Technology of Ophthalmic Devices

Prepared by

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Acknowledgments

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توصيف مقرر دراسى

1- بيانات المقرر		
الرمز الكودى :	**اسم المقرر : تكنولوجيا الاجهزة البصرية** **Technology of optical instruments**	**الفرقة /المستوى : التانية**
التخصص :بصريات	**عدد الوحدات الدراسية : نظرى 3 عملي 12**	

2- هدف المقرر:	**This course will provide the student with the basic knowledge regarding the optical instruments, structure and operation.**
3- المستهدف من تدريس المقرر :	
ا. المعلومات والمفاهيم :	**By the end of this course the student will be able to:** • Identify basic principles of different optical instruments. • Recognize the construction of optical instruments. • Explain the operation of the optical instruments. • Discuss the output results of each instrument. • Describe the method of measurements of the optical instruments. • Identify vision defects using different instruments. • Identify the importance of each instrument.
ب- المهارات الذهنية :	**By the end of this course the student will be able to:** • Differentiate between the different optical instruments. • Achieve the safety of operation of each instrument. • Interpret the vision defects.
ج- المهارات المهنية الخاصة بالمقرر:	**By the end of this course the student will be able to:** • Perform basic technical skills of measuring visual acuity test. • Assess ocular alignment and motility, eye movement, hyperopia, myopia, astigmatism, presbyopia, aphakia, visual field, intraocular pressure measurement. • Apply the basic concept of dedicated visual defects. • Apply the basic equations of geometric optics relevant to the optical instruments. • Apply the general principles of safety. • Demonstrate the general vision defects.
د- المهارات العامة :	**By the end of this course the student will be able to:** • Achieve oral and/or written reports about the different instruments • Communicate effectively with patient, family and health care team
4- محتوى المقرر:	**The course of optical instruments includes:** **the construction , operation, measuring the vision defects for all of the following equipment:** • Retinoscopy • ophthalmoscope • telescope • microscopes • slit-lamp • fundus camera • refractor meters • Keratometer • Gonioscopy • Focimeter • orthoptic instruments

• optical pachometer • The Optical Coherence Tomography • Autorefractometers • Phoropter • P.D meter • IOL master • Pentacam	

1- lectures 2- Small group teaching. 3- Case scenarios. 4- Teaching videos. 5- Clinical hands on.	**5- أساليب التعليم والتعلم**
Not applicable	**6- أساليب التعليم والتعلم للطلاب ذوى القدرات المحدودة**
	7- تقويم الطلاب :
Quizzes Mid -term exam Oral exam final exam	**أ- الأساليب المستخدمة**
Quizzes (3rd , 8th, 12th, week) Mid -term exam 6th week Final practical exam 14th week Final written exam 15th week	**ب- التوقيت**
Quizzes(10 marks) Mid -term exam(20 marks) Final practical exam(30 marks) final exam(90 marks)	**ج- توزيع الدرجات**
	8- قائمة الكتب الدراسية والمراجع :
• Basics of the optical instruments	**أ- مذكرات**

• basic ophthalmology , harper r.a. , ed (2010) • the eye exam and basic ophthalming instruments by lewis RS (2007) • the ophthalmic assistant by STEIN HA, STEIN RM	**ب- كتب ملزمة**
• OPTHALMIC MEDICAL BY Emanuel Newmark , MD,FACS MARV A. O HARA ,MD,FACS,FAAP	**ج- كتب مقترحة**
----------	**د- دوريات علمية أو نشرات ..... الخ**

Contents

Course Description

This course will provide the student with the basic knowledge regarding the optical instruments, structure and operation.

Core Knowledge

By the end of this course, students should be able to:

- Identify basic principles of different optical instruments.
- Recognize the construction of optical instruments.
- Explain the operation of the optical instruments.
- Discuss the output results of each instrument.
- Describe the method of measurements of the optical instruments.
- Identify vision defects using different instruments.
- Identify the importance of each instrument.

Core Skills

By the end of this course, students should be able to:

- Differentiate between the different optical instruments.
- Achieve the safety of operation of each instrument.

Course Overview

		Methods of Teaching/Training with Number of Total Hours per Topic				
ID	**Topics**	**Interactive Lecture**	**Field Work**	**Class Assignments**	**Research**	**Lab**
1	**Anterior Segment Examination**	9	9	9	9	18
2	**Posterior Segment Examination**	9			9	18
3	**Refraction and Strabismus Equipment**	9	9		9	18
4	**Advanced optical instruments**	9		9	9	18
TOTAL HOURS (180)		**36**	18	**18**	36	72

Chapter 1
Anterior Segment Examination

Sections

- **The Slit-lamp**
- **Tonometry and Gonioscopy**
- **Keratometer**

Introduction

This book will give you an introduction about the instruments used in an outpatient department on a daily basis. An ophthalmic technician should be able to identify instruments, the purpose it is used for and how to maintain them. Good maintenance of the instruments prolongs its life and helps in obtaining accurate data from patients. In this chapter we will discuss the equipment used for anterior segment examination

The Slit-lamp

Slit lamp is an instrument used to study the anterior segment of the eye under magnification (Figure 1).

Figure 1 - Slit Lamp

❖ **Purpose**

1. The slit lamp microscope enables the observer to view binocularly eyelids, lashes, conjunctiva, sclera, cornea, anterior chamber, iris, lens and the anterior portion of vitreous and permits the detection of the disease in these areas.
2. It allows the examination of the anterior chamber angle structures, using a goniolens.
3. It helps to view the fundus using either 90 D, or 78 D lens.
4. The attachment of an applanation tonometer enables the measurement of intra ocular pressure
5. It is used to deliver laser treatment to both the anterior and posterior segments of the eye.

❖ **Description of the instrument**

➢ It consists of three major components

1. An ***illuminating system*** consists of light source, mirrors and prisms.
2. ***Magnification system*** consists of the biomicroscope
3. ***Mechanical system*** consists of
   - *Chin rest* mounted on a vertical stand for placing the patient's chin in correct position. The height of the chin rest is adjusted manually to bring the chin rest to the level of the patient's chin
   - A *head rest* with a head band is available for securing the patients head to the stand if necessary.
   - A *joystick* is provided to move the illuminating system and the microscope together up or down, left or right, forward or backward as needed during observation.

- The bulbs used in the illuminating system are of low voltage and a suitable transformer is provided with the slit lamp.
- It is always advisable to use the transformer in its lowest setting for most of the observation and to use a higher setting for a brief period for a detailed examination.

❖ **Care**

- The slit lamp should to be located in a place easily accessible to the ophthalmologist in the examination room.
- An electrical plug point should be available near the equipment.
- The connecting wire should not be in the path of the patients or staff.
- Remove the dust and clean the slit lamp daily.
- When not in use keep the equipment covered with the dust cover.

- When the ophthalmologist examines an infected case such as a corneal ulcer or conjunctivitis, clean the head band and the parts touched by the operator and patient in the slit lamp with a clean cloth using alcohol or other volatile disinfectants.

❖ **Maintenance**

1. The instrument can be cleaned with a soft clean cloth.
2. The slit lamp has a locking device that should be engaged when the examination is completed. If the slit lamp table is suddenly jerked and the slit lamp is not locked, it could be damaged.
3. The chin rest and hand rest should be wiped with an alcohol wipe between patients.
4. Never touch the mirror of a slit lamp because fingerprints will prevent full illumination and damage the mercury coating.
5. The slit lamp is to be thoroughly examined and cleaned properly by the instrument maintenance department or the assistants.
6. Handle the equipment with care, as it is costly.

The instruments used in measurement of intra ocular pressure are;

1. Schiotz tonometry
2. Applanation tonometry
3. Non-Contact Tonometer (Air-Puff tononmeter)

❖ **Schiotz Tonometry**

➢ Simple, portable, inexpensive instrument used in the measurement of IOP (Figure 2).

➢ **Principle**

- Schiotz indentation tonometry relies on the principle of indentation in which a plunger with a preset weight indents the cornea.

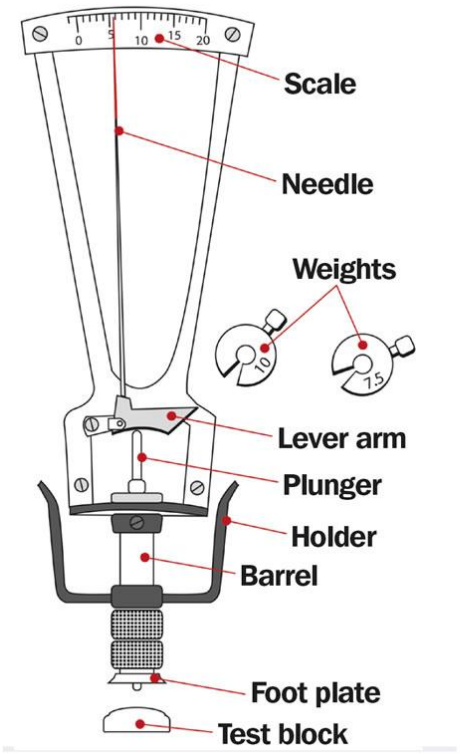

Figure 2 - Schiotz Tonometer

- **Parts of the Schiotz tonometer (Figure 2)**
  - Handle for holding the instrument in vertical position on the cornea
  - Foot plate which rests on the cornea
  - Plunger which move freely within the shaft in the foot plate
  - A bent lever whose short arm rests on the upper end of the plunger and a long arm acts as a pointer needle.
  - Scale
  - Weights 5.5 gm is fixed to the plunger. Extra weights 7.5 and 10 gms are also with the instrument.

- **Measurement**
  - **T**he weight rests on the plunger, and attached to it is a pointer needle and scale for measurement.
  - The tonometer is placed on the cornea; a reading is taken from the scale.
  - The number is converted to millimeters of mercury (mm Hg) by using a conversion card.

- **Care:**
  - The instrument should be kept carefully clean.
  - Calibration should be tested before using - A test block is provided with each tonometer. The tonometer is held perpendicular to the test block, and when placed on the block the needle should align at zero position. There is a nut screw on tonometer that can be loosened so that needle can be set back to zero.
  - Never bend the needle to scale the instrument at zero.
  - Adding or subtracting from the reading to allow for needle misalignment is incorrect.

- **Maintenance and Sterilization of Schiotz tonometer**
  - Keep the instrument covered within the case while not in use

- After measurement, remove the weights and unscrew the plunger to clean thoroughly
- The plunger must move freely with in the footplate. It must be clean without particles
- The plunger is removed from the barrel and cleaned with alcohol
- A pipe cleaner is used to clean the inside of the barrel
- Sterilize the part of the instrument that will come in contact with the patient's eye with an antiseptic solution
- Allow three minutes for the alcohol (sterilizing agent) to dry to prevent alcohol keratitis
- The foot plate of the Schiotz tonometer may also be sterilized by flame sterilization

❖ **Applanation Tonometer**

➢ The Goldmann Applanation tonometry is another instrument used in measurement of intraocular pressure (Figure 3).

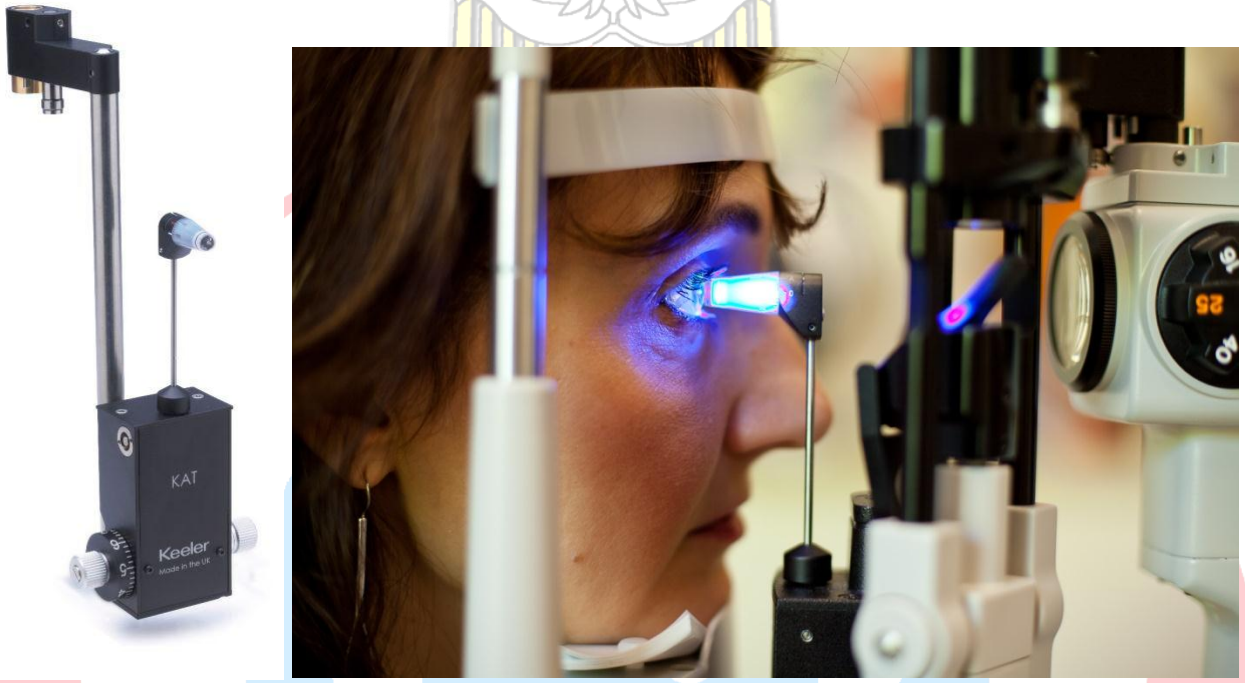

Figure 3 - Applanation Tonometer

➢ **Principle**

- The tonometer is used in conjunction with a slit lamp and a cobalt blue filter.
- A drop of topical anesthetic and fluorescein dye are instilled before measurement of the intra ocular pressure.
- The tonometer tip touches the eye and the force is increased by turning the adjustment knob until a circle of cornea of 3.06 mm in diameter is flattened.
- The end point is when the inner edge of the two semicircles just touches each other.
- Measure the force that is required to flatten the cornea and multiply it by 10 to express the intraocular pressure in mmHg.

- **Parts of the Applanation tonometer**
  - A split prism head (tonometer tip) attached by a rod to a casing that delivers the measured force, controlled by an adjustment knob.

- **Care**
  - Clean the tonometer in between patients.
  - Calibrate the instrument on a regular basis using the controlled weight supplied with the instrument.
  - Place the applanation head in a suitable container after use.

- **Maintenance**
  - To clean the tonometer, wipe the entire tonometer tip carefully and thoroughly with an alcohol wipe and allow it to air dry for one to two minutes before use.
  - Be sure to get rid of the disinfectant and allow for thorough air drying. If the patient's eye comes in contact with the disinfectant solution, corneal damage, pain and discomfort could result.

❖ **Non-contact tonometer**

➢ It is an instrument used to measure intra ocular pressure without contacting the eye (Figure 4).

Figure 4 – Air Puff non-Contact tonometer

➢ **Advantages**

- It doesn't touch the eye.
- No anesthesia required.

➢ **Procedure**

- It has a video monitor to observe the eye and set up proper alignment.
- The instrument can be table mount / hand held.
- The readings are taken when a soft gentle puff of air is directed at patients eye.
- The pressure is displayed on the radio monitor.

➢ **Contraindication**

- NCT cannot be used in patients with edematous or ulcerated cornea, following a keratoplasty or penetrating trauma.

➢ **Principle**

- By measuring time necessary for a given force of air to flatten a given area of the cornea, the IOP is calculated.

➢ **Maintenance**

- The dust cover keeps the instrument dust free.
- At the start of the day check the air nozzle by firing an air pulse without a patient in place.
- A clean dry cotton swab or a soft cloth can be used to clean the fixation area.

❖ Gonioscopy and Gonio-lenses

- Gonioscopy is the procedure in which the angle of the anterior chamber is examined. Four structures, namely, Schwalb's line, the trabecular mesh work, the scleral spur and the ciliary body band are examined.

- **Indications for Gonioscopy**
  - In glaucoma patients for differentiation of the types of glaucoma (angle-closure or open angle)
  - To visualize and remove a foreign body at an angle
  - To study tumors of the iris and abnormalities of its angle
  - To view the back of the iris, the ciliary body and the ciliary processes

- **Types of goniolenses (Figure 5)**
  - ***Direct goniolenses:*** provides direct view of the angle and can be used for both diagnostic and surgical purposes. It does not require the use of a slit lamp and is used with the patient lying in supine position.
  - ***Indirect goniolenses:*** provides a mirror image of the opposite angle and can be used only in conjunction with a slit lamp for diagnostic purposes. This is the most commonly used gonio lens in an ophthalmic department.

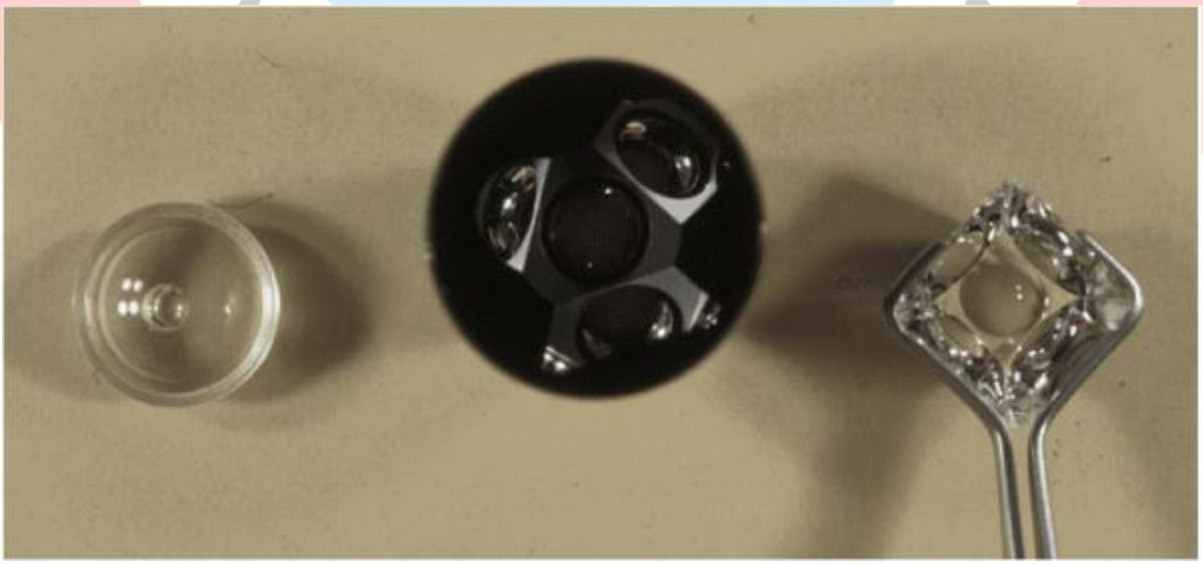

Figure 5- Different types of Goniolenses.

- **Parts of the Goniolens**
  - Highly polished truncated silver surfaced pyramid with a plain anterior viewing surface
  - There are different types of gonio lens which are single mirror, three mirror and four mirror.
  - The lens is used with a forty five degree angle so that the entire 3600 of the anterior chamber can be observed.
- **Care**
  - The lens has to be placed in the lens case provided for it.
  - The lens has to be held only at the pyramid side and plain mirror surface should not be touched.
- **Care and maintenance**
  - Clean the instrument after each use with clean cloth
  - Remove the dust that cannot be cleaned with liquid, by blowing it off with dry empty bulb syringe.
  - Remove finger prints or oil from the lens after use.
  - Be sure that all the cleaning agents are completely removed from the lens surface.
  - Check the ocular surface of the pyramid looking for any breaks that could damage the cornea while using the instruments.

The Keratometer

- The Keratometer is an instrument used to measure the anterior curvature of the cornea. The measurements are commonly referred to as ***K-readings***. Recently, these measurements have been

integrated with auto-refractometers or specialized automated Keratometers.

- **Purpose**
  - Contact lens fitting
  - Determination of corneal astigmatism
  - Calculation of intraocular lens powers

- **Description (Figure 6)**
  - Telescope like part
  - Knobs - four knobs for reading angular position
  - Circular scale for reading angular position
  - Two knobs for making adjustments on either side of instrument.

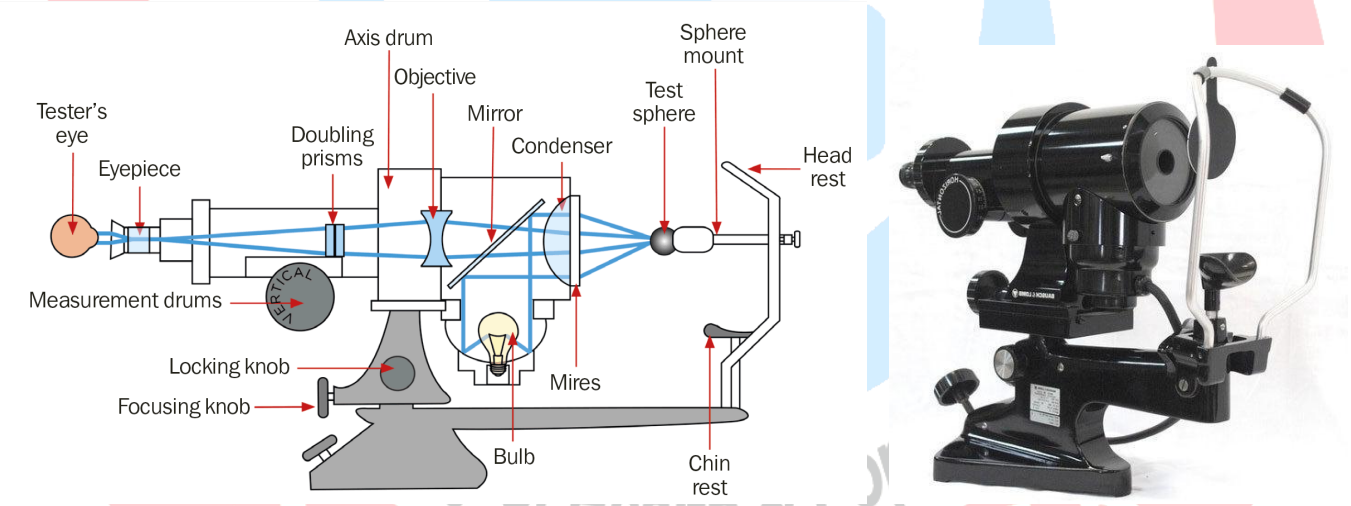

Figure 6 – Manual Keratometer parts.

- **Care**
  - Keep the instrument covered and turned off when not in use.
  - Calibration of the Keratometer should be checked to assure accuracy of the readings.

- Do not attempt to adjust the drum scales.

➢ **Maintenance**

- Remove the dust and stain on the equipment on daily basis.
- If bulb gets fused it has to be replaced.

Chapter 2
Posterior Segment Examination

Sections

- **Ophthalmoscope**
- **Fundus camera**

The Ophthalmoscope

❖ **Direct ophthalmoscope**

➢ Light from a bulb is reflected at right angles and projected at a spot. This spot of light is used to view the fundus through the pupil of the eye (Figure 7).

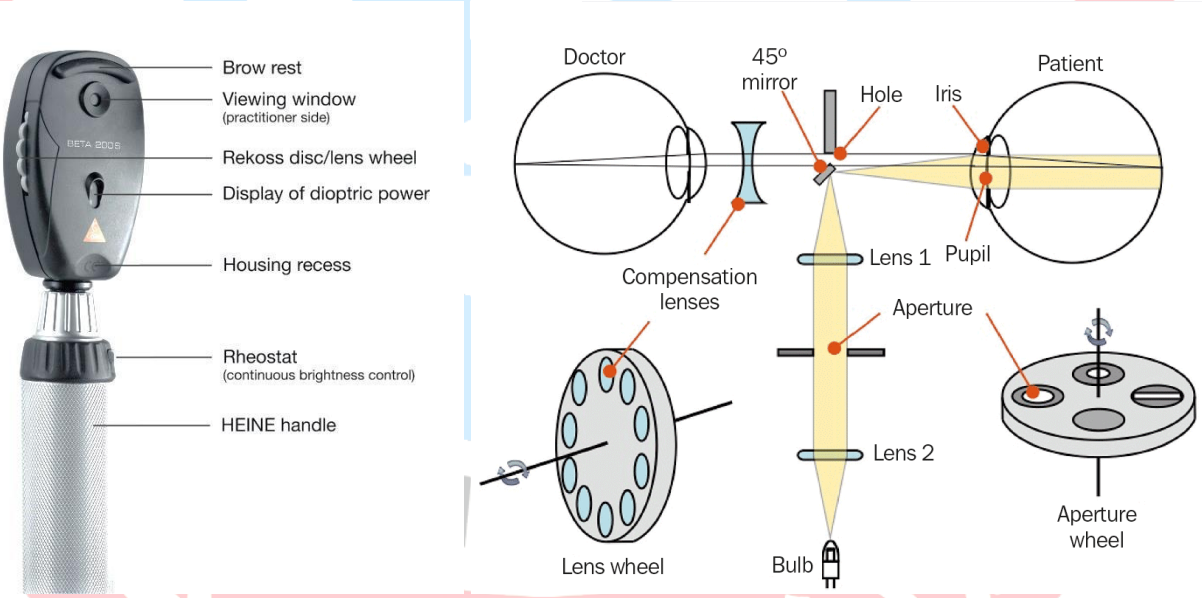

Figure 7- Direct Ophthalmoscope

❖ **Electrical system**

➢ Dry cells or rechargeable batteries

➢ Switch with a rheostat that controls the current flow through the bulb for changing its brightness

❖ **Optical system (the head) (Figure 7)**

- This is fitted on the handle with the spring loaded lock
- **It consists of**
  - System of condensing & focusing lens
  - Reflector to produce the spot of light.
  - ***The viewing system***
    - Consist of a wheel with lenses of different powers ranging from -20 to +20D.
    - The power of the lens used for viewing is indicated on the disc and can be seen through a window in the head.
    - There is a provision in the head for changing the spot size or for obtaining a semi-circular spot or for reducing it to a streak
    - There is a provision in the head for obtaining red free light by inducing filter in the path of light.

❖ **Maintenance**

- Remove the dust and stain on the outside of the instrument
- When not in the use keep the instrument in the box / pouch provided for it.
- During rounds it should always be carried in the box / pouch provided for it.
- Reverse the cell at the end of the day.
- Spare parts.
- A spare bulb.
- A pair of fresh cells.

❖ ***Important notes regarding the direct Ophthalmoscope***

- The cells have to be replaced when the battery is low
- Both the cells should be replaced
- When fresh cells are loaded the voltage could go up to 3.1v (usually 2.5 v or 2.8 v). It should not be turned to maximum brightness.
- In case of rechargeable batteries, the batteries should be recharged periodically.
- Sudden jerks or impact to the instrument on the table should be avoided to prevent the bulb from getting fused.
- Store the instrument with the viewing lenses set at zero.

❖ **Indirect ophthalmoscope**

- The modern indirect ophthalmoscope helps to view the fundus with the help of a hand held high positive aspheric lens (20D) (Figure 8).

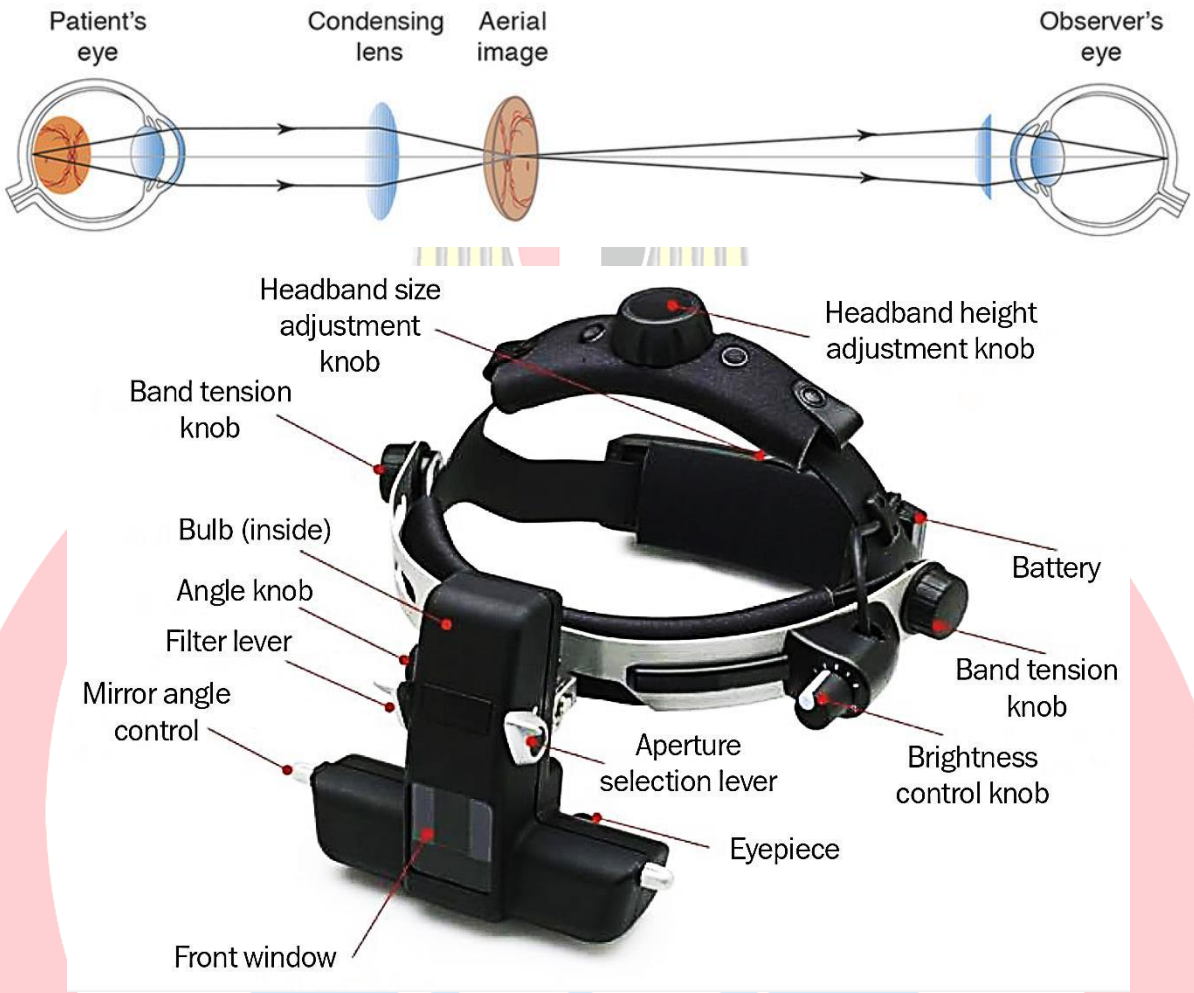

Figure 8- Indirect Ophthalmoscope

- **Description (figure 8)**
  - ***An illuminating system:***
    - Consists of tungsten filament lamp or halogen lamp, a front silvered concave reflector, two condensing lens and provision for introducing filters.
  - ***An electric system:***
    - Consists of step down transformer provided with switch, a rheostat, a fuse and a sufficiently long connecting cable.
  - ***Stereoscopic viewing system (vision box):***
    - Has two eye pieces which can be moved laterally according to the user's interpupillary distance (IPD).
    - The vision box is attached to the illuminating system.
  - ***A headband that supports the illumination system:***
    - The illuminating system and the attached vision box are attached to the head band

which the ophthalmologist wears. The cable for the lamp is also attached to the head band.

- **Care**
  - Use the bulb in a low illumination setting. When there is a need to increase it to a high illumination use it only for brief periods.
  - The instrument should be hung using its head band only, it should not be hung on a hook by its electrical cord, since it may cause electrical failure.
  - When not in use switch it off.

- **Maintenance**
  - Remove the dust and stain on the instrument daily with a clean dry cloth
  - When not in use, keep the instrument in its box and keep the box closed
  - The head band may get oily and may also become wet with the sweat of the ophthalmologist. The instrument must be wiped clean to remove the oil and the sweat
  - When the bulb is fused out, take it to the ophthalmic instrument service station or to the dealer to get the bulb changed.

- **Spare parts**
  - A spare bulb
  - A spare fuse

- **Advantages of the instrument**
  - Stereoscopic view
  - Wider field of view
  - Increased illumination
  - Reduced distortion
  - Ophthalmologist works from a distance.

- **Difference between direct and indirect Ophthalmoscopes**

	Direct Ophthalmoscope	Indirect Ophthalmoscope
Pupil	Non-dilated	Fully dilated
Image	Erect	Vertically and horizontally inverted
Field of view	Small (6°)	Wider (25°)
Magnification	Large (15)	Small (x3 in 20D lens) (x5 in13D lens)
Binocularity	-ve	+ve
Effects of patients' refraction error on the image	+++	---

❖ **Fundus viewing lenses**

- It is a device used to examine the posterior vitreous and the posterior pole of the fundus and its periphery. The most commonly used lens are 90 D, 78 D and 20D.
- **90 D and 78 D lenses (Figure 10):**
  - These are non-contact high power condensing lenses.
  - Used only with the slit lamp.
  - They bring the retinal image within the focal range of the slit lamp.
  - 90-D lens (the most common), gives a wider field of view but lesser magnification than the 78 D lens.
  - The image formed in the lens is a real inverted image.

Figure 10 – 90 D fundus lens & Slit-lamp fundus biomicroscopy.

- **20 D and 28 D lenses:**
  - It is also known as pan retinal viewing lens.
  - It is a hand held non-contact biconvex lens used along with indirect ophthalmoscope.
  - The image formed in the lens is a real inverted image.
  - It helps to view the periphery of retina to look for common retinal conditions like diabetic retinopathy, intraocular foreign body, retinal detachment and degenerative changes in high myopia (Figure 11).

Figure 11- Indirect Ophthalmoscopy with a 20 D lens.

- **Care**
  - Remove the dust from the lens after use.
  - Do not handle the lens by touching the lens surface.
  - Replace it back in its case after each use.

- **Maintenance**
  - Clean the lens regularly with solution to remove dust and oily fingerprints.
  - Do not clean the lens with a dry cloth, this will promote dust to build up.
  - Do not rub the lens too hard, as this can remove the antireflective coating.
  - Never autoclave or boil the lens.

Fundus Camera

- A Fundus Camera is a device for photographing the retina. It is a specialized low power Microscope with an attached Camera designed to Photograph the Fundus (the interior of the Eye), including the Retina, Optic disc, Macula, and Posterior pole.

- **The optical design of fundus cameras:**
  - It is based on the principle of monocular indirect ophthalmoscopy where the Observer's eye is replaced with a camera.
  - A fundus camera provides an ***upright, magnified view*** of the fundus.
  - A typical camera views **30 to 50°** of retinal area, with a magnification of **2.5x**.

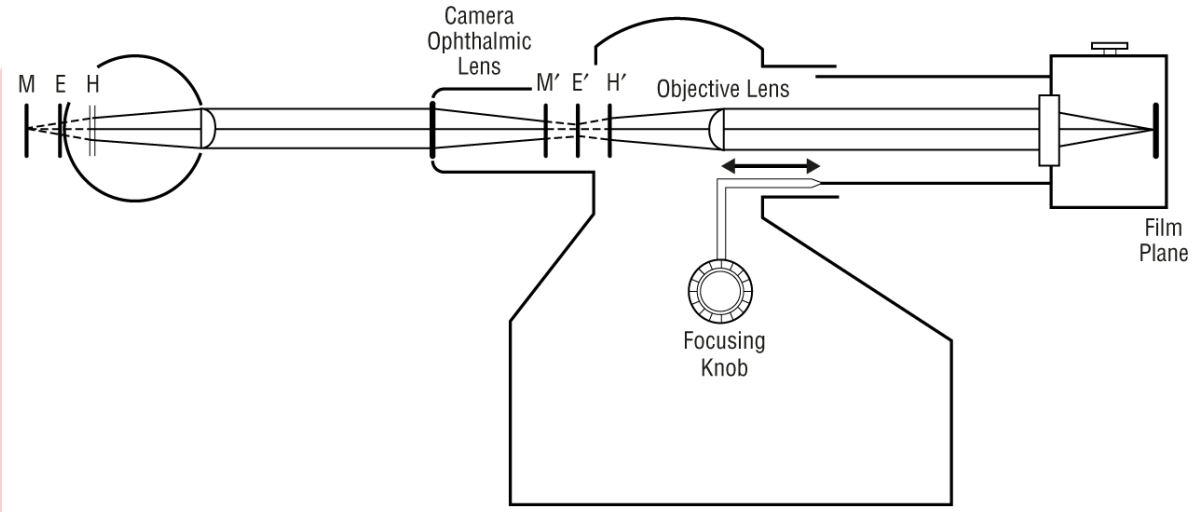

Figure 12- A simplified schematic of the design of a Fundus Camera.

  - **The optics of a fundus camera are similar to those of an indirect ophthalmoscope in that the observation and illumination systems follow dissimilar paths (Figure 12):**
    - The observation light is focused via a series of lenses through a ring shaped aperture, which then passes through a central aperture to form an annulus, before passing through the camera objective lens and through the cornea onto the retina.
    - The light reflected from the retina passes through the un-illuminated hole in the annulus formed by the illumination system.
    - As the light paths of the two systems are independent, there are minimal reflections of the light source captured in the formed image.

- The image forming rays continue towards the low powered telescopic eyepiece.
- When the trigger is pressed, a mirror interrupts the path of the illumination system allow the light from the flash bulb to pass into the eye.
- Simultaneously, a mirror falls in front of the observation telescope, which redirects the light onto the capturing medium, whether it is film or a digital camera (CCD).

❖ **Modes:**

➢ **Color Photography (Fundus photo):**

- Where the retina is illuminated by white light and examined in full color.

➢ **Red free fundus photography:**

- This utilizes a filter in order to better observe superficial lesions and some vascular abnormalities within the retina and surrounding tissue.
- A green filter ~540-570 nm is used to block out red wavelengths of light.
- This allows a better contrast for viewing retinal blood vessels and associated hemorrhages, pale lesions such as drusen and exudates, and subtle characteristics such as nerve fiber layer defects and epiretinal membranes.

➢ **Angiography:**

- It is a process of recording vascular flow within the retina and surrounding tissue by injecting a fluorescent dye into the blood stream.
- The dye fluoresces a different color when light from a specific wavelength (excitation color) reaches it.
- Barrier filters then only allow the autoflourescent wavelengths of light to be photographed.
  - Using this method a timed sequence of photographs can be produced that show the progression of the dye into the vessels and reveal the flow dynamics and related pathologies. Specific methods include:
    - ***Sodium Fluorescein Angiography (FFA or FA):***
      - It is used for the imaging of retinal vascular disease
      - It utilizes blue excitation light of ~490 nm and fluoresces a yellow light of ~530 nm.
      - FFA is routinely used to image Cystoid Macular edema and Diabetic Retinopathy among others.

- ***Indocyanine Green Angiography (ICGA):***
  - It is used primarily for imaging deeper choroidal diseases.
  - It utilizes near-infrared diode laser of 805 nm and barrier filters allow light of 500 and 810 nm to be photographed.
  - ICGA is useful for seeing choroidal vessel outpouching in cases of idiopathic polypoidal choroidal vasculopathy, abnormal vessels supplying ocular tumors, hyperpermeable vessels leading to central serous chorioretinopathy among other conditions.

Chapter 3
Refraction Equipment

Sections

- **Retinoscopy**
- **Refractometers & Autorefractometers**
- **Focimeter**
- **Phoropter**

Retinoscopy

❖ Retinoscopy is an objective method of measuring the optical power of the eye.

❖ A retinoscope is used to illuminate the inside of the eye, and to observe the light that is reflected from the retina. These reflected rays alter as they pass through the optical media of the eye, and by examining just how these emerging rays change, we determine the refractive power of the eye.

❖ We label retinoscopy as "objective" because we evaluate the eye as an optical instrument, initially ignoring any information the eye transmits to the brain. Thus ***retinoscopy does not depend on the patient's vision or judgment***.

❖ The streak retinoscope is a hand held instrument used to determine the refractive power of the eye objectively.

➢ **Description (Figure 13)**

- The instrument is similar to that of a direct ophthalmoscope.
- The light emitted from the instrument can be rotated 360 degree.
- There is no lens disc in retinoscope.
- **Two systems:**
  - **Projection system**

- ***Light source:*** A bulb with a linear filament that project a line or streak of light. Turning the sleeve on the instrument rotate the bulb, which in turn rotate the projected streak. This turning sleeve and rotating the light streak is called meridian control.
- ***Condensing bulb:*** Resting in the light path, the lens focuses rays from the bulb on the mirror
- ***Mirror:*** Placed in the head of the instrument, the mirror bends the path of light at right angle to the axis of the handle. A beam projects from the head of the instrument.
- ***Focusing Sleeve:*** This varies the distance between the bulb and lens to allow the retinoscope to project rays that either diverge (plane mirror effect) or converge (concave mirror effect). Hence, the sleeve is also called vergence control. In most instruments, the sleeve changes the focus (vergence) by moving the bulb up and down.
- ***Current source:*** This is provided by a corded handle (connected to a transformer stepped down to 2.5v to 3.5v) or battery handle.

♦ **Observation system**

- Peephole: Light reflected by the illuminated retina enters the retinoscope, passes through an aperture of the mirror and come out through the peephole at the rear end of the head. When we move the retinoscope we see movement of the streak /spot projected on the retina while looking through the peephole.

➢ **Care**

- It should be turned off immediately after use.
- Bulbs should be changed when it gets fused.

➢ **Maintenance**

- Same as for an direct ophthalmoscope.

Figure 13- Parts of the streak retinoscope.

Refractometers

- Automated refractors (Figure 14) exist for both objective and subjective refractometry, reducing the need to use a Phoroptor or trial frame and lenses.
  - The automated ***objective refractors*** use infrared light to provide data similar to that resulting by manual retinoscopy.
  - Automated ***subjective refractors*** depend totally on patient responses, the same as manual refractometry performed with Phoroptors or trial lenses and frames.
  - ***Combination objective/ subjective refractors*** allow the operator to use patient responses to check visual acuity before and after the measurement as well as to refine sphere, cylinder, and axis after the objective measurement has been made.
- In general, automated refractors of all types are ***expensive*** machines.

Figure 14 – Automated Refractometer

- **Types of refractometers:**
  - ***Objective Refractors:***
    - Automated objective refractors are *simple* to operate.
    - Minimal storage and use space is required.
    - However, results may be *variable* and are *not accurate enough* to allow prescription without refinement.
    - Additionally, accurate results may not be possible in patients with some disorders, e.g. immature cataracts, or certain physiologic features, such as small pupils.

- ***Subjective Refractors***
  - Some subjective automated refractors *allow testing of both distance and near vision* and allow *over-refraction* of a patient's current eyeglasses.
  - Some models feature an automated system of refracting steps, and others allow two different refractions to be compared easily.
  - However, a subjective refractor is *difficult to operate* and requires a skilled, well-trained operator.

- ***Objective/Subjective Refractors***
  - With objective and subjective capability in the same instrument, a combination automated refractor may save space in the office, because it eliminates the need for the traditional 6 meters testing distance required by manual refinement.
  - Like purely subjective refractors, combination units still require skilled operator and training for accurate refinement.

Focimeter or Lensometer

- Lensometry is a procedure used to measure the prescription of a patient's existing eyeglass lenses or the power of contact lenses.
- Lensometry is performed with a specialized instrument known as a lensmeter or vertexometer (Figure 15).
- Lensometry measures 4 principal properties of lenses:
  - Spherical and cylindrical power in diopters;
  - Axes, if the lenses have a cylinder component;
  - Presence and direction of a prism included into the lens;
  - Optical centers.
- Lensometry performed on a patient's eyeglasses before refraction can provide a starting point for the current refraction. This is also useful in showing changes in refractive error.
- Lensometry also serves to check that a patient's glasses have been made in agreement with the doctor's prescription.
- Lensometers could be manual or automated (Figure 15).

Figure 15 – Manual Lensometer (Left) – Automated Lensometer (right)

Trial lens set and the Phoropter

❖ ***Trial frame and loose trial lenses (Figure 16):***

- This equipment is used when performing retinoscopy and refraction and to confirm refractive findings.
- It is also useful when performing tests evaluating ocular alignment of a patient without his or her glasses.

Figure 16 – Trial lens set with trial frame (Center).

❖ ***The phoropter (Figure 17):***

- This device (also called a ***refractor)*** stores a range of trial lenses, It is used when performing retinoscopy and refraction.
- It provides an alternative to a trial frame and loose lenses.
- It consists of a face plate that can be suspended before the patient's eyes.
- The plate contains a wide range of spherical and cylindrical lenses that the examiner can dial into position (Figure 17).
- Most refractors have a variable setting for the interpupillary distance and have a convergence lever feature to allow the eyes to converge for determining near vision correction.
- Other accessories vary widely among makes and models.

Figure 17- The refractor: Manual (Left)/ Automated (Right).

Chapter 4
Advanced optical instruments

Sections

- **Corneal Topography.**
- **The Optical Coherence Tomography**

Corneal Topography

❖ Corneal topography is a method of corneal curvature examination assisted by computer analysis. The corneal topographer consists of a computer linked to a lighted bowl; it projects a series of illuminated rings on to the corneal surface, which are reflected back into the instrument. The reflected rings of light are analyzed by the computer and a topographical map of the cornea is generated.

❖ Corneal topography with computerized videokerotoscopy provides color coded maps of the corneal surface. The dioptric powers of the deepest and flattest meridians and their axes are calculated and displayed.

❖ A series of data points are generated on a placido disk which has been projected on the cornea.

➢ **Indications**

- To calculate meridians astigmatism associated with contact lens wear
- To diagnose the corneal distortions such as early keratoconus and keratoconus suspects
- To evaluate pre and postoperative changes in corneal shape after refractive surgery, corneal grafting or cataract extraction
- To reveal the corneal scarring
- To detect irregularities in corneal shape

- **Scales:**
  - Absolute scales.
  - Relative scales (Figure 18):
    - The cool shades of blue and violet represent flatter areas of the cornea.
    - The warmer shades of orange and red represents steeper areas of cornea.

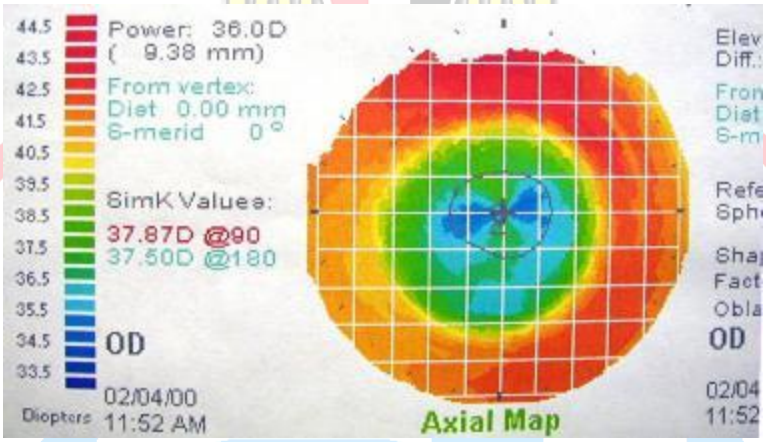

Figure 18 – Corneal topography

- **Advantages**
  - Painless and rapid.
  - A non-contact examination.
  - Its ability to detect conditions invisible to most conventional testing.

- **Assisting in corneal topography**
  - Help the patient sit comfortably.
  - Enter the patient's details in the computer.
  - Describe the purpose and nature of the procedure in detail in the patient's own language.
  - Adjust the height of the chin rest, to keep the chin and for head against the head band.
  - Ask the patient to look at the light in the center.
  - After the topography is over, take the print out and make sure that it is attached to the case sheet.

- **Uses of corneal topography**
  - Corneal topography is used in the diagnosis and management of various corneal curvature abnormalities and diseases:
    - Keratoconus / keratoglobus / pellucid marginal degeneration
    - Corneal scars or opacities
    - Corneal deformities
    - Fitting contact lens
    - Irregular astigmatism following corneal transplanting (for suture removal)
    - Planning refractive surgery
    - Post-operative cataract extraction with required astigmatism
    - Suture relaxation in astigmatic keratotomy.

❖ **The Pentacam camera (figure 19):**

- This machine can also be used to determine corneal topography using a different optical principle for oblique imaging (Scheimpflug photography).
- The Pentacam camera can also determine the depth of the anterior chamber, corneal power, topography of the lens, and the density level of a corneal opacity.

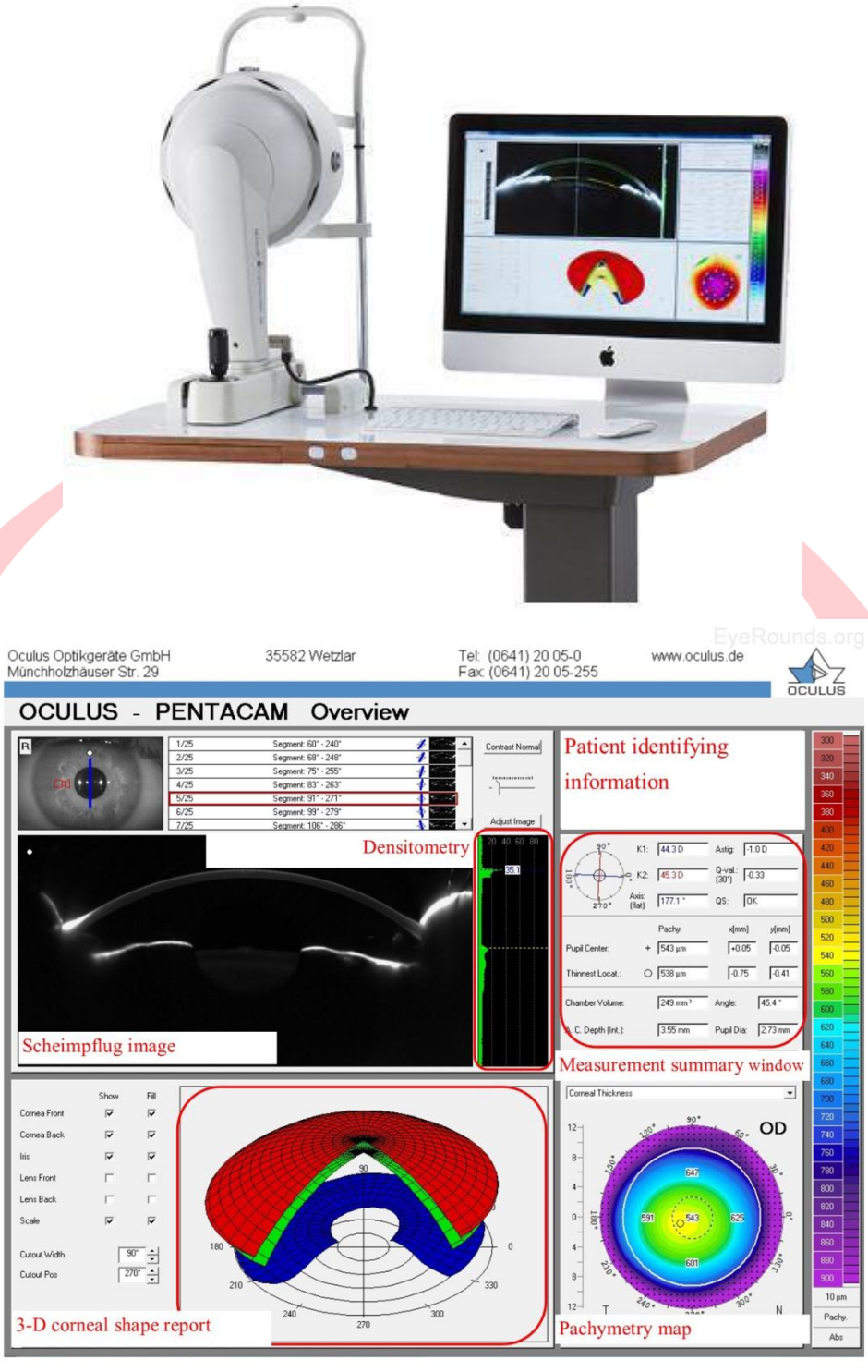

Figure 19 – Pentacam machine (above) & output (below).

The Optical Coherence tomography

❖ This is a non-invasive, non-contact, trans-pupillary imaging technology that can make an image of the retinal structure with a resolution of 10-17 microns using the reflection of light from different structures within the eye.

➢ **Procedure**

- An infrared diode laser (~850nm) beam is focused on retina using complex lens system.
- An infrared camera is used to view fundus and beam.
- Ocular fixation is achieved using a computer-controlled light that fixates the scanned eye or an externally-mounted light on a slit lamp.
- Dark colors (like blue and black) reflect areas of minimal optical reflectivity and bright colors (as red and white) represent areas of high reflectivity.

➢ **Uses**

- Studying macular holes.
- Studying the Epiretinal Membrane.
- CSR (Central Retinopathy).
- Diagnosing ARMD (Age-related macular degeneration
- Determining RNL thickness (Retinal nerve fiber layer).

Figure 20 - OCT machine

- **Advantages**
  - Objective.
  - Quantitative.
  - No contact with the patient.
  - High resolution.

- **Disadvantages**
  - Limited uses in media opacities like cataracts or vitreous hemorrhage.

- **Preparation of patient**
  - Explain the procedure to the patient, in their own language.
  - Explain the advantages.
  - Explain to the patient the importance of steady fixation. If there is no steady fixation it will take a long time to complete the test.
  - Seat the patient.
  - Adjust stool, table and chin rest for optimal patient comfort.
  - Keep their chin over the chin rest and forehead against the head band gently.
  - Tell them to steadily fixate on target light.
  - Gently separate the eyelids, when the probe beam is focused.

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