

PREDICTING BINOCULAR VISUAL FIELD SENSITIVITY FROM MONOCULAR VISUAL FIELDS IN ALL GRADES OF GLAUCOMA

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Abstract :

Background :

Glaucoma is the second leading cause of blindness in the world. The role of binocular visual field is very important in our day-to-day life activities. The Standard automated perimetry conventionally check the monocular visual field. The binocular visual field assessment has much more importance in the quality of life.

Objective :

- To predict binocular visual field sensitivity using three methods (best location ,average sensitivity and binocular summation)
- Comparing and variation within the three methods .
- Binocular visual field sensitivity in all grades of glaucoma

Methods

The retrospective analysis was conducted in 90 patients according the severity of glaucoma (mild 30, moderate 30 and severe 30) and confirmed the glaucomatous field based on Anderson criteria. Binocular visual field sensitivity predicted from standard 24-2 monocular visual field using the methods best location, average sensitivity and binocular summation was conducted using the statistical tools repeated-measures ANOVA , ANOVA .

Results

Through one way analysis test ,we find out that there is a significance ($p < 0.01$) in mean threshold in different grades with each grade of severity classified using mean deviation. Best location and average sensitivity method against the binocular summation method in each grade of glaucoma. In mild grade, the average sensitivity method underestimated by 11.06 dB (SD: 1.78) and in best location method it underestimated by 9.94 dB (SD: 1.85). In moderate grade of glaucoma, the average sensitivity method underestimated by 9.92dB (SD: 0.51 db) and in best location method, it underestimated by 7.75dB (SD: 0.90). In severe grade of glaucoma, the average sensitivity method underestimated by 9.05dB (SD: 2.50) and in best location method, it underestimated by 3.71dB (SD: 1.88).

Conclusion

Binocular visual field plays a crucial role in daily life activities of glaucoma patients those who are in severe stage. Thus we can evaluate the quality of life of patients with visual field loss comparing with their binocular visual field. Best location and average sensitivity method against the binocular summation method in each grade of glaucoma .

IndexTerms – Quality of life ,Binocular visual field

INTRODUCTION

Glaucoma is the second leading cause of blindness in the world. It is defined as optic neuropathy with corresponding loss of visual field leading to irreversible blindness¹. Around 60.5 million people with open angle glaucoma and angle closure in 2010 expected to increase up to 79.6 million by 2020¹. Glaucoma is a disease which starts in the mid peripheral retina and followed by gradual loss of central vision loss at the late stage³. Visual field is the portion of the space which can be seen simultaneously when eye is looking in one particular direction^{1,3}. Visual field testing allows practitioner to determine the outer boundary in the field but to investigate several locations within the boundary that are preferentially damaged in glaucoma². Periodic visual field testing is very important in known cases of glaucoma; it provides progression of visual field. Binocular visual field (BVF) is important for our day to day life. Currently we perform monocular visual field test for the assessment and treatment of glaucoma. Binocular visual field is not affected in the mild stages of glaucoma and it is affected and symptomatic in severe stages of glaucoma. In glaucoma nerve fibre bundles are damaged at the optic disc area and decrease and lost its sensitivity results in scotoma or generalized depression⁴. The ultimate goal of glaucoma management is to preserve the visual function and quality of life^{3,4}. The hallmark defect of glaucoma is the nerve fibre bundle defect results from the damage to the optic nerve head². Perimetry refers to the clinical assessment of visual field²

- Identification of abnormal fields
- Quantitative assessment of normal or abnormal field to guide the follow up care^{4,6}

Visual field testing can be performed from confrontation technique to the advanced computer programme, automated perimetry. Standard automated perimetry is these can divide the visual field quadrants into superior 50 degree, inferior 70 degree, temporal 100 degree and nasal 90 degree^{3,6}. Fovea is located 10 to 15 degree nasally and the nerve fibre bundles are located in the optic nerve head. Loss of retinal nerve fibres results in glaucoma. Assessing the visual field is important to decide the treatment. There are some methods in testing visual field.

Kinetic versus static perimeter

- Manual versus automated perimetry

Kinetic perimetry uses a known constant stimulus size and intensity^{5,6}. It can be done by

- Confrontation method
- Lister's perimetry
- Tangent's screen scotometry
- Goldmann's perimetry

Static perimetry have 50 to 100% more intense than kinetic target, presenting a stimulus in a pre determined position for a preset duration with varying luminance⁶. It can be done by

- Goldmann's perimetry
- Friedman's perimetry
- Automated perimetry

Manual perimetry is performed by the technician; they decide the stimulus size, intensity, speed of movement and duration of exposure of the stimulus.

Automated perimetry, we can test both central and peripheral visual field. In automated perimetry the strategies used are 10-2, 24-2, and 30-2. For example in 10-2, 10 represent degree of field test and 2 represent the testing protocol. There are two main testing protocols, one directly on the horizontal and vertical axis and two on either on both the sides.^{2,6}

Humphrey automated visual field test, we have stimulus size and intensity from a range of 0 db to maximum of 51 db against the background of 31.5 apostilbs. The db values refers to retinal sensitivity rather than a stimulus intensity and the major advantage of using automated perimetry is to compare patient's sensitivity from the stored values that have been obtained from the age matched normal. Loss of visual function affecting the quality of life results in increased risk of motor vehicle collisions and falls and decreased ability to perform daily tasks.^{2, 3, 6}

Binocular visual field extends about 180 degree across the horizontal meridian. In our clinical set up we do not perform binocular visual field testing. Estermann is one of the binocular visual field testing available in automated Humphrey visual field .The test is performed both eyes open.

This consist of 120 test point with a non adjustable supra threshold of 10 db and it automatically eliminate the blind spot^{5,6}. The limitation is there is no control of fixation. It is not practically useful in our daily routine clinical set up. The test is usually performed for issuing driving licence in countries abroad. The results obtained are a Pass/Fail without any other descriptive information.⁵ Mean deviation is derived from the total deviation plot and it gives the overall depression of the field. If the value is positive the field is better than normal and if it is negative the field is depressed than normal. According to Anderson criteria glaucoma is classified as mild, moderate and severe.

NEED OF THE STUDY.

Binocular visual field plays a crucial role in daily living activites of a glaucoma patient. Binocular visual field test can be used as a tool for assessment and management of glaucoma as well. This would help practitioners get a better understating of how exactly patient field looks like when they view binocularly. Binocular VF are involved in activities like walking ,driving, writing . Also, binocular visual field assessment will help low vision practitioners to better guide or manage patients with severe glaucomatous damage.

3.1Population and Sample

Out of 2000 subjects, recruited 90 samples according in our inclusion and exclusion criteria. All patients were underwent Humphrey visual field 24-2 strategy with 54points monocularly. A subject was considered to glaucoma, have glaucomatous visual field loss in any one eye. Tested each eye with appropriate lens correction. Out of 90 data we again classified it into according to the severity of glaucoma into mild, moderate & severe.

Inclusion criteria:

1. Age above 40 years
2. Patients with Primary glaucoma
3. SITA Standard 24-2 Visual Field report
4. Confirmed Glaucomatous visual field defects (According to Anderson s criteria)
5. Glaucomatous damage in one eye or both eye

Exclusion criteria:

1. Previous ocular surgeries except Cataract
2. Posterior segment disease other than glaucoma
3. Artifactual Visual fields
4. Fixation losses greater than 20%
5. False Positive greater than 15%
6. Poor test reliability
7. Significant cataract affecting visual field threshold

RESEARCH METHODOLOGY

The methodology section outline the plan and method that how the study is conducted. This includes Universe of the study, sample of the study, Data and Sources of Data, study's variables and analytical framework. The details are as follows;

3.1 Population and Sample

Out of 2000 subjects, we recruited 90 samples according to our inclusion and exclusion criteria. All patients were underwent Humphrey visual field 24-2 strategy with 54 points monocularly. A subject was considered to glaucoma, have glaucomatous visual field loss in any one eye. Tested each eye with appropriate lens correction Binocular visual field is going to find out from this monocular visual field by binocular summation method and integrating method. Out of 90 data we again classified it into according to the severity of glaucoma. We are going to predict binocular visual field sensitivity from monocular visual field by using methods like best location, average sensitivity and binocular summation in all grades of glaucoma.

3.2 Data and Sources of Data

The visual field data were collected from visual field department, Glaucoma services. The visual field data stored in the HFA machine as Extensive mark up Language (XML) format and only the user friendly report is printed as visual field report. The extraction of visual field data from HFA machine in Extensive mark up Language (XML) file format. We took the data of the January 2015- December 2015. The data extracted into external hard drive and stored in a secured computer. For the convenience of data analysis, the 24-2 visual field data were converted from XML format to Microsoft excel file using Sequel server studio data tool business intelligence for Microsoft visual studio.

3.3 Theoretical framework

We are going to predict binocular visual field sensitivity from monocular visual field by using methods like best location, average sensitivity and binocular summation in all grades of glaucoma.

1. Best location : Most sensitive of the two visual field locations between eyes for corresponding visual field points
2. Average sensitivity : Average sensitivity of the two eyes for corresponding visual field point
3. Binocular summation : Probability summation of the sensitivities of the two eyes according to the following equation:

$$\text{Binocular Sensitivity} = \text{Sqrt} [(SL)^2 + (SR)^2]$$

3.4 Statistical tools and econometric models

The statistical analysis was performed using the SPSS software.

1. Repeated measure ANOVA : It compare the three methods (best location, average sensitivity, binocular summation) for finding out the significance in the group.
2. ANOVA : To find out the significance of the each method (best location, average sensitivity and binocular summation)

IV. RESULTS AND DISCUSSION

4.1 Results of Descriptive Statics of Study Variables

Table 4.1: Descriptive Statics

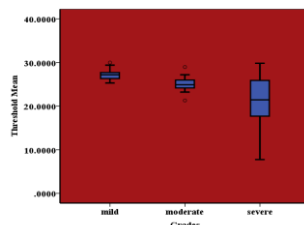
	Number of subjects (%)
Age(in years)	40 – 80
Mean	58.54
SD	9.58
Gender:	
Male	54 (60%)
Female	36 (40%)
Type of glaucoma :	
POAG	37 (41.1%)
PACG	44 (48.8%)
OHT	4 (4.4%)
NTG	3 (3.3 %)
JOAG	2 (2.2 %)
Severity of glaucoma :	
Mild	30 (33.33%)
Moderate	30 (33.33%)
Severe	30 (33.33%)

Table 4.1

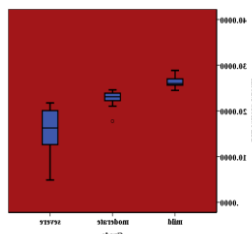
The mean age was 58.54 ± 9.58 years, 54 males and 36 females. Out of 90 samples we have 37 POAG, 44 PACG, 4 OHT, 3 NTG and 2 JOAG. We divided the 90 glaucoma according to the severity into 30 mild, 30 moderate and 30 severe. Out of 90 data, we divided the glaucoma into primary open angle, primary angle closure, ocular hypertension, normal tension glaucoma and juvenile angle glaucoma. In each type of glaucoma we divided according to the severity. In mild grade 12 POAG, 16 PACG, 3 OHT. In moderate grade 12 POAG, 15 PACG, 1 OHT, 1 NTG AND 1 JOAG. In severe grade 13 POAG, 13 PACG, 2 NTG and 1 JOAG and it is explained in table 2

Table 2 : Number of subjects in each type of glaucoma with grades of severity

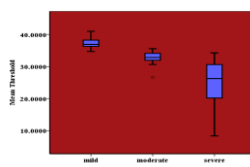
Type of glaucoma	Mild	Moderate	Severe	Total
POAG	12 (40%)	12 (40 %)	13 (43.33%)	37 (41.11%)
PACG	16 (53.3%)	15 (50%)	13 (43.33%)	44(48.8%)
OHT	3(10%)	1 (3.33%)	0 (0%)	4 (4.44%)
NTG	0 (0%)	1 (3.33%)	2 (6.66%)	3 ((3.33%)
JOAG	0	1(3.33%)	1(3.33%)	2 (2.22%)
Total	21	30	39	90



1a: Best Location method (p value < 0.05)



1. b : Average sensitivity method (p value < 0.05)



1.c Binocular summation method (p value < 0.05)

Figure 1: Mean Threshold in Different Grades with each grade of severity classified Using Mean Deviation

The figure 1 explains the :

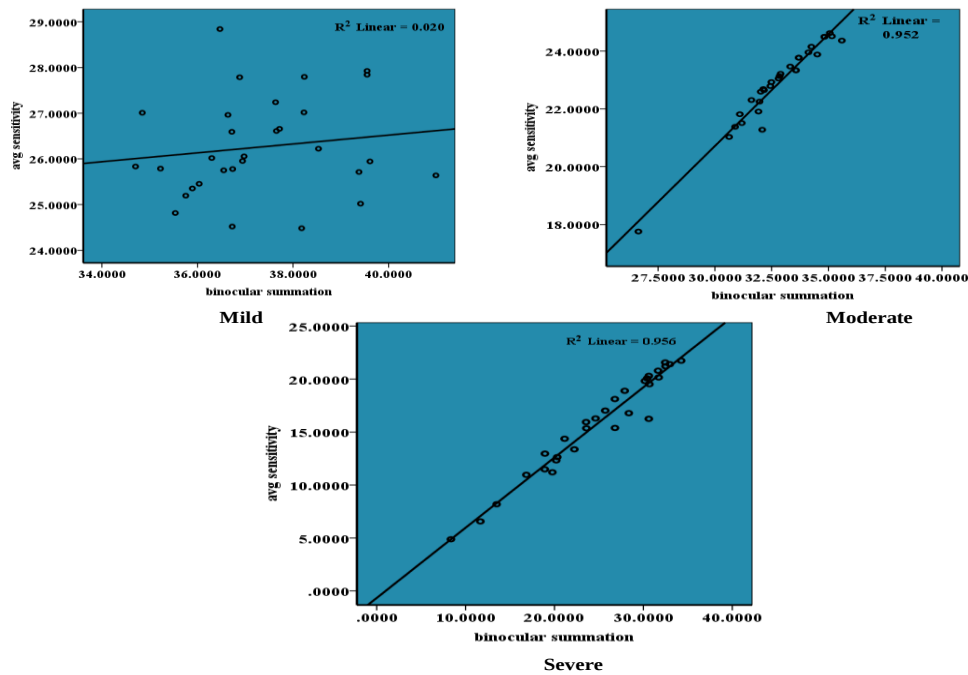
1a : In mild grades of glaucoma, < -6dB threshold ranges from 26.36 to 27.69 , **moderate grades of glaucoma** (-6dB to -12 dB) threshold ranges from 24.22 to 25.98 and in **severe grade of glaucoma**(> -12 dB) threshold ranges from 17.80 to 25.8.

1b : In mild grades of glaucoma (<-6dB) threshold ranges from 25.66 to 27, **moderate grades** (-6dB to -12 dB) , threshold ranges from 22.26 to 23.85 and in **Severe grades** (> -12dB) , threshold ranges from 12.72 to 20

1c: In mild grade of glaucoma (< -6 dB) threshold ranges from 36.34 to 38.24 , **moderate grades of glaucoma** (-6dB to -12 dB) threshold ranges from 31.98 to 34.01 and in **severe grades of glaucoma** (> -12dB) threshold ranges from 20.22 to 30.61 dB

In this study Out of 90 patients, the two methods were evaluated against the binocular summation method in each grade of glaucoma.

In mild grade, the average sensitivity method underestimated by 11.06 dB (SD: 1.78) and in best location method it underestimated by 9.94 dB (SD: 1.85). In moderate grade of glaucoma, the average sensitivity method underestimated by 9.92dB (SD: 0.51 db) and in best location method, it underestimated by 7.75dB (SD: 0.90). In severe grade of glaucoma, the average sensitivity method underestimated by 9.05dB (SD: 2.50) and in best location method, it underestimated by 3.71dB (SD: 1.88).



Correlation of average sensitivity and binocular summation in all grades

In mild grade, correlation of binocular summation and best location is 0.015, it ranges from 25 to 30 dB. In moderate grade the correlation of binocular summation ranges and best location is 0.746 from 25 to 40 dB. In severe grade, the correlation of binocular summation and best location is 0.946, ranges from 5 to 30 dB and it is explained in figure 6

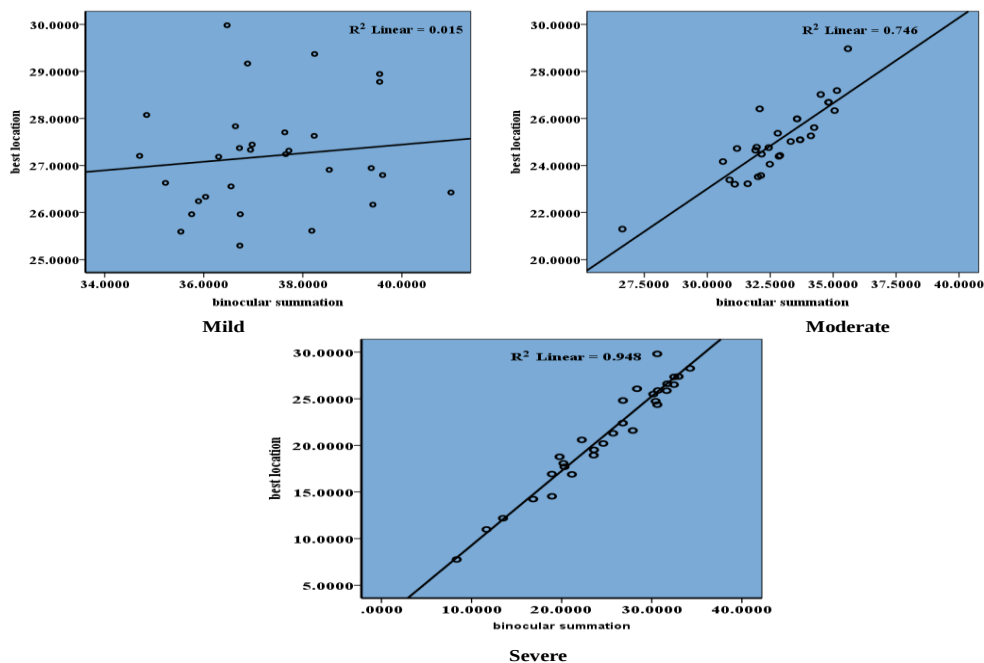


Figure 6: Correlation of best location and binocular summation in all grades

In mild grade, mean value of average sensitivity is 26.26 ± 1.08 , best location 27.2 ± 1.17 and binocular summation 37.32 ± 1.58 . In moderate grade of glaucoma, mean value of average sensitivity is 22.87 ± 1.42 , best location 25.04 ± 1.51 and binocular summation 32.79 ± 1.79 . In severe grade of glaucoma mean value of average sensitivity is 15.85 ± 4.63 , best location 21.19 ± 5.61 and binocular summation 24.90 ± 6.83 . In all methods and grades there is a significant difference of less than 0.05.

By comparing each method by bonferronic post- hoc analysis there is a significant difference. In mild grade, binocular summation underestimated the other two methods (average sensitivity and best location), average sensitivity underestimated by 11.06 db and best location by a10.12 db and average sensitivity underestimated best location by 9.40db.

In moderate grade, binocular summation underestimated average sensitivity by 9.91 db and best location by 7.75db.

Comparison of average sensitivity, best location and binocular summation in calculating the binocular visual field

Methods	Mild	Moderate	Severe	P value
Average sensitivity	26.26 ± 1.08	22.87 ± 1.42	15.85 ± 4.63	< 0.05
Best location	27.2 ± 1.17	25.04 ± 1.51	21.19 ± 5.61	<0.05
Binocular summation	37.32 ± 1.58	32.79 ± 1.79	24.90 ± 6.83	<0.05
P value *	0.00	0.00	0.00	

I. ACKNOWLEDGMENT

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