Introduction

Retinoscopy is an objective measurement of a patient’s refractive error. Known by its many names (skiascopy, scotoscopy, pupilloscopy, shadowscopy, umbrascopy, etc.), the procedure is based on the principle that when light is reflected from a mirror into the eye, the speed with which and direction in which the light will be reflected back and move across the pupil (with/against) depends on the eye’s refractive error.¹

According to the AOA clinical practice guidelines, retinoscopy is part of the visual evaluation protocol for infants, toddlers, preschoolers, and all school-age children.² It can be used to gain insights into the patient’s potential and actual behavior. There are various methods of retinoscopy, with no right or wrong method. One way is not better than another, but rather, one way is used to understand something more specifically than the others. As such, it’s important to be familiar with all methods of retinoscopy—you never know when it will help you make a clinical decision in a complex case.

A review of general optics helps to solidify the understanding of retinoscopy results. When performing standard distance retinoscopy, an image of the patient’s illuminated retina is formed at the patient’s far point.³,⁴ If the patient is emmetropic, parallel rays focus on the retina, and the far point is infinity (retina is conjugate with infinity). In hyperopia, parallel rays focus behind the retina, and the far point is beyond infinity. You will get a reflex movement that moves with your light, and plus (+) lenses will converge rays onto the retina. In myopia, parallel...
rays focus in front of the retina, and the far point is between infinity and the eye. You will get a reflex movement that moves in the opposite direction to your light, and minus (-) lenses will diverge rays onto the retina. The image that is at the far point is located by moving the illumination across the fundus while noting the speed and movement direction of the reflex.

• Slow movement: large refractive error, far from neutrality
• Brisk movement: close to neutral
• With movement: hyperopic, add (+) to neutralize
• Against movement: myopic, add (-) to neutralize

Aside from speed and movement, fundus reflex properties such as the width and brightness of the streak should be noted. The reflex will be brightest when the retinoscope aperture coincides with the far point of the eye, and it will be dim in highly myopic and hyperopic patients.

The orientation of the retinoscopy streak is always perpendicular to the meridian being examined. In distance retinoscopy, the goal is to obtain a neutral reflex (no with or against movement) and to identify the distance refractive error. This is obtained when the far point of the patient coincides with the retinoscope after the practitioner’s working distance is removed. To work out how much has to be removed, remember that the distance from the retinoscope to the patient’s eye is 1/F diopters (F is in meters). The average working distance for practitioners is 66 cm (1.50 D) or 50 cm (2.00 D), which has to be subtracted from the final spherical finding. In spherical refractive error, one spherical lens will provide a neutral reflex in all meridians, while in astigmatic refractive error, when one axis is neutralized, a second meridian will still show movement of the reflex, and there will be a break in alignment between the retinal reflex and the light streak.

While we won’t fully delve into performing distance/static retinoscopy, there are some tips to consider when performing the technique. When working with minus cylinder, always neutralize the most-plus or least-minus meridian first. If both meridians are with motion, neutralize the dimmer, slower meridian first. If both meridians are against motion, neutralize the brighter, faster meridian first. If one meridian is with and one meridian is against motion, neutralize the meridian that has with motion first. Out-of-phoropter testing is preferred for younger and/or uncooperative patients; use a lens rack or loose lenses to neutralize the reflex. Inconsistent/false readings can occur and are largely due to one of the following: the examiner is not aligned with the patient’s visual axis, the examiner has uncorrected refractive error, the working distance is wrong or fluctuating, there is a lack of patient cooperation/fixation/accommodation, and/or the examiner is inexperienced.

Historically, retinoscopes are broken down into reflecting-mirror (plane mirror, Priestley-Smith mirror (plane and concave)) and self-illuminating (spot and streak retinoscopes). In a reflecting-mirror retinoscope, a beam from an external light source is reflected into the patient’s eye through a perforated mirror. The emergent rays enter the examiner’s eye through the central perforation. Tilting the mirror produces movements of the illuminated retinal area. In a self-illuminated retinoscope, the light source and mirror are incorporated into the instrument. In a streak retinoscope, the light source is a linear filament, while the spot has a circular light. There are several advantages to each type of instrument, and practitioners will typically prefer one over the other for their individual needs. In general, streak retinoscopy is more commonly used to analyze distance refractive error, while spot is used to analyze behavioral and accommodative responses to near vision targets.

Retinoscopy evaluation itself can be broken down into three subsets. For the remainder of the paper, we will concentrate on dynamic retinoscopy.

• Static: The patient looks at distance with accommodation relaxed. The examiner evaluates distance refractive error.
• Dynamic: The patient looks at a near object with accommodation active. The examiner evaluates the accommodative response, how the patient is obtaining information, and the energy required for it to happen; i.e., observing the visual performance of the patient.
  o Skeffington #5 (20” Dynamic Retinoscopy)
  o Skeffington #6 (40” Dynamic Retinoscopy)
  o Monocular Estimation Method (MEM) Retinoscopy
  o Book Retinoscopy
  o Bell Retinoscopy
  o Stress Point Retinoscopy
  o Nott Retinoscopy
  o Just Look Retinoscopy
Near/Mohindra: In a fully dark room while the patient fixates the retinoscope light to attain an approximation of distance refractive error. In patients where cycloplegia is contraindicated or unfavorable and distance retinoscopy is unreliable, a practitioner can perform Mohindra retinoscopy to approximate the distance refractive error. When the room lights are fully darkened and the retinoscope light is on, most patients will attend to the light. The examiner positions themselves 50 cm away, occludes the non-testing eye, and neutralizes the reflex with loose lenses. Because the retinoscope light is a poor stimulus to accommodation, the technique provides a good approximation of distance refractive error. Once neutralization is attained, remove -0.75 D sphere for infants and -1.25 D sphere for patients above 2 years of age to get the approximate distance refractive error.

Dynamic retinoscopy is generally performed with the patient's habitual specs or probing lenses in place. Out-of-phoropter spot retinoscopy is generally preferred, with the examiner staying as close to “on visual axis” as possible while the patient is reading. Most retinoscopy sets will come with various accompanying clip-on cards; these allow dynamic retinoscopy to be performed with the reading material and retinoscope at the same plane. Alternatively, reading material can be held by the provider/patient with the retinoscope held slightly above at the same distance from the patient.9,10

- With movement seen: Light is focused behind the retinoscope (add + to neutralize). Indicates a lag of accommodation (under accommodating, ‘normal’ of +0.25 to +0.75).
- Against movement seen: Light is focused between the retinoscope and the eye (add - to neutralize). Indicates a lead of accommodation (over-accommodating).
Neutral movement seen: Light is focused conjugate with retinoscope. Indicates that the accommodative response is equal to the accommodative stimulus (considered over accommodating).

Near Point Retinoscopy / Skeffington #5

**Purpose**
- To approximate the most-plus lens acceptable at near viewing.
- #5 is at 20 inches working distance. #6 is at 40 inches and is rarely used.

**Evaluation**
- The patient is sitting behind the phoropter with both eyes open in a moderately lit room with their distance Rx in the phoropter (#4).
- The doctor holds the retinoscope 20” away with a 20/40 block of letters clipped onto the retinoscope.
- The patient visually interacts with the target by calling out what they see to ensure fixation.
- Add plus sphere until against motion is seen OU, then reduce plus until first neutral, no motion, is seen (high neutral).

**Record**
- Distance Rx
- Reading material used
- Distance at which reading material is held
- Lens power of the ‘high neutral’

**Interpretation**
- The high neutral finding provides the gross approximation of the most-plus lens that will be accepted by the patient.
- Not used to prescribe the measured value, but instead the finding is compared with other binocular and accommodative findings to allow for more complete information and modification of considered near lenses.

Monocular Estimation Method (Harold Hayes)

**Purpose**
- Objectively determines a patient’s accommodative posture while reading grade-appropriate words and helps determine the appropriate near Rx.
- While it is called the Monocular Estimation Method, the procedure is performed with both eyes open.

**Evaluation**
- The patient sits with both eyes open in a bright room with their habitual near Rx.
- Age-appropriate MEM cards are attached to the retinoscope.
- A 40 cm working distance is standard, but MEM can be performed at the Harmon distance or the patient’s habitual working distance as well.
- The Harmon distance is considered the minimum distance that reading/close viewing material should be held for good visual hygiene. It is measured as the distance from the patient’s elbow to their center knuckle.
- The patient reads the words/names the pictures out loud. Instruct the patient to keep the images clear at all times.
- Make a single, quick sweep for each eye with the retinoscope and observe the color, motion, direction, and speed of the reflex for each eye.
- Try to estimate the amount of with or against motion seen in each eye (this will come with practice).
- Since the patient is corrected, there should be no astigmatism, but if there is, note it.
- Use a loose neutralizing lens of the estimated magnitude from the reflex and place it in front of one eye; scope again to see whether the lens neutralizes the reflex.
- The lens should not be held in front of the eye for more than 1/2 second (the lens will affect the accommodative response), so get ready to scope before introducing the lens and only do 1 sweep. You don’t want to give the eye time to accommodate to the lens or disrupt binocularity.
- The lens is mainly used to confirm the observation/estimation of the doctor. Accuracy of estimation will come with time and experience.
- The procedure can also be repeated through a proposed near Rx to help find the Rx to give the most effective match between visual posture and demand at near.
- Perform for the other eye.

**Recording**
- Working distance
- MEM card/reading material used
- Did the patient have an Rx, what was it?
The power of the neutralizing lens for OD/OS
Fluctuations or instabilities in the reflexes, any astigmatism noted

Interpretation

• Accommodative demand is determined by the viewing distance and the patient’s refractive error. Patients generally have a normal lag of accommodation between the stimulus to accommodation (where text is held) and how much the eye actually accommodates (accommodative response for that distance/text). A healthy visual system will do the least amount of work to get clear and comfortable vision, so it will under-accommodate slightly for the stimulus distance. The normal lag of accommodation at 40 cm ranges between +0.25 and +0.75 D.
• A high accommodative lag, ≥ +1.00 D, signifies an inadequate accommodative response. Possible culprits could be overminused Rx, uncorrected hyperopia, accommodative insufficiency, esophoria, and poor negative fusional vergence.
• A lead of accommodation, plano or any minus, signifies an exaggerated accommodative response. Possible culprits could be overplussed Rx, accommodative spasm, exophoria, and poor positive fusional vergence.
• If the reflexes are unequal between the two eyes, the lag is greater than +0.75 D (under-accommodation to stimulus), or any against motion is seen (over-accommodation to stimulus), it is a sign of an accommodative dysfunction.
• In general, a patient will show less with motion with a smaller target or increased intellectual demand; some will move from with to against motion if sufficiently challenged.
• If a patient loses concentration or fixation on the target, the lag may be much greater than expected.

Nott Retinoscopy (I.S. Nott)³⁻¹⁰

Purpose

• To assess the amount of lag or lead of accommodation; used to compare the accommodative response relative to the accommodative demand.
• Similar to MEM, but the reading target stays still while the retinoscope moves closer/farther to find the accommodative response instead of adding lenses.

Evaluation

• Place a 20/20 block of letters and the retinoscope at 40 cm/16” and have the patient read out the letters/pictures like in MEM.
• Keep the letters (visual stimulus) in place and move the retinoscope (usually farther) until you see a neutral response.
• The accommodative response (in diopters) subtracted from the accommodative demand (working distance in diopters) provides the amount of accommodative lead/lag. Normal response is a lag of +0.25 to +0.75.
• Can place a ruler between the patient and the provider to read off the distance between where the card and the retinoscope are located.
• Finding the lag of accommodation:
  • Distance from the reading target to the canthus = 40 cm (2.5 D).
  • Distance from the retinoscope to the canthus = 50 cm (2 D).
  • (+2.50) - (+2.00) = +0.50 D.

Recording

• Reading material used
• Did the patient have an Rx; if so, what?
• Distance of reading material/retinoscope at neutral
• Fluctuations or instabilities in the reflex

Interpretation

• Same as MEM.

Bell Retinoscopy (W.R. Henry and R.J. Apell)³⁻¹⁰

Purpose

• To objectively determine the relationship between accommodation and convergence on a near task and the effect of lenses on the relationship; helps to determine whether plus lenses are acceptable at near.
• To measure the lag of accommodation as a linear measurement rather than with lenses.
• The technique is named after the small dangling bell originally used as the fixation target; now we use a Wolff wand or any shiny, metal ½” diameter ball on a stick.
Evaluation

- The patient sits with both eyes open and their habitual near Rx in a moderately lit room.
- The examiner sits opposite the patient, about 20” (50 cm) away, with a Royal Air Force Ruler (RAF) placed between the patient and the examiner.
- You can use an RAF or place a long ruler on your shoulder while the patient holds the ‘0’ mark to their outer canthus.
- Hold a Wolff wand at eye level to the patient in one hand and the retinoscope in the other; both should be at 20” from the patient and at midline (ret slightly above the wand).
- The patient is to look at the Wolff wand. Have the patient try to see their reflection in the wand to ensure that the patient is visually stimulated and properly fixating.
- Start to scope one eye and then the next.
- If against motion is seen (over-accommodating), place probe lenses of the same amount in front of both eyes until no more against motion is seen.
- If with motion is seen (or get with motion after probe lenses), keep the retinoscope distance stable. Slowly (2”/sec) start to move the Wolff wand toward the patient, with the patient keeping their attention on the wand and trying to see their reflection.
- Stop when you notice a switch to against motion.
- Move the wand 1-2” closer, then move the wand back until you switch back to with motion again.
- Make note of the distances on the ruler for each switch; this is the range of neutrality.
- If they are having difficulty converging on the wand, you can have the patient place a finger on the wand to give kinesthetic/motor feedback on where to converge.
- Remember that as the patient converges, you are scoping more off-axis.
- You can use different probe lenses to see their effect on the range of neutrality.
- If there is a loss of binocularity and one eye deviates from fixation, the reflex will become brighter in that eye.

Recording

- Habitual Rx used
- N: Initial neutral motion at 20 inches

Interpretation

- The distance between the retinoscope and the wand when the motion changes is a physical measure of the lag of accommodation.
- The accommodative flexibility is assessed by how quickly (vs. sluggishly) the reflex changes.
- Lenses that normalize the ranges are considered an acceptable nearpoint prescription.
- Range of Neutrality: Normal Ranges
  - 14” - 17” (35-42 cm) to against motion
  - 15” - 18” (37.5-45 cm) on release back to with motion
- Example of normal finding:
  - Habitual Near Rx: OD 14/16”, OS 14/16”
  - With +0.50: OD 18/20”, OS 18/20”

Book Retinoscopy (Gesell Institute, G. Getman)3-10

Purpose

- The basis of this technique is that the retinoscopy reflex changes based upon the level of involvement or interaction a child has with the material at which they are looking. Decoding and comprehension (cognition) change the retinoscopic reflex.
- This technique probes the patient’s accommodative system, binocularity, ability to sustain interest, attention, and information processing ability while reading and is used to determine the effect of lenses on reading comprehension and developmental stages.

Evaluation

- The patient sits with both eyes open in a moderately lit room with their habitual near Rx.
- The patient holds reading material at their habitual working distance (such as a picture book for preschoolers or Gray Oral Reading Paragraphs 2 grades below the patient's grade level).
Give them the material and have them hold it where they usually do; do not instruct the working distance.

Ask the patient to read the text out loud (or describe all the pictures they see in the picture book) to check that the patient is able to read at this level.

The patient should continue reading as you start to scope each eye individually.

The retinoscope should be slightly above the reading material, at the same distance from the patient.

Make note of the direction of motion, color, and brightness of the reflex.

Using lens flippers, place probe lenses in front of both eyes.

You are not trying to neutralize the motion (since they have their Rx on) but are looking at the effect of the lenses on the motion, color, brightness, and flexibility of the reflex. Here, you don't have to remove the lens after half a second.

Make note of the following with and without the probe lenses:

- Frequency of visual errors
  - Sight vocabulary errors
  - Comprehension
  - Phonetics
  - Anticipatory skills
  - Reading rate
  - Persistence at task
  - Working distance
  - Posture

Record
- Grade level of reading material used
- Distance at which reading material is held
- Probe lenses used
- The type and direction of motion, the estimated amount of motion, the color and brightness of the reflex, and your interpretation both for initial evaluation and with probe lenses.
- The effect of the probe lenses on overall fluency and characteristics of reading and whether the patient’s response could be altered.

Interpretations
- “Against” Motion, Bright Reflex, Bright Pink or White Color:
  - Comprehension takes substantial mental effort
  - Interest in the material is high
  - The text is instructional for the patient
  - Neutral-Low “With” Motion, Bright Reflex, Pink Color:
    - The material is easy
    - Comprehension takes little effort
    - Interest in the material is low
  - Larger “With” Motion, Dulling of Reflex, Brick-Red Color:
    - The material is too difficult to comprehend
    - No meaning is obtained
    - Frustration level is reached/lack of interest
  - Free and Easy reading level: the reflex varies from neutral to with motion, is bright, and has sharp edges with a pinkish/orange color.
    - Instructional reading level (maintaining the reading task with comprehension in spite of being stressed): the reflex is a varying, fast against motion while the color is bright, sharp, and very pink/bright orange.
    - Frustration reading level (reading with minimal comprehension): the reflex shows a slow against motion with a dull brick-red color. The patient is in ‘flight’ mode.

Stress Point (D. Harmon and R. Kraskin)³-¹⁰

Purpose
- To determine the optimal near point plus lens to relieve near point stress, prevent near point stress-induced vision disorders, and permit maximum visual efficiency.
- This technique grew out of a series of observations made by Drs. Harmon and Kraskin while looking at changes seen with a spot retinoscope used at the patient’s Harmon distance.

Evaluation
- The patient sits with both eyes open in a moderately lit room and their habitual near Rx.
- The examiner sits opposite the patient, 20” (50 cm) away, with an RAF or long ruler on their shoulder, while the patient holds the ‘0’ mark to their outer canthus.
- The examiner holds the Wolff wand in one hand and the retinoscope in the other, both at the patient’s Harmon distance.
• The patient is to look at the Wolff wand and try to see their reflection in the wand.
• As the examiner scopes, initially, the reflex should be relatively bright.
• Start to move the wand closer to the patient along their midline and scope one eye. The examiner is looking for the point where the reflex changes luminance/brightness.
• As the wand comes closer to the patient, the reflex should brighten and then immediately go dull, then return to bright again.
• The distance of that reflex change (bright to dull to bright) is the stress point of the patient’s visual system.
• Repeat for the other eye.
• Repeat with probe lenses to observe the distance where the stress point occurs.

Recording
• Habitual Rx used
• Initial stress point distance
• Distance of patient’s Harmon distance
• Difference between stress point and Harmon distance
• Probe lenses used and their effect on the stress point distance

Interpretation
• A bright reflex represents a state of active ‘computing,’ where the patient is engaged with and has visual attention on the target. In the fight-flight continuum, the patient is in ‘fight’ mode.
• As the wand is brought towards the patient, there is a zone inside the patient’s Harmon distance (between the examiner and the patient) where the patient changes ‘how they look’ to continue to remain engaged with the target.
• There is a period where the visual process remains ‘on’ or ‘actively processing,’ where the reflex remains bright, prior to reaching the stress point.
• The stress point is the point when the visual process shifts from ‘fight’ to ‘flight’ (from ‘engaged’, ‘standby’ or ‘spatial computing’ — ‘preservation of self’)
• Harmon described a momentary massive brightening followed by a significant decrease in luminance at this threshold.
• Instead of looking for an optical phenomenon, you gain insight into the patient’s fight-flight continuum, which can help understand how the patient approaches visual tasks.

Harmon/Kraskin found that lenses could change the location in space where the patient made the shift from fight to flight.
Low (+) lenses shift the stress point towards the patient and increase the volume of space where the patient can remain in fight mode.
It is desirable to have the stress point closer to the patient so that they are not working under physiological stress/in flight mode.
General guide: the stress point should be 10 cm closer than Harmon distance/working distance.
In children, the stress point should occur at about 4” (10 cm) closer than the Harmon distance.
In adults, the stress point should occur at about 6” (20 cm) from the face.

Just Look (G. Steele)¹⁴

Purpose
• Allows quick observation of the patient’s basic near point status to be considered later in the context of the patient’s overall ocular and visual evaluation.
• ‘Refraction’ is not the primary goal; the goal is to see how the patient interacts/engages visually with their environment.
• Done before distance refraction and without the patient’s habitual lenses.
• Especially useful in infants, toddlers, and patients with disabilities.

Evaluation
• Both eyes are open, with no correction in place.
• The patient views an age-appropriate target at near: finger puppets, pictures, video, etc.
• The examiner scopes to look at the quality, brightness, color, and motion of the reflex for 5-10 seconds; do not rush.
• Scope, observe reflex, introduce a near target, and watch what happens to the ‘looking response’ when they are actively looking/attending.

Recording
• Working distance
• Quality, brightness, color, and motion of reflex initially vs. when the near target is introduced

Interpretation
• The reflex will change with the patient’s mood and the target to which they are attending.
<table>
<thead>
<tr>
<th>Test</th>
<th>What Is Assessed</th>
<th>Target</th>
<th>Cognitive Demand</th>
<th>Method/Result</th>
<th>Expected Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monocular Estimation Method (MEM)</td>
<td>Amount of lag or lead of accommodation relative to convergence (stable viewing distance and ret)</td>
<td>Picture or letter target on head of the retinoscope at a fixed distance of 40 cm (16”), patient's working distance, or Harmon distance</td>
<td>Moderate; patient calls out the pictures/letters</td>
<td>Put in lenses to neutralize the reflex (-) is a lead of accommodation (+) is a lag of accommodation</td>
<td>+0.25 to +0.75</td>
</tr>
<tr>
<td>Nott</td>
<td>Amount of lag or lead of accommodation relative to convergence (stable viewing distance, moving ret)</td>
<td>Picture or letter target and retinoscope starting at 40 cm (16”), then target stays still while retinoscope moved (usually farther)</td>
<td>Moderate; patient calls out the pictures/letters</td>
<td>Accommodative response (location of ret in diopters) subtracted from accommodative demand (location of target in diopters) to determine accommodative lead/lag</td>
<td>10 cm (+0.50)</td>
</tr>
<tr>
<td>Book</td>
<td>Visual processing level</td>
<td>Habitual near WD chosen by patient for reading material and ret</td>
<td>High</td>
<td>Use probe lenses to make note of the motion, color, brightness, and reflex flexibility as well as reading ability and fluency</td>
<td>Various depending on task</td>
</tr>
<tr>
<td>Bell</td>
<td>Range of neutrality of accommodation</td>
<td>Wolff wand and retinoscope start at 50 cm (20”) initially, then retinoscope stays still while wand is moved closer</td>
<td>Low; patient looks at own reflection in the Wolff wand</td>
<td>Move the wand closer. Distance between retinoscope and wand when the motion direction changes from with to against is the physical measure of accommodative lead/lag and range of neutrality</td>
<td>14-17” to against motion, and 15-18” on release back to with motion</td>
</tr>
<tr>
<td>Stress Point</td>
<td>Response to near stress</td>
<td>Wolff wand and retinoscope start at Harmon distance initially, then retinoscope stays still while wand is moved closer</td>
<td>Low; patient looks at own reflection in the Wolff wand</td>
<td>Move wand closer along midline; while reflex is bright, patient is actively processing, then reflex will have a sharp brightening followed by dimming (representing the stress point)</td>
<td>Stress point at least 10 cm closer than Harmon distance</td>
</tr>
</tbody>
</table>
• Compare the results to other standard dynamic retinoscopy determinations; this technique allows for an additional dimension in the visual examination of patients to help determine the endpoint or neutrality of motion and visual processing.
• Add in probe lenses; start prescribing where you see the patient beginning to engage with the visual target.
• Attending and Interacting: bright red reflex
• No interaction/contact: dull brick-red reflex
• Intense central reflex: associated with hyperopia

Conclusion

In conclusion, there is no one right way to use a retinoscope, and none of these techniques is thought to be better or worse than another. They each lend themselves to being used to answer slightly different questions about the patient’s potential and actual behavior. Practitioners should familiarize themselves with a variety of methods of using the retinoscope and practice each on a number of patients to become comfortable enough in using the technique so that it is available when needed.

References