

Short-term effect of slit-lamp illumination and argon laser light on visual function of diabetic and non-diabetic subjects

I. M. GHAFOUR,¹ W. S. FOULDS,¹ AND D. ALLAN²

From the ¹Tennent Institute of Ophthalmology, University of Glasgow, Western Infirmary, Glasgow G11 6NT, and the ²West of Scotland Health Boards, Department of Clinical Physics and Bio-Engineering, 11 West Graham Street, Glasgow G4 9LF

SUMMARY Visual acuity, colour vision, and contrast sensitivity of diabetic and non-diabetic subjects were measured before, 20 minutes after, and 24 hours after exposure to slit-lamp illumination either alone or during argon laser photocoagulation. In some instances a significant deterioration of these visual functions was noted when the tests were repeated 20 minutes after light exposure, but by 24 hours after light exposure visual function of all groups had returned to pre-exposure levels. The visual acuity was the most systematically affected by the procedure; there were wide interindividual differences in the changes observed in the other tests.

Many reports have highlighted the damaging effect of light on the structure of animal and human retinae.¹⁻¹⁰ In particular, it has been suggested that prolonged exposure to light from diagnostic instruments such as binocular indirect ophthalmoscopes,^{2,6} operating microscopes,⁷ and slit-lamp microscopes^{7,10} may have a deleterious effect on retinal structure and function. A deterioration of visual acuity of 1 to 5 lines after extensive photocoagulation therapy in some patients with diabetic retinopathy,¹¹⁻¹³ deterioration of colour vision 12 months after photocoagulation,¹⁴ and changes in dark adaptation and electrophysiology have also been reported.¹⁵ By contrast other investigators have reported an improvement of visual acuity and colour vision.^{16,17}

This paper reports a study carried out to determine the short-term effects of exposure to tungsten light from a slit-lamp microscope, either alone or combined with argon laser photocoagulation, on the visual acuity, contrast sensitivity, and colour vision of diabetic and non-diabetic subjects.

Subjects and methods

Three groups of individuals were involved in this study: (A) 24 normal subjects examined on the slit-

lamp microscope for 20 minutes; (B) 30 diabetics also examined on the slit-lamp for 20 minutes; (C) 24 diabetics tested before and after receiving laser treatment for proliferative diabetic retinopathy.

During the 20 minutes that the individuals in groups A and B were subject to the light of the tungsten source of the slit-lamp the light was projected on to different areas of the retina through a Goldmann 3-mirror contact lens. Subjects in group C were exposed to both slit-lamp light and the blue-green light of the argon laser during the course of a pan-retinal photocoagulation session lasting typically 20 minutes. Five hundred to 1000 burns 500 μm diameter were given at this session and all the laser burns were placed in the peripheral, non-macular retina. Topical cyclopentolate was used for mydriasis in all 3 groups.

The same slit-lamp was used for all 3 groups. The lamp intensity control was set to the same fixed stop on every occasion and the resulting retinal illuminance was approximately 170 mW cm^{-2} .

Visual acuity was measured on a Snellen test chart with a stenopaic aperture. Colour vision was tested by the Farnsworth-Munsell 100-hue test¹⁸ in standard artificial daylight (Hubble 'VeriVide' cabinet). Contrast sensitivity was tested with plates 2 to 7 of the Arden grating test¹⁹ under the same standard lighting conditions.

For colour vision and contrast sensitivity testing a

Table 1 Allocation of subjects to the 3 visual function tests and actual or simulated treatment

	Normals, slit-lamp only	Diabetics, slit-lamp only	Diabetics, laser
Visual acuity	6	8	7
100-hue test	10	14	8
Arden grating test	8	8	9
Totals	24	30	24

+3.00 DS lens in a trial frame or clipped to the subject's own glasses was used to counteract the accommodative paralysis induced by the cycloplegic drops.

Each individual performed one test of visual function; some of each group performed the visual acuity test, some the 100-hue test, and some the Arden grating test. Table 1 shows the numbers from each group performing each visual test.

An initial test was performed before exposure to light and repeated 20 minutes after the end of the slit-lamp examination or argon laser session. A further test was performed 24 hours later.

All statistical comparisons were made by the sign test, a non-parametric paired procedure. Significance levels are given for a 2-tailed test.

Results

VISUAL ACUITY

Six normal subjects exposed to slit-lamp illumination were tested. One person had an initial acuity of 6/5

and the others could all see 6/6. The test 20 minutes after exposure revealed drops in acuity of between 0 and 5 lines on the Snellen chart (Fig. 1a), with a mean drop of 1.8 lines. These changes in acuity were not statistically significantly different from zero ($0.05 < p < 0.1$). By 24 hours after exposure each subject's acuity had returned to its original level.

The diabetics exposed to slit-lamp light had initial acuities ranging from only 6/6 down to 6/24. They experienced deteriorations of acuity of 0 to 3 lines, mean 1.5 lines. This change was significant ($0.01 < p < 0.02$). Again there was recovery over the 24 hours following examination, 8 out of 11 individuals regaining their initial acuity and the other 3 making a less complete recovery to be 1 line poorer (2 subjects) or remaining at the 20-minute level of 1 line poorer (1 subject) than the initial acuity. For the group these residual differences after 24 hours were not significant. ($p > 0.2$). These data are summarised in Fig. 1b.

The diabetics who actually received laser treatment also showed a significant deterioration at the 20-minute test ($0.02 < p < 0.05$) with individual acuity reductions of 0 to 2 lines. After 24 hours 4 of the 7 patients had regained their initial acuity, while the other 3 remained 1 line poorer, 2 of these showing no change from the 20-minute testing and the third improving by reducing his deficit from 2 lines at 20 minutes to 1 line at 24 hours. Again the final acuities of these diabetics were, as a group, not significantly different from their initial values ($p > 0.2$). These changes are shown in Fig. 1c.

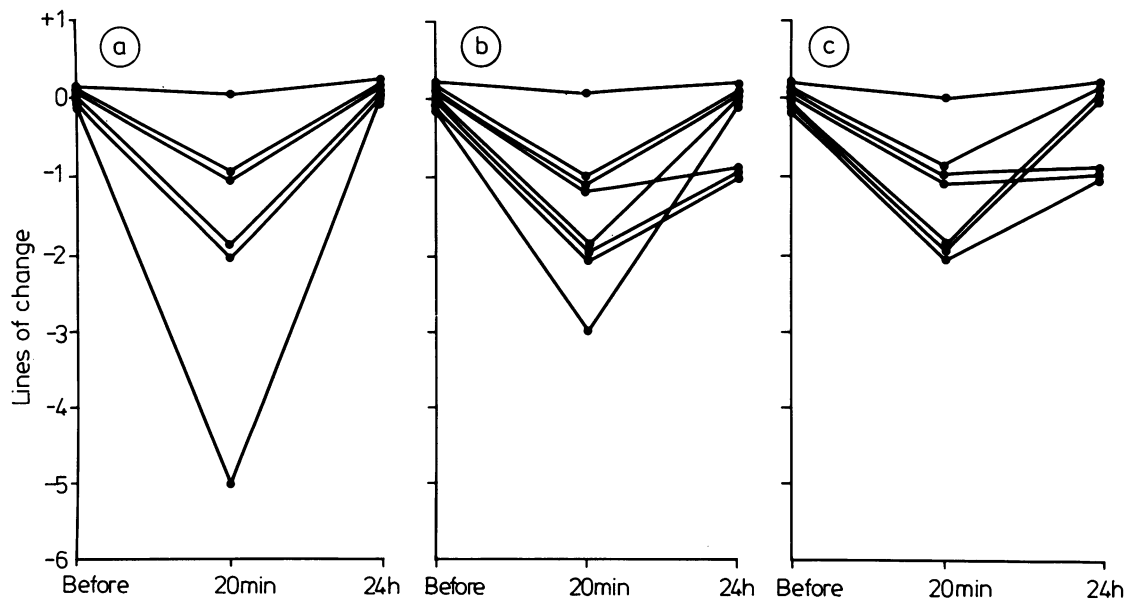


Fig. 1 Numbers of lines change in Snellen acuity for (a) normals, slit-lamp only, (b) diabetics, slit-lamp only, and (c) diabetics, slit-lamp and laser, at 20 minutes and 24 hours after exposure. Deterioration of vision is shown as a negative figure.

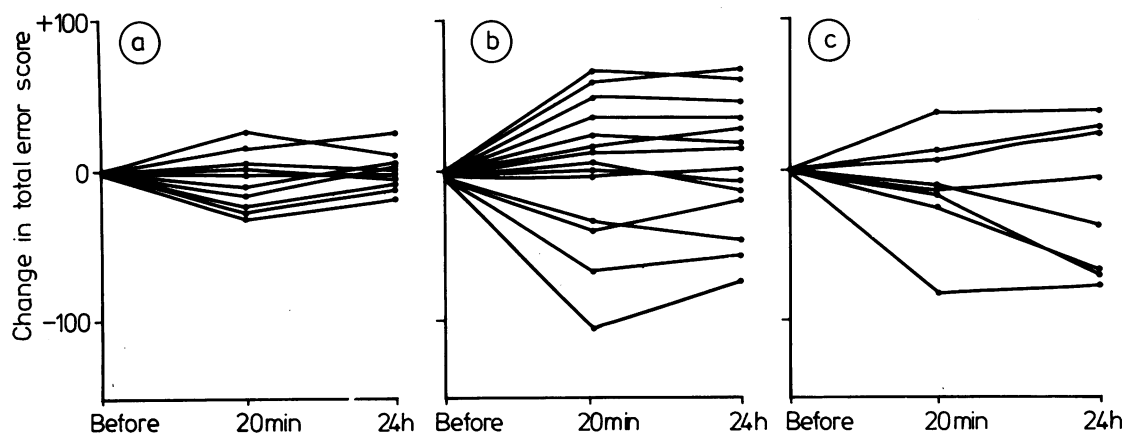


Fig. 2 Changes in 100-hue test total error scores for groups as Fig. 1. Deterioration of colour vision (increasing error score) is shown as a negative figure.

COLOUR VISION

The changes in colour vision as assessed by the total error score on the 100-hue test were rather more variable than the Snellen acuity figures. Both sizeable improvements and deteriorations were recorded for individual subjects (Figs. 2a-c). For example, normal subjects showed changes after 24 hours ranging from an improvement of 22 to a deterioration of 20 in total error scores of around 100. The diabetics showed even wider variations, as much as 60 to 70 in either direction after 24 hours.

Statistical comparisons revealed no significant changes from the initial values for any of the 3 groups of subjects at either 20 minutes or 24 hours after exposure ($p > 0.5$ for the groups at all times).

CONTRAST SENSITIVITY

The changes in contrast sensitivity thresholds also covered a range from improvement to deterioration.

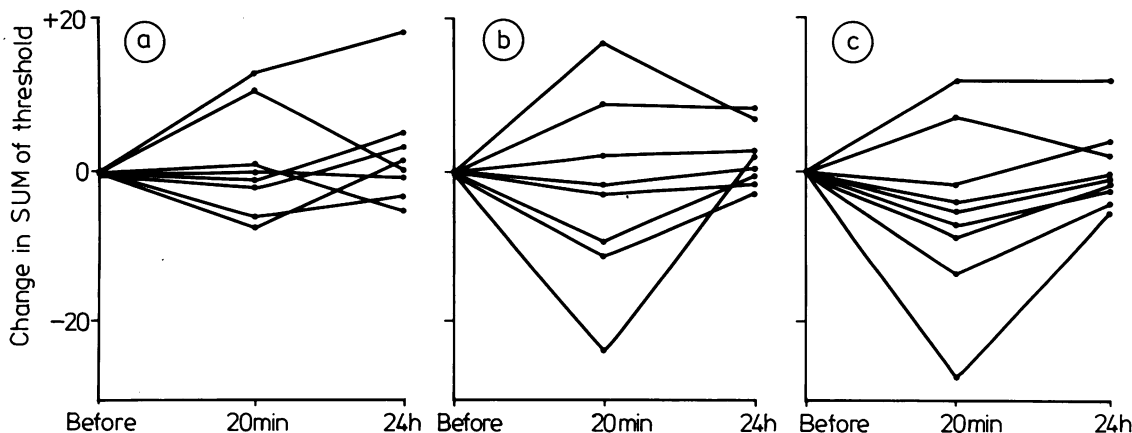


Fig. 3 Changes in sums of contrast thresholds from Arden grating test for groups as in Fig. 1. Deterioration of contrast threshold is shown as a negative figure.

Instead of the tedious presentation of data for each plate of the grating test, the results are summarised in Figs. 3a-c, where the changes in the sum of the thresholds for the 6 plates for each subject are shown graphically.

There was only one significant change in measured threshold. Patients in group C (lasered group) when tested on plate 3 showed a significant increase in threshold at the 20-minute retest as compared with the pre-exposure threshold for this plate ($0.01 < p < 0.02$). All other tests at 20 minutes and 24 hours after light exposure showed no differences when compared with the pre-exposure measurements ($p > 0.1$ in all cases except group A plate 5, when $0.05 < p < 0.1$).

Discussion

The diabetic subjects, particularly those with proliferative retinopathy, had generally poorer visual

acuity, colour vision, and contrast sensitivity than the normal subjects. More detailed studies of contrast sensitivity^{20,21} and colour vision^{22,23} in diabetics have been reported elsewhere. However, in the present work it is the changes in visual function over the test period rather than the actual levels of visual performance which are of primary interest.

While it is clear that after 3-mirror examination on a slit-lamp microscope the occasional individual may experience a considerable loss of acuity temporarily (e.g., the normal subject who was 5 lines poorer 20 minutes after exposure), the change is of short duration in most cases, and recovery is complete within 24 hours. Of the 21 from all groups whose visual acuity was tested 15 had regained their original acuity within 24 hours, and the other 6 remained 1 line poorer.

This pattern is consistent with clinical experience, since seldom does a patient return to report a marked change in visual performance which can be attributed to the effects of illumination during examination or treatment.

A possible alternative explanation for the drop in acuity at 20 minutes after light exposure is a change in corneal refraction induced by the contact lens. As all acuities were measured with a stenopaic aperture, a temporary corneal disturbance is an unlikely explanation for the findings.

The individual results of the contrast sensitivity and colour vision tests showed considerable variations in some cases. Any systematic effect that intense illumination might have on these measures of visual function is evidently more subtle than can be detected with the numbers of subjects in our study. Perhaps the point which is best demonstrated by these results is that there is a significant 'noise' level in tests such as the Arden grating test and the 100-hue test which superimposes random variations on any real change in visual performance and makes these changes hard to detect.

The general level of light exposure of the subjects' retinae in our study is clearly typical of that received by patients in the clinic, and outside the operating theatre a patient's retina is unlikely to be exposed to such bright light for longer. In experiments where histopathological damage to the retina has been induced the exposure times and intensities have been much more severe.^{24,9} In addition the rhesus monkey has been used in many of these experiments, and there are known factors which make difficult a meaningful extrapolation to the human clinical situation.²⁴

It appears that scattered light from the actual laser treatment has no dramatic effect on visual performance in the short term. There is no marked difference between the changes seen in the diabetics who

received laser photocoagulation and those who did not. This is perhaps not unexpected, since the macula was avoided during photocoagulation, and all the tests of visual function employed give considerable weight to macular performance.

Our study leads us to conclude that, while the normal panretinal laser photocoagulation procedure, with its associated exposure to slit-lamp illumination, generally leads to a transitory deterioration of vision, recovery is rapid. Such residual deficiencies as remain in individual cases at 24 hours after exposure are slight and are certainly far short of outweighing the longer term benefits likely to ensue from appropriate laser treatment.

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