

## CHAPTER 13

### VISUAL FUNCTIONS

#### (1) VISUAL ACUITY

**DEFINITION:** It is the ability to appreciate the form of the smallest retinal image and is measured by the smallest object which can be seen at a certain distance.

##### 1) FAR VISION

**DEFINITION:** The power by which the details of visible far objects can be distinguished from one another.

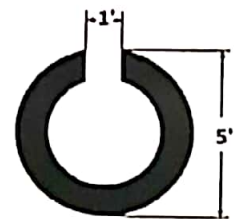
**VISUAL ANGLE:** It is the angle formed by two lines drawn from the extremities of the object through the nodal point of the eye (*Fig.13.1*).

##### MINIMUM VISUAL ANGLE (FIG.13.1):

**Definition:** It is the smallest angle subtended at nodal point of eye by 2 small points to be seen separate (1 minute of a degree in test charts for 6/6 = 1, 10 minutes of a degree for 6/12 = 0.50 and 100 minutes of a degree for 6/60 = 0.01).

**Principle:** Stimulation of two separate cones enclosing an unstimulated cone should occur if two separate points are to be distinguished by the retina:

- (1) Cone diameter at the centre of the fovea =  $1.5\mu\text{m}$  (0.0015mm).
- (2) Linear separation of 2 cones separated by a third cone = 0.003mm.
- (3) Angular resolving power (*Chapter 2*) = 0.78 minutes of arc (47 seconds).

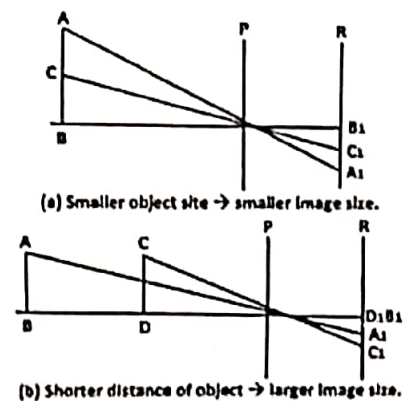


*Fig.13.1: Landolt's broken ring.*

##### SIZE OF RETINAL IMAGE:

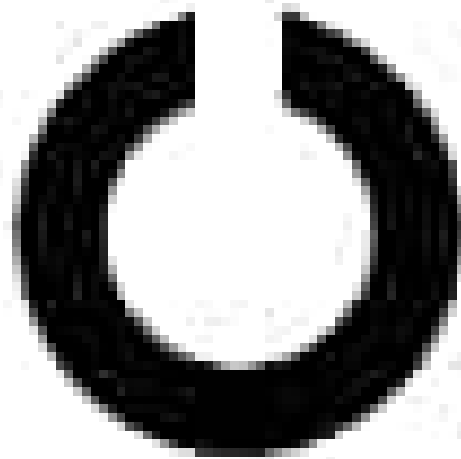
###### (1) Size of retinal image depends on:

- 1) Size of object: The smaller object size, the smaller is the image size and vice versa. In *Fig.13.2a*, CB is half AB and so its image  $C_1B_1$  is half  $A_1B_1$ .
- 2) Distance of object from eye: The shorter the distance of the object, the larger is the image size and vice versa. In *Fig.13.2b*, AB is at a distance twice CD and so its image  $A_1B_1$  is half  $C_1D_1$ .



*Fig.13.2: Size of retinal image.*

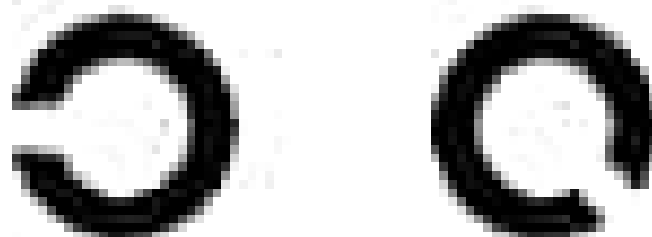
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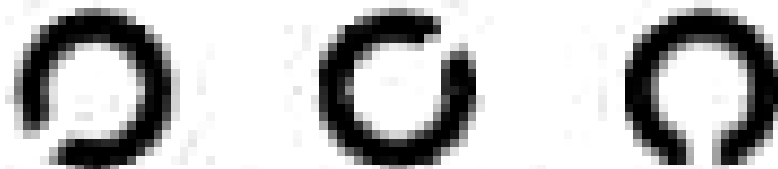
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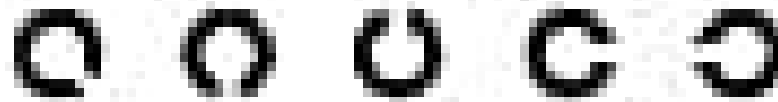
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**(2) Minimum visual angle (V) of Snellen's and Landolt's test types:**

$$V = \frac{D}{M}$$

*D = Distance of object from eye.*

*M = size of object.*

**(3) Minimum distance for test type (from reduced eye):**

- 1) If the object is at infinity: Its image will be at 20mm which is the length of the globe (approximately).
- 2) If the object is at 5 metres: Its image will be at 20.06mm (So 5 metres is the minimum distance at which the test type is used).

**VERNIER ACUITY (ALIGNING POWER OF THE EYE):**

**Definition:** It is the ability of the eye to detect a break in a line or a displacement in a contour.

**Explanation:** One to one relationship of cone, bipolar cell, ganglion cell, and nerve fibre is the most accepted theory.

**Character:** It is as fine as 3-5 seconds of arc (as it is only a fraction of the angular diameter of a foveal cone which is 36 seconds of arc).

**Clinical applications:**

- (1) Endpoint in several ophthalmic instruments: As the keratometer, lensmeter and applanation tonometer.
- (2) Vernier test on a Vernier scale: Is a delicate test for detection of macular damage when vision is 6/6 as measured by Snellen chart.
- (3) Amsler grid chart: Vernier acuity is the basis of Amsler grid chart (A 10 x 10 cm chart which is divided into small squares of 5 x 5 mm and containing a central white fixation spot). The patient is asked to look at the central fixation spot with the uncovered eye and any noticed distortion, wavy lines, blurred areas or black spots indicate a macular lesion.

**TYPES OF VISUAL ACUITY:**

- (1) **Unaided visual acuity:** Without correction.
- (2) **Optical visual acuity:** Visual acuity of a single letter.
- (3) **Maximum visual acuity:** Smallest line of test objects in which more than one half of targets are correctly recognized.
- (4) **Absolute visual acuity:** Fully corrected by spectacle lenses situated at the anterior focal point of the eye with the accommodation relaxed.
- (5) **Relative (best corrected) visual acuity:** Fully corrected by spectacle lenses worn in the ordinary position.

**FACTORS AFFECTING VISUAL ACUITY:**

- (1) **Refraction:** refractive errors lead to decreased visual acuity.
- (2) **Contrast:** Decreased contrast leads to decreased visual acuity.
- (3) **Pupil size:** Decreased visual acuity with:-
  - 1) Pupil size below 2.5mm: Due to diffraction.
  - 2) Dilated pupil: Due to aberrations and uncorrected errors of refraction.



**(4) Stiles-Crawford effect:**

(a) First kind: Rays striking the photoreceptors at oblique angles are not efficient as the parallel rays.

(b) Second kind: Oblique rays cause a different colour sensation than axial rays.

**(5) Intensity of illumination:** Decreased intensity of illumination leads to decreased visual acuity.

(6) **Fixation:** Fine ocular movements which occur during fixation lead to image perfection.

(7) **Tear film:** Its abnormalities lead to defective visual acuity.

(8) **Stimulated part of retina:** Visual acuity decreases outside the fovea due to decreased ganglion cells.

**SNELLEN'S FRACTION:**

(1) Visual acuity =  $\frac{d}{D}$

*d = Distance between test object and eye.*

*D = Distance from normal eye at which target subtends an angle of one minute at nodal point.*

**(2) Snellen's notation:**

1) In metres: 6/4, 6/5, 6/6, 6/9, 6/12, 6/18, 6/24, 6/36 and 6/60.

2) In feet (6metres=20feet): 20/20, 20/30, 20/40, 20/60, 20/80, 20/120 and 20/200.

(3) **Decimal notation:** 1 (6/6), 0.7 (6/9), 0.5 (6/12), 0.3 (6/18), 0.25 (6/24), 0.17 (6/36) and 0.1 (6/60).

**VISUAL ACUITY TESTS (FOR FAR VISION):****(1) Verbal vision tests:****1) Test charts:****1- Targets of test charts:**

(a) Each target consists of E letters (in Snellen's test types), C broken rings (in Landolt's charts), or numbers: E letters are less confusing than C broken rings.

(b) Each target is constructed to subtend a visual angle of 5 minutes of a degree (5') when viewed from the specified distance: Therefore to recognize a target, the eye must have a limit of resolution of one minute of a degree (1') which is the angle subtended at the edges of each letter (Fig.13.1).

(c) The targets are of diminishing size: The largest having a viewing distance of 60m, with smaller letters for distances of 36m, 24m, 18m, 12m, 9m, 6m, 5m, and 4m.

**2- Distance between patient and targets of the test charts:**

(a) Usually at 6m from the chart: A normal eye reads the 6m size from a distance of six m and is said to have 6/6 vision; while, a weaker eye may only be able to resolve the larger letters, e.g. the 24m size and is said to have 6/24 vision.

(b) If for any reason the patient reads the chart from a different distance: The numerator of the acuity is changed accordingly, i.e. 6/6 becomes 4/6.

## 2) Chart projectors:

- 1- Principle: These are optically identical to slide projectors (Fig.13.3). Slide  $O_1O_2$  lies between  $F_1$  and  $F_2$  of the projection lens  $L$ , through which the light source  $S$  is imaged after passing through the condensers  $C$  and the slide. Image  $I_1I_2$  is inverted, magnified and projected on the screen (In chart projector the charts are incorporated in rotatory discs between the illumination source and the projection lenses, Fig.13.4).

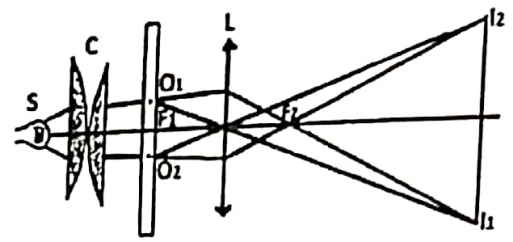


Fig.13.3: Optics of slide projectors.

## 2- Components:

- (a) Light source: The filament of the bulb is imaged at or close to the projection lens system (after passing through the condensers and the chart) to get the maximum amount of light which passes through projection lenses and keeps illumination of screen even (Fig.13.4).

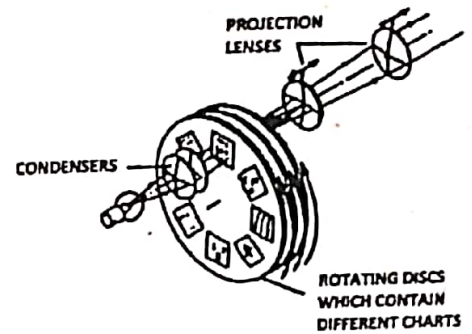


Fig.13.4: Optics of chart projectors.

- (b) Projection lens system: Is calibrated to subtend a visual angle of 5 minutes of a degree for each projected target within a range of refracting distances from the screen. This calibration allows the projector to be freely placed within that range of refracting distances from the screen to perform the visual acuity tests (usually 2.9 to 6.1m).
- (c) Charts: Incorporated in rotatory discs situated in-between the light source and the projection lens system (various visual tests charts are incorporated including Worth's four dots and Duochrome tests).
- (d) Screen: The majority of screens used specularly reflect the incident illumination in order to retain any polarization.
- 3) Video acuity tester: It is test chart upon a television monitor. The display is controlled by a keyboard which allows the examiner to select letters at different sizes.
- 4) Auto-acuitometer: It is used for automatic measurement of visual acuity and near vision. It contains a small computer, a random access slide projector and a joy stick lever:
- The computer would present to the patient a slide which contains a single Landolt C and then wait for the patient to respond by pushing the lever in the direction of the gap in the C.
  - Depending upon the patient's response, the computer would then present either a smaller or larger symbol.
  - At the end of a series of measurements, the computer would then calculate the patient's acuity and print out the result.



**(2) Nonverbal vision tests:**

These methods determine the potential visual acuity in infants and young children mainly, in illiterates, in malingerers and in mentally handicapped:

**1) Assessment of fixation:**

1- Fixation preference: The corneal reflex is observed while the child is fixing a pen light:

(a) Central steady maintained fixation: Means good vision.

(b) Uncentral, unsteady and unmaintained fixation: Means poor vision.

2- Base-up prism: To dissociate the eyes with better assessment of fixation of each eye.

3- Fixation and following of light or toys: Can be done even with less than 6/60 vision.

4- Touching or picking up of small beads or objects: Confirms that the child is seeing.

5- Bruckner method: The observer looks through an ophthalmoscope to observe both the red reflex coming back from the eye and the pupil behavior → If the patient fixes the light, the pupil gets smaller and the red reflex becomes darker than when he is not fixing.

2) Preferential looking: Moving striped and grey cards are presented to the infant → based on the observation that infants are more interested in looking at patterned (striped) stimuli.

3) Catford drum (evoked optokinetic nystagmus): A drum with striped pattern (of white and dark bands) is moved across the subject's visual field in one direction to elicit optokinetic nystagmus and its presence noted by observation or by an electro-oculogram to record eye movements (*Fig. 13.5*).



*Fig. 13.5: Catford drum.*

**4) Visual evoked response (VER)**

Definition: It is a method by which the action potential produced by electrical activity of the visual cortex is recorded in response to light or pattern stimulation of the eye (*Fig. 13.6*):

(a) Flash VER: Represents the function of the central 20° of the retina.

(b) Pattern VER: Represents the function of the fovea.

Normal response:

(a) Double-peaked response, the smaller wave being related to visual acuity (the smaller wave is altered by affections of the central vision as in macular or optic nerve disease affecting the papillo-macular bundle).

(b) Opacities of the ocular media do not affect VER.

Value:

(a) Assessment of refractive error.

(b) Objective testing of the visual acuity in infants and young children.

(c) Electro-physiological study of the optic nerve disease, colour blindness and amblyopia.



*Fig. 13.6: Visual evoked response: (a) Normal; (b) Abnormal.*

**E**

**1 20/200**

**F P**

**2 20/100**

**T O Z**

**3 20/70**

**L P E D**

**4 20/50**

**P E C F D**

**5 20/40**

**E D F C Z P**

**6 20/30**

**F E L O P Z D**

**7 20/25**

**D E F P O T E C**

**8 20/20**

**L E F O D P C T**

**9**

**F D P L T C E O**

**10**

**P E Z O L C F T D**

**11**

E

1 20/200

F P

2 20/100

T O Z

3 20/70

L P E D

4 20/50

P E C F D

5 20/40

E D F C Z P

6 20/30

F E L O P Z D

7 20/25

D E F P O T E C

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T D P L T C E O

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P E E O L O T T D






















































































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LETTER  
SIZE    INTERNAL

SMALLEST DISTANCE EQUIVALENT  
METER    FOOT  
DISCREPANCY OF ADD FOR 1 M

8.0 M	.267						6/20	20/40	20 D
6.3 M	.200						6/26	20/32	15 D
5.0 M	.160						6/36	20/25	12 D
4.0 M	.125						6/50	20/30	10 D
3.2 M	.102						6/60	20/18	8 D
2.5 M	.080						6/72	20/15	6 D
2.0 M	.063						6/100	20/10	5 D
1.6 M	.050						6/124	20/80	4 D
1.25 M	.040						6/150	20/63	3 D
.80 M	.030						6/180	20/50	2.5 D
.63 M	.025						6/216	20/40	
.50 M	.020						6/252	20/32	
.40 M	.016						6/300	20/25	
.32 M	.012						6/360	20/20	
.25 M	.010						6/432	20/16	
.20 M	.008						6/518	20/12.5	
							6/75	20/10	

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## 2) NEAR VISION

**DEFINITION:** The power by which the smallest types can be read comfortably.

### FACTORS AFFECTING NEAR VISION:

**(1) Refractive errors:**

- 1) Hypermetropes and corrected aphakics for far hold the card beyond 33cm.
- 2) Myopes hold the card nearer than 33cm.

**(2) Age:** In old age with presbyopia the near vision distance is more than 33cm.

**(3) Accommodation:** Diminished accommodation leads to an increase in the near vision distance.

**(4) Convergence:** Convergence anomalies affect the near vision (affect the near point of convergence).

**(5) Pupil size:** Increased pupil size leads to peripheral and spherical aberrations.

### CLINICAL TESTS FOR NEAR VISION:

**(1) Snellen's letters (Snellen's equivalent) for near vision:** A photographic reduction of the Snellen's letters to 1/17 times is used.

**(2) Jaeger's test types:** These are graded sizes of letters of pleasing types.

**(3) Modified Jaeger's test types:** Graded sizes of modern types on test cards (J<sub>1</sub>, J<sub>2</sub>, ... etc.).

**(4) Faculty notation:**

- 1) Used Times Roman typeface with standard spacing and specimens of printing are given in sizes 5pt., 6pt., 8pt., 10pt., 12pt., 14pt., 18pt., 24pt., 36pt., and 48pt. upon a white paper.
- 2) The near vision is recorded as N followed by a number indicating the type face size (i.e. N.5 is printed in 5 point type, N.8 in 8 point type, ... etc.).

**(5) Numbers and broken rings with Snellen's letters.**

**(6) Arabic letters or numbers.**

**(7) Auto-acuity meter.**

### TESTING FOR NEAR VISION:

**(1) The patient sits on a chair:** With a good light thrown over his left shoulder.

**(2) The smallest test type:** Which he can read comfortably with a note of the appropriate distance at which the test card is held is the near vision (for example: N.V. = J<sub>1</sub> at 33cm in Jaeger notation).

**No. 1.  
37M**

In the sacred temple of the Libanians on the slopes of Mount Casagrande the most part of the capital, and the most important portion of the island. The temple of the Libanians was the most sacred of all sacred places and temples on the island. The temple was situated on the slopes of Mount Casagrande, and the most important portion of the island. The temple was situated on the slopes of Mount Casagrande, and the most important portion of the island.

**No. 2.  
50M**

Marston's party, the public administration was conducted by the cities and villages of the island. The cities and villages of the island were the most important portions of the island. The cities and villages of the island were the most important portions of the island. The cities and villages of the island were the most important portions of the island.

**No. 3.  
82M**

the cities of the island. The principal portions of the island were situated under the empire, and the emperor, for the most part, was satisfied with governing those portions which had been acquired by the policy of his reign. The cities and villages of the island were the most important portions of the island. The cities and villages of the island were the most important portions of the island.

**No. 4.  
75M**

secured for Augustus to relinquish the ambitious design of subduing the whole earth, and to introduce a spirit of moderation into the public councils. Instead of going to his temple and chapel, it was very rare for him to discover that Rome, in her present troubled situation, had much less to hope than to fear from the chance of war; and that, in the prosecution of

**No. 5.  
1.00M**

the undertaking became every day more difficult, the event more doubtful, and the possession more precarious, and less beneficial. The experience of Augustus added weight to these salutary reflections, and effectively convinced him that, by the prudent vigor of

**No. 6.  
1.25M**

his councils, it would be easy to secure every concession which the safety or the dignity of Rome might require from the most formidable barbarians. Instead of exposing his person or his legions to the arms of the Parthians, he obtained, by an honor-

**No. 7.  
1.50M**

able treaty, the restitution of the standards and prisoners which had been taken in the defeat of Crassus. His generals, in the early part of his reign, attempted the reduction of Ethiopia and Arabia Felix. They marched near a thou-

**No. 8.  
1.75M**

sand miles to the south of the tropic; but the heat of the climate soon repelled the invaders, and protected the unwarlike natives of those sequestered regions.

**No. 9.  
2.00M**

The northern countries of Europe scarcely deserved the expense and labor of conquest. The forests and morasses of Germany were

**No. 10.  
2.25M**

filled with a hardy race of barbarians who despised life when it was separated from freedom; and though, on the first

**No. 11.  
2.50M**

attack, they seemed to yield to the weight of the Roman power, they soon, by a signal



- N45** Look after your spectacles well. Always put them on and remove them carefully. Keep them clean, to do this we recommend washing in warm soapy water and drying with a soft cloth. If they have been anti-reflection coated a special cleaner may be recommended. We wish you many enjoyable hours of use with them.
- N5** We advise that when you read you do so in a good light. During the day sit near a window, in the evening use a table or standard lamp as well as central illumination. When reading wearing bifocal or progressive power lenses, don't forget to look down when using an eye rather than head movement. When wishing to view an object to your side through progressives, point your nose towards it. Do ask for full instructions.
- N6** After collection of your spectacles, the dispensing optician is always available to carry out adjustments and repairs if necessary. He or she will also be happy to advise you about prescription sunglasses, contact lenses, safety spectacles, magnifiers and all other optical aids at any time.
- N8** The skill of the dispensing optician lies in the interpretation of the prescription into an accurate optical appliance. Your prescription has been duly analysed and your lens type decided upon. You will have been given advice on your frame style and measured for a suitable one.
- N10** The ophthalmic dispensing profession was established over 250 years ago. As then, opticians' skills continue to be very precise. By utilising modern technology practitioners can ensure patients' needs for the twenty first century are satisfied.
- N12** Dispensing opticians are registered when qualified to fit and supply spectacles and other optical appliances. They train for three years before registration.
- N18** An optometrist or doctor has checked your ocular health, the working of your visual system and has issued a prescription for spectacle lenses if necessary.
- N24** Good vision can be maintained by having your eyes examined regularly.

## (2) CONTRAST SENSITIVITY AND GLARE

**CONTRAST SENSITIVITY:** Is the ability to perceive slight changes in luminance between regions which are not separated by definite borders.

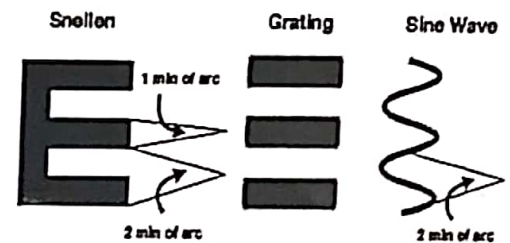
**GLARE:** It is the strong unpleasant light which leads to dazzling.

### SPATIAL FREQUENCY:

**Definition:** It is the number of black and white bars or strips (cycles) on a target as the letter E on Snellen's chart within degrees of angular subtense (degrees of the angle subtended by the spacing between the black bars) and is described in terms of cycles/degrees (cpd).

**Explanation (Fig.13.7):**

- (1) One black and one white bar = 1 cycle.
- (2) If this cycle subtends 1 degree (60 minutes) of arc: It is 1 c/d (1 cpd).
- (3) Therefore spatial frequency of 30 cycles/degree (30 cpd), means that:-
  - 1) Each black bar of letter E on Snellen's chart subtends 1 minute of arc at 6/6.
  - 2) Each white bar of letter E on Snellen's chart subtends 1 minute of arc at 6/6.



*Fig.13.7: Spatial frequency.*

$$\begin{aligned}
 \text{(4) Spatial frequency:} &= \frac{180}{\text{Snellen's denominator in metres}} \\
 &= \frac{600}{\text{Snellen's denominator in feet}}
 \end{aligned}$$

So, 6/6 (20/20) vision has a spatial frequency of  $\frac{180}{6} = \left(\frac{600}{20}\right) = 30 \text{ cpd}$ .

So,  $30 \text{ cpd} = 6/6 (=20/20)$ .

**Sine waves and sine squares pattern:**

- (1) Sine waves: If the light intensity is plotted across the retinal image of a black bar against a white background (white bar), a sine wave pattern is obtained.
- (2) Sine squares: The sum of sine waves of different spatial frequencies, amplitude and phases gives rise to a sine square pattern.

### FACTORS AFFECTING CONTRAST SENSITIVITY:

- (1) **Spatial frequency:** Contrast sensitivity is decreased with increased spatial frequencies.
- (2) **Age:** Contrast sensitivity is decreased with age due to increased scattering by the lens and decreased ability of the retina-brain processing system to enhance contrast.

*NB: In young patients with eye disease as cataract or corneal oedema: Contrast enhancement mechanism will improve the fuzzy picture and its details.*

- (3) **Hypoxia:** Decrease contrast sensitivity due to retinal or cerebral disturbance.
- (4) **Light scattering by opaque tissues:** Contrast sensitivity is decreased with opaque cornea or cataract in presence of glare source (in spite of good visual acuity) which causes light to spread diffusely over large areas of the retina with formation of a poor retinal image.
- (5) **Wavelength:** Contrast sensitivity is decreased (with poor discrimination) with larger R-G wavelengths.
- (6) **Grating motion:** Contrast sensitivity is decreased with increased motion.
- (7) **Illumination:** Contrast sensitivity is decreased with decreased illumination.
- (8) **Bar width:** Contrast sensitivity is decreased with decreased bar width.

*NB: The cornea is transparent due to: The arrangement of the collagen fibrils (with refractive index of 1.47 i.e. close to that of glass) and the mucopolysaccharide matrix (with refractive index of 1.33 i.e. similar to water) with spacing of less than half a wavelength light.*

### CLINICAL CONDITIONS AFFECTING CONTRAST SENSITIVITY:

#### (1) Optical conditions:

##### 1) Corneal conditions (Decrease contrast sensitivity due to increased light scattering):

- 1- Corneal oedema.
- 2- Contact lens problems.
- 3- Keratoconus.
- 4- Keratoplasty and refractive surgery.

##### 2) Lens conditions:

- 1- Cataract and opacified posterior capsule: Decrease contrast sensitivity by increased light scattering.

*N.B: 4mm YAG laser capsulotomy is good for daylight but 6mm YAG laser capsulotomy may be needed at night (with pupil dilatation): To avoid annoying glare from head lights.*

##### 2- Intraocular lenses (IOLs):

- (a) Dislocated IOL: Light rays coming through the aphakic portion of the pupil lead to poor retinal image with decreased contrast sensitivity.
- (b) Multifocal IOL: Results in one blurred image and another sharp image on the retina with decreased contrast sensitivity.

#### (2) Nonoptical conditions:

##### 1) Retinal diseases:

- 1- Diabetic maculopathy (due to macular thickening).
- 2- Macular degeneration.

##### 2) Optic nerve affections:

- 1- Papilloedema.
- 2- Optic neuritis.
- 3- Glaucomatous cupping and atrophy.

##### 3) Strabismic amblyopia: Can be assessed by contrast sensitivity testing.

*NB: Contrast sensitivity decreases in early glaucoma and can be used for assessment of diminished visual function for early diagnosis of glaucoma.*



**GLARE AND CONTRAST SENSITIVITY TESTS:**

**Definition:** Are clinical tests for visual function which are described by a graph.

**Value:**

- (1) Contrast sensitivity testing: It describes a number of levels of vision and so is more accurate than chart visual acuity for assessment of the progress of the above clinical conditions.
- (2) Glare testing: It describes the increase in light scattering in different clinical ocular conditions.

**Principles:**

- (1) Contrast sensitivity chart: A chart with different size lines of targets with different grades of grey.
- (2) Glaring light: Is used to decrease the contrast of the target if the patient has a light scattering lesion.

**Elements of testing:**

(1) Contrast sensitivity targets:

1) Illumination: Of target is needed for tests done under dim illumination.

*NB: Standard luminance: (1) For visual acuity projectors: 120 candela/m<sup>2</sup>.*

*(2) For contrast sensitivity targets: 85 candela/m<sup>2</sup>.*

2) Target details:

- 1- Type of targets: (a) Letter targets.  
(b) Grid targets.

2- Size of targets: Targets should subtend an angle of 2°– 6° because contrast sensitivity is not only a foveal function:-

(a) The size of the E letter on the Snellen's visual acuity chart depends on the angular subtense of the letter:

a) 6/6 letter subtends an angle of 5 minutes of arc.

b) White spaces between each black bar of E subtend 1 minute of arc.

(b) The alternating grid pattern: Uses cycles per degree (cpd).

3- Grading within targets: Different levels of contrast sensitivity and spatial frequencies.

3) Test media:

- 1- Printed tests (plates).
- 2- Slides in a projection device.
- 3- Video-display channel.

(2) Glare testing:

1) Intensity of glare:

1- From 100-400 candela/m<sup>2</sup>: For cataracts and corneal conditions.

2- More than 400 candela/m<sup>2</sup>: For special tasks as night driving.

2) Position of the glare source: 1- Adjacent to the target.

2- Surrounding the target (is better).

3) Standards for glare disability: To simulate the work of the patient.

**(3) Contrast sensitivity curve:**

- 1) Shape: Is the same in all groups of patients.
- 2) Position: 1- Normal position.  
2- Moved towards lower contrast.  
3- Moved towards lower spatial frequencies.

**Clinical tests:****(1) Contrast sensitivity testers:****1) Printed tests:**

- 1- Pelli-Robson letter chart: Consists of 8 rows of 6 letters all of the same size but decreasing in contrast every group of 3.
- 2- Arden gratings: A pattern of stripes is exposed from low to high contrast in 6 plates studied at 57cm with spatial frequency increasing from 0.2 cpd to 6.4 cpd, each being double the frequency of the previous one.
- 2) Slides in a projection device: With slides of letter or grid targets similar to those of printed tests.
- 3) Video-display channel: By which the letter or grid targets are presented on a screen.

**(2) Glare testers: 1) Brightness acuity tester (BAT).**

- 2) Miller Nadler glare tester.

**(3) MACULAR FUNCTIONS**

**DEFINITION:** It is the visual sensations on stimulation of macula (cones) with light:

- 1- Form sense (details).
- 2- Colour sense.

**MACULAR FUNCTION TESTS:****(1) With clear media:**

- 1) Visual acuity.
- 2) Pupillary reactions.
- 3) Colour vision tests.
- 4) Ophthalmoscopy.
- 5) Slit-lamp biomicroscopy (with Hruby lens and Volk lens).
- 6) Amsler grid test.
- 7) Photostress test:
  - 1- The patient, with corrected distance visual acuity, fixates a light from a pen-torch held about 3cm away for 10 seconds.
  - 2- The recovery time after which the patient can read any 3 letters of the pre-test line is:
    - (a) Less than 50 seconds normally.
    - (b) More than 50 seconds in macular disease.
    - (c) Within normal limits in optic nerve lesions.

**(2) With opaque media:**

These are tests for potential visual acuity in patients with opaque media as in cataract to confirm that the patient is seeing but most of these tests give little information about the actual level of vision (except the interferometers):

- 1) Perception of light (PL): PL means abnormal retina or optic nerve.
- 2) Pupillary reactions: Are abnormal in optic nerve damage.
- 3) Colour differentiation with red, green and blue coloured glass discs: Is good if the macula is healthy.
- 4) Nonverbal vision tests: (*Chapter 13*).
- 5) Maddox rod test:
  - 1- Maddox rod is put before the cataractous eye, while covering the other eye.
  - 2- The spot of distant light appears as a red line (which is unbroken) if the macula is healthy.
- 6) A black disc with multiple perforations (or with 2 pinholes):
  - 1- Is placed in a trial frame in front of the eye and light is thrown over it.
  - 2- The patient can count the number of lights (holes) if the macula is healthy.
- 7) Foveal ERG: Is abnormal with diseased macula.
- 8) Entoptic retinal view test (Purkinje vascular tree): A patient with a normal fundus can see the entire retinal vasculature if his eye is closed and the globe is massaged with a torch through the lower lid (scotomata may be noticed by the patient).
- 9) Haidinger's brushes: Is an entoptic phenomenon seen when viewing a plane-polarized field through a blue filter. The normal macula can appreciate a flare as the Henle's layer in the macula is oriented to polarize incident light. The coordinator utilizes this phenomenon in evaluation of macular function and treatment of eccentric fixation in an amblyopic eye.
- 10) Laser interferometer: (*Chapter 32*).



**V R S K D R**

**N H C S O K**

**S C N O Z V**

**C N H Z O K**

**N O D V H R**

**C D N Z S V**

**K C H O D K**

**P E I H Y P**

