National Academy of Opticianry

Continuing Education Course

Approved by the American Board of Opticianry

Visual Assessment Training Procedures

National Academy of Opticianry
8401 Corporate Drive #605
Landover, MD 20785
800-229-4828 phone
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National Academy of Opticianry

PREFACE:

This continuing education course was prepared under the auspices of the National Academy of Opticianry and is designed to be convenient, cost effective and practical for the Optician.

The skills and knowledge required to practice the profession of Opticianry will continue to change in the future as advances in technology are applied to the eye care specialty. Higher rates of obsolescence will result in an increased tempo of change as well as knowledge to meet these changes. The National Academy of Opticianry recognizes the need to provide a Continuing Education Program for all Opticians. This course has been developed as a part of the overall program to enable Opticians to develop and improve their technical knowledge and skills in their chosen profession.

The National Academy of Opticianry

INSTRUCTIONS:

Read and study the material. After you feel that you understand the material thoroughly take the test following the instructions given at the beginning of the test. Upon completion of the test, mail the answer sheet to the National Academy of Opticianry, 8401 Corporate Drive, Suite 605, Landover, Maryland 20785 or fax it to 301-577-3880. Be sure you complete the evaluation form on the answer sheet. Please allow two weeks for the grading and a reply.

CREDITS:

The American Board of Opticianry has approved this course for two (2) Continuing Education Credits toward certification renewal. To earn this credit, you must achieve a grade of 80% or higher on the test. The Academy will notify all test takers of their score and mail the credit certificate to those who pass. You must mail the appropriate section of the credit certificate to the ABO and/or your state licensing board to renew your certification/licensure. One portion is to be retained for your records.

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COURSE PREREQUISITE:

The student should have a general understanding of the refractive status of the human eye.

COURSE DESCRIPTION:

Information that will be covered in this course will include information regarding visual assessment testing, including instrumentation and processes. Information will include the importance of history taking.

LEARNING OBJECTIVES/OUTCOMES

At the completion of this subsection, the student should be able to:

- List basic instruments used in visual assessment
- List visual assessments performed during a standard examination
- Explain visual acuity
- Explain contrast sensitivity
- Explain accommodation
- Discuss basic instrumentation used for testing purposes

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Introduction

The refraction will determine if the patient has an ametropia or a refractive error. If distance light rays focus on the retina without accommodative effort, the patient is emmetropic. If the distant lights rays focus in front of the retina, the patient is myopic. Pseudomyopia is caused by an involuntary contraction of the ciliary muscle. The unintended accommodation will blur distance objects. This accommodative spasm may be caused by excessive near work. It can be relieved by prescribing plus lenses to relax the near accommodative effort. If the distant light rays focus behind the retina, the patient is hyperopic. Latent Hyperopia refers to when a portion or all of the hyperopia is being compensated for through accommodation. A cycloplegic refraction is needed to measure the amount of hyperopia, particularly in young patients. If all distant light rays do not come to a point focus, the patient has astigmatism. Presbyopia occurs when the crystalline lens can no longer change shape enough to produce the required plus power. (Loss of accommodation)

The Eye Exam

The refraction is a separate component from the examination. It will identify the refractive error. A comprehensive eye exam will determine the refractive status and health of the eye. The process begins with a complete medical history and some preliminary tests. The refraction will determine the strength of the lenses necessary to give the patient the best visual acuity. The health of the eye is evaluated using several instruments. Based on the refractive findings and observations, additional tests may be required.

Patient History

Taking a good history from a patient can make the difference in whether they will ultimately be satisfied with their glasses/vision/contact lenses. You have to find out why they are there to see you, right then. A patient history is the story of a patient's medical and visual disorder. There are generally two types of patients who come in for an exam. The first types are those who are there for a routine examination. The other types are symptomatic of some type of ocular disorder. History taking includes a series of questions in an orderly sequence. Without some orderly sequence, you won't find out the required information. For example, if you only ask a general question, you will find that some people tell you too much information, while others won't tell you enough. In addition, the orderly sequence builds information that may identify a problem requiring that you ask more questions as they are needed.

The chief complaint is the patient's main reason for seeking an exam. The medical history should include general health history along with a specific ocular health history. All prescription and nonprescription medications should be noted. Many patients don't include over the counter medication or herbal supplements, so you should ensure that they are included. If you are unfamiliar with a medication, you should look it up in a Physicians Desk Reference (PDR) to check for ocular side effects. Family medical and ocular history may alert you to inherited disorders that affect the eye. A family history of diabetes, strokes, tumors, glaucoma, cataracts, amblyopia and retinal problems could be significant. The history should also reveal if their current eyewear is meeting their visual needs for occupational and recreational activities.

A good patient history is important, and must include but not be limited to the following:

- Contact information should be complete and you should be sure to include information regarding privacy restrictions for HIPAA purposes. You should also give the patient a copy of your Privacy policy.

- Contact information should include:
    - Full Name
        - What name do they wish to be called
    - Verification of identity
    - Address
    - Telephone numbers: home, work, cell phone
    - E-mail
    - How do they prefer to be contacted
    - Can a message be left
    - Who can information be shared with (HIPAA)
- Age
- Birthday
- Gender
- Occupation
    - Type of work
    - Near/intermediate/distant
    - Environment
    - Safety issues at work
- Chief Complaint
    - This should be recorded in their exact words. The chief complaint can lead to additional questions.
- Visual requirements
    - Lifestyle
    - Hobbies
    - Work
    - Full or part time wear
    - Other

- Visual requirements
    - Near
    - Intermediate
    - Distant

- Ocular History – Patient
    - Visual
        - Blindness
            - Total
            - Partial
            - Scotomas
        - Redness
        - Pain

        - Burning
        - Itching
        - Discharge
        - Loss of vision
        - Eye fatigue
        - Blurred vision at near
            - Close work – presbyope
        - Distance work – myopia
            - Kids sit close to the TV
            - Bigger things easier to see
        - Loss of central vision
            - Macula or optic nerve problem
        - Distorted Vision
        - Night Blindness
        - Ascending Veil
        - Flashes of light
        - Floaters
    - Asthenopia – This is a general term that can include many symptoms including:
        - "Eyes just don't feel right"
        - Headaches – where
        - Migraines
        - Symptoms
            - Eyestrain
            - Fatigue
    - Eyes Pulling
    - Inability to focus
    - Heaviness of the lids
    - Sensitivity to light - Photophobia
    - Tendency to fall asleep after reading for short periods of time
    - Double vision - Diplopia
    - Medications
        - Inhalants
        - Contactants
        - Ingestants
        - Ocular medications
    - Allergies
        - Seasonal
        - Medications
        - Solutions
        - Any
    - Diseases of the eye
    - Injuries to the eye
    - Surgeries to the eye
    - Were they previous CL wearer
        - What type
        - What did they like or dislike
        - Can prior records be obtained

- Ocular History – Relatives
    - Visual
        - ANY history of blindness

        - Strabismus
        - Loss of vision
        - Glaucoma
        - Macular degeneration
        - Retinitis Pigmentosa
        - Nystagmus
    - Medications
    - Allergies
    - Diseases
    - Injuries
    - Surgeries

- Medical History – Patient
    - History of present illness
    - History of past illness
    - Significant medical illness
    - Heart
    - Diabetes
    - Thyroid
    - Blood pressure
    - Pregnancy
    - Cancer
    - Marfan's Syndrome
    - Sickle Cell
    - Albinism
    - Any other disease – Headaches

- Medical History - Relatives
    - Heart
    - Diabetes
    - Blood pressure
    - Thyroid
    - Cancer
    - Any other disease – Headaches

In addition, in today's environment, because many patients have some form of managed care, you must have information in their history regarding insurance coverage and identify their eligibility.

Remember that as opticians/technicians, we take the patient's history. We don't interpret the history since we aren't doctors. Don't attempt to do so. We are supplying important background data that will benefit the doctor in his/her diagnosis. Use short sentences – the doctor will get into the details. Take your time – but don't wear out the patient.

Pretesting

SOAP

SOAP is an acronym for Subjective, Objective, Assessment and Plan. This approach is used to chart patient files. SOAP notes are most commonly used by eyecare professionals as a type of roadmap of care. Using this approach will help eyecare professionals in being consistent with the care of patients. It follows a logical sequence.

If you only look at the objective data, you miss potential symptoms your tests couldn't detect. If you only look at subjective data, you get patients claiming pain, but only trying to score free drugs. You need both to get a full picture of a problem before you assess and plan. By institutionalizing this simple framework, the medical community has been able to significantly decrease its error rate. The best way to get real subjective data is to be open.

S – Subjective is the patient's own responses. For example, visual acuity charting follows a logical sequence and requires a response from the patient. We begin with the right eye, left eye, both distant and near. Information also important to note is acuity with glasses, with contact lenses and without correction.

O – Objective is what you the eyecare professional will observe. For example, slit lamp evaluation, retinoscopy, autorefraction. An objective finding would be an example of auto refraction. There is no response from the patient in this test. Most pretests with the exception of visual acuity result in objective findings.

A – Assessment is a quick summary of the patient with the main symptoms/diagnosis.

P – Plan is what the eyecare professional will do to treat the patient. This should include each item addressed in the diagnosis and ensure that the patient's chief complaint is dealt with. Plan for follow-up should be included.

Testing Instrumentation

Finding the starting point in a refraction may begin by simply identifying what the patient's previous refractive error was. This can be done having access to prior records, or it may be done by neutralizing the power in their most current spectacles. As a matter of fact, that is great information to have and can help in troubleshooting as well. The next step could be retinoscopy or auto refracting the patient.

Auto Refractors

In many practices today, you may find that the use of auto refractors that often combine keratometry are used as starting points for the refraction and examination of the patient. While these instruments have certainly improved over the years, they are not ideally recommended to take the place of a refraction. There are a number of brands by various manufacturers and are relatively simple to use.

An automated refractor, or auto refractor, is a computer-controlled machine used during an eye examination to provide an objective measurement of a person's refractive error and prescription for glasses or contact lenses. This is achieved by measuring how light is changed as it enters a person's eye.

The automated refraction technique is quick, simple and painless. The patient takes a seat and places their chin on a rest. One eye at a time, they look into the machine at a picture inside. The picture moves in and out of focus and the machine takes readings to determine when the image is on the retina. Several readings are taken which the machine averages to form a prescription. No feedback is required from the patient during this process.

Within seconds an approximate measurement of a person's prescription can be made by the machine and printed out.

In some offices, this is used to provide the starting point for the optometrist in subjective refraction tests. Here, lenses are switched in and out of a phoropter and the patient is asked "which looks better" while looking at a chart. This feedback refines the prescription to one which provides the patient with the best vision.

Automated refraction is particularly useful when dealing with non-communicative people such as young children or those with disabilities.

Phoropter

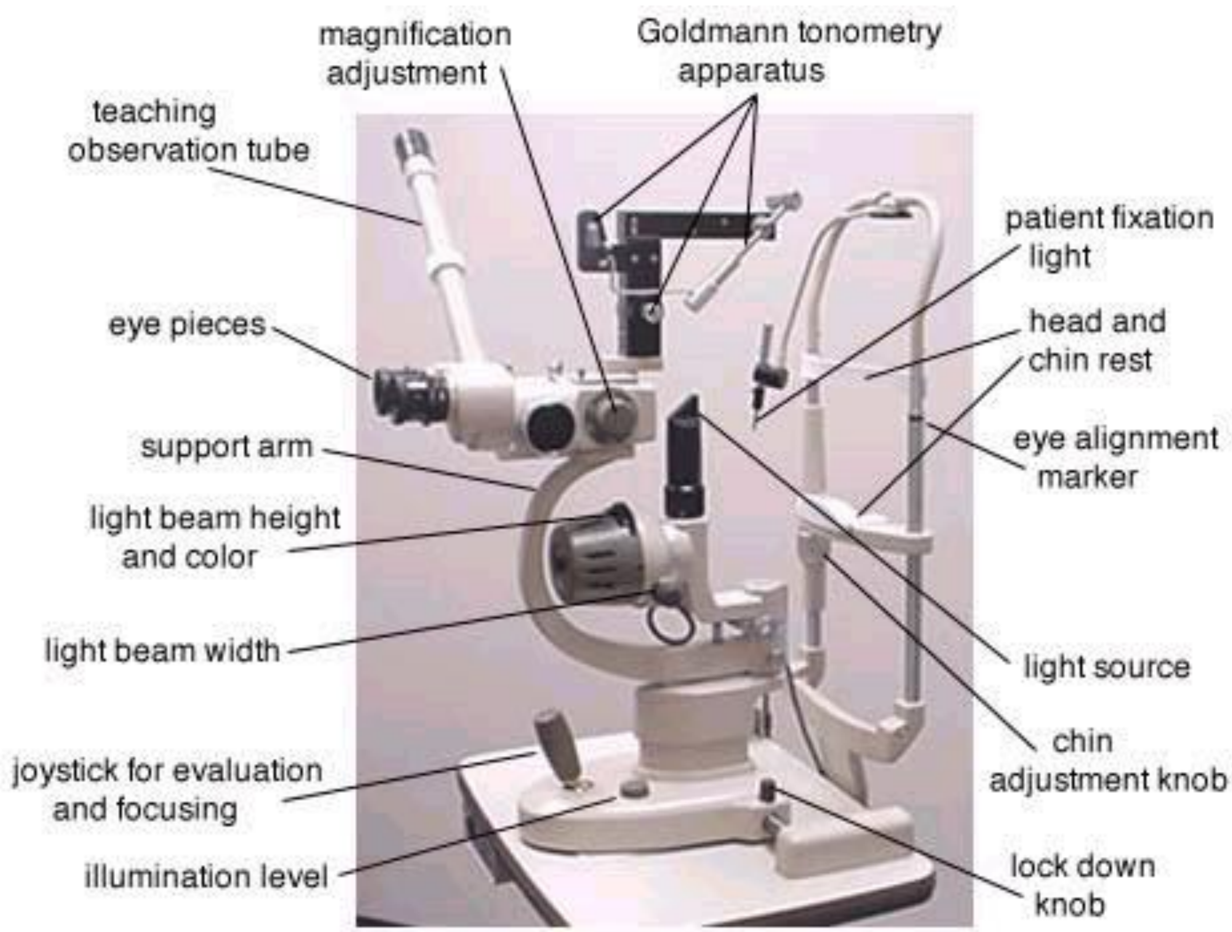
The phoropter is a complex lens holding instrument that is designed to allow the examiner to change lenses efficiently and easily. It determines the objective and subjective sphero-cylindrical refraction of the patient. In addition, it can also determine possible muscle imbalances in a patient.

The parts of a phoropter include the following:

- Spherical lens Control
- Minus-plano-cylinder Control
- Aperture Control/Strong sphere control
- Jackson Cross Cylinder
- Risley Prism
- Adjustments
  - PD knob
  - Leveling Knob
- Vertex distance control

Slit Lamp

The slit lamp is an instrument consisting of a high-intensity light source that can be focused to shine a thin beam (slit) of light on the eye and into the eye. It is used in conjunction with a biomicroscope. The lamp facilitates an examination of the anterior segment, or frontal structures, and posterior segment of the human eye, which includes the eyelid, sclera, conjunctiva, iris, natural crystalline lens, and the cornea. The binocular slit-lamp examination provides a stereoscopic magnified view of the eye structures in detail, enabling anatomical diagnoses to be made for a variety of eye conditions, diseases, and anomalies. It is a binocular corneal microscope. It has two main parts, a controllable light source and a binocular microscope.



If someone is going to "FIT" contact lenses, they must be able to evaluate the lens on the eye and the health of the cornea to accommodate a prosthetic device/contact lens, so it is imperative that they master the slit lamp. There are a number of illuminations that can be used in evaluating the eye and if evaluating contact lenses, the actual lens fit.

Using the slit lamp, the examiner may instill fluorescein dye in the eye. The fluorescein dye stains the tear film on the surface of the eye and is combined with the cobalt filter (blue light) in the slit lamp to aid in evaluation in tear film breakup, for contact lens or dry eye evaluation. It is also used for identifying the depth and size of any corneal defects such as a corneal abrasion or ulcer. There are many more uses for the slit lamp in an eyecare practice.

The slit lamp examination may detect many diseases of the eye, including:

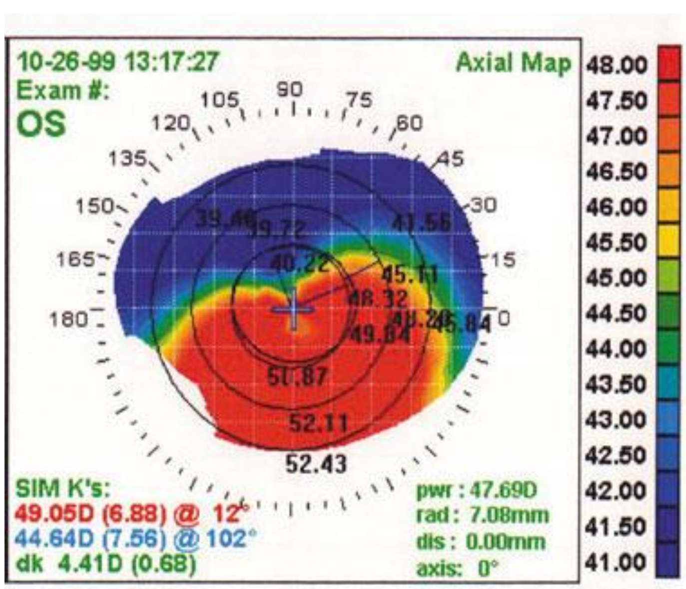
- Cataract
- Conjunctivitis
- Corneal injury
- Fuch's dystrophy
- Keratoconus (Fleisher ring)
- Macular degeneration
- Corneal Edema
- Contact lens/cornea relationship
- Others

Keratometer and Topographer

Some people incorrectly believe that keratometry and corneal topography is primarily useful in contact lens fitting as well as refractive surgeries. However, having a good knowledge of the topography of the cornea can give valuable information regarding the true refractive status of the eye. An example is when a patient has been misdiagnosed with a high refractive astigmatism when in fact keratoconus is present.

Keratometry

The Keratometer only measures approximately 3 mm of the central corneal cap. However, understanding Keratometry helps the eyecare professional understand Topography better. Since the cornea is actually an aspheric surface, meaning that the radius of curvature of the cornea changes as we move from the central portion of the cornea to the periphery, the keratometer is unable to measure these peripheral curvatures. To discuss corneal topography, the corneal surface is divided into three zones; the apical zone, the limbal zone, and the transitional zone.



Keratoconus

Corneal topography on the other hand produces detailed information about the curvature (power) of the cornea. Brands vary, but each has computer software to measure and analyze the surface of the cornea and generate a color map from the data. The data allows the fitter to monitor corneal disease and detect irregularities in the shape of the cornea.

The measurement of the radius of curvature of the cornea and its respective refractive power is called keratometry. The keratometer can be considered a corneal lensmeter (lensometer) as it interprets the refractive power of the cornea.

If the powers in each principle meridian are different, there is corneal astigmatism. The amount is determined by comparing the difference of these two principal meridians. If a cornea has a power of 43.00 Diopters in one meridian and 45.00 Diopters in the opposite meridian, there are 2.00 Diopters of corneal astigmatism. Let's give another example. Say the 43.00 D is found in the 180 º meridian, and the 45.00 D is found in the 90 º meridian. In addition, the manifest Rx is -2.00 -2.00 X 180. The manifest Rx shows 2.00 D of cylinder, which matches the difference in the two principle meridians. That means that the patient has corneal astigmatism and no residual astigmatism. In addition, because the weakest meridian is at 180 º, the patient has with the rule astigmatism (WRA). WRA With the rule astigmatism is defined in regular corneal astigmatism when the radius of weakest power (curvature) is in the 180º horizontal meridian +/- 30º. Against the rule astigmatism (ARA) is determined when the radius of weakest power (curvature) is at the 90º vertical meridian +/- 30º. A rigid contact lens rides on the steepest meridian of curvature. On a patient of with the rule astigmatism, a rigid lens will ride superior-inferior with the interaction of the eyelids during a blink. Lenses worn on against the rule astigmatism patients will tend to ride medial-lateral, inconsistent with the blinking action of the eyelids. Oblique astigmatism occurs when the strongest and weakest meridians are those meridians between 150-120 º and 30 º - 60 º.

Visual Field Analyzer

During a routine eye exam, the examiner can determine through visual field testing the full horizontal and vertical range of what the patient is able to see peripherally. This is commonly referred to as "side vision."

Visual field tests assess the potential presence of blind spots (scotomas) which could indicate eye diseases. A blind spot in the field of vision can be linked to a variety of specific eye diseases, depending on the size and shape of the scotoma.

Many eye and brain disorders can cause visual field abnormalities. For example, optic nerve damage caused by glaucoma creates a very specific visual field defect. Other vision problems associated with blind spots developing within the visual field include optic nerve damage (optic neuropathy) from disease or toxic exposure or damage to the light-sensitive inner lining of the eye (retina).

Brain abnormalities such as those caused by strokes or tumors can affect the visual field. In fact, the location of the stroke or tumor in the brain can frequently be determined by the size, shape, and site of the visual field defect.

Types of Visual Field Tests

Confrontation visual field testing typically is used as a screening visual field test. One eye is covered while the other eye fixates on a target object, such as the doctor's open eye, while the examiner stands or sits directly in front of the patient. The patient is then are asked to describe what is seen on the far edges or periphery of their field of view. As an example, the examiner may hold up different numbers of fingers within the patient's peripheral field of view and ask how many can be seen while they continue to fixate on the examiner's eye.

Types of Field Analyzers

There are various types of field analyzers. The most basic could be as simple as a tangent screen, which is simply a black felt cloth with a plotting system of pins placed in specific areas on the cloth. More technologically advanced instruments include computerized field analyzers.

Fundus Photography

A fundus camera or retinal camera is a specialized low power microscope with an attached camera designed to photograph the interior surface of the eye, including the retina, optic disc, macula, and posterior pole (i.e. the fundus).

Fundus cameras are used by optometrists, ophthalmologists, and trained medical professionals for monitoring progression of a disease, diagnosis of a disease (combined with retinal angiography), or in screening programs, where the photos can be analyzed later.

Fundus photography is performed to identify and classify normal retinal structures as well as retinal defects and diseases of the retina. They are usually performed after the patient has been dilated. In the past, a specialized 35 mm camera was used. Today's technology uses computerized digitalized imaging. While there are other manufacturers of computerized imaging systems one example of this type of technology is the Optomap.

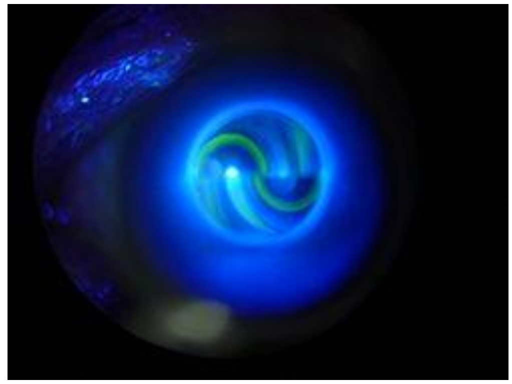
The Optomap Retinal Exam is used by the examiner to get an ultra-wide field view of the retina (the back of the eye). While eye exams generally include a look at the front of the eye to evaluate health and prescription changes, a thorough screening of the retina is critical to verify that the patient's eye is healthy. This can lead to early detection of common diseases, such as glaucoma, diabetes, macular degeneration, and even cancer. The exam is quick, painless, and may not require dilation drops.

Tonometers

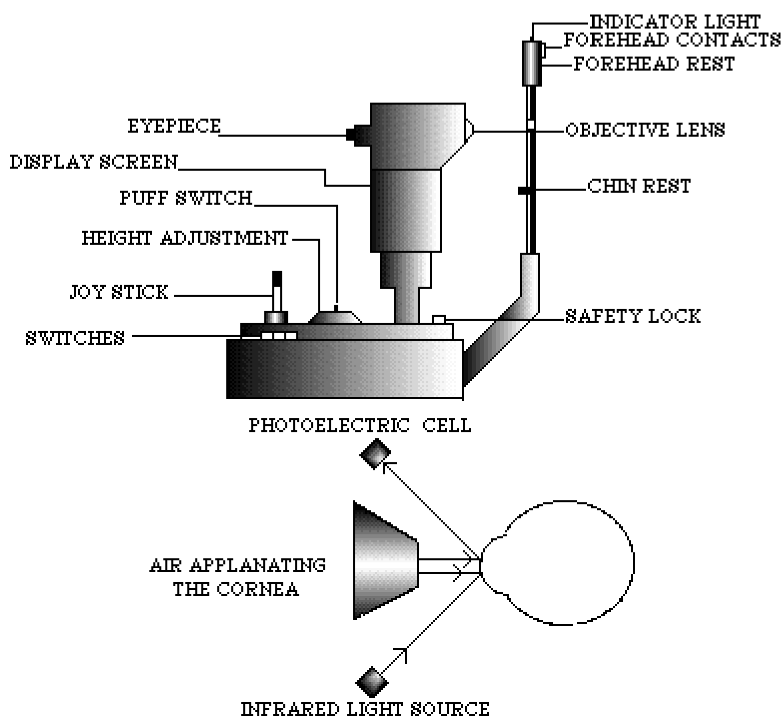
Tonometry is the procedure used to measure intraocular pressure (IOP) or tension. It is measured with the use of a tonometer. There are various types of instruments used for measuring IOP. Most tonometers are calibrated to measure pressure in mmHg (mm of mercury). Tonometry is an important test in the evaluation of patients with glaucoma. Normal pressure ranges in the human eye are from 16 – 20 mmHg. Abnormal (increased) pressure is a result of excessive production of aqueous (fluid) inside the eye. As mentioned earlier in the OCPP, this pressure occurs when more aqueous is produced than is drained out through anal of the canal of Schlemm.

One type of instrument used for measuring IOP is an Applanation tonometer.   Applanation tonometry achieves the measurement by the force required to flatten (applanate) a constant area of the cornea (3.06mm using the Goldmann tonometry). Another commonly used applanation tonometer is a hand held instrument often called a tono pen. Another commonly used measuring instrument is a non-contact tonometer often called an air puff tonometer. The measurement from an air puff is acquired by a high pressure of air “puffed” on the cornea, which will identify the IOP. The applanation method is by far considered more accurate. Applanation tonometry is performed using corneal anesthesia, while air puff tonometry requires none since there is no actual contact with the cornea. Air puff tonometry is oftentimes used only as a screening method and when elevated pressures are detected further testing with applanation tonometry is required.

Applanation tonometry - Goldmann tonometry is considered to be the gold standard in tonometry as it is the most widely accepted method of determining approximate intraocular pressure. A special disinfected prism is mounted on the tonometer head and then placed against the cornea. The examiner then uses a cobalt blue filter to view two green semi circles. The force applied to the tonometer head is then adjusted using the dial until the inner edges of these green semi-circles meet. Because the probe makes contact with the cornea, a topical anesthetic, such as oxybuprocaine, tetracaine, proparacaine (alcaine) or proxymetacaine is introduced onto the surface of the eye in the form of an eye drops.



The non-contact tonometer is an applanation tonometer and works on the principle of a time interval. Measuring the time it takes from the initial generation of the puff of air to where the cornea is exactly flattened (in milliseconds) to the point where the timing device stops. It takes less time for the puff of air to flatten a soft eye than it does a hard eye. Non-contact tonometers vary in design as well as complexity; however, the following is an illustration of the common instrument.



Contrast Sensitivity

Contrast sensitivity is the visual ability to see objects that may not be outlined clearly or that do not stand out from their background. The ability to see a shade of gray on a white background or to see white on a light gray background declines with age. Cataracts, diabetic retinopathy and other conditions can also affect contrast sensitivity.

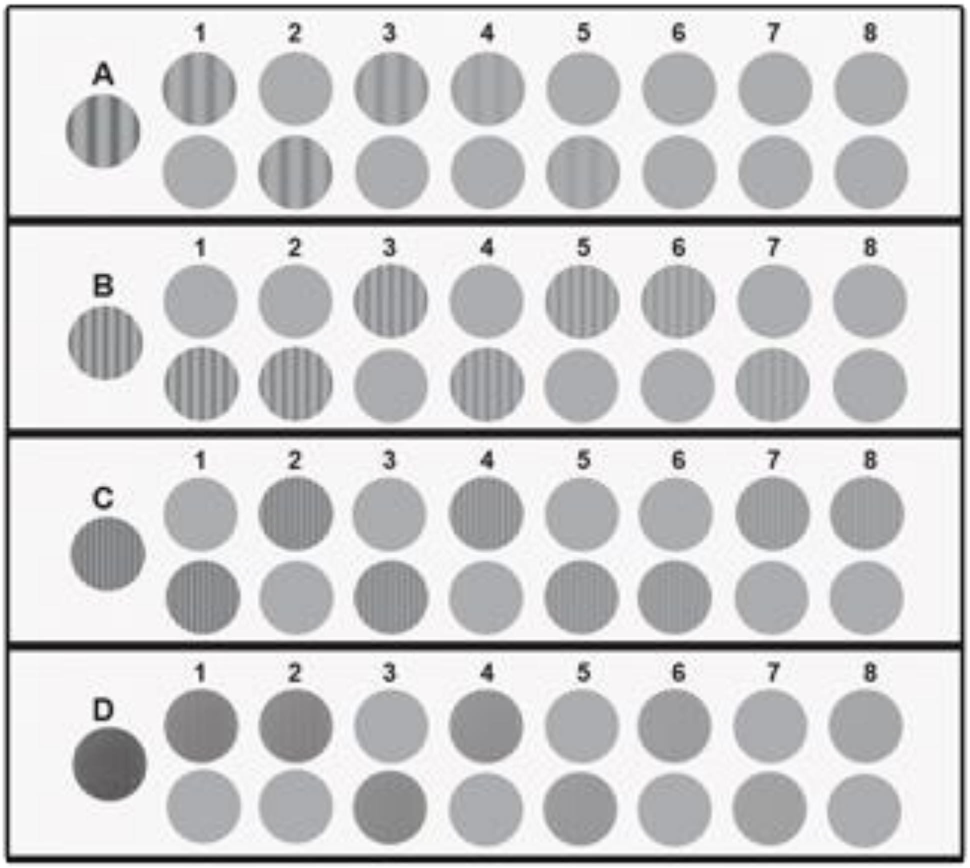
A person with low contrast sensitivity may have such vision difficulties as:

- Trouble seeing traffic lights or cars at night
- Not being able to see spots on clothes, counters, or dishes
- Missing facial gestures
- Not seeing whether a flame is burning on a stove
- Needing a great deal of light to read
- Experiencing tired eyes while watching television.

How Is Contrast Sensitivity Testing Performed?

Contrast sensitivity tests measure the degree to which this ability has been lost. Unlike the Snellen visual acuity test, which measures the ability to see objects (or letters) of different sizes, a contrast sensitivity test measures two variables, size, and contrast. The ability to detect objects of different sizes at lower contrasts is expressed as a contrast sensitivity function (CSF). The test determines the person's contrast detection threshold, the lowest contrast at which a pattern can be seen.

Typically, the best scores of CSF are recorded for medium-sized objects when their contrast is low. The smallest objects can be detected only when their contrast is very high. Imagine an image comprising vertical black and white stripes. If the stripes are very thin, individual stripes will not be visible. Only a gray image is visible. As the stripes then become wider, there is a threshold width from where it is possible to distinguish the stripes.



The fact that larger objects require higher contrast is explained not by how the eye gathers information but by how the brain processes that information. The brain is relatively insensitive to what neurologists call "low spatial frequencies." Contrast sensitivity readings are presented as a curve, which plots the lowest contrast level at which a person can detect an object of a given size. The higher the contrast sensitivity, the lower the contrast level at which an object can be seen.

Why is contrast sensitivity testing important?

CSF measurements can be important in diabetes and cataract medicine. Cataracts are a clouding of the eye’s natural lens, which causes light to scatter on the retina, reducing image contrast and causing dimness of vision. Many cataract patients have good visual acuity, but they still notice a loss of their visual capability. Contrast sensitivity testing can provide a true "real world" vision of a patient’s functional vision. Tests of contrast sensitivity are normally done before and after cataract surgery, to document the degree of improvement that has been achieved.

Studies in recent years suggest that early signs of diabetic retinopathy can be detected by evaluating contrast sensitivity. A person with diabetes may have a 20/30 score for visual acuity and still be experiencing eye damage that requires treatment to prevent progression. A low CSF score for a patient with good visual acuity is an indication of diabetic retinopathy. So is a difference in readings of contrast sensitivity between the two eyes.

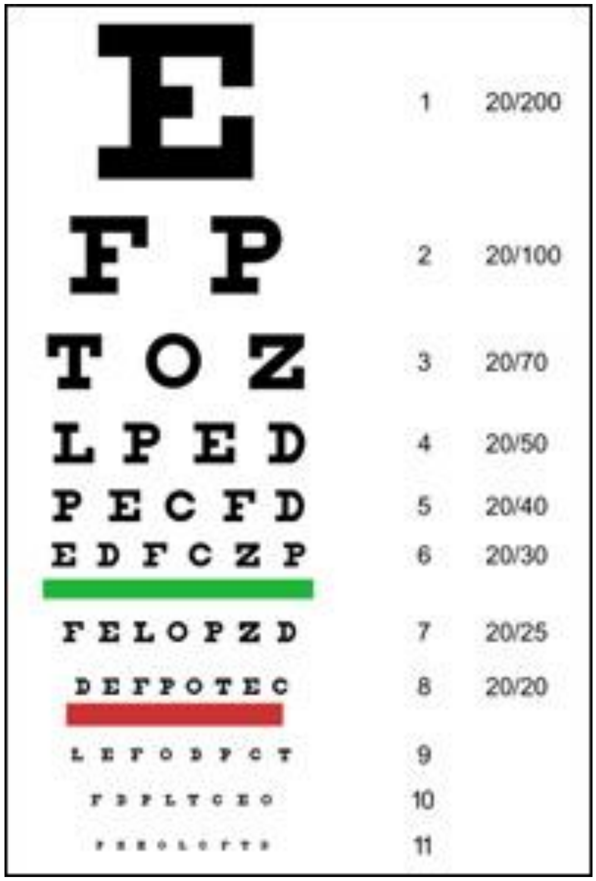
Visual Acuity (VA)

Visual acuity (VA) is acuteness or clearness of vision, especially form vision, which is dependent on the sharpness of the retinal focus within the eye and the sensitivity of the interpretative faculty of the brain.

The normal eye can distinguish two points separated by an angle of one minute. Each letter on an acuity chart subtends a five-minute angle to the eye independent of distance.

VA is a quantitative measure of the ability to identify black symbols on a white background at a standardized distance as the size of the symbols is varied. It is the most common clinical measurement of visual function. In the term "20/20 vision" the numerator refers to the distance in feet from which a person can reliably distinguish a pair of objects. The denominator is the distance from which an 'average' person would be able to distinguish —the distance at which their separation angle is 1 arc minute. The metric equivalent is 6/6 vision where the distance is 6 meters. Twenty feet is essentially infinity from an optical perspective (the difference in optical power required to focus at 20 feet versus infinity is only 0.164 diopters). For that reason, 20/20 vision can be considered nominal performance for human distance vision; 20/40 vision can be considered half that acuity for distance vision and 20/10 vision would be twice normal acuity. The 20/x number does not directly relate to the eyeglass prescription required to correct vision; rather an eye exam seeks to find the prescription that will provide at least 20/20 vision.

First, check the patient's acuity with their current prescription. If the patient correctly identifies half of the letters on the line, record the acuity minus the number of letters missed. Example: 20/30 -2. If it is less than 20/20, you use the pinhole test to see if a new refraction may improve their acuity. The pinhole test is done with the patient looking through a pinhole in an occluder. The pinhole screens out the out-of-focus light rays and allows the in-focus or axial rays to strike the retina. This reduces the diameter of the blur circle improving visual acuity. If the pinhole acuity shows improvement, a change in prescription should help. If there is no improvement with the pinhole, it may be a medical problem causing the reduction in acuity.



Reduced Acuity Testing

Some patients will be unable to recognize even the largest letters at the standard testing distance. By reducing the testing distance or using a special chart with larger letters, we may be able to measure the patient's acuity. Some patients may only be able to count fingers (CF) at a close distance. For example, CF @ 4ft. means the patient was able to count how many fingers you held up at a distance of four feet. Light projection indicates that the patient can identify the position of a penlight when it is moved to an up, down, left or right position. Light perception indicates that the patient can tell if the lights are on or off. If the patient has no light perception (NLP) they are totally blind.

Accommodation

Accommodation is the process by which the crystalline lens of the eye changes shape which changes the lens's optical power to maintain a clear image (focus) on an object as its distance changes.

The young human eye can change focus from distance to 7 cm from the eye in 350 milliseconds. This dramatic change in focal power of the eye of approximately 15 diopters (a diopter is 1 divided by the focal length in meters) occurs as a consequence of a reduction in zonular tension induced by ciliary muscle contraction. The amplitude of accommodation declines with age. By the fifth decade of life, the accommodative amplitude has declined so the near point of the eye is more remote than the reading distance. When this occurs the patient is presbyopic. Once presbyopia occurs, those who are emmetropic (do not require optical correction for distance vision) will need an optical aid for near vision; those who are myopic (nearsighted and require an optical correction for distance vision), will find that they see better at near without their distance correction; and those who are hyperopic (farsighted) will find that they may need a correction for both distance and near vision. The age-related decline in accommodation occurs almost universally, and by 40 years of age, most of the population will have noticed a decrease in their ability to focus on close objects. This is commonly referred to as presbyopia.

It is normally accompanied by a convergence of the eyes to keep them directed at the same point, sometimes termed accommodation convergence reflex.

The push-up method determines the near point of accommodation by moving a test object closer to the eye until it blurs. The near object is usually the 20/20 line on a near acuity card.

Near Point

The closest distance at which an object can be brought into sharp focus is called the near point of accommodation. As we get older, the lens undergoes changes which cause the near point to get farther away.

When determining near viewing distance, it is recommended not requiring more than half of the eye's ability to accommodate to be used for comfortable viewing.

Far Point of the Eye

The far point of the eye is the object point imaged by the eye onto the retina in a non-accommodated eye. If a corrective lens is used to correct for myopia, the lens has its secondary focal point coincident with the far point of the eye.

The far point of the emmetropic eye is at infinity. Myopia exists if, without accommodation, a point at infinity is imaged in front of the retina (in the vitreous). The stimulus on the retina is therefore not a point, but a blur circle. Moving the object closer to the myopic eye, until the image is a point focus on the retina, establishes the far point of the eye.

Hyperopia exists if, without accommodation, an object point at infinity is imaged neither in the vitreous nor on the retina, but theoretically, behind it.

Chart Abbreviations

These are commonly used abbreviations found on patient charts. They will be helpful when reviewing the patient’s previous visits.

- VA Visual Acuity
- Cc With correction
- Sc Without correction
- N Near
- D Distance
- PH Pinhole
- J Jaeger notation

Preliminary Tests

The preliminary tests are performed to gain information regarding the patient's refraction and functional vision. Based on the patient history all or some of these tests may be performed. They include vision assessment, visual fields, accommodation, convergence, color vision testing, and ocular muscle deviations. In addition, the most current previous glasses need to be neutralized to determine the changes in vision. This gives the refractionist a starting point for the refraction.

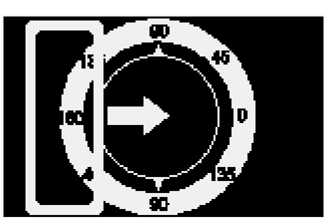
Objective Refraction: Retinoscopy

The purpose of retinoscopy is to objectively determine the refractive status of the patient's eyes. The results of retinoscopy can be used as the starting point for the subjective refraction or the final prescription for a non-verbal patient. The Retinoscope consists of a light source, a condensing lens, and a mirror. The mirror is either semi-transparent or has a hole in it through which the operator can view the patient's eye and the beam of light. A Spot Retinoscope projects a circular beam of light on the patient's retina. The Streak Retinoscope projects an oblong beam and is the most popular Retinoscope used today.

As the light bounces off the retina in the back of the eye, movement of the reflection or retinoscopic reflex can be observed. The motion is compared to the movement of the Retinoscope. If the reflex moves in the same direction as the Retinoscope, it is referred to as "With Motion", which indicates that the eye is hyperopic and requires plus lenses to correct it. If the reflex moves against the direction it is referred to as "Against Motion", which indicates that the eye is myopic and requires minus lenses to correct it. If you observe no motion and the pupil fills with light, you have neutralized the eye.

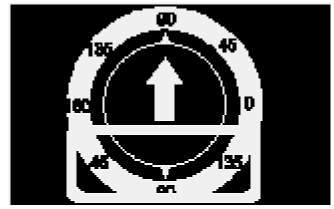
Retinoscopy Procedures

To begin the retinoscopy procedure, the patient is positioned behind the Phoropter and asked to focus on a distance acuity chart, even if the letters are blurry. It is important that they not look at the Retinoscope light or the operator. The operator uses their right eye to check the patient's right eye so as to avoid blocking their view of the chart. The operator will hold the Retinoscope a set distance away from the patient's eye, known as the "Working distance". The beam from the Retinoscope will be slightly divergent because the operator will be closer than optical infinity. The operator must add plus power to the lens system to compensate. The compensation is calculated using D = 100cm/f. For example, if the operator is 66cm away from the patient, D = 100/66, the needed plus power would be +1.50. Most Phoropters have a built-in working lens of either +1.50D or +2.00D that can be positioned in the eye aperture.



Where the beam strikes and extends beyond the eye aperture is known as the Intercept. The retinoscopic reflex from a Streak Retinoscope will parallel the intercept scissors movement. You would then rotate the beam until the reflex aligns with the intercept.

To check a meridian for motion, the beam is positioned 90 degrees away. For example, when the beam is vertical, you are determining the motion in the horizontal meridian. As the motion is observed, lenses are changed in the Phoropter until neutrality is achieved. To verify neutrality, move toward the patient and you should observe "With Motion". If you move away from your working distance, you should observe "Against Motion".



Subjective Refraction

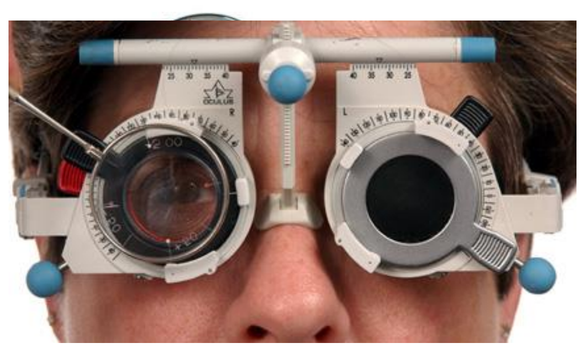
The starting point for the subjective refraction could be the patient's current Rx, the results of an auto refractor or retinoscopy. The Patient should be informed that they will be presented with different lens choices and be asked to tell which one is clearer. If they can't tell the difference between two lenses just say they are the same.

Subjective Refraction: Sequence

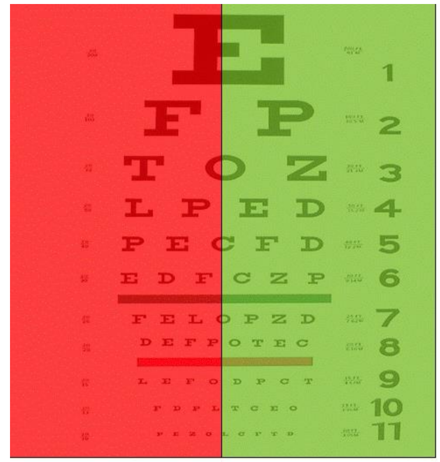
The subjective refraction takes into account the patient's response to several tests. The sequence of the subjective exam is important to achieve reliable results. The starting point prescription should be in the Phoropter prior to positioning it in front of the patient's eyes. Initially, each eye should be refined separately with the other eye occluded. The cylinder axis is the first component to be refined. The most popular method to refine first the axis and then the cylinder power is the Cross Cylinder test. We will discuss this test in detail on the next below. After the cylinder, the sphere power is refined to avoid too much minus or plus power. The Duochrome or Bichrome Test is helpful and will be discussed later. The last step in the sequence is to make sure that both eyes are seeing well together. We will discuss binocular balancing and the use of the Prism Dissociated Test and the Duochrome.

Jackson Cross Cylinder (JCC) Test

The Jackson Cross Cylinder can fine both cylinder axis and power. It has a minus cylinder (usually -0.25D) perpendicular to a plus cylinder axis of the same power. Our discussion will assume you are using a minus cylinder Phoropter. To refine the cylinder axis, the knurled knob used to flip the lenses is positioned at the parallel to the correcting cylinder axis. This positions the plus and minus cylinder lenses 45 degrees away from the cylinder axis. When the lens is flipped, the position of the plus and minus cylinder is reversed. As the lens is flipped, the patient is asked if they see better at position one or two. The cylinder axis is then rotated a few degrees to the direction of the red dot on the Cross Cylinder and the lens is flipped again. When the patient reports no difference in the two positions, the axis has been located. The next step is to refine the cylinder power. The Cross Cylinder is rotated until its axis aligns with the cylinder axis. The lens is then flipped again and the patient is asked to identify the preferred position. If the vision is better when the red dot is aligned with the cylinder axis, the cylinder power should be increased. If they like the vision when the white dot is aligned with the cylinder axis, the cylinder power should be reduced.

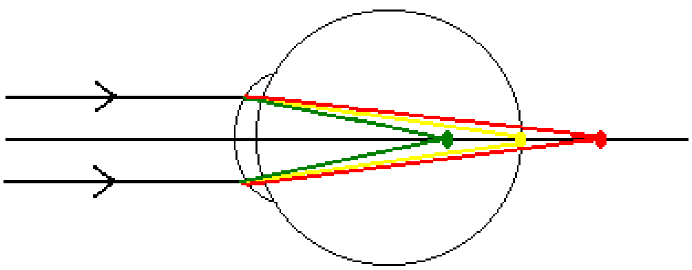


Refining the Sphere Power



To refine the sphere power, the patient's vision should now be "fogged" by adding a +1.00D to the sphere power or reducing the minus power by 1.00D. This will relax the patient's accommodation and help avoid prescribing too much minus power. The patient should still be able to see the 20/30 or 2/40 line on the acuity chart. You then ask the patient to look at the 20/20 line and tell you when they can just read it as you add minus power in 0/25D steps.

The end result can be checked using the Duochrome test. A filter in the projector will cause one-half of the acuity chart letters to be red and the other side green. The eye is most sensitive to the yellow wavelengths of light in the visible spectrum.



When the yellow light is focused on the retina, the shorter green wavelengths are focused in front of the retina and the longer red wavelengths are focused an equal distance behind the retina. If the sphere power is properly refined, both sides of the chart should appear equally clear. If the green side is clearer, the patient is over minused and the green wavelengths have been moved closer to the retina. If the red side is clearer, the patient is over plussed and the red wavelengths have been moved closer to the retina.

Medications Used During Refraction

Mydriatic drops act on the iris muscles causing the pupil to dilate. This allows the doctor to examine the posterior segment of the eye. Neo-Synephrine, Paredrine ad Epinephrine are some common mydriatic agents. Cycloplegic drops work on the pupil causing it to dilate and they paralyze the ciliary muscle to inhibit accommodation. Their use will be discussed as part of a cycloplegic refraction.

Miotics are used to stimulate the sphincter muscle of the iris causing it to constrict. It may be used to treat glaucoma as it improves the outflow. It may also be helpful in reversing an inadvertent angle closure due to the use of mydriatics or cycloplegics. The most common miotics are Pilocarpine and Carbachol.

Topical anesthetics are also used when the doctor performs surgery or removes foreign bodies. Ophthain, Ophthetic and Pontocaine are commonly used topical anesthetics.

Cycloplegic Refraction

The purpose of a cycloplegic refraction is to measure the patient's refractive error in the absence of accommodation. It is needed for small children and when latent hyperopia is suspected. The cycloplegic agents paralyze the ciliary body. The patient's IOP (intraocular pressure) and the depth of the anterior chamber should be checked prior to the drops being administered. Cycloplegics have a mydriatic effect causing the iris to dilate. This dilation could cause an angle closure.

Cycloplegic Agents include:

- Atropine 0.5% or 1%
- Cyclopentolate 0.5% (Infants) or 1%
- Homatropine 2% or 5%
- Tropicamide 0.5% or 1%

Atropine is one of the most powerful cycloplegic agents and its effects can last up to two weeks. *Cyclopentolate* takes effect in thirty minutes and lasts 3 – 6 hours. *Homatropine* has effects in between atropine and cyclopentolate and wears off in 1 to 3 days. *Tropicamide* is the shortest acting cycloplegic taking effect in 20 minutes and lasting for about 20 minutes.

Visual Evaluation - Far Point - Distance

Visual evaluation to determine the far point for distance vision may mean that the refractionist is able to use projection charts. However, to get an accurate acuity of a visually impaired patient can be a problem. The largest letter or optotype is usually 20/200. In addition, there are no optotypes between 20/100 and 20/200 on standard charts. That means that the test distance will probably have to be reduced. Hand held charts can be used to reduce the testing distance. Special low vision charts have letter sizes up to 20/700. Low illumination may not be satisfactory so the chart should be well illuminated for the best results.

Converting to 20 Foot Notation

If you had to reduce the testing distance, the top number is the reduced distance and the bottom number is the size of the letter recognized. To convert the acuity, multiply the top number by the number needed to produce an answer to twenty. Then multiply the bottom number by the same integer. Example: 5/100 = 5x4 / 100x4 = 20/400

Convergence

The purpose of the Near Point of Convergence Test is to determine the patient's ability to converge the eyes while maintaining fusion. A penlight or transilluminator can be used for initial screening. The patient is instructed to look at the light and report how many targets they see. If it appears doubled, move it further away until it appears single. Move the target toward the eyes until the patient reports that it appears double or you see one eye lose fixation on the target. The distance at which this occurs is known as the break point. A break point greater than 7cm is considered abnormal.

Binocular Balance

The purpose of Binocular Balancing is to make sure that the accommodation of both eyes is equally relaxed. The most common way to accomplish this is to use the six diopter auxiliary vertical prism lens available in most Phoropters. This causes the patient to see two charts with one above the other. The patient is again fogged and then asked if the letters on both charts are equally sharp. If they are equal, the fog is removed simultaneously by reducing plus 0.25 at a time until maximum acuity is achieved. The duochrome filter can be used with the prism dissociation to help determine which eye should be adjusted.

Testing for Muscle Problems

The Maddox Rod is a group of either red or clear parallel glass rods that act as a cylinder to dissociate the eyes. When placed in front of one eye, it converts a white point of light into a line perpendicular to the axis of the rods. It is helpful in detecting phorias and tropias. If a red Maddox rod is placed horizontally in front of the right eye, the patient sees a vertical red line when viewing a white dot of light on the screen. The left eye will still see the white dot. If there are no vertical muscle problems, the red line will pass through the white dot. If the red line appears on the right side of the dot, the patient has an esophoria or esotropia. To measure the deviation, prisms are placed in front of the eye until the line passes through the white dot. This is easily done using the Risley's Rotary prism located on most Phoropters. It provides a method of rapidly increasing prism power without having to use individual prisms.

Ocular Muscle Deviations

The tests used to detect muscle deviations are known as the Alternating Cover and Cover/Uncover test. These tests are used to determine phorias and tropias. A phoria is a tendency of the eye to turn when fusion is broken. A tropia is a definite turning of the eye.

The cover test is one of the most widely used tests for detection and measurement of strabismus by an examiner. During a cover test, the patient looks at a fixed object. An occluder is placed in front of one eye, for 2-3 seconds, then the occluder is moved to the other eye and the examiner observes and records any movement of the eyes. This process can be repeated several times until you have correctly noted the direction of eye movement as the eye is uncovered. If the eye moves in when uncovered, it has an Exo deviation, if it moves out it is an Eso, if it moves up, it is a Hypo and down for a Hyper. The Cover/Uncover Test will determine if the deviation is a phoria or a tropia. If the patient has a phoria, each visual axis will be aligned with the target when both eyes are open.   If the patient has a tropia, one visual axis will align with the target and the other visual axis will be misaligned with the target when both eyes are open.

Diplopia

Diplopia is defined as double vision. It is the perception of two images from a single image. Rarely, it may occur in one eye only (monocular), but more commonly in an abnormal positioning of the two eyes in relation to each other.

A double image is seen by the brain caused by a muscular imbalance in one or more muscles of the eye overcoming the brain's desire for fusion.

Tonicity

Tonicity - The state of slight contraction of all six extraocular muscles of the eye while at rest in order to hold the eye steady in a fixed position.

Tonicity is defined as the state of healthy tension or partial contraction of muscle fibers while at rest; tone; tonus.

Fusion

Fusion is defined as the cortical integration of the images received simultaneously by the two eyes. It is the function of merging simultaneous bilateral retinal images into a single perceptual image; sensory fusion.

Fusion - The ability of the brain to form a single image by coordinating the movements of the two eyes so that the visual images fall on corresponding areas of the retinas of the two eyes.
Stereopsis

Stereopsis is a higher quality of binocular vision. Each eye views an object at a slightly different angle so that fusion of images occurs by combining slightly dissimilar images. It is the combination of these angular views that yields stereopsis (3-D vision). Depth perception is the impression of relative or absolute differences in the distance of objects from the observer; it may be achieved with one eye (relative) or with two eyes (binocular). Stereopsis is true, three-dimensional depth perception achieved by slightly dissimilar images falling on corresponding retinal points in the two eyes. It is not obtainable with one eye. It must have the same image size and be in the same location on the retina. The Stereo Fly test is used to establish gross stereopsis. It gives the eye care provider some sense of the patients' ability to perceive depth. It is used in conjunction with Polaroid 3-D Vectograph lenses. This test is useful for young children that may have difficulty following instructions. With the Stereo Fly, the patient wears the cross-polarized filters and is asked to touch the fly's wings. This is a gross assessment. The patient will reach above the page to touch the wings if they have three-dimensional vision. If they will touch the page, they do not have gross stereoposis and are seeing the fly as one-dimensional. Gross perception of the fly wings is recorded as 3,000 seconds of arc. Keep in mind that because you are not wearing the cross-polarized filters, you will not see the perception of the wings off of the page. Intermediate stereopsis can be measured using the animals in rows A, B and C on the page opposite the fly. The patient is to report which animal in each row seems to be popping off of the page. Row A is a cat and represents 400 seconds of arc. Row B is a rabbit representing 200 seconds of arc. Row C is a monkey representing 100 seconds of arc. Fine stereopsis can be measured in the same way. The diamond shapes on the upper area of the same page have circles at each point. In each diamond shape, one of the circles appears to lift off the page. The patient reports the location of that circle in each diamond. The last figure measures 40 seconds of arc. Reassure the patient that there are no incorrect answers. It is fine if the figures seem one dimensional as this is simply an evaluation.

Muscle Imbalances – Terminology

Orthophoria - ortho (correct) + phoria (carrying)
Eyes that are “carried correctly”
Proper extraocular muscle tonicity is maintained
Fusion takes place because an image is formed on corresponding points of each retina
Heterotropia -hetero (different) + tropia (turning)
Turning in different directions
Strabismus, squint, crossed-eyes
Eccentric fixation in which the non-fixating eye is turned in another direction, thus retinal images fall on non-corresponding points of each retina.

Strabismus - a disorder in which the two eyes are not correctly aligned. If untreated it can lead to amblyopia - also called "lazy eye" - a condition in which the vision in one eye deteriorates. Strabismus and amblyopia are together the most common causes of visual impairment in children.

Strabismus, more commonly known as crossed-eyes, is a vision condition in which a person cannot align both eyes simultaneously under normal conditions. One or both of the eyes may turn in, out, up or down. An eye turn may be constant (when the eye turns all of the time) or intermittent (turning only some of the time, such as, under stressful situations or when ill). Whether constant or intermittent, strabismus always requires appropriate evaluation and treatment.

Amblyopia is a term for loss of vision in one or both eyes, with no organic pathologic condition in the eyes or optic nerve.

- Eso - Turning in
- Exo - Turning out
- Hyper - above - up
- Hypo - below - down
- -phoria - tendency to turn
- -tropia - definite turning

Esotropia (Cross-eyes) is defined as a misalignment of the eyes in which one or, less commonly, both eyes turn inward or nasally particularly seen with hypermetropia. This is also referred to as a convergent squint. The eye has a definite turning in. This is sometimes referred to as Boss-eyed.

Exotropia is defined as divergent strabismus. Turning laterally or temporally of one, or rarely, both eyes. It is a definite turning out of one or both eyes. It is also sometimes referred to as Wall eyes.

Hypertropia is defined as an upward deviation of one eye while the other eye remains straight and fixates normally. It is a vertical turning upward of one eye. It is a definite turning upward of one eye.

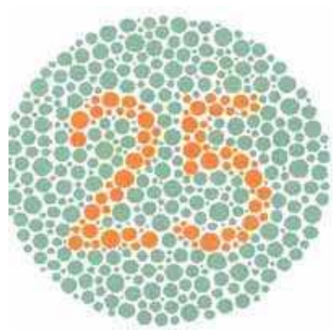
Hypotropia is defined as a downward deviation of one eye. It is a vertical turning down of one eye. It is a definite turning down of one eye.

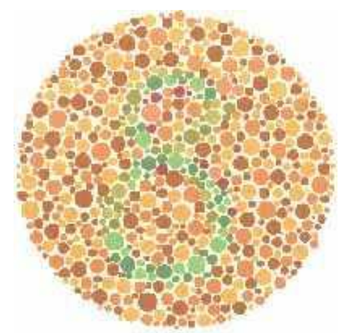
Phorias

- Esophoria
    - A tendency of the eye to turn in
- Exophoria
    - A tendency of the eye to turn out
- Hyperphoria
    - A tendency of the eye to turn up
- Hypophoria
    - A tendency of the eye to turn down.

Color Vision

The purpose of color vision testing is to screen for acquired or hereditary color vision defects. While many people use the term color blindness, there is in reality almost no true color blindness. Any discrepancy in color perception is more correctly referred to as color deficiency, not color blindness. Congenital color defects occur in 8% - 10% of the male population and .4% of the female population.





The retinal receptors consist of rods and cones with cones being responsible for day vision, central visual acuity, and color vision. These cone cells react to certain wavelengths or colors. Colors are interpreted into three primary colors of red, green and blue. There are three classifications of color vision which are:

- Trichromatism: using all three primary colors
- Dichromatism: using two primary colors
- Monochromatism: absence of any color sensation, seeing everything in the same color (which is very rare)

Color deficiencies are categorized by the color:
- Protanomalous: red
- Deuteranomalous: green
- Tritanomalous: blue-yellow

The Ishihara book consists of a series of pseudoisochromatic plates that determine the type of color deficiency. Standard testing distance for color vision is 70 - 75 cm while the patient is using their vision correction under standard illumination. Patients should give prompt responses to the patterns or numbers on each page. The tester will record the number of correctly identified plates, a slash mark, and then the number of plates tested. For example, if the patient was tested on 12 plates, and they got 10 correct on the right eye and 12 correct on the left eye, it would be recorded thusly:

OD 10/12 OS 12/12 Ishihara

The Farnsworth D-15 Dichotomus Test is another test that is used for color discrimination. Again, the patient wears vision correction and uses standard daylight illumination. In the Farnsworth D-15, the patient is asked to arrange discs in color sequence in a tray.

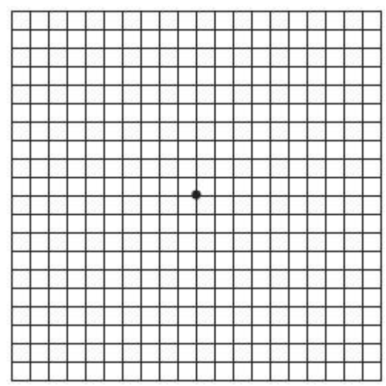
The Farnsworth-Munsell 100 Hue test is also used for hue discrimination. With the Farnsworth-Munsell 100 test, the patient is given four separate trays and asked to arrange the 85 colored discs in color hue sequence.

Visual Fields:

A patient with normal binocular vision has a visual field of approximately 190 degrees. Normal Monocular: 95 degrees outward, 60 degrees inward, 75 degrees downward, 60 degrees upward.

Conditions such as Glaucoma and Retinitis Pigmentosa will reduce the peripheral field of view. Macular Degeneration will create a central field loss including a scotoma (blind spot). Testing includes the use of automated perimeters, tangent screens, and Amsler grids.

A patient with normal binocular vision has a visual field of approximately 190 degrees. Conditions such as glaucoma and Retinitis Pigmentosa (RP) will reduce the peripheral field of view. The peripheral field can be evaluated with a perimeter which is an instrument that measures the angular extent of the visual field. Perimeters also identify scotomas or blind spots in the visual field. Macular Degeneration will create a central field loss. A central field loss can be detected by having the patient view an Amsler Grid and describe if the lines are wavy or if a dark spot is located in the center of the grid. A Confrontation Test is a rough method of determining the approximate extent of the visual field. The patient, with one eye occluded, faces the examiner at a distance of 60cm and fixates on the opposite eye of the examiner. The test object is moved around a plane midway between the examiner and the patient, starting far in the periphery and moving it towards the patient in various meridians until it is seen.



Low Vision

Not all patients are correctable to 20/20 vision. These visually impaired patients may benefit by using optical and non-optical devices in addition to their spectacles.

Legal Categories

Visual Acuity defines certain legal benchmarks. For example, in the State of Florida, to renew a driver's license, the driver must pass a Motor Vehicle Department vision test. If their acuity is less than 20/40, they fail the test. They then have the option to go to an Ophthalmologist or Optometrist. If the doctor will certify that their acuity is at least 20/70, they can renew their license. Another important level is 20/200. This level defines legal blindness entitling the patient to additional support services and tax credits. It is interesting to note that only 25% of the legally blind population is totally blind.

Convergence

The purpose of the Near Point of Convergence Test is to determine the patient's ability to converge the eyes while maintaining fusion. A penlight or transilluminator can be used for initial screening. The patient is instructed to look at the light and report how many targets they see. If it appears doubled, move it further away until it appears single. Move the target toward the eyes until the patient reports that it appears double or you see one eye lose fixation on the target. The distance at which this occurs is known as the break point. A break point greater than 7cm is considered abnormal.

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