COMPARISON BETWEEN THRESHOLD PUPIL PERIMETRY AND SUPRATHRESHOLD PUPIL PERIMETRY

SACHIKO OKUYAMA, CHOTA MATSUMOTO, ATSUSHI IWAGAKI, SONOKO TAKADA and TOSHIFUMI OTORI

Department of Ophthalmology, Kinki University School of Medicine, Osaka-Sayama City, Osaka, Japan

Abstract

Purpose: Pupil perimetry has so far been performed by the two following methods: suprathreshold perimetry during which the amplitude or ratio of pupil constriction is determined, and threshold perimetry during which the threshold of pupil reaction is determined. The authors compared the values obtained with these two methods using the modified Octopus 1-2-3.

Subjects and methods: Pupil perimetry was performed in ten normal subjects in the upper nasal field on the 135° meridian within the central 30° visual field, using a background luminance of 3 asb, a stimulus size 5, and a stimulus duration of 200 msec. On suprathreshold perimetry, the ratio of pupil constriction was measured using a stimulus intensity of 6dB (1005 asb). On threshold perimetry, the lowest stimulus intensity that caused pupil reaction was determined when the stimulus intensity was gradually increased in 1dB steps.

Results: The ratio of pupil constriction in suprathreshold perimetry and the pupillary sensitivity in threshold perimetry were well correlated (Spearman’s rank correlation coefficient: 0.67; n=80; p<0.001). Interindividual and intraindividual variations on suprathreshold perimetry were larger than those on threshold perimetry. The examination time with suprathreshold perimetry was much shorter than that with threshold perimetry.

Conclusion: Suprathreshold pupil perimetry was clinically more practical than threshold pupil perimetry.

Introduction

There are two different methods by which pupil perimetry can be performed. One is suprathreshold perimetry during which the parameters of pupil constriction are determined and evaluated. The other is threshold perimetry during which the threshold of pupil response is determined. Suprathreshold pupil perimetry is a time-saving method, because one perimetric value is obtained from only one stimulus presentation. On the other hand, with threshold pupil perimetry, several stimuli presentations are needed to obtain one threshold value. Recently, computerized methods of pupil perimetry using automated perimeters were developed and evaluated1-5. Suprathreshold perimetry is usually performed during such automated perimetry. In the present study, we deter-
mined the pupillary thresholds and compared them with the values obtained with suprathreshold perimetry in normal subjects.

Subjects and methods

Ten eyes of ten normal subjects were examined by both suprathreshold and threshold pupil perimetry. The mean age was 31.4±5.5 years (minimum: 26 years; maximum: 42 years). All the subjects in this study had corrected vision of 20/20 or better. Their intraocular pressures were lower than 21 mmHg. They did not suffer from any systemic or ophthalmic diseases and had taken no medications that were likely to affect their visual or pupillary functions. Their pupil sizes were greater than 3 mm under room light, and their direct and consensual pupillary light reflexes and accommodative pupil reactions were clinically normal. This study was performed using a modified Octopus 1-2-3 perimeter, its remote software package, and a 486/33 mHz IBM compatible personal computer.

Suprathreshold perimetry was performed under the following conditions: background luminance of 3 asb, stimulus size of 5, stimulus duration of 200 msec, and stimulus intensity of 6dB (1005 asb). The inter-stimulus interval was approximately 4.5 seconds. The ratio of pupil constriction was given by the amplitude of the pupil constriction divided by the pupil size at the beginning of the light reflex.

For threshold perimetry, we used the same background luminance, stimulus size and stimulus duration as above. The inter-stimulus interval was approximately 2.5 seconds. Thresholds were measured by the ascending method. At each test point, measurement was started with a weak stimulus that caused no pupil response. The stimulus intensity was gradually increased in 1dB steps until the light reflexes occurred constantly after each stimulus presentation. The lowest stimulus intensity causing a discernible pupil reaction was determined from the pupillograms.

Test points were located at 0, 4, 8, 12, 16, 20, 24 and 28° in the upper nasal field on the 135° meridian. Each test point was measured three times with both the above-mentioned methods. To avoid the effect of fatigue, we performed each examination within one minute and then had a break, the length of which depended on pupillary stability and the subjects’ needs. We calculated the arithmetic mean from three values obtained at each test point with each method in each subject. We also calculated the short-term fluctuation (SF) obtained with each method in each subject.

Results

Profiles of pupillary sensitivity were remarkably steep in the central 4° visual field (Fig. 1). The arithmetic mean of the pupillary sensitivities of ten normal subjects was 33dB at the fixation point. Its difference in threshold values at between 0° and 4° of eccentricity was larger than one log unit. With the exception of the fixation point, it decreased by approximately 2dB per 4° of eccentricity, and was considerably lower than the differential light sensitivity.

The slope of the profile obtained with suprathreshold perimetry was similar to that obtained with threshold perimetry (Fig. 2). Examined values obtained with suprathreshold perimetry correlated well with the sensitivity of pupil perimetry in our
Threshold pupil perimetry and suprathreshold pupil perimetry

normal subjects (Spearman’s rank correlation coefficient: 0.67; n=80; p<0.001) (Fig. 3).

Interindividual variation with suprathreshold pupil perimetry was greater than with threshold pupil perimetry. The SF of each subject averaged 2.6±0.9dB and ranged from 1.4-4.1dB with threshold pupil perimetry. On the other hand, it averaged 4.5±1.3% and ranged from 2.4-7.1% with suprathreshold pupil perimetry. The ratios of the fluctuation values to the actual values obtained with suprathreshold pupil perimetry were greater than those obtained with threshold pupil perimetry.

The examination time with threshold perimetry using our method was approximately eight times as long as that with suprathreshold perimetry.

Discussion

The slope of the pupil perimetry profile was steeper than that of the visual field in normal subjects, under the examination conditions used by us. It was especially steep in the central 4° visual field. Kardon and Thompson reported almost similar results in pupillary threshold fields obtained using different methods. The pupil field is not parallel to the visual field. The difference between pupillary and visual thresholds is probably based on the difference in the neural processing system.
Interindividual and intraindividual variations in pupil perimetry were larger than in visual thresholds of normal subjects. This is probably due to a fundamental difference between the visual system and the pupillomotor system. Variations of iris mechanics and situations of autonomic and central nervous systems constantly relate to pupil size and activity.

In a previous study, we investigated examination conditions with regard to the reduction of interindividual variations in suprathreshold pupil perimetry. In this study, we performed suprathreshold perimetry under the same conditions we had previously investigated. However, interindividual and intraindividual variations during suprathreshold perimetry were greater than those during threshold perimetry. The amplitude of pupil constriction seemed to be more influenced by iris mechanics and autonomic balance than the pupil threshold.

Values on suprathreshold pupil perimetry were found to be well correlated with those on threshold pupil perimetry, and the slopes of the pupil field obtained with both these methods were almost the same under the conditions we used. However, suprathreshold perimetry was more time-saving than threshold perimetry. It is particularly important to keep the examination time in pupil perimetry as short as possible, because fatigue can easily reduce pupil size and activity. Thus, it was concluded that suprathreshold pupil perimetry is clinically more practical than threshold pupil perimetry.

Fig. 2. Profiles of the arithmetic mean of three measurements on the 135° meridian with suprathreshold pupil perimetry in ten normal subjects.
Threshold pupil perimetry and suprathreshold pupil perimetry

Fig. 3. Correlation between the ratios of pupil constriction with suprathreshold perimetry and pupillary sensitivity with threshold perimetry in ten normal subjects.

References