Are Digital Imaging Devices Better than General Ophthalmologists at Diagnosing Glaucoma?

Roberto M Vessani[1] and Remo Susanna, Jr[2]

1. Assistant Professor, Glaucoma Service; 2. Head, Ophthalmology Department, University of São Paulo

Abstract

Evaluation of the optic nerve head (ONH) and retinal nerve fibre layer (RNFL) is fundamental for glaucoma diagnosis. Limitations in clinical assessment of this structure may be related to normal anatomical variability and level of experience. Computerised imaging technologies such as scanning laser ophthalmoscopy, scanning laser polarimetry and optical coherence tomography have been proposed as alternative methods to help the clinician in glaucoma diagnosis. Recent case–control studies suggest that these instruments do not provide better ability to discriminate normal from glaucomatous eyes compared with glaucoma experts, but that the reverse may be true for examiners with lower levels of experience in this disease. Increasing evidence suggests that the combination of information provided by subjective and objective analysis of ONH and RNFL could be useful to improve diagnostic certainty.

Keywords

Glaucoma, optic disc, retinal nerve fibre layer, general ophthalmologists, stereophotography, imaging devices

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Correspondence: Roberto M Vessani, Rua Pará 222, Apartment 92, 01243020 São Paulo, Brazil. E: robves@terra.com.br

Clinical Evaluation of the Optic Nerve Head and Retinal Nerve Fibre Layer in the Diagnosis of Glaucoma

The evaluation and management of patients suspected of having glaucoma is part of the daily routine of many ophthalmologists. When examining each patient, clinicians integrate information from various diagnostic tools to make their decisions.

Assessment of the appearance of the optic nerve head (ONH) is a cornerstone of the diagnosis of glaucoma. A method for detecting abnormality and also documenting changes in this structure should be part of routine glaucoma management. Currently, stereophotographic examination of ONH and the retinal nerve fibre layer (RNFL) is considered to be the most adequate tool for this task. However, due to the subjective nature of this method, some factors may influence its ability to discriminate between healthy and glaucomatous eyes.

The examiner's level of training and experience is one such factor. It has been demonstrated that this element seems to affect stereophotograph grading in glaucoma diagnosis: general ophthalmologists tend to perform better than optometrists and residents[1] and glaucoma experts better than general ophthalmologists.[2,3] Differences in knowledge of the characteristics of glaucomatous optic discs or in the ability to identify them may be part of the explanation. Intra- and inter-observer agreement may also be influenced by the examiner's experience: glaucoma experts usually show better results than other eye-care professionals.[2] However, it should be mentioned that even glaucoma experts may not necessarily demonstrate good inter-observer agreement.[4] In a study by Varma and colleagues, intra-observer agreement in assessing glaucomatous disc damage was substantial but inter-observer agreement was moderate; in this study, the need to develop standardised methods for inter-observer evaluation of the optic disc in glaucoma is emphasised.

Regardless of the level of experience in glaucoma diagnosis, another aspect to be considered in an eye-care professional's examination of the ONH is anatomical variability. There are large variations in disc size within any given population and also among populations. Assessment of optic disc size is an important component of ONH examination as the size of the neuroretinal rim and the optic cup vary in line with this parameter.[5] Therefore, disc size itself may influence the likelihood of a clinician making a diagnosis of glaucoma. It has been demonstrated that glaucomatous optic neuropathy may be missed more frequently in eyes with small optic discs.[6]

Peri-papillary RNFL is another fundamental component of ONH examination and its visibility may vary according to fundus pigmentation due to retinal pigment epithelium and the underlying blood vessels of the choroid. Clinical ability to identify RNFL defects may also be influenced by the type of defect, where diffused defects may be more difficult to identify compared with localised defects.

Considering the difficulties associated with subjective evaluation of the ONH and peri-papillary RNFL, objective methods have been proposed to measure these structures.

Computerised Imaging Devices for Glaucoma Diagnosis

During the last 20 years, computerised imaging devices that evaluate the optic disc, RNFL and macular thickness have been developed and proposed to help clinicians diagnose and monitor glaucoma, providing

objective and quantitative measurements of these structures. Optical coherence tomography (OCT: Carl ZeissMeditec, Dublin, CA), scanning laser polarimetry (SLP: GDx-VCC; Carl ZeissMeditec Inc., Dublin, CA) and confocal scanning laser ophthalmoscope (CSLO: Heidelberg retina tomograph [HRT]; Heidelberg Engineering GmbH, Dossenheim, Germany) are among these instruments. In the last few years these technologies have continuously received significant modifications to improve their ability to detect glaucomatous damage. The good reproducibility of the objective measurements provided by these technologies and the possibility of comparing a patient with a population of age-matched normal subjects may facilitate an eye-care professional's ability to identify abnormal structural features.

The ability of these techniques to diagnose this disease has been evaluated over the years in various studies.[7–10] Most of them suggest that these three technologies provide good ability to separate normal from glaucomatous eyes in case–control studies; however, this performance seems to be influenced by optic disc size and extent of glaucomatous damage, among other factors.[11]

Computerised Imaging Devices versus Clinician Assessment in Glaucoma Diagnosis

Like any other diagnostic method in medicine, computerised imaging devices must prove their advantages against the gold standard: clinical evaluation of the optic disc and RNFL.

Comparison of methods by Greaney and co-workers[12] demonstrated that subjective evaluation of the optic disc by glaucoma experts is at least as good as that provided by computerised imaging devices such as OCT, HRT and GDx.

A few years ago, a consensus of the World Glaucoma Association concluded that, according to the limited evidence available, the sensitivity and specificity of imaging instruments for detection of glaucoma are comparable to the results of expert interpretation of colour stereophotographs.[13]

Recently, DeLeon-Ortega and colleagues[14] demonstrated that subjective assessment performed by masked expert stereophotography graders performed better at discriminating glaucomatous and non-glaucomatous eyes compared with the best objective parameters provided by the three technologies (HRT-II: global cup-to-disc area ratio; GDx-VCC: nerve fibre indicator; and Stratus OCT: RNFL thickness, ONH vertical integrated rim area and macular thickness). Badalà and co-workers[15] also found that the latest versions of these technologies did not produce better results than evaluation of the ONH stereo-photographs by glaucoma experts.

Unfortunately, evaluation of stereophotographs by glaucoma experts may not reflect ONH assessment by all ophthalmologists in their clinical practice, and could overestimate the diagnostic performance seen in the primary care setting. Comparison of computerised imaging instruments against examiners with less experience in glaucoma diagnosis may provide different results.

Two recent studies tried to address this matter.[2,3] Reus et al.[2] compared the accuracy and reproducibility of SLP-VCC and CSLO in diagnosing glaucoma with that of clinical assessment of stereoscopic ONH photographs by various eye-care professionals (including glaucoma experts, general ophthalmologists, residents and optometrists). The authors observed that SLP-VCC had the highest diagnostic accuracy. CSLO had a comparable diagnostic accuracy to glaucoma specialists and general ophthalmologists. Residents classified the fewest eyes correctly. In addition, for any technique or grader, eyes with mild glaucomatous loss were more difficult to classify correctly than eyes with more damage.

Vessani et al.[3] evaluated subjective assessment of ONH and RNFL by general ophthalmologists and by a glaucoma expert compared with objective parameters of computerised imaging devices represented by OCT (Stratus OCT), scanning laser ophthalmoscope (HRT III), and SLP (GDx ECC) in discriminating glaucomatous and non-glaucomatous eyes. The study revealed that parameters from computerised imaging devices, either by absolute values or by classification based on comparison with an internal database, may be better at separating glaucomatous eyes with established visual field defects from normal controls compared with general ophthalmologists, but not compared with a glaucoma expert.

General ophthalmologists used in referred studies may not represent all clinicians who deal with glaucoma suspects in the primary care setting. The ability to detect disease may be influenced by level of experience, continuous medical education, conditions of work and other factors. Therefore, the current findings of those studies cannot be generalised to all ophthalmologists. They also do not suggest that computerised imaging devices should replace general ophthalmologists in the diagnosis of glaucoma patients in their practice. However, the results demonstrate that examiners who are less experienced in glaucoma diagnosis may perform differently against computerised imaging instruments in research conditions.

Studies to evaluate the ability of computerised imaging instruments to detect glaucoma have employed a case–control design including glaucoma patients (cases), defined based on the presence of repeatable characteristic glaucomatous visual field defects, and normal subjects (controls), generally required to have normal visual fields, normal intraocular pressures (IOPs) and healthy appearance of the optic nerve. These studies are clearly important to provide an initial exploratory evaluation of the ability of these tests to detect glaucomatous damage.[16] However, further steps should be taken to evaluate whether these imaging devices are able to provide clinically relevant information.

In a real clinical situation, the ophthalmologist can deal with a patient who may not be defined as normal or having glaucoma, but who rather is a suspect. Therefore, when evaluating diagnostic studies it is important to appraise whether the test has been evaluated on a population that is representative of the one in which the test will be applied in clinical practice. To establish diagnosis in this type of patient, the clinician integrates the maximum possible information, such as medical history, clinical examination and additional tests, to improve the level of certainty of the final diagnosis. Subjective grading of the ONH plays a key role in the clinical evaluation of a patient for glaucoma, together with all other available clinical information, such as presence of visual field defects and level of IOP.

It is possible that computerised instruments could provide important additional information in this situation. It has been suggested that RNFL measurements may provide an important degree of additive information when combined with subjective assessment of the optic

disc. Vessani et al.[3] observed that this improvement in glaucoma detection may be more significant for non-glaucoma experts.

Continuous training of all eye-care professionals in the detection of signs of glaucoma in the optic disc is another possible way to improve the ability to detect the disease. Strategies with simple systematic approaches and educational interventions instructing primary care physicians in the recognition of glaucomatous changes in the optic disc may improve diagnostic ability and management of glaucoma in a short period of time. Economic factors may indicate this type of approach as a more reasonable choice to improve glaucoma diagnosis, considering the actual cost of each of these imaging technologies; this may be especially important in developing countries.

In conclusion, it is expected that imaging techniques may assist clinicians in the management of glaucoma, but they have not yet been proved to be a substitute for clinical assessment of ONH and RNFL. ■

Roberto M Vessani is an Assistant Professor in the Glaucoma Service in the Ophthalmology Department at the University of São Paulo Medical School. His main interest is diagnostic tests in glaucoma, including clinical evaluation of optic disc stereophotographies, computerised imaging devices and automated perimetry. He is also involved in methods to evaluate intraocular pressure in glaucoma such as the diurnal tension curve and the water drinking test.

Remo Susanna, Jr is Head of the Ophthalmology Department at the University of São Paulo Medical School and Past President of the World Glaucoma Association (WGA). His main interest is diagnostic tests in glaucoma, including clinical evaluation of optic disc stereophotographies, computerised imaging, automated perimetry and intraocular pressure. He is also involved in clinical trials to evaluate new clinical and surgical therapies in glaucoma.

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