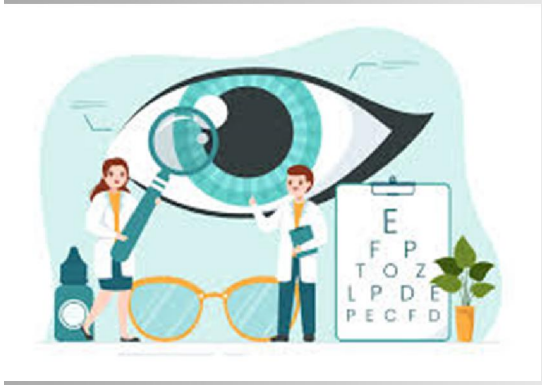


UNIT 4: OPHTHALMIC DIAGNOSTIC PROCEDURES

HEMANGINI PARMAR
BIOMEDICAL DEPARTMENT
GP, AHMEDABAD

COURSE OUTCOME:

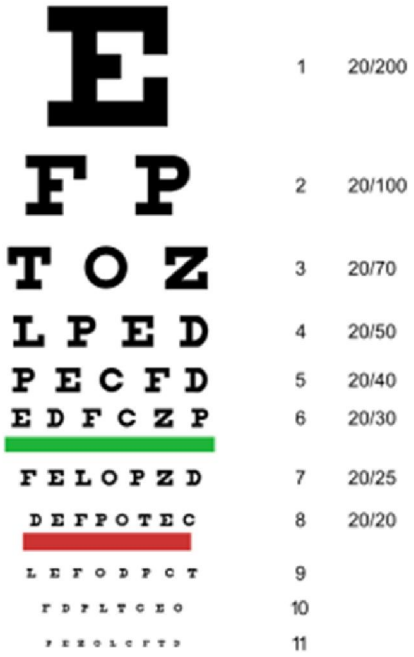
- Demonstrate different type of ophthalmic instruments

UNIT OUTCOMES:

- 4a. Elaborate visual acuity in detail.
- 4b. Explain procedure of optical coherence tomography.
- 4c. Classify different wave of ERG.
- 4d. Describe fluorescein angiography.
- 4e. Identify different part of slit lamp.

VISUAL ACTUITY

- Visual acuity is a measure of the clarity or sharpness of vision.
- It quantifies the ability of an individual to discern fine details and distinguish objects at a specific distance.
- Typically, visual acuity is assessed by reading letters or symbols of varying sizes from a standardized eye chart, such as the Snellen chart.



A typical Snellen chart that is frequently used for visual far acuity testing

https://en.wikipedia.org/wiki/Visual_acuity

VISUAL ACTUITY

- The Snellen chart, for example, consists of letters arranged in rows, with each row corresponding to a specific visual acuity level.
- The letters become progressively smaller as you move down the chart. Visual acuity is expressed as a fraction, with the numerator indicating the distance at which the test is performed (usually 20 feet or 6 meters), and the denominator representing the distance at which a person with normal vision can read the same line.
- For instance, if a person has 20/20 vision, it means they can read at 20 feet what a person with normal vision can read at 20 feet. If a person has 20/40 vision, it means they can only read at 20 feet what a person with normal vision can read at 40 feet. In other words, their vision is less sharp, and they require objects to be closer to see them clearly.

VISUAL ACTUITY

- Visual acuity is influenced by various factors, including the health of the eye's structures, such as the cornea, lens, and retina, as well as conditions like refractive errors (e.g., nearsightedness, farsightedness, astigmatism), cataracts, and retinal diseases.
- Assessing visual acuity is an essential part of routine eye examinations and is crucial for diagnosing and monitoring vision-related conditions.

VISUAL ACTUITY TEST

- The visual acuity test is a common procedure used to measure the sharpness of a person's vision. It's typically performed as part of a routine eye examination by healthcare professionals, including optometrists and ophthalmologists.
- The test helps assess how well a person can see and whether corrective measures, such as glasses or contact lenses, are needed.

Here's a general overview of how the visual acuity test is conducted:

- **Preparation**: The person undergoing the test is positioned at a specific distance from an eye chart, typically 20 feet (6 meters) away, although sometimes the test may be conducted at a shorter distance, such as 10 feet (3 meters) for children.
- **Eye Covering**: If testing one eye at a time, the other eye is covered with an occluder or patch to prevent it from contributing to the results.

VISUAL ACTUITY TEST

- **Eye Chart**: The most commonly used eye chart is the Snellen chart, which consists of rows of letters or symbols of different sizes. Each row represents a different level of visual acuity, with the letters becoming progressively smaller from top to bottom.
- **Testing**: The person is asked to read aloud the letters or symbols on the chart, starting from the top row and moving down. The examiner notes the smallest line of letters that the person can accurately read.
- **Recording Results**: Visual acuity is typically expressed as a fraction, with the first number representing the testing distance and the second number indicating the distance at which a person with normal vision could read the same line. For example, 20/20 vision means the person can read at 20 feet what a person with normal vision can read at 20 feet. If a person's vision is 20/40, it means they can only read at 20 feet what a person with normal vision can read at 40 feet.
- **Repeat**: The test may be repeated for the other eye if necessary.

OPTICAL COHERENCE TOMOGRAPHY

- Optical Coherence Tomography (OCT) is a non-invasive imaging technique used in ophthalmology to obtain high-resolution cross-sectional images of the retina, optic nerve head, and anterior segment of the eye.
- It provides detailed information about the microstructure of ocular tissues, aiding in the diagnosis, monitoring, and management of various eye conditions.

OPTICAL COHERENCE TOMOGRAPHY

Healthcare providers use OCT to diagnose and manage several conditions that affect the eyes, including:

- Glaucoma: If you have glaucoma, fluid and pressure build up in your eye and damage your optic nerve.
- Age-related macular degeneration: People may lose central vision with this condition. It's a progressive disease related to aging but, fortunately, treatments are available for some forms.
- Diabetes-related retinopathy: Diabetes damages the small blood vessels of your eye leading to vision loss. Fluid can leak out of your eye causing blurry vision. In severe forms, your entire retina can detach from the back of your eye and glaucoma may develop. People can become completely blind, but with treatment, diabetes-related retinopathy can be controlled.

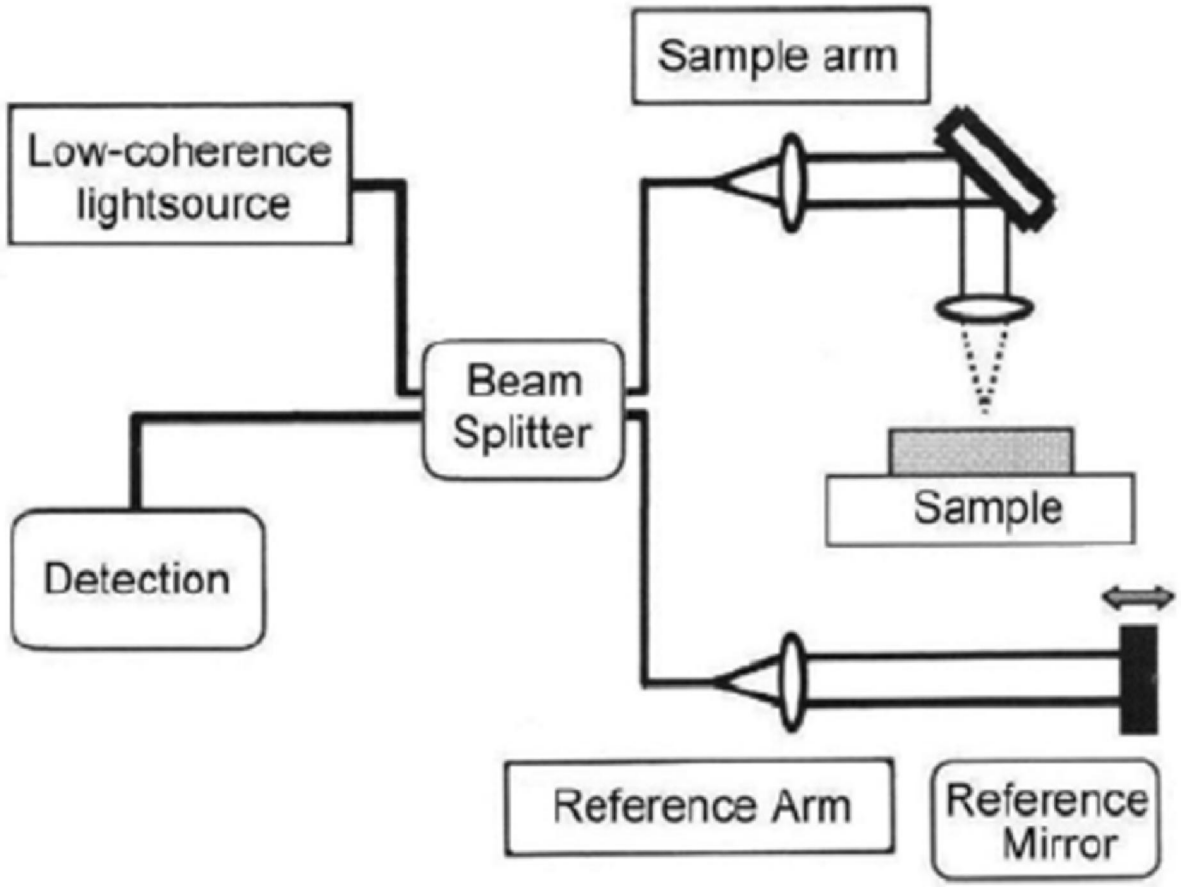
OPTICAL COHERENCE TOMOGRAPHY

- Cystoid macular edema: Macular edema refers to the swelling of your macula with fluid. Your macula is the part of your retina that has the most light-sensing cells.
- Macular pucker: Scar tissue can grow over the surface of your retina causing distorted vision. Surgery can sometimes help.
- Macular hole: A macular hole happens when your retina pulls apart forming a hole in your macula. This can affect your vision, but can be repaired by surgery.
- **Cone and cone-rod dystrophies:** These conditions affect the cells of your eyes that are sensitive to light and color. When the condition worsens, you can have vision loss.
- **Tumors in your choroid and retina:** These cancers happen in your retina and your choroid, a vascular layer found between your retina and your sclera.

PRINCIPLE OF OCT

- The Principle of OCT, or Optical Coherence Tomography, lies in its ability to provide high-resolution, cross-sectional images of biological tissues using light waves. By measuring the echo time delay and magnitude of backscattered light, OCT generates detailed images of tissue microstructure, making it valuable in various medical fields such as ophthalmology, cardiology, and dermatology. This non-invasive imaging technique aids in diagnosis, monitoring disease progression, and guiding therapeutic interventions with its capability to visualize tissue layers and abnormalities at the micron level.
-

COMPONENT OF OCT



A simplified schematic of Time domain (TD-OCT)

https://www.researchgate.net/figure/A-simplified-schematic-of-Time-domain-TD-OCT_fig4_274383296

COMPONENT OF OCT

- Light Source: OCT systems use broadband light sources such as super luminescent diodes or femtosecond lasers to provide high axial resolution.
- Beam Splitter and Interferometer: The beam splitter directs light into the sample arm and reference arm of the interferometer.
- Sample Arm: In ophthalmic OCT, the sample arm delivers light to the eye, and the backscattered light from different layers of the retina is collected.
- Reference Arm: This arm directs light to a reference mirror, generating the reference beam.
- Detector: The detector records the interference pattern, which is then processed to form the OCT image.

ADVANTAGES OF OCT

- Non-invasive: OCT imaging does not require direct contact with the eye, making it comfortable for patients.
- High Resolution: OCT provides high-resolution cross-sectional images, enabling detailed visualization of tissue layers.
- Real-time Imaging: OCT allows real-time imaging of ocular structures, facilitating immediate diagnosis and treatment planning.
- Quantitative Analysis: OCT provides quantitative measurements of tissue thickness and morphology, aiding in disease monitoring and treatment evaluation.

ERG: ELECTRORETINOGRAM

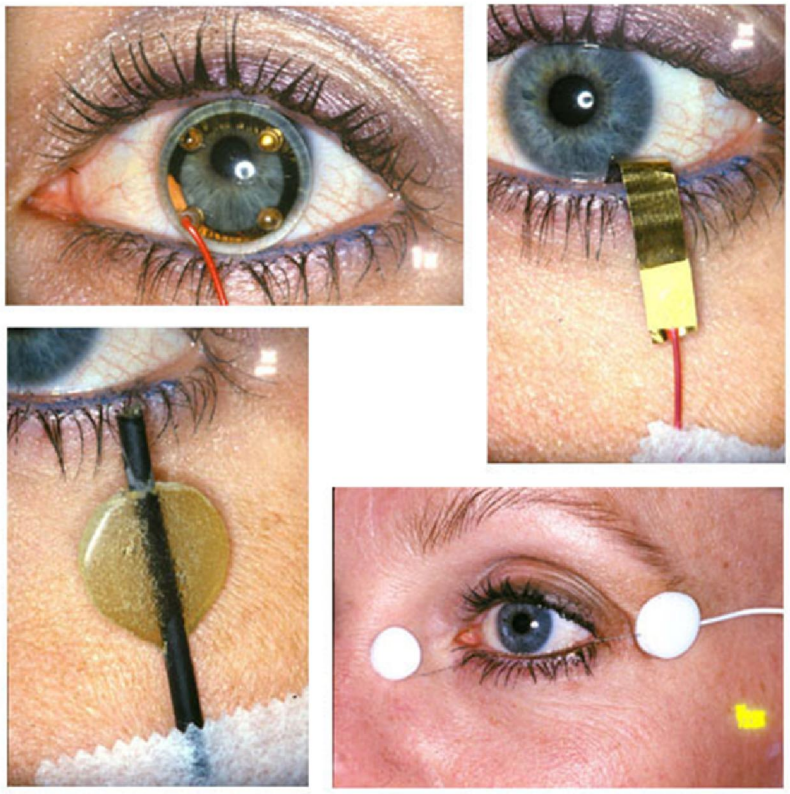
- The Electroretinogram (ERG) is a diagnostic test that measures the electrical activity of the retina in response to light stimulation.
- ERG responses can be classified into several different waves based on their timing and morphology. Here are the main waves typically observed in an ERG recording.
  - a wave
  - b wave
  - c wave
  - d wave

ELECTRODE PLACEMENT

- Typically, ERG involves the use of several electrodes placed strategically around the eye to measure the response of different retinal areas.
- **Active Electrode**: The active electrode, also known as the corneal electrode, is usually a small contact lens or a conductive fiber loop placed on the cornea. It measures the electrical responses directly from the retina.
- **Reference Electrode**: It is typically placed on the surface of the skin near the eye, such as the temple or forehead.
- **Ground Electrode**: It is usually placed on a non-ocular area with good electrical conductivity, such as the forehead or earlobe.

electrodes placement in ERG

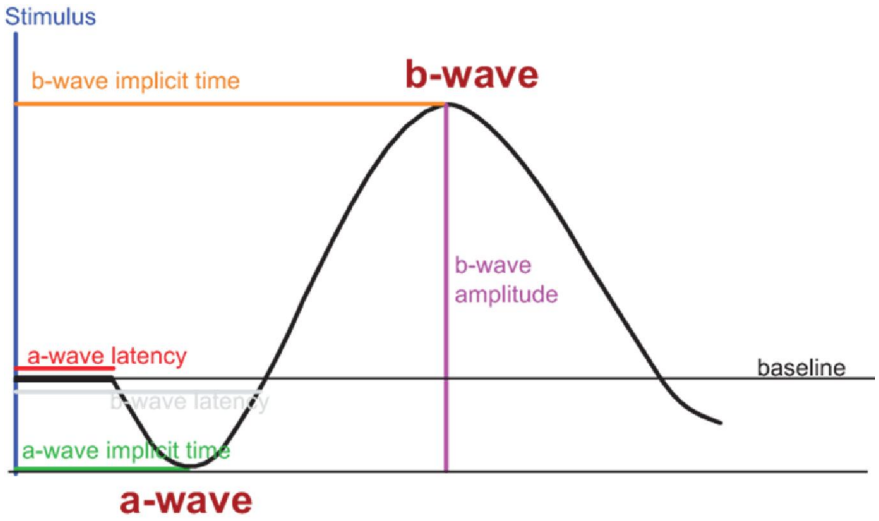
ELECTRODE PLACEMENT



some corneal ERG electrodes

ERG: ELECTRORETINOGRAM

- The a-wave of the electroretinogram reflects the activity of photoreceptors; the b-wave indicates the activity of the amacrine, horizontal, bipolar, and Müller cells.
- implicit time refers to the time occurring between the initiation of the light stimulation (flash) and the peak of a-and b-waves.
- The a-wave amplitude was measured from baseline to a-wave trough; the b-wave amplitude was measured from a-wave trough to b-wave peak.



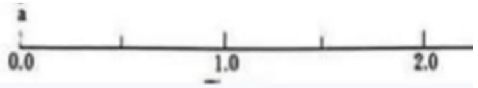
ERG: ELECTRORETINOGRAM

a-wave: initial corneal-negative deflection, derived from the cones and rods of the outer photoreceptor layers

b-wave: corneal-positive deflection; derived from the inner retina, predominantly Muller and ON-bipolar cells

c-wave: derived from the retinal pigment epithelium and photoreceptors

d-wave: off bipolar cells.



Dark adapted **Oscillatory potentials**: Responses primarily from the amacrine cells/inner retina.

Latency of response refers to the onset of the stimulus to the beginning of the a-wave.

Implicit time or peak time is a measure of the time interval from onset of the stimulus to the peak of the b-wave

FLUORESCEIN ANGIOGRAPHY

- Fluorescein angiography (FA) is a diagnostic imaging technique used to visualize the blood circulation within the retina, choroid, and optic nerve head. It involves the intravenous injection of a fluorescent dye called fluorescein sodium, which quickly circulates through the bloodstream and highlights the blood vessels in the back of the eye when illuminated with a specialized blue light.

A normal FA

FLUORESCEIN ANGIOGRAPHY

- Fluorescein angiography (FA) is a diagnostic imaging technique used to visualize the blood circulation within the retina, choroid, and optic nerve head. It involves the intravenous injection of a fluorescent dye called fluorescein sodium, which quickly circulates through the bloodstream and highlights the blood vessels in the back of the eye when illuminated with a specialized blue light.

A normal FA

USE OF FA

Here is a list of some common indications for performing fluorescein angiography:

- **Diabetic Retinopathy**: FA is valuable in evaluating the extent and severity of diabetic retinopathy, including the presence of microaneurysms, capillary non-perfusion, neovascularization, and macular edema.
- **Age-Related Macular Degeneration (AMD)**: FA helps in characterizing the type of AMD, distinguishing between dry and wet forms. It aids in detecting choroidal neovascularization (CNV), assessing its activity, and guiding treatment decisions.
- **Optic Disc Evaluation**: FA assists in assessing the circulation of the optic nerve head, identifying optic disc edema, and detecting abnormalities such as optic disc neovascularization.
- **Evaluation of Trauma**: FA may be used to assess the extent of vascular damage and identify areas of retinal ischemia following ocular trauma or injury.

PROCEDURE FOR FA

Here's a step-by-step description of the fluorescein angiography procedure:

- **Preparation**: Before the procedure, the patient's medical history is reviewed to check for any allergies or contraindications to fluorescein dye. The patient's pupils are typically dilated using eye drops to allow for better visualization of the retina.
- **Injection of Fluorescein**: The patient is seated comfortably, and a small needle is used to inject a small amount of fluorescein dye into a vein, usually in the arm. The dye is rapidly circulated throughout the body, including the blood vessels in the eye.
- **Image Acquisition**: As the dye reaches the eye, a specialized fundus camera equipped with filters to capture fluorescent light is used to take a series of rapid-fire photographs or videos of the retina. The camera captures images at specific time intervals to track the dye as it flows through the retinal circulation.

PROCEDURE FOR FA

- **Image Analysis**: The images obtained during fluorescein angiography are then analyzed by an ophthalmologist or trained technician. They look for abnormalities in the blood vessels, such as leakage, blockages, or abnormal growth patterns, which may indicate various eye conditions such as diabetic retinopathy, macular degeneration, retinal vein occlusion, or choroidal neovascularization.
- **Post-Procedure**: After the procedure, the patient's eyes may be sensitive to light due to pupil dilation. It is advised to wear sunglasses when leaving the clinic to protect the eyes from bright light. Some patients may experience temporary yellowish discoloration of the skin due to the excretion of the dye through the kidneys, which is harmless and resolves within a day or two.

REFRACTIVE INSTRUMENTS

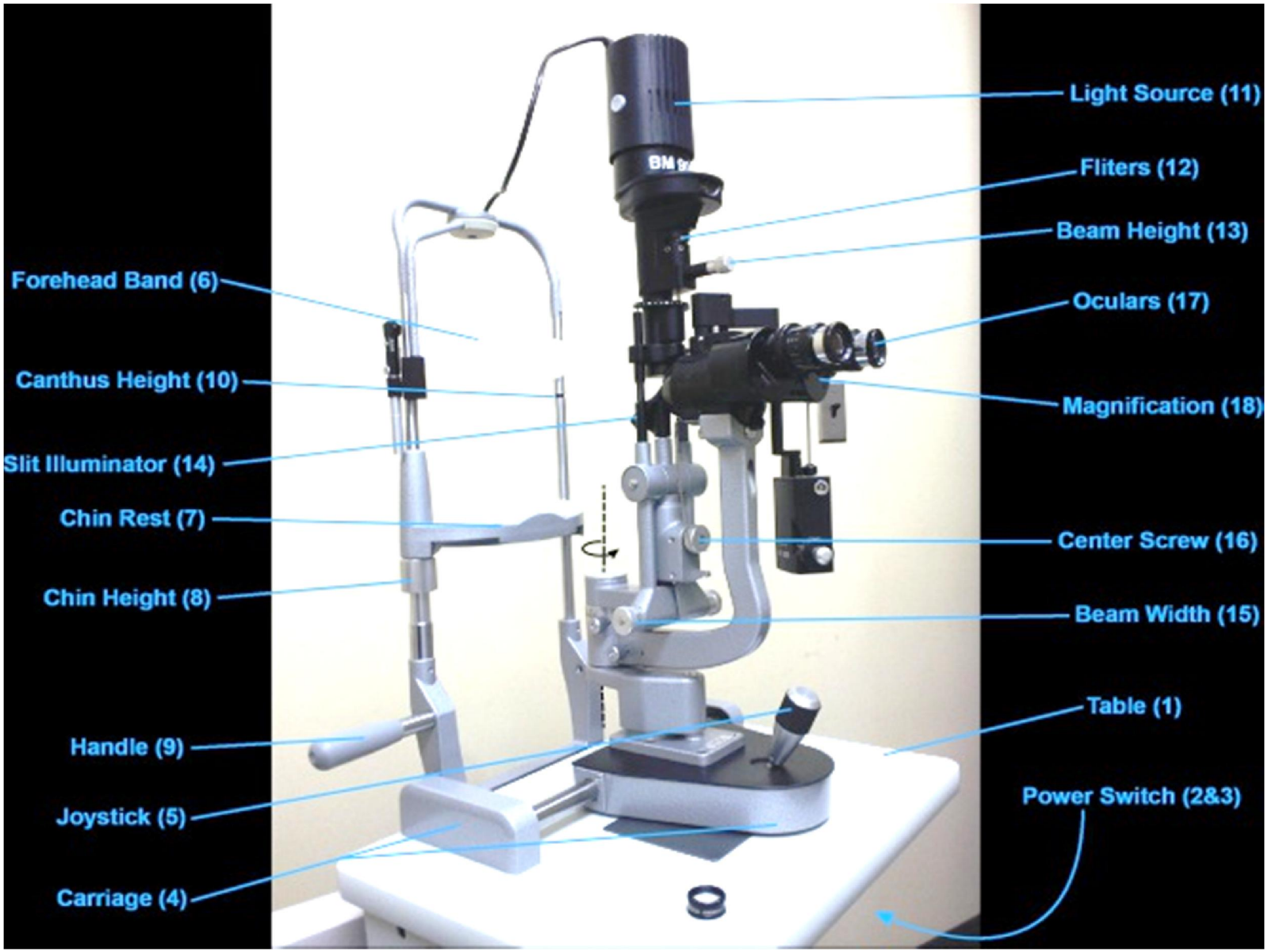
- Refractive instruments are tools used in optometry and ophthalmology to measure and correct refractive errors of the eye, such as myopia (nearsightedness), hyperopia (farsightedness), astigmatism, and presbyopia. These instruments help eye care professionals determine the appropriate prescription for corrective lenses (glasses or contact lenses) to improve visual acuity. Some common refractive instruments include:

1. **Phoropter**
2. **Autorefractor**
3. **Retinoscope**
4. **Keratometer**
5. **Topographer**

SLIT LAMP

- The slit lamp ophthalmoscope is a specialized tool used in ophthalmology to provide a magnified view of the eye's anterior segment.
- It consists of a binocular microscope and a high-intensity light source that can be focused to shine as a thin sheet of light onto the eye.
- This allows for a detailed examination of the cornea, iris, lens, and anterior chamber, aiding in the diagnosis and management of various eye conditions. The lamp facilitates an examination which looks at anterior segment, or frontal structures, of the
- human eye, which includes the:-
  - Eyelid
  - Cornea
  - Sclera
  - Conjunctiva
  - Iris
  - Aqueous
  - Natural crystalline lens
  - Anterior vitreous

SLIT LAMP


Light Source (11)
Fliters (12)
Beam Height (13)
Oculars (17)
Magnification (18)
Center Screw (16)
Beam Width (15)
Table (1)
Power Switch (2&3)
Forehead Band (6)
Canthus Height (10)
Slit Illuminator (14)
Chin Rest (7)
Chin Height (8)
Handle (9)
Joystick (5)
Carriage (4)

SLIT LAMP

A . Slit Lamp Base

- 1. Adjustable table
- 2. Power switch
- 3. Intensity Rheostat
- 4. Locking carriage (for coarse X-Y plane)
- 5. Joystick (for fine X-Y, as well as Z)

B. Patient Support Frame

- 6. Forehead Band
- 7. Chin rest
- 8. Chin height adjustment knob
- 9. Patient Handles
- 10. Canthus Height Indicator

C. Illumination Arm (on swivel)

- 11. Light Source
- 12. Illumination filters
- 13. Beam Height Adjustment
- 14. Slit illuminator
- 15. Beam width adjustment
- 16. Center screw

D. Viewing arm (on swivel)

- 17. Oculars
- 18. Magnification control knob

SLIT LAMP

- **Base**: The base of the slit lamp provides stability and support for the entire instrument. It is typically mounted on a table or stand and may include controls for adjusting the height and angle of the instrument.
- **Chin Rest**: The chin rest is a padded platform located at the front of the slit lamp. It helps the patient stabilize their head and maintain the proper position during the examination by resting their chin on it.
- **Headrest**: The headrest is an adjustable support that provides additional stability for the patient's forehead or temple. It helps ensure that the patient's head remains steady and aligned with the instrument's optical axis during the examination.
- **Binocular Microscope**: The binocular microscope is the main optical component of the slit lamp. It consists of two eyepieces (oculars) that allow the examiner to view the magnified image of the eye. The microscope can be adjusted for interpupillary distance and diopter correction to accommodate different users.

SLIT LAMP

- **Slit Lamp Illumination**: The slit lamp illumination system consists of a bright light source, typically a halogen or LED lamp, that produces a narrow beam of light. The intensity and angle of the light beam can be adjusted using controls on the instrument. Filters may also be used to modify the color and characteristics of the light.
- **Slit Beam Aperture**: The slit beam aperture is a mechanical diaphragm located within the illumination system that controls the size and shape of the light beam. It can be adjusted to produce a thin slit of light in various orientations, allowing the examiner to illuminate specific areas of the eye.
- **Slit Beam Width and Height Controls**: These controls allow the examiner to adjust the width and height of the slit beam aperture, thereby controlling the size and shape of the illuminated area on the eye.
- **Joystick or Control Handles**: These handles allow the examiner to move and position the slit lamp, as well as adjust the focus and alignment of the microscope and illumination system.
- **Filters**: Slit lamps often feature interchangeable filters that can be inserted into the illumination system to enhance contrast, reduce glare, or visualize specific structures within the eye, such as blood vessels or abnormalities in the cornea.

PRINCIPLE OF SLIT LAMP

- The principle of a slit lamp ophthalmoscope revolves around the use of a high-intensity light source, a microscope, and a slit mechanism to provide a detailed examination of the anterior segment of the eye.
- The slit lamp ophthalmoscope operates by combining a controllable light source, a binocular microscope, and an adjustable slit mechanism to enable precise examination of the anterior segment of the eye. This tool's flexibility and functionality make it indispensable for ophthalmic professionals in routine eye care and disease diagnosis.
- The principle behind the slit lamp ophthalmoscope lies in its ability to illuminate and visualize the structures of the eye in detail, aiding in the diagnosis and treatment of various eye disorders.

APPLICATION OF SLIT LAMP

Here are some key applications:-

- 1. Routine Eye Examinations:-

• Slit lamps are commonly used in routine eye examinations to assess the overall health of the eye, identify refractive errors, and detect any abnormalities or diseases.

- 2. Contact Lens Fitting:-

Eye care professionals use slit lamps to examine the fit of contact lenses and assess the health of the cornea.

- 3. Glaucoma Evaluation:-

The instrument is valuable for evaluating the drainage angle of the eye and assessing the optic nerve head, aiding in the diagnosis and management of glaucoma.

- 4. Anterior Segment Imaging:-

Slit lamps can be equipped with imaging devices for capturing photographs or video of the anterior segment, assisting in documentation and monitoring of eye conditions.

REFERENCES

- https://www.healthline.com/health/visual-acuity-test#results
- https://en.wikipedia.org/wiki/Visual_acuity
- https://www.aao.org/eye-health/treatments/what-is-optical-coherence-tomography
- https://en.wikipedia.org/wiki/Optical_coherence_tomography
- https://www.slideshare.net/shirishaguguloth5/electroretinogram-erg
- https://webvision.med.utah.edu/book/electrophysiology/the-electroretinogram-clinical-applications/
- https://eyeguru.org/essentials/fluorescein-angiography/
- https://classroom.google.com/u/1/g/tg/NjUzNTEwNzIzMzcx/NjU4OTY2MjcxODc3#u=NTMwNDc5Njc1Nzgy&t=f