Forum:Seminar papers/Biophysics/2. LF/2018-2019/Group 2/JK

Perimetry

Introduction

Perimetry is a systematic measurement of differential light sensitivity in a visual field. Objects are presented at various places within the visual field while the patient’s gaze is fixed. The visual fieldvis the area that one eye is able to see without moving the angle of vision. It is a subjective method of examination, which always needs cooperation of the patient, and possibility of errors must be considered. The patient should not move and must give attention to the instructions given.

Average healthy visual field of human eye is about 60° upwards, 70° downwards 65° towards the nose and 95° outwards. We are able to distinguish between central vision and peripheral vision. As the name says, central vision gives us information from the center of the visual field of the eye. This area is about one fifth of the whole visual field but over 80% of eyesight information comes from this area. Area of peripheral vision is around central vision and it does not give us as sharp image as the central vision. The status of the visual field gives us useful information, not only about functioning of the retina, but the condition of the optic nerve and intracranial section of the visual path. It is also important to outline the existence of several types of perimetry: Tangent Perimetry, Goldmann Perimetry, Automated Perimetry (is based on Goldmann perimetry) and Microperimetry. Our paper will focus on automated perimetry only as it is the most widespread type of perimetry in modern hospitals.

Importance to Clinical Medicine

Perimetry is mainly used in Ophthalmology which is the branch of medicine that specializes in detecting, diagnosing and managing a variety of eye conditions such as blindness, cataracts and glaucoma. In addition, as perimetry is focused on detecting the blind spot of the eye it can also discuss the problem of scotoma that can be a sign of a disease in the eye. Consequently, the most important use of Perimetry is to prevent damage of the optic nerve, central nervous system, visual structures in the brain and also the diseases of the eye which can cause peripheral vision loss and other visual field abnormalities. Physicians can associate these defects in the visual field with certain diseases, by assessing and interpreting their patterns. The Perimetry test is also used to diagnose many diseases other than those mentioned before. The examples of such more complicated diseases are: macular degeneration, optic glicoma, brain tumor, stroke, optic neuropathies, central nervous system disorder and the pituitary gland disorder. The results of the Perimetry test can tell in which areas the patient has a problem in his visual field and indicate the areas of the brain or optic nerve that are damaged or about to be damaged as a cause of disease. The most commonly discussed disease by the Perimetry is **glaucoma** which is one of the chief causes of irreversible blindness in the world that can cause damage to the optic nerve. The loss of a certain number of axons of the optic nerve leads to areas of reduced eyesight in the visual field, so called scotomas. Modern computed perimetry enables ophthalmologists to detect areas of reduced sensitivity. Perimetry, besides Tonometry, Gonioscopy and Ophthalmoscopy is of particular importance in the diagnosis and follow-up of glaucoma. Glaucoma is a slowly progressing disease and is one of the most common causes of blindness worldwide. The number of glaucoma patients is estimated to be 72,9 million in 2020, of which around 11,2 million will go blind ambilateraly, because their disease is not treated in time.

Equipment

Automated Perimeter MEDMONT M-700.

The perimeter is used usually by the ophthalmologists. It is one of the best tool for assessing visual fields.

• Fixation point: fixation target at which the patient must fix their vision.

• The response button the patient uses when he sees the light.

• The eyepatch you will use to cover one eye.

• C**hin-Brow Rest** - purposed to make patient feel comfortable and fully concentrate on the test. It also provides fixation of forehead and chin making it easier for the patient to focus on fixation point.

• **Multiple light dots** - normally they are switched off, when the test starts one will be active at any one time. The patient must press the response button when he sees the light.

The operating software **MEDMONT STUDIO**

Has options such as:

• Global Statistics - Allows interpretation of the perimetry results. After the patient finishes the test his results will be compared to the average result of his age group. This tool compares all the points tested and allows us to interpret which areas have defects compared to an average healthy person.

• Regression and Histogram analysis - Shows the patterns over time in the form of a diagram or histogram that will display changes over time.

• Full patient history - allows doctor to track the changes in the visual field of a particular patient making it possible to identify long term patterns.

Methodology

1. Turn both required equipments on.

2. Open the operating system Medmont Studio.

3. Create a new file for the new patient.

4. After completing the patient’s personal data in the file and saving them, start a new examination.

5. A new window will open, which represents the perimeter. The small black circles with the blue number inside (to be seen on that new window) are the light points of the test. The blue numbers stand for the starting exposure level, measured in decibels.

6. The type of the exam chosen should be the glaucoma test. Determine the perimeters of the measurement. False positives, false negatives and fluctuation measurement should be chosen as further parameters.

7. Choose one eye (right/left) to start the procedure with and select it then in the Eye menu.

8. The non-tested eye should be covered and the patient should sit comfortably and remain attentively in front of the perimeter screen. Silence should be kept and it is very important to not disturb the patient.

9. Turn the lights off in the room and cover the patient’s back of the head with a cloth.

10. Once the patient recognizes the light on the screen an immediate response should be made by pressing the button.

11. The examiner sets demonstration mode first, before the actual examination starts, in order for the patient to get used to the response button.

12. The actual test only begins after the examiner presses the Start button. The circles on the screen change their colours according to their current status. BLUE stands for as yet untested, RED for exposed but not seen, GREEN for exposed and seen and WHITE for final completed state.

13. At the end of the test, the results regarding fixation losses, false positives or negatives will be displayed on the screen.

14. The file should be saved in the operating system.

False -ve:

Around every 10th exposure the perimeter will expose one of the completed points of 9dB or dimmer to the patient again (but increasing it by 9dB). If the patient will notice this exposure it means that they see this point and have no blindspot there. However, if the exposure remains unnoticed by the patient, it means that he had completed the point by guessing rather than by seeing it. Higher false negatives - less reliability. Value of about 33% would indicate low reliability of the patient and the test.

False +ve:

False +ve tests whether patient really sees the light or he just responds to a rhythm of lights Instead of testing already completed points, this reliability test is based on using the time slot of the light but not exposing any light at all. Therefore, if the patient simply responds to a rhythm he would press the button while there might not be any light. High value of False +ve indicates low reliability of the patient. 20% rate would indicate low patient's reliability as well as low reliability of the test.

Fluctuation Measure

Fluctuation measurement adds a further level of confidence by re-testing a number of suspect points and recording the variability of these results as a fluctuation measure. As the test progresses, four spatially dispersed and completed points with the highest defect levels are chosen for fluctuation testing and are re-tested four times.

• 3 or more points with SD > 2.50 - Indicates high severity

• 2 or more points with SD > 2.75 - Indicates medium severity

• 1 or more points with SD > 3.05 - Indicates low severity

Abnormal Points

3 Conditions must be satisfied for a point to be considered abnormal:

1. It deviates by more than 6 dB from the mean of its neighbours

2. The variation within the neighbourhood is reasonable for this test.

3. There are an adequate number of neighbour points (i.e. the point is not isolated).

The Button Retest Abnormals will retest those abnormal points. Abnormal points might occur because of loss of attention of the patient during the test or simply not reacting to a light despite seeing it.

Fixation Loss

A Fixation Loss control is set automatically. A fixation loss higher than 20 % indicates low patient and low test reliability.

Data processing

1. Open the saved file. The menu on the upper side of the screen , will show you three icons that will give you the options of showing the patient’s information, the test results (eg: as the thumbnail view) and the analysis of the patient’s examination.

2. When opening the patient’s information on the left side, one is given many options of viewing the results by clicking on View Mode. Combination view sets four different view types of the same exam. The button enables a more detailed view of the results.

3. Leads to the window of display setting, where particular view should be chosen.

4. One should then choose the four view types: the first should be set as Plan, the second as Perspective, the third as Numeric, and finally the fourth also as Plan , however in grey scale.

5. For all views Non-linear Scaling should be selected and for the first view Section should be checked. In the first and in the second views it is important to select Level. Also relevant for the second are the selection boxes of Hill of vision, Attributes and Statistics. In the third view Age normal deviation should be selected.

6. The resulting views can be displayed as a printing preview and then printed to be attached to the results of the examination.

EVALUATION OF THE DEFECT BY STATISTICAL INDEXES

HoV (Hill of Vision). Depending on the eccentricity (distance from the center expressed in degrees) the threshold value changes. Values of the patient's HoV are expressed as the linear slope dB/10° and level in dB corresponding to 3° eccentricity. The calculation might be like this: We need to know dB for 20°, we have value for 3°. The value of dB will be lower at 20° than at 3° as we move further from the centre. The difference between 20° and 3° is 17°. 17/10 = 1.7; we also know slope HoV (3.5 dB/10°). We multiply 3.5 by 1.7: 3.5*1.7 = 5.95dB. Therefore, the difference will be 5.95dB. We know that at 20° it is lower therefore we subtract: 25.5dB - 5.95dB = 19.55dB.

Overall defect (OD) is the mean difference between the age normal HoV and the mean deviation or patient based HoV. This number is negative if the patient’s HoV is less than the age normal HoV.

Pattern defect (PD) is based on spatial correlation, and is a measure of the clustering and depth of defects. It is a scaled mean value of the product of a point’s HoV deviation and that of its neighbours. For example if deviations from the patient’s HoV are distributed more or less randomly throughout the field, then the PD will be small. As deviations tend to cluster, the index will increase, particularly where both the absolute deviations and clustering are high. Pattern Defect of Low Severity is more or equal to 2.8; Medium Severity is more or equal to 5.7; High Severity is more or equal to 8.6.

Conclusion

Automated perimetry has evolved exponentially over recent years due to modern computer technology that enables more complex visual stimuli and advanced test procedures opposed to the traditional methods of testing.

Automated perimetry characterizes and monitors a range of optical diseases such as glaucoma, thus aiding treatment and improving management of these diseases. Advances and developments in this visual field procedure can be accomplished if they adhere to multicentre trials that yield clinical significance. Advancement is needed since many tests proved automated perimetry to be not sensitive enough, since the patients can always ‘guess’ when the light is on, generating too many false positives.

Developing more objective perimetry could be possible. This entails using evoked potential testing, an analysis of brain waves, to do objective visual fields. Connecting the machine to the optic nerve and the corresponding part of the brain would make guessing impossible for the patient.

It means that the patient would just have to look at the stimulus and the instrument would detect its response. In conclusion, physicians are trying to develop the perfect test to detect pathologies, since when are they present and what should be done to treat them. Until then, automated perimetry is the most reliable of visual field examinations that can aid patients that have or could develop ocular disorders.

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