Original article

Effectiveness of measuring the central field with the Berkeley field test

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Abstract

Introduction: There are several limitations of the Amsler chart as a screening tool due to its low sensitivity and high false-negative results. The Berkeley central visual field test (BCFT), which is a simple power-point presentation of a 50-point scoring system for the central 10 degree of the visual field, was devised as an alternative to the Amsler chart. **Objectives:** To compare the efficacy of measuring the central visual field using the Berkeley central field test (BCFT) and the Amsler grid test. **Materials and methods:** In a comparative and validity study, 30 subjects with maculopathy and 35 controls were recruited. The maculopathy subjects with the best corrected visual acuity of 20/200 or better and 2.5M for distant and near vision respectively, were included. All the subjects under went a complete eye examination where visual assessment was done using the distant and near vision Log MAR Chart. The subjects were assessed with the Amsler chart-II at a distance of 30 cm. The BCFT was used as a 50-point scoring system. The effectiveness of BCFT was compared with that of the Amsler grid regarding the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). **Results:** Out of 65 subjects, 30 subjects had maculopathy and 35 were normal. The mean age of the 65 subjects was 49.8±9.1 years. Of the 30 subjects with maculopathy, the majority (54%) had age- related macular degeneration. The sensitivity, specificity, PPV and NPV of the Amsler grid test were found to be 80%, 100%, 100% and 87%, respectively, whereas those of the BCFT were 71%, 99%, 98% and 82% (*p=0.37*). **Conclusion:** The BCFT test was as good as the Amsler grid test at detecting the presence of maculopathy.

Keywords: Amsler chart, BCFT, visual field, maculopathy

Introduction

The visual field is the area perceived simultaneously by a fixating eye. Different methods of visual field examination can be employed to determine the limits of the visual field and gaps within it. Some widely used visual field tests only deal with the central region of the visual field: for example, the tangent screen usually tests within 30 degrees of the fixation point and the Amsler grid test and the automated Humphrey visual field test 10-2 (Wiggins & Dersu, 2007; Anderson et al, 2005) analyze the field of vision within 10 degrees of the point of fixation (Wiggins & Dersu, 2007; Garber 1994; Amsler, 1953).

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The ability of patients to accurately detect changes in their vision and seek immediate referral is crucial in macular diseases like age-related macular diseases (AMD) to administer appropriate treatment on time (Crossland & Rubin, 2007). The Amsler chart which was first introduced by the Swiss ophthalmologist Marc Amsler in 1920 is used to measure the central field of 10 degrees from fixation (Amsler, 1953). It is a cost-effective tool and can be used to self-monitor the progression of macular diseases. The main chart from the Amsler grid test consists of a grid of 20x20 5-millimeter squares with two oblique diagonal lines crossing each other at the central fixation point (Figure 1). Each 5 mm square subtends an angle of one degree on the retina when the grid is held at 30 cm from the eye. The area of the whole chart is a square that subtends 20 degrees of visual field (Amsler, 1949).

There are some limitations of the Amsler chart as a screening tool. For example, the presence of scotomas was noted in 2% of control subjects who had no symptoms of scotoma (Loewenstein et al, 2003). In the Schuchard (1993) study, the sensitivity of the Amsler chart has been shown to be as low as 56% when compared to that of fundus microperimetry (Schuchard, 1993). It has been apparent that the Amsler chart produces a high level of false-negative reports and this finding is even higher when there is a lack of close supervision and patient education (Fine et al, 1986).

The BCFT was designed by Prof Ian Bailey from the University of California, Berkeley University, and the version of the program we used is a simple power-point presentation that is compatible with virtually all computers. The BCFT with dark lines on a white background is used as a 50-point scoring system for the central visual fields (Figure 2) within the central 10 degrees at a viewing distance equal to twice the distance between the long vertical red lines seen at the edge of each slide. The test targets subtend an angle of approximately 30 minutes of arc (equivalent to 10/1000 or Goldmann-III). Of the 50 targets, 20 are positioned superiorly and 30 inferiorly as recommended by the AMA Guides for Evaluation of Permanent Impairment (Rondinelli, 2008). Five points are tested along 10 different hemi-meridians. The points are at eccentricities of 1°, 3°, 5°, 7° and 9°. There are four hemi-meridians in the superior field (at 25°, 65°, 115° and 165°), and six hemi-meridians in the inferior field (at 195°, 225°, 255°, 285°, 315° and 345°).

So, we used the Berkeley central visual field test (BCFT) to compare the findings with that of the Amsler grid chart test in patients with central retinal diseases which are likely to cause some central field loss.

Materials and methods

Study design and sample size

A cross-sectional, comparative and validity study was carried out in 30 consecutive subjects with known maculopathy detected by two ophthalmologists from November 2009 to April 2010 from the Shree Naval P Baliwalla Centre for Vision Rehabilitation of the Lotus College of Optometry, Mumbai, India. The subjects were excluded from the maculopathy group if there was any other retinal abnormality, the corrected distant visual acuity was worse than 6/60 and the near visual acuity worse than 2.5M at 25 cm. Among these 30 subjects, all the eyes of 26 subjects having a bilateral maculopathy and four subjects having a unilateral maculopathy, comprising of a total of 56 eyes, were considered for the evaluation as the known maculopathy group.

Thirty-five consecutive normal subjects were recruited from the Shree Naval P Baliwalla Centre for Vision Rehabilitation of the Lotus College of Optometry. The subjects were excluded from the normal group if there was any retinal abnormality, any media opacities causing diminution of the corrected distant visual acuity of worse than 6/12, and near visual acuity worse than 1M at 40 cm. Both the eyes of the 35 normal subjects and four normal eyes of the unilateral

maculopathy subjects, comprising of a total of 74 eyes, were enrolled for evaluation as the normal group.

Informed consent

Informed consent was taken from all the subjects. The research protocol was approved by the ethics review committee of the Lotus College of Optometry. The research protocol adhered to the provision of the Declaration of Helsinki for research involving human subjects.

Ocular examination

a) All subjects underwent a complete eye examination. Presenting and best-corrected distant visual acuities were assessed using a Log MAR chart that was designed to be used at 10 feet under normal room illumination. It had five letters in each row. There was a geometric progression (reducing by 0.1 log units or 79.4%) of size from one row to the next in each line. The near vision was assessed with a LogMAR letter chart with the subjects wearing the best refractive correction, and with a near addition in presbyopic subjects.

b) Objective refraction was performed using a Heine Retinoscope at a 50cm distance and subjective refraction was performed with full-aperture trial lenses.

c) The anterior segment examination was performed with a slit-lamp and the dilated fundus examination was performed with indirect ophthalmoscopy.

d) The visual field examinations were conducted with the Amsler chart type II and the central field test.The test to be performed first was decided randomly by tossing a coin.

In our study, we used the grid in black on a white background, that is, the Amsler chart type II (Figure 1), to make findings comparable with that of the BCFT that uses black lines on a white background. The subjects with BCVA were instructed to fixate the central dot at the center of the grid which was at a distance of 30 cm. The subjects were asked to report any regions of the grid pattern that appeared to be missing, blurry, faint, distorted or otherwise abnormal. Records of their descriptive responses were made on a printed replica of the grid showing the regions of abnormal appearance.

With the BCFT, the subjects were instructed to fixate at the central black dot point where the diagonal lines cross each other. The clinician progresses forward or backward through the sequence of the MS PowerPoint slides using the ARROW keys and the subject responds using the MOUSE or giving a verbal response. Between each of the 50 test slides, there was a blank slide with no test target.

Evaluation tools

The primary question asked was whether either or both of the tests of the central visual field indicated the presence of a visual field defect. For the analysis of the results, we determined sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). The criteria for a field defect in the BCFT were having one or more points missed. Similarly, the criteria for a "field defect present" for the Amsler chart were any abnormal appearances reported.

Data analysis

All the data were entered into the statistical package for social studies (SPSS) version 16.0. The subjects' characteristics were expressed in the mean, standard deviation (SD) and percentage and the variables among the maculopathy group and the normal group were compared using the unpaired t-test. The Chi-square test was performed to analyse the effectiveness between the Amsler grid test and the BCFT. AP-value of less than 0.05 was taken as significant for the confidence interval of 95%.

Results

There were 65 subjects, of which 30 were cases with a known maculopathy and 35 who had no known maculopathy were of the control group (Table 1). The mean age of the control group (46.6±8.2 years) was less than that of the maculopathy subjects (53.5±8.8). The male to female ratio was 1.7 in the control group and 1.5 in the maculopathy group,but the difference was not statistically significant. As expected, the visual acuities were worse in the maculopathy subjects,

who used higher power additions and showed wider variation in their refractive error (Table 1). The mean time required for each of the two tests was about the same for both the groups, but the SDs were very tight.

In the maculopathy group the majority of the subjects hadage-related macular degeneration (AMD, n = 16, 54%), followed by heredo-macular degeneration (HMD, n=6, 20%), macular hole (n=3, 13%), macular scar (n=2, 7%), Stargardt's disease (n=2, 3%) and cellophane maculopathy (n=1, 3%). In four patients, the maculopathy was unilateral. Thus, 56 eyes had maculopathy.

When maculopathy was present, the Amsler grid showed a false-negative value in 19.6%, whereas the BCFT showed a false-negative error in 28.6% of the cases. In the normal cases, the Amsler grid presented 100% true negative values, whereas the BCFT produced 1.3% false- positive values (Tables 2 and table 3).

Both the tests were good in identifying the presence of maculopathy, having no difference in the detection of the true positives (Yate's chi-square=87.4, p=0.37, df=1) and normal (Yate's chi-square=69.3, p=1.0, df=1). However, the Amsler test gave slightly better results for sensitivity (80% vs 71%), while the specificity values were almost the same (100% vs 99%). Consistent with this, the NPV was slightly better for the Amsler test (87% to 82%) and the positive predictive values were almost the same for both the tests (100% to 98%).

Figure 1: Amsler grid chart

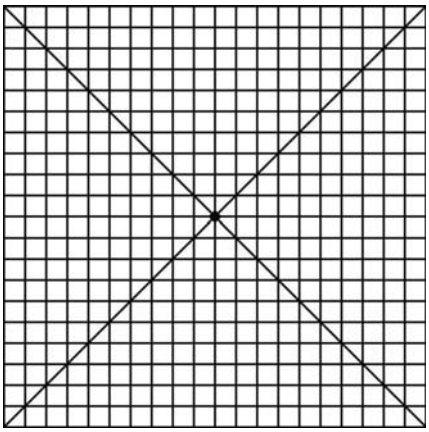

Figure 2: Berkeley central visual field test chart

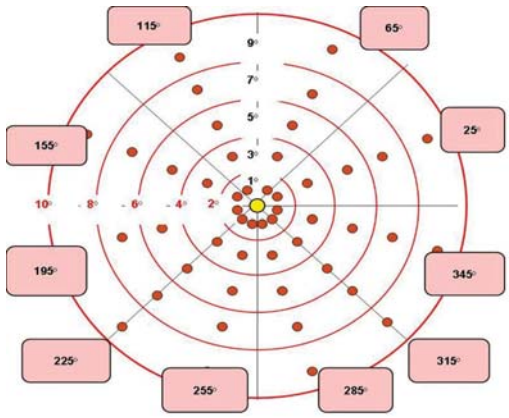

Table 1: Specifications of the participants in the study

Description	Maculopathy subjects n=30 subjects	Normal subjects n=35 subjects	*p*
Age (years)	53.5±8.8	46.6±8.2	0.5
Male: Female	1.5:1	1.7:1	0.8
Presenting VA (Log MAR)	0.9±0.3	0.2±0.2	**0.00**
Corrected VA (Log MAR)	0.4±0.3*	0.0	
Spherical equivalent refractive error	-0.10±2.30D	0.20±0.60D	0.07
Spectacle addition for near vision in Diopter	2.70±0.90	1.50±0.80	**0.00**
Best corrected near visual acuity in Metric notation	1.10±0.40	0.60±0.10	**0.00**
Time for the Amsler grid in minutes	2.20±0.20	2.00±0.20	**0.00**
Time for the BCFT in minutes	2.00±0.10	2.00±0.10	0.06
VA = visual acuity; * significantly improved from presenting visual acuity *P* = value significant at 0.05 or less by unpaired sample t-test			

Table 2: Amlser grid test in maculopathy and normal subjects

		Maculopathy As detected by fundus exam		Total 130
		Present (56)	Absent (70+4)	
Amsler grid test abnormality	Present	True positive (45)	False positive (0)	PPV (45/45=100%)
	Absent	False negative (11)	True negative (74)	NPV (74/85= 87%)
		Sensitivity (45/56=80%)	Specificity (74/74= 100%)	

(PPV= positive predictive value; NPV= negative predictive value)

Table 3: Berkeley central field test in maculopathy and normal subjects

		Condition (Maculopathy) As detected by fundus exam		Total 130
		Present (56)	Absent (70+4)	
BCFT test abnormality (any missed point)	Present	True positive (40)	False positive (1)	PPV (40/41=98%)
	Absent	False negative (16)	True negative (73)	NPV (73/89= 82%)
	Total (130)	Sensitivity (40/56=71%)	Specificity (73/74= 99%)	

(BCFT= Berkeley central field test; PPV= positive predictive value; NPV= negative predictive value)

Table 4: Outcome of central visual field test by the Amsler grid and the BCFT

Conditions	Tests report	Amsler	BCFT
Maculopathy present (n=56)	True positive	45	40
	False negative	11	16
Maculopathy absent (n=74)	False positive	0	1
	True negative	74	73

(BCFT= Berkeley central field test)

Discussion

The Amsler grid test is used to detectde fects within the central 10 degrees of the field of vision. Descriptions on the findings of the Amsler grid test and its limitations have been well documented by many investigators (Crossland & Rubin, 2007; Amsler, 1949; Loewenstein et al, 2003; Schuchard 1993). There are several possible explanations for the high level of false- negative results with the use of the Amsler grid test, such as the use of a preferred retinal locus away from the scotoma boundary (Timberlake et al, 1986; Sunness et al, 1996; Crossland et al 2005), averaging of the crowded stimuli (Parkes et al, 2001), asymmetry of attentional deployment in the peripheral retina (He et al, 1996) and the phenomenon of filling-in (Komatsu, 2006; Safran & Landis, 1999; Gerrits & Timmerman, 1969; Schuchard,1993; Ramachandran, 1991).

The BCFT is easy to administer and requires minimal patient education, unlike the Amsler grid test, and produces reliable result (Fine et al, 1986). The BCFT doesn't detect metamorphopsia, the phenomenon of filling-in and scotomas; however, it does detect the loss of sensitivity. Moreover, the mean time required by the Amsler grid ($p = 0.00$) was significantly different in the normal and maculopathy groups, the testing taking longer in maculopathy (Table 1), whereas mean test time was the same for both the groups when tested with the BCFT ($p=0.06$). The BCFT implies just a detection of 50

points in the central 10 degree as a sensitivity presenting a single point at a time. So the time taken was found to be constant for both normal and maculopathy subjects. But the Amsler test is more subjective and needs constant vigilance to detect a defect and requires a longer time in maculopathy subjects.

In the 56 eyes with known maculopathy (Table 4), both the tests found central visual field defects in the majority of cases (Amsler: 80.4% and BCFT: 71.4%), having no statistically significant difference (Yate's chi-square=0.78, p=0.37, df=1). The Amsler test showed the better sensitivity. This may be due to the larger size of the abnormal appearance on the Amsler chart than the one target point in the BCFT. For the 74 eyes with normal vision, there was only one result (Yate's chi-square=0.0, p=1.0, df=1) suggesting the presence of a central visual field defect (1 false positive). The finding of a false negative error with the Amsler chart is comparable with that of the Schuchard study (Schuchard, 1993). However, we did not measure the scotoma size, though scotoma of less than 6 degrees was reported to be not detected in the Amsler grid test (Schuchard, 1993).The effectiveness was found to be good in both the Amsler and BCFT findings of all 130 eyes. No abnormal findings were found on either the Amsler chart or the BCFT in the comparison with normal subjects.

One limitation of this study was its relatively small sample size. The BCFT is a computer based test that requires computer equipment and a power source. To compare the reliability of these two methods, it would have been necessary to conduct repeated measurements either using a second clinician to repeat the tests on the same visit after some time, or testing the patients again at a second visit, after the first testing session and as early as possible.

Conclusion

The BCFT test was as good as the Amsler grid test at detecting the presence of maculopathy. Both the tests were good in the detection rate. The BCFT took slightly less time for the maculapthy patients and is easy to administer. However, the Amsler test had better sensitivity for identifying the presence of maculopathy.

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