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MAJOR REVIEW

Staging Functional Damage in Glaucoma: Review of Different Classification Methods

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Abstract. Classification of glaucomatous visual field defects for different severity levels is important. The reasons for this are numerous, and include: to distinguish between healthy and diseased individuals, to have homogeneous grouping criteria when perimetry is used to define the severity of glaucoma, to adjust therapy on the basis of disease severity, to describe visual field conditions in a short and simple format, to monitor the progression of the disease, and to provide a common language for both clinical and research purposes. Many severity classification methods have been proposed, although none have had widespread use in clinical practice. Other methods, like the cumulative defect curve (Bebie curve), can be used to distinguish the type of visual field loss as diffuse, localized, or mixed. This article provides a review of the main classification methods that have been proposed in the past 40 years. (**Surv Ophthalmol 52**:156–179, 2007. © 2007 Elsevier Inc. All rights reserved.)

Key words. chronic open-angle glaucoma • functional loss classification • perimetry • staging methods • standard automated perimetry • visual field defect • visual field loss characteristics

I. Introduction

Primary open-angle glaucoma (POAG) is a slow, progressive disease for which patients must be monitored throughout their life. The diagnosis of glaucoma is classically based on three criteria: an elevated IOP, typical visual field defects, and characteristic optic disc damage. Unfortunately, the IOP value alone can neither be used to separate healthy from affected individuals nor to stage the disease in different classes of increasing severity, due to its poor sensitivity and specificity. Visual field loss and optic disk damage are thus important, both in the early diagnosis of chronic glaucoma and in the definition of the stage of the disease. Structural alterations can be assessed and recorded manually, using an ophthalmoscopic examination of the optic nerve head with a slit lamp, or by means of various automated image analysis systems (HRT, OCT, etc.). All of the manual-type systems are subjective, poorly reproducible, and require specific clinical experience.[5,13,34,56,67,73,86] Computerized devices are able to analyze the optic disc and nerve fiber layer and to classify the structural damage,[69,82] but are currently under evaluation to determine their clinical utility. The use of these devices in glaucoma management has yet to be widely accepted. Moreover, this type of technology is expensive and is not accessible to many ophthalmologists. Visual field testing with standard automated perimetry (SAP) is currently the most common method used to quantify glaucomatous damage. A standardized staging of glaucomatous functional damage severity, which

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provides a reliable and simple classification of visual field defects, would be very useful both for fields of research and in day-to-day clinical practice for several reasons:

a) To distinguish between healthy and diseased eyes.
b) To use homogeneous criteria for grading severity of disease (which is useful for inclusion criteria in clinical studies in glaucoma, deciding on quantity and type of treatment, etc.).
c) To record and store visual field data in a simple and clear format.
d) To provide better follow-up of the disease.
e) To aid in giving a more reliable prognosis of the disease.
f) For medical-legal purposes.

The method of how visual defects can be classified has been an issue that many have dealt with in past years. One of the simplest and most effective ways to classify defects is to use visual field data obtained by manual kinetic perimetry, SAP, and/or non-conventional testing techniques.

An ideal method for classifying functional damage in glaucoma should be standardized, objective and reproducible, user-friendly, supported by scientific and clinical evidence, adaptable for data obtained from different models of perimeters, supply useful information on the characteristics of visual field defects (shape, type, location, and depth), able to provide a classification which is consistent with structural damage data, widely used and accepted, able to monitor even relatively small changes in functional loss over time, and made available on computer software for easy day-to-day clinical use.

A number of different methods have been proposed in the past for classifying both the severity and characteristic of visual field defects. This article deals with a historical review of the various classification and staging methods of functional damage, which have been used in the field of glaucoma over the past 40 years.

II. Methods for Classifying Visual Field Loss Severity

A. METHODS BASED ON MANUAL PERIMETRY DATA

In 1958, the American Medical Association proposed a scoring system in an article entitled "Guides to the evaluation of permanent impairment. The visual system."[3] The score gives information pertaining to the percentage of retained visual field. This score is obtained by adding the number of degrees of eight principal meridians, and then dividing the total by five. The width of the scotoma is subtracted from the peripheral visual field value in the same meridian. A table was designed that lists the corresponding percentage loss of visual field.

The traditional classification method proposed by Aulhorn and Karmeyer was designed on the basis of a very large sample of glaucomatous patients tested with a manual Tübingen perimeter.[11] Visual field defects are divided in five stages (Table 1). This method has had widespread use in the past, and is still considered to be a fundamental reference point in glaucoma research (Fig. 1).

It is simple, clinically useful, and does not require any statistical or complex analysis. The idea of subdividing visual field loss into five stages has been used in several other modern classification methods. The Aulhorn and Karmeyer method is, however, subjective, dependent on user experience, poorly reproducible, and based on an infrequently used testing procedure. It can be, however, modified,[43] and still used to classify visual field loss severity when the defect morphology is an important parameter. The SAP gray scale printout should be used in the staging of defects with this method.

In 1967, Esterman proposed a grid to be used in the quantitative evaluation of the tangent screen field.[32] The same author then proposed a similar method to score conventional kinetic perimetry.[33] It consisted of 100 units of unequal size, each representing 1%, in which proportionally higher units were assigned to field areas of greater importance (Fig. 2).

The recorded visual field data is superimposed onto the grid and areas within the patient's visual field limits are then counted. This permits the score to be expressed as a percentage. The Esterman monocular and binocular grids were later integrated with Humphrey perimeters. Automated functional scoring is based on the percentage of points seen.

This system, which was originally designed to quantify visual disability and not to specifically stage

TABLE 1

Aulhorn and Karmeyer's classification

Stage I: Only relative defects.
Stage II: Spot-like, stroke-like, or arcuate absolute defects, having no connection to the blind spot.
Stage III: Arcuate absolute defects already connected to the blind spot, with or without a nasal break-through into the periphery.
Stage IV: Extensive ring-shaped or half ring-shaped defects, with a central island of sensitivity maintained.
Stage V: Central island collapse, with only the temporal visual field area remaining.