USAGE OF DIGITAL D CHART TEST AS A MODIFICATION OF AMSLER GRID IN OPHTHALMOLOGY AND OPTOMETRY

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The authors of the study declare that no conflict of interest exists in the compilation, theme and subsequent publication of this professional communication, and that it is not supported by any pharmaceuticals company.
This study has not been submitted for processing to any other journal or printed in any other journal.
The authors of the study further declare that in the last 24 months they have been and continue to be contractually bound employees of the Faculty of Medicine of Masaryk University in Brno or of the Department of Ophthalmology and Optometry of St. Anne's University Hospital.
The study originated within the framework of the project for specific research of the university chancellor MUNI/A/0809/2019.

Received: 8 June 2020
Accepted: 27 July 2020
Available on-line: 1 November 2020

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SUMMARY

Aims: Metamorphopsia is important symptom of macular disease. The most common simple detection method of metamorphopsia is Amsler grid. Usually it is used monocularly with best correction for near. Patient should evaluate grid deformation and describe position of the deformity. This method is based on qualitative principle. For quantitative evaluation we can use Software D Chart (Thomson Software Solution). This instrument enables evaluate degree and position of the metamorphopsia in central visual field. Our goal was to establish M-score values in group of young healthy subjects without correction (M-score natural), with cylindrical spectacle lens (M-score SL) and in group of patients with age related degeneration (M-score ARMD).
Objects and Methods: We had 33 probands divided into 2 samples. The first sample contains 15 young probands with average age 23 years without any eye pathology. The second sample contains 18 patients with ARMD (7 with dry form and 11 with wet form). In our study we used software D Chart (Thomson Software Solution). This software was use in Acer PC with touchable screen. We note total M-score in right eye of all probands. Level for statistic evaluation was set on $p = 0.05$.
Results: Natural M-score values for young probands was: median 0, minimum 0, maximum 2.3. With cylindrical lens we got these values: median 25.2, minimum 3.6, maximum 41.6. In second sample with probands suffer from ARMD we got these values: median 0.8, minimum 0, maximum 29.4. Wilcoxon non-parametric test was used for statistical evaluation. We proved statistically significant difference between all variables. M-score natural vs. M-score SL showed $p < 0.001$, M-score natural vs. M-score ARMD showed $p = 0.04$ and M-score SL vs. M-score ARMD showed $p < 0.001$.
Conclusion: Our study showed statistically significant differences between variable M-score natural, M-score SL and M-score ARMD. We found that printed Amsler grid as well as its digital modification D Chart are suitable for determining metamorphopsia in central visual field. The main advantage of D Chart is quantitative evaluation of the test with M-score and digital registration of retinal changes during patient´s follow up.
Key words: D Chart, M-score, Amsler grid, ARMD, spectacle correction, cylinder

Čes. a slov. Oftal., 76, 2020, No. 4, p 160–164

INTRODUCTION

D Chart software (Thomson Software Solutions) is a tool for evaluating the degree and position of metamorphopsia in the central visual field. Its authors are considered to be Velichko Manahilov and Niall Strang from the Department of Vision Science at Glasgow Caledonian University, and David Yorston and Gerry McGowan from Gartnavel General Hospital [1].

Metamorphopsia is an important symptom of macular pathology. The most frequent method of detecting metamorphopsia is the Amsler grid [2,3]. The Amsler grid is used monocularly with best corrected near vision. The patient's task is to evaluate deformation of

the grid from a regular reading distance, and describe the position of the deformation. This is primarily a qualitative assessment of the grid image. For a record of the examination it is recommended that the patient draws an image of the grid as he or she perceives it. We may then compare records from the individual examinations at subsequent follow-up examinations.

We can trace the development of computer aided quantification methods for examination of metamorphopsia of the eye from the year 1989. The first digital tests of this type contained circles of various size with a central fixation point for examining the visual field within the range of 10°. The patient's task was to use a computer mouse to adjust the shape of the circle in accordance with his or her visual perception. This test was suitable primarily for evaluation of already developed and severe forms of metamorphopsia [4].

Another version of the test for quantification of metamorphopsia appeared in 1999, named M-Charts, and was used in a study for evaluating the degree of metamorphopsia upon a background of idiopathic epiretinal membrane [4]. In principle the test used lines formed by individual points at various distances (from 0.2° to 2°) with a central fixation point. The patient's task was to evaluate whether these lines were warped. During the course of the test, the computer program presented lines with increasing distances between points and in various angles (from 0° horizontally to 90° vertically according to a TABO-schema). At the end of the test the metamorphopsia score was determined, based on the "visual angle". This represented the distance between the points on the presented lines in which the patient considered the line to be straight. If the patient therefore saw a horizontal line as straight with a distance between the points of 0.6°, the patient's metamorphopsia score was 0.6.

The M-Charts test was not suitable for patients with low visual acuity (< 6/20) and extensive paracentral scotoma. The test was proven to be effective for evaluating wet form age-related macular degeneration [5,6].

Precise mapping of metamorphopsia and measurement of its severity is important also for patients with full thickness macular hole (FTMH) or epiretinal membrane (ERM). It has been demonstrated that following vitrectomy, removal of the internal limiting membrane and ERM brings about an improvement of visual functions without an improvement of central visual acuity.

Quantification of metamorphopsia may therefore help in the evaluation of a patient's visual functions, as well as in the selection of a suitable patient for surgery. This led the authors to develop the test known as the D Chart, which can be used before and after surgery on patients with low visual acuity in order to evaluate their metamorphopsia [7]. In the original version the test was in the form of paper cards. On the cards were printed rings, formed by small test squares around a central fixation point. The rings were of various radii. The distance between the individual squares placed within the regular grid was 0.4° to 1.8°. The patient's task was to designate the place where the grid appeared deformed in each of a total of eight sectors of the ring. The sum of the maximum distance between the squares of each sector and for each size of the ring, in which the patient still saw the grid as deformed, forms the total metamorphopsia score (M-score). In a pilot study [7] a decrease of the median of the total M-score was demonstrated in patients before and after surgery from 10.2 to 0.5 in the case of macular hole and from 5.2 to 0.45 in the case of epiretinal membrane.

At present an electronic version of the D Chart test is available (Thomson Software Solutions), which can be installed on a computer and projected to the patient on the computer monitor. We have this version available at our centre (St. Anne's University Hospital, Brno). We use it primarily for observing changes in the central visual field in patients with macular pathologies (for example wet and dry form age-related macular degeneration). We also used this electronic version for the purposes of our study.

The aim of our study was to determine and compare the values of the total M-score in healthy patients without ocular pathology naturally and with spectacle correction inducing distortion of visual perception, and in patients with age-related macular degeneration (ARMD). Last but not least, the aim was also to compare the data with already existing studies.

METHOD

We had 33 subjects available for the study, who were divided into two groups. The first group comprised young individuals (15 individuals, mean age 23 years, SD 1 year) without ocular pathology. The second group consisted of patients from a macular

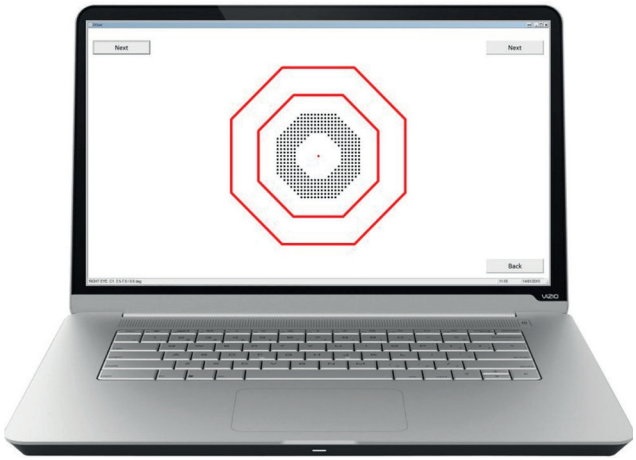


Fig. 1. Test interface upon testing of metamorphopsias in D Chart program

clinic (18 individuals), with an average age of 78 years (SD 7 years). These concerned 7 patients with dry form ARMD and 11 patients with wet form ARMD.

On all the subjects we selected only the results of testing from the right eye, with or without spectacle correction, for the analysis. The subjects from the first group were examined naturally (without correction, VA 1.0 decimally), and subsequently with a cylindrical spectacle lens (+3 D, axis of 180°), which was intended to simulate distortion of the image. Patients from the second group underwent the examination with their own correction for near vision, or without correction if they did not use it.

Software from the company Thomson Software Solutions referred to as a D Chart was used in the study. The program was recorded into a touch-screen Acer computer. The examination of each patient took place at a distance of 40 cm in front of the monitor, and the patients had their spectacle correction for near vision if they required it. A red fixation point with a size of 0.5° was located in the centre of the test field, which was in the shape of a ring composed of black squares. The entire test was composed of a total of 4 parts, in which the size of these rings was altered. The diameter of the testing ring was progressively increased (1.5 cm, 3.5 cm, 7 cm and 12 cm). The patient was called upon to fix the red point in the centre of the test field. The examination was conducted monocularly. If the patient recorded distortion of the black squares in a certain part of the test field, he/she indicated this location by touching the computer screen. The patient always reacted upon a change of size of the projected stimulus. During the course of the examination the density of the black squares and the size of the rings was altered. At the end of the examination the degree of metamorphopsia was recorded with the aid of the total M-score, which was expressed as the angle difference in the distance of the black squares, when the examined patient no longer spotted metamorphopsia. The results of the examination were recorded in a table in the program MS EXCEL, and subsequently statistically evaluated with the aid of the statistical program Statistika version 12 from STATSOFT and MedCalc. The statistical level of significance was set at p = 0.05.

RESULTS

In the subjects we recorded the total M-score for the right eye, as presented in table 1. With the aid of a normality test (Kolmogorov-Smirnov test, also graphically, see graph 1) we demonstrated the non-parametric distribution of data, and for this reason we decided to use the median and quartiles for the purposes of the descriptive statistics. We recorded the highest value of the median in the variable M-score with spectacle lens. This value represents the central value of this variable. By contrast, the lowest median was recorded in the variable M-score natural, which is what we expected.

For a statistical analysis of the differences between the non-parametric variables we used a Wilcoxon non-parametric test. We demonstrated statistically significant differences between all the variables. The calculated values are presented in table 2. The largest statistical difference was found between the variables M-score natural and M-score with spectacle lens. By contrast, the smallest statistical difference was found between the variables M-score natural and M-score ARMD. Graph 1 illustrates the differences between the variables in graphic form.

DISCUSSION

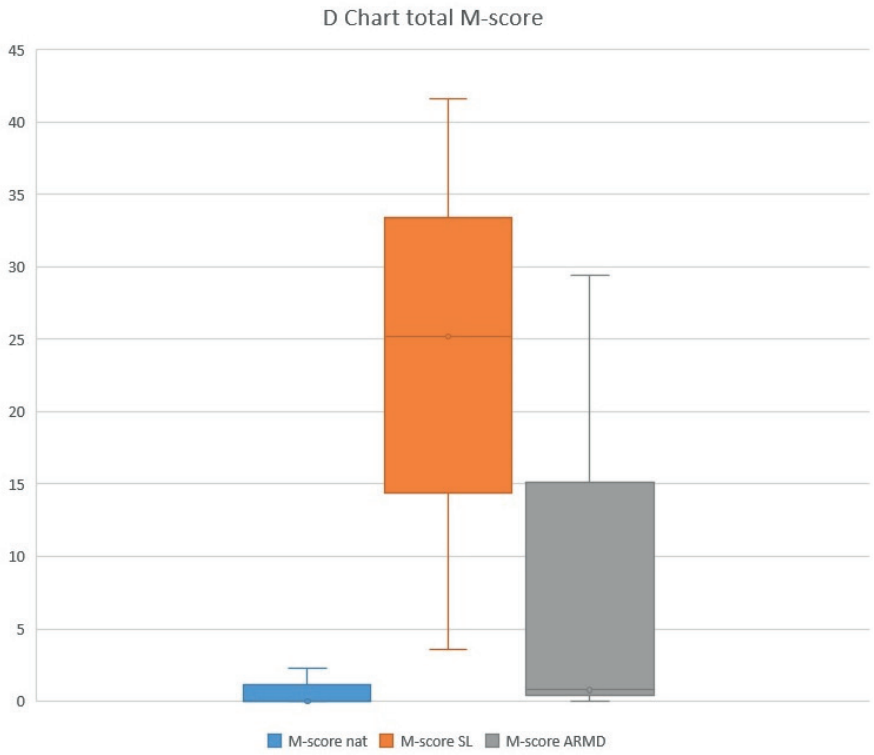
In our study we verified that the digital form of the Amsler test can be a highly effective instrument for the diagnosis and identification of metamorphoptic changes of the central visual field in patients with age-related macular degeneration, as well as in patients using high cylindrical correction.

Table 1. Median of values of total M-score for right eye (M-score nat – natural, M-score SL – with spectacle lens, M-score ARMD – in patients with ARMD)

	M-score nat	M-score SL	M-score ARMD
Median	0	25,2	0,8
Minimum	0	3,6	0
Maximum	2,3	41,6	29,4

Table 2. Statistical evaluation of variables of M-score nat, M-score SL, M-score ARMD with the aid of a Wilcoxon test (p = 0.05; M-score nat – natural, M-score SL – with spectacle lens, M-score ARMD – in patients with ARMD)

P-value	M-score nat	M-score s BC	M-score VPMD
MS nat	-	< 0,001	0,04
MS SL	< 0,001	-	< 0,001
MS VPMD	0,04	< 0,001	-



Graph 1. Box graph for variables M-score nat, M-score SL, M-score ARMD (ring inside rectangle represents median, height of rectangle expresses range of quartiles, sections delimit minimum and maximum)

Authors who used the digital version of the Amsler test for detecting pathological changes in the central visual field in patients with wet form macular degeneration [5,6], or who observed the response to the treatment of this pathology [8] recorded similar experiences.

For comparison we also state that our values of the total M-score (median M-score ARMD 0.8) overall correspond to the postoperative values from the study by McGowan [7], in which a decrease of the median of the total M-score (median) was recorded in patients before and after surgery from 10.2 to 0.5 in the case of macular hole and from 5.2 to 0.45 in the case of epiretinal membrane.

Some studies [9,10] indicate that following operations such as peeling of the epiretinal membrane, there is no subsequent improvement of visual acuity, but the patient's quality of life is improved due to the reduction of the size of metamorphopsia. This fact can be documented by the decreasing value of the total metamorphopsia score (total M-score).

Similar results were produced in a study [11] in which the authors evaluated change of metamorphopsia before and after treatment of ARMD with bevacizumab. An M-Chart with 19 vertical and horizontal point lines within a range from 0.2° to 2.0° was used here for the evaluation of metamorphopsia. It was determined that after treatment there was a reduction of the metamorphopsia score in the vertical direction in 16 patients by a mean value of 0.2°, and in 7 patients by a mean value of 0.1°. No change was recorded in 13 patients. In the horizontal direction the metamorphopsia score was reduced in 22 patients by 0.2° and in 3 patients by 0.1°. In 11 patients there was no change. In total 36 patients were tested. The median of the vertical metamorphopsia score was 0.25° before treatment and 0.2° after treatment. In the horizontal direction there was a reduction from a median of 0.3° before treatment to 0.2° after treatment. The authors of the study also did not demonstrate a statistically significant correlation between the vertical and horizontal metamorphopsia score and visual acuity of the patients (R = -0.2, or R = -0.06). Also interesting is the result of the specificity of both variants of the tests with which the authors worked in this study. This was 100 % for the digital version of the M-Charts and for the printed version of the Amsler grid.

The above-stated value of specificity of the classic Amsler grid confirms the significant screening potential of this test. We can state simply that this test does not generate false positive results, which is highly advantageous for the purposes of screening metamorphopsia. Nevertheless, from a practical perspective, the classic printed version of the Amsler test is more advantageous for use by the patients themselves, above all due to its simplicity and portability. The Amsler test can also be used for observing changes in patients with glaucoma [12].

CONCLUSION

In our study we demonstrated statistically significant differences between the variables M-score natural, M-score with spectacle lens and M-score in patients with dry and wet form ARMD. We confirmed that the digitally modified Amsler test is suitable for the diagnosis of metamorphoptic changes in the central visual field. The main advantage of the digital D Chart test is the quantitative evaluation of the test with the aid of the M-score, and registration of its changes during long-term observation of the patient.

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