Retinal function in Swedish ophthalmologists using argon lasers as reflected in colour contrast sensitivity. Normal thresholds in the great majority of the cases.

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ABSTRACT.

Purpose: To map the colour contrast sensitivity (CCS) and possible elevations of colour contrast thresholds in Swedish ophthalmologists operating argon lasers. Material and methods: CCS was measured by a computer and colour monitor system developed by Arden and co-workers. CCS of 58 Swedish ophthalmologists, all users of argon laser, was compared to 26 age-matched controls. The ophthalmologists provided information on their professional use of lasers, whether the laser was equipped with a blue-absorbing filter, and the length of time spent in retinal surgery. Results: There was no significant difference in colour vision comparing laser-users to controls (p<0.2). However, eight subjects showed elevated tritan thresholds (>1 SD above mean), in three of the cases an elevation >2 SD above mean. All these colleagues had an extensive exposure to blue-green laser and/ or a long time spent operating. Compared to others, they had performed more laser sessions prior to the lasers being equipped with protecting filters (p<0.01). Conclusion: Normal thresholds were found in a majority of the cases and no permanent impairment of retinal function was observed among these ophthalmologists. However, the laser-users with the greatest number of sessions seemed to show a certain decrease in retinal function as reflected in tritan thresholds.

Key words: colour contrast sensitivity – argon laser operators – ophthalmologists.

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Previous studies have shown that the use of argon lasers may cause a decrease in tritan colour contrast sensitivity in the operating ophthalmologist (Arden et al. 1988). After treatment sessions using argon blue-green laser, an elevation of the tritan threshold was observed which lasted for several hours (Gündüz & Arden 1989). This acute change in sensitivity was obviously due to “flash-backs” from the aiming beam, reflected from the surface of the contact lens, and occurred only at high intensity of the aiming beam and at shorter wavelengths (argon blue-green). In addition, a chronic reduction in tritan colour contrast sensitivity was found to occur (Berninger et al. 1989). To confirm these findings, a larger survey was performed, where 211 ophthalmologists were tested during the 1990 Essen Meeting of the German Ophthalmological Society. It was found that about one-third of the laser users had tritan colour contrast thresholds elevated >2 standard deviations (SD) above the mean threshold of the non-users (Arden et al. 1991). A relationship between the number of patients treated and the loss of tritan colour contrast sensitivity was found. In a subsequent study of UK ophthalmologists, an improvement was found in colour contrast thresholds, probably as a consequence of improvements in safety measures (Arden & Hall 1995).

In order to investigate the condition of the Swedish ophthalmologists, we performed a study determining the colour contrast sensitivity among colleagues using argon lasers and, in some cases also operating microscopes.

Material and Methods

Subjects

A number of ophthalmologists from the southern part of Sweden, experienced in laser treatment of diabetic patients and in some cases also engaged in retinal surgery, were invited to participate in the study that took place during a regional meeting. A letter was sent to the head of each Department of Ophthalmology in the area, asking him/her to inform the
members of his/her staff about the study and the possibility of participating. Fifty-eight ophthalmologists volunteered (25 women and 33 men). About half of them were tested during the meeting, and the others the following year. The mean age of the participants was 45.7±6.3 (SD) years, range 30–57 years.

The control group consisted of 26 healthy volunteers with no experience of lasers or operating microscopes. Mean age was 43.6 (±12.8), range 19–59 years. There was no significant difference in age (p=0.3) between the two groups.

**Questionnaires**

The participants were asked to fill in a questionnaire prior to testing, in order to obtain information about exposure to laser light, whether the laser was equipped with a protecting filter or not, and the additional use of operating microscopes. Furthermore, inquiries were made about the general health and eye condition of the participants. To elucidate the exposure to laser light in more detail, an additional inquiry was sent to the participants asking them to specify the number of laser sessions. In addition, we asked them to estimate the proportion of laser sessions before and after the laser was provided with a protecting filter, if any.

**Colour contrast sensitivity testing**

Colour contrast sensitivity was measured with a system earlier described (Arden et al. 1988), with some modifications, as reported earlier (Frennesson et al. 1995). Briefly, protan, deutan and tritan colour axes were tested using a system based on a 25 MHz Intel 80386 DX computer, a 21’’ colour monitor (0.28 dot pitch, NEC MultiSync 6 FG) and a TSL graphics card. At the resolution we used (960×760 pixels), the refresh rate was 90 Hz.

For each person, only one eye was tested. A heterochromatic flicker brightness match was performed prior to testing by each participant to assess the relative spectral sensitivity of the person concerned. The apparatus then automatically adjusts its output according to the individual variations becoming evident. All colours in the subsequent colour contrast test were equiluminous for each individual. The stimulus used consisted of one out of nine letters of standard optotype. One letter at a time was presented in the centre of the screen. The viewing distance was 1 metre and the letter subtended a visual angle of 3°.

The letter appeared for 200 ms every second and flickered between the two extremes of the colour confusion line for the protan, the deutan and the tritan axis, respectively. Colour contrast was defined as 0% when the letter had the same hue as the background and 100% when the difference in colour between the letter and the background was at its maximum achievable by the colour monitor. The colour contrast threshold was determined to the minimum percentage colour contrast required for identification of the letter. The thresholds were determined to within ±0.3%, which is the limit of the system.

**Statistical analyses**

Statistical analyses were carried out by using Student’s t-test. We also used the non-parametric Mann-Whitney rank sum test. However, since the results were similar to those of the t-test, we only report the latter.

The study was approved by the Ethics Committee of Linköping University.

**Results**

The subjects had a corrected visual acuity ranging from 0.9 to 1.5. None of the subjects reported any systemic disease such as diabetes or systemic hypertension, or any eye disease (see below, Discussion).

**Exclusions**

Three male ophthalmologists stated that they had a congenital colour vision defect. They all showed elevated thresholds for the protan and the deutan axes, and one of them for the tritan axis as well. All were excluded from further calculations. In addition to these three subjects with known colour deficiencies, one male colleague with moderate laser experience (less than 1000 sessions) was found to have elevated thresholds for protan and deutan (13.21 and 18.40, respectively) but normal tritan colour vision sensitivity. Such a finding may reflect a mild colour anomaly and therefore this subject was also excluded. Mean age of the remaining 54 subjects was 45.3 (±6.3), range 30–57 years.

**Colour contrast sensitivity**

There were no significant differences in colour vision between the laser-users and the controls in any of the three colour axes (Table 1). Comparing the laser-users with the controls, five of the laser-users showed decreased tritan sensitivity (>1 SD above normal), but none more than 2 SD above normal. However, within the group of laser-users, eight individuals showed elevated tritan thresholds (>1 SD above mean) and of these, three subjects had tritan thresholds of >2 SD above mean. These three individuals differ significantly (p<0.001) from the remaining 46 subjects. To rule out the effect of age, which has been shown to be very small (Arden & Hall 1995), the age of the “outliers” was compared to the age of the other laser-users. There was no significant difference (p=0.8). Of these laser-users, all but one had an extensive exposure to blue-green argon laser (>4000–5000 laser sessions), or had spent a long time in retinal surgery. Compared to the rest of the laser-users, these eight colleagues had performed significantly more laser sessions before the lasers were equipped with bluelight-absorbing filters (p<0.01). The exception was a young male colleague with about two years’ experience of laser treatment (less than 100 sessions). He used argon blue-green light (Laser Tek from 1985). The laser was stated to have a permanent bluelight-absorbing filter and a green aiming beam.

<table>
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<tr>
<th>Table 1. Colour contrast thresholds in all colour axes (±SD). Laser-users compared to controls, after exclusions.</th>
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<tbody>
<tr>
<td><strong>Laser-users</strong></td>
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<td>Proportion</td>
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Discussion

We could not confirm earlier reports of a decrease in tritan sensitivity in a fairly high percentage of ophthalmologists using argon lasers (Arden et al. 1991). Compared to normals, none of the subjects showed tritan thresholds which exceeded 2 SD. Of the laser-users, only three showed tritan thresholds of >2 SD above mean. They had in common an extensive exposure to blue-green laser and/or a long time spent in retinal surgery. Thirty hours’ use of the operating microscope has earlier been estimated to give an elevation in tritan threshold equivalent to one panretinal photocoagulation (Arden et al. 1991). In agreement with the UK survey (Arden & Hall 1995), we found normal tritan thresholds in the great majority of the cases. Our study was performed at a time when precautions were already being taken to minimize the risk of damage due to short-wavelength light. The lasers mostly used are now equipped with bluelight-absorbing filters or a helium-neon laser aiming beam. However, the operating microscope filters, which have now been available for five years, seem to have been used by a very limited number of surgeons due to their discoloration of the fundus picture.

None of the subjects was reported to suffer from diabetes or systemic hypertension. Several previous studies report the occurrence of elevated tritan thresholds in diabetes, also before the development of serious retinopathy (Arden et al. 1988, Arden et al. 1991, Treagear et al. 1993). There are also indications that patients suffering from systemic hypertension without retinopathy show decreased tritan sensitivity (Arden & Hall 1995).

Furthermore, it is known that eye diseases such as drusen maculopathy (Frennesson et al. 1995, Holz et al. 1995), ocular hypertension and glaucoma (Yu et al. 1991, Fristerm 1997) cause an elevation of tritan thresholds. No such diseases, however, were reported among the subjects.

In conclusion, normal tritan thresholds were found in the very great majority of the cases and no permanent impairment of retinal function was observed among these ophthalmologists. However, those ophthalmologists with the greatest number of sessions using argon laser or operating microscope seemed to show a certain decrease in retinal function as reflected in tritan thresholds, in spite of the use of filters during recent years.

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References


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