Visual fatigue phenomenon and prescribing tinted lenses in patients with optic neuritis

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SUMMARY The fatigue phenomenon of grating visual acuity was examined in 36 patients with optic nerve disorders by means of a laser interferometric acuity device. The phenomenon was found in 6 of 36 cases even under a luminance corresponding to the Japanese standards of office illumination. This fact indicated that the patients suffered visual fatigue in their everyday vision. After they were prescribed tinted lenses to eliminate the fatigue, the patients had comfortable sustained vision in their daily work.

It has been shown that in the normal eye, and in some types of ocular pathology such as macular degenerations, decimal acuity increases linearly with the luminance and remains relatively constant at higher intensities.¹ The reverse occurs in congenital achromatopsia, where acuity reaches its maximal value at low luminance and with further increase falls rapidly unless retinal illumination is reduced. Optic nerve lesions may have similar consequences. Patients with optic neuritis often complain of visual difficulties under bright illumination while they are reading or writing, even in the convalescent stages.

Recently Enoch *et al.* described visual fatigue or a saturation-like effect when testing static visual fields in patients with optic nerve lesions.^{2–7} The test was termed 'the flashing repeat static test,' and the subsequent loss of sensitivity was related to the patient's general level of light adaptation, that is, the higher the luminance of the general background environment, the more rapid the fall-off in sensitivity. They also showed a time-based fall-off in grating visual acuity under intense illumination using a HeNe laser interferometer in a case of probable multiple sclerosis.⁸ However, scant attention has been paid to the fatigue phenomenon in conditions of ordinary illumination, which is a more important matter for patients.

In this study we examined the fatigue phenomenon of grating visual acuity in conditions of ordinary illumination in 36 cases with optic nerve disorders.

Tinted lenses were then prescribed for the patients to give them comfortable, sustained vision in their daily work.

Materials and methods

Nine subjects (9 eyes) without any ophthalmological abnormalities were used as the normal controls. The age range was 26 to 64 years, mean 39 years. Thirty-six patients (42 eyes) with optic nerve disorders were studied. Their age range was 19 to 64 years, mean 39 years. Multiple sclerosis was diagnosed in 2 cases, anterior ischaemic optic neuropathy in 2, and toxic neuropathy in 1 case, but in the others the causes of the disorders could not be determined. The patients had visual acuity of more than 0.7 in conventional acuity charts. The fatigue phenomenon of grating visual acuity was examined at a steady-state period at a minimum of 2 months after the patients regained their best visual acuity.

An interferometric acuity device using HeNe laser light (EA-251, Takata Co., Ltd, Tokyo, Japan) was used for this study. The equipment is shown in Fig. 1 with the field of view seen by the person being tested. The test field subtended 4.75°. The space-averaged luminance was restricted to 1500 cd/m² and 250 cd/m², which corresponded respectively to the luminance in daylight in fine weather and to the recommended office illumination of Japanese industrial standards.⁹ A grating contrast of 0.9 was used. The contrast was $(L_{\max} - L_{\min}) / (L_{\max} + L_{\min})$ where $L_{\max}$ was the highest and $L_{\min}$ the lowest luminance in the grating.

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Fig. 1 The laser interferometric acuity device used for the examination of visual fatigue phenomenon with the subject's field of view on the right.

The fatigue phenomenon of the grating acuity was examined by the modified method of Enoch *et al.*⁸ After accurately centring the patient in relation to the instrument, with interfering beams readily able to enter the pupil, the observer was asked to close the

eyes for a period of 5 minutes in the dark-room. Immediately after the patient opened his eyes the line frequency of the gratings was quickly adjusted until the lines were too fine to be detected. The line frequency was then reduced until the patient just detected the presence of the lines. At that moment the patient pushed a button switch, and the grating visual acuity was automatically recorded. The test was repeated after 5 minutes. The line orientation was set only vertically in this study.

For some patients tinted lenses were placed in front of their eyes until the fatigue phenomenon disappeared. The transmission curves of the lenses used in this study are shown in Fig. 2. The total light transmissions (TLT) of 80, 55, 45, 20, and 1% were used. After these tests suitable tinted lenses were prescribed for the patients.

Fig. 2 The light transmission curves of tinted lenses used in this study. Total light transmission (TLT) is 80, 55, 45, 20, and 1% (high to low).

Results

The time-based fall-off of grating acuity was not found in the normal controls with a space-averaged luminance of either 1500 or 250 cd/m². With a space-averaged luminance of 1500 cd/m² a fall-off of the grating acuity was found in all cases with optic nerve disorders. In contrast, with 250 cd/m² most patients had no tendency to experience fall-off except in 6 eyes of 6 patients (Fig. 3).

Table 1 gives the clinical details of these 6 cases, with the results of the fatigue phenomenon. The patients had a visual acuity of more than 0.7 in conventional acuity charts, but they complained of visual difficulty during reading even under ordinary illumination. The attenuation ratio of the grating

Fig. 3 The time-based fall-off changes of grating visual acuity in 6 eyes of 6 patients in space-averaged luminance of 250 cd/m². The luminance corresponds to the recommended office illumination of Japanese industrial standards.

acuity is $(VA_1 - VA_5)/VA_1$ where VA_1 is the initial and VA_5 the final acuity after 5 minutes measurement of the fatigue phenomenon. The patients had an attenuation ratio of 20 to 48.4% in the affected eyes. To reduce the fatigue phenomenon the tinted lenses were prescribed. In Fig. 4 the results of the examination for prescribing tinted lenses in case 1 are illustrated. The closed and open circles indicate the affected and unaffected eyes respectively. In the affected eye the time-based fall-off of the grating acuity is found in a space-averaged luminance of 250 cd/m². By wearing the tinted lense of TLT 55% the extent of the fall-off decreased, and it completely

disappeared with a lens of TLT 20%. The lens of TLT 20% was prescribed for the affected eye, and for the unaffected eye a tinted lens of the same light transmission was prescribed for cosmetic reasons. By this means the patient gained comfortable sustained vision during her office work. The visual complaints of the other patients, were also improved after prescribing the tinted lenses.

Discussion

After the acute stage many patients with optic neuritis regain visual acuity, which may recover to the normal level, but they often complain of some visual defect. To understand the nature of these defects the atrophic states of the retinal nerve fibre layer, the static visual fields, and the contrast sensitivity functions have been examined, and some anatomical and functional losses have been determined in 'recovered' cases.¹⁰⁻¹³

The visual fatigue phenomenon is one of the most characteristic defects of vision in optic neuritis. It was initially demonstrated by Enoch *et al.* under intense illumination.⁶⁻⁸ In the present study the phenomenon was found to occur even under ordinary illumination such as standard office lighting in Japan. This indicates that the patients with recovered optic neuritis may have visual fatigue in their daily vision. In fact these patients complain of visual fatigue under ordinary illumination and sometimes reduce the illumination while reading or writing. After being prescribed tinted lenses to eliminate the fatigue the patients have a comfortable, sustained vision in their daily work. We therefore recommend examining the fatigue phenomenon and prescribing suitable tinted lenses for patients with recovered optic neuritis.

Table 1 Clinical details of 6 cases which have the fatigue phenomenon of the grating acuity in 250 cd/m². The attenuation ratio of the grating acuity is $(VA_1 - VA_5)/VA_1$ where VA_1 is the initial and VA_5 the final acuity after 5 minutes' measurement of the fatigue phenomenon

Case	Age	Sex	Corrected visual acuity	Diagnosis	Fatigue phenomenon of grating visual acuity			Prescribed tinted lens (TLT %)	Complaint
					Initial visual acuity (V_1)	Final visual acuity (V_5)	Attenuation Ratio (%)		
1	29	F	VD=1.2	R optic neuritis	0.96	0.58	39.6	20	Disappeared
			VS=1.2		1.06	1.03	2.8	20	
2	49	M	VD=1.0	R optic neuritis	0.90	0.72	20.0	45	Disappeared
			VS=1.2		1.20	1.20	0.0	45	
3	30	M	VD=1.2	L optic neuritis	1.05	1.04	1.0	55	Improved
			VS=1.0		1.06	0.59	44.3	55	
4	38	F	VD=1.2	R optic neuritis	1.04	0.77	26.0	45	Improved
			VS=1.0		1.08	1.06	1.9	45	
5	46	M	VD=0.7	R optic neuritis	0.66	0.38	42.4	20	Disappeared
			VS=1.0		1.21	1.20	0.8	20	
6	22	M	VD=1.5	R optic neuritis	0.95	0.46	48.4	45	Improved
			VS=1.5		1.25	1.19	4.8	45	

TLT=total light transmission.

Fig. 4 The results of the fatigue phenomenon in case 1 with or without tinted lenses. Open circles indicate unaffected eyes and closed circles affected eyes.

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