

# Evaluation of Reliability of Visual Field Examination in Glaucoma Patients

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*Pak J Ophthalmol 2009, Vol. 25 No. 3*

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Received for publication  
October 2008

**Purpose:** The purpose of our study was to evaluate the reliability of visual field examination in glaucoma patients undergoing perimetry for the first time on Octopus 300 series perimeter.

**Materials and Methods:** The study was conducted in the Department of Ophthalmology, Abbasi Shaheed Hospital from January 2007-June 2008. Patients were randomly selected from the glaucoma clinic who went for routine perimetry for the first time. Patients were examined in detail, diagnosis was established and were sent for field examination to assess the extent of damage by glaucoma. Perimetry was done on Octopus 301 series perimeter after setting all the parameters and under constant supervision.

**Results:** A total of 117 patients were examined from January 2007- June 2008. A male preponderance was seen and majority of the patients belonged to 60-70 years age group making upto 37.4 % followed by 40-50 years age group i.e 25.6%. Maximum number of patients have percentage of false positives and false negatives between the range of 0-5 % which shows that a large number of patients (62% patients in false positives and 79% patients in false negatives in their right eyes and 68.4% patients in false positives and 74.6% patients in false negatives in their left eyes) had a reliable field (96(82%) patients had Reliability factor in acceptable normal range their right eyes and 104(89%) patients had reliability factor in acceptable normal range in left eyes. It shows that majority of patients had a reliable field test. It is also obvious that fields of left eyes were more reliable as compared to right eyes.

**Conclusion:** It was concluded that computerized perimetry could play an important role to diagnose and assess the progression of glaucoma provided its reliability lies within the indices set by the manufacturers of the perimeter. To make this test reliable one needs full cooperation and comfortable seating of the patient, better understanding of the test and accurate setting of the parameters of the machine so that there is less chance of false positive and false negative catch trials and reliability factor remains within normal limits.

Perimetry the evaluation of visual field, is an important diagnostic test in ophthalmology, not only for managing glaucoma using static perimetry in the central 30 degree visual field but also for diagnosing and monitoring the progression of many other eye diseases. Although the visual field examination is used in conjunction with other clinical findings such as intraocular pressure, and the assessment of structural changes at the optic nerve head and retina, perimetry remains indispensable test

documenting visual function. After all; patients are not concerned about pressure or appearance of their discs but they are worried about maintaining vision<sup>1</sup>.

The reliability (accuracy) of any given visual field exam is dependent upon the manner in which the patient responds to the test. If the patient is alert, understands what is expected of him, and follows directions, the chances of an accurate measure of his visual field are good.

Automatic perimetry is merely a computer assisted examination and not a fully automatic test because the results depend upon the patient's cooperation and accuracy of answers to the question of whether or not a light stimulus was perceived. Therefore automatic perimetry remains a subjective test and for this reason it is important to always realize that the visual field data is only as reliable as the ability of the patient to perform the examination<sup>1</sup>.

Visual field testing accuracy is important, especially when following glaucoma patients.

The ophthalmologist has three primary sources of information that aid him in the diagnosis and treatment of glaucoma: the intraocular pressure reading, the appearance of the optic nerve head, and the results of visual field testing. The intraocular pressure is useful in gauging the effectiveness of therapy, but it does not tell much about the progress of the disease. Thus, the ophthalmologist relies heavily on the appearance of the optic nerve head and the results of visual field testing to tell him if the patient's vision is getting worse or not. An accurate visual field test is very important tool in glaucoma assessment.

Automated perimeters have several methods of keeping track of the accuracy of the examination. These indicators can tell the operator if the test is going smoothly, or if adjustments need to be made. The indicators on the printout help the ophthalmologist to decide if the test was a valid measurement.

### **Fixation Losses**

In order to get an accurate measurement of the sensitivity of any given portion of the peripheral retina, using an automated perimeter, the eye must remain stationary while it is to stare at. If the patient maintains fixation (looks at the target all the time), then the eye does not move. High fixation losses may indicate poor fixation. For this reason Octopus 301 series perimeter used in our study is equipped with electronic eye fixation control system. While the eye monitor shows whether or not patient is fixating, mistakes are not correctable. The electronic control system interrupts the examination and signals examiner that patient is not fixating or is closing the eye. The system also senses when the patient blinks during a stimulus presentation and repeats the same question later during the test. Basically the eye fixation control makes sure that only those stimuli are validated when the eye is well fixated and not blinking<sup>1</sup>.

### **False Positive Catch trials**

The number of false positive answers (positive response when no stimulus was presented) is expressed as a percentage of total positive trials. In a situation where patient shows 20% false positive answers the other questions are also probably answered with the same rate of error. Care should be exercised with the rate of false responses higher than 10-15%. This problem may appear with persons who are too eager to do well or patients who are too nervous or have not been instructed properly<sup>1</sup>.

### **False Negative catch Trials**

False negative answers (Negative response after presentation of brightest possible stimulus in an area where patient showed sensitivity on prior questions) are also expressed in percentage of total questions asked. Patients with higher than 10-15% rate may need closer surveillance because they are no longer concentrating or are not in good condition<sup>1</sup>.

### **Reliability Factor**

The reliability factor **RF** indicates the patients cooperation This value is calculated from positive and negative catch trial questions. It is expressed as percentage of the sum of false positive and false negative answers divided by total number of catch trial questions. It is the rate of incorrectly answered catch trials expressed as percent. If RF is 10% then RF value exceeds 10% results must be cautiously evaluated<sup>2</sup>. The RF value normally should not be higher than 15%. A grade of 0 is excellent<sup>1</sup>.

### **Pupil diameter**

The amount of light entering the pupil is controlled by the diameter of pupil. For example a change from 7 mm to 5 mm will reduce the amount of light entering the eye to half. As a rule it is understood that with 3mm or wider pupil diameters the results will be within normality. Below this value a uniform depression of visual field in order of 1-3 dB and as much as 3-4 dB for a 1.5 mm pupil. This effect can be much greater in cataract patients. Because of this it is extremely important to note the size of pupil for proper interpretation of fields and to compare it with previous results<sup>1</sup>.

### **Learning effect**

In their first test patients often hesitate to press the button when a faint stimulus near the threshold is

presented and in the follow up examination the sensitivity values tend to be higher. Due to this learning effect a second examination is recommended in borderline cases<sup>3</sup>.

### **Fatigue effects due to long test duration**

The fatigue effect is usually seen in lengthy threshold examination which can take as long as 10-20 minutes. The fatigue effect consists of two components, the patient's physical fatigue and the fatigue caused by increased strain upon visual system during long examination. When patient becomes tired his/her attention level will decrease and answers will become less reliable. To help alleviate this problem Octopus perimeter has a staging technique system that is the total field examination is divided into 4 stages and after completing 1 stage we can give a pause. The data of this stage is saved and the examination is not disturbed then we can proceed to the next stage<sup>1</sup>.

Keeping these criteria in mind we conducted a study at Eye department Abbasi Shaheed hospital.

Our study included 117 patients who were registered at the Glaucoma clinic and after routine examination were sent for perimetry for the first time.

### **Purpose of Study**

The purpose of our study was to evaluate the reliability of visual field examination in glaucoma patients undergoing perimetry for the first time on Octopus 300 series perimeter.

### **MATERIALS AND METHODS**

The patients were randomly selected from the Glaucoma clinic when they were registered and were sent for routine perimetric examination for the first time. Before sending for field test these patients were thoroughly examined. The examination included detailed slit lamp examination, measurement of intraocular pressure by Applanation tonometry, detailed funduscopy to assess the status of optic disc and gonioscopy where required. The type of glaucoma was diagnosed and patients were sent for routine perimetry.

The inclusion criteria were new referral, no previous threshold visual field tests, absence of hearing or cognitive impairment, understanding language, and best corrected visual acuity of 6/36 or better in both eyes.

The *exclusion criteria* were patients who had already undergone the examination once, patients with hearing problems and patients with dense cataracts and corneal opacities. The perimetry was carried out on Octopus 301 series perimeter using standard glaucoma G1 dynamic white on white programme, after instructing the patient properly patient data regarding name, ID, gender, visual acuity and intraocular pressure was fed in the computerized perimeter. The patients were seated comfortably and their spectacle number placed in the given socket. The pupil size was noted. The patients were supervised throughout the test by well trained examiners and fixation was maintained by the electronic eye fixation control system in the perimeter through out the test as the reliability of visual fields depends largely upon quality of eye fixation. Test duration, positive catch trials, negative catch trials and reliability factor were noted. The reliability of the results was assessed after a thorough review of reliability indices.

### **RESULTS**

A total of 117 patients were examined from January 2007- June 2008. The results are tabulated as follows:

A male preponderance was seen and majority of the patients table 1 belonged to 60-70 years age group making up to 37.4 % followed by 40-50 years age group i.e 25.6% table 2. The size of pupil noted in almost all the patients was in range of 3-7 mm which is a reliable range for normality.

Almost 90% of the patients completed the test in 6-9 minutes 8 % completed in 10-15 minutes and only 2% took time more than 15 minutes.

The number of false positive answers (positive response when no stimulus was presented) is expressed as a percentage of total positive trials False negative answers (Negative response after presentation of brightest possible stimulus in an area where patient showed sensitivity on prior questions) are also expressed in percentage of total questions asked. False positives and negatives were calculated in both eyes and are tabulated as follows table 3.

It is quite obvious from the above tables that maximum number of patients have percentage of false positive and false negatives between the range of 0-5% which shows that a large number of patients (62% patients in false positives and 79% patients in false negatives in their right eyes and 68.4% patients in false positives and 74.6% patients in false negatives in their

left eyes) had a reliable field. The reliable range of rate of false positives and false negatives in Octopus 301 series perimeter, the machine we used is 10-15%.

**Table 1:** Gender distribution

Gender	No of patient's n (%)
Male	77 (65.8)
Female	40 (34.2)

**Table 2:** Age distribution

Age	No of patient's n (%)
10-20	3 (2.7)
20-30	6 (5.1)
30-40	9 (7.8)
40-50	30 (25.6)
50-60	18 (15.4)
60-70	44 (37.4)
70-80	7 (6)

**Table 3:** False positives in Right eye & Left eye

Range of false positives % in Right eye	No of patient's n (%)	Range of false positives % in left eye	No of patient's n (%)
0-5	72 (62)	0-5	80 (68.4)
5-10	0 (0)	5-10	1 (0.8)
10-15	28(2.4)	10-15	21(17.9)
15-20	1(0.8)	15-20	2 (18)
20 and above	16 (13.2)	20 and above	13 (11.1)

Reliability factor table 4 RF indicates patients cooperation and is actually the percentage of sum of false positive and false negative answers divided by total number of catch trial questions .According to the settings of the perimeter we used value of RF should not be higher than 15%. A grade of 0 is excellent. It is evident from the table 4 that 96(82%) patients had Reliability factor in acceptable normal range their right eyes and 104(89%) patients had reliability factor in acceptable normal range in left eyes. It shows that

majority of patients had a reliable field test. It is also obvious that fields of left eyes were more reliable as compared to right eyes.

**Table 4:** Reliability Factor

Reliability factor	No of patient's Rt. Eye n (%)	No of patient's Lt. Eye n (%)
0-5	57 (48.8)	67 (57.3)
5-10	29 (24.8)	28 (24)
10-15	10 (8.5)	9 (7.7)
15-20	6 (5.1)	5 (4.3)
20 and above	15 (12.8)	8 (6.75)

## DISCUSSION

Perimetry; the evaluation of the visual field, is an important diagnostic test particularly in glaucoma, but also for diagnosing and monitoring the progression of many other eye diseases The computer supported static perimetry was introduced for the first time by Fankhauser and it proved to be more practical as compared to the traditional manual goldman method<sup>4</sup>. But automatic perimetry remains a subjective test where the results depend upon patient's collaboration and accuracy of the answers. As it serves as an essential tool in diagnosis and monitoring of progression of glaucoma so it should be as reliable as possible.

We conducted a study at eye department Abbasi Shaheed Hospital from January 2007–June 2008 to including 117 patients to evaluate the reliability of Visual Fields of the Glaucoma patients who underwent perimetry for the first time.

A male preponderance was seen and majority of the patients belonged to 60-70 years age group making up to 37.4% followed by 40-50 years age group i.e 25.6%. The size of pupil noted in almost all the patients was in range of 3-7 mm which is a reliable range for normality.

It was observed that maximum number of patients have percentage of false positives and false negatives between the range of 0-5 % which shows that a large number of patients (62% patients in false positives and 79% patients in false negatives in their right eyes and 68.4% patients in false positives and 74.6% patients in false negatives in their left eyes) had a reliable field.

The reliable range of rate of false positives and false negatives in Octopus 301 series perimeter, the machine we used is 10-15%.

According to the settings of the perimeter we used value of RF should not be higher than 15%. A grade of 0 is excellent. It was seen that 96(82%) patients had Reliability factor in acceptable normal range their right eyes and 104(89%) patients had reliability factor in acceptable normal range in left eyes. It shows that majority of patients had a reliable field test. It is also obvious that fields of left eyes were more reliable as compared to right eyes.

The validity of information obtained from visual field tests depends upon the ability of the patient. However standardized reliability criteria have been adopted at 7<sup>th</sup> visual field symposium at Amsterdam i.e fixation loss rate less than 20% false positive response rate less than 33% and false negative rate less than 33% of test catch trials<sup>5</sup>.

A study was conducted at Dana centre for preventive ophthalmology, Wilmer Institute Johns Hopkins Hospital, Baltimore to evaluate the reliability indices of automated perimetric tests. They observed that 45% of the glaucomatous patients had unreliable fields with the use of manufacturer's reliability criteria. The greater rejection rate was due to higher rate of false negative responses. While in our study it was observed that 18% patients had an unreliable field in their right eyes and 11.1% patients had an unreliable field in their left eyes. The rate of unreliable false positives (14% in right eye and 11% in left eye) and unreliable false negative responses (13 % for right eye and 13% for the left eye) seems to be equal<sup>6</sup>.

A number of studies have shown that 29-45% of full threshold SAP test results using the standardized reliability indices with most of the unreliable fields attributable to fixation losses<sup>6-10</sup>.

So it is obvious that reliability of visual field depends largely on quality of eye fixation. For this reason the Octopus perimeter which we used in our study is equipped with an electronic eye fixation control system. This system interrupts the examination and signals the examiner to correct the situation when the patient is not fixating. This system also senses when the patient blinks during a stimulus presentation and repeats the same question later during the test. Basically the eye fixation control makes sure that only those stimuli are validated when the eye is well fixated and not blinking.

Katz et al found that 19% of normals, 28% of ocular hypertensives, and 37% of glaucoma patients were unreliable on their first C30-2 full threshold field<sup>11</sup>.

It is also possible that test duration may influence the reliability and in particular may influence reliability in glaucomatous patients<sup>12-14</sup>.

But fortunately today by using a faster strategy testing time can be reduced to 6-8 minutes with dynamic strategy or even as less to two minutes with TOP (Tendency oriented Perimetry) for full threshold data. Even with normal strategy the test time can be significantly reduced to 6-9 minutes in cases where the field appears either well within normal limits or shows severe loss<sup>1</sup>. In our study almost 90% of the patients completed the test in 6-9 minutes.

It is thought that continuous monitoring during the test may have a positive effect on reliability of field tests but studies of continuous patient monitoring show that it has neither any positive effect in individual reliability indices nor a positive group effect<sup>15-16</sup>. The Octopus 301 perimeter we used does not need a dark room so the perimeterist can attend to other tasks and be still there to supervise the test without having any significant effect on reliability of the test.

Another important factor that may effect the reliability of the test is the patient instruction. A well instructed patient may perform well and may have a more reliable test as compared to a patient who does not have a proper understanding of the procedure. So it extremely important to spend sometime for careful and adequate patient instructions to have a reliable test result<sup>17</sup>.

The benefits of careful patient instruction by technicians performing visual field tests has been repeatedly and frequently advocated. The constraints of time and resources, however, limit the extent and quality of information delivered to patients during routine visual field testing. The incorporation of a video guiding and reassuring the patient on taking the visual field test is an effective way of using available clinic time. A reduction in the number of patients requiring attendance for a "repeat visual field" can reduce demand on this frequently used service<sup>18</sup>.

## Conclusions and Suggestions

### How to avoid artifacts and improve field reliability

Because the complete perimetric examination is a rather elaborate procedure it is important to make sure

that time invested is well spent .Therefore it pays to the maximum care to obtain reliable results by strictly following certain rules to avoid common pitfalls.

- The examiner should note that patient is a good and active collaborator and had no difficulty in following the examination.
- Enter the patient data carefully and explain the procedure to the patient clearly.
- Inform the patient that not all the stimuli are visible and he should press the button only when the stimulus is visible.
- Explain the importance of making an effort to stay attentive.
- Tell the patient not to be concerned about making a mistake
- .Check the patient's refraction and select corresponding thin rim lenses to be inserted in the given socket. Note the correct position of cylinder axis.
- Moderate myopic patients who leave their contact lenses must inspect them before the test as dirty contact lenses result in artifacts.
- Make sure the patient's eye to be tested is wide open to avoid artifacts.
- A prominent nose, heavy brow or long eyelashes can also cause artifacts leading to misinterpretation of visual field. If such problem is faced turning or tilting patient's head is recommended without losing fixation.
- The occluder should be applied in such a way that patient feels comfortable. Ask the patient to blink normally.
- Position the patient with the eye close to the trial lens to avoid artifacts as ring scotomas.
- It is recommended that fixation mark be adjusted to dimmest light and is still visible to the patient.
- Make sure patient has no difficulty in pressing the button.
- Stay nearby during the procedure and inform the patient often about the progression of the test to encourage him to answer the questions properly.

In the end we recommend a machine with such electronic devices which can sense the fixation losses themselves and help to rectify it to improve the reliability of the test. In addition these machines should be advanced enough to reduce the subjectivity of the test and improve the reliability.

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