Clinical Issues: Glaucoma diagnosis and detection of progression in the presence of concomitant diseases

Ananth Viswanathan FRCOphth MD PhD, Consultant Surgeon, Moorfields Eye Hospital, London
Honorary Visiting Professor, City University, London
Honorary Senior Lecturer, Institute of Ophthalmology, London

Core Concepts

- An examination of the neuroretinal rim and surrounding retinal nerve fiber layer is necessary to detect glaucomatous optic neuropathy.
- Glaucoma often affects the superior and inferior poles of the disc.
- Presence of disc hemorrhage and/or retinal nerve fiber layer defects is very suggestive of glaucoma.
- Most automated perimeters report age-adjusted thresholds accounting for normal age-related sensitivity. Reproducible VF changes may be the first signs of glaucoma.
- Quantification of progressive disc/RNFL changes may be aided by analysis of serial confocal scanning laser ophthalmoscopy, OCT or polarimetric images.
- Pointwise analysis for VF progression is more helpful than use of global indices.
- Using glaucoma change software is more reliable than clinical judgement alone.

‘Glaucoma’ encompasses a group of conditions defined by characteristic, progressive changes in the optic nerve head (disc) and visual field. Diagnosis depends on the ability to identify pathological features in the disc and visual field reliably whereas detection of progression depends on the ability to identify change in these features reliably. Ageing changes and age-related comorbidities hamper these tasks. An appreciation of the effects of normal ageing and of age-related pathology other than glaucoma on the visual field and disc appearance enables the relative contribution of glaucoma to these clinical signs and investigations to be deduced.

1 Diagnosis

1.1 Disc

Glaucomatous optic neuropathy is characterised by a loss of neuroretinal rim tissue at the optic disc. An examination of the contour of the neuroretinal rim is necessary to detect this. Particularly in the presence of other age-related change such as cataract, this is best performed by stereoscopic evaluation of the disc through a dilated pupil with a direct or indirect fundus lens at the slit lamp. Glaucomatous change may be differentiated from normal age-related narrowing of the neuroretinal rim because glaucoma often affects the superior and inferior poles of the disc preferentially. The presence of disc haemorrhage and/or retinal nerve fibre layer defect(s) is very suggestive of glaucoma since their prevalence in the general population is low. Cup/disc ratio has a wide normal range; it also depends on age, disc size and intraocular pressure.

1.2 Field

As most automated perimeters report age-adjusted thresholds, they account for normal age-related sensitivity decline: for example the Total Deviation plot of the Humphrey Field Analyzer (Carl Zeiss Meditec Inc., Dublin, CA, USA). Glaucomatous defects can be dis-
Figure 1: An example of the follow-up analysis printout of the Glaucoma Progression Analysis I (GPA). The printout shows the analysis for three tests descending in chronological order. The progression analysis is shown as the rightmost graph for each test. Points showing deterioration (p < 0.05) compared to baseline are shown as empty triangles. Points in which this behaviour is maintained in two consecutive tests are shown as half filled triangles. Points in which this behaviour is maintained in three consecutive tests are shown as filled triangles.

Figure 2: An example of the PROGRESSOR cumulative graphical display. Each test location is represented by a bar graph. Each bar in the graph represents the result of one test for that location. Longer bars correspond to worse sensitivity and the slope of the regression line is colour coded for significance according to the Legend. Thus, in this example, many points in the superior nasal field have bars which are progressively lengthening over time and have significant negative slopes. This behaviour represents visual field progression. Its arcuate distribution suggests that the cause is glaucoma.

tinguished from those caused by other pathology by a thorough history and examination to detect co-morbidity along with noting the characteristic patterns of glaucomatous loss, such as paracentral scotoma, nasal step and arcuate scotoma. Some perimetric algorithms, such as the Pattern Deviation plot of the Humphrey Field Analyzer, highlight these focal changes and diminish the importance of diffuse depression of the hill of vision, which may be caused by other age-related pathology such as cataract. Repeat the field test if results are uncertain. Reproducible visual field changes may be the first signs of glaucoma rather than detectable change in the optic disc.³

2 Progression

2.1 Disc
Judging progressive disc changes by serial clinical examinations or serial photographs is difficult and unreliable. Salient features are progressive narrowing of the neuroretinal rim, violation of the ISNT rule where it was previously obeyed, increase in zone β peripapillary atrophy, increase in number or width of RNFL defects and presence of optic disc haemorrhages. For the last, consider differential diagnoses such as diabetic retinopathy and posterior vitreous detachment. Quantification of progressive disc/RNFL changes may be aided by analysis of serial confocal scanning laser ophthalmoscopy, ocular coherent tomography or polarimetric images, but despite significant improvements, much of the software for these analyses remains rudimentary.

2.2 Field
To distinguish the effects of progressive glaucoma on the visual field from those of coexisting pathology, consider the characteristic patterns of glaucomatous loss as described in 1.2 above. It is more useful to analyse visual field progression on a point wise basis rather than with global indices. Using glaucoma change software is more reliable than clinical judgement alone.⁴ Two examples of such software are the Glaucoma Progression Analysis I (Carl Zeiss Meditec Inc., Dublin, CA, USA, figure 1) and the PROGRESSOR software (Moorfields Eye Hospital, London / Medisoft Ltd., Leeds, UK, figure 2). Of these, the PROGRESSOR software gives an es-
Core concepts
- Estimation of optic disc size is an integral part of the clinical examination of glaucoma.
- Without consideration of optic disc size, cup size and cup/disc ratio are not clinically meaningful parameters.
- There are four methods for estimating optic disc size.
- Measurement of the vertical diameter of the optic disc by means of a continuously adjustable beam of the slit lamp and a magnifying lens provides a rapid and easy estimation of optic disc size.

The degree of optic disc cupping in normal eyes is strongly related to optic disc size. Some large cups within big-sized discs tend to be mistaken as abnormal. On the other hand, some minute cups in small discs may be wrongly considered normal. Estimation of optic disc size is, therefore, an important part of optic nerve examination.

Measurements of the optic disc size made with parametric imaging methods or by planimetry are less subjective (and, consequently, less prone to errors) than clinical examination. Also, these imaging methods and ophthalmoscopic examinations are not interchangeable clinically. Usually it suffices to know whether a given optic disk is abnormally large, medium or abnormally small; this can be achieved relatively simply.

The degree of optic disc cupping in normal eyes is strongly related to optic disc size. Some large cups within big-sized discs tend to be mistaken as abnormal. On the other hand, some minute cups in small discs may be wrongly considered normal. Estimation of optic disc size is, therefore, an important part of optic nerve examination.

2. Distance (in disc diameters) between the disc and the fovea. In normal sized eyes, the distance between the disc and the fovea should approximate two and a half disc diameters. The shorter the distance, the larger the disc and vice versa.

3. Area calculation with a slit lamp and a magnifying lens. Use a slit lamp with a continuously adjustable vertical light beam and a scale calibrated in millimetres. Examine with any magnifying fundoscopy lens. Place the slit beam coaxial with the observation axis. Then adjust a narrow beam to the vertical and horizontal diameters of the optic disk using the inner margin of the white Elschnig’s ring. Make at least three measurements. Then multiply the average of these three measurements by the magnification correction of the lens being used. The correction factor for the 60D Volk lens is 1, for the 78 D, 1.11 and for the 90 D, 1.33. Then use a modified formula of the ellipse (area: r/4 X horizontal diameter X vertical diameter) to calculate the area of the disc.

References