SURVEY OF OPHTHALMOLOGY VOLUME 52 • SUPPLEMENT 2 • NOVEMBER 2007

What Are the Options of Psychophysical Approaches in Glaucoma?

Matthias Monhart

HAAG-STREIT AG, Köniz-Bern, Switzerland

Abstract. The article attempts to provide useful information on psychophysical tests in glaucoma management. This includes the suitability of various glaucoma screening methods, optimum screening parameters for glaucoma detection, and methods for glaucoma follow-up. There is clear evidence that perimetry methods using temporal modulation show a larger area under the curve than standard perimetry methods for the detection of glaucoma. Once the disease is established, there is no significant advantage for flickering stimulus targets. In most cases pattern standard deviation (sLV), or the number of points with a total deviation at the 5% probability level, are best for the identification of glaucoma suspects. If early diagnosis and glaucoma screening is requested, perimetry methods with temporal modulation show a larger area under the curve than standard perimetry methods. In the course of the disease, standard automated perimetry is still the method of choice for functional follow-up. (**Surv Ophthalmol 52**:S127–S133, 2007. © 2007 Elsevier Inc. All rights reserved.)

Key words. detection • FDT • Flicker • glaucoma • HPRP • Matrix • motion perimetry • perimetry • progression • Pulsar • Rarebit • SAP • SWAP • visual fields

"Current clinical indicators of visual function and measures of optic disk structure provide largely independent measures of progression."[2, p. 333] This quote of Paul Artes and Bal Chauhan is part of the conclusion of a 2005 publication from *Progress in Retina and Eye Research*. In that study, 84 patients with a clinical diagnosis of open-angle glaucoma were followed over an average of 7.4 years; different criteria for both "event-based" and "evidence of change-based" progression were applied. The results of the different criteria were very similar. For example, when applying event-based progression analysis with intermediate criteria to 84 patients, 22 progressed with standard automated perimetry (SAP), 21 progressed with confocal scanning laser tomography (CSLT) and 20 progressed with high-pass resolution perimetry (HPRP, a contrast sensitivity test). Of these patients, only 5 progressed in all three methods. This is clear evidence that combining psychophysical and morphological methods improves detection and no perimetry method should be underestimated.

In this article, studies have been selected that used similar definitions for their subject groups. Information on all included methods plus a list of advantages and disadvantages are summarized in the Appendix.

Objective Criteria for the Comparison of Methods

In order to find a suitable method for glaucoma detection and follow-up, various criteria are useful. One objective measure for the detection of pathology is the receiver-operating characteristic (ROC). The ROC helps to select an optimum cut-off value and to compare the sensitivity of all included tests at a given specificity. Fig. 1 is a graph showing the sensitivity (ability to correctly detect pathology) on the *y*-axis and "1 – specificity" (probability to erroneously classify a normal subject as pathologic) on the *x*-axis. The quality of a test method is determined using the area under curve (AUC) calculated from the ROC. Other comparison

0039-6257/07/$–see front matter
doi:10.1016/j.survophthal.2007.08.007

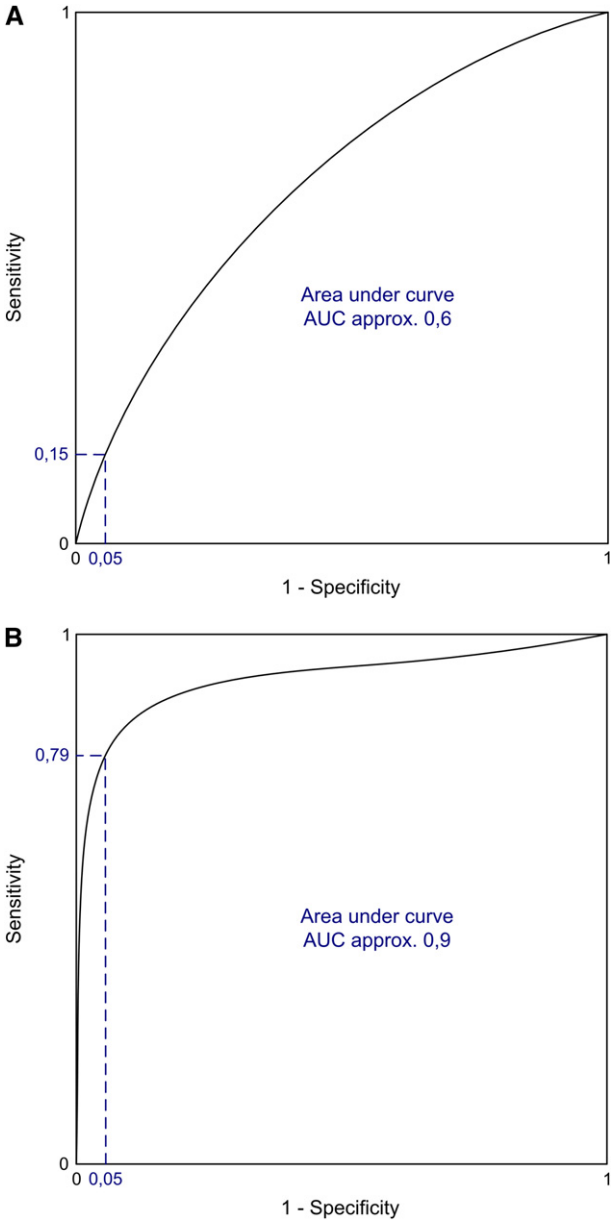

Fig. 1. Comparison of two receiver operating characteristics (ROCs).

methods—such as the prevalence-value-accuracy (PVA) plot analysis—go a step further and include the cost of misclassification (follow-up costs caused by false-positive and false-negative diagnosis) and may thus lead to different results.

APPLICATION OF ROC

In a population-based study in Maryland,[22] the AUC for Goldmann tonometry in the detection of glaucoma was 0.79 with a sensitivity of 28% at 95% specificity (at IOP cut off 24 mm Hg).[11] In a study by Dielemans et al the overall prevalence of primary open-angle glaucoma (POAG) in a Dutch population of 55 to 89 years was reported to be 1.1%.[6] Taking these numbers as baseline, screening 1,000 persons would result in an average of 3 persons correctly identified as having POAG, 8 falsely missed, and 49 false positives. For screening, high specificity is desirable but the more important requirement clearly is high sensitivity. Because psychophysical methods use multiple parameters to identify abnormality, the parameter with the largest AUC is of interest for an objective comparison. Care should be taken if results of different studies are being compared because the difference in subject groups and other factors induce variability.

Optimum Parameters for Glaucoma Screening

A recent publication by Sample et al[20] compared SAP, short wavelength automated perimetry (SWAP), frequency-doubling technology (FDT), and HPRP to identify useful parameters for the determination of abnormality. The results of the study are summarized in Table 1. Using FDT in the progressive glaucomatous optic neuropathy group, the AUC for the criteria Pattern Standard Deviation (PSD) > 4.76 dB was 0.875 and thus in the same range as the optimum parameter. Considering this, PSD (sLV) could be used for the discrimination just as well and was the best performing parameter seen over all four methods.

TABLE 1

Area Under Curve and Optimum Parameters for Standard Automated Perimetry (SAP), Short Wavelength Automated Perimetry (SWAP), Frequency Doubling Technology (FDT), and High-pass Resolution Perimetry (HPRP)

Method	GON Criteria	AUC	PGON Criteria	AUC	Sens/Spec (%)
SAP	PSD (sLV) > 2.31 dB	0.713	TD* 1%, 4 points	0.797	55/90
SWAP	PSD (sLV) > 4.48 dB	0.733	PSD (sLV) > 4.482 dB	0.775	45/90
FDT	TD* 5%, 4 points	0.795	TD* 5%, 4 points	0.880	71/90
HPRP	MD > 2.67 dB	0.670	PSD (sLV) > 0.872 dB	0.780	52/90

*TD; Total Deviation corresponds to the probability plot in Octopus.