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Professional paper

Visual Field

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A B S T R A C T

This article is dedicated to main information about visual field, monocular and binocular ranges of visual field including their defects. Visual field loss may occur to disease of the eye, optic nerve or brain. Typical changes are present at glaucoma and macular degeneration. Visual pathway is also mentioned. The basic medical examinations of visual fields are Amsler grid, kinetic and static perimetry and the other. Newer method is microperimetry which detects the changes directly on the retina. The aim of this poster is importance and determination of visual field as a preventive ophthalmologic and optometric examination.

Key words: *visual field, visual pathway, visual field defects, examination of the visual field, Amsler grid, kinetic and static perimetry, microperimetry*

Introduction

The vision provides the basic information about space around us, allowing the orientation in space and affects our daily lives. As a specialists – optometrists and ophthalmologists we have a number of simple tools and devices that are able to determine the quality and function of visual functions and visual pathways. The various diagnostic procedures are then able to identify possible failures, provide available treatment and to facilitate better patient orientation in space.

Visual Field

Visual field is the entire area that can be seen when the eye is directed forward, including that which is seen with peripheral vision.The normal human visual field extends to approximately 60 degrees nasally, from the vertical meridian in each eye, to 100 degrees temporally and approximately 60 degrees above and 75 below the horizontal meridian. The ranges of binocular visual field is about 160–170°. Different animals have different fields of view, depending on the placement of the eyes, some birds have a complete or nearly-complete 360 degree field of view[1,2].

Visual field defects

A visual field is a loss of part of the usual field of vision, so it does not include blindness of either one eye or both. The lesion may be anywhere along the optic pathway; from retina to ophthalmic cortex. This may be central (e.g. optic disc or nerve problem) or peripheral (along the visual pathways from the optic chiasm back).

Central field loss occurs with:

1. Optic neuropathy
2. Macular degeneration
3. Macular holes
4. Cone dystrophies
5. A number of rare conditions like Best's disease, Stargardt's disease and achromatopsia.

Peripheral field loss occurs with:

- Retinitis pigmentosa
- Chorioretinitis
- Glaucoma
- Retinal detachment
- Leber's optic atrophy

Scotoma is a type of visual field defect. It is a defect surrounded by normal visual field. Relative scotoma is an area where objects of low luminance cannot be seen but larger or brighter ones can.Absolute scotoma – nothing can be seen at all within that area. Hemianopia – binocular visual defect in each eye's hemifield. Bitemporal hemianopia – the two halves lost are on the outside of

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each eye's peripheral vision, effectively creating a central visual tunnel. Homonymous hemianopia – the two halves lost are on the corresponding area of visual field in both eyes, e.g. either the left or the right half of the visual field. Altitudinal hemianopia – refers to the dividing line between loss and sight being horizontal rather than vertical, with visual loss either above or below the line. Quadrantanopia – is an incomplete hemianopia referring to a quarter of the schematic 'pie' of visual field loss. Sectoral defect is also an incomplete hemianopia.

Examination of the Visual Field

Perimetry and visual field testing have been used as clinical ophthalmic diagnostic tools for many years, and this manuscript will provide a brief historical overview of these procedures and the individuals who developed them. Today, we have many different forms of perimetry that are designed to evaluate different locations within the visual pathways and various mechanisms and subsets of mechanisms within the visual system. However, the most widely used method of performing perimetry and visual field testing has not substantially changed for more than 150 years, consisting of detecting a small target superimposed on a uniform background at different locations within the field of view. Although the basic test procedure has remained similar throughout the ages, there have been many advances in test administration, standardization, statistical evaluation, clinical analysis, interpretation, and prediction of outcome based on visual field findings[3].

A visual field test is an eye examination that can detect dysfunction in central and peripheral vision which may be caused by various medical conditions such as glaucoma, stroke, brain tumors or other neurological deficits. The exam may be performed by a technician in one of several ways. The test may be performed by a technician directly, with the assistance of a machine, or completely by an automated machine. Machine based tests aid diagnostics by allowing a detailed printout of the patient's visual field. The names for this test may include Perimetry, Tangent screen exam, Automated perimetry exam, Goldmann visual field exam, or Humphrey field exam.

Here is a list of techniques used to perform this test:

Confrontation visual field exam / Donder's test – The examiner will ask the patient to cover one eye and stare at the examiner. The examiner will then move her hand out of the patient's visual field and then bring it back in. The patient signals the examiner when her hand comes back into view. This is frequently done by an examiner as a simple and preliminary test.

Tangent screen exam or Goldmann field exam – Here the patient is asked to sit 1 meter (approximately 3 feet) from a screen with a target on the center. The eye that isn't tested is covered during the exam. While the patient stares at the target the examiner will move an object toward the patient's visual field. The patient signals the examiner when the object comes into view. This exam allows the patient's visual field to be mapped.

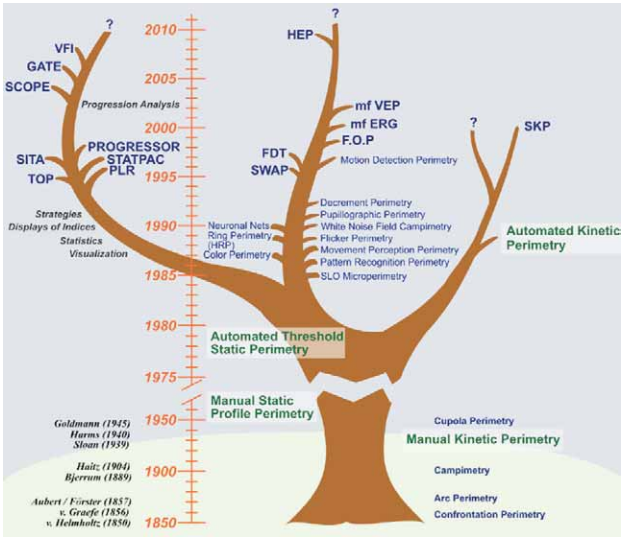


Fig. 1. The »perimetric family tree« diagrams the evolution of clinical methods for the visual field testing during the 20th century. (FDT = Frequency Doubling Technology, FOP = Fundus oriented perimetry, GATE = German Adaptive Thresholding Estimation, HEP = Heidelberg Edge Perimeter, mfVEP = multi-focal Visually Evoked Potentials; mf-ERG = multi-focal Electroretinogram, PLR = pointwise linear regression, SCOPE = Scotoma oriented Perimetry, SITA = Swedish Interactive Thresholding Algorithm, SKP = semiautomated Kinetic Perimetry; SWAP = Short Wavelength Automated Perimetry; TOP = Tendency-Oriented Perimetry; VFI = Visual field index).

Automated perimetry exam – The patient sits in front of a concave dome with a target in the center. The eye that is not being tested is covered. A button is given to the patient to be used during the exam. The patient is set in front of the dome and asked to focus on the target at the center. A computer then shines lights on the inside dome and the patient clicks the button whenever a light is seen. The computer then automatically maps and calculates the patient's visual field.

Kinetic perimetry uses test objects that are fixed in size and brightness. They are moved from non-seeing areas into seeing portions of the visual field, the test subject being asked to signal when the object first becomes visible. This method is particularly realistic and relevant to clinical practice, since visible objects in everyday life come to notice either through their own movements or by gaze movements of the eye, causing their images to move across the retinal surface. The results of this method are plotted in the form of so-called isopters, which are lines of equal differential light sensitivity (DLS). The most commonly used kinetic test is Goldmann perimetry. It tends to be used for more neurological conditions, although not exclusively so. It is also used where there is suspicion of functional rather than organic problems as a characteristic pattern of spiralling isoptres may be seen.

Goldmann perimetry also has its limits and can be affected by ptosis, refractive errors, tremor and inadequate operator skills.

Static perimetry employs stationary test objects that vary in size and brightness, but never move. If the test object locations are arranged in a linear sequence, a vertical slice is made through the hill of vision, analogous to profile portrayals used in cartography. This largely manual technique is useful when examining the central and paracentral areas of the central visual field, e.g. when used to study cases of central serous retinopathy. Static profile perimetry of this sort has been done as a manual technique that is seldom used now and is included in this discussion largely for the sake of completeness. If the test objects are to be presented across an area of the field (usually as a rectilinear grid), a computer algorithm controls their display in a manner that is largely independent of the examiner's input – a method called static automated perimetry. A graphic representation of the hill of vision can be generated by interpolation of the DLS values, producing an image that is much like the appearance of the polygonal facets that make up the surface of a geodesic dome.

Amsler Grid

The Amsler grid, used since 1945, is a grid of horizontal and vertical lines used to monitor a person's central visual field. The grid was developed by Marc Amsler a Swiss ophthalmologist. It is a diagnostic tool that aids in the detection of visual disturbances caused by changes in the retina, particularly the macula (e.g. macular degeneration, Epiretinal membrane), as well as the optic nerve and the visual pathway to the brain.

In the test, the person looks with each eye separately at the small dot in the center of the grid. Patients with macular disease may see wavy lines or some lines may be missing.

Amsler grids are supplied by ophthalmologists, optometrists or from web sites, and may be used to test one's vision at home. The original Amsler grid was black and white. A color version with a blue and yellow grid is more sensitive and can be used to test for a wide variety of visual pathway abnormalities, including those associated with the retina, the optic nerve, and the pituitary gland. The Amsler grid is a tool that eye doctors use to detect vision problems resulting from damage to the macula (the central part of the retina) or the optic nerve. The damage may be caused by macular degeneration, glaucoma or other eye diseases, so the Amsler grid is useful in detecting these problems[4].

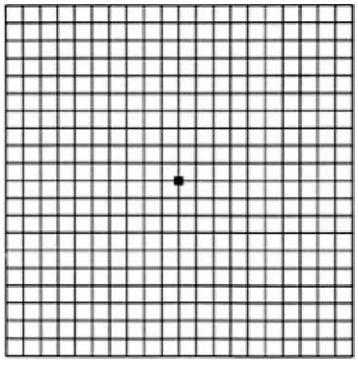


Fig. 2. An Amsler grid as seen by a person with normal vision.

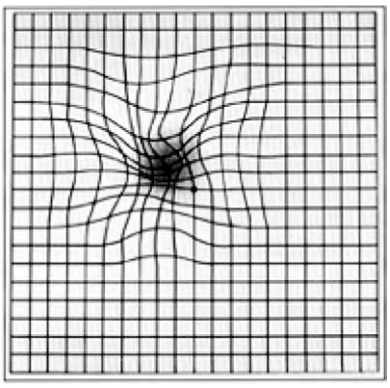


Fig. 3. An Amsler grid, artist's conception, as it might by viewed by a person with age related macular degeneration.

How to test yourself with the Amsler Grid

If you need reading glasses, please wear them while you use the Amsler grid. The grid should be at about the same distance from your eyes that any other reading material would be.

Cover one eye, then focus on the dot in the center.

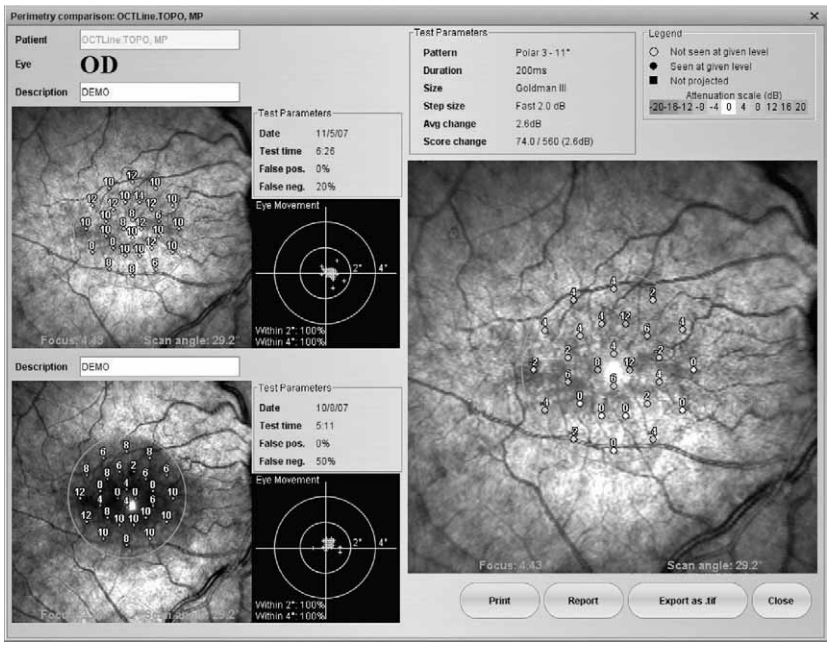
- Do any of the lines look wavy, blurred or distorted? (All lines should be straight, all intersections should form right angles and all the squares should be the same size.)
- Are there any missing areas or dark areas in the grid?
- Can you see all corners and sides of the grid?
- Don't forget to test both eyes.

Very important is to report any irregularity to your eye specialist immediately. The patients can mark areas of the chart that you're not seeing properly and bring it with you to your eye exam.

Microperimetry

With today's new ophthalmic therapies clinicians require additional tools to effectively monitor the results of treatments over time. While OCT alone offers high quality imaging of retinal structures, Microperimetry provides the clinician with the ability to test and monitor changes of the patient's retinal function in selected location on the fundus.

The Microperimetry test runs simultaneously with the confocal ophthalmoscope (SLO), and provides real-time tracking of retinal motion and patient fixation during the exam. Multiple Microperimetry exams can be stored, compared and subtracted automatically over time,



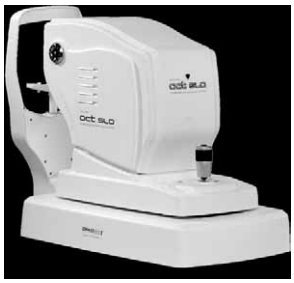


Fig. 4. Microperimetry is an optional add-on to the Spectral OCT SLO System.

displaying progression or regression of the retinal function within a specific area of the fundus.

Microperimetry (also known as fundus perimetry) allows for exact topographic correlation between fundus details and its light sensitivity (differential light sensitivity or retinal threshold).

The principle of microperimetry rests on the possibility to see – in real time – the retina under examination (by infrared light) and to project a defined light stimulus over an individual, selected location. Because light projection is just related to previously selected anatomical landmarks, and it is independent of fixation and any other eye movement, the examiner obtains the functional response of the selected area. The characteristics of fixation (location and stability) are easily and exactly quantified with microperimetry. Scanning laser ophthalmoscope (SLO) microperimetry was the first technique which allowed to obtain a fundus-related sensitivity map, inpatients with any level of visual acuity or fixation characteristics. Using red light background illumination and stimuli, precise identification of individual fixation locus and increment threshold at manual preplanned loci could be quantified with SLO microperimetry. But, SLO fundus perimeter did not allow to perform fully automatic examination. Moreover, automatic follow-up examination to evaluate exactly the same retinal points tested during baseline microperimetry was not available with this instrument. These limitations have been overcome by the MP1 microperimeter, a recently developed automatic fundus perimeter. This instrumentperforms automatic microperimetry, independent of fixation characteristics. MP1 microperimeter automatically compensates for eye movements during the examination via a software module that tracks the eye movements with respect to an initial frame. Automatic follow-up examination quantifies retinal threshold exactly over the same retinal points tested during baseline examination (even if fixation changes during follow-up time).

Static microperimetry is more commonly used, but a kinetic test is also available. SLO microperimeter results are displayed over the black and white infrared image of the fundus, MP1 microperimeter results may be reported over a high quality color retinography. The quantification of macular threshold and retinal fixation characteristics allows the clinician to improve his/her diagnostic accuracy and better predict the outcome of surgical and non-surgical treatments of different macular disorders. Clinical applications of microperimetry may be summarized as follows:

- Advanced age-related macular degeneration (atrophic and neovascular AMD): detection of location and stability of fixation (foveal and extrafoveal); quantification of scotoma characteristics; quantification longitudinally over time of the functional impact of any treatment (medical, laser or surgical) at specified retinal locations.
- Early AMD: evaluate the functional deterioration over discrete macular lesions along the natural history or following treatment.
- Diabetic macular edema: evaluation of the functional impact of different degrees of macular edema; comparison of functional values with OCT data; evaluation of the effects of different laser treatment modalities (ETDRS standard, subthreshold, micropulsed, etc.) on macular function.
- Vitreo-retinal interface disorders: comparison of macular function with OCT data; prognostic value of microperimetric data vs vitreo-retinal surgery results.

– Any maculopathy which needs detailed functional evaluation.
– Low-vision patients: quantification of fixation location and stability; planning of visual rehabilitation program and evaluation of results.

In my preparing dissertation work I examine the measurement the patients with exsudative ARMD before and after treatment of bevacizumab.

The variable impact on visual function of macular diseases depends on the extension and degree of pathological alterations in the macular area. In the past, the role of psychophysical tests was merely to document the decrease of visual acuity, and the progression of central scotoma associated with progressive maculopathy. Currently, the use of microperimetry (fundus perimetry) has greatly improved the role of psychophysical tests in the evaluation of any maculopathy. Fixation characteristics are critical for reading, and any variation of size, shape and intensity of scotoma greatly influences visual performance. Microperimetry allows to exactly quantify location and stability of fixation, and retinal threshold in the macular area. Automatic follow-up examination allows the clinician to evaluate the natural history of any disease, and to monitor the effect of any therapeutic intervention. Maintenance and improvement of quality of vision (not merely visual acuity) is the new goal of any treatment of macular/retinal disorder. But quality of vision needs to be quantified in a reliable and reproducible way. Microperimetry may play a fundamentalrole in this area.

Conclusion

The examination of the visual field is one of the most important testing in optometric and ophthalmological practice. This simple technique often help to detect the beginning of possible disease. There is a possibility to get an overview of the posterior segment of the eye and better to understand the potential loss in vision, together with the examination of the retina.

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VIDNO POLJE

SAŽETAK

U ovom radu raspravlja se o važnosti vidnog polja u monokularnom i binokularnom vidu, kao i o kliničkoj patologiji, sa naglaskom na bolesti oka, očnog živca i centralnog živčanog sustava – CNS. Tipične promjene susreću se kod glaukoma i makularne degeneracije – AMD. Osnova medicinskog ispitivanja bazira se na Amsler testu, kinetičkoj i statičkoj perimetriji. Nova metoda perimnetrije je mikroperimetrija, koja detekcionira promjene u retini.