General Refraction Techniques

Prior to starting your refraction, baseline visual acuities (OD, OS and OU) must be determined. For individuals with near vision complaints, and all presbyopes, near acuity should also be documented using M notation, with the testing distance documented if different than 16 inches (40 centimeters).

Accurately assessing visual acuity is important for many reasons. It allows clinicians to:
- Determine best corrected acuity with refraction
- Monitor the effect of treatment and/or progression of disease
- Verify eligibility for tasks such as driving
- Verify eligibility as "legally blind"

When measuring distance acuity, there is no longer a need to measure visual acuity in a darkened room. In the past, when projected charts were used, the room lights had to be lowered for better contrast on the chart. Now, with high definition LCD monitor acuity charts and ETDRS charts, contrast is no longer an issue. Additionally, for some patients, particularly those with difficulties adjusting to lower lighting conditions, taking them from a normally lit waiting room into a darkened clinic or work up room will artificially lower their acuity, because they do not have enough time for their eyes to adjust to the lower light conditions. Because clinical decisions are based on these acuity measurements, accurate assessment of each person's acuity is critically important.

With this in mind, all acuity testing should be done with the overhead lights on in the exam or work up room. However, if the patient you are working up complaints of photophobia and asked to have the lights lowered, definitely do that and simply note in the record that the recorded acuities were done with the lights down or off, or with the patient wearing their sunglasses, or whatever the situation is that varies from the lights on norm.

When doing retinoscopy, you will want the lights lowered. But, once you start your refraction, you will achieve greater accuracy when you refract with the lights on. Keeping the lights up during your refraction is important in an effort to avoid over minusing your patients. When someone is over minused, the chart will look darker, which can be mistakenly thought of as better.

Pinhole Visual Acuity: For individuals who do not have any type of ocular disease, a pinhole aperture can be a useful tool in determining if a refractive error is present or if a refractive change is needed. The most useful pinhole diameter for clinical purposes is 1.2 millimeters. This size pinhole will be effective for refractive errors of +/- 5.00D. A pinhole improves visual acuity by decreasing the size of the blur circle on the retina resulting in an improvement of the individual's visual acuity. However, if the pinhole aperture is smaller than 1.2 millimeters, the blurring effects of diffraction around the edges of the aperture will actually increase the blur circle, causing the vision to be worse.

Individuals with macular disease, as well as other ocular diseases that affect central vision, may have similar or even reduced acuity when looking through a pinhole. This is because the reduced amount of light entering through the pinhole makes the chart less clear. Additionally, it can be difficult to use eccentric fixation through a pinhole. For this reason, individuals with ocular disease should not be told that a spectacle correction change will not improve their vision, based solely on their looking through a pinhole. Careful retinoscopy along with a trial frame refraction is needed to determine whether an individual with pathology induced vision loss will benefit from a spectacle correction change.

Standard Subjective Refraction Techniques

Plus cylinder phoropter

The goal of the subjective refraction is to achieve clear and comfortable binocular vision.

The ability of the refractionist to maintain control during the refraction is directly related to their ability to communicate clearly and directly with the patient.

The subjective refraction starts after retinoscopy, or after auto refraction. Retinoscopy or auto refraction provides the refractionist with an objective assessment of the patient's refractive error. It is possible to start with the patient's previous RX. However, this is the least desirable way to start a refraction, because there is no objective information about the patient's current refractive error.

For purposes of this document, the starting point will be from the objective determination of refractive error by auto refraction. Whether you start your refraction with the auto refraction findings, or after retinoscopy has been preformed, you will first check acuity in each eye separately and then proceed to the Initial Maximum Plus to Maximum Visual Acuity (MPMVA) step.

Set up for Subjective Refraction

- Before putting the phoropter in front of the patient, put the auto refraction findings in the phoropter and unocclude both eyes.
- After positioning the phoropter in front of the patient, level the phoropter and make sure the interpupillary distance is properly adjusted.

Initial Maximum Plus to Maximum Visual Acuity (MPMVA)

- Next, occlude the left eye, put several lines of letters on the eye chart (20/20 – 20/50 or 20/15-20/40) and ask the patient to read the smallest line they can.
- Assuming the patient can read the letters being presented; begin by adding +0.75D to the phoropter. This should result in the lost of 2-3 lines of vision.

- If there is no loss of vision, add another +0.75D and make sure there has been a decrease in vision from your starting point, of 2-3 lines.
- Next, slowly decrease the power in the phoropter (less plus or more minus), in 0.25D steps, until the patient is able to see the 20/20 or 20/15 line or until there is no further improvement in vision. Expect about a one-line improvement on the eye chart for every -0.25D added.
- Once you have achieved the initial maximum plus to maximum visual acuity, the patient's cylindrical correction can be refined.

Refining Cylinder Axis and Power

- Swing the Jackson Cross Cylinder (JCC) in front of the patient's eye to refine cylinder axis and power.
- As a general rule, if the patient's refractive error is primarily cylindrical, or if by auto refraction you found 1.00D of cylinder or more, start by checking the cylinder axis first. Otherwise, start by checking the cylinder power first.
- To check the cylinder axis first, position the JCC so that the white and red dots straddle (45 degrees on either side) the cylindrical axis.
- With the patient looking at either a single line of letters, one line larger than their best visual acuity found during the initial MPMVA, or the same grouping of letters you started with,
- Tell the patient, "I am going to give you two choice, neither choice will be perfectly clear, however, I want you to tell me, which lens choice is clearer; choice one or choice two; choice three or choice four, etc.?"
- Be sure to use fresh choices and new numbers with each pair of choices presented.
- Move the axis in the direction of the white dot, initially in 15-degree increments, for individuals with 2.00D of cylinder or less. You will decrease the increments size, following a reversal (15 to 10 to 5 to 3 to 1 degree), as the axis is refined.
- For individuals with more than 2.00D of cylinder, start with 5-degree increments, decreasing the increment size following a reversal (5 to 3 to 1 degree), until the axis is refined.
- Next, to check cylinder power, adjust the position of the JCC so that the white or red dots correspond with the cylinder axis.
- Ask the patient, which lens choice is clearer, choice one or choice two, etc.?
- If the patient chooses the white dot, add +0.50D of cylindrical power while remembering to add -0.25D of spherical power (to maintain spherical equivalent).
- If the patient chooses the red dot, remove +0.50D of cylindrical power and add +0.25D of spherical power (to maintain spherical equivalent).
- Once the patient reverses; chooses the red dot after previously choosing the white or vice versa, adjust the cylinder power by 0.25D in the opposite direction of your previous change. The spherical power does not need to be adjusted for this 0.25D change.
- Once again, check the cylindrical power with the JCC to see if the patient wants more or less power. The goal is to give the least amount of cylindrical power that provides the clearest vision.

- Once the cylindrical power and axis have been refined with the JCC, remove the JCC from in front of the patient's eye and ask the patient to read the smallest line they can.
- Remember, if the starting cylinder power is 1.00D or greater, check the cylinder axis first. Only for cylinder powers less than 1.00D, will you check the cylinder power first.

Cylinder Power Search

- If retinoscopy, auto refraction and/or lensometry suggest no cylinder was needed and you suspect there may be some, do a cylinder power search.
- With your JCC oriented for power at 90 and 180 degrees, ask the patient, which is better, choice one or two.
- If no preference, repeat at 45 and 135 degrees.
- If the patient has a preference, add +0.50 cylinder at the axis where the white dot is oriented, along with -0.25D sphere to maintain spherical equivalent.
- Using standard JCC technique described above, refine the cylinder power and axis.

Second Maximum Plus to Maximum Visual Acuity (MPMVA)

- This step is performed when cylinder power has changed 0.50D or more, and/or if cylinder axis has changed by 10 degrees or more during cylinder power and axis refinement.
- Begin by adding +0.50D to the phoropter. The patient should lose about 2 lines of vision. If the acuity is the same or better, add another +0.50D until the vision is blurred by 1-2 lines of acuity.
- Next, slowly decrease the power in the phoropter (less plus or more minus), in 0.25D steps, until the patient is able to see the 20/20 or 20/15 line or until there is no further improvement in vision.
- Occlude the right eye while un-occluding the left. Repeat the same process for the left eye, beginning with the Initial Maximum Plus to Maximum Visual Acuity.

Binocular Balance

- Once the monocular subjective refraction has been completed for each eye, it is time for the binocular balance. Binocular balancing is only done when the visual acuity is relatively equal between the two eyes.
- Binocular balancing can be accomplished in two different ways. Binocular balancing can be done using the Risley prism on the phoropter or by alternate occlusion. In either case, you should start the binocular balancing procedures by adding +0.75D sphere to both eyes so that the patient's visual acuity is blurred to the 20/30 – 20/40 level. By slightly blurring vision in this way, eye dominance is effectively neutralized during the balancing process. It is important to make sure the patient is mildly blurred before using either of the following binocular balancing techniques.

Risley Prism Binocular Balancing Technique

- Using the Risley prisms, applied 3 prism diopters base up in front of the right eye and 3 prism diopters based down in front of the left eye. This will result in the right eye seeing the lower image and the left eye seeing the upper image.
- Asking the patient to ignore brightness differences (this can be confusing for some patients), have them tell you which image appears clearer. Add +0.25D to the clearer eye to fog it further.
- Again ask the patient which image is clearer, add +0.25D to the clearer eye.
- The end point is reached when either both sets of letters look the same, or when the patient's dominant eye appears slightly clearer than their non-dominant eye.

Alternate Occlusion Technique

- After fogging the patient as noted above, alternately cover one eye and then the other eye while asking the patient which eye sees the chart more clearly; eye one or eye two (to avoid confusion, say “eye one” or “eye two” not “right eye” or “left eye” as you alternately occlude). Add +0.25D to the clearer eye to fog it further.
- The end point is reached when either both sets of letters look the same, or when the patient's dominant eye appears slightly clearer than their non-dominant eye.

Determining the Final Correction

- Once the binocular balance is completed, add -0.25D OU, one step at a time to bring the patient back to their best visual acuity. Remember, you should expect about one line of improvement in vision with each -0.25D you add.
- Do not give additional minus spherical power without an improvement in acuity.

Duochrome Test

- Duochrome (red - green) test - can be used as a monocular or binocular test to determine the proper spherical power. With this test, if the letters on the green side of the chart appear blacker, add +0.25D. If the letters on the red side of the chart appear blacker, add -0.25D. The endpoint is reached when the letters appear equally black on both the red and green side. It is important to ask the patient to tell you which side the letters look "blacker" on, not which side they look "clearer" on.

Considerations when Refracting in a Shorter Room

Shorter examination rooms are common outside of pediatric practices. A shorter room is considered a room less than optical infinity, which is 20 feet or 6 meters. It is important to recognize that when refracting in a shorter lane, vergence and accommodation are in play?

To calculate vergence, use the formula 1/x (meters), or 100/x (cm) or 40/x (in). Given this, the vergence demand in a 10’ exam room is 40/120 = 0.33D. Therefore, when testing acuity in a 10’ lane, the patient is effectively getting an extra -0.33D of refracting power from the shorter room. With this in mind, for every patient refract in a shorter exam room to be focused at infinity, additional minus power needs to added to what was found in the phoropter.

For example, you should add -0.25D for a 10' exam room. Add -0.50D for a 6' exam room.

Consider what happens when testing visual acuity in a shorter exam room. In a shorter room, the patient is getting at least an extra -0.25D of improvement in their vision on the eye chart. This is why someone can have 20/20+2 entrance acuity and still need an extra -0.50D in his or her final RX, to see 20/15. It is important to note that the acuity charts in shorter exam rooms are adjusted to the correct letter height for the room's testing distance, so the visual acuity measured in a shorter exam room is the correct acuity.

Finally, with respect to visual acuity testing, it is important to understand that when a patient leans in to see the chart better, the testing distance can be 12-20" less. A lean of 16 inches in a 10' exam room is equivalent to a one-line improvement in vision. With this in mind, it is important for accuracy to have the patient sit back in the exam chair. No leaning forward.

Cardinal Rules of Refraction

- Refraction is both an art and a science. Given this, it is important to know that patients do not always respond accurately during testing with the Jackson Cross Cylinder, as well as during Duochrome testing. This is why starting with an objective assessment of the patient's refractive error will help you stay on target with your refraction.
- Keep It Simple- keep the description of what you are doing as simple as possible.
- Maintain Your Patience - go slowly when needed and try to make the choices as easy as possible to avoid frustration by both you and your patient.
- Provide Encouragement - particularly when working with patients that are hard to refract.
- Proceed with a Purpose - do not offer more choices than are necessary to establish your endpoint. Boredom and fatigue can result in poor subjective responses.

Our ultimate goal is to make both images looked the same, yet we continually are asking which is better, knowing that the decision gets harder as we get closer to our goal of equality.

Favorite Phrases

- During the subjective portion of the refraction say – "I am going to have you look through two different lenses. Although neither lens may be perfect, I want you to tell me which one looks clearer".
- When the patient becomes indecisive, remember to add - "or do they look the same?" Advise them it is OK to think the choices look about the same.

Prescribing Glasses

Question: What do you check when a patient complains that their new glasses are not as good as their previous pair?

Answer:
1. Ask specifically what the complaint is. Distance? Near? Asthenopia? Diplopia? Pain behind the ears or at the bridge of the nose from ill-fitting glasses?
2. Read the new and old glasses on the lensometer and compare.
3. If you feel the RX is reading different than prescribed on an automated lensometer, check the RX on a manual lensometer to be sure.
4. Remember that digital lenses, particularly digital progressive lenses will not measure exactly to the power prescribed. This is because digital lenses are designed to adjust for the different vertex distances the patient will have when viewing through different parts of the lens.
5. Make sure the old glasses did not have any prism.
6. Check the patient for undetected strabismus with cover testing.
7. Refract the patient again. Possibly, with a cycloplegic agent, if the symptoms warrant.
8. Check the optical centers in comparison with the pupillary centers.
9. Check whether the reading segments are in the correct position.
10. Make sure the new glasses fit the patient correctly.
11. Check whether the old glasses were made in a plus cylinder design using the Geneva lens clock.
12. Check whether the base curve was changed using the Geneva lens clock.
13. Evaluate the patient for dry eyes.
14. If the patient has a high prescription, check the vertex distance. Often is it easier to refract such patients over their old pair of glasses to keep the same vertex distance.
15. Check the pantoscopic tilt. Normally the tilt is 10-15 degrees so that when the patient reads, the eye is perpendicular to the lens. If the tilt is off, especially in relation to the old glasses, the patient may be noticing this change.
16. With postoperative glasses, evaluate for diplopia in downgaze due to anisometropia.
17. Perhaps the add is too strong or too weak. Check the patient using trial lenses and reading material.
18. Sometimes if the diameter of the lens is much larger in the newer frame, the patient may be noticing distortion in the periphery of their lenses. In this situation, encourage a smaller frame. Conversely, if the new frame is significantly smaller, the patient may notice the edges of the lenses or, the reading area of their multifocal lens may be too small to use efficiently. In this situation, encourage a larger frame.
19. Above all, try to test the new prescription in a trial frame with a walk around the office; you do not want to go through this process again.