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ORIGINAL ARTICLE

VISUAL FIELD SCREENING IN DIABETES

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Abstract

Regular retinal screening of all diabetic patients is recommended because early detection and treatment of diabetic retinopathy can prevent or reduce visual loss. A screening test which detects changes in retinal sensitivity before retinopathy is detected ophthalmoscopically would be a valuable tool in drawing attention to those patients at risk of developing retinopathy. The aim of this study was to determine if visual field changes in forty six (46) diabetics with little or no diabetic retinopathy could be detected using a Humphrey Field Analyzer full field 120 point (threshold related) screening test. The results show that this test can detect visual field defects both in diabetic subjects with no retinopathy and those with mild retinopathy. Since it is comparatively quick, reasonably sensitive and able to test out to 60 degrees it may be a useful test in preliminary screening for diabetic eye disease.
Key Words: *retinal screening, diabetic retinopathy, Humphrey Field Analyser full field 120 point screening test.*

INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disease characterised by hyperglycaemia (high blood glucose levels) due to a deficiency of insulin. There are two types of Diabetes Mellitus:

Insulin-dependent diabetes mellitus (IDDM or Type 1) involves a true deficiency of insulin. This is due to atrophy of tissues in the pancreas which normally contain insulin producing cells. IDDM occurs predominantly in young people. Symptoms include excessive urine production, excessive thirst and marked weight loss[1].

Non-insulin-dependent diabetes mellitus (NIDDM or Type 2) involves a resistance to the action of insulin rather than a true deficiency, and occurs in middle aged or elderly people who are frequently overweight. The symptoms are often those of the late complications of diabetes[1] including retinal damage, declining renal function, interference with circulation to the legs and peripheral nerve damage.

Diabetic retinopathy (DR) is one of the major complications of diabetes mellitus. It is one of the most important causes of adult blindness, and is said to be the most common single cause of blindness in the under 65 age group[2]. It is, however, a poten-

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tially treatable complication of diabetes mellitus. Loss of retinal pericytes is considered the primary event in DR, while the role of thickening of the endothelial basement membrane is unclear. These combined lead to capillary closure and abnormal vascular permeability, which underline all the ophthalmoscopic lesions of diabetic retinopathy[2].

The longer the duration of the diabetes, the greater the risk of retinopathy. The relationship of metabolic control of the diabetes to the frequency and severity of the retinopathy is not settled but it is generally assumed that good control delays the onset of retinopathy[3].

Regular retinal screening of all diabetic patients has been recommended because early detection and treatment of DR can prevent or reduce visual loss[2].

A screening test which detects changes in retinal sensitivity before retinopathy is detected ophthalmoscopically would be a valuable tool in drawing attention to those patients at risk of developing retinopathy. The importance of screening for diabetic eye disease is outlined by the Retinopathy Subcommittee of Australian Diabetes Society[2] who states that:

> "Other health professionals should also be encouraged to promote screening and carry out preliminary examinations for diabetic eye disease."

There have been several studies which have examined the visual fields of diabetic subjects in order to determine the relationship between field loss and retinopathy[4-9]. Using different types of field test they have found that visual field defects occur in patients with DR, and may also occur in patients with little or no clinically detectable retinopathy[4,8]. However, the field tests used in these studies were either too time consuming for general diabetic retinal screening, not sensitive enough or unable to test out to 60 degrees.

Two studies which have examined the visual fields of diabetics both with and without detectable retinopathy are those of Roth[4] and more recently Trick[8]. Roth[4] tested subjects with no retinopathy as well as subjects with retinopathy using a *central 20 degrees field scotometer*, and found that all patients with ophthalmoscopically visible retinopathy had scotomata as did nearly half those without visible retinopathy. It was postulated from this study that scotomata may represent a form of pre-retinopathy and may be related to defects in the retinal capillary circulation. However, since this visual field test only examines the central 20 degrees, subjects with subclinical microcirculatory changes in the mid periphery would be missed.

Trick et al[8] tested subjects using the *Humphrey* 30-2 automated perimetry, classifying them as either having little to no DR or mild background DR. They further divided them into categories based on whether they had IDDM or NIDDM. Their aim was to determine whether sensitivity in the visual field was reduced in diabetics with little or no DR, as well as to determine if there was an association between visual field loss and insulin dependency of the diabetic subject. They found that visual field defects did sometimes occur in diabetic subjects without detectable retinopathy. They also found that there was a high percentage of field defects in NIDDM subjects with mild background DR. The field test chosen for this study was able to quantify visual field sensitivity but it didn't test beyond 30 degrees and therefore as with the Roth[4] study may have missed some defects in the mid periphery. It was also a time consuming

test and therefore not useful as a routine screening test for all diabetics.

A visual field test which is rapid, sensitive and able to test out to 60 degrees would seem to be the best field test for routinely examining the retinal sensitivity of diabetic patients with little or no clinically detectable DR. If field defects are found in the absence of detectable DR (possibly indicating a state of preretinopathy), these patients could be monitored more closely.

The aim of the present study was to determine if visual field changes in diabetics with little or no DR could be detected using a *Humphrey Field Analyzer* full field threshold related screening test. Any practical screening test must inherently be a compromise between speed, ease of use and sensitivity. This test (taking approximately 5-7 minutes per eye) was comparatively quick, reasonably sensitive and examines 60 degrees of field.

METHOD

Patient Selection

Forty six diabetic subjects (29 males and 17 females) from a private ophthalmic practice were studied over a 5 month period. Permission from subjects was sought by informed consent. The subjects ranged in age from 17 to 80 years, the mean age being 50.6 years.

Each subject was asked to give details of their diabetes type (IDDM or NIDDM) and the duration of the condition. There were 24 IDDM subjects and 22 NIDDM subjects, duration of the condition ranged from 1 month to 35 years, the mean duration being 9.7 years. The level of control as indicated by present average blood glucose levels (BGL's) was also noted, however the subjective nature of the responses were not able to be verified by objective methods, such as blood testing on the day of the assessment of confirmation by the referring practitioner. Control was considered as being good if BGL's averaged 4-8, fair if they averaged 8-12, poor if they averaged more than 12 and unknown if the subject had no knowledge of their BGLs. Twenty one (45.6%) had good control, 16 (34.8%) had fair control, 6 (13.1%) had poor control and 3 (6.5%) had unknown control.

Prior to visual field assessment, each subject's visual acuity (VA) was assessed monocularly at 6 metres using a Snellens chart, and intraocular pressures (IOPs) on those over 40 years of age were assessed using Goldman applanation tonometry.

Criteria for inclusion in the study was a corrected monocular VA of 6/9 or better in at least one eye, IOP < 21mmHg (if over 40 years of age), no history or ocular signs of any disease likely to cause visual field defects, and no previous laser photocoagulation. Thirty six subjects (78.3%) had a visual acuity of 6/5, 8 subjects (17.4%) had acuity of 6/6, and 2 subjects (4.4%) had acuity of 6/9.

The subjects who met the inclusion criteria outlined above, underwent a visual field assessment using the Humphrey Field Analyzer's Full Field 120 point screening test (threshold related).

Humphrey Field Analyzer

The Full Field 120 point screening test pattern was chosen from the Humphrey Field Analyzer's range of screening tests because it tests out to 60 degrees and takes approximately 5-7 minutes to do. The number and location of points tested gives a good compromise between the Full Field 81 point pattern and the Full Field 246 point pattern.

The type of screening strategy chosen was

the threshold related strategy. With this strategy, if the subject sees a point the first or second time it is tested, the area is recorded as normal. When the subject doesn't see the stimulus the point is tested again to make sure the miss wasn't a mistake. If the point is missed a second time, the Analyzer registers a miss and moves on to test other points. Screening is done at an intensity 6 dB brighter than the expected threshold and therefore missed points are known to be at least 6 dB deep.

Testing Procedure

Only one eye of each subject was tested in order to eliminate the possibility of fatigue and possible enhancing effects of the learning curve on cooperation levels. The eye with the best corrected monocular VA was chosen. If the corrected monocular VA for each eye was equal then the right eye was chosen. The near lens correction to be used for the central field testing was calculated automatically by the Analyzer using the subject's distance correction.

Standard parameters were used for each test, namely a size III stimulus white target, a central fixation target and blind spot check size III.

The visual field test procedure was explained to each subject before commencing the test. A black patch was placed on the eye not being tested and then each subject was correctly and comfortably set up at the machine. Prior to the commencement of the Full Field 120 point screening test, a demonstration test (lasting up to 60 seconds) was given to subjects to ensure correct understanding of the test procedure.

After the visual field assessment, each subject's pupils were dilated with mydriacyl 0.5% and they underwent a fundus examination by one of two ophthalmologists for retinopathy assessment. Retinopathy was classified as nil if there was no detectable background diabetic retinopathy at all, mild if there was background diabetic retinopathy and moderate if there were some areas of ischaemia and haemorrhages not requiring laser photocoagulation. Thirty subjects (65.2% had nil retinopathy, 14 (30.4%) had mild retinopathy, and 2 (4.4%) had moderate retinopathy. Table 1 shows the frequencies of diabetes type in relation to retinopathy type.

TABLE 1
Frequencies of diabetes type in relation to retinopathy type.

	IDDM	NIDDM	Totals
Nil	9	21	30
Mild	13	1	14
Moderate	2	0	2
Totals	24	22	46

Statistical Analysis

The mean, maximum and minimum scores, range and standard deviation were calculated for the number of missed points on the field test and for the central and peripheral reference levels used for the field testing of each individual subject. Observed frequency tables were compiled to examine the incidence of field loss in relation to retinopathy type and diabetes type.

Unpaired t-tests were performed to compare diabetes type with age, disease duration, missed points on the field test, and central and peripheral reference levels. One factor analysis of variance (ANOVA) was used to determine the differences between retinopathy and age, disease duration, missed points on field testing, central reference level and peripheral reference level.

Significance levels for all statistical tests

was $p = 0.05$. Subjects with moderate retinopathy were excluded from some of the statistical analyses because of the small sample size involved (n=2). After consultation with colleagues it was decided that 5 or more missed points would be considered clinically significant. Given that the Field Analyzer always rechecks missed points to make sure the miss wasn't a mistake, it was decided that allowing more than 4 missed points to be ignored could result in retinal pathology being missed. Although the Analyzer does check for patient reliability during testing it was decided that up to 4 points missed could be due to patient fatigue or misunderstanding and therefore should not be considered as significant.

RESULTS

Table 2 shows the means, maximum and minimum scores, range and standard deviation for the points missed on field testing, and for the central and peripheral reference levels.

TABLE 2
Means, maximum and minimum scores, range and standard deviation for the points missed on field testing.

Summary statistics	Missed points	Central reference point (in dB)	Peripheral reference point (in dB)
Mean	9.7	36.7	33.7
Minimum score	0	32	26
Maximum score	59	40	42
Range	59	8	16
Standard deviation	11.1	2	4.4

Table 3 shows the frequency of retinopathy type in relation to whether fields were normal or abnormal.

TABLE 3
Frequency of retinopathy type in relation to whether fields were normal or abnormal.

	Nil retinopathy	Mild retinopathy	Totals
Normal	13 (43.3%)	5 (35.7%)	18 (40.9%)
Abnormal	17 (56.7%)	9 (64.3%)	26 (59.1%)
Totals	30	14	44

Table 4 shows the frequency of diabetes type in relation to whether fields were normal or abnormal.

TABLE 4
Frequencies of diabetes type in relation to whether fields were normal or abnormal.

	IDDM	NIDDM	Totals
Normal	9 (40.9%)	9 (40.9%)	18 (40.9%)
Abnormal	13 (59.1%)	13 (59.1%)	26 (59.1%)
Totals	22	22	44

Tables 5 and 6 show the breakdown of IDDM and NIDDM subjects into subgroups based retinopathy type and field type.

TABLE 5
IDDM
Breakdown of subjects into subgroups based on retinopathy type and field type

Retinopathy	Fields	Number	Percentage
Nil	Normal	4	18.2
Mild	Normal	5	22.7
Nil	Abnormal	5	22.7
Mild	Abnormal	8	36.4

Unpaired t-tests showed that there was *a significant difference* between diabetes type and age ($t = -3.53$, $df = 44$, $p = 0.001$)

and duration of the condition (t = 6.47, df = 44, p = 0.0001). However there was *no significant difference* between diabetes type and points missed on field testing (t = -0.8, df = 44, p = 0.4276), central reference level (t = 1.36, df = 44, p = 0.1793) and peripheral reference level (t = 1.3, df = 44, p = 0.2004).

TABLE 6
NIDDM
Breakdown of subjects into subgroups based on retinopathy type and field type

Retinopathy	Fields	Number	Percentage
Nil	Normal	9	40.9
Mild	Normal	0	0
Nil	Abnormal	12	54.5
Mild	Abnormal	1	4.5

One factor ANOVA tests showed that there was *a significant difference* between retinopathy and diabetes duration (F = 51.75, p = 0.0001). However there was *no significant difference* between retinopathy and age (F = 0.03, p = 0.8611), points missed on field testing (F = 0.52, p = 0.476), central reference level (F = 0.05, p = 0.8163), and peripheral reference level (F = 0.01, p = 0.9343).

DISCUSSION

This study demonstrated that visual field defects in diabetics can be detected using the Humphrey Field Analyzer's Full Field 120 point screening test (threshold related). More importantly, this study found that there was no statistical difference between retinopathy type and the number of points missed on field testing. This indicates that the screening test can detect field defects in both subjects with no retinopathy and subjects with mild retinopathy.

Roth[4] and Trick et al[8] have shown that field defects can occur in subjects without detectable retinopathy. The Roth study[4] found that 48.5% of the subjects without retinopathy had scotomata. Trick et al[8] found that 26.3% of their total diabetic subjects had fields which were "probably abnormal". Of those without detectable retinopathy, 17.7% of the NIDDM group and 14.3% of the IDDM group had field defects.

The present study revealed that of those with no detectable retinopathy, 56.7% had abnormal fields (using 5 or more missed points as the criteria for classifying fields as abnormal). These results are more consistent with those of Roth[4] than those of Trick et al[8]. The classification of fields as being normal or abnormal was determined subjectively by clinicians in this study, whereas in the study by Trick et al[8] field classification was determined statistically by the STATPAC analytical program contained in the Humphrey Field Analyzer threshold strategies (not contained in the Humphrey screening programs).

In this study there was a statistically significant difference between diabetes type and age, and between diabetes type and duration of the condition. The average age of diabetic subjects was less for IDDM subjects than NIDDM subjects, and diabetics with a longer duration of the condition were more likely to have IDDM than NIDDM. These findings are consistent with the literature, which indicates that IDDM occurs predominantly in young people while NIDDM occurs predominantly in older people[1].

There was also a statistically significant difference between retinopathy type and duration of the condition. This is consistent with the findings of the Retinopathy Subcommittee of Australian Diabetes Soci-

ety[2], which has found that the longer the duration of diabetes, the greater the risk of retinopathy.

Trick et al[8] found that visual field defects occurred most frequently in NIDDM subjects with mild background retinopathy (72.3%). The present study found that there was no statistically significant difference between diabetes type and points missed on field testing. However the sample size for NIDDM subjects with mild retinopathy in this study was so small (n=1) that no comparisons can be made for this subgroup. For NIDDM subjects with no retinopathy (n=21), 57.1% had abnormal fields, compared with 55.6% of IDDM subjects with no retinopathy (n=9).

Diabetic subjects without retinopathy who demonstrate field defects may in fact be exhibiting a type of preretinopathy, indicating alteration in retinal function[4]. If this is the case then follow up studies of subjects without retinopathy (both with and without field defects), could be carried out over a specified time period in order to determine whether in fact those with field defects develop retinopathy more frequently than those without field defects. It could also be determined whether there is an increase in field defects prior to the onset of detectable retinopathy, as suggested by Roth[4] in his discussion of a possible follow up study.

CONCLUSION

The present study has shown that the Humphrey Field Analyzer Full Field 120 point screening test (threshold related) is able to detect changes in the retinal sensitivity of both IDDM and NIDDM subjects. This test is comparatively quick, reasonably sensitive and able to test 60 degrees, and therefore may be useful in preliminary screening for diabetic eye disease. Since orthoptists have expertise in field testing procedures, they would be in a position to undertake retinal screening of diabetics, and therefore to open up a new avenue of orthoptic care in the eye health team.

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