Retinoscopy

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Retinoscopy: Research Applications

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Retinoscopy: Research Applications

Refractive Error Is Relevant in our Patients

- Following lens removal, vitreoretinal surgery, corneal surgery
- Performance dogs Ofri R. et al. AVJR 2012, 73; 546-50
- Assistance dogs Murphy CL et al. IOVS 1992; 33: 2459-63
- Performance horses
- While naturally occurring, clinically significant refractive error is relatively uncommon in our patients, retinoscopy allows clinician to rule out ammetropia as cause of visual problem
Lens Systems of the Mammalian Eye

- cornea:
  - 70-80% of refractive power
  - 40-45 diopters in dog

- crystalline lens:
  - 20-30% of refractive power
  - 13-15 diopters in dog

- in emmetropic eye, brings incident light rays from optical infinity to point source on retina
Basic Definitions of Refraction and Refractive Properties

- **Vergence** - the character of light rays, defined by the curvature of its wave front. The rays may have a negative (divergent), positive (convergent) or plano (parallel) vergence.

- **Refraction** - bending of light rays, as with a glass lens or the lens systems of the eye. Plus lenses (convex) converge parallel light rays while minus lens (concave) diverge light rays.

- **Diopter (D)** - a measure of lens power, defined by its focal point in meters (e.g., 5 diopter lens has a focal point of 0.2 meters or 1 meter/5D).

- **Optical Infinity** - an distance greater than 6 meters.
Basic Definitions of Refraction and Refractive Properties

- **Meridian** - an imaginary line on the surface of a spherical body. A corneal meridian is this line marking the intersection with the corneal surface and an anterior-posterior plane passing through the apex of the cornea.
Basic Definitions of Refraction and Refractive Properties

- **Emmetropia** - an eye without refractive error where the plus lens of the cornea and crystalline lenses refract light to a point source on the retina.

- **Ametropia** - an eye with a refractive error, generally from variations in the axial length of the eye, astigmatisms, or a shift in position or absence of the lens.

- **Hyperopia** - an eye with a refractive error caused by relatively too little refractive power, generally caused by a shorter than normal axial length.

- **Myopia** - an eye with a refractive error caused by relatively too great a refractive power, generally caused by a longer than normal axial length.

- **Anisometropia** - difference in refractive state of the two.
Basic Definitions of Refraction and Refractive Properties

- **Astigmatism** - an aspherical ametropia, caused when the refractive surfaces of the eye have different radii of curvature in different meridians, generally caused by difference in corneal curvatures. Such an eye has two or more principle focal points, or two or more points of focus on incident light rays.
Principles of Retinoscopy or “Putting Yourself at the Far Point of the Patient’s Eye”
Retinoscopy (Skiascopy)

- objective means of determining refractive or dioptric state of the eye
- observing characteristic light rays or “reflexes” created by illuminating the retina with a band of light from a retinoscope
- the character of these reflexes, and how they are influenced by refractive lenses placed between the eye and retinoscope, indicates refractive power of the eye
Design of Retinoscope

- light projection system:
  - tungsten bulb filament emits a streak of light
  - condensing lens which changes vergence of light
  - sleeve which controls vergence by changing orientation of mirror, and controls (horizontal or vertical) direction of light streak
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- examiner observation system:
  - peephole aperture allows examiner to view emergent light rays from the eye
Retinoscopes

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Refracting Lens

- trial lens set:
  - plus and minus spherical lenses in 0.25D increments
  - plus cylinder lenses for spherocylindrical refraction technique

- lens (skiascopy) bar or rack:
  - series of spherical plus and minus lenses in increments of 0.5D to 1.0D
  - in U.S., black bar contains plus lenses, red bar minus lenses, European designs may be the opposite
Incident Light Rays and Refractive State

- incident light rays acted on by lens systems of the eye
- emmetropic eye:
  - focal point on retina
- hyperopic eye:
  - focussed beyond retina
- myopic eye:
  - focussed in front of retina (in vitreous)
Retinoscopic Reflexes

- emergent light rays reflecting from an illuminated retina leave the eye and are refracted by the lens systems of the eye in the same manner as incident light rays
- emmetropia:
  - leave eye as parallel rays
- hyperopia:
  - leave eye as diverging rays
- myopia:
  - leave eye as converging rays
Far Point of the Eye

- point in space, conjugate with, or corresponding to, the retina
- emmetropic eye:
  - emergent light as parallel rays; far point AT infinity
- hyperopic eye:
  - emergent light as divergent rays; far point BEYOND infinity
- myopic eye:
  - emergent light as convergent rays; far point IN FRONT OF infinity
- with emergent light rays, the further the far point is from infinity, the greater the refractive error
Emergent Light Rays from a Retinoscope

- appear as band of light, with adjacent shadow as streak is passed across patient’s pupil
- diverging or parallel light rays:
  - “with” motion (moves in same direction as sweep)
- light rays have come to a focal point and crossed:
  - “against” motion (moves in opposite direction to sweep)
- light rays at the far point (in the process of crossing):
  - pupil fills with light, no motion seen…“neutralization”
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Emergent Light Rays from a Retinoscope

- If far point is beyond the retinoscope, a with motion is seen.
- If far point is between the eye and the retinoscope, an against motion is seen.
- If at far point, neutralization is seen.
- Examiner’s goal is to find far point.
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Retinoscopy Simulator

- VIDEO
Retinoscopic Reflexes Viewed at Infinity

- emergent light rays from emmetropic and hyperopic eyes have not yet converged to a focal point:
  - “with” motion
- emergent light rays from myopic eye have converged, crossed, and begun to diverge:
  - “against” motion
Retinoscopy Working Distance

- optical infinity (>6 meters) too distant from eye to perform retinoscopy
- infinity recreated by placing retinoscope at a known distance from eye, the “working distance” and placing a “working lens” in the path of reflected light rays
Retinoscopy at 1 Meter

- emmetropia and hyperopia:
  - “with” motion
- myopia >1 diopter:
  - against motion
- add 1 D “working lens” in front of eye:
  - emmetropic eye at far point = “neutralization”
- to reach far point for other refractive states:
  - add more plus lens to 1 D for hyperopic eye
  - add more minus lenses to 1 D for myopic eye
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  - add more minus lenses to 1 D for myopic eye
Finding the Far Point

- "with" motion wants PLUS lenses
- "against" motion wants MINUS lenses
Retinoscopy at 66 cm

- with no working lens:
  - emmetropia, hyperopia, & myopia <1.5 D show “with” motion
  - myopia 1.5 D shows neutralization
  - myopia >1.5 D shows “against” motion

- use 1.5 D “working” lens:
  - emmetropia shows neutralization
  - hyperopia shows “with” motion (add plus lenses)
  - myopia shows “against” motion (add minus lenses)
Retinoscopy at 66 cm

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  - emmetropia, hyperopia, & myopia <1.5 D show “with” motion
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  - hyperopia shows “with” motion (add plus lenses)
  - myopia shows “against” motion (add minus lenses)
Retinoscopy

Working Distance

- A single lens is used for both the “working lens” and additional “correcting” lenses.
- When neutralization is reached, subtract the working lens strength from gross (total) refraction to yield net refraction.
- 66cm = Working lens of +1.5D
- 50cm = Working lens of +2.0D
Examples at 66cm Working Distance

- Neutralization seen at +2.0D:
  +2.0D (gross refraction)
  - 1.5D (working distance)
  +0.5D (net refraction)
Examples at 66cm Working Distance

- Neutralization seen at +0.5D:
  +0.5D (gross refraction)
  - 1.5D (working distance)
  -1.0D (net refraction)
Examples at 66cm Working Distance

- Neutralization seen at -1.5D:
  - -1.5D (gross refraction)
  - 1.5D (working distance)
  - -3.0D (net refraction)
Examples at 50cm Working Distance

- Neutralization seen at +3.0D:
  - +3.0D (gross refraction)
  - -2.0D (working distance)
  - +1.0D (net refraction)
Examples at 50cm Working Distance

- Neutralization seen at -1.0D:
  - -1.0D (gross refraction)
  - 2.0D (working distance)
  - -3.0D (net refraction)
Technique of Retinoscopy

- semidarkened room, assistant holds animal, directs gaze
- retinoscope held in palm, thumb on sleeve, lens bar in other hand, distance 66 or 50 cm from patient
- vergence set by moving sleeve down, direction set so vertical streak projected on eye
- optical alignment...align Purkinje images on anterior cornea and lens
- streaks brought into pupil with slow, deliberate movement (shake head back and forth), find neutral point
- direction of beam is then rotated to produce horizontal streak and this meridian is assessed...ALWAYS ASSESS BOTH MERIDIANS
Identifying Neutrality

- with no lenses, determine if “with” motion, “against” motion, or neutrality:
  - note that all emmetropes and almost all ammetropes will show a “with” motion at 66 cm with no refractive lenses
- with motion = add progressively stronger plus lenses
- against motion = add minus lenses
- because against motion more difficult to see and confusing:
  - to confirm, reverse vergence, “against” becomes a “with”!!
  - approach neutrality from “with” side….go past neutrality until with motion seen, bracket back to neutrality
Characteristics of Neutrality

- **great distances from neutrality:**
  - reflexes are dull, slow moving, streak is fairly broad

- **within 4 diopters of neutrality:**
  - streak becomes narrow, distinct

- **within 2 diopters neutrality:**
  - streak becomes faster and brighter

- **at neutrality:**
  - streak is infinitely fast (no motion is seen), very bright, and light fills pupil
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Retinoscopy Simulator

- VIDEO
Confirming Neutrality

- Neutrality not a point, but rather a zone between the last recognizable “with” motion and the first recognizable “against” motion
- Judge endpoint slightly on the “with” motion side of this zone (point when last recognizable, slight “with” motion is seen)
- At neutralization, lean forward from 66 cm to observe with motion, lean backward from 66 cm to observe “against” motion….. (“reversal point”)
Estimating Hyperopia

- “enhancement” estimates gross hyperopia
- at working distance, compare thickness of beam in pupil (retinal band) vs. outside the pupil (face band)
- slowly raise vergence until the beam of light is the thinnest possible
Estimating Hyperopia

<1.0 D gross hyperopia:
- beam will not enhance

1-3 D gross hyperopia:
- retinal band thinner (1/2 to 3/4) than face band

4-5 D gross hyperopia:
- retinal band may be enhanced to thin streak, and it is only slightly more narrow than face band

emmetrope has +1.5 D of gross hyperopia at 66 cm:
- retinal band 3/4 width of face band, which is broad
Estimating Myopia

- “far point determination” estimates net myopia
- If against motion observed at 66 cm, >1.5 D myopia present
- Change vergence by moving sleeve up to confirm
- Move sleeve back down, slowly move progressively slower to eye, streaking beam until neutralization reached
- Estimate your distance from the eye at neutrality:
  - Neutralization at 33 cm = -3.0 D refractive state
  - Neutralization at 50 cm = -5.0 D refractive state
**Astigmatism**

- **Astigmatism** - an aspherical ametropia, caused when the refractive surfaces of the eye have different radii of curvature in different meridians, generally caused by difference in corneal curvatures. Such an eye has two or more principle focal points, or two or more points of focus on incident light rays.
Astigmatic Refractive Errors

- Neutralization seen with different lenses in two different meridians.
- Or... when neutralization reached in one meridian, streak is rotated, either a “with” or “against” motion is seen.
- Major or principle meridians:
  - Least and most refractive meridians.
  - Generally oriented with axes at or near 90 degrees and 180 degrees.
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Astigmatic Refractive Errors

- simple astigmatism
  - emmetropia/ammetropia
- compound astigmatism
  - hyperopia/hyperopia or myopia/myopia
- mixed astigmatism
  - hyperopia/myopia
Astigmatic Refractive Errors

- regular astigmatism
  - principle meridians 90 degrees apart
- irregular astigmatism
  - principle meridians not 90 degrees apart
Astigmatic Refractive Errors

- Oblique astigmatism:
  - regular astigmatism (90 degrees apart) that is tilted
  - “break” phenomena when performing retinoscopy
Astigmatic Refractive Errors

- "with the rule" astigmatism
  - most refractive corneal meridian vertical

- “against the rule” astigmatism
  - most refractive corneal meridian horizontal

*Vertical retinoscopic streak measures power in horizontal corneal meridian*
Designating Refractive Error

- determine net refraction in both vertical and horizontal meridians
- if refraction is same, eye is “spherical”, if two meridians are different eye is “astigmatic”
- average the two meridians to get “average” refractive state
- or... designate two meridians with “lens cross”
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Practical Aspects of Veterinary Retinoscopy

- use retinoscopy bar vs. trial lens set
- good assistant invaluable
- estimating techniques useful to perform first and reduce refraction time
- optical alignment (Purkinje images) critical, must constantly realign
Practical Aspects of Veterinary Retinoscopy

- Retinoscopy should generally be performed without mydriasis.
- Cycloplegia/mydriasis used in humans to eliminate accommodation.
- While retinoscopy results not significantly different with and without mydriasis in dogs and horses, mydriasis reduces accuracy in identifying neutrality due to spherical aberration:
  - Full mydriasis often causes swirling or “scissors” motion.
  - If mydriasis present, concentrate on center of pupil.
Practical Aspects of Veterinary Retinoscopy

- brightness of tapetum is useful in identifying neutrality
- refracting aphakes or pseudophakes challenging:
  - opaque ocular media
  - surgically-induced astigmatism
  - on pseudophakes, reflex different in pupil covered by IOL optic and that area outside of IOL optic
Retinoscopy
Model Eyes
Check Your Working Distance
Retinoscopy Simulator