Glaucoma - Old Truths Newly Understood

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Introduction

In the past, glaucoma was defined as an optic neuropathy consisting of increased cup-to-disc ratio (CDR), elevated intraocular pressure (IOP) and visual field (VF) defects. An enormous amount of work has been done in the past decade to re-evaluate these pillars of diagnosis. As a result, there have been fundamental alterations in the definition of glaucoma, as well as many of the concepts related to this disease. Here we introduce some of the important conceptual shifts that have evolved recently.

Vertical CDR with respect to Vertical Disc Diameter (VDD)

Increased CDR remains an old truth for characterising glaucomatous optic neuropathy (GON). However, the days have gone where an increased CDR was sufficient for diagnosing GON. Vertical CDR (VCDR), which is defined as the longest vertical cup diameter divided by the longest vertical disc diameter (VDD), is a more sensitive and specific indicator of GON. Horizontal CDR, even if increased, may not be specific for GON. In fact, a cup with horizontal CDR larger then VCDR, in other words a horizontally oval cup, is considered as non-glaucomatous cupping. In the past we may be taught to use an arbitrary cut-off point for defining an increased CDR, such as 0.5. This old truth now has to be understood with respect to VDD. Studies have shown that the VDD varies across individuals and in general, follow a Gaussian distribution. People with large disc will have their optic nerve fibre more spread out across a wider diameter, necessarily resulting in a larger cup, say 0.8, even in the absence of glaucoma. Patients with small disc will have the same optic nerve fibre crowded within a small cup and hence, their normal VCDR may be in the range of 0.1-0.2. Epidemiological data have well-demonstrated the relationship between VDD and VCDR (Figure 1). An example is shown here in Figure 2, where the VCDR of 0.85 for this disc is minimally glaucomatous cupping as it is a large disc with VDD of 2.3 mm. In another example shown in Figure 3, a VCDR of 0.55 represents a moderate to advanced glaucomatous damage because of its small VDD of 1.4 mm. We should also be reminded not to underestimate the cup size by defining the cup with respect to palor of neuroretinal rim-we should always define the cup with respect to the indentation of small vessels tha emerge from the optic disc. Having said all that, the important take home message is: the VDD can be measured using the direct ophthalmoscope and then measure the VDD by focusing the calibre over the disc.

Morphological changes of Glaucomatous Optic Neuropathy (GON)

Apart from VCDR, other morphological features of the optic discs were known to serve as important clues to GON. Many of the old truths about these changes in a GON remain, but the newer understanding is that they should be given greater emphasis, apart from VCDR, in diagnosing GON. Glaucoma is now a morphological diagnosis of optic nerve head. This is especially important in a group of “pre-perimetric glaucomas” (see below), where anatomical damage of optic nerve head by glaucoma occurred in the absence of detectable functional visual field damage.

In the early stage of glaucoma, selective loss of neural rim tissue in glaucoma occurs primarily in the inferotemporal region of the optic nerve head and a lesser extent in the superotemporal sector. As glaucoma progresses, the temporal neural rim is typically involved after the vertical poles, with the nasal quadrant being the last to go. This extends to become what is known as the “ISNT” Rule - in a healthy optic disc the thickness of neural rim should be in the order of Inferior (thickest) ♦ Superior ♦ Nasal ♦ Temporal (thinnest) (Figure 4). If that order is violated, a disc may be glaucomatous.

Intraocular Pressure (IOP)

One of the key old concepts to be newly understood is that IOP is NO longer needed for diagnosing glaucoma. The concept of “normal IOP” with the magic figure of 21 mmHg was all along an unfounded assumption. It
probably stems from studies with Leydhecker et al., using the old-time Schiotz tonometer to study the IOP profiles of 10,000 subjects. In that study, the mean of IOP was 15.8 +/- 2.57 mmHg, with 2 SD above mean being 20.9 mmHg which they interpreted as “upper limit of normal.” While a high IOP is still definitely a single most important risk factor for development of glaucoma (the probability of developing glaucoma reaches 0.5 at 27-28 mmHg and approaches 1 (i.e. certainty) at 35 mmHg or above), glaucoma occurs frequently in patients with normal or low tension. The Baltimore Eye Study has confirmed that up to 50% of the subjects with glaucoma can present with normal IOP on 1st visit and 33% of those with normal IOP on 2nd visit. The prevalence of open angle glaucoma with normal or low tension was 57.1% in UK, 61% in Singapore, and up to 92.2% in Japan.

In fact, we do not have sufficient evidence in the literature to justify the concept of normal IOP. Thus, many glaucomatologists nowadays abandon the concept of normal range of IOP and IOP has already been deleted from the definition of glaucoma for some years.

Having said that, it is important to note that IOP remains one of the most important pathogenetic mechanism for glaucoma, and lowering IOP is still one of the most effective way to halt glaucoma progression, even if the pretreatment IOP is well within the “normal” range. The conceptual change here is glaucomatous damage occurs at previously thought “normal” IOP.

Visual Field Defects

VF damage represents a functional damage as a result of glaucoma. However, studies have shown that before functional deterioration, anatomical damage would have occurred long before that. What is more, it takes more than 50% of the retinal nerve fibre layer to die before appreciable functional loss over VF tests. Therefore the concept of pre-perimetic glaucoma arises—where objective signs of anatomical derangement occurs without VF loss which is a subjective test. With the advent of newer diagnostic instruments like Heidelberg Retinal Tomography (HRT) and Optical Coherence Tomography (OCT), more pre-perimetic glaucoma can now be diagnosed and treatment instilled earlier on. Even without sophisticated instrument, an accurate appreciation of GON morphologically over direct visualisation is no inferior.

Conclusion

Glaucoma will continue to be one of the most important ophthalmic diseases with the aging population. While nowadays we have seen less missed cases of APACG admitted for neuroimaging to look for causes of severe headache and vomiting, diagnosing chronic forms of open and closed angle glaucoma remains challenging. With the latest trend in emphasising more on diagnosing glaucoma based on morphological GON, the challenge is even greater. Ability to measure IOP at a GP’s office or at home will definitely help, but as described above, it would probably be even more helpful if one can diagnose glaucomatous optic neuropathy with confidence using one’s direct ophthalmoscope, as IOP is not necessary for glaucoma diagnosis. It is time for doctors, whether ophthalmologists or not, to start picking up the direct ophthalmoscope again, look at the disc, and look hard at the disc.

Messages: old signs newly understood

1. Vertical CDR must be interpreted with respect to Vertical disc diameter for classifying a glaucomatous disc or not.
2. IOP is no longer necessary in diagnosing open angle glaucoma.
3. VF loss is not needed for diagnosing glaucoma.
4. Glaucoma is diagnosed based on evidence of morphological optic disc damage.
5. It is time for doctors, whether ophthalmologists or not, to start picking up the direct ophthalmoscope again, look at the disc, and look hard at the disc.
Figure 4. The “ISNT” Rule - in a healthy optic disc the thickness of neural rim should be in the order of Inferior (thickest) → Superior → Nasal → Temporal (thinnest).

References