow-ups. However, at 1 month follow-up, the visual acuity was still significantly lower than that of controls. Vision in fellow eyes was not significantly different from that of controls at any visit, and did not show any significant change over time (Table 2).

The mean sensitivity of the central visual field as measured by Humphrey visual field (HVF) 10-2 was significantly reduced at presentation in affected eyes when compared to fellow eyes and controls. This improved significantly by 1 month after presentation and reached near normal levels and did not improve significantly thereafter. The mean sensitivity of fellow eyes was comparable to that of controls at all visits (Table 3; Figure 1). The pattern deviation and change (within and between groups) for HVF 10-2 mean defect was similar to that discussed for HVF 10-2 mean sensitivity (Table 4).

On Microperimetry, the mean sensitivity (central 20 degrees of the visual field) of affected eyes was significantly lower at presentation as compared to fellow eyes and controls, and improved significantly by 1 month follow-up. However, at 1 month, the mean sensitivity was still significantly lower than that of controls. Further changes in mean sensitivity over time were not statistically significant. The mean sensitivity of fellow eyes was not affected at any visit in comparison to controls (Table 5;

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		At first visit (0 month)	At 1 month	At 3 months	*p* value (for change over time)
Group A (n=10)	Decimal scale (Mean±SD)	0.27±0.19	0.72±0.26	0.89±0.24	$p(A_0,A_1)$: <0.001 $p(A_1,A_3)$: 0.012
Group B (n=10)	Decimal scale (Mean±SD)	0.93±0.14	0.92±0.18	1.01±0.14	$P(B_0,B_1)$: 0.755 $p(B_1,B_3)$: 0.088
Group C (n=20)	Decimal scale (Mean±SD)	0.94 ± 0.17			
p value(for intergroup differences)		$p(A_0,B_0)$: <0.001 $p(A_0,C_0)$: <0.001 $p(B_0,C_0)$: 0.91	$p(A_1,B_1)$: 0.07 $p(A_1,C_0)$: 0.02 $p(B_1,C_0)$: 0.85	$p(A_3,B_3)$: 0.15 $p(A_3,C_0)$: 0.89 $p(B_3,C_0)$: 0.38	

Group A: Eyes affected by optic neuritis; Group B: fellow eyes; Group C: eyes of controls.

Table 2: Visual acuity changes and trend.

	At first visit (0 month)	At 1 month	At 3 months	*p* value (for change over time)
Group A (Mean ± SD)	14.16±11.51	28.55±8.32	28.90±8.36	$p(A_0,A_1)$:<0.001 $p(A_1,A_3)$:0.468
Group B (Mean ± SD)	30.40±1.98	32.04±1.61	31.56±1.76	$p(B_0,B_1)$:0.085 $p(B_1,B_3)$:0.344
Group C (Mean ± SD)	31.04±1.95			
p value (for intergroup differences)	$p\ (A_0,B_0)$: 0.001 $p\ (A_0,C_0)$: <0.001 $p\ (B_0,C_0)$: 0.328	$p\ (A_1,B_1)$: 0.084 $p\ (A_1,C_0)$: 0.158 $p\ (B_1,C_0)$: 0.373	$p\ (A_3,B_3)$: 0.212 $p\ (A_3,C_0)$: 0.545 $p\ (B_3,C_0)$: 0.475	

Group A: Eyes affected by optic neuritis; Group B: fellow eyes; Group C: eyes of controls.

Table 3: HVF 10-2 Mean threshold sensitivity changes and trend.

	At first visit (0 month)	At 1 month	At 3 months	*p* value (for change over time)
Group A (Mean±SD)	-20.87±12.13	-6.06±8.71	-5.74±8.42	$p(A_0,A_1)$:<0.001 $p(A_1,A_3)$:0.53
Group B (Mean±SD)	-4.02±1.72	-2.49±1.88	-3.04±1.82	$p(B_0,B_1)$:0.09 $p(B_1,B_3)$:0.19
Group C (Mean±SD)	-7.27±1.84			
p value (for intergroup differences)	$p(A_0,B_0)$: 0.002 $p(A_0,C_0)$: <0.001 $p(B_0,C_0)$: 0.109	$p(A_1,B_1)$: 0.192 $p(A_1,C_0)$: 0.071 $p(B_1,C_0)$: 0.650	$p(A_3,B_3)$: 0.250 $p(A_3,C_0)$: 0.148 $p(B_3,C_0)$: 0.871	

Group A: Eyes affected by optic neuritis; Group B: fellow eyes; Group C: eyes of controls.

Table 4: HVF 10-2 Mean defect: changes and trend.

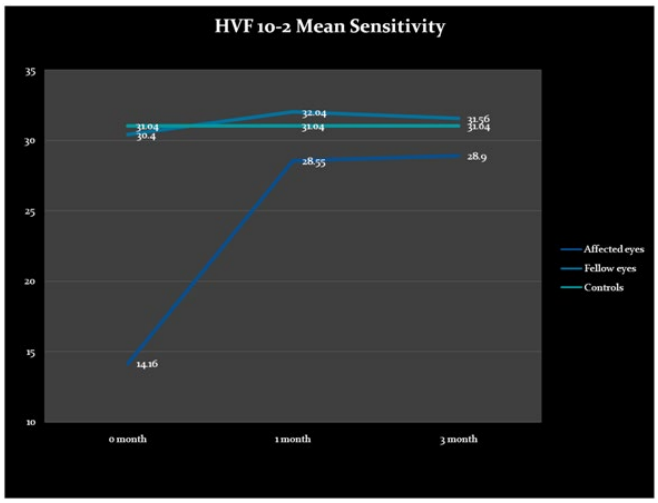

Figure 1: Graphical trend of change in HVF 10-2 mean sensitivity.

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Figure 2). The trend of affection and change of mean defect on microperimetry paralleled that of mean sensitivity (Table 6).

On the HVF 30-2 examination, the affected eyes showed a similar trend of affliction and recovery as the 10-2 though the fellow eyes differed. The mean sensitivity for fellow eyes was found to be significantly lower than that for controls at the time of presentation. This improved significantly by the first follow-up visit to match that of controls. No further statistically significant improvement was seen (Table 7; Figure 3). The results of mean defect on HVF 30-2 echoed those of mean sensitivity (Table 8).

The microperimetry mean sensitivity showed a strong and significant correlation with visual acuity and the mean sensitivity and mean defect on HVF 10-2 (Table 9).

DISCUSSION

Microperimetry has several advantages over standard automated perimetry. These range from greater accuracy to more aesthetically appealing results. Our study was designed to evaluate the sensitivity of microperimetry for visual field analysis in optic neuritis and compare it with HVF 10-2. In addition, we also compared the findings of HVF 30-2 to the above two field tests

	At first visit (0 month)	At 1 month	At 3 months	*p* value (for change over time)
Group A (Mean±SD)	5.60±7.32	15.34±4.59	16.41±4.87	$p(A_0,A_1)$:<0.001 $p(A_1,A_3)$:0.058
Group B (Mean±SD)	16.54±1.46	16.67±1.52	16.93±2.16	$p(B_0,B_1)$:0.839 $p(B_1,B_3)$:0.699
Group C (Mean±SD)	17.30±1.64			
p value (for intergroup differences)	$p(A_0,B_0)$:0.002 $p(A_0,C_0)$:<0.001 $p(B_0,C_0)$:0.109	$P(A_1,B_1)$:0.437 $p(A_1,C_0)$:0.030 $p(B_1,C_0)$:0.214	$p(A_3,B_3)$:0.920 $p(A_3,C_0)$:0.849 $p(B_3,C_0)$:0.901	

Group A: Eyes affected by optic neuritis; Group B: fellow eyes; Group C: eyes of controls.

Table 5: Microperimetrymean threshold sensitivity changes and trend.

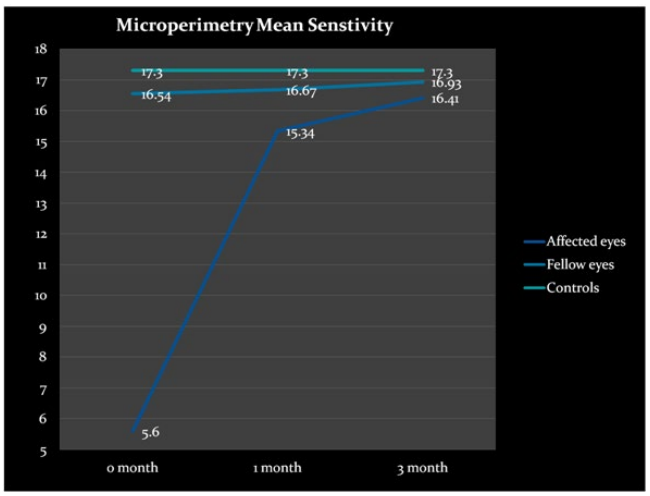

Figure 2: Graphical trend of change in microperimetry mean sensitivity.

	At first visit (0 month)	At 1 month	At 3 months	*p* value (for change over time)
Group A (Mean±SD)	-12.63 ± 6.80	-4.35±4.68	-3.31±4.96	$p(A_0,A_1)$:<0.001 $p(A_1,A_3)$:0.083
Group B (Mean±SD)	-3.09±1.39	-3.04±1.46	-2.81±2.14	$p(B_0,B_1)$:0.930 $p(B_1,B_3)$:0.736
Group C (Mean±SD)	-2.42±1.70			
p value (for intergroup differences)	$p(A_0,B_0)$:0.004 $p(A_0,C_0)$:<0.001 $p(B_0,C_0)$:0.143	$p(A_1,B_1)$:0.664 $p(A_1,C_0)$:0.027 $p(B_1,C_0)$:0.169	$p(A_3,B_3)$:0.494 $p(A_3,C_0)$:0.796 $p(B_3,C_0)$:0.901	

Group A: Eyes affected by optic neuritis; Group B: fellow eyes; Group C: eyes of controls.

Table 6: Microperimetry mean defect: changes and trend.

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	At first visit (0 month)	At 1 month	At 3 months	*p* value (for change over time)
Group A (Mean±SD)	12.88±10.32	25.73±7.72	26.02±7.54	$p(A_0,A_1)$:<0.001 $p(A_1,A_3)$:0.60
Group B (Mean±SD)	26.03±2.59	28.58±1.50	27.86±1.77	$p(B_0,B_1)$:0.03 $p(B_1,B_3)$:0.26
Group C (Mean±SD)	27.99±2.31			
p value (for intergroup differences)	$p(A_0,B_0)$:0.004 $p(A_0,C_0)$:<0.001 $p(B_0,C_0)$:0.044	$p(A_1,B_1)$:0.636 $p(A_1,C_0)$:0.224 $p(B_1,C_0)$:0.914	$p(A_3,B_3)$:0.743 $p(A_3,C_0)$:0.259 $p(B_3,C_0)$:0.619	

Group A: Eyes affected by optic neuritis; Group B: fellow eyes; Group C: eyes of controls.

Table 7: HVF 30-2 Mean threshold sensitivity changes and trend.

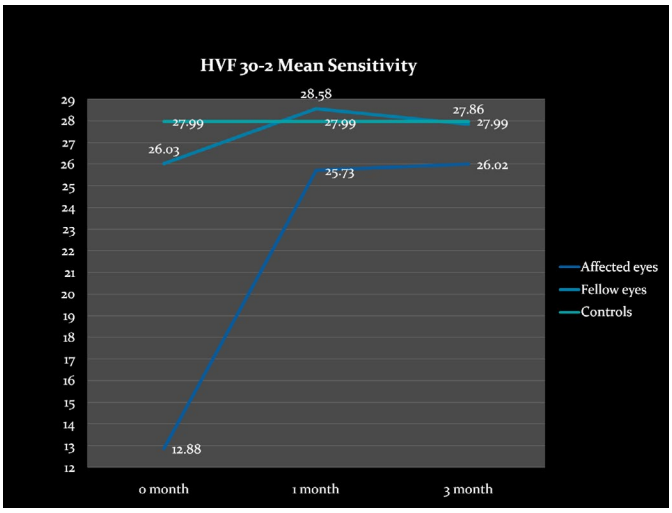

Figure 3: Graphical trend of change in HVF 30-2 mean sensitivity.

	At first visit (0 month)	At 1 month	At 3 months	*p* value (for change over time)
Group A (Mean±SD)	-19.32±11.38	-5.61±8.29	`-5.37±7.82	$p(A_0,A_1)$:<0.001 $p(A_1,A_3)$:0.63
Group B (Mean±SD)	-4.85 ± 2.06	-2.41±1.58	-3.14±1.53	$p(B_0,B_1)$:0.03 $p(B_1,B_3)$:0.19
Group C (Mean±SD)	-3.08±2.24			
p value (for intergroup differences)	$p(A_0,B_0)$:0.001 $p(A_0,C_0)$:<0.001 $p(B_0,C_0)$:0.031	$p(A_1,B_1)$:0.192 $p(A_1,C_0)$:0.29 $p(B_1,C_0)$:0.914	$p(A_3,B_3)$:0.341 $p(A_3,C_0)$:0.112 $p(B_3,C_0)$:0.502	

Group A: Eyes affected by optic neuritis; Group B: fellow eyes; Group C: eyes of controls.

Table 8: HVF 30-2 Mean defect: changes and trend.

	At presentation	**At 1 month**	**At 3 months**
Visual Acuity	*r=0.865* *p=<0.001*	*r=0.678* *p=0.008*	*r=0.715* *p=0.004*
Mean sensitivity 10-2	*r=0.917* *p=<0.001*	*r=0.965* *p=<0.001*	*r=0.970* *p=<0.001*
Mean defect 10-2	*r=0.914* *p=<0.001*	*r=0.963* *p=<0.001*	*r=0.969* *p=<0.001*

Group A: Eyes affected by optic neuritis; Group B: fellow eyes; Group C: eyes of controls.

Table 9: Correlation of microperimetry mean threshold sensitivity with visual acuity and 10-2 visual field parameters.

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in order to determine whether peripheral visual field testing provides any extra information than can be obtained from the central visual field alone.

Visual acuity in clinically affected eyes was found to be significantly lower than fellow eyes and controls. It improved incompletely over 1 month and needed a period of 3 months to reach normal levels, similar to the control group (p=0.89). This is consistent with previous studies that have reported delayed recovery of vision.[26-29] This delayed recovery in visual acuity was paralleled by the delayed recovery of central 20 degree sensitivity on microperimetry at 1 month but not the sensitivity of the 10-2 standard automated perimetry. This may imply that field testing by microperimetry is more sensitive to visual function changes. A similar result was reported by previous studies in literature.[24,25]

The finding that on microperimetry, at 1 month follow-up, the mean sensitivity in affected eyes was still lower than that of controls (p=0.03) suggests that subtle residual changes in macular sensitivity may persist in eyes with optic neuritis (atleast for the first month) even after apparent clinical resolution on the standard 10-2 perimetry (p=0.16).These results are in contrast to a recent report by Lima et al, [23] where in they suggested that microperimetry detects lesser sensitivity loss than standard automated perimetry in diseases involving the inner retina and optic nerve. However, their assumption is based on studies in glaucoma. Optic neuritis has a significant pathogenetic differences from glaucoma, and these may explain the difference in sensitivity patterns of the two tests in the two disorders. Acton et al[26] published a review highlighting the differences between microperimetry and standard automated perimetry and found adequate evidence to show the link between functional and structural changes in diseases pertaining to the retina as well as correlation between visual outcome and sensitivity on microperimetry. Whilst not strictly comparable to the current study, the review does concur with our study.

Another significant finding in our study was that the asymptomatic fellow eyes were found to have defects (compared to controls) on HVF 30-2, whereas they tested normal on HVF 10-2 and microperimetry. This suggests that though macular sensitivity may be unaffected in fellow eyes at the time of acute attack of optic neuritis, there are changes in the remaining visual field (central 60 degrees), which may affect the quality of vision and be a marker for subclinical damage. Thus, even though central visual field examinations like HVF 10-2 and microperimetry chart scotomas and other defects in much greater detail, testing a larger area of the visual field cannot be done away with. Likewise for cases of optic neuritis with unaffected visual acuity, peripheral field defects may be present which would get missed on a test such as the microperimetry and would require a full field evaluation. Nevalainen et al,[1] Fang et al[3], Rothova Z et al,[5] and Mienberg et al[30] agree with this view, but Keltner J et al[4] opine that in most cases, follow-up of optic neuritis eyes can be monitored by central visual field alone.

Among the central visual field tests, microperimetry appears to be superior to the standard automated perimetry. However there are potential drawbacks associated with this technology including the cost, requirement of technical expertise, and the long duration of the test (approximately 15 minutes per eye). The duration however can be reduced to a great extent (as low as 5 minutes per eye) by judicious selection of the test protocol and the testing strategy. Additionally, the inability to acquire peripheral visual fields prevents it from being a holistic perimetry testing system.

To conclude, the superior sensitivity of microperimetry and its greater correlation with vision as compared to HVF 10-2 put forward a case for the use of microperimetry as an alternative visual field examination in patients with optic neuritis. However, the standard HVF 30-2 examination remains indispensable in the work-up of optic neuritis.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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