Vision Technician

(Job Role)

Qualification Pack: Ref. Id. HSS/Q3001

Sector : Health Care

Textbook for Class XI

विद्यया ऽमृतमश्नुते

एन सी ई आर टी
NCERT

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Foreword

The National Curriculum Framework–2005 (NCF – 2005) recommends bringing work and education into the domain of the curricular, infusing it in all areas of learning while giving it an identity of its own at relevant stages. It explains that work transforms knowledge into experience and generates important personal and social values such as self-reliance, creativity and cooperation. Through work one learns to find one's place in the society. It is an educational activity with an inherent potential for inclusion. Therefore, an experience of involvement in productive work in an educational setting will make one appreciate the worth of social life and what is valued and appreciated in society. Work involves interaction with material or other people (mostly both), thus creating a deeper comprehension and increased practical knowledge of natural substances and social relationships.

Through work and education, school knowledge can be easily linked to learners' life outside the school. This also makes a departure from the legacy of bookish learning and bridges the gap between the school, home, community and the workplace. The NCF – 2005 also emphasises on Vocational Education and Training (VET) for all those children who wish to acquire additional skills and/or seek livelihood through vocational education after either discontinuing or completing their school education. VET is expected to provide a 'preferred and dignified' choice rather than a terminal or 'last-resort' option.

As a follow-up of this, NCERT has attempted to infuse work across the subject areas and also contributed in the development of the National Skill Qualification Framework (NSQF) for the country, which was notified on 27 December 2013. It is a quality assurance framework that organises all qualifications according to levels of knowledge, skills and attitude. These levels, graded from one to ten, are defined in terms of learning outcomes, which the learner must possess regardless of whether they are obtained through formal, non-formal or informal learning. The NSQF sets common principles and guidelines for a nationally recognised qualification system covering Schools, Vocational Education and Training Institutions, Technical Education Institutions, Colleges and Universities.

It is under this backdrop that Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal, a constituent of NCERT has developed learning outcomes based modular curricula for the vocational subjects from Classes IX to XII. This has been developed under the Centrally Sponsored Scheme of Vocationalisation of Secondary and Higher Secondary Education of the Ministry of Human Resource Development.

This textbook has been developed as per the learning outcomes based curriculum, keeping in view the National Occupational Standards (NOS) for the job role and to promote experiential learning related to the vocation. This will enable the students to acquire necessary skills, knowledge and attitude.

I acknowledge the contribution of the development team, reviewers and all the institutions and organisations, which have supported in the development of this textbook.

NCERT would welcome suggestions from students, teachers and parents, which would help us to further improve the quality of the material in subsequent editions.

Hrushikesh Senapaty
Director
National Council of Educational
Research and Training

New Delhi
June 2018

About the Textbook

Blindness and visual impairment continue to be a major public health problem in India. Availability and easy access to primary eye care services is essential for elimination of avoidable blindness. For this reason, an integrated health care system with primary eye care are being promoted by the Government of India, and vision centers at the level of community health centers and primary health centers are being developed on priority. Eye Health Care has become one of India's largest sectors both in terms of revenue and employment. The rapid growth in the industry has led to the demand for trained personnel for various job roles in this area.

A vision technician assists the Ophthalmologist in conducting eye tests, measuring eye function and outlining the diagnosis to treat eye disorders and disease. The vision technician is also responsible for administrative duties—scheduling appointments and maintaining medical records, clinical duties—taking and recording vital signs and medical histories, preparing patients for examination, and dispensing ophthalmic prescription besides demonstrating wearing and removal of contact lens to patients, informing about practicing contact lens hygiene and scheduling contact lens wearing as per prescription of ophthalmologist.

This textbook has been developed with the contribution of the expertise from the subject and industry experts and academicians for making it a useful and inspiring teaching-learning resource material for the vocational students. Adequate care has been taken to align the content of the textbook with the National Occupational Standards (NOSs) for the job role so that the students acquire necessary knowledge and skills as per the performance criteria mentioned in the respective NOSs of the Qualification Pack (QP). The textbook has been reviewed by experts so as to make sure that the content is

not only aligned with the NOSs, but is also of high quality. The NOSs for the job role of 'Vision Technician' covered through this textbook are as follows:

HSS / N 3001 : Obtain the case history
HSS / N 3002 : Measure visual acuity
HSS / N 3003 : Assess refractive status
HSS / N 3004 : Dispense spectacles and optical prescription accurately

In Unit 1 of this textbook, the student will learn about the anatomy of the eye, field of vision and the dynamic range of the eye. Units 2 and 3 will focus on comprehensive eye care. It will cover major eye problems and their treatment to avoid blindness and also about clinical duties, common eye problems and injuries affecting different structures of the eye. Units 4 and 5 will discuss the five complex functions of the human eye—visual acuity, field of vision, contrast sensitivity, colour perception and image formation; and the kind of observations suggested by different types of eye care professionals. Unit 6 will deal with the techniques and procedures of retinoscopy, the different kinds of diagnoses for treating refractive errors, and much more. Unit 7 will give an insight into the techniques of transposition of an optical prescription, eyeglass and contact lens as well.

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Gandhiji's Talisman

I will give you a talisman. Whenever you are in doubt or when the self becomes too much with you, apply the following test:

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it? Will it restore him to a control over his own life and destiny? In other words, will it lead to Swaraj for the hungry and spiritually starving millions?

Then you will find your doubts and your self melting away.

M K Gandhi

Contents

Unit 1

Structure of Human Eye

Introduction

How many of your family members use spectacles?

Let us study how the human eye uses light and enables us to see objects.

Eyes are the most valuable organ of the human body, which process the images of objects in the vicinity. The eyes interpret size, shape, colour and distance of the objects and give a 3D picture of the objects visible.

The eyes are seated in a hollow cone shaped cavity (socket) of the human skull named orbit. The movements of the eye are regulated by six muscles. Fatty tissues in the orbit surrounding, which protect the eyeball, give it flexibility to function. The adnexal structures, like eyebrows, eyelashes, eyelids, protect eyes from foreign elements and injuries.

The liquids maintaining the shape of the eyeballs are called aqueous humour and vitreous humour.

The eyeball acts like a camera; the image of the objects received by the eyes are conducted to the brain. The visibility by one eye is known as monocular vision, and that by both eyes is binocular vision.

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Did you know?

Our eyes are sophisticated cameras; they take many pictures in seconds and the brain processes them as messages. Through our eyes, we see the colourful world around us.

Session 1: Anatomy of Human Eye

In this session, you will learn about the parts of human eye (Fig. 1.1) and their functional connections with the human body. The human eye is one of the important sensory organs of the human body. It is very sensitive and exposed to various diseases, thus protection and prevention is necessary to keep the eye safe and healthy.

Three layers of human eye

The eyeball has three coats as given below.

External fibrous coat

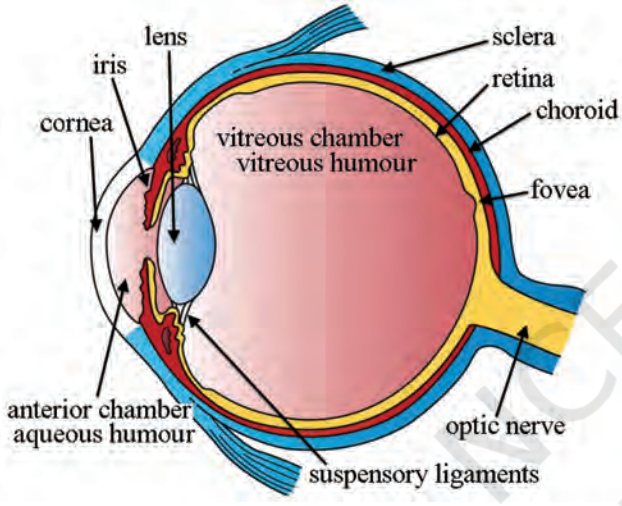

Fig. 1.1: Structure of Eye

The anterior, transparent, one-sixth part of the eyeball is called cornea. This refracts the rays of light into the eye. Cornea further extends with a membranous structure called conjunctiva. The connecting area of cornea and conjunctiva is limbus. External fibrous coat is formed of cornea and sclera.

Middle vascular coat

This coat is formed by the iris, ciliary body and choroid (anterior to posterior). This coat is vascular and pigmented, underlying the sclera.

Internal nervous coat

Internal nervous coat is formed of retina. The retina receives an inverted image of the objects seen. These images are conducted to the brain through a nerve called the optic nerve, which is connected at the posterior end of the eyeball.

Parts of human eye

(a) Anterior chamber: It is the one-third part of the eyeball which is bound by the cornea anteriorly, and the lens posteriorly. It contains the iris and a fluid called the aqueous humour.

(b) Posterior chamber: It forms the rest of the two-thirds of the eyeball, bound by the intraocular lens anteriorly and optic nerve head and retina posteriorly. It contains a gelly-like fluid called vitreous humour.

(c) Pupil: It is an aperture of variable size in the centre of iris, which regulates the amount of light entering the eyeball.

(d) Iris: It is the coloured membrane behind the cornea and in point of lens with an aperture of variable size called pupil. It has a circular and long muscle fibre. Iris is attached to the ciliary body.

(e) Lens: It is a transparent, biconvex structure situated between the iris and vitreous humour. Its function is to focus the luminous rays; these rays form a perfect image on the retina. With age, the central portion of the lens compresses by the surrounding fibres and results in opacity, which is called cataract.

Blind spot

The beginning of the optic nerve in the retina is called the optic nerve head or optic disc. Since there are no photoreceptors (cones and rods) in the optic nerve head, this area of the retina cannot respond to light stimulation. As a result, it is known as the 'blind spot', and everybody has one in each eye.

(f) Vitreous humour: This is a gel-like substance which maintains the shape of the eyeball. It is also a refractive media.

(g) Retina: It is a transparent layer forming the inner coat of the eye, it supports the choroid layer. The rays of light, on entering the eyeball, converge and form an image on the fovea—the posterior part of the eye on retina.

(h) Sclera: It is the outermost coat of the eyeball. It maintains strength and structure of the eyeball. It is also known as the white of the eye.

(i) Cornea: It is the clear, transparent, anterior portion of the external coat of the eyeball. The rays of light enter this layer. Cornea accounts for two-thirds of the total optical power of the eye.

Practical Exercise

Visit an eye care unit or clinic with your friends and teacher to observe various charts displaying the anatomy of eye.

Check Your Progress

A. Fill in the blanks

1. The _____ is the transparent front part of the eye.
2. The _____ is a gel-like substance that helps to keep the eyeball in its proper shape.
3. The _____is also known as the white of the eye.

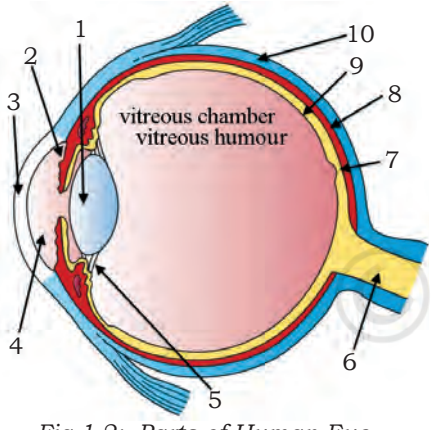

Fig.1.2: Parts of Human Eye

B. Label the parts of the eye in Figure 1.2 and also list them in the Table given below.

S.No.		S.No.	
1.		6.	
2.		7.	
3.		8.	
4.		9.	
5.		10.	

Session 2: Field of Vision and Dynamic Range of Human Eye

In this session, you will learn about the field of vision and the dynamic range of the human eye. The eyeball acts as a camera and the message of image formation is received and directed to the brain.

Field of vision

The field of vision is the area that is seen all around. The field of view of a human eye is 95° on the left or right of

the eye, 75° downwards, 60° towards the nose, and 60° upwards (Fig.1.3). It is in this space that an object can be seen while the eye fixes upon one point.

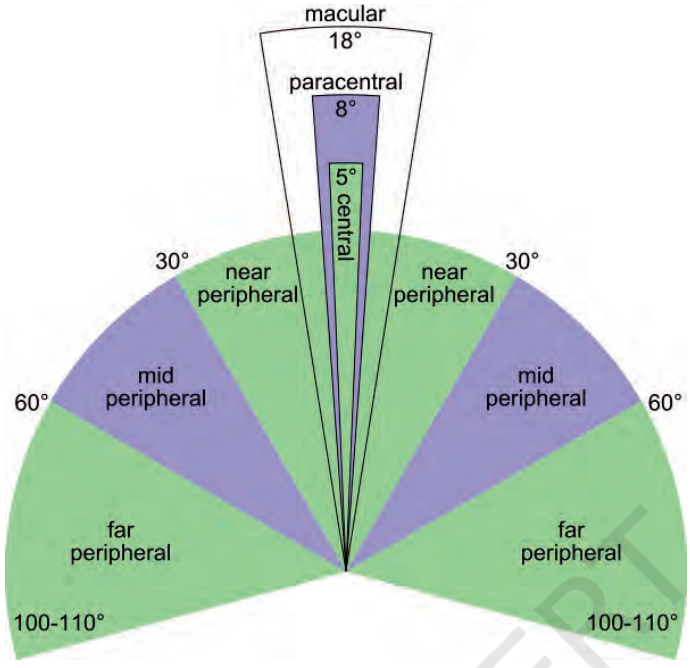

Fig. 1.3: Field of vision for human eye

Monocular vision

Monocular vision is the vision when each eye is used separately to see an object.

Binocular vision

Binocular vision is the vision when both eyes are used together to see an object. It gives perception of size, shape and depth of the object seen. As a result, the object seen by either eye is interpreted as a single image. Thus binocular vision is important, and required for drivers, pilots and such coordinated operations like catching a ball, etc.

Practical Exercise

Visit a nearby eye unit or clinic with your friends and teacher. Observe how the ophthalmologist studies the field of vision and extraocular muscles, balancing the eye system of a patient.

Did you know?

Why do we have two eyes for vision and not just one?

There are several advantages of having two eyes instead of one. It gives a wider field of view. A human being has a horizontal field of view of about 1500 with one eye, and of about 1800 with both eyes. The ability to detect faint objects is, of course, enhanced with two detectors instead of one.

Some animals, usually prey animals, have both their eyes positioned on opposite sides of their heads to give the widest possible field of view. But our eyes are positioned on the front of our heads, and it thus reduces our field of view in favour of what is called stereopsis. Shut one eye and the world looks flat-two-dimensional. Keep both eyes open and the world takes on the third dimension of depth. Because our eyes are separated by a few centimetres, each eye sees a slightly different image. Our brain combines the two images into one, using the extra information to tell us how close or far away things are.

Check Your Progress

A. Fill in the blanks

1. The _____ is the extent of the observable world.
2. _____ vision is one in which each eye is used separately.

B. Short answer questions

1. Describe the field of view of the human eye.
2. Why is Binocular vision required for coordinated operations?

Session 3: Movements of Human Eye

In this session, you will learn about the types of eye movement.

Types of eye movement

The movement of eyes is under voluntary control of the eyes. The types of movement include voluntary (both vertical and horizontal), tracking (both voluntary and involuntary) and convergence. The movements of the eye must conjugate in order to prevent double vision. The retina is a photo-sensitive layer that forms about 65% of inner surface of the eyeball. At the posterior end of the retina is a small elevation called the fovea or fovea centralis (Fig. 1.4). It has the sharpest vision and colour perception.

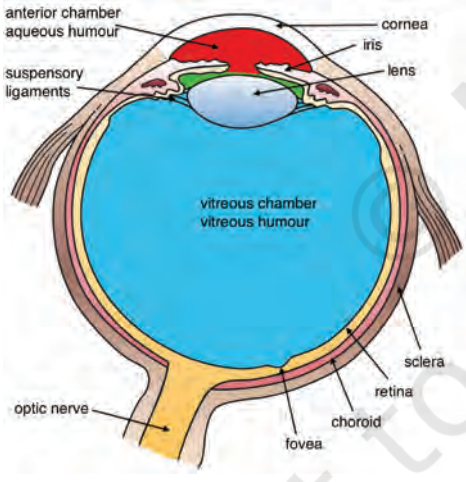

Fig. 1.4: Diagram showing Fovea

Muscles of the eye

The movement of eyeball is controlled by six muscles. Each eye moves in all the directions. The eyes also have a rotational movement. Horizontal eye movements are controlled by the medial and lateral rectus muscles, while superior rectus and interior rectus muscles perform superior and inferior movement of the eyes. A machine is used by opthamologists to record muscle balances and movements of eyes it is called synaptophore (see Fig. 1.5).

Extra ocular cranial nerves and nuclei

There are three cranial nerves innervating eye muscles. The oculo motor nerve, (CNIII), innervates all of the extra ocular muscles. It also innervates the elevator of the upper lid. In addition, cranial nerves no. II, IV, V and VII also have play a role in other functions of the eyes, such as movement of upper lid, tear secretion, etc.

Fig. 1.5: Synaptophore machine

Tracking or smooth pursuit eye movements

We are able to move our eyes smoothly when tracking a moving object. This is an involuntary fixation on objects that are moving in relation to the head. The eyes have the tendency to track moving objects.

Practical Exercise

Visit a nearby eye unit or clinic with your friends and teacher. Observe the operation of the synaptophore.

Check Your Progress

A. Fill in the blanks

1. In the middle of the retina, there is a small elevation which is called the _____.
2. The movements of the eye must conjugate in order to prevent _____.
3. Horizontal eye movements are controlled by medial and lateral _____ muscles.

B. Short answer questions (30-40 words)

1. What is fovea centralis?
2. Name the four movements of eye.
3. Name the muscles of the human eye.
4. Which cranial nerves take part in the functioning of eyes?

Unit 2

Obtaining Case History of a Patient

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Have you ever thought why a technician collects information from the patient before she/he meets an ophthalmologist?

Introduction

The medical history or case (medical) history of a patient is the information gained by a physician by asking relevant questions. These questions are related to complaints explained by the patient himself/ herself or/and by other people who can give suitable information. This helps the opthalmologist to obtain useful information to formulate a diagnosis and provide medical care to the patient.

Comprehensive care requires the enquiry about the patient's problems. Major eye problems, such as errors of refraction, cataract, squint, glaucoma and diabetic retinopathy, injury needs to be diagnosed in the earliest stage for restoration of eyesight. Such kind of eye diseases can be detected timely and referred at an early stage.

The information obtained in this way, together with the physical examination, enables the physician and other health professionals to frame a diagnosis and treatment plan. The treatment plan may include investigations to confirm the diagnosis. In case the diagnosis is not confirmed, a provisional diagnosis is

formulated, and other possibilities (the differential diagnoses) may be added. The treatment plan may then include further investigations to verify the diagnosis.

Let us now discuss about various aspects to be considered while recording the medical history of a patient.

SESSION 1: RECORDING MEDICAL HISTORY OF A PATIENT

In this session, you will learn about the procedure to record the ophthalmic and optometric history of a patient and also to explain the diagnosis determined by the ophthalmologist.

A practitioner interrogates the patient to obtain the following information related to the patient:

(a) Identification and demographics: It includes the name, address, occupation, age, sex, height, weight, marital status, contact number of the patient and the person accompanying.

(b) Chief complaints (CC): It includes the details of major health related problems and its duration (for example, eye pain, eye infection, etc.).

(c) History of the present illness (HPI): It includes the complaints, enumerated in the CC. It is also called 'History of presenting complaint' or HPC.

(d) Past medical history (PMH): It includes the details of major illnesses, any previous surgery or operations (sometimes distinguished as 'Past Surgical History' or PSH), any current ongoing illness (for example, diabetes).

(e) Family diseases: It includes details of family diseases, especially those that are relevant to the patient's chief complaint.

(f) Social history: It includes details of living arrangements, occupation,marital status, number of children, drug addiction (including tobacco, alcohol, etc.), recent foreign travel, and exposure to pet animals.

(g) History related to medications: It includes information regarding those medicines prescribed by doctors or obtained over-the-counter.

(h) Allergies: It includes details about allergies to medications, food, cosmetics and other environmental factors.

(i) Sexual history: It includes details about obstetric or gynaecological history.

Chronic effect

A change that occurs in the body over a relatively long time (weeks, months or years) following repeated exposure or a single overexposure to a substance.

It is generally said that the diagnosis is uncovered in the history of the patient. The basis of a correct history is the correspondence between the doctor and patient. However, to get an accurate, representing record of what is troublesome to the patient, and how it has developed, is not an easy task. The history is a sharing of experience between the patient and doctor. Frequently, the history alone does uncover a diagnosis. During the course of the history, you will gather information related to the patient's education and social background.

Recording medical history

While asking questions to the patients, remember that the questions can be verbal or non-verbal. Therefore, your behaviour, your physical position and your body language should be such that the patient is comfortable to talk to you and clearly answers your questions. You should make a note of the symptoms as you go along, so that you become instrumental in getting the right diagnosis and treatment plan. Children vary widely in their ability to communicate. Have toys handy for the child and take notes throughout the consultation. Generally, relatives are there to help and support the patient. They are helpful sources of additional information.

Types of patients

NOTES

You may encounter various types of patients. They may be of the following types:

Quiet or shy patients

It is difficult to get answers from such patients. You will receive only monosyllabic answers, which can be extracted by direct questioning.

Acute effect

A change that occurs in the body within a relatively short time (minutes, hours, days) after exposure to a substance.

Acute exposure

A single exposure to a hazardous agent.

Overconfident patients

They will address or add lot of their anxiety by turning up with an armful of answers which you may not find very useful.

Angry patients

Patients may get uneasy due to excessive delay in the waiting room, perceived medical failings or if they are not taken seriously. Such patients are difficult to handle and you need to first pacify them before you begin questioning.

Returning patients

Such patients need endless reassurance. Obtain the history from their relatives or friends. Where you suspect that there is a mental health problem, try to corroborate the information you are obtaining. If the patient is violent or intoxicated, describe the situation you are in and document verbatim what is said.

Overview of medical history

Past medical history (PMH)

This should include the usual health questions, but the main emphasis should be on the conditions directly

contributing to ocular problems, such as diabetes, hypertension, and coronary artery disease, etc.

Past ocular history (POH)

This should include enquiring about past clinic visits and surgeries. Specifically enquire about cataract surgeries, eye trauma, eye infections and glaucoma. You can get the patient's ocular history by examining their eye treatment record and medicines used.

Family history

Focus on the family history with regard to the occurrence of diabetes and glaucoma, error of refraction squint and blindness. Patients will often confuse glaucoma with cataract, so be sure to clarify the difference.

Allergies

Make a note of all basic allergies and their reaction.

Professional history

Know the professional background of the patient. Farmers, welders, blacksmith, factory workers, carpenters, etc., such patients are prone to have eye injuries.

Medications

Find out what eye medication the patient has used, and why. Are they using a regular eye drop? Did they bring their drops with them? If your patient can not remember their medications, it often helps to ask about the cap colour of the bottle (for example, all dilating drops have red caps).

History of present illness related to eyes

A detailed ocular history is essential for diagnosis. Specific history of the present illness reviews should include the following:

Floaters and flashes of lights: These are the classic symptoms of a retinal detachment and retinal tears and early cataract. Therefore, every patient should be asked about these symptoms.

Transient vision loss: Curtains of darkness might indicate an ischemic event or a retinal detachment.

Blurry vision: For assessing blurry vision, ask questions like—is the vision always blurry? Does it worsen when reading or watching TV? Is there a glare problem at night that might indicate cataract? History of coloured halos around a light bulb, suggestive of early glaucoma.

Practical Exercise

Visit a nearby vision care clinic or centre. Try to ask questions to the patients having eye problems. Note down your observations.

Check Your Progress

A. Fill in the blanks

1. The medical history or case history of a _____ is the information gained by a doctor/nurse/technician by asking specific questions, with the aim of obtaining information useful in providing medical care.
2. Chief complaints include the major _____ problem or concern and its time course (for example, eye pain, eye infection, etc.).
3. Past medical history includes major _____, any previous surgery or operations or any ongoing illness.
4. Past _____ history should include conditions directly contributing to ocular pathology, such as diabetes, hypertension, and coronary artery disease.
5. Ocular history should include enquiring about past clinic visits and _____.
6. Retinal examination is a prerequisite for all patients undergoing _____ surgery.

B. Short answer questions (30–40 words)

1. Enlist the questions asked by a practitioner to a patient.
2. Why is it important to know the history of a patient's illnesses?

Session 2: Documenting a Patient's Medical History

In this session, you will learn to identify the purpose behind documenting the patient's case history. You will also learn about the need of confidentiality as per the clinic or hospital.

The medical record is property of hospital and not of the patient, the clinical department or the attending doctor, the hospital is the custodian of the documents. The information contained in records are confidential and privileged and cannot be publicly, divulged without the consent of the patient except under the process of law. Information like date of admission, discharge, birth or death can only be furnished to friends or relatives.

A detailed medical history of the patient is recorded to rule out systemic problems,such as diabetes, heart disease, lung disease, bleeding disorders, renal dysfunction and any drug allergies,or check if there has been prolonged use of medication. If there is any positive finding, the patient should be evaluated with the help of a general physician.

Pertinent ocular history (POH)

History of injury, inflammation, raised eye pressure or retinal diseases should be obtained as any of these, if present, can affect the visual prognosis of the person after surgery. Also along with the history of cataract surgery or any other surgery done the information about the operative and post-operative course of the eye operated should be obtained. If the person has had a corneal surgery, information about the type of procedure used is helpful in predicting the intraocular lens power. The history of long-term diseases affecting the retina must also be enquired about. This may get masked by the cataract and should be explained.

Surgical history

History of any eye surgery includes dates of operations, operative reports, and details of the eye surgery.

Obstetric history

The details of past obstetric history, including any complications and medication, history of allergies to any drug or cosmetic, is of value.

Medications and medical allergies

The medical records may contain a summary of the patient's current and previous medications as well as any medical allergies.

Ocular investigations

The following ocular investigations are performed as part of the pre-operative evaluation:

- Visual acuity of the patient is recorded.
- The eyelids and the tear drainage systems are examined for any infection. If infection is present, appropriate measures should be taken and eye surgery should be postponed till recovery.
- Examination of anterior segment with a slit-lamp, with special reference to maturity of the cataract.
- Retinal examination is a pre-requisite for all patients undergoing cataract surgery. If the fundus is not seen or if retinal function is found to be defective, the visual prognosis should be explained to the patient.
- An ultrasonography is done to assess the retina, when the cataract is not age-related.
- Intraoccular pressure is recorded to rule out coexisting glaucoma.
- The power of the intraocular lens to be implanted should be measured.

Confidentiality of the patient's medical history

Medical record is the property of hospital and not of the patient, the clinical department or the attending doctor. The hospital is the custodian of documents. The information contained in records is confidential and privileged which cannot be publically divulged without the consent of the patient under process of law. Information, such as date of admission,

discharge, birth or death, can only be furnished to near and dear ones.

Practical Exercise

Visit a nearby vision care clinic and observe how the vision technician or an ophthalmologist or any other staff member maintains the patient's case history and other documents. Write a report on your observation.

Check Your Progress

A. Fill in the blanks

1. _____ acuity of the patient is recorded as a part of pre-operative evaluation.
2. Ultrasonography is done to assess the _____.
3. Intra-occular pressure may be recorded to rule out _____.

B. Short answer questions (30–40 words)

1. What is the importance of knowing the medical history of a patient?
2. Describe the pre-operative occular investigations.
3. Retinal examination is one of the necessary components of investigation before cataract operation. Why?

Session 3: Integrating Medical History and Physical Examination for Treatment Plans

You have learnt to take down the medical history. You will learn about the method generally adopted to integrate medical history with physical investigation, to frame treatment plans and modalities.

Medical record and history

The terms medical record, health record, and medical chart are used to describe the systematic documentation of a patient's medical history. The

traditional medical record for in-patient care can include admission notes, on-service notes, progress notes, pre-operative notes, operative notes, post-operative notes, procedure notes, etc. The 'notes' entered by eyecare professionals order for treatment schedule, various tests, etc.

Physical examination

This is the recording of the patient's vital signs and other health related parameters (Table 2.1). This includes the examination of the different systems of human body. Vision, pupil, and intra-ocular pressure and fundus exam are the vital signs to be examined. After a brief history, these are checked before dilating the pupils for internal examination of the eyes.

Table 2.1 History and suggested examination of patients with different eye problems

Eye problems	History and visual acuity
Red, painful eyes	Lids, lacrimal system, conjunctiva, cornea, pupils, anterior chamber and intraocular pressure, syringing of lacrimal sac.
Foreign body	Lids, conjunctiva and cornea. If anatomical examination of the eye is mandatory
Reduced vision	Cornea, anterior chamber and beyond, functional testing of visual field, pupils, optic nerve and macula
Double vision/orbital problems	Fundus, optic nerve function, extraocular muscle function and their balances.
Headache/neurological sounding problems in absence of red eye	Fundus, optic nerve, pupilary functions, blood pressure, full neurological examination, measure intra ocular pressure and status of spectacles.

As the drops dilating the pupil affect vision, pupil size, and potentially may elevate pressure of the eyes, therefore the following signs need to be checked:

Transient vision loss

Curtains of darkness might indicate an ischemic event or a retinal detachment, therefore evaluate these symptoms in detail.

Blurry vision

The vision worsens when reading or watching television in a wrong posture (people blink less when watching television and develop dry eyes). A glare of light at night that might indicate cataracts or seeing halos around the light bulb is an alarming sign of risk in intra-ocular pressure.

Red, painful eyes

It is a common complaint; therefore, be sure to ask about the nature of the pain (is this a scratchy pain, aching pain, or only pain with exposure to bright light). Is there any discharge?

Chronic itching and tearing

Is it due to blepharitis or some allergy? Is it in both eyes or only in one eye?

Headaches and scalp tenderness

Ask about other associated symptoms, like jaw stiffness, weight loss, and night sweats.

Test results

This includes the results of testing, such as blood tests.

Assessment and treatment plan

The assessment is a written summation of what are the most likely causes of the patient's current set of symptoms (see Fig. 2.1). The treatment plan is the road map that a patient will follow on his or her journey through treatment. Treatment planning is a never-ending part of therapeutic plans. It is to take into account all of the physical, emotional, and behavioural problems relevant to the patient's care, as well as the patient's strengths and weaknesses.

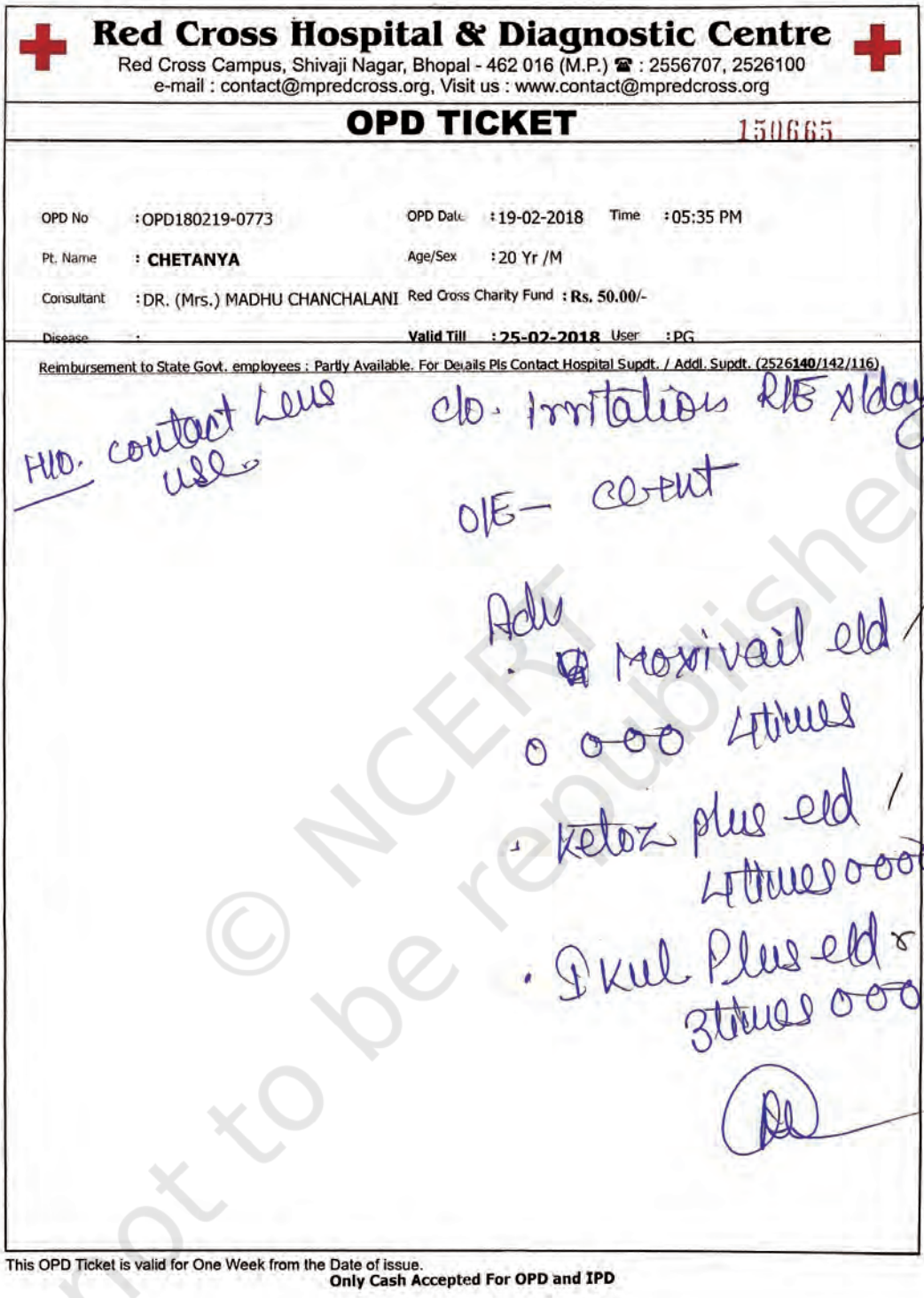

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Fig. 2.1: Assessment and Treatment Plan

Practical Exercises

1. Visit a nearby vision care clinic to observe the method of recording notes on eye examination, diagnosis, and management of eye ailments.
2. Make a chart of the history of a patient and suggested examination of a patient.

Check Your Progress

A. Fill in the blanks

1. The treatment plan is the road map that a _____ will follow on his or her journey through the treatment.
2. Chronic itching in the eye may be due to_____ or _____.

B. Short answer questions (30–40 words)

1. What is the importance of 'notes' in medical records?
2. If anybody is suffering from headache, then what probable examination is to be suggested?

Session 4: Assessing Functionality of a Patient's Eyes

You will learn about how an ophthalmologist assesses the patient's health and determines the functionality of a patient's eyes.

The three vital signs that an ophthalmologist should observe are: vision, pupil reaction and pressure of eye; ocular movements and field of vision can be additional signs to examine before putting drops to dilute the pupils for fundus examination.

Assessing functionality of eyes

There are various tests that are routinely performed in specialty units to assess the functionality of eyes, such as:

Visual field assessment

It is a method of measuring the entire span of vision, i.e., their central and peripheral (side) field of vision.

The charting of visual field is a subjective examination. Help the patient understand the test instructions to seek full cooperation. Visual field is used to detect signs of glaucoma, damage to the optic nerve or to the retina.

Ultrasound scan

Eye and orbit ultrasound needs high-frequency sound waves to measure and produce detailed images of the eye and eye orbit. The orbit is the socket in skull that holds the eye. This test provides a much more detailed view of the inside of the eye than is possible during a routine eye examination. It is used to visualise the lens, vitreous and retina or any growth or tumour around the eye.

Exophthalmometer

It is an instrument used for measuring the degree of forward displacement of the eye in a condition called exophthalmos. The device allows measurement of the forward displacement of eyeball beyond lateral orbital rim to the front in a condition named proptosis (for example, thyroid eye disease).

Keratometry

It is a diagnostic instrument for measuring the curvature of the anterior surface of the cornea, particularly for assessing the extent and axis of astigmatism.

Fluorescence Angiography

It is a medical procedure in which a fluorescent dye is injected into the bloodstream. The dye highlights the blood vessels in the retinal vessels of the eye so they can be photographed to plan the treatment. This test is often used to manage disorders of diabetic retinopathy and the presence of blood in vitreous part of the eye.

Optical coherence tomography (OCT)

It is a non-invasive imaging test that uses light waves to take cross-section pictures of retina and optic nerve (the light-sensitive tissue lining at the back of the eye).

In case of any eye problems in infants, they can be taken for their first eye check-up after the age of six months.

Practical Exercise

Visit a vision care clinic or centre, and observe an ophthalmologist performing various tests for assessing the functionality of eyes. Write a report based on your observations.

Check Your Progress

A. Fill in the blanks

1. The three vital signs that an ophthalmologist should observe are vision, pupil, and _____.
2. Keratometry is done to assess the curvature of the anterior surface of _____ .
3. Optical Coherence Tomography is a non-invasive _____ test that uses light waves to take cross-section pictures of the retina and optic nerve.
4. Children should have their first _____ exam at the age of six months.

B. Short answer questions (30–40 words)

1. What is the importance of visual field assessment? Explain the process used to treat diabetic retinopathy.

Unit 3

Common Eye Problems

Introduction

The eye care staff performs eye examination and carefully test every aspect concerned with the eyes.

In this unit, you will learn about common eye problems affecting the various anatomical structures of the eye, for example conjuctiva, cornea, retina, intraocular lens, etc. The unit will also cover the diseases caused by pathogens, for example by bacteria, viruses, etc. Eye infection can spread from person to person, by contact of pathogens through eyewear, eye cover and objects touched by an infected patient.

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Biological agent

Any living organism (for example, virus or bacteria) that affects the body, a part of the body, or any of its functions are called biological agents. Their effects may be beneficial or harmful.

The students will also learn about the various diseases affecting different anatomical structure of the eyes, like conjunctival hyperaemia, conjunctival chemosis, sub-conjunctival haemorrhage xerosis and inflammatory conditions of conjuctiva. Further, they will also learn about the common diseases of cornea, such as corneal abrasion or keratitis. The students will be taught about age-related macular degeneration, glaucoma and cataract.

Did you know?

Damage to or malfunction of any part of the visual system can lead to significant loss of visual functioning. For example, if any of the structures involved in the transmission of light, like the cornea, pupil, eye lens, aqueous humour and vitreous humour, or those responsible for conversion of light to electrical impulse, like the retina or even the optic nerve that transmits these impulses to the brain, is damaged, it will result in visual impairment. You might have experienced that you are not able to see objects clearly for some time when you enter from a brightly lit to a dimly lit room. The pupil of the eye acts like a variable aperture whose size can be varied with the help of the iris. When the light is very bright, the iris contracts the pupil to allow less light to enter the eye. However, in dim light the iris expands the pupil to allow more light to enter the eye. Thus, the pupil opens completely through the relaxation of the iris.

After reading this Unit, the students will know about the types of refractive errors, many symptoms related to eye problems, such as watery eyes, redness, headache, coloured haloes, and hotophobia, etc.

Bifocal

Lens with one segment for near vision and one segment for far vision are called Bifocal. The term 'bifocal' can apply to both eyeglass and contact lenses.

The knowledge about eye injuries by any source should be taken care of at the earliest so that further complication can be avoided. The injuries can be mechanical, physical or chemical-oriented. The proverb 'prevention is better than cure' is of utmost importance and to be valued. If at all injury takes place, the vision technician needs to know primary care measures.

Session 1: Common Eye Problems and Infections

In this session, you will learn about the common eye problems, which include red eyes, itching, injuries, conjunctivitis, corneal diseases, etc.

An eye disease, induced by pathogens, for example bacteria, viruses and different other microorganisms, causes an eye infection. A large number of the viruses, bacteria, parasite, and other organisms that can attack the human body are capable of affecting the inner part of the eye. Eye infections can range from the normal conjunctivitis to other rare allergies. Eye infections can fluctuate in the level of seriousness, yet many times, they are not difficult to cure.

Eye infections are typically transferable from one person to another. An eye infection may occur due to immediate contact by touching eyewear or eye covers of an infected person. Infections could be brought on through infected eyewear, eye surgery, trauma to the eye or deficiency of vitamins, etc. However, infections can be more regular around the individuals who wear contact lenses, to a great extent due to infections in the contact lens. The symptoms for different infections

contrast. The most commonly-known type of infection is bacterial conjunctivitis which results in red, swollen and itchy eyes. There is regular release of fluid and a steady disturbance in bacterial conjunctivitis.

Conjunctiva and its diseases

It is a thin membrane that covers the inner surface of the eyelid and the white part of the eyeball (the sclera). Inflammation of the conjunctiva is called conjunctivitis. It makes the white of the eye look red, which is also called conjunctival hyperemia.

Conjunctival chemosis

It is the swelling of the conjunctiva. Effective treatment includes cold compresses, chilled artificial tears and steroid eye drops.

Sub-conjunctival haemorrhage

It is the bleeding underneath the conjunctiva. The conjunctiva contains many small, fragile blood vessels that are easily ruptured or broken. When this happens, blood leaks into the space between the conjunctiva and sclera.

Conjunctival xerosis

Dryness of the eye surface caused by deficiency of tears or conjunctival secretions is known as conjunctival xerosis. It may be associated with vitamin A deficiency, trauma, or any condition in which the eyelids do not close completely.

Inflammatory conditions

An inflammatory condition is known as conjunctivitis, also called 'pinkeye'. These may include:

Infective viral and bacterial conjunctivitis

Viral conjunctivitis and bacterial conjunctivitis may affect one or both the eyes. Bacterial conjunctivitis often produces a thicker, yellow-green discharge. Both types can be associated with cold or the symptoms of a respiratory infection, such as a sore throat. Both viral and bacterial types are very contagious. They are spread

through direct or indirect contact with the eye secretions of an infected person. Adults and children can both develop these types of pinkeye. Bacterial conjunctivitis is more common in children than in adults.

Allergic conjunctivitis

It affects both the eyes and is a response to an allergy-causing substance, such as pollen dust or cosmetics. The body's release of histamine can produce a number of allergy signs and symptoms, including red or pink eyes. If you have allergic conjunctivitis, you may experience intense itching, tearing and inflammation of the eyes, as well as sneezing and watery nasal discharge.

Chemical or irritational conjunctivitis

It is not contagious and is caused by exposure to irritants including chlorine from swimming pools, contact lens solutions, cosmetics, foreign objects, injury to the eye, intense light (i.e., snow blindness) and smoke.

Cornea: Its disorders and diseases

The cornea is the transparent part of the eye that covers the front portion of the eye. It covers the pupil, iris and anterior chamber of eye. The cornea's main function is to refract the light rays when they enter the eye. The cornea is responsible to focus most of the light that enters the eye.

Diseases of cornea

Fig. 3.1: Corneal Disease

Even though the cornea appears clear in such condition, the patient's vision can still be very blurry (Fig.3.1).

Corneal abrasion

A scratch on the surface of the cornea. It may occur by dust, contact lenses, or any other objects.

Glaucoma

It refers to a group of eye diseases wherein the optic nerve gets progressively destroyed (Fig.3.2). This is often due to an increase of pressure within the eye,

resulting in gradual vision loss and, eventually blindness. (IOP). Normal intra occular pressure is 14.6–22.04 mm of mercury, it is measured by an instrument named schiotz tonometer.

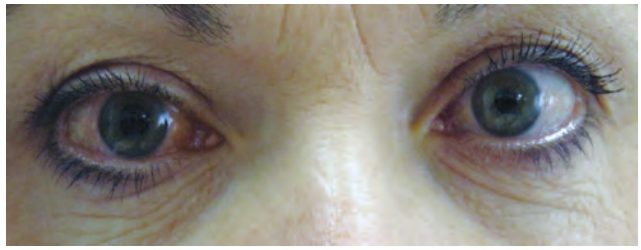

Fig. 3.2: Glaucoma

Another instrument used to measure IOP is called the applanation tonometer. It is generally brought about by anomalous high pressure inside the eyeball. There are restrictions in the field of vision as a result of the damage to the optic nerve.

Cataract

It is the clouding of the eye's natural lens, which lies behind the iris and the pupil (Fig. 3.3). Cataracts, most commonly cause diminishing of vision in people over 40 years of age, and is the principal cause of blindness. A cataract starts out small and at first, has little effect on the vision. One may notice that the vision has blurred a little, like looking through a cloudy piece of glass or viewing an impressionist painting.

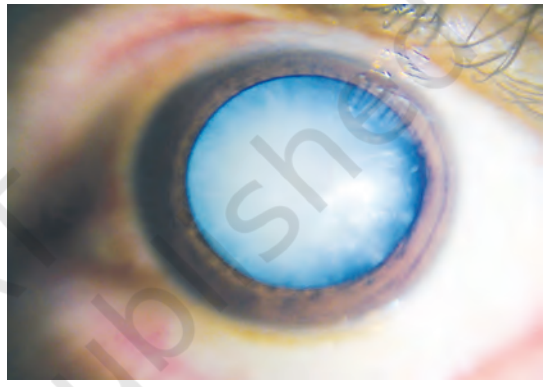

Fig. 3.3: Cataract

Practical Exercise

Activity 1

Prepare a chart of the common eye problems. Paste pictures or drawings and mention the common symptoms associated with the eye problems.

Materials required

1. Chart paper
2. Scissor
3. Adhesive
4. Sketch pens
5. Eraser
6. Scale and
7. Pictures of common eye conditions

Check Your Progress

A. Fill in the blanks

1. An eye disease induced by _____, for example, bacteria, viruses and different other microorganisms, causes an eye infection.
2. Eye infections can range from the normal conjunctivitis to rare _____.
3. The conjunctiva is a thin membrane that covers the inner surface of the _____ and the white part of the eyeball (the sclera).
4. Inflammation of the conjunctiva is called _____. It makes the white of the eye look red.

B. Short answer questions

1. What is conjunctival chemosis?
2. Which disease is caused by Anomalous High Pressure inside the eyeball? Explain how?
3. What is cataract?

SESSION 2: SYMPTOMS OF COMMON EYE PROBLEMS

In this session, you will learn about the common eye problems, which may include defects of vision, blurry vision, etc.

Common symptoms

Some of the common symptoms of eye problems include the following:

Watering of eyes

This could be due to inflammation of cornea or conjunctiva and other conditions, such as blocked lacrimal passages and the presence of a foreign body.

Redness of the eye

This can be due to the presence of a foreign body, conjunctivitis, keratitis, anterior uveitis, angle closure, glaucoma, etc.

Swelling

Incorrect error of refraction can cause headache. Other causes could be a migrane, sinusitis or tension.

Coloured halos around bulbs

This is suggestive of angle closure glaucoma, corneal edema and acute conjunctivitis with mucus crusts.

Diplopia (double vision) or multiple images

This may be due to a squint, corneal edema, cataract, astigmatism and subluxated lens.

Photophobia

This means the fear of light which is caused due to corneal abrasions, corneal ulcers, anterior uveitis, and acute closure glaucoma. It is due to ciliary spasm activated by light.

Itching

This is an indicator of some kind of allergy or conjunctivitis or dry eyes.

Defects of vision

Sometimes the vision is blurred due to an inability of the rays of light to focus clearly on the retina. This is called visual defect and it occurs due to the refractive error of the eye.

The three major errors of refraction are:

- Myopia (nearsightedness)
- Hyperopia (far-sightedness)
- Astigmatism

Myopia

It is a condition when a person can see nearby objects clearly but cannot see distant objects. It usually develops in childhood or young age. In

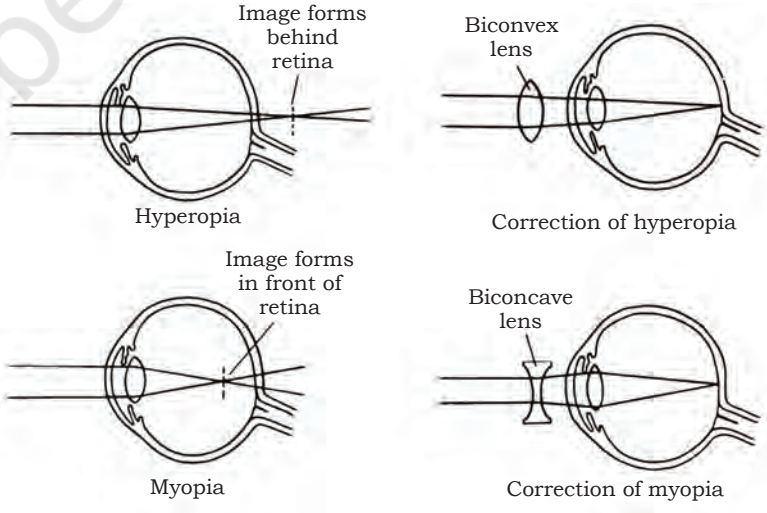

Fig. 3.4: Hyperopia and Myopia

this condition, the light from an object is focussed in front of the retina. The condition is due to elongation of the eyeball or change in curvature of the eye lens.

Symptoms

The main symptom of myopia is blurred vision and an inability to see distant objects. Other symptoms of the visual defect are headache, watery eyes, itching and dryness in the eyes. Children who suffer from myopia find it difficult to see letters distinctly written on the blackboard when sitting on the back benches of the classroom.

Types of myopia

There are generally two types of myopia.

1. *Simple myopia:* The power in simple myopia is usually less than 6 dioptre. Dioptre is the unit of power of a lens.

2. *Pathological myopia:* In this type of myopia, the refractive defect of the eye is very high. It is progressive and generally present from early childhood. The power is usually more than 6 dioptre.

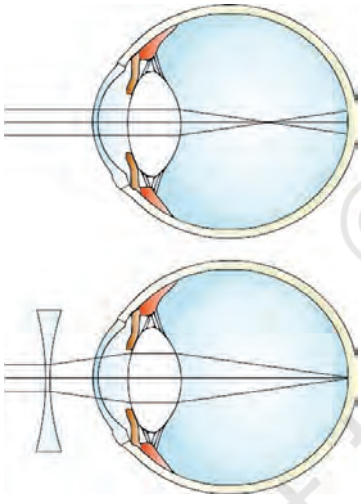

Fig. 3.5: Myopia Treatment

Treatment

Myopia can be corrected by using concave lens of suitable power (Fig. 3.5). The concave lens can help to form an image on the retina.

Hypermetropia

Hypermetropia or Hyperopia or far-sightedness is a condition in which the person can see distant objects clearly but is unable to see the nearby objects distinctly. This condition is caused when light from an object is focussed at a point behind the retina. The size of the eyeball in hypermetropia is smaller than normal.

Symptoms

A person with hyperopia cannot see nearby objects distinctly. The other symptoms are headache, strain in the eyes after prolonged work involving looking at nearby

objects, such as desk job, sewing, knitting, etc. Hyperopia can be detected at any age.

Treatment

Hyperopia is corrected by the use of a convex lens of suitable power.

Astigmatism

A person suffering from astigmatism has blurred, distorted or fuzzy vision, as the light rays are focussed on two or more points on the retina (Fig. 3.6).

Symptoms

A person with astigmatism complains of headache or eye strain and blurred vision.

Treatment

Astigmatism is corrected by the use of a cylindrical lens in the spectacles.

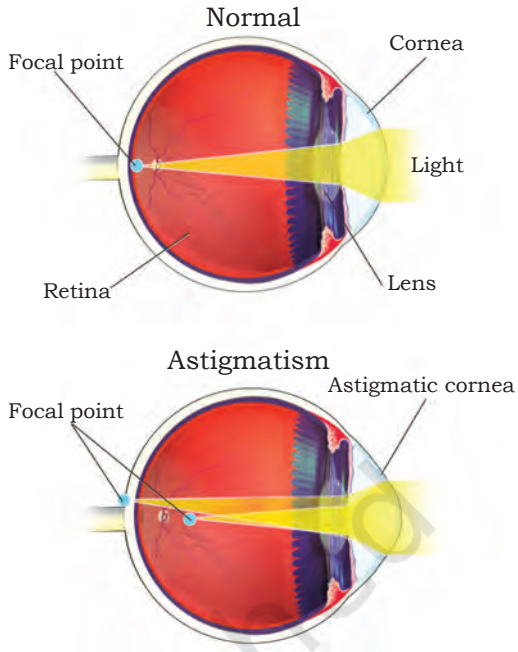

Fig. 3.6: Astigmatism

Presbyopia

The power of the eye to see nearby objects decreases with ageing. They find it difficult to see nearby objects comfortably and distinctly without corrective eyeglasses. This condition is called presbyopia (Fig.3.7). This occurs due to diminished flexibility of the ciliary muscles and eye lens. Sometimes, a person may have both myopia and hyperopia. Such people often require bifocal lenses.

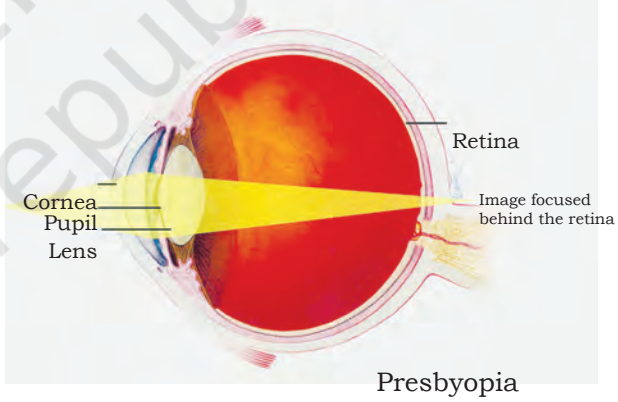

Fig. 3.7: Presbyopia

Treatment

Presbyopia is corrected using convex lenses, which can be used for reading and any other work involving looking at nearby objects.

Xerophthalmia

Xerophthalmia is dryness of the eyes. It is caused by a reduction in tear formation. Vitamin A supplements are given to patients with xerophthalmia.

Symptoms

These include night blindness, itching and eye irritation. In addition to the eyes being very dry, there is a loss of lustre of the surface of the eye. The cornea becomes soft and gradually opaque.

Some other eye problems

(i) Dry eyes: When the eyes do not have enough tears, it results in dry eyes. It may develop due to working on computers or using mobile phones for a long time. The dry eye syndrome is a condition when the eyes are unable to secrete sufficient amount of tears to keep the eyes lubricated. In this condition, the patient complains of a foggy vision.

(ii) Watery eyes: When the eyes handle an excess of tears, it results in watery eyes.

(iii) Eye pain: This implies the inconvenience that can happen inside and around the eye. It normalises on its own without treatment.

(iv) Eye emergencies: These occur when chemicals or a remote object gets into the eye, or can happen because of an accident that influences the surrounding area of the eye. Emergencies require prompt medical attention.

Fig. 3.8: Eyelid Problems

(v) Excess of tearing: Excess of tears can take place due to improper light conditions, wind or temperature changes. Securing your eyes by wearing sun or protective glasses can frequently take care of this problem. Sometimes, tearing may additionally imply that you have a more genuine problem. For example, an eye infection or a blockageof the tear duct, allergens.

(vi) Eyelid problems: The eyelids secure the eye, disperse tears, and control the amount of light entering the eye (Fig. 3.8). Agony, itching, watering from eye, are some of the symptoms occurring due to eyelid problems, such as hanging eyelids, flickering or aggravated external edges

of the eyelids close to the eyelashes. Eyelid problems frequently might be treated with cleaning, medicines or surgery.

(vii) Foreign particle in the eye: Any foreign particle, such as dust, entering the eye can create uneasiness and needs proper attention.

(viii) Blepharitis: It is the swelling of the roots of the eyelash. The reason for such a condition is still vague, but allergies, parasites, dandruff, and certain drugs may increase the probability of the condition.

(ix) Eye redness: It happens when the blood vessels of the eyes get swollen. It can happen because of dry air, dust or allergies. Uveitis is the inflammation of the uvea—the middle layer of the eye that consists of the iris, ciliary body and choroid. This can be caused by eye injury and inflammatory diseases. Exposure to toxic chemicals, such as pesticides and acids used in the manufacturing processes can also cause uveitis.

Practical Exercise

Visit your nearest eye clinic with your friends and teacher, and find out what sort of treatment methods they use for various eye infections. Note your observations and include them in your portfolio of activities.

Check Your Progress

A. Fill in the blanks

1. Myopia is a condition when a person can see _____ objects clearly, but cannot see _____ objects.
2. Dry eyes occur when the eyes do not have enough _____.

B. Short answer questions

1. What are the causes of diminishing of vision?
2. What is photophobia?
3. Describe presbyopia and its treatment.

SESSION 3: EYE INJURIES

In this session, you will learn about the causes, general symptoms, precautions and management of eye injuries.

Ocular trauma injury

Ocular trauma refers to an injury to the eye, either accidental or intentional. Trauma can occur due to various types of injuries during birth, domestic work and in sports. The most common type is occupational injury which may occur at an agricultural or industrial workplace. Trauma to the lens, or eye damage can be caused by three types of injuries: mechanical, physical and chemical.

Mechanical injury

These include blunt injuries (caused by blunt objects, like a ball or a fist) and penetrating injuries (caused by a sharp object, like a knife, compass, etc.). A blunt injury may cause lens opacity, either immediately or after sometime. A perforating injury results in opacity of the eye lens at the site of injury to the lens and progresses to complete opacity. This often requires immediate surgery.

- Blunt injury for example, caused by a fist or ball;
- Perforating injury for example, caused by sharp instruments; and
- Explosive injury for example, caused by a gunshot, bomb blast or firecrackers.

Physical injury

The lens is extremely sensitive to ionising radiation—for example, gamma rays, UV rays, etc., especially on long-term exposure to these agents. Physical injury can be caused by thermal, flame, hot liquids, radiation and electrical contact. Exposure to radiation and electric current may produce physical injuries to the lens while acids, alkalis and metals are the causes of chemical injuries. Cataract due to electrical injury may regress, remain stationary or mature to complete cataract over a period of months or years. Microwave radiation does not have much effect on the lens.

Chemical injury

This can occur due to acid or alkali. Small pieces of metal, especially iron and copper which enter accidentally in the eye, can also cause cataract.

Precautions

Work-related trauma is preventable and every effort should be made for its prevention. Precautions and adequate safety measures are necessary in high risk areas, like industries, agricultural fields and sports. Some of the preventive measures which can be adopted to prevent injury to eyes are as follows:

- Do not rub the eye.
- Use the corner of a soft clean cloth to draw particles out of the eye, or hold the eyelids open and flush the eyes continuously with clean water. If a particle is large or sticks in the eye, do not attempt to remove it and consult the doctor immediately.
- Cover the eye with a pad and go to an eyecare professional at the earliest. When the chemical agent has entered the eye, flush the eye and surrounding area with clean water for 30 minutes.
- Use a protective glass shield, a helmet and spectacles to prevent accidents.
- Do not neglect any form of eye injuries.

Management of eye injuries

- Remove the person from the source of the injury to a relatively safe place.
- If the person is unconscious, stabilisation of his general status is a priority over looking for eye injuries.
- The injured person may require investigations, like X-ray and CT scan to identify damage to the bones, soft tissue and eyeball.
- A tear of the eyelid, conjunctiva, cornea needs to be sutured at the earliest.
- Traumatic cataract may need surgery to restore vision, depending on the location and density of the opacity. More serious complications, like

retinal detachment or vitreous haemorrhage may need surgery.

- Foreign bodies lodged inside the eye may also require surgical removal.
- Conditions like sub-conjunctival haemorrhage require only an antibiotic and observation, as they resolve on their own in a matter of weeks.

Practical Exercise

Visit a vision centre or an eye clinic and study the common eye injuries that the patients come to the centre/clinic for. Write a short note on any two eye injuries that you learned about during your visit.

Check Your Progress

A. Fill in the blanks

1. Ocular trauma refers to any injury to the eye, either _____ or intentional.
2. Traumatic lens or eye damage can be caused by three types of injuries: _____, physical and chemical.
3. Remove the person from the _____ of the injury to a relatively safe place.
4. _____ cataract may need surgery to restore vision.

B. Short answer questions

1. What is ocular trauma and its causes?
2. Describe the precautions for preventing eye injuries.
3. How to address conditions like sub-conjuctival haemorrhage?

Unit 4

Measuring Visual Acuity

Introduction

Five complex functions of the human eye comprise visual acuity, visual field, contrast sensitivity, colour perception and image formation. To identify the actual cause of poor vision, ophthalmologists apply a number of methods to determine the visual acuity of a patient. Technicians, therefore, play an important role to test and determine accurate visual acuity of a person. It is important to measure visual acuity, record and document the findings for further reference.

This unit will give the students an insight into visual acuity, how to measure it, the normal vision, and its significance to record visual acuity. They will learn to describe the relation between visual acuity and refractive errors. The students will also be able to record visual acuity for distant and nearby vision. This unit will cover vision related abbreviations being used in the prescriptions and case paper of eye patients.

After studying this unit you will learn about:

- The importance to measure visual acuity
- How visual acuity is to be measured
- When and why should vision be retested with a pinhole
- How to record visual acuity

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Did you know?

Snellen chart was developed by Dutch ophthalmologist Herman Snellen in 1862 and thus is named after him.

SESSION 1: MEANING OF VISUAL ACUITY

In this session, you will learn about the reasons to measure visual acuity. Visual acuity is the angular measurement of the amount of clarity that a person has with his vision in relation to an object of a particular size at a particular distance. Low visual acuity is an obstacle in the day-to-day life. This visual assessment can help to identify errors of refraction, other ocular diseases and optical disorders. Visual acuity is evaluated before and after the correction of error of refraction for far and near distances for each eye.

Reasons to measure visual acuity

Relationship between measure of visual acuity and refractive error

Refractive error is defined as ametropia. This error occurs due to faulty refraction in the eyeball, which may be due to the abnormal size of the eyeball, uneven curvature of cornea or flexibility of the eye of lens. A very high or very low refractive error would cause myopia (near-sightedness), or hypermetropia (far-sightedness). The state of normal refractive status is termed as emmetropia.

Practical Exercise

Visit a vision care clinic to observe the methods used to measure visual acuity for far and near distances.

Check Your Progress

A. Fill in the blanks

1. Refractive error is defined as _____.
2. A very high or low refractive error would cause _____ or _____.

B. Short answer questions (30-40 words)

1. What is visual acuity? And how is it measured?
2. What is the connection between error of refraction and visual acuity?

Session 2: Process of Measuring Visual Acuity

In this session, you will learn about the Snellen chart and its benefits.

Visual acuity or VA is tested and measured by asking the patient to identify images or read letters on a chart. Black letters or symbols against white on a chart represent extreme contrast. This helps the vision technician to measure a patient's acuity of vision. The tests to record visual acuity include Snellen chart and E-test. There are also tests to check acuity for near distances. The visual acuity distance is usually measured at six metres or 20 feet. A suitable test distance is obtained by using mirrors and a reflective system when the examination distance is lesser than 20 feet.

Fig. 4.1: Snellen Chart

Snellen chart

VA is considered normal when it is recorded as 20/20 by the Snellen chart. In case the patient fails to read at all, he is called for further testing (Fig.4.1).

E-test

This is used to test the VA of pre-school as well as older children. The test is known as the illiterate E-test or the E-game (Fig. 4.2). Sometimes, other letters, numbers or symbols are also used. When the children are tested with the E-game, they are asked to point towards the E with their hands or finger. This test may be tough to use as children are often confused between right and left or due to differences at the stages of development, even if they may have good vision acuity.

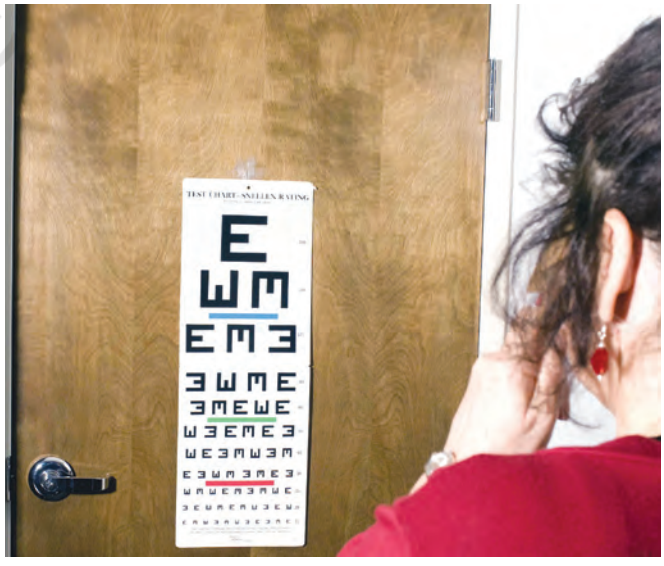


Fig. 4.2: E-test

Conventionally, the first visual acuity test is done in the right eye, followed by the left eye. Hence, a patch or an occluder is used while testing the VA in each eye. Using

Fig. 4.3: Test for Near Vision

an adhesive patch can be a good occluder. The line where the patient can read the maximum number of small letters is recorded.

Tests for near vision (Fig.4.3) are used to identify a person's ability to see near objects clearly. Hence, a near vision test is necessary to identify whether a person requires spectacles or another device to have clear vision at near distances. Near tasks include activities, such as eating, art and craft work, personal care and hygiene activities, reading, and some other work tasks. A number of methods are available to test the near vision. Jaegar's test is commonly used to test near vision. Reading cards are specifically used for testing near vision acuity.

Practical Exercises

1. Visit a vision care clinic and observe the method of measurement of visual acuity.
2. A young man has some problem in the eye. He needs to go to a vision technician. What is the first test that the vision technician will do? Mention the reason behind this.

Check Your Progress

A. Fill in the blanks

1. The visual acuity for distance is usually measured at a distance of _____ metres.
2. A patch or _____ is used while testing the VA.

B. Short answer questions (30-40 words)

1. What is the distance between a patient and the Snellen chart?
2. What is the Snellen chart?

Session 3: Normal Vision and Keeping Record of Visual Acuity

In this session, you will understand normal vision and the simple, effective method of stating visual acuity.

Eyes of every individual are uniquely different and so is their vision. Therefore, it is important to understand normal vision first. Normal vision is often described as a 20/20 vision (feet equivalent to 6 metres). Other important skills of vision are eye coordination, peripheral field, ability to focus, perception of depth, and colour vision which play an equally important role in determining visual acuity. Thus, it becomes important to also check the physiological health of various components of the eye.

Visual acuity measures the vision of a person. The purpose of examination of the eye is to identify the most suitable prescription of glasses to provide visual correction. On understanding normal vision, a person will have a clear understanding of the terms near-sightedness, far-sightedness, astigmatism, or blurriness due to age.

Nearsightedness or **myopia** is a condition when the patients can clearly see the objects that are close by, while the objects that are far away are blurred. The treatment for this condition is using corrective lenses like contact lenses or eyeglasses for better vision, or taking the help of refractive surgery.

Far-sightedness is another clinical condition of the eye, medically known as **hyperopia**, where the patient can see the objects at a distance quite clearly, but has a hazy vision of the objects that are closer. It is treated with contact lens, refractive surgery or by using eyeglasses for correction.

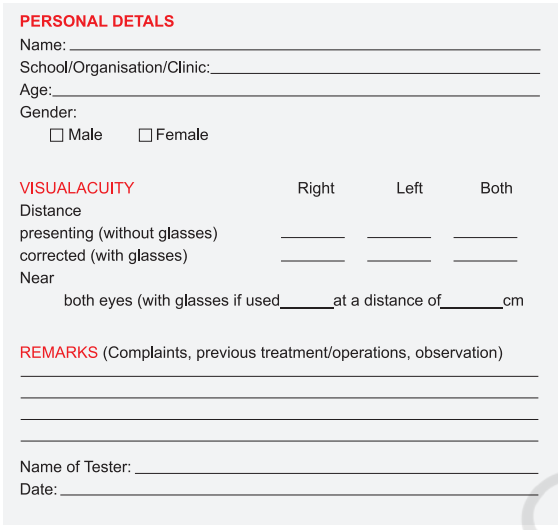
Astigmatism is another clinical condition of the eye where the curvature of the cornea is uneven, which creates difficulty for the eye to have a clear vision. This eye condition generally supplements either with far-sightedness or near-sightedness.

Presbyopia due to age is a common problem faced by people as they near the age of 40 years. A major section of people start holding their favourite reading

Did you know?

Treatment for astigmatism includes the use of refractive surgery or corrective lenses, addressing the irregular curvature of the cornea.

materials at convenient distances so as to see clearly, but have to strain to see, though they are able to see quite clearly the objects that are faraway. This clinical condition of the eye which is age related, is medically known as **presbyopia**, which actually starts around the age of 40 years, and continues over the years, though major changes can be noticed at a much later stage. This condition of the eye can be treated by using corrective lens or by refractive surgery.



PERSONAL DETALS

Name: _____

School/Organisation/Clinic: _____

Age: _____

Gender:

☐ Male ☐ Female

VISUALACUITY	Right	Left	Both
Distance			
presenting (without glasses)	_____	_____	_____
corrected (with glasses)	_____	_____	_____
Near			
both eyes (with glasses if used _____ at a distance of _____ cm			

REMARKS (Complaints, previous treatment/operations, observation)

_____

_____

_____

_____

Name of Tester: _____

Date: _____

Fig. 4.4: Visual acuity record

In the previous sessions, discussions were carried out on a vision technician's ability to measure the patients' visual ability, the relationship of visual acuity and refractive error and various kinds of tests assessing visual acuity have been discussed in this session (Fig. 4.4). The importance of recording visual acuity. Here, it is necessary to differentiate between *visual functions* and *functional vision,* first. In this context, it must be understood clearly that visual functions denote the way the eye functions, and functional vision indicates the functional aspect of a person in his or her daily life.

Practical Exercises

1. Visit an eye unit or clinic to observe the methods to record vision and also observe the management of other refractive conditions.
2. Visit a nearby vision care clinic and observe how they are recording visual acuity (Use additional sheets of paper if necessary).

Check Your Progress

A. Short answer questions (30–40 words)

1. What is 20/20 vision? What is the difference between 20/10 visions?
2. Is 20/40 correct vision? Justify your answer.

3. List some names of eye diseases.
4. What is the difference between near-sightedness and far-sightedness?
5. What is myopia?
6. What is presbyopia?
7. What is the importance of recording visual acuity?
8. How should visual acuity be recorded?

B. Write short notes on the following:

1. Visual Acuity
2. Near Vision

Some Important Abbreviations	
VA	Visual Acuity
c.c.	With correction
s.c.	Without correction
N	Near
D	Distance
PH	Pinhole
OD or RE	Right Eye
OS or LE	Left Eye
OU	Both eyes (together)
J	Jaeger notation
CF or FC	Count Fingers or Finger Counting
HM	Hand Motion
LP	Light Perception
NLP	No Light Perception
F/FFix/	Follow
20/40-2	Missed two letters on the 20/40 line
20/50+2	Read 2 letters on the line following the 20/50 line+ Entopic response
LP c pro	Light Perception with Projection

Unit 5

Basic Visual Assessment

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Introduction

Primary eye care is an essential component of primary health care. Since most of the blinding ocular conditions are preventable or curable, the availability of eye care services at the primary level can reduce the incidence of blindness in the community.

The backlog of cataract blindness is more in rural areas; early detection of operable cataracts at the primary level by health care personnel like vision technicians is of utmost importance. An early detection of glaucoma, error of refraction, squint and such other vision damaging eye ailments needs attention at the primary level. In this session, you will learn about the role of vision technician, optometrist, orthoptist, ophthalmologist (eye specialist) for basic visual assessment in the eye care services.

Various diseases of the eye can be detected by a systematic examination of eyes for example, recording visual acuity, refraction, ocular mobility, field of vision charting, external examination of eyes, intraocular pressure and colour vision test.

Session 1: Eye Care Professionals

You will study about the roles and functions of ophthalmologist, optometrist and orthoptist.

Ophthalmologists

This is a specialist for medically and surgically curable eye problems. An advanced education and training is required to become an ophthalmologist (Fig.5.1). After completion of MBBS degree, a postgraduate in ophthalmology is called an ophthalmologist.

Fig. 5.1: An ophthalmologist at work

Optometrists

An optometrist (Fig. 5.2) need not study medicine like MBBS doctors. The optometrists provide only limited services of eye care. A diploma and bachelor's in optometry is a course where students undergo training for vision care services. Optometrists prescribe the number of spectacles and contact lenses at the initial stages.

Fig. 5.2: An optometrist at work

Orthoptists

They are not required to study medicine like an ophthalmologist. A full-time diploma/degree course is required to qualify for performing orthoptic treatment. Orthoptists deal with assessment diagnosis and management of the patient with eye muscle disorders. Orthopists help the ophthalmologists for management of eye muscles disorder patients. Orthoptists serve patients of all age groups.

Practical Exercise

Visit an eye unit or clinic to understand the role of various eye care personnel.

Check Your Progress

A. Short answer questions (30–40 words)

1. What is ophthalmology?
2. What is the role of an optometrist?
3. What are the roles and functions of an ophthalmologist?

Session 2: Basic Examination for Eye Diseases

This session is to learn about the basic examination of eyes, and visual disorders. You will also learn about various terms and instruments used for eye tests.

A series of tests are performed by the eye care professionals to assess the vision by eye examination. People must have a routine eye check-up as it is being recommended by health professionals, as many of the eye diseases are asymptomatic. Through an eye examination, various eye diseases affecting the vision can be detected. An eye examination consists of the following tests:

Visual acuity

It means the ability to know the details of the objects a person sees. The term 6/6 is more commonly used, which is represented in metres. Visual acuity for distance is measured by the Snellen chart.

Refraction

A method used to correct the defect of vision is called refraction. Refraction consists of two parts.

1. Objective refraction
2. Subjective refraction

Fig. 5.3: Process of refraction

Objective refraction

Refraction done without any feedback from the patient is known as objective refraction. Objective refraction is done by retinoscopy or auto-refractor. Retinoscope is a device or instrument used for objective refraction.

Subjective refraction

Refraction that requires responses from the patient is known as subjective refraction. A trial frame and retinoscope is used by the professionals; the patient reads the eye chart. According to the line on the chart that the patient has read, lenses are selected for correction of error of refraction.

Occular motility

When the patient complains about double vision, ocular motility is tested for diseases of muscles around the eyes. The patient is asked to move the eyes in nine cardinal directions of the gaze. The extra ocular muscles are tested in the directions of action of inferior, superior, lateral and medial rectus muscles, superior and inferior oblique muscles.

Visual field testing

This test is done to assess the central and peripheral fields of vision.

External examination of eyes

This includes an inspection of the eyelids, the position of eyes and the surrounding structure of eyes.

Slit-lamp examination

In this procedure, the eyes are examined through an optical system that magnifies the image of the eye.

Intraocular pressure

It is the fluid pressure inside the eye. Intraocular pressure is measured by a device called tonometer. The normal range is 10–21 mmHg.

Fundus examination

This is an important part of eye examination. During fundus examination, the optic disc and retinal vasculature, media are viewed and the observations are recorded. This examination of eyes is done from a distance of about 50 cm.

Practical Exercise

Visit an eye unit or clinic to understand the role of personnel in vision care services, and to observe the functions of equipments used for the examination of eyes.

Check Your Progress

A. Fill in the blanks

1. _____ _____ _____ is done to assess the extent of the peripheral field.
2. A _____ trial frame is used by the professionals.
3. _____ is done by retinoscopy or autorefractor.

B. Short answer questions

1. What is IOP? Give the normal range of IOP.
2. What is visual acuity?
3. Emphasis is given on movement of eye in various directions. What is this condition known as?

C. State whether the following are True or False

1. Refraction is a method to correct the defects of vision.
2. Visual field testing is done to assess visual acuity.
3. Intraocular pressure (IOP) is also known as refractive error.

SESSION 3: EYE EXAMINATION

In this session, you will learn about the basic eye examination methods and the procedures to conduct the eye tests by various equipments. To check for eye diseases and the vision, a series of tests are designed. A variety of instruments and equipments are used. The procedures of eye examination are as follows:

Check visual acuity

Clarity or a sharp vision is called visual acuity. A routine examination is mandatory in case of visual acuity for all patients. Several charts of test letters are used among which commonly used is the Snellen chart. The patient is seated 20-feet away from the Snellen chart, a clean card is placed in front of one eye, then in front of the other eye. The chart has letters of reducing size from top to bottom. The patient has to read the chart from the top most to the lower most lines. A patient who is able to read the letters of the 20/20 line from a distance of 20 feet is said to have a 20/20 vision. The process is applied for the other

eye too. The test should be repeated with glasses being used by the patient. The vision recorded without glasses is uncorrected vision and with glasses is corrected vision.

Colour vision

Colour vision test

This tests a person's ability to distinguish between primary colours and shades. The test by Ishihara is the most common test in use.

Ritter

A series of plates made up of dots of primary colours is used. A person with normal colour perception can identify the pattern in which the dots are set up. A colour-deficient person finds it difficult to identify the different patterns of colours.

Practical Exercises

Visit an eye unit or clinic to observe the methods of eye examination and testing colour vision.

Check Your Progress

A. Fill in the blanks

1. A _____ tests a person's ability to distinguish between the primary _____ and shades.

B. Short answer questions (30-40 words)

1. What is ritter?
2. Which is the most common test for checking colour vision defect?
3. List the equipment used for eye examination.

Session 4: Visual Assessment of the Eye

You will learn about the basic visual assessment techniques. Ophthalmoscopy is usually part of a routine eye test to screen the eye diseases, at the back of the eye. The back of the eye is called the fundus.

Fig. 5.4: Ophthalmoscope

It consists of:

- Retina
- Optic disc
- Choroid layer

This test may also be advised to observe the media and blood vessels, affected by high blood pressure or diabetes. The equipment used to examine the retina is called an ophthalmoscope (Fig.5.4). Ophthalmoscopy or fundoscopy or examination of the retina is a procedure to screen eye diseases. These include:

- Diabetic retinopathy
- Glaucoma (rise in pressure of the eye)
- Eye disease caused by High blood pressure
- Macular degeneration (loss of vision in the centre of the visual field)

Preparation for treatment

Eye drops are used to dilate the pupils. This makes the pupils larger and easy to look through. However, the eye drops make vision blurry and sensitive to light for a few hours. The patient should arrange for someone to drive back after the test. He/she should use dark glasses for few hours after the test and take rest for the day. If a patient is allergic to some medication, he/she should tell the ophthalmologist. Eye drops should not be used without the doctor's advice as it can cause an allergic reaction. Finally, the patient should tell the ophthalmologist if he/she has glaucoma or has a family history of glaucoma. Most eye doctors will not use eye drops on a patient with suspected glaucoma. The drops can raise the intraocular pressure of eyes.

Procedure

Before ophthalmoscopy, the patient may receive eye drops to dilate the pupils. The drop may sting for a few seconds. Drops can also cause an unusual taste. The goal is to get the best view of the back of the eye.

Direct examination

The patient is seated in a chair for direct examination. The lights in the room are turned off (see Fig. 5.5).

The ophthalmologist sits across the patient and uses an ophthalmoscope to examine the eyes. An ophthalmoscope is an instrument that has a source of light and several small lenses for an ophthalmologist to look through. The ophthalmologist may ask the patient to look in certain directions to view the back of the eye. The bright light may be slightly uncomfortable and can cause after-images to appear. However, it does not cause pain.

Fig. 5.5 Direct examination

Indirect examination

This test allows the doctor to view the structures at the back of the eye in greater detail (Fig. 5.6). For this test, the patient will be asked to lie down or sit in a reclined position. The ophthalmologist will have a bright light positioned around his forehead so that the beam of light will pass through the eyes. A convex lens will be held in front of the eye. Then, the doctor will hold the lids and the eye is opened to look into. Pressure may also be applied to the eye with a small, blunt probe. This may cause discomfort but not pain. A lens of 13D power is placed near the eye to condense light to focus on the eye.

Fig. 5.6 Indirect examination

Slit-lamp examination

This procedure gives the ophthalmologist the same view of the eyes as indirect examination, but with a higher magnification (Fig. 5.7). The ophthalmologist sits with the instrument in front of the patient. There is place for the patient to rest the chin and the forehead. This keeps the head steady during the examination. A bright light is turned on in front of the eye. The ophthalmologist will use a microscope to look into the eye to view the structures at the back of the eye. The patient is asked

Fig. 5.7 Slit-lamp examination

to look in different directions. The ophthalmologist uses fingers to open the eye for a better view. This examination may cause discomfort, but is not painful. The patient may see after-images after the light of the slit-lamp is turned off. They will go away after blinking several times.

Risks

The only risk of ophthalmoscopy is that of an allergic reaction to the eye drops. Such reactions are rare. However, they may cause

- Dry mouth
- Flushing of face
- Instant rise of intraocular pressure
- Dizziness
- Nausea and vomiting

Steps of eye examination

Check visual acuity (VA)

This should be done by first having the examinee wear his or her corrective lenses, then recheck without correction.

Check near visual acuity

Let the examinee read a card, held approximately 14 inches (35.6 cm) away, at a normal reading distance. Use bright lighting during this test. Decreased near visual acuity could be due to central cataract or presbyopia—presbyopia affects most people after the age of 40. As age advances, the lens of eye loses its ability to accommodate to focus small letters, or small objects at near distance.

Test peripheral vision by checking visual field

This is tested by confrontation method. The examinee focusses at a finger placed at a distance of ½ metre; the finger is moved in vertical and horizontal directions till it is invisible. The examinee should have at least 70 degrees of vision in the meridian of each eye.

Test colour vision

Ask the examinee to look at the colours on the eye chart and identify them, particularly red and green.

Stereopsis

Stereopsis is a term that is most often used to refer to the perception of depth and 3D structure obtained on the basis of visual information with reference to binocular vision and monocular vision. We do not have a specific test for depth perception but we do ask the patient if he is able to see with both eyes or with just one.

Eye examination

Conjunctiva

Inspect the bulbar conjunctiva (on the globe) and palebral conjunctiva (on the internal surface of the lids) for blood vessels, secretions, or redness, and presence of any foreign bodies. For the bulbar conjunctiva, note the colour of the underlying sclera, as well as any unusual vascularity and prominence.

Cornea

Inspect the cornea for any deposits or defects, surface thinning, cloudiness, or presence of blood vessels invading the surface. Examine the tear film for both quantity and quality. Gently pull down the lower lid to check the quantity. A normal amount of tear film should leave 1 mm meniscus between the globe and the edge of the lower lid. Check the tear break-up time to check the quality of the outer oily layer to prevent evaporation.

Lacrimal sac

To check the lacrimation system, put gentle pressure over the lacrimal sac area in between the inner end of the eye and the base of the nose.

Lens

Look for any lens opacities or cloudiness, which may indicate the presence of a cataract.

Practical Exercise

Visit an eye care unit or clinic to observe the visual assessment techniques.

Check Your Progress

A. Fill in the blanks

1. _____ is a procedure to screen for eye diseases.
2. A lens of _____ is placed near the eye to condense light to focus on it.

B. Short answer questions (30-40 words)

1. What is ophthalmoscopy?
2. What is the back of the eye called?

Unit 6

Assessing Refractive Status

Introduction

The eye (Fig. 6.1) plays an important role as an organ for vision in life. It helps in interpreting the shape, colour, and dimensions of the objects around us. The human eye can see in bright or dim light, but it cannot see objects when there is no light.

Fig. 6.1: Human Eye

Due to excessive stress factors, such as reading, watching television from a close range, working on computers all day, etc., the vision may be affected. An individual can have myopia, hyperopia, astigmatism, or presbyopia. These eye diseases can be corrected by the use of contact lenses, spectacles, or clinical surgery. Here, we will discuss about refractive error and its types, and how to identify refractive error. Also, various methods of correcting or curing the eyesight will be discussed in this unit. Important terms and methods, such as laser surgery, keratometry, retinoscopy, opthalmoscopy, auto refraction, photo-refraction, etc., will be discussed in detail. Techniques and procedures of retinoscopy, and auto-refractor and neutralisation will be described briefly.

Session 1: Meaning of Refractive Status and Refraction

In this session, you will learn about the symptoms, common refractive errors, ophthalmoscopy and the steps followed in neutralisation and its treatment.

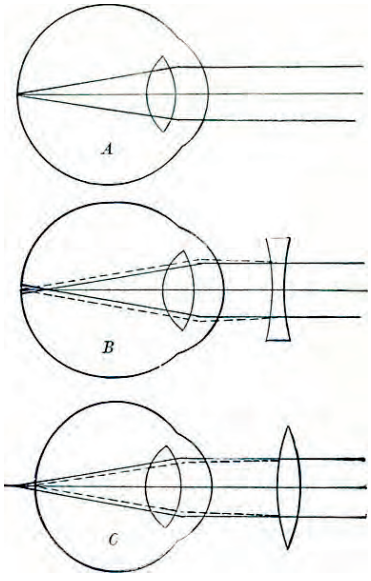

Fig. 6.2: The most common refractive errors

Refractive error

In simple words, refractive error is a condition when light rays do not fall on the retina in the eye (Fig. 6.2). It is an eye disorder and is found in 70% of the total population. The refractive errors cause a blurred vision; as a result, it may cause visual impairment.

Symptoms

- Blurred vision
- Difficulty in reading or seeing at a close distance
- Crossing of the eyes in children, i.e., squint

Types of refractive errors

Myopia (near-sightedness)

Myopia, commonly known as near-sightedness or short-sightedness, is a condition in which there is difficulty in seeing distant objects clearly.

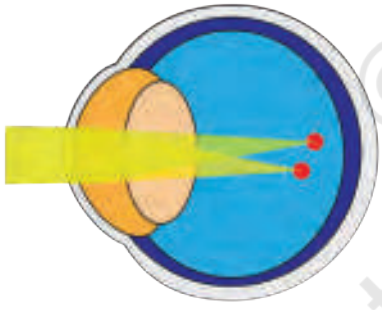

Fig. 6.3: Multiple focus points in astigmatism

Hyperopia (far-sightedness)

Hyperopia, commonly known as far-sightedness or long-sightedness, is a condition in which there is difficulty in seeing close objects clearly.

Astigmatism

Astigmatism refers to distorted vision, as the image is formed on multiple points of the retina (Fig. 6.3).

Presbyopia

In this condition, a person has difficulty in reading or seeing at an arm's length. It is an ageing process of the eye.

Diagnosis of different types of refractive errors

Refractive errors may rise from many different causes. Diagnosis of refractive errors is normally confirmed

by recording VA by an eye care specialist, and by retinoscopy. An automated refractor is an instrument used in place of retinoscopy to estimate a person's refractive error.

Presbyopia

An eye doctor will ask the patient to read the near vision chart and will give suitable corrections. The patient can also consult with the doctor for presbyopia surgery as an alternate method of treatment.

Astigmatism

The patient has a blurred vision when he/she reads the Snellen chart for distant vision. Keratometry may be used to measure the curvature of the cornea's front surface confirmed by corneal topography.

Treatment

The management of refractive errors depends upon the type of error of refraction. The refractive error may be corrected by using glasses, contact lenses and refractive surgery.

Optical image of retinoscopy

Opthalmoscopy

Also known as fundoscopy, it is a test to see the inside of the eye to examine the cavity (fundus) of the eye, vitreous and other structures (Fig. 6.4). It is a routine test while the examination of the eye is done. The goal is to get the best view of the cavity of eye.

Fig. 6.4: An ophthalmologist performing retinoscopy

Direct examination

The patient is made to sit on a chair. The lights in the room are to be turned off or dimmed. The ophthalmologist sits across the patient and uses an ophthalmoscope to examine the patient's eye. An ophthalmoscope is used for the examination. It has a light and several small lenses for the ophthalmologist

to look through. The ophthalmologist may ask the patient to look in certain directions as he or she looks at the back of the eyes.

Indirect examination

It helps to see the structures at the back of the eye, in detail. The patient has to lie down or sit in a reclined position. The ophthalmologist will have a bright light positioned around his or her forehead that will be thrown in the patient's eye. A lens is to be held in front of the eye, the doctor will hold the patient's eye open to look into it. The patient is asked to look in certain directions. Pressure may be applied on the patient's eye with a small, blunt, probe. This may be uncomfortable but is not painful.

Auto-refractor

An auto-refractor or automated refractor is a computer-controlled machine used to measure the refractive error.

Neutralisation

The power of an unknown lens can be determined by neutralising it with another lens of known power.

Practical Exercises

1. Visit an eye care unit or clinic and observe the methods of recording visual acuity, refractive error and the procedure of correction.
2. A patient visualises a clear view of the objects that are near to him and visits the clinic. How would you conclude what type of refractive error the patient is suffering from?
3. An old lady is unable to visualise anything clearly. If the doctor asks you to find out what type of refractive error the lady is suffering from and suggest a way of curing the condition, what would you suggest?
4. A patient seems to be suffering from myopia and you were to test her eyes. What is the method of confirmation that you will use to know that the person is suffering from myopia?
5. Visit an eye care unit or clinic to observe operation of an ophthalmoscope and auto-refractometer.

CHECK YOUR PROGRESS

A. Fill in the blanks

1. _____is used to measure the curvature of the steepest and flattest meridians in the cornea's front surface.
2. _____ is a computer-controlled machine used during an eye examination to provide a rough measurement of a person's _____.

B. Write a short notes on the following.

1. Ophthalmoscopy
2. Auto-refractor
3. Keratometry

C. Short answer questions (30-40 words)

1. What is refractive error? State some of its symptoms.
2. Classify the types of refractive errors.
3. What are the primary treatments for a myopic patient?
4. State briefly about the diagnosis of presbyopia?
5. Define neutralisation. State the steps of performing it (Use a separate sheet if needed).

D. State whether the following are True or False

1. Eyeglasses, contact lenses, and refractive surgery are the secondary options to treat the visual symptoms of those with myopia.
2. An automated refractor is an instrument that is sometimes used in place of retinoscopy to objectively estimate a person's refractive error.
3. Blurred vision is one of the symptoms of refractive errors.

SESSION 2: PROCESS OF RETINOSCOPY

In this session, you will learn about the process of retinoscopy and its optical principle.

Retinoscopy

It is the technique to obtain an objective measurement of the refractive error of the patient's eyes. The examiner

uses a retinoscope to pass light into the patient's eyes and the reflection of the patient's retina is observed by the eye-specialist. The light reflex is neutralised by lenses and the prescription of the lenses is given to prepare spectacles.

Retinoscope

The retinoscope is a small handheld instrument that is self-luminous and is used to measure the refractive condition of the eyes for the correction of refractory error.

Types of retinoscopy

Static retinoscopy

It is a type of retinoscopy that is used to determine the refractive error of patients.

Dynamic retinoscopy

In this, the patient is made to focus on a nearby object rather than distant objects. The term dynamic means the accommodation of the patients is active. The results of the static and dynamic retinoscopy are the same.

Book retinoscopy

This type of retinoscopy is specially done or performed for children, with the help of a picture book. The retinoscopy is performed while the child focusses on the pictures of the book and tries to identify them.

Practical Exercise

1. Visit an eye care unit or clinic to observe the procedure of retinoscopy.
2. A young boy visits the clinic, and you were to perform the retinoscopy of the patient. How are you going to perform the retinoscopy of the patient's eye?
3. An old lady comes to the clinic, and you were to check the retinoscopy reflex of the patient with the help of retinoscope. Explain the process.

CHECK YOUR PROGRESS

A. Fill in the blanks

1. _____ retinoscopy is used to determine the refractive error of patient.
2. The _____ is specially done or performed for children, with the help of a picture book.
3. The _____ is a small handheld instrument that is self-luminous and is used in a standard clinical procedure for measuring the refractive condition of the eye.

B. Multiple choice questions

1. Which of these is a type of retinoscopy specially done or performed on children?
   a) Static Retinoscopy
   b) MEM Retinoscopy
   c) Dynamic Retinoscopy
   d) Book Retinoscopy

SESSION 3: OPERATION OF AUTO-REFRACTOMETER

In this session, you will learn about auto-refraction, types of auto-refraction, techniques and methods of auto-refraction.

Auto-refractometer

An auto-refractometer also called an automated refractor, is a device used for eye examination to determine visual accuracy. The auto-refractometer has been in use since the 1970s. It quickly became a popular diagnostic device because of its ease of use. Refractive errors are diagnosed with this device and can help the doctor to determine whether a person needs spectacles or contact lenses (Fig. 6.5).

Fig. 6.5: Auto refractor equipment

Cycloplegic refraction

This is a procedure used to determine a patient's refractive error by temporarily paralysing the ciliary

muscles. Eye drops are used to temporarily paralyse or relax the ciliary body of the eyes. Cycloplegic refraction is sometimes used when testing the vision of young children. A cycloplegic refraction is also performed as part of vision correction by laser or LASIK technique to determine the absolute refractive error before proceeding with laser eye surgery.

Techniques and methods of auto-refraction

The procedure of auto-refraction includes the following steps:

- Cycloplegic drops with one drop of proparacaine, 4% and 1% cyclogyl once or twice in 40 minutes is put in eyes.
- A manual cycloplegic retinoscopy is performed with the help of a trial frame.
- The difference in diopters, between the auto-refraction and manual retinoscopy is calculated.

Reasons for auto-refractor testing

Auto-refractor is used by eye care professionals help determine whether a patient needs spectacles or contact lenses. Modern auto-refractor is extremely accurate and easy to use. They save time during eye examination. The cycloplegic drops are not needed to perform refraction.

Practical Exercise

Visit an eye care unit or clinic to observe the method of refraction by an auto-refractor.

CHECK YOUR PROGRESS

A. Fill in the blanks

1. An auto-refractor is also called an _____.
2. _____ drops with one drop of _____(4%) and 1% cyclogyl, once or twice in 40 minutes is put in the eyes.

B. Write short notes on the following.

1. Techniques and methods of auto-refraction
2. Reasons for auto-refractor testing
3. Types of auto-refraction

C. Short answer questions (30-40 words)

1. What is retinoscopy based auto-refractor?
2. How is an auto-refractor test performed?

Notes

Unit 7

Spectacles, Optical Prescription and Contact Lenses

171163CH07

Introduction

The topic deals with the process of inspection of prescribing spectacles and dispensing optical prescriptions to patients with visual complaints.

Optical devices include spectacles that correct human vision, which are prescribed by a licensed eye care professional by an authority.

Optical dispensing making the optical devices available to the patient without alteration of a prescription issued by a licensed eye care professional. All contact lenses are to be dispensed in accordance with a valid prescription.

A licensed dispensing optician is a person possessing a valid license by the state, authorised for optical dispensing. The optician will dispense spectacle, contact lenses and optical devices.

A detailed eye examination is performed by an eye care professional; the eye doctor will give a number to the glasses or contact lenses, and will also check the eye for diseases. In case of refractive errors and low vision, spectacles and low vision devices are one of the essential parts of the treatment.

The steps which are followed for provision of refractive services and low vision case are as follows:

- *Screening*: Identification of individuals with poor vision who can improve, by using spectacles or other optical devices.
- *Refraction*: Evaluation of the patient to determine the type of spectacles or device that may be needed.
- *Manufacture*: Manufacture of spectacle or an appropriate device, both of these can be done locally, purchased or can be obtained through donation.
- *Dispensing*: Supply of suitable fitting spectacles or device as per correct prescription.
- *Follow-up*: Fitting or repair of spectacles, devices and re-dispensing can be done as a follow-up.

Session 1: Reasons for Vision Disorders

In this session, you will learn about the reasons causing eye disorders, principle of optics, the different lens powers, and the refractive errors and their remedial measures. Spectacles are prescribed, keeping in mind the conditions of near-sightedness, far-sightedness, and astigmatism.

You may recall

Near-sightedness or myopia

When distant objects are not visible or seem blurred, but nearby objects can be seen clearly.

Factors

1. Heredity plays a major role; where one of the parents has myopia, the children are predisposed to the condition.
2. It is noticed in the child who reports a difficulty in the vision while seeing the blackboard in class or TV screen at home.

Persons with myopia (near-sightedness) can avail any of the following options as part of treatment:

- Spectacles
- Contact lenses
- Refractive surgery procedures

You may recall

Far-sightedness or hyperopia

It is a refractive error when the nearby images of an object are not clear. Persons with far-sightedness can avail the following options as part of treatment:

- Distant vision spectacles
- Reading spectacles
- Contact lenses
- Bifocal spectacles
- Progressive spectacles
- Refractive surgery procedures like LASIK

Astigmatism

It is an imperfection of either the cornea curvature, or the lens index, giving rise to a refractive error when light does not focus properly on the retina, forming distorted images on it. The above conditions are called corneal astigmatism or lenticular astigmatism. Persons with astigmatism can avail:

- Spectacles or contact lenses, with cylindrical correction.
- Refractive surgery procedures like LASIK, PRK, or LASEK.

Types of lenses

Bifocal lenses

These are prescribed for distance and near, to those patients who have distance and near vision problem causing eye strain while looking far away and/or near objects. A small lower part of the lens contains the power required for near-vision correction. The rest of the lens has power for distant vision. The lens segment for near vision correction are of the following shapes:

- a half-moon shaped, D segment or straight-top or flat-top
- a round segment
- a narrow rectangular area, known as the ribbon segment

For distant vision, one has to see through the upper segment of the lens of spectacle. To focus on reading

materials and nearby objects within 18 inches, one has to look through the lower segment of spectacles.

Trifocal lenses

These have three segments of power in a lens—they are for distance, intermediate and near vision. D-bifocal and executive styles are in vogue. Trifocals mostly help drivers who need to have a distant vision to gauge the distance while driving, intermediate vision for dashboard viewing, and near vision for viewing road maps; it is also of use for painters, lawyers and teachers who need to see frequently at three different levels.

Contact lenses

These are used for optical correction, worn in close contact to the cornea to correct defective vision. They provide better field of vision and have several advantages over spectacles. Contact lenses do not collect moisture. They can be worn in all conditions, like rain and excessive sweating. These are best used in outdoor activities as for pilots, sports persons and astronauts. Corrective contact lenses are used to improve vision by correcting the visual error.

Power of lenses

There are two types of lenses:

(a) Plus-powered lenses
(b) Minus-powered lenses

Plus-powered lenses

They are thicker at the centre than the edges. These lenses magnify images so that the images appear bigger.

Minus-powered lenses

They are thinner at the centre and thicker at the edges. They do not magnify images; thus, the images appear to be smaller. Optical lenses can be spherical or cylindrical lenses.

Correction of refractive errors

Myopia is corrected by concave lenses and hyperopia is corrected by convex lenses (Fig. 7.1). To correct astigmatism,

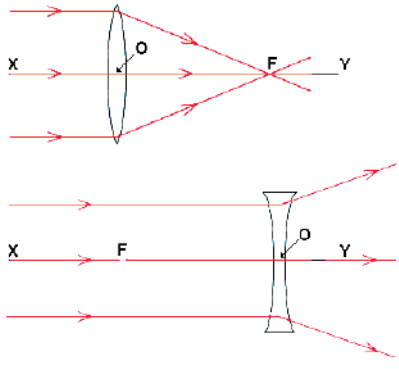

Fig. 7.1: Correction of refractive errors

a cylindrical lens is used. The refractive power is measured in optical units called dioptres. This measurement is indicative of the refractive power that the lens has. The higher the dioptre, the stronger the lens.

Practical Exercises

1. Give a solution to this case scenario:
   (a) student in the classroom comes to the teacher and complains that she cannot see the blackboard clearly. What eye disorder could the student be suffering from? Explain its treatment.
   (b) A doctor is treating a patient and finds out that his family has a history of eye disorders. What types of refractive errors could the patient suffer from?
2. Visit an eye unit or clinic to study the system of dispensing optical prescription and study the optics of various lenses.

Check Your Progress

A. Fill in the blanks

1. Astigmatism is an imperfection of either the _____ or the _____.
2. Trifocal lenses have three levels of focus_____, _____, and _____.
3. Contact lenses are _____ _____ worn in close contact to cornea to correct the _____ vision.
4. Hyperopia is corrected by _____ lenses.
5. The refractive power is measured in _____ units called _____.

B. Short answer questions (30-40 words)

1. What are the different types of lenses?
2. How can refractive error be corrected?
3. What is an optical centre?
4. What is dioptre?

C. State whether the following are True or False.

1. Far-sightedness is a refractive error.
2. Heredity plays a major role in the onset of myopia.
3. Bifocal lenses contain three segments of power.
4. Trifocal lenses correct disorders of accommodation.
5. Contact lenses collect moisture.
6. Myopia is corrected by convex lenses.

Session 2: Optical Prescription Notation

In this session, you will learn about the optical prescription notation. In order to dispense optical prescriptions and provide the correct spectacles, the optician has to understand the prescription written by an eye care professional. Optical prescriptions are written in a standard format. Latin abbreviations are in vogue for writing eyeglass prescriptions.

Table 7.1: Optical Prescription

Name : Vijay Anand Joshi					
Age: 68 yrs	Occupation: Ophthalmologist			Contact No.	
Address: PSS Central Institute of Vocational Education, Shyamla Hills, Bhopal					
Previous Glasses	-1.00/-2.00X90°		-0.50X100°	+2.25	
Spectacle Prescription					
RX	Sph.	Cyl.	Axis	Add.	Vision
Right Eye	-1.00	-1.75	90°	+2.25	6/9
Left Eye	-1.25	-0.25	90°	+2.25	6/6
					Optometrist Signature

Common abbreviations

Sph : Sphere or spherical power
Cyl : Cylinder or a power that corrects astigmatism
Axis : the angle, in degrees, between the two meridians present in an astigmatic eye
D : the unit to measure the correction or the focussing power also known as dioptre

The general form of writing the prescription for astigmatism is Sph x Cyl x Axis

SVD : Single Vision Distance. It prescribes glasses for distant vision only.

SVN : Single Vision Near. It prescribes glasses for reading only.

IPD : Inter Pupillary Distance. It denotes the distance between the centres of the two pupils. This measurement fulfills the criteria of preparing and designing of comfortable and optically perfect spectacles; also useful to decentre the lens while fitting bifocal or multifocal lens in spectacle frames.

Notations used in optical prescriptions

Following is an example of optical prescription:

OD: -3.00-0.50 X 180
OS: +2.00 DS
ADD: +1.75 OU

- The letter OD stands for 'oculus dexter'. It indicates the right eye.
- The letters OS stands for 'oculus sinister'. It stands for the left eye.
- RE for Right Eye and LE for Left Eye and BE for both Eyes are in vogue.
- The first number to the right of OD is -3.00. It indicates the sphere part of the prescription.
- The sphere number denotes either nearsightedness or far-sightedness.
- The sign of negative (–) shows the negative power of the lens used to correct near-sightedness or myopia.
- In case of a (+) sign, it is used for the lens to correct far-sightedness or hyperopia.
- The next number to the right of the spherical number is $-0.50X180^0$.
- This number stands for the cylinder part of the prescription.
- The next number adjacent to the cylinder number –0.50 is x 180.
- This is referred to as 'axis 180'.

- In the next line, +2.00 represents the sphere number for the left eye. The letters DS, mean 'diopters sphere'.
- It specifies that the correction for the left eye is spherical in nature and does not have astigmatism.
- Finally, the column of near which reads ADD: +1.75 OU denotes the power that needs to be 'added' to the distance prescription for both eyes to resolve the nearness focussing problems. These 'add power' or a 'bifocal power' helps the patient for reading and close range activities.
- Therefore, from the above example, we can calculate the total power needed for single vision reading glasses.
- The prescription for reading glasses for the right eye would be: -3.0 DS – 0.50X180
- The prescription for the left eye would be: +2.0 DS = +2.0 DS
- Add BE+1.75.

Practical Exercise

Visit an eye care unit or clinic to learn the techniques of transposition of optical prescription.

Check Your Progress

A. Fill in the blanks

1. Optical prescriptions are written in _____.
2. _____ is the unit to measure the focussing power, also known as _____.
3. The letter OD stands for _____ _____, it indicates the right eye.

B. Short answer questions (30-40 words)

1. An optometrist has to give bifocal lenses to a patient. How should he/she add the 'add power'?

2. An optometrist wants to compare the present refraction with the previous prescription. What should he do?
3. What is cylinder power?
4. What does OU stand for?

C. State whether the following are True and False

1. Optical prescriptions are written without any standardised notation.
2. Spherical power has same power in all meridians.
3. In transposition, the sign of the sphere is changed.
4. The general form for writing a prescription for astigmatism is Sph + Cyl x Axis.

Session 3: Principle of Foci Meter and Types

In this session, you will learn the principle of foci meter and the types of foci meters.

Fig. 7.2: Foci meter

What is a foci meter?

A foci meter (Fig. 7.2) is an instrument which is customised to measure vertex powers and prismatic effects of the spectacle and contact lenses, to mark uncut lenses and to verify the accurate mounting of lenses in spectacle frame.

Functions of a foci meter

The functions of a foci meter are to

- check the existing spectacles of patients;
- check new eyeglasses and verify their powers;
- check the powers of lenses in the laboratory;
- facilitate the marking and setting of uncut lenses before glazing;
- measure the spherical lens power, the cylindrical power, and verify the reading addition;

- mark the actual optical centres of the lenses; and
- find the axis direction of the cylindrical lenses.

Types of foci meter

Foci meters vary according to the type of target viewed through the instrument.

Fixed ring target

An array of dots which distorts linearly according to the power of the lens viewed.

Rotating line target

The target will be observed as a line when rotated to match the cylinder axis.

Projection foci meter

Uses a screen to present an electronically generated image.

Lens meter

An automated device used to interpret the refractive power of the lens being assessed.

Neutralisation of lenses

Hand neutralisation is in use to determine the power of a lens. This type of neutralisation is time-consuming and susceptible to subjective error. Thus, foci meters are in vogue in place of hand neutralisation.

Process of hand neutralisation depends on the following principle:

While looking at an object through a lens, move the lens simultaneously to make the object appear to move too. Depending on the type of lens, the movement of the object will vary. If the chosen lens is convex, i.e., positive, the object will appear to move in the direction opposite to the direction in which the lens is moved.

This is said to be the 'against' movement; whereas if the lens is concave, i.e., negative, the object will seem to move in the direction the lens is moved or a 'with'

movement. So, when a pair of lens of equal but opposite powers is put together, there occurs zero movement of the object. This allows to measure the power of the lens. This method is used to verify spectacle correction by an optometrist.

Spectacle correction by foci meter

This is achieved through the following steps:

- A dot is placed in the lens at the optical central position.
- The lens is then placed on the lens table with the centre dot in the centre of the rest.
- Now the target is brought into focus.
- The target is displaced, as there is prism in the lens.
- The target gets displaced in the direction of the base of the prism.
- For prism base up, it gets displaced up and for prism base down it gets displaced down.
- The target gets displaced to the right for base-in prism for the right eye and base-out prism for the left eye.
- Similarly, the target is displaced to the left for base-in prism for the left eye, and base-out prism for the right eye.
- The axis ring is rotated so that the meridian cross-line cuts through the centre of the target.

Practical Exercise

Visit an eye care unit or clinic to observe the operation of a foci meter and determine the power of an unknown lens.

Check Your Progress

A. Fill in the blanks

1. Foci meters vary according to the type of _____.
2. For convex lens, the object will appear to move _____ to the direction of the lens moved.
3. Foci meter is an instrument which is customised to measure _____ and _____.

B. Short answer questions (30-40 words)

1. What is a foci meter?
2. What are the types of foci meters?
3. What is hand neutralisation?
4. How is spectacle correction done by foci meters?
5. A patient has been using spectacles and has come for correction of power. What instrument will be able to measure it and how?
6. A patient has come to the clinic after he was prescribed a spectacle correction. What procedures were carried out for the correction?

C. State whether the following are True and False

1. Foci meters measure the power of existing lens only.
2. Foci meters are never used in the laboratory.
3. There exists only one type of foci meter.
4. Hand neutralisation is a time-consuming process.

Answer Key

UNIT 1: Structure of Human Eye

Session 1: Anatomy of Human Eye

1. Cornea
2. Vitreous
3. Sclera

Session 2: Field of Vision and Dynamic Range of Human Eye

1. Field of vision
2. Mono-ocular

Session 3: Movements of Human Eye

1. Fovea centralis
2. Double vision
3. Rectus

UNIT 2: Obtaining Case History of a Patient

Session 1: Recording Medical History of a Patient

1. Patient
2. Health
3. Illness
4. Medical
5. Surgeries
6. Cataract

Session 2: Documenting a Patient's Medical History

1. Visual acuity
2. Retina
3. Glaucoma

Session 3: Integrating Medical History and Physical Examination for Treatment Plans

1. Patient
2. Blepharitis or allergy

Session 4: Assessing Functionality of a Patient's Eyes

1. Pressure of eye
2. Cornea
3. Imaging
4. Eye

UNIT 3: Common Eye Problems

Session 1: Common Eye Problems and Infections

1. Pathogens
2. Allergies
3. Eye lids
4. Conjunctivitis

Session 2: Symptoms of Common Eye Problems

1. Nearby
2. Tears

Session 3: Eye Injuries

1. Accidental
2. Mechanical

3. Source
4. Traumatic

UNIT 4: Measuring Visual Acuity

Session 1: Meaning of Visual Acuity

1. Ametropia
2. Myopia or hypermetropia

Session 2: Process of Measuring Visual Acuity

1. 6 metres
2. Occluder

UNIT 5: Basic Visual Assessment

Session 2: Basic Examination for Eye Diseases

1. Visual field testing
2. Phoroptor
3. Objective refraction

Session 3: Eye Examination

1. Colour vision

Session 4: Visual Assessment of the Eye

2. Ophthalmoscopy
3. +13 D

UNIT 6: Assessing Refractive Status

Session 1: Meaning of Refractive Status and Refraction

1. Keratometer
2. Automated-refractor, eye

Session 2: Process of Retinoscopy

1. Static
2. Book retinoscopy
3. Retinoscope

Session 3: Operation of Auto-refractometer

1. Automated-refractometer
2. Cycloplegic, proparacaine

UNIT 7: Spectacles, Optical Prescription and Contact Lenses

Session 1: Reasons for Vision Disorders

1. Corneal curvature, lens index
2. Distance, intermediate, near
3. Optical correction, defective
4. Convex
5. Optical, Dioptre

Session 2: Optical Prescription Notation

1. Standard format
2. D, Dioptre
3. Oculus dexter

Session 3: Principle of Foci Meter and Types

1. Target viewed
2. Opposite
3. Vertex power, prismatic effects

GLOSSARY

Aaberrometer: *A device that can identify common and more obscure vision errors by measuring the way light waves travel through the eye's optical system.*

Accident Prevention: *The systematic application of recognised principles to reduce incidents, accidents, or the accident potential of a system or organisation.*

Acetate: *Type of plastic often used in eyeglass frames.*

Accommodation disorder: *It refers to the eye's ability to automatically change focus from seeing at a distance to seeing at near. Accommodation disorders have a variety of causes. Symptoms include blurred vision, double vision, eye strain, headache, fatigue and difficulty concentrating (particularly while reading). Presbyopia is an accommodation disorder that affects everyone if they become old enough, since its causes relate to the aging of the eyes.*

Acute Effect: *A change that occurs in the body within a relatively short time (minutes, hours, days) following exposure to a substance.*

Acute Exposure: *A single exposure to a hazardous agent.*

Area Sampling: *Collection and analysis of representative samples of air in general work areas in order to determine the concentrations of any contaminants that are present.*

Bifocal: *Lens with one segment for near vision and one segment for far vision. The term 'bifocal' can apply to both eyeglass lenses and contact lenses.*

Binocular vision: *Ability of both eyes to work together to achieve proper focus, depth perception and range of vision.*

Biological Agent: *Any living organism (for example, virus or bacteria) that affects the body, a part of the body, or any of its functions. The effects may be beneficial or harmful.*

Blind Spot: *The beginning of the optic nerve in the retina is called the optic nerve head or optic disc. Since there are no photoreceptors (cones and rods) in the optic nerve head, this area of the retina cannot respond to light stimulation. As a result, it is known as the "blind spot," and everybody has one in each eye.*

Cataract: *Clouding of the natural lens of the eye, usually caused by aging in conjunction with other risk factors, such as exposure to the sun's UV rays, smoking, steroid intake and diabetes. Symptoms include blurred vision, glare, halos around lights, colours that are less bright, a cloudy spot in your vision and, sometimes, temporary vision improvement. Read more about cataracts.*

Chemical Agent: *A chemical substance that affects the body, a part of the body, or any of its functions. The effects may be beneficial or harmful.*

Chronic Effect: *A change that occurs in the body over a relatively long time (weeks, months, years) following repeated exposure or a single over exposure to a substance.*

Chronic Exposure: *Repeated exposure to a hazardous agent.*

Ciliary Body: *An annular (ring-like) structure on the inner surface of the anterior wall of the eyeball, contained within the uveal tract and composed largely of the ciliary muscle and bearing the ciliary processes.*

Dust: *Fine particles of a solid that can remain suspended in air. The particle size of a dust is larger than that of a fume.*

Ergonomics: *An applied science that studies the interaction between people and the work environment. It focuses on matching the job to the worker.*

Fovea: *In the human eye the term fovea (or fovea centralis) is the "pit" in the retina that allows for maximum acuity of vision. The human fovea has a diameter of about 1.0 mm with a high concentration of cone photoreceptors.*

Fume: *Finely divided solid particles that are formed when a hot metal vapour cools and condenses.*

Hazard: *The potential of any machine, equipment, process, material (including biological and chemical) or physical factor that may cause harm to people, or damage to property or the environment.*

Hazardous Material: *Any substance that may produce adverse health and/or safety effects to people or the environment.*

Health: *The World Health Organization has defined health as more than just the absence of disease. Rather, it is a state of complete physical, mental and social well being.*

Ingestion: *The swallowing of a substance.*

Inhalation: *The breathing in of an airborne gas, vapour, fume, mist or dust.*

Injection: *To force or drive liquid or gas into the body*

Iris: *The opaque muscular contractile diaphragm that is suspended in the aqueous humor in front of the lens of the eye; perforated by the pupil and continuous peripherally with the ciliary body; possesses a deeply pigmented posterior surface, which excludes the passage of light except through the pupil, and a coloured anterior surface which determines the colour of the eye*

Limbus: *Junction between the cornea and the sclera*

Macula: *The most sensitive part of the central retina, responsible for visual acuity and colour vision.*

Reducing Agent: *A substance that accepts oxygen or gives up hydrogen during a chemical reaction.*

Risk: *The probability of a worker suffering an injury or health problem, or of damage occurring to property or the environment as a result of exposure to or contact with a hazard.*

Sampling: *The process of taking small representative quantities of a gas, liquid, or solid for the purpose of analysis.*

Solvent: *A substance that dissolves other substances. Many solvents are flammable.*

Substitution: *The replacement of toxic or hazardous materials, equipment or processes with those that are less harmful.*

Toxic: *Harmful or poisonous.*

NOTES

List of Credits

Vijay Anand Joshi

Unit 1

Fig.1.5

Unit 4

Fig.4.4

Unit 5

Fig.5.1, Fig.5.2, Fig.5.3

Unit 6

Fig.6.5

Chetanya Koli

Unit 2

Fig. 2.1

JP Government Hospital, Bhopal

Unit 5

Fig 5.5, 5.6, 5.7

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Unit 1

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Unit 7

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