Size Matters: Why Optic Disk Size should be Measured When Assessed for Glaucoma?

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INTRODUCTION

Examining the optic disk is crucial to detecting glaucoma. Correct diagnosis requires measuring the disk’s size in particular. Knowledge of the disk size is very important for an accurate diagnosis of glaucoma. Same cup size in two different disks may have different implications. Disk size can be measured clinically as well as with optic nerve imaging devices, HRT, OCT, GDx. In all glaucoma workups, size of disk should be mentioned as average normal, smaller or large.

WHY MEASURE THE OPTIC DISK?

The answer is based on two fundamental structural observations: First, the optic disk area varies widely among individuals by a factor of approximately 1:7.1 The horizontal and vertical disk diameters are also highly variable, although to a somewhat lesser extent.2 Second, the size of parameters such as the neuroretinal rim, the cup, and the commonly used cup-to-disk ratio are determined by the optic disk’s size.3-5 Thus, a large cup-to-disk ratio may be physiologic if the optic disk is large,6 whereas even a small cup-to-disk ratio may signify glaucomatous optic neuropathy in the presence of a small disk.7 Therefore, when evaluating an optic disk such as the one shown in Figure 1 it is essential to know its size. Moreover, recent systems for staging glaucomatous optic disk damage require the consideration of disk size.8 One also might view differently the results of population-based glaucoma prevalence studies in which an arbitrary cup-to-disk ratio was used as a diagnostic criterion without accounting for disk size. This is analogous to current interpretation of previous studies that reported IOP in large populations without taking accounting for corneal thickness. Moreover, asymmetric cupping, commonly interpreted as a sign signifying possible glaucoma, may indeed be a physiologic result of asymmetric disk size rather than an indication of glaucoma (Abstract, Bujak and Yan, ARVO 2004).

The Moorfields Regression Analysis used by the Heidelberg Retina Tomograph (HRT; Heidelberg Engineering GmbH, Dossenheim, Germany) takes disk area into account, because it was shown to improve discrimination between healthy disks and those with early glaucoma.9 Investigators in the scanning laser ophthalmoscopy ancillary study to the Ocular Hypertension Treatment Study found that most optic disk parameters were significantly larger in blacks than in other racial groups. When disk size was included in the multivariate analysis, however, these differences were no longer statistically significant.10 The investigators suggested that the size of patients’ optic disks must be considered in addition to their race when diagnosing glaucoma (Fig. 1).

In the standard printout of the HRT3 (Heidelberg Engineering GmbH), the statistical normality analysis of every disk parameter is adjusted for the disk’s size. Researchers have also recently reported correlating the size of the optic disk to measurements of the retinal nerve fiber layer’s thickness by optical coherence tomography (OCT)11 and scanning laser polarimetry.12

HOW TO MEASURE THE OPTIC DISK?

The clinician may measure the vertical and horizontal disk diameters at the slit lamp using contact or noncontact lenses. A narrow beam is projected onto the disk, its length is adjusted to the diameter of the disk within (but not including) the peripapillary scleral ring, and this length is read on the scale of the slit-lamp in millimeters.13-15 The clinician may hold the lens with his thumb and index finger while his fourth finger rests on the patient’s cheekbone; this approach keeps a constant length between the lens and the patient’s eye, and it also maintains the stability of the lens, thus allowing more precise measurements. Different fundus lenses provide different magnification of fundus objects.15,16 Thus, in order to obtain the actual disk size, the magnification specific to the lens used must be known. However, as explained below, this may not be necessary in routine clinical measurement. The eye’s refraction, when not unusually ametropic, and the distance between the fundus lens and eye, do not significantly alter the measurement.16

Novel imaging devices such as the HRT and Stratus OCT (Carl Zeiss Meditec, Inc., Dublin, CA) analyze the optic disk,
including its size. The standard OCT printout includes a measurement of the disk area and vertical diameter. The standard HRT printout includes disk area, and the clinician may request the calculation of any disk diameter via the “interactive measurements” option. The HRT is dependant on the subjective outlining of the nerve by the examiner. The OCT can either automatically determine disk size by detecting the edge of the RPE, or this can be done manually by the examiner; these two methods have been found to differ significantly in many cases. These automated or semi-automated measurements have higher reproducibility and lower interobserver variability compared with the clinician’s own assessment of the optic disk. In addition, the printouts allow easy documentation and archiving of the disk’s status. For these reasons, practitioners are relying increasingly on these instruments as diagnostic tools, even to the point of replacing a careful funduscopic evaluation.

ARE DISK SIZE MEASUREMENTS BY DIFFERENT METHODS INTERCHANGEABLE?

At present, the disturbing answer is—no. The range of differences in measurements of the size and other parameters of the optic disk between various modalities does not allow their interchangeability or the provision of conversion formulas. Realizing this, Jonas suggested that, in daily practice, clinicians need not incorporate into their evaluations the exact numerical value of the disk’s size and various conversion formulae. Instead, he recommended using a quick, crude estimate of whether the disk in question was of average, smaller, or larger size. Even so, in a recent study, we found poor agreement between the HRT-II (Heidelberg Engineering GmbH), the Stratus OCT, and funduscropy—both in absolute measurements of the optic disk’s size, and in the categorization of disks as small, average, or large (Fig. 2).

PRACTICAL IMPLICATIONS

Until further technological adjustments are made, the estimation of both the absolute and relative size of a disk can only be defined separately for each measuring technique. Because all of the modalities provide relatively reproducible measurements, however, they may each be used successfully to define a nomogram and thus for diagnostic purposes. Measuring the

Fig. 1: This patient has IOPs under 20 mm Hg, full visual fields, and optic disks that are suspicious for glaucoma. The clinician must measure the size of these disks before making a diagnosis, however
vertical or horizontal diameter of the optic disk at the slit lamp is the easiest and least time-consuming approach. One may use either diameter to classify the disk’s size. For research purposes, one may use both diameters in the following formula to calculate: Disk area: area = \( \pi r/4 \) horizontal diameter \( \times \) vertical diameter. \(^{21}\)

Measurements of the disk at the slit lamp are affected by magnification factors related to the slit lamp and lens used. Some standardization may be achieved by multiplying measured size by the magnification factor provided by the manufacturer for each lens. Alternatively, each clinician therefore should establish his own normal values, for example, by measuring the disks of 30 or so patients of the same ethnic background. During subsequent routine clinical examination, this allows the quick classification of the disk as average-sized, small or large, with immediate implications on the meaning of the observed disk parameters such as the cup, rim, and cup-disk ratio. Using machines such as the HRT provides a greater degree of standardization. For the classification of disk size, the clinician can grossly rely on the normal values provided by the instrument’s database, provided he/she is familiar with the source of the database (e.g. race and age of the population) and its relevance to his own patients. For example, the HRT3 currently has ethnic-selectable databases, with the Caucasian database including some 700 healthy eyes. It classifies each optic disk as small, average, or large based on disk area (Fig. 3), with average disk area defined as mean ±1 SD (2.03 ± 0.4 mm\(^2\) for Whites).
CONCLUSION

Measuring the size of the optic disk is required for the accurate diagnosis of glaucoma. Without this information, clinicians may overdiagnose the disease in eyes with large disks and physiologic cupping, and they may miss early glaucoma in eyes with small disks and small cups. Whether measuring the disk at the slit lamp or with imaging devices such as the HRT or Stratus OCT, practitioners must be familiar with the methodology and variability of each method. At present, measurements are not interchangeable between these modalities.

REFERENCES