THRESHOLD AMSLER GRID TESTING
AND
RESERVING POWER OF THE POTIC NERVE

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Since Amsler grid testing was introduced by Dr Marc Amsler on 1947and up till now, it has an important role in evaluation of the central 10°surrounding the fixation points (1, 2). The test consists of 7 charts that are essential in the analysis of the visual functions. It helps in the early functional evaluation of the maculopathies and near by retinopathies, together with glaucomatous visual field defects and optic nerve diseases. It is the only portable visual field testing suitable for screening.

The Amsler chart is a square-shaped chart 10 cm long. It is divided into 20 small squares, 5 mm each with central white spot used as a fixation point. The linear measurement correspond to an angle of 20°to the whole chart and 1°for each square, when held at 28-30 cm from the eye. In the field of vision the network occupies an area 10° all around the fixation point (Fig1). The image of the chart grid extends beyond the macula (Fig 2). Its nasal border is two-thirds distant from the foveola to the disc. Small vessels radiate and even penetrate the macula on every side of the chart image.

The dimensions of the Amsler grid retinal image (Fig 3) and its contents represent an angle of 20°which equals a side measurement of 5.36mm; the grid therefore covers 28.73 sq mm. Each small square of the grid of 1°equals to 0.27mm at the side. The big oval network represents the macula; it measures 8° (2.14mm) in length and 6° (1.6mm) in width. The smaller of the two central circles represents the foveola; its diameter is 0.2mm. Around this, the bigger circle 0.44mm in diameter represents the avascular area of the central retina.

Clinical notes:

The Importance of the central 10°of the visual field is from the fact that in normal eye with 20/20 vision at fixation, visual acuity decreases rapidly in the peripheral field so that: at 5°, it is 20/70, at 10°, it is 20/100 and at 20°, it is 20/200.

By testing the visual field using Amsler grid, you can precisely detect what represents the borders of the macula on the chart which is a central oval area starting after 6 small squares in the horizontal meridian and 7 small squares in the vertical one. This could help the physician to report accurately that any changes reported by the patient are near the arcades, Para macular, macular, foveal, or even foveolar.

The important benefit of the Amsler chart testing is to decide whether the patient should be subjected to further advanced investigations (FFA,OCT,HRT,VF,….etc)

How to use the Amsler chart

There are 7 charts.
Each is held at a distance of 28-30 cm with the patient the patient wearing his near correction if indicated.
The chart must be clearly and evenly lighted as for testing reading correction.
Each eye is examined separately, one at a time.
The patient must fix his gaze on the white spot in the center of the chart during the whole time of the examination, observing at the same time the whole chart and the details of the network.
All the observations and information given by the patient should be noted, recorded, and added in a separate chart printed in black on white paper for the convenience of the recording.
The border of the missed small squares could be out lined with the help of black indicator with a white dot at the end. This white dot moved from the periphery to the center in each o'clock, so as to let the patient stated where it appears or disappeared.

There are 6 questions that are asked in logical order.

1st Question.
Do you see the white spot in the center of the squared chart?

There are 3 options:
1-Yes; this means that there are no central scotoma and shift to the second question.
2-Yes; but it is blurred. This means that there is a relative central scotoma and the patient can easily point out a circle around the spot.
3-No the central spot is invisible; I see it only when I glance aside. This means an absolute central scotoma. In such case, we show the patient chart no. 2 on which the diagonal lines help to fix the center of the square and he will point out the limits of his central scotoma.

2nd Question.
While keeping the subject fixing upon the white spot in the center; can you see the four corners of the big square.

There are three options:
1- Yes. Then skip to the third question.
2- No one of the corner, corners, or sides are missing.
Here we could have either:
a) Arcuate scotoma of Bjerrum in chronic glaucoma which coming from the near blind spot, covers the superior or inferior temporal angle of the square, or two at once. The patient may also point out the loss of other side of the square; this is nasal restriction.
In advanced glaucoma and pigment degeneration of the retina, all corners and sides disappear and annular scotoma is diagnosed. The field left in the middle will be easily outlined and measured by the number of small squares left intact in each direction helped by the indicator.
b) Caecocentral scotoma in toxic amblyopia that is bilateral and temporal to the blind spot. It may be absolute or relative scotoma detected by chart no. 3 (red squares on black background).

3rd Question:
While the observer keeps fixing to the central point, do you notice any interruption in the network, like a hole or spots and if so, where?

This question deals with juxta- and Para central scotomas, absolute (completely blurred) or relative (partially blurred i.e. white lines could be barely seen). Chart no. 4 facilitates the perception of the scotoma where the patient can easily point out the location.

4th Question:
While the observer keeps fixing on the central point, do you see all lines, horizontal and vertical, straight and parallel, i.e., do you see the small squares regular and equal.

This question deals with metamorphopsia; is it localized, gross, or minute. As a result of nonparallism, one might recognize micropsia or macropsia.

For analysis of the different types of metamorphopsia, chart no. 5 and 6 will be helpful, held first horizontally, then vertically, and if necessary, obliquely, where lines seems to have been drown by free hand and not ruled. The subject states the site of these lesions on the chart, to be recorded by the observer.

5th Question:
While the observer keeps fixing on the central point, independently of the blurred spots or distortion, can you see?

* A movement, vibration, or wavering of lines
* Anything shining, colour tint...

And if so, where on the square.

Astonishingly, this symptom, or entoptic phenomenon is not uncommon especially during evolution of fresh maculopathies or scotomas, and if it is present, especial ophthalmic examination should be performed.

6th Question:
While the observer keeps fixing on the central point, we ask:

* At what distance from the central point do you see the blur or distortion. How many small squares between the central point and the distortion.

In order to accurately locate juxta-ceneral visual disturbances, one might use chart no. 7 in which a central rectangle subsided into smaller squares (half degree) contains the fovea

Chart no. 7, is also useful in high myopia, when held in the punctum remotum of the uncorrected eye and used as Amsler test.

N.B: All the observations and information given by the patient should be noted, recorded, and added to the patients file.
This document has great value during ophthalmoscopic examination or fundus photography of the macular region when it is compared point to point.

The observer keeps fixing the central point.

- Do you see the central white spot?

- Do you see the 4 corners of the big square?

- Do you notice any interruption in the network?

- Do you see all vertical and horizontal lines straight.

- Do you see movements or vibrations of lines, or anything?
  shining, or color tint?

- If there is blur or distortion, how far from the central spot and what about its size?

THE CHARTS:

Chart 1: Standard chart, in many cases sufficient.

Chart 2: Used in cases with central scotoma. The diagonal Lines help to fix the center of the square.

Chart 3: Standard chart, but red on black. It is used in Color scotoma (relative, absolute)

Chart 4: Used to reveal only scotoma, no lines or forms to be distorted.

Chart 5: Parallel lines to detect metamorphopsia, and used either vertically or horizontally.

Chart 6: Another chart for minute details of metamorphopsia

Chart 7: Minute examination of the macula and fovea represented by the rectangle with subdivided small squares.

THRESHOLD AMSLER GRID TESTING

Polarized filters have the character that they permit light only in one direction. If two filters are perpendicular to each other complete darkness would be achieved, and vice versa. In between two positions different degrees of illumination from complete darkness to maximum illumination would be perceived.

Amsler grid testing is a suprathreshold stimulus. On lowering the luminance conditions by viewing the white grid on a black background through two cross-polarizing filters that create low luminance i.e., increase the sensitivity of the traditional Amsler grid and change the condition to Threshold Amsler grid (TAG) test (3).

By the use of TAG test we could either detect relative scotomas (areas of depressed retinal sensitivity) that may pass undetected in early cases of diabetic retinopathy, glaucoma, optic neuritis, or even in any case of retinopathies or maculopathies. This is because patients using TAG test could detect shallow (relative) scotomas not previously noticed during standard Amsler Grid testing (Fig 4)

TAG testing could detect the reserving power of the macula and optic nerve (5). Histological studies of the optic nerve in glaucoma suspects with normal findings from kinetic visual field examination may have a loss up to 40% of the retinal ganglion cell axons (6). Astonishingly, it is estimated that no more than 44% of the foveolar neuroretinal channels are required to have 6/6 vision (7). Thus, 6/6 vision is not a proof of having no pathology. 6/6 vision is not a point, but an area ranging from completely healthy, to a compensating one that hardly sees 6/6 vision. This area represents the reserving power of the optic nerve and macula.

How to perform the test:

The device consists of a trail frame in which a pair of polarized lenses is fixed in front of the patient's near correction. The patient views the Amsler grid of white on a black background that is held at a distance 30 cm. The posterior lens is immobile and set at a 0 degree and the anterior one is set on the graduated portion of the trial frame at 90 degrees (Fig 5).

The gratings of the two polarized filters are perpendicular, permitting no light penetration and least illumination or complete darkness would be perceived. If the lenses' gratings are parallel, maximum light penetration is transmitted. Thus light transmission could be varied according to the degree of rotation of the front polarized filter ranging from complete darkness at perpendicular position to maximum illumination at the parallel position (3). The subject wears the trial frame and the eyes are examined alternatingly while viewing the Amsler grid and the angle between the two filters is adjusted perpendicular i.e. the subject could no longer see the grid. The angle is then rotated by 2 degrees at a time to increase the illumination till the patient states that he could just count the small squares of the Amsler grid. The previous 6 questions of Amsler grid testing are then asked to detect easily; if present, the presence of any relative or absolute scotomas, or the angle of polarization. The angle of polarization represents the number of degrees of rotation of the front polarized filter needed by the subject just to count the small squares of Amsler Grid. This degree of rotation is the amount of the reserving power of the optic nerve and the macula. The normal range of reserving power (degree of rotation) is different according to the age of subjects with no local or systemic diseases. Ranging from 6-8 degrees in 10-20 years subjects, 8-10 degrees in 20-40 years subjects and 10-14 degrees in subjects above 40 years (5).This is because of the fact that normal subject normally lose 5000 nerve fiber of the optic nerve per year. Any increase in the angle of polarization (degree of rotation) according to the age group of each patient is an indication of early maculopathies or optic nerve affection. This could be applied, for example in cases of suspected low tension glaucoma in cases of deep cup or early macular edema in diabetic patients. Thus testing the reserving power could be used to deny or prove any disease affecting the macula and optic nerve, as if it is lying within the normal range of a subject according to his group of age or not.

We could also predict any pathology during follow up and start treatment before irreversible damage occur. With the use of NASSAR LAW:
P (percentage of reserving power) = 111.2 – 28/15 X D (degree of rotation) (5).

We could have the equivalent percentage of different degree of rotation (NASSAR RESERVING POWER TABLE - table 1) and consequently an evidence of the absence or presence of any pathology in a subject with 6/6/ vision.

Table 1 NASSAR RESERVING POWER TABLE. (5)

Angle of polarization (Degree of rotation)	percentage of reserving power
6	100
8	96.26
10	92.53
12	88.80
14	85.06
16	81.33
18	77.60
20	73.86
22	70.13
24	66.40
26	62.66
28	58.93
30	55.20
32	51.46
34	47.73
36	44.00

For example if we have 22 years old patients with suspected deep physiological cup or low tension glaucoma. If his reserving power (angle of polarization - degree of rotation) is within normal range (8-10 degrees) according to his group of age, it is not low tension glaucoma and beyond this degree of rotation, immediate treatment should be started before irreversible damage occur and his percentage of reserving power could be calculated from either NASSAR LAW or TABLE. The same principle could be applied for detection of early diabetic macular edema or any other maculopathies or optic neuropathies.

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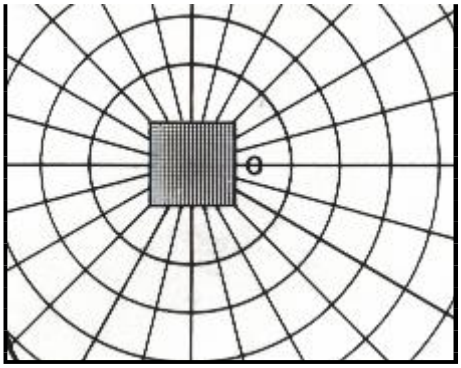


Fig (1) Amsler chart occupies an area of 10 degree around the fixation point of the visual field.

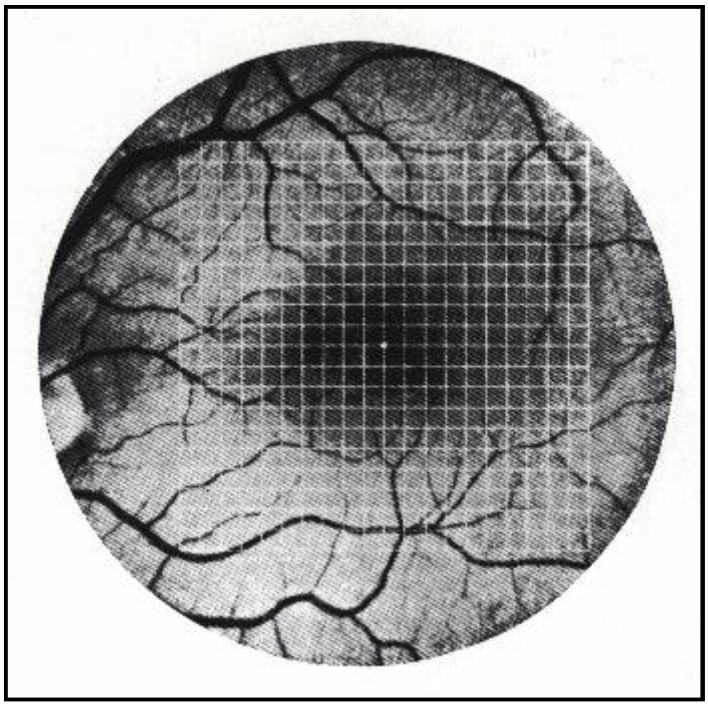


Fig (2) Image of Amsler chart extends beyond the macula.

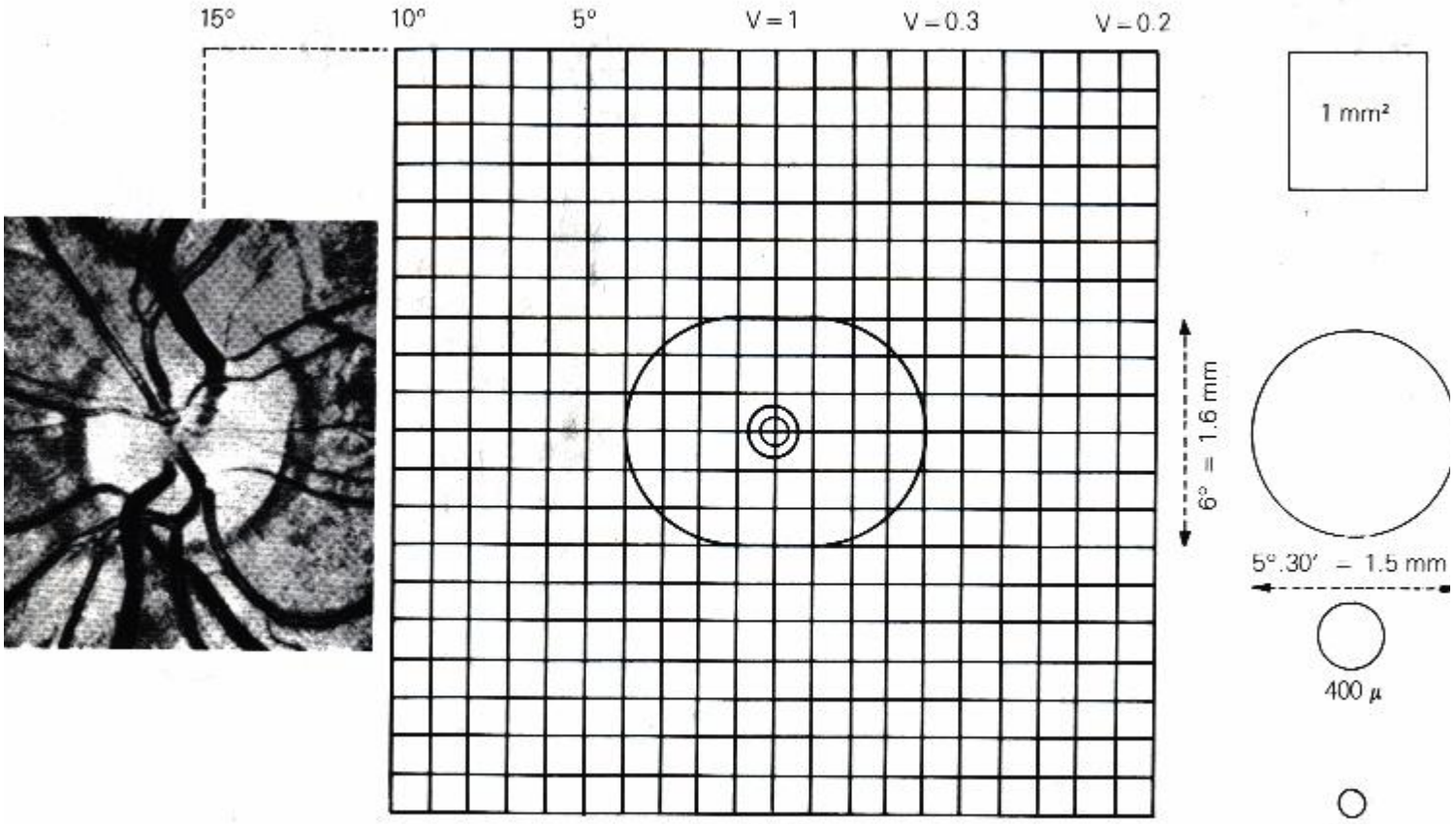
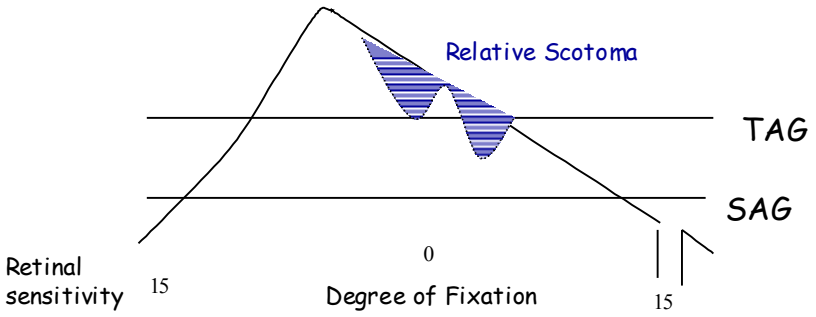


Fig 4 : Relative scotoma (diagonal lines) where suprathreshold standard Amsler Grid (SAG) miss the relative scotoma, detected by the Threshold Amsler Grid testing (TAG)



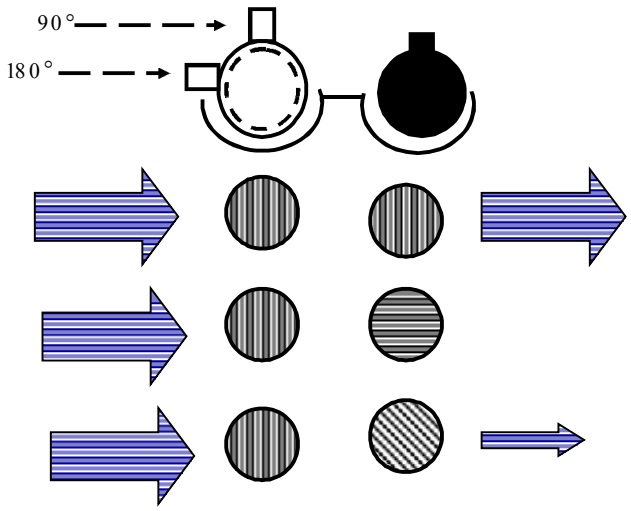


Fig 5: Tag testing device (trial frame. Two perpendicular polarized lenses and Amsler chart) to calculate the reserving power of the macula and optic nerve.
A: parallel position, maximum illumination
b: perpendicular position, minimal illumination
c: in-between position, different degrees of illumination