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The learning effect in Humphrey Field Analyser testing in glaucoma patients: how many practice sessions are enough?

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Abstract

Purpose: The learning effect is an essential factor in many psychophysical tests. This study aims to examine the learning effects of Humphrey Field Analyser (HFA) in patients with glaucoma.
Study design: Cross-sectional study.
Methods: Twenty eyes of 12 patients (10 patients [83.4%] open-angle glaucoma, 1 patient [8.3%] angle-closure glaucoma, and 1 patient [8.3%] secondary glaucoma) were sent to HFA examination for three different sessions of examination. The inclusion criteria were patients with glaucoma who completed three HFA examinations. The results were analysed using ANOVA and Tukey's post hoc test. The primary outcomes were reliability, global indices, and the threshold sensitivity between the three sessions.
Results: Duration to complete the HFA test statistically decreased after the third session (first *vs* third session: 387 ± 96 *vs* 307 ± 93 sec; $p = 0.017$) as well as fixation loss (first *vs* third session: 0.25 ± 0.19 *vs* 0.05 ± 0.11: $p = 0.001$). False-negative results improved after the third session (first *vs* third session: 0.15 ± 0.15 *vs* 0.02 ± 0.03 $p < 0.001$). There was no statistically significant difference in false-positive,

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mean deviation, pattern standard deviation, and visual field index within the three sessions.
Conclusions: There was shorter test duration, decreased fixation loss, and decreased false negatives in the third session of HFA, but there was no statistically significant change to the global indices. Experience has important effect on perimetry results. Thus, the learning effect should be taken into consideration for management of patients with glaucoma.

Keywords: glaucoma, visual field, learning effect

Kesan proses pembelajaran ke atas pesakit glaucoma yang melakukan ujian medan penglihatan menggunakan Humphrey field analysis: berapa kali ujian adalah memadai?

Abstrak

Tujuan: Proses pembelajaran adalah penting dalam mana-mana ujian yang melibatkan psikofizikal. Kajian ini bertujuan mengenalpasti proses pembelajaran minimum yang diperlukan oleh pesakit glaukoma bagi menghasilkan ujian medan penglihatan yang baik.
Kaedah kajian: Kajian keratan rentas
Metodologi: Dua puluh pesakit (dua puluh mata) telah menjalani ujian medan penglihatan mengunnakan Humphrey field analysia (HFA) untuk tiga sessi yang berlainan. Mereka terdiri dari 10 pesakit glaukoma bersudut terbuka, 1 pesakit glaukoma bersudut tertutup dan satu lagi adalah pesakit glaukoma sekunder. Kriteria utama adalah mereka perlu melengkapkan tiga sessi HFA. Keputusan ujian HFA telah dianalisa menggunakan one-way ANOVA dan Tukey post-hoc. Dapatan utama dari ujian ini adalah dari segi kebolehpercayaan, indeks global, dan ambang sensitivity di antara ketiga-tiga ujian HFA.
Keputusan: Waktu bagi melengkap ujian HFA berkurangan dengan signifikan pada ujian yang ketiga (ujian pertama: 387 ± 96 vs ujian ketiga:307 ± 93 sec; $p = 0.017$), begitu juga dengan kehilangan penetapan (fixation loss) (ujian pertama 0.25 ± 0.19 vs ujian ketiga 0.05 ± 0.11; $p = 0.001$). Kekerapan negatif palsu juga berkurangan selepas sessi ujian ke tiga (ujian pertama 0.15 ± 0.15 vs ujian ketiga 0.02 ± 0.03; $p < 0.001$). Tiada perbezaan signifikan secara statistik pada nilai positif palsu, min sisih, sisihan corak piawai dan indek medan penglihatan di antara ketiga-tiga ujian HFA.
Kesimpulan: Terdapat pengurangan masa ujian, kehilangan penetapan dan

kekerapan negative palsu pada ujian HFA yang ketiga tetapi tiada perubahan signifikan secara statistik pada indeks global. Pengalaman memberi kesan penting ke atas keputusan ujian perimetri. Dengan itu, proses pembelajaran perlu diambil kira dalam perawatan pesakit glaukoma.

Kata kunci: glaukoma, medan penglihatan, proses pembelajaran

Introduction

Glaucoma is the leading cause of non-reversible blindness.[1] Visual field analysis is a critical feature in diagnosing and managing glaucoma. The Humphrey Field Analyser (HFA) is one of the several methods available to measure the visual field. The learning effect is an essential factor that needs to be addressed when evaluating the visual field. It is assumed that experience might affect the result after performing several standard automated perimetry tests.[2]

Like other subjective psychophysical tests, the perimetry examination needs the patient's concentration and cooperation. The patient's performance may become better after several attempts. The more experience the individual has in perimetry, the better the result. An inexperienced subject might produce visual field results that show abnormality. Thus, this learning curve might mask the defect and create confounding results.[3] Gardiner *et al.* examined the learning effect for 6 years and concluded that it improved at each yearly visit.[4] The variability of test results decreased significantly with experience and began to appear after the second visit.[3] This learning curve has been reported consistently in other studies, and there is general agreement in the literature that at least three initial tests should be performed.[5,6] However, repeating the tests for reliable results is sometimes problematic, as glaucoma should often be diagnosed as quickly as possible.[5]

The learning curve is due to the psychological phenomenon of the visual system adapting to the process or improvement in the patients' recognition of the stimulus. Therefore, this study aims to evaluate the learning effect of HFA in patients with glaucoma.

Methods

This study was a cross-sectional study. Twenty eyes of 12 patients were recruited from routine follow-ups in the Glaucoma Clinic in Dr. Sardjito Hospital, Yogyakarta, Indonesia. No subjects had media clarity abnormalities (cornea, lens, and vitreous) or retinal diseases. Each participant was then enrolled for three perimetry examinations corresponding to their examination schedule in three different sessions

separated for at least 1 week. In each session, both eyes were examined using the Zeiss HFA (Zeiss Humphrey Field Analyser 3 Visual Field-Testing System, Carl Zeiss Meditec, Germany). Each patient was analysed using the 24-2 SITA Standard test pattern. Patients were excluded if they were not cooperative in each test session.

The HFA assessed the test duration, reliability indices, and global indices. The reliability indices recorded by this study were fixation loss as well as false negatives and false positives, while the global indices were Mean Deviation (MD), Pattern Standard Deviation (PSD), and Visual Field Index (VFI). Statistical analysis was performed using one-way ANOVA for all three sessions, continued by Tukey's post-hoc test.

Results

A total of 20 eyes from 12 patients were examined. The mean participant age was 41 ± 21 years old; seven participants (59%) were women and five (41%) were men. Based on the diagnosis, 10 patients (83.4%) were diagnosed with open-angle glaucoma, 1 patient (8.3%) with angle-closure glaucoma, and 1 patient (8.3%) with secondary glaucoma (Table 1).

The overall test duration was significantly improved on the third attempt compared to the first attempt ($p = 0.017$). The fixation loss also statistically improved in the third attempt compared to the first attempt ($p = 0.001$). Similarly, there was also statistically significant improvement in false-negative value ($p < 0.001$). Lastly, there was a statistically significant improvement in the first attempt compared to the second attempt ($p = 0.008$) and the first attempt compared to the third attempt ($p < 0.001$) (Table 2).

Table 1. Subject characteristics

Characteristics	**Value**
Age (mean ± SD)	41 ± 21 years
Sex	
Male	5 (41%)
Female	7 (59%)
Diagnosis	
Open-angle glaucoma	10 (83.4%)
Angle-closure glaucoma	1 (8.3%)
Secondary glaucoma	1 (8.3%)

Table 2. HFA parameters in three sessions

Parameter	a	b	c	P	a *vs* b	a *vs* c	b *vs* c
Test duration (sec)	387 ± 96	348 ± 77	307 ± 93	0.023	0.353	0.017	0.325
Fixation loss	0.25 ± 0.19	0.16 ± 0.16	0.05 ± 0.11	0.001	0.227	0.001	0.075
False negative	0.15 ± 0.15	0.05 ± 0.08	0.02 ± 0.03	0.000	0.008	0.000	0.639
False positive	0.09 ± 0.14	0.04 ± 0.06	0.02 ± 0.03	0.056	0.207	0.053	0.785
MD (dB)	-8.51 ± 10.26	-6.72 ± 9.85	-6.29 ± 9.52	0.754	0.835	0.759	0.990
PSD (dB)	5.02 ± 3.85	4.29 ± 3.42	3.45 ± 3.42	0.382	0.798	0.349	0.731
VFI (%)	77 ± 31	83 ± 28	84 ± 28	0.730	0.778	0.763	1.000

All data presented as mean ± SD. MD: Mean Deviation; PSD: Pattern Standard Deviation; VFI: Visual Field Index; a: first attempt; b: second attempt; c: third attempt

Discussion

In the present study, we found a significant improvement in test duration, fixation loss, and false-negative reliability indices on the second and third tests. The improvement in test duration indicates the learning effect experienced by the patients, showing that the patients understood how the test works and how to concentrate better compared to the first test. This learning effect was also shown in the improvement of reliability indices (fixation loss and false-negative). However, there was minimal improvement in false positives due to accurate machine settings and parameters used in this study. Global indices were unaffected by repeated examination. The same results were also observed in another study.[7] This might be because MD, PSD, and VFI represent the damage caused by glaucoma, which are reproducible and are not affected by the learning effect.

Perimetry is a subjective test that requires high concentration. Therefore, it is subject to a learning effect as the patient learns to respond consistently during the test, and high reproducibility of test measurements is often considered to diminish the learning effect.[8] Learning may be observed within a single examination of a given eye, between eyes at the same visit, or between subsequent examinations. In the present study, the learning effect diminished after the third session. This result is similar to a previous study that found changes in the threshold sensitivity in the first two sessions that were performed by an inexperienced individual.[9]

Fatigue should be taken into account since a prolonged test duration would produce worse results. Visual fatigue was suspected to be a factor behind result inconsistency. Therefore, patients were advised to rest prior to the first eye test and before beginning the second eye test.[10] One significant factor that creates a poor result on the first attempt is the patient's failure to understand the test.[11] Anxiety may have also influenced the first test results because the first test was conducted during the patients' first hospital visit. Aside from that, the patients may not feel comfortable when seated during the first test.[12] Therefore, this study's limitations were not considering the patients' cognitive level and fatigue for analysis. Further study is required to investigate the association between cognitive levels, anxiety, and patient's performance in HFA testing.

Conclusion

There was shorter test duration, decreased fixation loss, and decreased false negatives after the third HFA examination session, but there was no statistical change to the global indices. Many factors can affect the reliability of visual field examination in glaucoma patients. These factors are patient's cooperation, understanding, psychological condition, and fatigue. These factors should be considered prior to the tests. In addition, at least three perimetry examinations should be taken to obtain a reliable visual field result.

Declarations

Ethics approval and informed consent
The study was conducted in accordance with the Declaration of Helsinki. The authors declared no conflict of interest regarding this paper's publication. The authors were accountable for all aspects of work in ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved. The authors' institutional ethics board (The Ethics Committee of the Faculty of Medicine, Universitas Gadjah Mada-Dr. Sardjito General Hospital) approved the study by issuing the ethical clearance number KE/FK/0562/EC/2021.

Competing interests
None to declare.

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