SOME ASPECTS OF THE COMPARATIVE CHARACTERISTICS OF DIFFERENT COMPUTERIZED PERIMETRY METHODS

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✧ ***Purpose*** **— to compare the ease of use, the comfort for persons to be tested, the examination rate, as well as the variability of repeated results obtained using four methods of computerized perimetry.** ***Materials and methods.*** **This clinical study included three groups of patients with open-angle glaucoma (OAG). The 1st group included patients with OAG stage I, the 2nd group — with OAG stage II, the 3rd group — with OAG stage III. The control group included healthy individuals. All tested persons underwent examinations by 4 computerized methods (HFA II, Tomey AP-1000, Pericom, and the FDT-perimetry modification developed at the Ophthalmology Department of the Military Medical Academy).** ***Results.*** **FDT-perimetry appeared to be the shortest, easiest test and most comfortable for tested persons. Perimetry using Tomey AP-1000, Pericom and HFA II was more time-consuming and more difficult to perform. Repeated results of all four methods were better than the first one due to the "learning curve" effect, and showed different variability.** ***Conclusion.*** **To obtain reliable computerized perimetry results, taking into account the possible "learning curve" effect, we recommend repeating the perimetric test at least 2–3 times at same conditions. It is important for the selected perimetric test to be easy to perform, comfortable for persons to be tested, and quite fast to perform.**

✧ ***Key words:*** open-angle glaucoma; computerized perimetry; perimetry methods; central visual field.

НЕКОТОРЫЕ АСПЕКТЫ СРАВНИТЕЛЬНОЙ ХАРАКТЕРИСТИКИ РАЗНЫХ МЕТОДОВ КОМПЬЮТЕРНОЙ ПЕРИМЕТРИИ

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✧ ***Цель*** **— сравнить простоту, комфортность для испытуемых, быстроту выполнения исследований, а также вариабельность их повторных результатов, полученных при использовании 4 методов компьютерной периметрии (КП).** ***Материалы и методы.*** **В клиническом исследовании приняли участие 3 группы больных открытоугольной глаукомой (ОУГ). В 1 группу вошли пациенты с I стадией ОУГ, во 2 группу — с II стадией, в 3 группу — с III стадией ОУГ. Контрольную группу составили здоровые лица. Всем испытуемым выполняли 4 метода компьютерной периметрии (HFA II, Tomey AP-1000, Периком и разработанную на кафедре офтальмологии ВМедА модификацию периметрии с удвоенной пространственной частотой — FDT-периметрию).** ***Результаты.*** **FDT-периметрия по сравнению с 3 сравниваемыми методами оказалась самой быстрой по времени тестирования, простой и комфортной для испытуемых. Периметрия с помощью периметров «Tomey AP-1000», «Периком» и «HFA II» была намного продолжительней по времени исследования, а также более сложной для выполнения, по оценке самих испытуемых. Повторные результаты всех 4 сравниваемых методов КП оказались лучше предыдущих вследствие эффекта обучения, показав различную вариабельность.** ***Заключение.*** **Для получения достоверных результатов компьютерной периметрии с учётом эффекта обучения один и тот же тест следует выполнять несколько раз в одинаковых условиях. При выборе теста имеет значение его простота и комфортность для испытуемого, а также быстрота выполнения.**

✧ ***Ключевые слова:*** глаукома открытоугольная; компьютерная периметрия; методы периметрии; время тестирования; центральное поле зрения.

Glaucoma is one of the leading causes of irreversible blindness and visual disability worldwide. Approximately 90 % of all glaucoma cases appear to be open-angle glaucoma (OAG). Early OAG stages are asymptomatic; therefore, patients often seek medical advice as late as in the stages II and III of the disease.

The most effective prevention of blindness secondary to glaucoma is its early diagnosis. It is based on the detection of specific changes in the optic nerve head structure and functions. Standard automated perimetry (SAP) "white on white" threshold strategies, performed using Humphrey or Octopus computer visual field analyzers are recommended by international experts for the early detection of the optic disc functional changes. For >25 years SAP has been the "gold" standard in perimetry. The first World Glaucoma Association Consensus Meeting in 2003 and a symposium at the International Glaucoma Congress in 2007 were devoted to the discussion on the modern specific perimetric methods, i. e., short wavelength automated perimetry (SWAP) and Frequency Doubling Technology (FDT) perimetry. Experts particularly reported that FDT perimetry may be significant in glaucoma screening and may be useful for monitoring visual field (VF) changes in glaucoma patients [10]. A modification of FDT perimetry was developed in the Ophthalmology Department of the Military Medical Academy (MMA), which established overall sensitivity and specificity to be non-inferior to the original method, enabling the screening strategy to be more sensitive [4, 5].

International experts recommend not to limit the VF examination with only one computerized perimetry (CP) method, but to use, if possible, several methods of perimetry available or repeat the same method several times [3, 10, 11] to detect the early glaucomatous light sensitivity changes in the central VF.

Result accuracy is an important aspect of any CP method. VF test results may be influenced by various factors including the study duration, training effect, pupil size, refractive errors and presbyopia, the presence and severity of cataract, and upper eyelid ptosis. Longer duration causes visual fatigue causing fixation loss, resulting in an increase in the number of fixation errors, deterioration in the stimuli perception, and increase of false positive and false negative responses. Together, all these may produce a significant impact on the reliability of the results [9, 12]. The number of fixation errors and false positive responses are among the most reliable criteria of the accuracy of VF test results. [3] Ideally, the duration of monocular threshold test should not exceed 6–7 min [6], and the functional screening should not last more than 5 min [1]. A reduction of VF test duration or only a 1-min break during the study may significantly decrease the negative impact of visual fatigue and increase the accuracy of the test result [8].

The variability of follow-up test results is another important factor affecting the CP reliability, which, in the opinion of several specialists, may be decreased with appropriate patient training and instruction. Repeated VF testing improves the mean defect (MD) and pattern standard deviation (PSD) global indices and decreases the study duration. The variability of VF test results depends on the severity of glaucomatous process. In patients with glaucoma stages II and III, e. g., there is much greater MD index variability than in patients with early glaucoma, which complicates the disease progression assessment even more [7, 11]. In addition, the variability of light sensitivity data in the peripheral parts of retina is even higher; therefore, CP testing of VF within 25° from the fixation point is preferable.

A patient's personal characteristics have a definite impact on CP data. In particular, sensorimotor reaction time is affected in the elderly, and the presence and severity of encephalopathy complicating a correct understanding of the task should be of concern. Detailed instruction to the patient and an introductory VF test may help to reduce the impact of these factors on CP results [9].

High variability of follow-up test results causes difficulty to judge VF defects as associated with glaucoma or not; therefore, test variability reduction is very important for the correct diagnosis and evaluation of glaucoma progression.

Therefore this study aimed to compare four different CP methods in terms of the simplicity and comfort level of the VF test for glaucoma patients, test duration, and the variability of follow-up results.

MATERIALS AND METHODS

The study involved 52 patients (96 eyes) with OAG stage I (41 eyes), stage II (36 eyes), and stage III (19 eyes). The mean age of the patients was 66 ± 13.2 years ($M \pm \delta$). Exclusion criteria included ocular or systemic diseases that may affect VF, except for glaucoma; refractive error exceeding ± 5.0 diopters; visual acuity <0.5. The control group consisted of 20 healthy subjects (40 eyes); the mean age of the subjects was 53 ± 7.6 years.

A standard ophthalmic examination was performed in each case. CP was performed using 4 computerized perimeters: Humphrey visual field analyzer (HFA II; USA-Germany), automatic computerized perimeter Tomey AP-1000 (Germany), automatic perigraph Pericom (Russia), and FDT perimetry method developed in the Ophthalmology Department of MMA [4]. All compared perimeters in addition to screening programs have a threshold test, except for the Pericom perigraph, which is a superthreshold perimeter. A morphometric optic disc assessment was performed in all patients using RTVue-100 optical coherence tomograph.

Test duration, MD (average deviation — AD) global index variability, the number of fixation errors, and false positive responses were compared. To assess the follow-up test variability each CP test was performed twice, with the follow-up test was performed on the next day. Patients' self-reporting was used to rate each of the four compared CP tests in terms of simplicity and comfort level of the VF test at the end of each testing program.

RESULTS

Testing programs with central VF area similar to the threshold 24–2 test of the "gold" HFA standard were selected for comparison. Threshold Central 22° test was selected for Tomey perimeter. Pericom program tests central 25° of VF and FDT perimetry examines the central 20° of VF. However, the number of tested points in these CP programs varied significantly: 56 points in the HFA test, 96 points in the Tomey test, and 128 points in the Pericom test. To achieve correct comparison, VF areas tested with HFA II, Tomey, and Pericom were divided into 16 squares, each corresponding to 10°×10° VF area similar to the one tested with the FDT perimeter. Thus, we evaluated the number and location of squares with scotomas revealed by each of the four compared methods.

FDT perimetry provided the fastest monocular test in OAG patients and in healthy subjects (test duration in OAG patients: stage I, 1.3 min; stage II, 1.6 min; stage III, 2.3 min; and in healthy people, 1.1 min). Other CP methods (HFA II, Tomey, and Pericom) proved to be more time-consuming tests (Figs. 1, 2), and test duration increased depending on the glaucoma severity.

While assessing the variability, it can be argued with varying degrees of certainty that the results of repeated central VF tests with each of the CP methods used, improvement was observed in most OAG patients and healthy individuals (Tables 1, 2). This can be explained by the patient pretest training effect. FDT perimetry had the lowest variability of the results compared with other CP methods (HFA II,

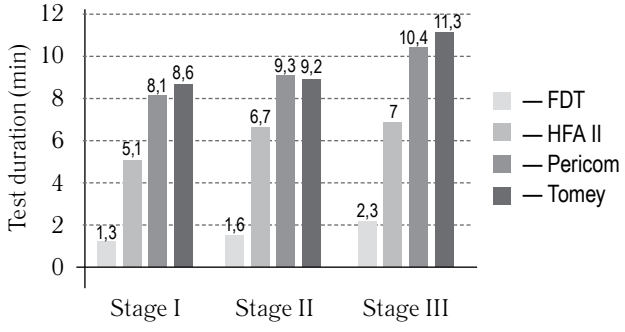

Fig. 1. Mean monocular test duration time (min) for four compared CP methods in patients with I, II and III glaucoma stages

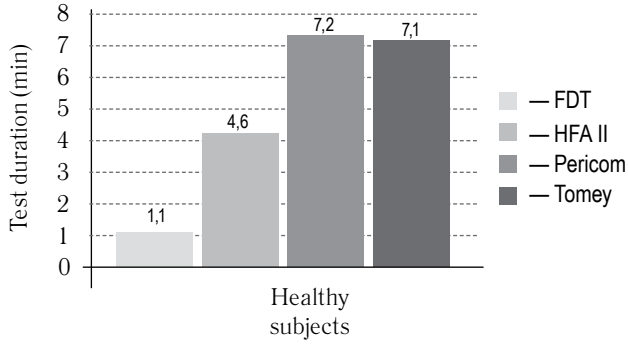

Fig. 2. Mean monocular test duration time (min) for four compared CP methods in healthy subjects

Table 1

Follow-up tests results variability in glaucoma patients (M ± m)

CP method	MD1 (AD 1)	MD2 (AD 2)	Fixation errors 1 (%)	Fixation errors 2 (%)	False positive results 1 (%)	False positive results 2 (%)
HFA	−6,7 ± 1,03	−6,3 ± 0,9*	16,3 ± 2,6	13,6 ± 2,6*	3,2 ± 0,4	2,3 ± 0,4**
Tomey	−2,2 ± 0,4	−2,1 ± 0,4**	27,5 ± 3,1	17,9±2,2**	5,9 ± 1,3	4,0 ± 1,1**
FDT	−0,23 ±0,03	−0,21±0,03**				
* — p > 0,05; * — p < 0,05						

Table 2

Follow-up tests results variability in healthy subjects (M ± m)

CP method	MD1 (AD 1)	MD2 (AD 2)	Fixation errors 1 (%)	Fixation errors 2 (%)	False positive results 1 (%)	False positive results 2 (%)
HFA	1,4 ± 0,3	0,91 ± 0,3**	17,3 ± 3,6	11,7 ± 2,9*	2,7 ± 0,5	2,2 ± 0,5*
Tomey	2,8 ± 0,2	2,61 ± 0,3*	20,5 ± 2,9	10,3 ± 2,4**	1,7 ± 0,6	1,6 ± 0,9*
FDT	0,03 ± 0,01	0,04 ± 0,01**				
* — p > 0,05; * — p < 0,05						

Table 3

Test duration time in glaucoma patients and healthy subjects (M ± m)

CP method	Test duration time in healthy subjects (min)		Test duration time in glaucoma patients (min)	
	Time 1	Time 2	Time 1	Time 2
HFA	4,8 ± 0,1	4,6 ± 0,1**	5,9 ± 0,1	5,8 ± 0,1**
Tomey	7,8 ± 0,1	6,7 ± 0,2*	9,3 ± 0,3	8,2 ± 0,3*
FDT	1,6 ± 0,2	1,1 ± 0,1**	1,9 ± 0,2	1,6 ± 0,1**
Перикom	7,3 ± 0,1	7,0 ± 0,1**	8,7 ± 0,2	8,5 ± 0,2**
* — p > 0,05; * — p < 0,05				

Tomey, and Pericom). The follow-up test duration was always reduced in all CP types (Tab. 3). Based on our own experience, we believe that it is advisable to repeat VF test not on the same, but on the next day. Therefore, general and visual fatigue is less expressed, and the "learning curve" effect has a more pronounced positive influence on the test accuracy.

According to the subjects' self-reporting, FDT perimetry was the most simple and comfortable method compared with other CP tests (HFA II, Tomey, and Pericom) which were more difficult to understand and accomplish.

CONCLUSIONS

1. FDT perimetry was the fastest, most simple, and comfortable among the compared VF tests (HFA II, Tomey, and Pericom) in healthy subjects and glaucoma patients.
2. In the follow-up tests results of all 4 CP methods the MD (AD) indices were increased, number of fixation errors and false positive responses were decreased, and test duration was decreased.
3. The training effect was obvious in the follow-up tests results of all the four CP methods in all the subjects, so retest should always be performed to achieve reliable results.

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