**Visual Acuity Variations under Different Contrast Conditions in Age-Related Macular Degeneration**

Patients Using Freiburg Visual Acuity Test


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**Introduction.** Age-related macular degeneration (ARMD) is progressive disease of the central retina and a major cause of blindness worldwide [1]. Visual loss from this condition is uncommon among persons under the age of 50, but its prevalence is likely to increase in absolute numbers globally as a consequence of population ageing [2].

It is very important to use diagnostic tools that can define early or preclinical stages of the disease because if untreated it can cause blindness in late stages of the disease. One common approach in assessing retinal function is measuring visual acuity (VA) [3]. Although acuity testing is simple to implement in a clinical setting, it does not give exclusive information on retinal function in early ARMD when changes in visual acuity are minimal (two letter loss or logMAR 0.04) [4]. So testing basic aspects of vision, such as color perception, contrast sensitivity, and visual adaptation, is more likely to reflect an alteration of retinal function in early ARMD [5]. Visual acuity tests by the typical Snellen chart using the Landolt rings (C optotypes) alone is insufficient because it provides limited information about the central vision and it is difficult to evaluate in patients with macular abnormalities because the reduction in acuity shows that foveal acuity is lower than peripheral acuity [6].

**Aim.** Evaluation of differences in visual acuity variations of eyes with early ARMD compared to healthy eyes under different contrast conditions using Freiburg Visual Acuity Test (FrACT).

**Methods and materials.** We performed 61 patients (97 eyes) case-control study and examined 33 eyes with early ARMD and 64 eyes without ARMD as a control group. Characteristics are presented in Table 1.

**Table 1.** The characteristics of patients with early age-related macular degeneration (ARMD) and healthy subjects included to the study.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Results</th>
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<tbody>
<tr>
<td></td>
<td>Early ARMD</td>
</tr>
<tr>
<td>Men, n (%)</td>
<td>9 (27.27%)</td>
</tr>
<tr>
<td>Women, n (%)</td>
<td>24 (72.73%)</td>
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<tr>
<td>Age, min - max (mean)</td>
<td>50-88 (68.55)</td>
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</table>
General ophthalmological examination, color fundus photography, optical coherence tomography imaging were used to evaluate ARMD and differentiate healthy eyes from early ARMD (Fig.1 and Fig.2). Best-corrected visual acuity (measured in decimals from 0.1 to 1.0) was evaluated using Landolt’s rings (C optotypes) by Snellen test types at a 5 meter distance from the chart.

![Fig. 1. Color eye fundus images of the human retina performed with OPTEK Visucam: A-healthy eye, B- early ARMD.](image1)

![Fig. 2. High-quality spectral-domain optical coherence tomography (SD OCT) images of the macula in healthy subjects (A) and in patient with early ARMD (B)](image2)

We tested visual acuity using computerized Freiburg Visual Acuity Test (FrACT version 3.9.3) with 3 different Michelson contrasts (100%, 50% and 3%). Different optotype sizes were used to evaluate differences in visual acuities with tumbling E optotype. It was presented in one out of 4 possible orientations. Patients had to choose the correct direction by commanding researcher to press the correct arrow on the keyboard (Fig. 3).

![Fig. 3. A –an example of Michelson contrasts (100%, 50%, and 3%), different optotype sizes and directions; B – possible orientations of tumbling E optotype](image3)
18 trials were set for each contrast testing eyes separately. Visual acuity variations set automatically and were evaluated using logMAR logarithmic scale in all tree contrasts separately (3%, 50% and 100%).

Statistical analysis was performed using the computer program SPSS / W 19.0 (Social sciences statistical package program for Windows, Inc., Chicago, Illinois, USA). T test and the Mann-Whitney U test were used for the comparison of the two groups. A statistically significant difference was considered if P<0.05.

**Results.** All participants were above 50 years old (from 50 to 88 years old) and best-corrected visual acuity of all participants was from 0,7 to 1,0. The mean and median visual acuity was 0,9.

We looked into 3 variations of contrasts in both groups – from 3% to 50%, from 50% to 100%, from 3% to 100% and estimated that variation of contrast between control group and early ARMD group was statistically significant from 50% to 100% (0,006±0,075 vs. 0,530±0,099, p=0,035). Contrast variations from 3% to 50% and from 3% to 100% didn’t show statistically significant difference (0,522±0,249 vs. 0,589±0,259, p=0,557; 0,516±0,231 vs. 0,536±0,244, p=0,675, respectively), even though means of these variation were higher than from 50% to 100% as showed in Fig. 4.

![Fig. 4. Means of contrast variations between both tested groups](image)

Furthermore in the variation of contrasts from 50% to 100% we found a statistical significant medium strong correlation to age in ARMD patients (Graph $y =-0,19+0.003x$, $(r = 0,4, p<0,001$). It’s graphic is showed in Fig. 5.
Conclusion. The variation of contrast between control group and early ARMD group was statistically significant from 50% to 100% (p=0.035) and it’s correlation to age supports hypothesis that age has a significant influence to visual acuity tested in different contrast conditions. Our study suggests that dependence of different contrasts to visual acuity for patients with ARMD is significantly higher than for healthy subjects and FrACT might be one of sensitive diagnostic criteria to differentiate healthy eyes from early ARMD.

References
Visual Acuity Variations under Different Contrast Conditions in Age-Related Macular Degeneration Patients Using Freiburg Visual Acuity Test
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Computerized Freiburg Visual Acuity Test (FrACT version 3.9.3) with 3 different Michelson contrasts (100%, 50% and 3%) was used to evaluate different visual acuity variations of eyes with early ARMD compared to healthy eyes. Results suggest that FrACT might be one of sensitive diagnostic criteria to differentiate healthy eyes from early ARMD as testing by the typical Snellen chart using the Landolt rings (C optotypes) alone is insufficient for the visual function testing and provides limited information about the central vision.