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Evaluation of stimulus velocity in automated kinetic perimetry in young healthy participants

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ABSTRACT

This prospective study aimed to evaluate the stimulus velocity for automated kinetic perimetry based on the test duration, the kinetic sensitivity, and the variability of the kinetic sensitivity in 31 eyes of 31 young healthy participants. Automated kinetic perimetry was performed using an Octopus 900 perimeter with Goldmann stimuli III4e, I4e, I3e, I2e, and I1e. The participants underwent testing at 14 predetermined meridians for each stimulus, with velocities of 2°, 3°, 4°, 5°, and 10°/s; each velocity was tested twice. The test duration, kinetic sensitivity, and variability of kinetic sensitivity were compared among the stimulus velocities. Twenty-nine eyes from 29 participants were analyzed, and two participants were excluded. The test durations at the velocities of 2°, 3°, 4°, 5°, and 10°/s were negatively correlated with the stimulus velocity ($p < 0.01$). The variability of the kinetic sensitivities did not significantly differ among the stimulus velocities. The kinetic sensitivities at 2° and 3°/s did not differ significantly for all stimuli. However, those at 4°/s decreased for III4e, I4e, and I1e ($p < 0.05$), and those at 5° and 10°/s decreased for all stimuli ($p < 0.05$) compared with those at 2° or 3°/s. Although the test durations for each stimulus velocity were negatively correlated with the stimulus velocities, a stimulus velocity of 3° or 4°/s might be recommended for automated kinetic perimetry based on the changes in the kinetic sensitivity. As this study included only young participants, further studies in elderly participants may also be necessary.

1. Introduction

Kinetic perimetry is the traditional method used to measure the extent of the visual field via an examiner controlling a moving stimulus (Goldmann, 1945a, 1945b, 1946). This technique is useful when examining patients without visual field defects within the central 30° (Hicks & Anderson, 1983; Keltner et al., 1999; Stewart, 1992) or patients with intracranial disease (Keltner & Johnson, 1984; Wong & Sharpe, 2000). Manual kinetic perimetry has the advantage of obtaining measurements while keeping pace with the patient's response time for stimulus exposure. However, standardizing the stimulus velocity among examiners is difficult because the perimetric results depend on the skill of the examiner (Trobe et al., 1980).

Moreover, some automated kinetic perimeters have been developed to address the disadvantages of the existing manual kinetic measurement techniques (Johnson & Keltner, 1987; Paetzold et al., 2004; Schiefer et al., 2001a, 2004; Wabbels & Kolling, 2001.), and clinical trials have found that automated kinetic perimetry yields results similar to those of manual measurements (Johnson & Keltner, 1987; Wabbels & Kolling, 2001). Although automated kinetic perimetry can stabilize the stimulus velocity to determine the optimal stimulus velocity, few studies have evaluated this technique. Previous reports have recommended stimulus velocities of 2°/s (Johnson & Keltner, 1987) or 4°/s (Wabbels & Kolling, 2001) for automated kinetic perimetry; however, these studies included few participants and measured areas within 70°. Therefore, the stimulus velocity requires further investigation.

This prospective study aimed to evaluate the stimulus velocity for automated kinetic perimetry based on the test duration, the kinetic sensitivity, and its variability with varying stimulus velocities in young healthy participants.

2. Methods

Thirty-one young healthy participants were enrolled in this prospective study. The required sample size for this study is

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discussed below. The study followed the tenets of the Declaration of Helsinki, and each participant provided written informed consent after the ethics committee of Kitasato University School of Allied Health Science (no. 2012-08) approved the study.

All participants underwent comprehensive ophthalmic examinations, noncycloplegic refraction testing, visual acuity (VA) testing at 5 m using a Landolt ring chart, measures of intraocular pressure (IOP), ocular axial length measurement, and fundus examination by a glaucoma specialist. The participants, who had a corrected VA of 20/20 or better, IOPs of 21 mmHg or less, a normal optic disc, and no ophthalmic diseases that affected the visual field test, were included. The eye with the lowest level of astigmatism from each participant was measured in this study. If the astigmatism was the same in both eyes, the eye with the lower degree of myopia was included.

Automated kinetic perimetry was performed using the Octopus 900 perimeter (Haag-Streit, Koeniz, Switzerland). It has a dome-shaped radius of 30 cm and can provide evaluations up to 90° of the visual angle horizontally, 60° of the visual angle superiorly, and 70° of the visual angle inferiorly. The measurement conditions for automated kinetic perimetry were calibrated automatically to the same measurements as the Goldmann perimeter, with a background luminance of 10 cd/m^2 (31.4 asb). Goldmann stimuli of III4e, I4e, I3e, I2e, and I1e were used. The stimulus velocities available for the Octopus 900 perimeter were 2°, 3°, 4°, 5°, and 10°/s. All participants underwent automated kinetic perimetry five times in a day in the following order: 2°, 3°, 4°, 5°, and 10°/s, and the same sequence was repeated on another day within two weeks. Fig. 1 shows the measurable area of the Octopus 900 perimeter and the starting locations with a moving stimulus, which included 70 predetermined points, with each stimulus measuring 14 points. These starting locations were chosen based on previous studies (Pineles et al., 2006; Wabbels & Kolling, 2001). Although the stimuli were performed in this order (III4e, I4e, I3e, I2e, and I1e), the starting locations of the 14 points at each stimulus were presented randomly in the extreme periphery of the normal age-corrected kinetic sensitivity for each stimulus. High degrees of myopia were corrected with contact lenses at the time of evaluation. The Octopus 900 perimeter was used to adjust for the reaction time (Becker et al., 2005; Nowomiejska et al., 2010; Schiefer et al., 2001b; Vonthein et al., 2007; Wakayama et al., 2011.). Specifically, the isopter was adjusted from the response time for stimulus exposure. However, the reaction time was not adjusted because this would have prohibited the direct comparison of the raw data of the stimulus velocities. The fixation of each participant was monitored with a display according to previous reports (Becker et al., 2005; Nevalainen et al., 2008; Nowomiejska et al., 2005; Schiefer et al., 2001b; Wakayama et al., 2011). The exclusion criteria were as follows: fixation loss recognized on the display and a lack of fit for corrective contact lenses.

The test duration, kinetic sensitivity, and variability of the kinetic sensitivity were compared among the stimulus velocities. The kinetic sensitivity (expressed in degrees) indicates the location from the fixation point at which the participant presses the response button for the kinetic stimulus. The variability of the kinetic sensitivity indicates differences in the kinetic sensitivity on the same meridian. Before the main measurements, all participants practiced with intensities of III4e, I4e, I3e, I2e, and I1e. A period of at least 5 min separated the measurements.

The test duration was compared among each stimulus velocity using the second test results. The kinetic sensitivity was averaged over all meridians within each stimulus and compared among each stimulus velocity using the second test results. The variability in the kinetic sensitivity at each stimulus was calculated as the mean

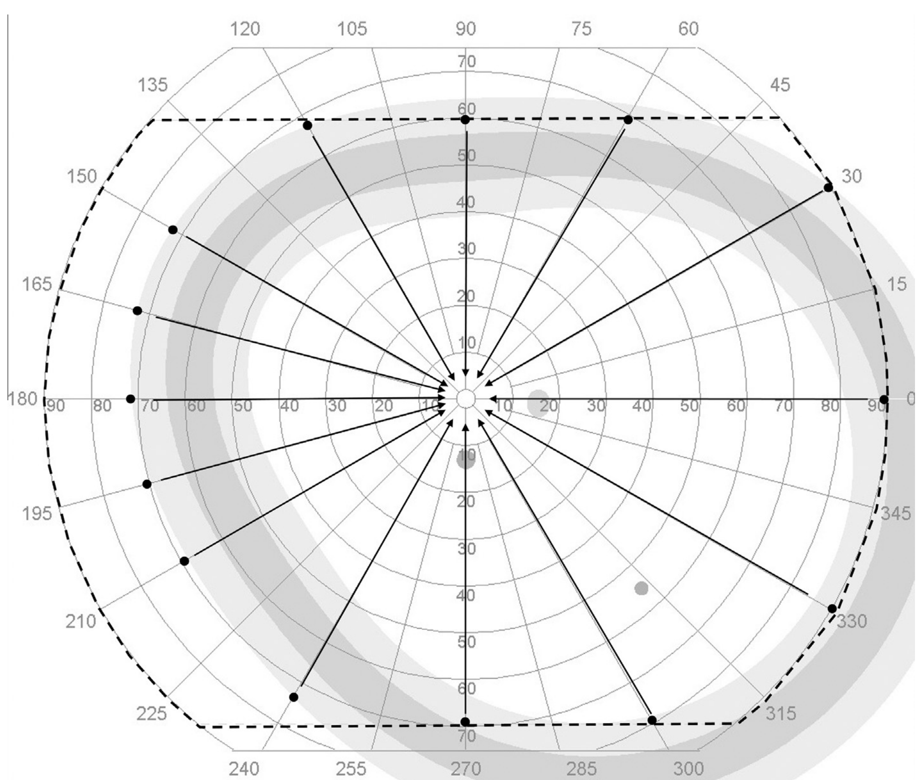

Fig. 1. The measurable area is depicted as a dashed line, and the starting locations with a moving stimulus are depicted using III4e as an example. The starting locations are situated at 30° increments, except at the nasal horizontal meridian, where the vectors were drawn every 15°. If the normal age-corrected kinetic sensitivity was outside of the measurable area (dashed line), the starting location was set to the extreme of the measurable area on the same meridian. The stimuli of I4e, I3e, I2e, and I1e are also provided using the same method.