

Clinical Practice Module

Quality
Assurance
in
REFRACTION

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FRANS CORNELIUS DONDERS 1818-1889

The founder of the modern knowledge of the errors of refraction

At the age of 24, Donders was appointed to the Utrecht Faculty of Anatomy and Physiology. During the ensuing nine years, he wrote several valuable papers on the motility of the eyes, muscae volitantes, the use of prisms in the treatment of squint, and relation between accommodation and convergence. At the age of 33, Donders became professor of Ophthalmology at Utrecht and founded the Netherlandish Hospital for Diseases of the Eye.

His friends von Graefe and Bowman encouraged him in his writing of his famous "Anomalies of Refraction and Accommodation," published in English in 1864.

In the field of Ophthalmology, Donders published papers on hyperopia, astigmatism and cylindrical lenses, action of miotics and mydriatics, accommodation, stereoscopic vision, color sense, and the relation between ametropia and strabismus. He also designed a number of instruments and appliances for use in Ophthalmology. Donders was the first to describe retinitis pigmentosa and nyctalopia.



Refraction

Disease Definition

Refractive error (ametropia) is a disorder that occurs when parallel rays of light entering the non-accommodating eye are not sharply focused on the retina. When focused in front of the retina, it is called myopia and when focused behind the retina, it is called hypermetropia. Presbyopia is a condition that develops with aging and results in insufficient accommodation for near work in a patient whose distance refractive error is fully corrected.

Epidemiology and Magnitude

Recent data suggests that a large number of people are blind in different parts of the world due to high refractive error because they don't use appropriate refractive correction¹. With blindness defined as presenting distance visual acuity <3/60 in the better eye, the prevalence of blindness due to refractive error has been reported to be as high as 0.2% in India⁷, for all age groups in the population considered together. If blindness is defined as presenting distance visual acuity <6/60 in the better eye, the prevalence of blindness due to refractive error in an Indian population was reported to be 0.36% including 0.06% from amblyopia resulting from high uncorrected refractive error⁷. These data suggest that about 1 out of every 280 people in the study population were blind from uncorrected or inadequately corrected refractive error or from refractive error related amblyopia.

Refractive error as a cause of blindness has been recognised only recently with the increasing use of presenting visual acuity for defining blindness. In addition to blindness due to naturally occurring high refractive error, inadequate refractive correction of aphakia after cataract surgery is also a significant cause of blindness in developing countries¹. Blindness due to refractive error in any population suggests that eye care services in general in that population are inadequate since treatment of refractive error is perhaps the simplest and most effective form of eye care. Strategies such as vision screening programmes need to be implemented on a large scale to detect individuals suffering from refractive error blindness. Sufficient numbers of personnel to perform reasonable quality refraction need to be trained in developing countries.

In India, refraction is performed mainly by ophthalmologists (about 10,000) by optometrists (about 5000) in the training centers and big hospitals and by ophthalmic assistants (about 2000) in out-reach clinics².

Adequate infrastructure has to be developed in underserved areas of the world to facilitate the logistics of providing affordable reasonable quality spectacles to individuals suffering from refractive error blindness.

In many parts of the world refractive error would become the second largest cause of treatable blindness after cataract if blindness were defined on the basis of presenting distance visual acuity³⁻¹⁰. Refractive error is also one of the most common causes of visual impairment^{3-5, 9-13}.

Because of the increasing realisation of the enormous need for correction of refractive error worldwide, this condition has been considered one of the priorities of the recently launched global initiative for the elimination of avoidable blindness: VISION 2020 – The Right to Sight¹⁴⁻¹⁵.

Impact of Blindness due to Refractive Error

Blindness due to uncorrected or inadequately corrected natural refractive error starts at a younger age than cataract, which manifests itself in old age⁷. If the impact of blindness due to refractive error is considered in terms of blind person years, a person becoming blind due to refractive error at a young age, and which is not corrected, would suffer many more years of blindness than a person becoming blind from cataract in old age and

would place a greater socio-economic burden on society. In the Indian state of Andhra Pradesh, among the individuals who are blind currently, the total number of blind-person years suffered over their lifetime by those blind due to refractive error was estimated to be about twice that suffered by those blind due to cataract⁷.

Role of School Screening

Risk of amblyopia in children due to uncorrected refractive errors is high. Proper glasses can be provided to them at an early age by conducting the school screening programmes and thus the risk of amblyopia be reduced. Moreover, Vitamin A deficiency and other ophthalmic diseases in children can also be detected at an early stage.

The programme uses school teachers as a first line of personnel. The programme covers middle school children only. One teacher is selected from each school. The teachers are then trained to detect abnormal vision among children using a specially designed E-card. This card has optotypes, which correspond with the 6/9 line of the regular Snellen's chart. All the children who cannot see the 6/9 optotypes are then referred to the ophthalmic assistant at the upgraded Primary Health Centre for refraction. Those children who need spectacle are then sent to a local optician with whom arrangements for provision of spectacles are made.

Role of Ophthalmic Assistants

1. Test vision, conduct refraction and prescribe corrective lenses.
2. Assist medical officers in providing primary care including treatment for trachoma, ocular injuries, and conjunctivitis etc.
3. Assist in conducting eye camps at the primary health centre.
4. Help in organising vision-screening programmes in schools.
5. Carry out eye health education activities.
6. Maintain the dark room and ophthalmic equipment in primary health centre.

Atmosphere for Refraction

Refraction room

Ideally, single or direct throw room (6 meter/20 feet) is to be used. But in smaller clinics (especially in major cities) double throw room (3 meter/10 feet) can be used with a plain mirror and reversible chart.

Illumination of the consulting room:

Any background illumination that falls on the screen will reduce the contrast of the symbol (or characters).

While the examination can be conducted in a dark room, it is not conformable for the patient and is not recommended by the British standards, which suggests that the minimum background illumination must be equal to 10% that of the chart.

Supplies needed for refraction

1. Snellen's test types
2. Near vision testing
Jaeger chart or Snellen's near vision test type
3. Retinoscope
 - a. Plane mirror retinoscope
 - b. Streak retinoscope
4. Trial frames: It should be light and readily adaptable, allowing adjustments for each eye separately.
5. Trial Case:

A sufficiency of test lenses should be at hand so that any reasonable combination of sphere, cylinder and prism can be put before the patient's eyes. A typical trial set of lenses will have spheres every quarter of a diopter to 4D and every half to 6D, thereafter every diopter to 14D and every 2 diopters to 20D and cylinders every quarter to 2 and half to 6.

For a complete examination, prisms up to 10, with an additional two of 15 and 20 prism diopters are also required, and accessories such as plano lenses, opaque discs, pin-hole and stenopic discs, Maddox rods, red and green glasses, and so on. All these are enclosed in a trial case. Jackson's cross cylinder can be used for perfect correction of refractive error.

Diagnosis

The evaluation of low to moderate refractive errors or presbyopia requires an assessment of both the refractive state of the eye and the patient's symptoms and visual needs.

History

The history should identify symptoms suggestive of a refractive error or presbyopia. If symptoms are present, an assessment of the resulting disability is undertaken.

Patient complaints can also arise from the treatment of the refractive error or presbyopia with spectacles.

Examination

Measurement of visual acuity (VA)

Visual acuity should be determined both binocularly and monocularly whenever possible. The evaluation method that is used varies according to the age of the patient.

Nonverbal child (upto 1 year)

1. The assessment for this age involves evaluation of ocular fixation and following to appropriate visual stimuli: for an infant under 4 months of age, use the examiner's or parents face; for an infant older than 4 months, use age-appropriate toys. Attempts should be made to assess the quality of the fixation response (central, eccentric, steady, unsteady, maintained) to the targets used. Even a subtle difference in the ocular fixation response of an infant with an otherwise normal eye examination requires monitoring to evaluate the presence or development of amblyopia.
2. Ability to fixate a light held at 33 cm.
3. Blink reflex in response to sound.

Verbal but preliterate child (1 to 5 year)

1. Ability to locate small objects (cake decorations).
2. Marble game test; in which child is asked to place marbles in holes of a card.
3. Illiterate E-card test.
4. Sheridan Gardiner (S-G) test.

Literate child (>5 year) and adults

Snellen's acuity chart.

Illiterate patients

Landolt C chart.

Set-up

1. Patient wears present glasses for the distance being tested (when the clinician wants to measure the patient's VA both with and without glasses. VA should be measured without glasses first).
 2. Patient holds occluder (or uses his/her hand).
 3. Patient views full chart.
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Step-by-step procedure

1. Always observe the patient not the chart
2. Patient covers LE, always check RE first
3. Instruct patient to read the smallest line of letters he can. If patient is unable to read 6/60, he is asked to walk towards the types and at a certain distance he may be able to see the largest type. The longest distance is determined at which the type is seen. Example: if he sees the top letter at a distance of two meters his visual acuity is 2/60. Next patient covers RE. Repeat steps 1 - 3
5. Illuminate near point card and hold it at proper distance : (40cm) for Jaeger card
6. Repeat steps 1 - 2 for near testing.

Recording

1. Write C, V \overline{cc} , or Va \overline{cc} , \overline{cc} , means 'with correction'. If VA is taken without correction, use \overline{sc} instead of \overline{cc} . (e.g., if patient habitually wears no glasses).
2. For each eye record Snellen fraction and /or print size separately for smallest (lowest) line in which more than half the letters were correctly identified. If off the – chart. See#8.
3. If additional letters were read on the next line, follow fraction or print size with a '+' sign and the number of letters read.
4. If letters were missed, follow fraction or print size with '-' sign and number missed.
5. Steps 3 and 4 can be used simultaneously
6. For near, also record the test distance
7. Record quality of responses if abnormal
8. Vision is so poor that Snellen fraction is inappropriate, measure and record the acuity that applies.
CF (counting fingers) at(distance)
HM (hand motion) at.....
PR (Light projection)
PL (Light perception)
NPL (no light perception)

Example

Va \overline{cc} RE 6/12 + 1.J2 at 40cm
LE 6 /9, J1-2 at 40cm

Pinhole VA

Pin hole (PH) vision is done when visual acuity (VA) is less than 6/12 at distance and near through the present glasses.

Note: When called for, PH is done in conjunction with VA.

Step-by-step procedure

1. Patient occludes eye not being tested. If both eyes are to be tested, occlude LE first.
2. Instruct patient to read the smallest line of letters he / she can through the PH.
3. Urge patient to read the next smallest line even if he has to guess.

Recording

Write 'PH' followed by the numbers as for VA

Example

RE VA \overline{cc} . 6 /12, PH: 6/9
LE VA \overline{sc} . 6/60, PH: 6/12

Verification of existing prescription glasses

The method of neutralisation is the simplest method. First a vertical and a horizontal line is drawn on a white sheet in the form of a cross. The lens is moved in a direction parallel to one of the lines, say up and down, when a deviation of the horizontal lines will be noticed; if the curvature of this meridian is convex (-), the apparent movement will be in a direction opposite to that of the lens, if concave (+), it will appear to be in the same direction as that of the lens. Lenses from the trial case of opposite sign and gradually increasing strength are now held up in combination with the lens under examination. This movement is exactly neutralised; this gives the dioptric value in this meridian.

Static Retinoscopy with Trial Frame

1. Patient wears trial frame. It should sit straight & comfortably on the patient's face.
2. Examiner is at same level as the patient, checks patient's RE with his/her RE and the patient's LE with his/her LE.
3. Examiner holds Retinoscopy 1 meter or 67 cm (arm's length) from patient's eye. This is the retinoscopy working distance and is converted to diopters.

Step-by-step procedure

1. Instruct patient to fix at a distance target with both eyes open.
2. Observe the reflex of patient's RE. If the movement is AGAINST neutralise with minus lenses, if the movement is WITH neutralise with plus lenses.
3. Locate the 2 principal meridians for the RE. If there is astigmatism, neutralise the less myopic (or the less hypermetropic) meridian with sphere first. Then neutralise the more myopic (or the more hypermetropic) meridian with cylinder. Use minus cylinder for myopia and plus cylinder for hypermetropia and aphakia. Remember to align the axis of the cylinder 90° away from the meridian of power.
4. Recheck the first (spherical) meridian, it should still be neutral.
5. Keep gross static finding in front of the patient's RE and neutralise the patient's LE using your left eye & left hand Repeat steps#1-4 for LE.
6. Check patient's VA without any lenses RE+LE (if necessary).
7. Convert the gross retinoscopy to net retinoscopy by adding the working distance (in Diopters) to the gross
Example: If the retinoscopy working distance is 67cm, the dioptral value is $100/67 = 1.5D$. This value will always be minus. If gross is -2 in RE, net will be $-3.5D$. Only add to the sphere: if gross is $+4.0+2.0 \times 90$, net is $+2.5+2.0 \times 90$.
8. Measure the patient's acuity RE and LE through the net retinoscopy.

Recording

Record net static for the each eye and the patient's VA through the net static.

Example:

Net static

RE - 1.5 sph 6/9

LE - 1.75 sph 6/9

Subjective Refraction with Trial Frame

A. Refining the Sphere

1. Take VA with net retinoscopy RE and LE.
 2. First Step: Add 0.25 or 0.5 DS of plus. This is to recheck that the patient is not accommodating and is not overcorrected. Keep adding plus until VA is 6/9. Then start to add 0.25 DS of minus (reduce plus), checking VA each time.
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3. End point :
 - a. VA is 6/6 or better
 - b. No improvement with + or - spheres

B. Refining the cylinder

Jackson crossed cylinder (JCC). Do this test only if the patient does not see 6/6 with the spherical correction or if patient has symptoms of astigmatism or if there is a large amount of cylinder ($>1.5D$) and a change of axis. Remember that with hand held JCC, the white slash marks represent -0.5 cylinder and the red slash marks represent $+0.5$ cylinder.

1. Instruct patient to look at 6/12 line or one line above best VA
2. Axis Check
 - a. Place the JCC in front of the trial frame with the red and white marks each at 45° to the trial lens cylinder axis, so that the handle of the JCC lies along the same line as the axis of the trial lens cylinder.
 - b. Instruct the patient 'I will show you two views of the line of letters & both may be blurred. You should tell me which view is sharper or less blurred'.
 - c. The JCC is now twirled so that the white marks (-) and the red marks (+) change positions.
 - d. The patient chooses a position, the axis of the cylinder will now be turned 10° towards the white marks.
 - e. Repeat steps a-d. If patient reverses direction, then turn back the axis only 5° or select the mean.
 - f. End point: Both views are equally blurred or same.
3. Power check
 - a. Place the JCC so that the red marks (+) lie along trial lens cylinder axis.
 - b. Instruct the patient as above.
 - c. Twirl the JCC over so now the white marks (-) lie over the trial lens axis.
 - d. The patient chooses, which side is clearer. If patient prefers red marks (+) add $+0.5$ to the cylinder; if patient prefers white marks (-) add -0.50 to the cylinder
 - e. End point: Both views equally blurred or the same.
 - f. Finish by adding maximum plus spherical lenses for best VA, or do fogging.

Note: JCC can be confusing to some patients. Do not do this technique if the patient does not understand / cooperate.

Fogging

At the end of the distance refraction you need to check if the patient's accommodation is relaxed.

1. Tell the patient that you will now put a lens in the trial frame, which will make his vision worse. Place a $+1.00$ DS in the frame and ask him to read down the chart.
2. With a pupil size of 4mm (approx) the patient will only be able to read down to 6/18 if his/her accommodation was relaxed.
 - If he can read 6/12 or better this usually indicates that the accommodation was still active.
 - If he can read 6/18 or worse their accommodation must be relaxed so there is no need to confirm the results with a cycloplegic refraction.

Note

If the pupils are small, 2mm or less, this test is unreliable, this may happen with elderly patients and with patient's using pilocarpine drops for glaucoma. In both these groups the accommodation is rarely active.

For patients with a best VA of 6/12 or worse, this technique is unreliable. Record the results in brackets.

Duochrome test

It is a quick method to determine whether the patient has too much minus or too much plus in his spectacle correction. The test uses a projected red and green bar of light, which are superimposed on the visual acuity test objects. The patient is asked, "Which is sharper (or darker), the green or the red, or are they the same?" If green letters are sharper, too much minus power has probably been added, so add plus sphere. If the answer is that the red side is sharper, then overall power is probably too plus and minus sphere should be added.

Cycloplegic Refraction

Purpose

To measure a patient's refractive error in the absence of accommodation.

Indications

- a. Binocular balancing
- b. To confirm
 - Latent hypermetropia
 - Strabismus of accommodative etiology
 - Accommodative spasm
- c. All children (below age of 15 years).

The cycloplegic drugs used are atropine given as 1-% drops or ointment twice daily for a week or thrice daily for four days prior to examination. We feel this is mandatory in all children under seven years and even older if there is any possible anomaly in muscle balance in which accommodation may be implicated. 2% homatropine can be used in children above the age of seven years. 1-% cyclopentolate is quite acceptable as an alternative to atropine, homatropine and the other longer acting cycloplegics.

1% tropacamide is used in adults (< 40 years of age) and 10% phenylephrine in those who are > 40 years old when indicated.

Procedure:

1. Check the IOP and anterior chamber angles to rule out risk of mydriatic side effect of cycloplegic agents.
2. Instill 2 drops of cyclopentolate with interval of 5 minutes & maximum cycloplegia occurs after 30-40 minutes.
3. Check for cycloplegia.

Ask the patient to look at a distant target while you neutralise the reflex (the standard way of performing retinoscopy) and then ask the patient to look directly at the retinoscope light while you see if the reflex is moving more with your sweep. If additional movement is noted, accommodation has not been fully reduced.
4. Perform retinoscopy and or a monocular subjective refraction on both eyes.

Expected findings:

If routine refractive techniques were unable to relax accommodation then additional plus will be found in spherical component of patient's refraction under cycloplegia.

Due to increase accommodation, in many children cylinder power measured during retinoscopy without cycloplegia is frequently inaccurate. Amount of cylinder found using cycloplegics is likely to be more accurate.

Commonly used Cycloplegic Drugs and Mydriatics

Drug	Concentration (%)	Onset of maximum Cycloplegia	Total duration of Cycloplegia
Atropine sulphate	1	6 - 24 hr	10 - 15 days
Scopolamine	0.25	30 - 60 mts	3 - 4 days
Homatropine	2	1 hr	1 - 2 days
Cyclopentolate	0.5 - 1	20 - 45 mts	12 - 24 hrs
Tropicamide	0.5 - 1	20 - 30 mts	4 - 10 hrs
Phenylephrine	5 - 10	20 mts	2 hrs

Post-mydratic Test

This test is performed if there is a difference between manifest and cycloplegic refraction. The patient is usually called after three days, when 1-% cyclopentolate is used.

Note: It is not necessary for every patient to undergo cycloplegic (wet) refraction. In most patients glasses can be dispensed with dynamic (dry) retinoscopy and subjective refraction. It is not only a quick but also accurate method if done properly.

Treatment of Presbyopia

It is to provide patient with convex lenses, so that his accommodation is reinforced and his near point brought within a useful working distance. It is wrong to follow a dogmatic rule such as addition of 0.5D above the age of 40. It is customary to start with an addition of +0.75D for distance correction. In all cases, it is better to under correct than to over correct. A good practical hint is to make sure that with the reading correction patient is able to read the near vision chart not only at his reading distance but also some 12-15 cm further away.

In some patients the cause of strain may be excessive convergence, in this case it can be relieved by using base in prisms or by decentering the lenses by a corresponding amount.

Tentative add as a function of age and refractive status

Age	Myope/emmetrope	Low hyperope(<4D)	High hyperope
33-37	0	0	+0.75
38-43	0	+0.75	+1.25
44-49	+0.75	+1.25	+2
50-57	+1.25	+2	+2.25
58-63	+2	+2.25	+2.5
64 & over	+2.25	+2.5	+2.5

Post-cataract Surgery Refraction:

In children:

Correction for near vision should be given to all the children who have undergone cataract surgery especially in those who have had surgery in both eyes.

In adults:

1. In aphakics:

Temporary correction is given immediately after surgery. Permanent correction is given after 6-8 weeks in case of silk sutures and after three months if nylon sutures are used. If high with the rule astigmatism is present then suture removal is done 6-8 weeks after surgery following which permanent correction can be given.

2. In ECCE with PCIOL:

Permanent correction is given in the same way as described above in aphakics.

3. In small incision cataract surgery:

Permanent correction is given one month after surgery.

With proper refraction and careful attention of the use of minus cylinder lenses and minimal vertex distances, many patients can tolerate high cylindrical correction in their spectacles.

Interpupillary Distance**Purpose**

To determine the distance in millimeters between the entrance pupils of the two eyes for a given viewing distance.

Equipment

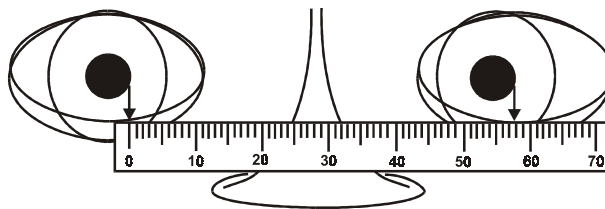
An easy to hold ruler marked in millimeters.

Setup

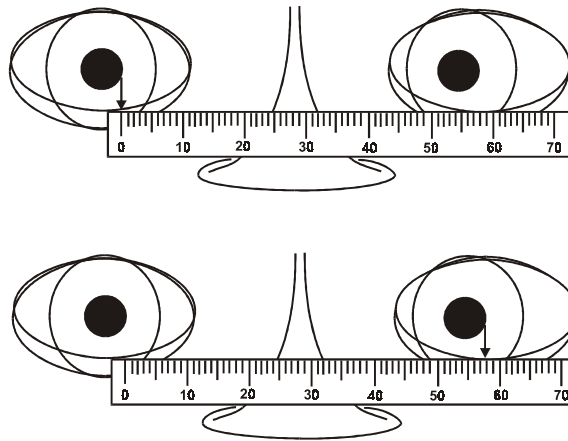
The examiner sits directly in front of the patient within easy arms reach.

Step-by-Step procedure**For Near PD**

1. Close your right eye and instruct the patient to look at your open left eye, the tip of your nose or some other near target. Align the zero point of the ruler on a landmark of the patient's right eye. Stabilize the ruler by resting two or three fingers on the patients face.
2. Still using your left eye, measure to the corresponding landmarks on patient's left eye. For example, if you set the zero on the nasal pupillary edge of the patient's right eye, measure to the temporal pupillary edge of his left eye.

**For distance PD**

1. Instruct the patient to look at your open left eye close your right eye.
2. Align the zero point of the ruler on a landmark (eg. nasal pupillary edge) Stabilise the ruler by testing two or three fingers on the patient's face.
3. Close your left eye. Instruct the patient to look at your now open right eye.
4. Measure to the corresponding landmarks on the patients left eye described in step 2 above.
5. Recheck the entire procedure.



Note: By following steps 1 to 5, although the patient never looks at distance, you measure his distance PD, with each eye pointing straight ahead, as if the patient had been looking at distance.

Recording

1. Write the distance PD followed by a slash, then the near PD in mm.
2. Sometimes the eyes are not centered with respect to the nose and separate, monocular PDs are recorded for each eye relative to the center of the bridge of the patients nose.
e.g. 1. 64/61
2. 62/58
3. RE 30/28
4. LE 32/30

Expected Findings

The average measurement for adult is 64/60.

Role of autorefractors

These provide an objective measure of refraction that can be successfully used as a preliminary screen on patients of school age (5 years) or older. Prescriptions cannot always be implemented using autorefraction results, as instruments can make errors upto 1 D or more but give reasonable correct axis of cylinders. There is also much variance in performance between autorefractors from different manufacturers and even between models from the same manufacturer. Therefore the chosen instrument should be carefully validated before use. The major drawbacks with conventional autorefractors are that they are expensive, are bench-top equipments and are relatively immobile.

Determination of Muscle Balance

1. Hirschberg corneal reflex test.
2. Cover test.
3. Ocular movements.

The corneal reflexes are inspected as the patient looks directly at a light held by the observer immediately in front of him. The pinpoint images of the light are reflected by the two corneae and is compared to the pupil. Roughly the angle of squint is 15° and 45° when the corneal light reflex falls on the border of the pupil and the limbus, respectively.

The cover test is carried out on the basis of the corneal reflexes. If the left eye is deviating and the patient fixes a near or distant object with the right eye, and on covering the right eye by the hand or by a card, the left eye takes up fixation, then it indicates a manifest strabismus. On removing the card, if the left eye remains fixing and the right stays in the deviated position, the squint has an alternating character. If, however, on removing the card the left eye returns to its former position and the right resumes fixation, a left (unocular) manifest strabismus is present.

The alternate cover test – the method of uniocular covering will elicit a latent strabismus (heterophoria). Here the behaviour of the covered eye is observed when the cover is removed. It may be found to have deviated while covered and to return to its fixing position on uncovering, while the other eye keeps its fixation and moves on neither covering nor uncovering.

The examination of the ocular movements should be carried out in all the principal positions of the gaze and may be supplemented by the performance of the cover test in these positions. Any defective movement or complaint of diplopia should be noted.

Of particular importance is the examination of convergence since an absolute or relative weakness of this function can be a potent cause of the symptoms of eyestrain. It is always to be remembered that convergence and accommodation are interconnected and weakness of one should direct attention to the other.

Guidelines for Spectacle Correction

1. **Myopia:** Asymptomatic myopes do not need spectacle correction. There is a controversy between giving undercorrection and full correction in myopes ($> 5D$). Full correction can be given to patients who are having visually demanding activities so that they can have a good distance vision. Over correcting myopic patients will cause excessive accommodation, which may create symptoms. Some patients may become symptomatic from increasing myopia at low levels of illumination. These patients may require increased correction for clear vision at night.
2. **Hypermetropia:** Slight under correction may be desirable in young and middle aged hypermetropes because there is some physiological accommodative tone. With the onset of presbyopia as the patient ages, full correction may be necessary to minimise difficulties with near vision.
3. **Astigmatism:** Full correction may not be needed for individuals with regular astigmatisms. Adults with astigmatism may not accept full cylindrical correction in their first pair of spectacles, or in subsequent spectacles if their astigmatism has been only partially corrected or its oblique axis astigmatism.
4. **Presbyopia:** In presbyopic patients, accommodative amplitudes are measured to determine if the available accommodation is sufficient for the near task. It is suggested that half of the accommodative amplitude be held in reserve for comfort.

Optical Dispensing

Materials used in making lenses

Nowadays spectacle lenses are made of either plastics or high quality glass.

Glass materials

- a. Crown glass refractive index 1.523
- b. Flint glass 1.62
- c. Barium crown 1.62
- d. Hidex - the high refractive index glass 1.806

Plastic materials

- a. Polymethyl meth acrylate (PMMA) \rightarrow index $n = 1.49$
- b. Allyl-di-glycol carbonate (Polycarbonate)(CR -39) \rightarrow index $n = 1.50$

Types of lens

- a. Spherical
 - b. Cylindrical
 - c. Sphero-cylindrical lens
-

Optic center

Optic center of a lens is a very important point as far as the dispensing is concerned. A lens is made up of prisms arranged base to base in center in + lens and apex to apex in center in - lens. When a ray passing through optic center, no refraction takes place. In other words there is no prism effect at the optic center. While fitting a lens in a spectacle frame, the optic center must be coincided with the pupillary center to prevent unwanted prism effect. Then the lenses are said to be centered. If the optic center is placed away from the pupillary center, the lens is said to be de-centered and a prism effect is produced.

Types of Bifocal lenses

1. Benjamin Franklin Bifocal (split bifocal) - not popular
2. Fused Bifocal - Crown and Flint segments are fused together by heating 600° C
3. Cement Bifocal - NV segments cemented by Canada balsam
4. Solid bifocal (one piece bifocal)

Bifocal Fitting

In bifocal fitting, one of the most important thing is the bifocal height of the segments. Segment top must be fitted on to the lower lid margin. In the case of D-bifocal and Executive bifocals it can be 2mm below the lower lid margin. The round segment must be decentered 2 to 3 mm inwards to give allowance for the convergence of the eye while reading so that maximum overlapping of the near visual fields is possible for binocular vision. In drivers, these segments must be set 4mm below the lower lid margin to give wider field of view for distance while driving. “D” shape bifocals and executive bifocal have “no jump” effects at the top of the segment where as round segment give jump effect.

Trifocals

Trifocal has three segments one for distance, one for intermediate distance and the other for reading.

Progressive lens:

It is a multifocal lens in which it gives continuous vision from 33 cm to infinity, through a progressive zone.

Tinted lens

These are used to protect the eyes from harmful radiations such as Ultraviolet and Infrared radiations.

Photochromatic lens

Silver Halide crystals are impregnated in the lens. When light falls on the lens, it becomes a darker shade and in dim light the colour fades.

Anti reflection coating

These are to reduce the intensity of the surface reflections and increase the transmission and transparency.

Lens shape

1. Round
2. Oval
3. Pantoscopic round oval (PRO)
4. Perimetric shape
5. Half eye shape
6. Rim less shape

Problem Solving

When a patient comes with complaints in a new spectacle the following points could be checked.

1. **Wrong prescription:** Before you start, check the total prescription because the examiner may have done a mistake during refraction testing or prescription writing.
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2. **Poor centration:** The lenses may not be centered properly. The optical centre of the lens should be checked and aligned with patient's eyes.
3. **Large frames:** The frames may be too large compared to the patient's face. If so, the patient will experience new distortions. He may have to go back to his correct size of frames.
4. **Incorrect lenses:** The lens power should be checked on either lens meter or manual method. Frequently they are not correct. Not only can the examiner make a mistake, but the optician and the optical lab also are capable of same sin.
5. **Vertex Problem:** The vertex distance (VD) must be measured, if the prescription calls. Distometer is used for more than ± 5.0 D, the VD should be measured to avoid the power variation that could lead to vision difficulties with spectacles.
6. **Frame Problem:** Misaligned frames and improper frames size can cause the following problems:
It may change Vertex Distance.
Frames slide forward.
Frames fit loosely.
Frames must be positioned awkwardly to see properly.
Frames temples create pressure on the side of the head or at the ears.
Eye lashes or eyebrows touch the lenses.
7. **Unwanted Prism:** Because of the false centration, prisms may be introduced that cause induced phorias. This is more common in strong reading glass.
8. **Base curve:** Due to incorrect form of lens, it may cause difficulty (distortions). A Geneva lens clock must be used to avoid it.
9. **Stress lens:** Shadowscope or Polaroid lens can be used to detect this.
10. **Thick lens.**
11. **Lens tilt, quality of lens:** If these things are not correct they may result in some difficulties to the patients and the latter can be detected by shadowscope.

Basics of contact lens

Types

1. **Rigid**
 - a. PMMA Lenses
 - b. Gas permeable
2. **Non Rigid**
Soft lens

Indications of Contact lenses

Myopia
Aphakia
Anisometropia
Keratoconus
Presbyopia

Contraindication:

Ocular

Inflammatory disease of lids, conjunctiva, cornea or ant. uveal tract
Corneal anaesthesia from any cause
Dry eye

General

Pregnancy

Oral Contraceptives

Choice of the Type of Lens

In the optical system of an eye by wearing a hard lens, any astigmatic effect of the cornea is abolished because the corneal substance and tears have almost the same refractive power as the material of the contact lens and the front spherical surface of this lens becomes effectively the front surface of the uniform ocular system. Soft lenses are spherical in design and being pliable simply conform themselves to astigmatic corneal surface, thereby losing the optical advantage of hard lens.

Therefore if one is prescribing for a patient with refraction having less than 1 D of corneal astigmatism, a soft lens will usually be first choice. With astigmatism of greater than 1D the alternatives are between choosing a hard lens and buying a soft lens of special design called toric lens.

Complications of Soft lens:

A. Acute complication

1. Painful red eye - a few hours after the lens has been worn
2. Discharge from the eye
3. Infective keratitis
4. Acanthamoeba keratitis



Fitting of soft lens



Removal of soft lens

- B. Poor vision
- C. Lens Spoilage
- D. Chronic inflammation and discomfort
 - 1. Giant papillary conjunctivitis
 - 2. Thiomersal Keratoconjunctivitis
 - 3. Microcystic Epitheliopathy

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PRESCRIPTION

M.R. No. _____

Date _____

Name _____

Address _____

	RIGHT				LEFT			
	SPH	CYL	AXIS	VISION	SPH	CYL	AXIS	VISION
D.V.								
N.V.								

INSTRUCTIONS

Interpupillary Distance **D.V.** _____ **N.V.** _____

Quality of the lens

Executive	‘D’ shape	Kryptok	Essilor Adapter Varilux comfort
White	Tint	Photogrey	Essilor Titus

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Ophthalmic Surgeon

Prescription to be returned by Optician to the patient to produce on future visits to the Surgeon.