NOVEL METHODS FOR THE ASSESSMENT OF VISUAL SYSTEM IN DISEASES OF THE BRAIN

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ABSTRACT

The application of principles and achievements of evidence-based medicine in clinical neurology has been expanded in recent years. The trends towards establishing early diagnosis, monitoring disease course and efficacy of treatment, as well as the feedback between theoretical, experimental neuroscience and clinical practice, have increased the significance of visual system assessment in brain disease. In numerous cases, functional state in diseases with or without proven structural lesions may be defined more accurately by new neuroophthalmological methods, which have found their application in clinical practice. At the Ist Clinic of neurology, Sveta Marina hospital - Varna, contemporary neuroophthalmological methods have been applied for the diagnosis of multiple sclerosis, Parkinson's disease, dementia, brain tumors, cerebrovascular disease. In the current publication we have presented: a method for detecting subjective visual dysfunction, related to quality of life, by means of the VFQ-25 questionnaire; a psychophysical method for visual assessment of alternating luminous areas (VAALA); evaluation of spatial contrast sensitivity (CS) by a computerized test and assessment of low-contrast visual acuity by modified number charts at 3% and 1.5 % contrast level. The necessity to recognize modern methods for assessment of visual system and the prospect for their integration into practice has been discussed.

Keywords: neuroophthalmological diagnostics, diseases of the brain

The application of principles and achievements of evidence-based medicine in clinical neurology has been expanded in recent years. The trends towards establishing early diagnosis, monitoring disease course and efficacy of treatment, as well as the feedback between theoretical, experimental neuroscience and clinical practice, have increased the significance of visual system assessment in brain disease. In numerous cases, functional state in diseases with or without proven structural lesions may be defined more accurately by new neuroophthalmological methods, which have found their application in clinical practice (3,7,8,17).

At the Ist Clinic of neurology, Sveta Marina hospital - Varna, contemporary neuroophthalmological methods have been applied for the diagnosis of multiple sclerosis, Parkinson's disease, dementia, brain tumors, cerebrovascular disease. In the current publication we have presented: a method for detecting subjective visual dysfunction, related to quality of life, by means of the VFQ-25 questionnaire; a psychophysical method for visual assessment of alternating luminous areas (VAALA); evaluation of spatial contrast sensitivity (CS) by a

computerized test and assessment of low-contrast visual acuity by modified number charts at 3% and 1.5 % contrast level (2,4,12,15,16).

Visual function and subjective visual disturbances in particular, represent an important aspect of quality of life of patients with diseases of CNS. The 51-NEI-VFQ questionnaire for assessment of visual function, elaborated by the US National Eye Institute, as well as its abridged form, VFQ-25, enrich the information from the assessment of subjective visual dysfunction related to quality of life in patients with neurological diseases (5,10,11). For the first time in Bulgaria, at the Ist Clinic of neurology, an official translation of VFQ-25 was used (16). The patient should answer 25 questions, grouped in 12 subscales, estimating specific visual situations by a given scale, scoring from 1 to 5 or 6, where 5 and 6 reflect the lowest level of functioning. Answers are consistent with daily needed correction with glasses/lenses. Data analysis is performed conforming to published standard instructions: answers to the 25 questions are scaled from 0 to 100, where 100 represents the highest level of functioning. For each subscale, a mean value is calculated for the answers of each patient, and a common result for all subscales, which only excludes the general health subscale.

The application of a vision-specific questionnaire allows to substantiate to some extent the subjective visual dysfunction, which is otherwise hard to document, disturbs

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patients' daily activities, and lowers quality of life. It is confirmed in the literature that the addition of VFQ-25 to the scales for assessment of disability is appropriate. This confirms the need for its understanding and application in Bulgarian neuroscience and clinical practice.

In recent years, psychophysical methods of assessment, allowing quantitative studies of human senses, more and more often come out of experimental laboratories and find their place in neurological practice. Psychophysical tests are usually hard to access and expensive, which narrows their application.

A psychophysical method for the assessment of VAALA, developed by a Varna Medical University team: Prof. Dr. D. Mintchev, Assoc. Prof. Dr. N. Deleva, Dr. Al. Tzoukeva, and Assoc. Prof. Sl. Slavtchev from the Varna Technical University was proposed in Bulgarian literature (12). On the basis of a previously described visual phenomenon, an apparatus (Lumitest-analyzer) and the psychophysical method were patented. The apparatus allows changes of luminance relationships between a central and a peripheral field on a screen, excluding the possibility of blinding. Technical and visual characteristics of the experimental model were calculated. The psychophysical method for assessment of VAALA is sufficiently accurate, quick, and ecologically clean. As a result of 10-year studies, published and presented at different scientific events, the diagnostic value of the method was proved. Statistically significant differences were found between the results of clinically healthy subjects and patients with different neurological diseases: ischemic stroke, supratentorial brain tumors, Parkinson's disease, MS, including patients with subclinical visual dysfunction. The method for assessment of VAALA is proper for repeated testing, allowing the follow-up of patients in a clinical setting. Theoretically, it may be useful for clarifying the complex functional characteristics of visual processes. It may as well be a condition for further studying of mechanisms, related with the described visual phenomenon (2,15).

The assessment of spatial CS is one of the psychophysical tests, which have been approved in clinical practice. Investigations in last decades have established that it could provide information unavailable from other diagnostic methods. Visual acuity and the test object's contrast level have considerable importance for the measurement of spatial CS. Adapted to clinical practice, this means that the psychophysical test allows a quantitative estimation of visual dysfunction, e.g. whether the patient sees well or poorly, small as well as big objects (1,6,9,14).

Standard spatial CS assessment is carried out using an oscilloscopic computerized test, where the patient should perceive sinusoidal grating in different spatial frequencies. At the 1st Clinic of neurology, spatial CS assessment is performed using a computerized oscilloscopic test, modified by Scheiber. On a 15" flat screen monitor (MAG 570FD), a circle-shaped target, 8 cm in diameter is visualized, with vertically oriented gratings in six different spatial frequencies of 2 cycles/deg, very large sines of 4, 8,

16, 32 to 64 cycles/deg, very narrow sines. At each spatial frequency, sinusoidal grating contrast is altered from 0.5 to 20. At a given spatial frequency, e.g. patterns with specific thickness, and variable contrast, after 15 minutes of adaptation to a specific background brightness, the patient, from a distance of 150 cm and at a visual angle of 3 deg, defines the moment when the object is seen or disappears, compared to the constant screen background: a method of adjustment. This way, the contrast threshold of the observer can be determined for the sinusoidal grating at a given spatial frequency. The experiment is repeated four times for each spatial frequency, two ascending and two descending attempts. CS is calculated according to a known mathematical formula, as a reciprocal value of contrast threshold: $CS = 1/\text{contrast threshold}$. A function of CS is created using the final results for CS at a specific spatial frequency.

Oscilloscopic computerized test for assessment of spatial CS in Bulgaria has only been used in scientific experimental laboratories, investigation centers, and thus is not popular enough as a criterion to prove visual dysfunction in brain disease. This test was used in 1st Neurological clinic to assess patients with MS, Parkinson's disease, and brain tumors. Our results confirmed the data from the literature where the spatial CS test is regarded as a method of choice for the diagnosis of subclinical visual impairment in MS and visual disturbances in patients with early Parkinson's disease, which cannot be demonstrated by routine neuroophthalmological methods.

Some authors consider the oscilloscopic computerized test for assessment of spatial CS suitable for clinical use. Opinions exist, that a more accessible alternative may be applied, that is contrast letter visual charts, including low-contrast ones. Two types of chart tests are available: standard visual acuity charts, but at different contrast levels, including low contrast, so called contrast letter visual charts, and tests for assessment of CS with optotypes of equal size, but different contrast level on the same page. In the first case, CS can be determined in different spatial frequencies, while in the second one, CS is measured directly, but in only one spatial frequency (letters are equally sized). An example for the first type of chart tests is Sloan's test with low contrast, where 10 capital letters are used (Z N H R V K D C O S), printed according to Snellen's principle of arrangement by size, but including low contrast level – 6.25 to 25%. In Pelli – Robson's test, an example for the second type of tests, capitals from Sloan's test are arranged by triplets with equal size and consecutively decreasing contrast in comparison with the preceding group of triplets by a factor of 1/2. In the literature it has been suggested that Sloan's low-contrast visual chart should be used in clinical neurological practice. In Bulgaria there are no adapted and standardized contrast visual letter/number charts. Some laboratories use the original Pelli-Robson test, where optotypes represent characters of the Latin alphabet. Conforming to the requirement that optotypes must be familiar to the examined person, we have elaborated low-contrast number

visual charts (approximately 3% and 1.5%) on the basis of the principles of Sloan's tests, but including well-known number optotypes (1 to 9) from Bulgarian vision charts. Using these modified low-contrast number visual charts, we have assessed patients with Parkinson's disease, MS, and brain tumors. Data from the literature for the high sensitivity of the test for substantiating visual impairment in different diseases of CNS, including difficult to diagnose subclinical impairment, have been confirmed. In recent years it has been proposed to replace the classical Snellen's 100% contrast test by Sloan's low-contrast visual charts in scales for assessment of disability. Sloan's charts are easy to use and provide information on CS in different spatial frequencies, which raises the significance of our low-contrast number visual test, modified for use in Bulgaria.

The introduced vision-specific questionnaire documenting subjective visual disturbances, and the other psychophysical methods are approved by modern neuroscience and practice, but they are little known and only partly applied in Bulgaria. These contemporary neuroophthalmological methods for assessment of visual system in brain diseases provide additional visual information with high confidence, which enriches and defines the neurological deficit more accurately. They are able to demonstrate visual disturbances even when results from routine neuroophthalmological tests are normal. Thus, they are able to capture minimal visual deficit, typical of subclinical visual impairment. This is important for the early diagnosis and the entire clinical characteristic of CNS diseases, as well as for the level of disability and the quality of life of patients. Therefore, it has been proposed in the literature to include the VFQ-25 vision-specific questionnaire and low contrast visual charts in disability assessment scales (4,13).

With the exception of the computerized oscilloscopic test of CS, all neuroophthalmological methods are easy to apply, quick and sufficiently informative, which permits their general use. On the other hand, theoretically, the discussed neuroophthalmological methods contribute to clarify neurophysiopathological mechanisms of visual system affection in brain diseases, especially in cases of normal visual acuity. The contemporary neuroophthalmological methods, applied for the first time in Bulgarian neurological practice can be regarded as quantitative, standardized, practical assessment of visual dysfunction in diseases of brain.

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