Topic: Macular Evaluation in Glaucoma - Why Is It Necessary?

Instructor: Prof. Prasanta Kumar Nanda

Contrary to the belief that glaucomatous damage starts at periphery and macula is affected in the advanced stage of the disease only, growing evidences suggest that early glaucomatous damage does affect macula. Traditionally evaluation of ONH & circum-papillary RNFL along with Visual Field assessment with either 24-2 or 30-2 has been the common clinical paradigm in glaucoma evaluation. These can miss detecting early glaucomatous central damage. Glaucoma is a disease where Retinal Ganglion Cells die. Macula contains about 50% of RGCs, in a multi-layered pattern. So, it makes sense to examine this area. We will discuss how macular evaluation not only helps in diagnosing glaucoma in its early stages, but also how it can help in overcoming the challenges of detecting progression in advanced disease. It is specifically helpful in monitoring glaucoma patients with certain ocular conditions like myopia and optic disc phenotypes. Moreover, macular region, which is about 12 degrees (3.5 mm) in diameter, is essential for everyday functions such as driving, reading, and face recognition. When This area is affected, the Quality of Life decreases dramatically. We will discuss in detail why, how, when and in whom macula evaluation is necessary and debate whether macular evaluation should be done for all glaucoma patients or not.

Topic: Understanding the Anatomy of Macula and how it relates to Glaucoma

Instructor: Dr Bhagabat Nayak

- To understand how glaucomatous damage affects vision, it helps to think about macular anatomy.
- The macula is a 5.5–6 mm area at the center of the retina responsible for high-resolution, sharp, colour vision. The center of the macula, called the fovea (1.5 mm), contains the highest density of cones. The foveola is the very center (350 micron) and is the most sensitive part of the retina.
- Although the macula represents less than 2% of the retina area, it contains over 30% of the Retinal Ganglion Cells (RGCs). 18% of Visual field. More than one layer of Ganglion cell up to 5 layers in parafovea region. Ganglion cell: cone=2.5:1
- In the macula, photoreceptor axons form the Henle fiber layer, which runs obliquely,
- The thickness of GCC complex and RNFL is more in inferior half of the macula, so more fiber goes to inferior pole of disc. The thickness is more in inferior pole of disc, for which early damage occurs there due to crowding and corresponding superior arcuate visual field defect at macula. The superior macular GCC + and RNFL goes more to temporal pole of disc as disc is 6°off set upwards to the macula, and the temporal pole less susceptible to damage due to less crowding.
- Glaucoma specifically affects the inner retinal layers—the Retinal Nerve Fiber Layer (RNFL), Ganglion Cell Layer (GCL), and Inner Plexiform Layer (IPL)—which are thickest in the macula.
- Axons from the inferior part of the macula tend to travel to a specific area of the optic disc, termed the "**macular vulnerability zone**," which is highly susceptible to damage.
- Macular damage is often arcuate (comma-shaped) in nature, following the path of nerve fiber bundles.
- A key indicator of glaucoma in macular imaging is the "temporal raphe sign"—a sharp horizontal line of thinning on a macular GCIPL thickness map.
- The standard 24-2 visual field (VF) test, with points spaced 6° apart, often misses early macular damage. A 10-2 VF test, which covers the central 10 degree with points spaced 2° apart is necessary to detect these early, subtle, paracentral defects.
- Macular damage in the "better" eye is associated with a dramatic decline in the quality of life, specifically affecting facial recognition, reading, and tasks requiring high contrast sensitivity even before visual field changes appear.

Topic: Central Visual Fields in Early Glaucoma

Instructor: Dr Tutul Chakravarti

The primary goal of glaucoma treatment is to protect central vision. Damage to the paracentral visual field can lead to split fixation, typically associated with advanced glaucoma. Historically, it has been noted that glaucomatous damage can affect the central field and macula in the early stages of the disease. Therefore, central visual field defects (CVFD) or glaucomatous macular damage may be a clinical feature of early glaucoma, particularly affecting the upper hemifield in mild-to-moderate cases. Central vision, linked to macular function, is crucial for daily activities, and damage to the macula can greatly affect QoL due to the high density of retinal ganglion cells (RGCs) there.

Glaucoma affects both central and mid-peripheral vision, with patients experiencing greater visual impairment in the central 10 °. However, common visual field tests often miss early signs of CVFDs, which can significantly affect patients' quality of life (QOL). Relying solely on 24-2 or 30-2 VF assessments can underestimate the severity and implications of glaucomatous vision loss.

- This course provides a comprehensive guide to understanding CVFDs in glaucoma, from early detection to advanced cases. We will explore the functional aspects of glaucomatous macular damage, and discuss the structure-function correlations between the 24-2 and 10-2 VF tests and the RNFL and RGC layers.
- A key debate will address whether the 24-2 VF or the 10-2 VF is more effective in detecting early glaucomatous macular damage. Additionally, we will discuss the lack of standard guidelines for detecting progression in advanced glaucoma and offer insights into the patterns of CVFDs over time.
- We will also compare the innovative 24-2C test to the traditional 24-2 test and the Octopus G1 program in detecting central defects.

Finally, we will evaluate if the SITA Faster algorithm presents a viable alternative to the SITA Standard.

Join us as we uncover these fascinating topics!

Topic: Macular Optical Coherence Tomography Imaging in Glaucoma

Instructor: Prof. Dr. Deepak Mishra

Glaucoma is a chronic progressive optic neuropathy characterized by retinal ganglion cell (RGC) apoptosis, retinal nerve fiber layer (RNFL) thinning, optic nerve head (ONH) cupping, and corresponding visual field defects. Increasing evidence indicates that glaucomatous damage begins at the level of RGC dendrites and cell bodies, many of which are concentrated within the central 4–5 mm of the macula. This anatomical and pathophysiologic basis has led to growing interest in macular optical coherence tomography (OCT) for early glaucoma detection. Beyond traditional peripapillary RNFL analysis, macular OCT enables assessment of total macular thickness, inter-eye asymmetry, and longitudinal progression. Arcuate RNFL defects may also be visualized extending from the macula toward the ONH. With advancements from Time-Domain to Spectral-Domain and Swept-Source OCT, high-resolution segmentation of inner retinal layers has become possible. Current macular analysis focuses on the ganglion cell–inner plexiform layer (GCIPL) and the ganglion cell complex (GCC), which includes RNFL, ganglion cell layer, and inner plexiform layer components. Modern devices generate thickness maps, asymmetry analyses, and progression change maps, improving structural assessment. Recent studies demonstrate that ganglion cell thickness measurements are at least comparable to peripapillary RNFL thickness for glaucoma diagnosis. Some evidence suggests macular changes may appear earlier and more consistently, particularly in pre-perimetric glaucoma and early central visual field defects, implying greater sensitivity for early detection. In cases where RNFL changes are subtle or unreliable, macular parameters may offer superior diagnostic value, although conflicting data indicate RNFL may perform better in certain populations. A practical advantage of macular OCT is easier acquisition with higher scan quality due to reduced eye movement requirements. Current best practice emphasizes a combined structural approach incorporating RNFL, GCIPL/GCC analysis, ONH parameters, and visual field testing. Emerging deep learning applications applied to macular OCT may further enhance early diagnosis before detectable functional loss occurs.

Topic: Role of Optical Coherence Tomography Angiography (OCTA) of Macula

Instructor: *Dr Sanghamitra Kanungo*

Angio OCT produces 3D angiographic vascular maps of the macula and optic nerve head without dye injection. Gives layer-specific vascular detail-separates superficial and deep plexuses. Is safe for repeat use and suitable for patients with dye allergies or renal concerns. Peripapillary Vessel Density-Strongly correlates with RNFL thickness and visual field indices—useful for staging and progression assessment. May precede detectable field loss, enabling identification of pre-perimetric glaucoma.

Macular Superficial Capillary Plexus Vessel Density-Reflects ganglion cell complex integrity and central visual function; valuable in central field/early macular damage.

It is less confounded by media staining; useful in high myopia where structural OCT may be altered by magnification and segmentation errors. These strengths make Angio OCT a practical extension of routine glaucoma imaging.

Topic: Structure-Function Relationship in Macular Evaluation of Glaucoma

Instructor: Prof. Sumita Mohapatra

Glaucoma is a chronic, progressive optic neuropathy characterized by distinctive 'structural' changes involving death of RGCs & loss of related axons (detected by OCT) associated with corresponding 'functional' changes (detected by perimetry)

Structure – Function (SF) relationship of macula in Glaucoma describes how the thinning of macular retinal layers particularly the Ganglion Cell Inner Plexiform Layer (structure) relates to the loss of visual sensitivity (function) in the central 10-20 degrees. The study of these correlations in the macula by combining OCT imaging and VF assessment is thought to be important for understanding the nature of glaucomatous damage and for strengthening the basis for diagnostic decisions.

Contrary to the widespread idea that at macula there's a disconnect between structural and functional damage, recently with the advent of modern technologies, it is getting clear that there is a significant, generally curvilinear S-F relationship. In initial phase, significant structural loss can occur with minimal functional loss. In the moderate stage, as the structure continues to thin, there is a rapid, steep decline in visual field sensitivity and the correlation is optimal. In advanced phase, the structural changes reach a 'measurement floor' where further decrease of the layers could not be measured, but function deterioration continues.

Studying Structure-Function Relationship in Glaucoma helps in early detection, staging of disease and monitoring Progression. A mismatch between structure & function can indicate other, non-glaucomatous pathologies or artefacts.

We will show how S-F relationship improves after accounting for anatomical displacement of the RGCs. Structure-Function relationship can vary according to stages of glaucoma and other factors like distance from fovea and region of macula, which will be discussed through the instruction course.