



RETINAL SENSITIVITY

Retinal sensitivity is the way we perceive light

Automated threshold perimeters and virtual reality headsets measure the width and depth of the visual field by plotting the threshold luminance value of the patient in various locations in the visual field

Modern perimeters characterize specific parameters of the overall visual field status by means of numbers called global indices

7

THE PUPILS



- The normal pupil size in adults varies from 2 to 4 mm in diameter in bright light to 4 to 8 mm in the dark
- Normal pupils have an equal response to light stimulus
- The pupillomotor function is abnormal if it fails to dilate to the dark or constrict to light or accommodation
- The popular acronym PERRLA – pupils equal, round, and reactive to light and accommodation – is a convenient but incomplete description of pupil function
- The PERRLA notation specifically omits important clinical data such as the actual size and shape of each pupil, the speed and extent of pupillary constriction, and the results of determining an afferent pupillary defect

Spektor RH The Pupil. In: Walker HK, Hall WD, Hurst KW, editors. *Clinical Methods: The History, Physical and Laboratory Examinations*. 3rd edition. Boston: Butterworths; 1990. Chapter 58. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK3811/>

8

MULTIFOCAL PUPILLOGRAPHIC OBJECTIVE PERIMETRY

- Multifocal pupillographic objective perimetry (mPOP) is a non-invasive examination method that measures pupil responses to visual field stimuli
- The technology works by not asking patients what they see, but by measuring physiological responses of the retina at multiple locations
- Pupillographic perimetry can assess pupillary reflex sensitivity and response time, potentially detecting very early functional vision loss before structural damage becomes visible



Giseman AR, Elmehry MA, Bakin DE, Briggall M, Chong Y, Davis Q, Lesmeis L, Levin LA, Meddies T, Taylor J, Wenzel A. Visual Function Measurements in Eyes With Diabetic Retinopathy: An Expert Opinion on Available Measures. *Ophthalmol Sci*. 2024 Apr; 6(4):51-100519. doi: 10.1016/j.xops.2024.100519. PMID: 38881606; PMCID: PMC11179417.

9

OBJECTIVE PERIMETRY VS. SUBJECTIVE PERIMETRY

| | |
|---|---|
| <ul style="list-style-type: none"> • Presents multifocal stimuli and records infrared pupil responses • No manual response required • No cognitive decisions required • No button pushing required • Blinking is tolerated • Fixation is required • Each report has numeric and grayscale maps, total/pattern deviations, probability plots, and global indices (MD, PSD, SF, CPSD) • Separate reports for Sensitivity and Delay for each eye | <ul style="list-style-type: none"> • Presents light stimuli at fixed locations • Patient presses a button when the light stimulus is seen • Requires understanding the task and sustained attention • Standard reports include numeric and grayscale maps, total/pattern deviations, probability plots, global indices (MD, PSD, SF, CPSD, VFI) • Reliability indices: fixation losses, false positives, false negatives (with thresholds for reliability) • Current "Gold Standard" clinically |
|---|---|

10

People with Diabetes (PwD)

38.4 million people have diabetes

- 11.3% of the population
- 29.2% of people 65 or older

• 8.7 million PwD are undiagnosed

People with Prediabetes

96 million people 18 or older

- 38% of population



NATIONAL
DIABETES
STATISTICS
REPORT

National Diabetes Statistics Report 2022. US Centers for Disease Control & Prevention Accessed on July 4, 2025. <https://www.cdc.gov/diabetes/pdf/data/statistics/national-diabetes-statistics-report.pdf>

11

DIABETIC RETINAL VASCULOPATHY



The diagnosis of clinical diabetic retinopathy has historically relied on the observation of lesions using ophthalmoscopy or fluorescein angiography

- Microaneurysms
- Intraretinal hemorrhages
- Hard exudates
- Intraretinal microvascular abnormality
- Capillary nonperfusion areas
- Neovascularization

12

DIABETIC RETINAL VASCULOPATHY DIABETIC MACULAR EDEMA

Diabetic macular edema is defined as the following:

- Retinal thickening within 500 microns of the macular center
- Hard exudates within 500 microns of the macular center with adjacent retinal thickening
- One or more optic disc diameters of retinal thickening, part of which is within one disc diameter of the macular center

Clinically significant diabetic macular edema may be present without visible vascular lesions and in the presence of 20/20 visual acuity

13

RETINAL BLOOD MICROCIRCULATION

- Normal blood flow in the superficial capillary and deep capillary plexus
- Normal vessel geometry
- Orderly blood vessel branching pattern
- Normal foveal avascular zone size
- Normal acircularity of the foveal avascular zone
- Normal choroidal vasculature

14

DIABETIC RETINAL VASCULOPATHY OCULAR PERFUSION IMPAIRMENT

Vessel Density (Superficial)

15

DIABETIC RETINAL NEURODEGENERATION

- In diabetes, a structure-function relationship exists between retinal neurodegeneration and vision loss
- In many patients, diabetic retinal neurodegeneration (DRN) precedes or parallels the development of diabetic retinal vasculopathy
- Mechanism of action is likely due to subclinical ischemia combined with the direct effects of hyperglycemia on the retinal nerve fiber layer
- Causes of neuronal cell loss
 - Oxidative stress
 - Chronic inflammation
 - Mitochondrial dysfunction

Schlotzer RPK. Retinal Neurodegeneration in Diabetes: an Emerging Concept in Diabetic Retinopathy. *Can J Ophthalmol*. 2011; 46(12):1245-50. doi: 10.1007/s10226-011-0248-9. PMID: 21892091. PubMed: 21864663.

Leidner-Cohen A, Audo I, Azar M, Gorman J, Sofroni R, Ergungor A, Li, Gargano J, Mohand-Said S, Pines T, Goldbaum R, Yankov S, Rosen M, Hwang J. Evaluation of retinal structure and blood flow-related retinal vascular response in normotensive patients with diabetes without retinopathy. *Invest Ophthalmol Vis Sci*. 2011; 52(12):2841-7. doi: 10.1167/10.9960. PMID: 21492278.

16

DIABETIC RETINAL NEURODEGENERATION

Diabetes-induced retinal neurodegeneration (DRN) can manifest on OCT retinal imaging as significant thinning of the retinal nerve fiber layer and the ganglion cell and inner plexiform layers

Ricca AM, Sabin PR, Abramoff MD. New Thinking on Diabetes and the Retina: The Process of Neurodegeneration Precedes Microvascular Disease. 15 November 2016. *Review of Ophthalmology*

17

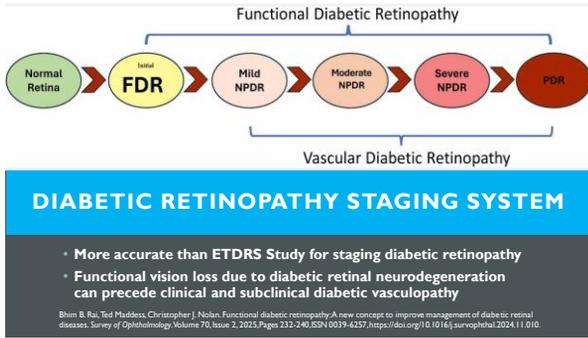
DIABETIC RETINAL NEURODEGENERATION

DRN occurs in people with diabetes regardless of clinical markers of diabetic metabolic control

Clinically significant ganglion cell complex Focal Loss Volume predates ophthalmoscopy-based detection of diabetic vasculopathy in 22% of people with diabetes

Hegazy AI, Zedan RH, Macky TA, Essam SI. Retinal ganglion cell complex using spectral domain coherence tomography in diabetic patients without retinopathy. *Int J Ophthalmol*. 2017; 10(10):1427-433. doi: 10.18240/ijo.2017.10.16

18



19

FUNCTIONAL DIABETIC RETINOPATHY

Potential Deficiencies in Sensory Capacity

- Decreased retinal sensitivity
- Decreased color vision
- Abnormal electroretinogram
- Abnormal dark adaptation
- Decreased contrast sensitivity
- Decreased low luminance visual acuity
- Decreased visual acuity

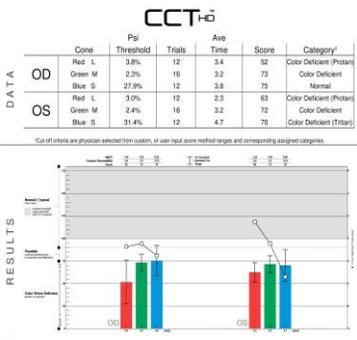
20

POTENTIAL DEFICIENCIES IN SENSORY CAPACITY

- Dyschromatopsia of diabetes is a chromatic visual disturbance that precedes clinical diabetic vasculopathy in up to 42% of PwD
- Color vision impairment is related to the duration of the diabetes
- Both blue-yellow and red-green defects occur in patients with diabetes and without clinical diabetic vasculopathy

Guanter et al. Early visual changes in diabetic patients with no retinopathy measured by color discrimination and electroretinography. Psychology & Neuroscience, 2013, 4, 2, 227-234. DOI: 10.1037/psn0000021

Grillo, L., Ramani R., Kishanbappa P., Ch. G. Ganesan S., Srivastava S., Shrivastava T. Color vision abnormalities in type II diabetes. Sankarā Nethralaya Diabetic Retinopathy and Molecular Genetics Study II Report (no. 2, India). Ophthalmol, 2017, Oct 65(10), 989-994.



21

POTENTIAL DEFICIENCIES IN SENSORY CAPACITY

Standard automated perimetry has the ability to diagnose functional deficits in early-stage diabetic retinopathy and diabetic macular edema

Foveal sensitivity is found reduced significantly in people with diabetes without clinical diabetic vasculopathy and with 20/20 visual acuity

A sensitive method for evaluation of retinal perfusion in people with diabetes, as areas of reduced retinal perfusion can have significant correlation

22

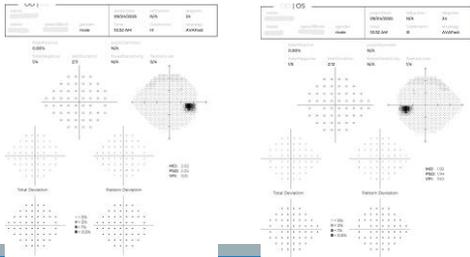
CASE REPORT DIABETES

- 55-year-old White male with a long-term history of diabetes
- Treated with oral medication
- Blood glucose level is stable
- He is 90 pounds overweight
- No unusual vision complaints
- Patient is using EyeMed Vision Insurance to cover his eye exam because he wants a new pair of eyeglasses
- Normal 'routine' eye exam findings
 - No clinical diabetic vasculopathy
 - No decreased visual acuity
 - Normal intraocular pressures
 - No anterior segment pathology

23

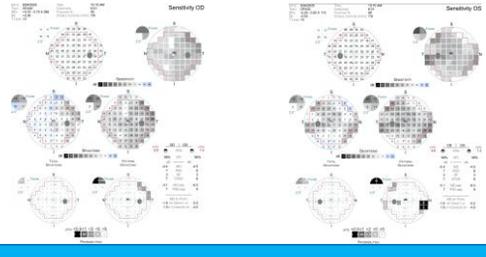
NO DIABETIC RETINAL NEURODEGENERATION

24



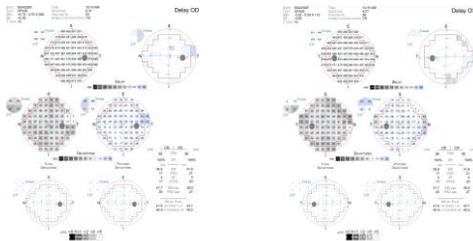
**SUBJECTIVE VISUAL FIELD EXAMINATION
NORMAL RESULTS**

25



**OBJECTIVE VISUAL FIELD EXAMINATION
ABNORMAL RESULTS**

26



**OBJECTIVE VISUAL FIELD EXAMINATION
ABNORMAL RESULTS**

27

| CPT Code | Description | Diagnosis Code | Payor | Approx Fee |
|----------|-------------------|-------------------------------|--------|----------------------|
| 92004 | Eye Exam | H52.4 (presbyopia) | EyeMed | \$50 |
| 92083 | Visual Field Exam | H53.453 (visual field defect) | Aetna | \$60 |
| 92137 | OCT Imaging | H53.453 (visual field defect) | Aetna | \$30 |
| 92283 | Color Vision Exam | H53.453 (visual field defect) | Aetna | \$50 |
| 92273 | ERG Testing | H53.453 (visual field defect) | Aetna | \$110 |
| | | | | \$50 or \$300 |

28

**DIABETIC
EYE
EXAM**

The main goal of the **diagnostic evaluation** of a patient with diabetes is to accomplish the following:

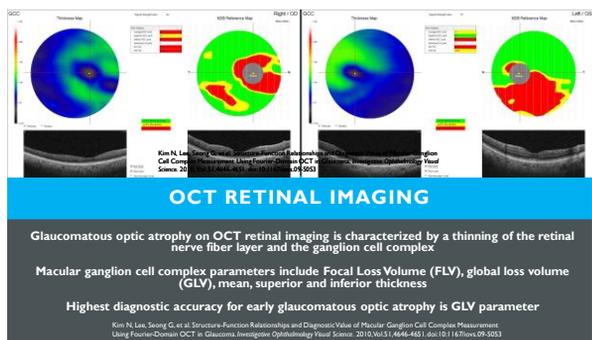
- Determine the presence or absence of diabetic retinopathy
- If diabetic retinopathy is present, classify the condition
 - Vascular damage to the retina
 - Neurodegenerative damage to the retina
 - Functional vision loss
- Identify and exclude any differential diagnoses
- Prescribe a treatment program
 - Diabetes surveillance examinations
 - Diabetic retinopathy surveillance examinations
 - Lifestyle modification recommendations
 - Nutritional supplementation
 - Referral back to medical doctor for treatment
 - Referral to retinal specialist for local treatment

29

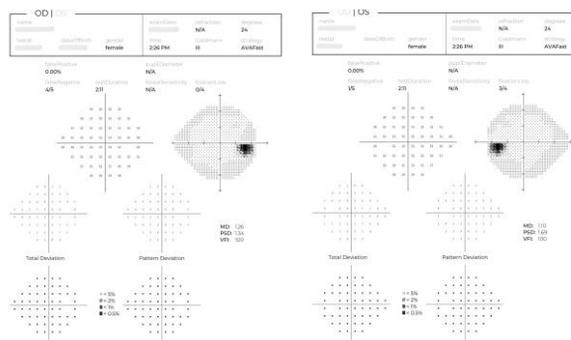
**CASE REPORT
GLAUCOMA**

- 75-year-old Black woman with a chief complaint of decreased vision since her last examination two years earlier
- IOPs are 10 mm Hg in each eye
- Mild cortical cataracts in each eye
- Long-term contact lens wearer
- Normal corneal topography
- Spectacle Prescription
 - 4.25 - 1.25 x 178 20/40
 - 4.75 - 1.00 x 180 20/40
- Highest IOP over the past fourteen years is 15 mm Hg

30



31



32

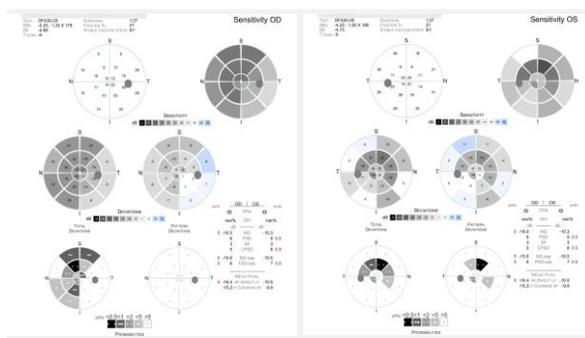
Advantages

- More diagnostic power via earlier detection of glaucoma-induced visual field loss in some patients
- More reliable test results in some patients
- No learning curve when performing initial visual field examination vs. subsequent examinations
- Better malingering detection than subjective perimetry

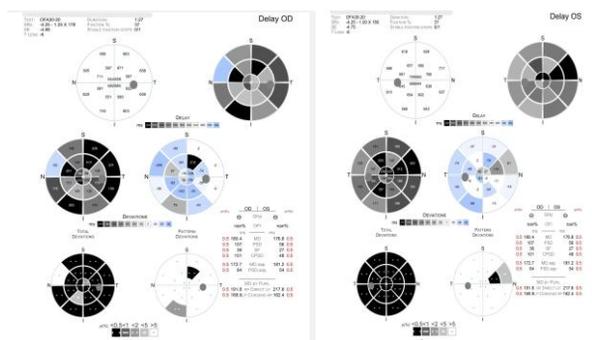
OBJECTIVE PERIMETRY

Madhus T, Clark CE, Kallik M, Sarig O, Essex RW, Rohan EMS, Saboo F, van Kleef P. Diagnostic Power and Reproducibility of Objective Perimetry in Glaucoma. *J Glaucoma*. 2024 Dec 1;33(12):940-950. doi: 10.1097/JGJ.0000000000000485. Epub 2024 Aug 23. PMID: 39171976; PMCID: PMC11168594

33



34



35

MEDICAL DECISION-MAKING

01

Treat glaucoma vs. monitor patient as a person suspicious for developing glaucoma

02

Make an earlier diagnosis of glaucoma vs. a later diagnosis of glaucoma

03

Wait for additional functional vision loss vs. preserve existing vision

36



CONCLUSION

Objective perimetry offers superior reliability over subjective perimetry by removing user bias, reducing test-retest variability, and enabling faster, objective testing in about 90 seconds

It eliminates the need for patient responses, making it ideal for young, elderly, or infirm patients, while providing unique metrics like pupil reaction delay