Feasibility of Saccadic Vector Optokinetic Perimetry

A Method of Automated Static Perimetry for Children Using Eye Tracking

Ian C. Murray, MSc,[1,2] Brian W. Fleck, MD,[1,2] Harry M. Brash, PhD,[2]
Mary E. MacRae, FRCOphth, BMed Biol, MB ChB,[3] Lai L. Tan, MB ChB,[1]
Robert A. Minns, FRCP(Edin), FRCPCH, PhD[1,2]

Purpose: To determine the feasibility of a new technique for suprathreshold automated static perimetry in children.

Design: Evaluation of diagnostic test or technology.

Participants: The study included 29 subjects comprising 4 groups: 12 adults with normal fields, 4 children aged less than 10 years with normal fields, 8 adults with visual field defect, and 5 children aged less than 10 years with suspected visual field defects.

Methods: The system comprises a personal computer, display, and eye tracker to monitor gaze position when stimuli are presented in the visual field. The natural saccadic eye movement to fixate on the stimuli, if seen, can be detected and measured to produce a visual field plot. Subjects performed 3 eye-tracking tests, unless unable to do so for any reason: a 40-point binocular test and two 41-point tests for each eye. The tests were based on the Humphrey Field Analyzer (HFA) Central-40 point screening test with a stimulus size of Goldmann III and intensity of 14 decibels (dB). Adults also performed the equivalent Humphrey screening test in each eye for comparison.

Main Outcome Measures: Comparison of visual field plot results between the eye-tracking tests and HFA tests in adults. Correlation between the eye-tracking tests and the clinical assessment in the children with suspected visual field defects.

Results: In the eyes of all normal adult and child subjects performing the eye-tracking test, the percentage of points in agreement with a healthy visual field was 99.2% and 99.1%, respectively. The percentage of points agreeing with the HFA's screening test in the adult eyes with visual field defects was 89.8%. Visual field defects were also correctly identified by the eye-tracking system in the eyes of children with suspected visual field defects.

Conclusions: The results demonstrate that suprathreshold automated static perimetry using eye tracking is a promising method of perimetry for use with children.

Financial Disclosure(s): Proprietary or commercial disclosure may be found after the references.
Ophthalmology 2009;116:2017–2026 © 2009 by the American Academy of Ophthalmology.

Assessment of visual field defect plays a crucial role in the management of children with a wide range of ophthalmologic disorders, including cerebral visual impairment, brain tumors, increased intracranial pressure, and glaucoma.[1–3] There is also call for a reliable and sensitive method to monitor visual field changes in children prescribed vigabatrin for epilepsy.[4–6] The difficulties associated with visual field assessment in children are well documented, and visual field assessment in children aged younger than 5 years currently is limited to the nonquantitative visual field assessment technique of "confrontation." Goldmann kinetic perimetry is more popular for use with children aged younger than 9 years.[7,8] However, kinetic perimetry still requires the child's cooperation to maintain a continuous fixation on a central target during the test, and results can be dependent on the examiner's testing skills.

Automated static perimetry (ASP) is the visual field assessment method of choice in adults. However, it is rarely reliable in children aged younger than 9 years. There are many documented problems that prevent accurate ASP testing in children: (1) having difficulty in learning the skills required to perform the task,[9] (2) maintaining a stable fixation on a central target,[10,11] and (3) sustaining attention and concentration[12–14] are some of the major contributing factors that lead to poor test reliability with young children. (4) In those aged younger than 5 years, it is difficult to inhibit the natural saccades that are normally triggered by the sudden appearance of light stimuli in the visual field,[15–17] which can also lead to poor test performance. (5) Some children may not tolerate the restrictions of head movement imposed on them during the test.

To overcome such difficulties with performing ASP in children aged younger than 9 years, researchers have concentrated on finding ways of improving children's test reliability. The development of algorithms designed to provide faster testing time, such as the Swedish Interactive

Published by Elsevier Inc.
ISSN 0161-6420/09/$–see front matter
doi:10.1016/j.ophtha.2009.03.015

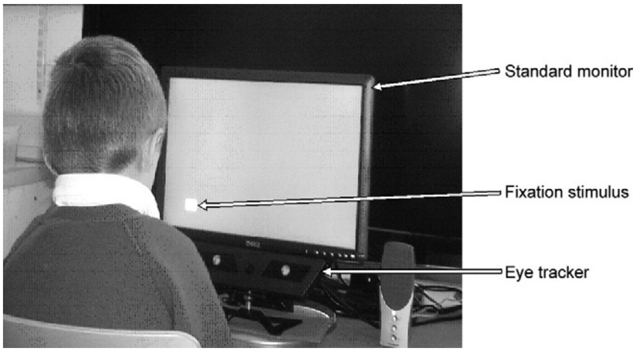

Figure 1. Saccadic vector optokinetic perimetry (SVOP) system during a visual field test.

Thresholding Algorithm Fast[18,19] and Tendency-Oriented Perimetry,[20,21] have been investigated with child subjects; however, the youngest age of a child capable of producing reliable results remains approximately 7 to 8 years.[14,22,23] Training and familiarization strategies for particular techniques have also been investigated as a way of improving reliability.[12,24] These research efforts do not address the fundamental problems inherent in performing ASP on children, and it is a new, child-friendly technique that is required. A novel system for assessment of visual fields in children has therefore been developed. This system makes use of relatively new advances in eye-tracking technology

Table 1. Subject Groups

Subject Group	No. of Subjects	Age (yrs) Mean	Range
Normal adults	12 (5 male, 7 female)	29.8	16–61
Normal children	4 (3 male, 1 female)	7.5	5–9
Adults with visual field defect	8 (5 male, 3 female)	63.3	17–77
Children with suspected visual field defect	5 (4 male, 1 female)	5.8	4–9

and should be more suitable for use with children. The system, termed "saccadic vector optokinetic perimetry" (SVOP), has been investigated as a means of quantifying visual fields in children and adults with normal visual fields and visual field defects, and is based on the principle of oculokinetic perimetry.[10,25]

The purpose of this study is to introduce SVOP and to present results that determine the technique's feasibility as a method of ASP particularly aimed at assessing visual fields in young children unable to perform any type of quantitative perimetry.

Materials and Methods

Equipment

Eye tracking is the process of measuring the point of gaze of a subject, and an eye tracker is a device that performs this measure-

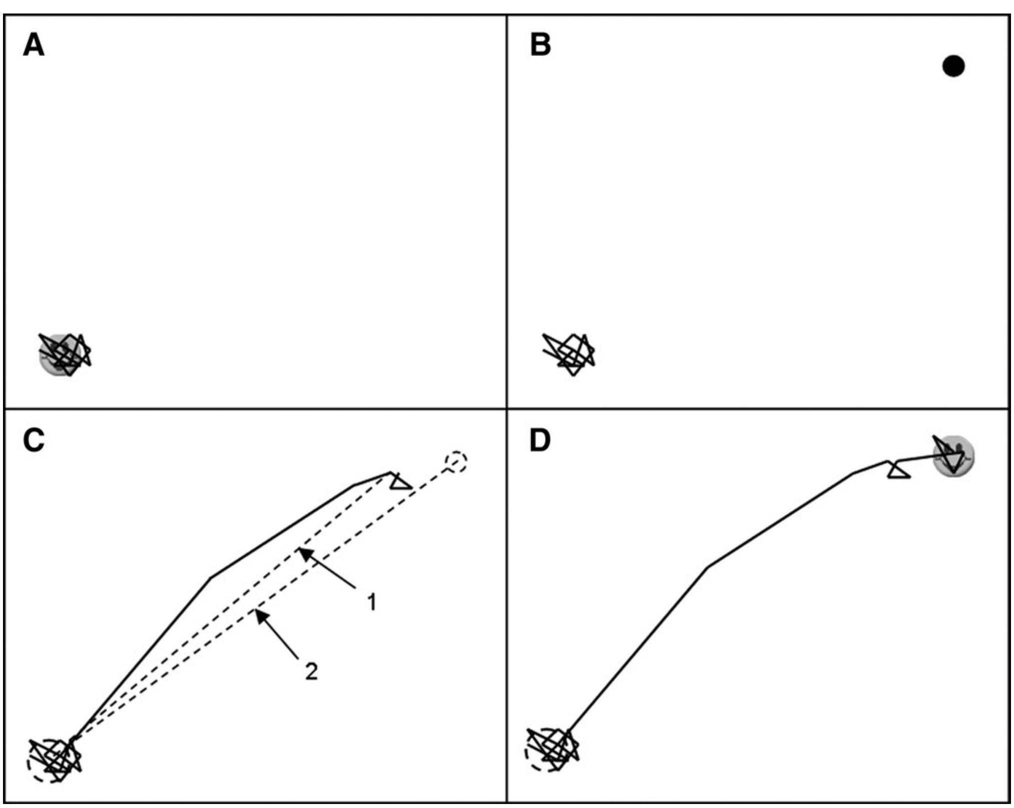

Figure 2. Visual field point being tested and seen. The gaze point changes every 20 ms (*solid lines*). **A,** The subject fixates on a fixation stimulus. **B,** Test stimulus is displayed corresponding to a visual field point. **C,** Change in fixation is detected (*dashed line 1*) and compared with the positional change in stimuli (*dashed line 2*). **D,** New fixation stimulus is displayed ready to repeat the process.