Color Vision in Patients with Acute Optic Neuritis

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Introduction. Optic neuritis is characterized by painful, usually monocular, visual loss with decreased visual acuity, defects of the visual field and color vision, and it may occur in up to two-thirds of individuals suffering from multiple sclerosis at some point in the course of their disease [1-4]. MS is more common among young and middle aged individuals [5-7]. The average onset of the disease is at 30 years of age, and it affects women more often than men (a ratio of approximately 2:1) [8, 9]. ON mostly occurs in persons under 50 years old [10-12] and ratio of females to males is 3.5:1 [13]. The most important factor is probably the loss of signal transmission in some axons due to a conduction block or ganglion cell death [14]. It is likely due to some inflammatory process which leads to delayed type IV hypersensitivity reaction induced by released cytokines and other inflammatory mediators from activated peripheral T-cells which can cross the blood brain barrier and cause destruction of myelin, neural cell death and axonal degeneration [15].

One of the earliest symptoms of optic nerve disc damage in visual processing is an impairment of normal color vision. It is also well recognized that ON can lead to color-vision deficits. Köllner H suggest that optic nerve disease leads to a preferential loss of red-green color vision [16]. Mullen et al. suggested that blue-yellow defects are more common color blindness type, or both type of color deficits are equally affected [17].

We assessed color contrast sensitivity in persons with acute optic neuritis.

Materials and methods of the study. Permission to undertake the study was obtained from the Ethics Committee for Biomedical Research.

The inclusion criteria for subjects were as follows: 1) Patients with an acute ON episode; 2) Participation consent.

The inclusion criteria for healthy patients were as follows: 1) No ophthalmological eye disorders were found on detail ophthalmological evaluation; 2) Participation consent.

In this research the visual acuity as well as the transparency of the cornea and lens, and the fundus was investigated in patients. Biomicroscopy was performed in order to assess the corneal and lenticular transparency. Non-
corrected and the best-corrected visual acuity (measured in decimals from 0.1 to 1.0) was evaluated using Landolt’s rings.

In the computer test of maximum colour contrast sensitivity the task of the subject is to determine the correct direction of a bar in a circle. The luminance of the grey background of the monitor was 350 cd/m². The luminance of the surrounding area was 400 cd/m². A subject has to press a button with a bar matching the direction of the bar in the circle. If the direction is unclear, a blank button is pressed. After each pressing of the button a blank screen appears and then, after one second, a circle with a randomly chosen direction of bars is shown. If the direction of the bar in the circle is chosen incorrectly, its color is automatically highlighted. After the correct choice of the direction of the bar, the intensity of its color is automatically dulled, and in the presence of this chromatic contrast of the bar the brightness of background of the circle is changed. The first correct answer after a series of incorrect answers or the first incorrect answer after a series of correct answers is accepted as subject’s maximum sensitivity to the target color of the bar. When a subject’s maximum sensitivity to the target color of the bar has been assessed, the color of the bar is changed, and everything starts from the beginning again. The bar can be of six colors: red, green, blue, greenish blue, violet and yellow. Once a subject’s sensitivity to all these colors has been assessed, all findings are recorded in a database, and the results of the test are presented in a result window. Color contrast sensitivity tests were performed in the case of the best-corrected visual acuity. The total error score (TES) for the hue test was determined.

The sensitivity of colors may be very high, i.e. the number of mistakes is up to 1.0; or normal average, i.e. the number of mistakes ≤ 2.0; or disturbed, i.e. the number of mistakes is more than 2.0.

Statistical analysis was performed using the computer program SPSS / W 13.0 (Social sciences statistical package program for Windows, Inc., Chicago, Illinois, USA). The TES was normally distributed (Kolmogorov-Smirnov $z = 1.19, p = 0.12$); therefore, parametric test (Student's t test) was used when assessing this variable. Statistically significant difference was considered if $p < 0.05$.

**Results.** The control group (Group 1) consisted of 120 (239 eyes) healthy persons (34 men and 86 women). The study group (Group 2) included 32 individual (64 eyes) with ON (10 men and 22 women). (Table 1).

**Table 1.** Demographic characteristics of the study population

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (Group I) n=120</td>
<td></td>
</tr>
<tr>
<td>Men, n (%)</td>
<td>34 (28)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Age±SD</td>
<td>40.0±11.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optic neuritis (Group II) n=32</td>
<td></td>
</tr>
<tr>
<td>Men, n (%)</td>
<td>10 (31)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Age±SD</td>
<td>39.4±11.1</td>
<td></td>
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</tbody>
</table>
Visual acuity was affected in 59.4% of patients with optic neuritis. The results of the study showed that visual acuity in the control group were significantly higher than in the Group II (1.0 vs. 0.72 ± 0.29, p < 0.01). Visual acuity ranged from 0.62 to 0.83 in II group.

Maximum color contrast sensitivity was affected in our research in 81% persons with ON. The total error score (TES) of maximum color contrast sensitivity was significantly higher in patients with ON compared to the controls 1.82 ± 0.65 vs. 6.28 ± 5.42, p < 0.01. Maximum color contrast sensitivity test results ranged from 0.15 to 4.18 in the healthy patients group, and from 2.85 to 23.39 in patients with ON.

During the maximum color contrast sensitivity test Group II patients had more errors in the blue-yellow color range 65.5% of patients. While in the healthy control group 130 eyes (54.4%) made errors in the blue-yellow color, 24 eyes (10%) made errors in the red-green color, and the best color sense discrimination in healthy controls was in blue-yellow for 65 (27.2%) eyes, and red-green for 20 (8.4%). (Table 2).

Table 2. Best and worse color sense discrimination using maximum color contrast sensitivity test (MCCST) in healthy patients (I group), and in patients with optic neuritis (II group).

<table>
<thead>
<tr>
<th>Best colour sense discrimination using MCCST</th>
<th>Eyes, n (%)</th>
<th>P-value</th>
<th>Worse colour sense discrimination using MCCST</th>
<th>Eyes, n (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group</td>
<td></td>
<td></td>
<td>Group</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Red-Green colour</td>
<td>20 (8.4)</td>
<td>2 (3.1)</td>
<td>0.05</td>
<td>24 (10.0)</td>
<td>2 (3.1)</td>
</tr>
<tr>
<td>Blue - Yellow colour</td>
<td>65 (27.2)</td>
<td>18 (28.1)</td>
<td>0.05</td>
<td>130 (54.4)</td>
<td>42 (65.6)</td>
</tr>
</tbody>
</table>

Discussion. In a variety of optic nerve disc diseases, one of the earliest changes in visual processing is an impairment of normal color vision, and it is also well established that MS and ON is associated with reduced high-contrast visual acuity, deficits of contrast sensitivity, and visual fields, although the exact nature of this loss is unclear. That is why for detailed visual examination, various functions are tested, such as cognitive perception, color contrast sensitivity, health of the visual system, and the central processing function.

Therefore the purpose of this article was to assess how the presence of ON is associated with the decreasing perception of colors. The results revealed that maximum color contrast sensitivity was affected in our research in 81% of persons with ON. The Optic Neuritis Study Group1 reported that 94% of patients had abnormal color vision in the acute phase of the disease and that about 40% had residual color defects at 6 months [18]. A predominance of red-green color
Defects in ON has been reported by several investigators using combinations of the F-M 100 [19, 20], the Farnsworth Panel D-15 [21], the Hardy-Rand-Ritter pseudoisochromatic plates [20], the Bostrom Kugelberg pseudoisochromatic plates [21] the Standard pseudoisochromatic plates [20] the Nagel anomaloscope [22] and others. However literature data analysing ON effect on color vision are inconsistent. Köllner rule proved that optic nerve disease leads to a preferential loss of red-green color vision [16, 23]. Some reports have found this type of defect to be predominant in ON [24, 25]. Others suggested that blue-yellow defects are a more common color blindness type, or both type of color deficits are equally affected [17]. Travis and Thompson used the red-green (Rayleigh equation) and green-blue (Engelkin-Trendelenburg equation) Pickford-Nicolson anomaloscope in 18 patients with presumed ON and found mixed patterns of loss [26]. Some others scientists proved that blue-yellow loss was more common in the acute phase; red-green loss was more common after 6 months [27]. So we evaluated color vision in the acute phase in patients with ON, and we proved that blue-yellow color vision loss was common in patients with ON group. One other study that reported a predominance of tritan defects in ON does not detail how early in the disease the patients were examined nor whether it was the first episode of ON [28]. Another study found no relationship between ON and color blindness, and it this may be due to a limited sample size or because the only red-green color deficit was measured using the Ishihara test [29].

References


To determine colour contrast sensitivity in persons with acute optic neuritis (ON). Our study included 32 patients with acute ON and 120 healthy control subjects. Computerized maximum colour contrast sensitivity (MCSS) test was used for colour discrimination. MCCS was affected in our research in 81% of persons with ON. The total error score of MCSS was significantly higher in patients with ON compared to the controls 1.82 ± 0.65 vs. 6.28 ± 5.42, p < 0.01. Blue - yellow defects in the acute phases of the illnesses (62.9% and 65.5% of cases) were more frequent than red - green defects. Persons with ON showed significantly worse total error scores on MCSS test than the controls (p < 0.001). Blue - yellow defects were more frequently met in the acute phase of ON.