INDIRECT OPTHALMOSCOPY and OPTOS

Types of Ophthalmoscopy

- Indirect ophthalmoscopy – Image between the patient and examiner
- Direct ophthalmoscopy – Fundus viewed directly

Both forms are very often used in a fundus evaluation.

Binocular Indirect Ophthalmoscopy (BIO)

Direct Ophthalmoscopy

- Virtual erect image
- Emmetropic eye is conjugate to infinity; emmetropic examiner could view fundus with naked eye if adequate illumination

Direct Ophthalmoscopy Illumination System

- Light source imaged onto patient’s retina – limited by patient’s pupil size
- Examiner must view the area illuminated – must be accurately aligned with the reflected beam
- Illuminated and observed retina must overlap
  - But this increases the reflections from the cornea

Direct Ophthalmoscopy Techniques to Achieve Alignment of Incident & Reflected Beams

- Beam splitter
- Perforated concave mirror
- Prism
Direct Ophthalmoscopy

Field of View (FOV)

- Limiting factors
  - Pupil size of patient
    - DO is better for getting through small pupils than BIO or fundus
    - With small pupil the biggest problem is the corneal reflection that blocks your view through the small pupil
  - Distance to observer
  - Refractive error
    - ↑ myopia → ↓ field of view
    - ↑ hyperopia → ↑ field of view
- FOV is ~10 to 15º in an emmetrope

Right eye – 30º field of view

Direct Ophthalmoscopy

How to Increase FOV

- ↑ pupil size (up to a point)
- ↓ distance of examiner to patient
- ↓ myopia

Direct Ophthalmoscopy

Magnification

- \( F \) (eye)/4
  - Emmetrope (60 D eye) : 60/4 = 15x
  - 10 D myope: 70/4 = 17.5x
  - 20 D myope: 80/4 = 20x

Mag (& FOV) greatly affected by refractive error unlike indirect ophthalmoscopy

Direct Ophthalmoscopy

Advantages

- Easy
- Quick
- Cheap instrument
- Erect and non-reversed image
- Good view through small pupil
- Good patient comfort
- High mag
- Useful for viewing the RNFL

Direct Ophthalmoscopy

Disadvantages

- Illumination low - limits resolution
- Monocular view - limits resolution
- Mag too high
- View greatly affected by astigmatism
- Inadequate view of periphery & mid-periphery
- Small field of view
- Reflections (corneal) are significant
- Cannot penetrate media opacities well
The Effect of High Mag/Small Field of View
DO would need ~400 linked fields to try to view the whole fundus!!!
More realistically 70 fields in a typical DO exam which covers the disc, macula and vascular arcades.

PanOptic™ Ophthalmoscope
by Welch Allyn
- Larger field of view (25º) than DO
- Higher mag: ~25% more than DO
- Erect, non-reversed image like DO

PanOptic™ Ophthalmoscope
ADVANTAGES
- Easy to use/learn (like DO)
- Large FOV (~25º)
- High mag - higher than DO
- Erect, nonreversed image
- Good view through small pupil
- Reflections not as bad
- Better (not good) view of periphery than DO

PanOptic™ Ophthalmoscope
DISADVANTAGES
- Cost
- Monocular view
- Too much mag??

Indirect Ophthalmoscopy
TYPES
- Monocular indirect
- Binocular indirect

MONOCULAR INDIRECT OPHTHALMOSCOPE
- Direct ophthalmoscope with handheld plus (+20 D) lens
- Instrument: AO, Propper
**BINOCULAR INDIRECT OPHTHALMOSCOPY**

- Image: Real, inverted, reversed, aerial, 3-D image
- Location of image: Between the patient and the examiner

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**Advantages**

- Binocular view
  - Binocular resolution
  - Binocular depth perception (stereopsis)
- High illumination → better resolution
- Low mag
- Large FOV

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**More Advantages**

- Large depth of field
- Very good view of peripheral fundus
- Very good view through dense media
- Long examiner to patient distance
  - Less chance for Swine flu, TB etc.
- Refractive error has little effect

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**Disadvantages**

- Difficult to orient to inverted, reversed image
- Technically difficult
- Pupil dilation required
- Patient comfort is lower
- More expensive instrumentation

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**TWO SYSTEMS**

**Illumination System**

- Components: BIO, lens
- BIO – produces light, collimates the light
- Condensing lens - focuses light into patient’s pupil plane if the lens is held at it’s focal length from the eye
- This gives maximal retinal illuminance
BINOCULAR INDIRECT OPHTHALMOSCOPY

**Key Clinical Point**

- Failure to hold the lens at its focal point from the patient’s eye → view in the lens will NOT be “filled” from edge to edge
- Distance of the lens from the eye does not effect the clarity of the fundus view

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“Full” view of fundus (Lens is “filled” edge to edge with fundus view)

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Dark shadow at edge of lens (lens is slightly <1 mm too close to eye)

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Lens Too Close vs. Lens at Proper Distance from Pt Eye

**Key Clinical Point**

- If the lens is held too close (very common):
  - The lens will NOT be “filled” → no edge to edge view of fundus
  - You will see a dark shadow at the edge of the lens (possible all around the edge or any one edge)
  - If the lens is very close rather than a shadow you will see a magnified view of the iris &/or lashes &/or conjunctiva
Lens not “full”
Note the dark shadows on both sides of the lens

BINOCULAR INDIRECT OPHTHALMOSCOPY
Observation System

- Parts: Lens, BIO headset
- Aerial image of fundus brought to a focus at about the focal length of the lens
  - Image is inverted, reversed, 3D, aerial
  - For a 20 D condensing lens image is about 5 cm from lens
- Image will be about 20 to 50 cm from the examiner depending on where the examiner positions himself/herself and the BIO design
- Much leeway for viewing distance

BIO OBSERVATION SYSTEM

The condensing lens forms a real, inverted image of the retina which is viewed by the examiner through the oculars of the ophthalmoscope.

BINOCULAR INDIRECT OPHTHALMOSCOPY
Viewing Distance

CLOSER VIEWING REQUIRES

- Greater accomodation
- Greater convergence
- Very important: Much more precise alignment of all components

“The Viewing Triangle” in BIO

Key Clinical Points

- It is very difficult to maintain a binocular, well-focused, well-illuminated image at closer distances
- Stay as far from the lens as possible even though closer distances give greater mag
How far? Depends on the BIO design (Heine – closer) and your comfort.
The Effect of a Short Examiner to Lens Distance

**BINOCULAR INDIRECT OPHTHALMOSCOPY**
**EQUIPMENT IN BIO**
- Headset
- Condensing lens

**BINOCULAR INDIRECT OPHTHALMOSCOPY**
**Functions of the BIO Headset**
- Optically shrinks examiner’s PD to ~15 to 20 mm
- Plus lenses (within the BIO headset) act to relax accommodation (not really!!)
- (Provides the illumination of the fundus)

**“The Viewing Triangle” in BIO**

**BINOCULAR INDIRECT OPHTHALMOSCOPY**
**Condensing Lens**
- Part of both systems in BIO
- High plus, aspheric, AR coated
- Ranges from 14 to 40 D
  - Most commonly used by far is 20 D – best balance of mag & FOV
  - The distance the lens is held from the eye varies with the lens power:
    - 20 D → 5 cm from eye
    - 30 D → 3.33 cm from eye
Four Functions of the Condensing Lens

- Illumination system – focuses BIO beam into plane of the patient’s pupil
- Forms an aerial image of the reflected beam from the patient’s fundus
- Gives larger FOV than DO due to ability to capture rays from more peripheral retina
- Images & magnifies patient pupil

Pupil Imaging & Magnification

- Makes the patient’s pupil conjugate to the examiner’s pupil
- Magnifies the patient’s pupil to allow the viewing triangle through the pupil
  - Higher plus lens → greater mag of pupils → greater ability to get through smaller pupils
  - So it is easier to get through the pupil with a 30 D lens than a 20 D lens (but lower mag of the retina)

“The Viewing Triangle” in BIO

Condensing lens should be held at about focal distance from the eye:

- 20 D → 5 cm from eye
- 15 D lens → 6.67 cm – you really have to stretch – VERY DIFFICULT!!
- 30 D lens → 3.33 cm from eye

MINIMIZING REFLECTIONS

- Illumination & observation beams must be separated to minimize reflections
- Pupillary dilation best way to minimize the effect of corneal reflections
  - Pupil dilation is virtually necessary for BIO due to the large separation of the illumination & observation beams and the separation of the lines of sight for the 2 eyes – “the viewing triangle”
- Reflections off of condensing lens - minimized by AR coat & lens tilt

Less Reflections with BIO than DO

Why? Separation of illumination and observation beams
**BINOCULAR INDIRECT OPHTHALMOSCOPY**

**Reflections**
- **MIO** – smaller separation of observation and illumination beams so easier to get into small pupil but much greater reflections
- **DO** – smallest separation → best to get through small pupil but worst corneal reflections especially in small pupil

**How does the Viewing Triangle Get Imaged into the Patient’s Pupil?**
- Mirrors in BIO headset optically shrink the examiner’s PD to ~15 to 20 mm
- Condensing lens magnifies the patient’s pupil
  - 4 mm pupil imaged by 20 D lens and viewed from 40 cm → magnified to 32 mm
  - 2 mm pupil same lens etc. → ~ 16 mm

**Regular vs Small Pupil Setting**
The Viewing Triangle Has Been Shrunk

**Keys for Small Pupil/Peripheral Retinal View**
- Higher power condensing lens → magnifies the patient’s pupil more
- Switch to small pupil setting → shrinks viewing triangle

**Optical Characteristics**

**MAGNIFICATION**
- **BIO total mag** = Instrument mag × Relative distance mag
- **Instrument mag**
  - Power of eye/Power of lens
    - Emmetropes: 60 D/20 D = 3x
    - -10 D myopes: 70 D/20 D = 3.5x
- **Relative distance mag**
  - Std viewing distance (25 cm) / actual viewing distance
    - For 40 cm viewing distance: 25 cm/40 cm = .625x relative distance mag
    - Can ↑ mag by viewing from a closer distance

**Viewing Distance**
**Key Clinical Points**
- **WARNING**: It is very difficult to maintain a binocular, well-focused, well-illuminated at closer distances
- Don’t get too close to the lens even though closer distances give greater mag
MOVING CLOSER TO THE LENS CAUSES

- Loss of binocularity (one line of sight not imaged through the patient’s pupil)
- Loss of image illumination

TOTAL BIO MAG FOR AN EMMETOPIC EYE

- Total BIO mag = instrument mag x relative distance mag
- Total BIO mag = power of eye/power of lens x 25 cm/viewing distance in cm
- 60 D/20 D x 25 cm/40 cm = 1.875 x mag

BINOCULAR INDIRECT OPHTHALMOSCOPY
FACTORS AFFECTING MAGNIFICATION

- Patient refractive error
- Power of the condensing lens
- Examiner to lens distance

BINOCULAR INDIRECT OPHTHALMOSCOPY
Field of View

- Much greater with indirect ophthalmoscopy than DO
- Condensing lens acts to capture rays from more peripheral retina
- Generally diameter of a single view in BIO is ~ 37º (vs ~10 º with DO)
- ↑ mag → ↓ FOV

FIELD OF VIEW

35º (37-48º in BIO) vs 20º (10-12º in DO)

BINOCULAR INDIRECT OPHTHALMOSCOPY
Decreased Field of View Caused By

- Lower power lens
- Smaller diameter lens
- Higher myopia
- Closer to the patient
- Pupil size (if small enough)
CLINICAL ADVANTAGE OF LARGE FOV

Allows much better detection of large lesions and the color differences which characterize them.

CLINICAL ADVANTAGE OF LARGE FOV

Slightly greater mag and smaller FOV than BIO

CLINICAL ADVANTAGE OF LARGE FOV

This is about ½ of the mag of DO

CLINICAL ADVANTAGE OF LARGE FOV

BINOCULAR INDIRECT OPHTHALMOSCOPY

Effect of Patient Refractive Error

- Very little effect in BIO
  - Major effect on DO
- Myopia
  - Total mag for -10 myopia: (70/20) (25/40) = 2.19x
- Hyperopia
  - Slight ↓ in mag
- Astigmatism
  - Slight meridional mag

BINOCULAR INDIRECT OPHTHALMOSCOPY

Effect of Examiner Refractive Error

- BIO eyepieces contain plus lenses to assist accommodation ~+1.75 to +2.50
  - NOTE: They were taken out of your BIOs but are included in case you want them
- Little accommodation needed for an aerial image at ~40 cm
- Clinical key: Use your best distance correction for BIO
**Clinical Key**

- Very common problem in early stages of learning BIO: proximal (nearness awareness) accommodation
- Blurs the aerial image
- Test for proximal accommodation: Image is clearer when you move closer to lens/patient
- Options: see next slide

**Clinical Uses of Various Ophthalmoscopes**

- BIO is extremely useful in cases of poor fixation or nystagmus
- BIO is the best procedure for visualizing the retina/ONH through dense media
- Complete fundus evaluation under optimal conditions requires dilation & BIO
- When dilation is indicated BIO should be performed; also DO or fundus lens

**Major Misconceptions**

- The major advantage of BIO is stereopsis (binocular depth perception) – NO!
- Binocularity is necessary to derive any advantage of BIO over DO, MIO or Panoptic- NO!

**Medico-Legal Issues**

In cases where dilation is indicated BIO should be performed under dilated conditions. More thorough techniques may also be indicated.

**Clinical Performance of BIO**

1. Patient education on dilation
   - Why is dilation necessary or recommended?
   - What is involved in dilation?
   - What effects will dilation have on vision, reading, driving ability etc.?
   - What is the duration of the dilation?
   - Discuss possible insurance coverage if extended ophthalmoscopy is needed
2. Patient education on BIO

Describe why you are recommending/performing the procedure(s)
Describe briefly what you are doing

PROCEDURES TO PERFORM BEFORE DILATION

- Complete case history
- Best corrected VAs
- Any test requiring optimal fixation, VA, binocularity &/or accommodation
- Pupils
- Anterior segment (SLE)
- Angles (peripheral AC depth)
- Tonometry
- Apply the dilating drops

IMPORTANT: For a baseline/periodic DFE, the goal is to get the drops into the patient’s eyes within 5 minutes of meeting the patient

PROCEDURES TO PERFORM BEFORE A BASELINE/PERIODIC DILATION WHERE PATIENT RETURNS FOR THE DFE

- Update the case history
- Best corrected VAs – use trial frame if necessary
- Any test requiring optimal fixation, VA, binocularity &/or accommodation – not likely
- Pupils
- Anterior segment (SLE) – real quick, done at initial exam
  - Be sure anterior seg is quiet, cornea epith intact (no staining)
  - Angles (peripheral AC depth)
  - Tonometry
    - GAT is best choice because anesthetic helps with dilation by ↓ stinging/burning → ↓ blinking. Also softens the epithelium → better, faster penetration of dilating drops
- Apply the dilating drops

IMPORTANT: For a baseline/periodic DFE, the goal is to get the drops into the patient’s eyes within 5 minutes of meeting the patient

Clinical Performance of BIO

PROCEDURE

1. Instrument adjustment
   - Place on head – snug on apex & around head
   - Eyepieces as close as possible to eyes/glasses & positioned for straight ahead (or downgaze) position of gaze
2. Turn on
3. Adjust vertical position of beam into vertical center of your field
4. Adjust horizontal centering of eyepieces
   - Eyes open, hold thumb at your viewing distance ~30 to ~40 cm
   - Close OS and slide the OD eyepiece to center your thumb in the center of your field of view for OD
   - Repeat for OS
   - Open both eyes - should have single thumb, binocular view, thumb should be clear

Correct positioning of BIO eyepieces
Incorrect positioning of BIO eyepieces
Oculars too far from eyes  Oculars tilted up

Correct positioning of eyepieces

Clinical Performance of BIO
HAND POSITIONING

5. Hold lens in *dominant* hand between thumb and forefinger
6. Grasp patient’s upper lid with thumb of non-dominant hand to immobilize it
7. Retract lower lid slightly with the middle finger of dominant hand
Clinical Performance of BIO

8. Direct patient’s fixation to eccentric gaze
   • Always start the exam in the retinal peripheral retina

9. Direct the BIO beam into the pupil and note the red reflex
   • Be sure that the BIO beam is centered on the pupil then DO NOT MOVE YOUR HEAD

10. Interpose the lens into the beam with the reflections on the lens roughly superimposed
    • Place the lens close to the eye so that an upright slightly magnified view of the globe and lids is apparent
    • Center the pupil within the lens

11. Flex forefinger and thumb to retract the lens away from the patient’s eye.
    • Be sure to retract the lens along the straight line going from the middle of the patient’s pupil to your pupil – the “common axis”
    • Keep the pupil centered in the lens (do not shift the lens off center) and keep the BIO light centered on the pupil as you retract the lens (do not shift your head up, down, left or right)
11. As you pull the lens away the pupil and fundus should enlarge to fill the lens

**Clinical Technique Key Point**
If the lens is too close (within the lens focal length) the pupil/fundus image will not enlarge to fill the lens

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**LENS POSITIONING**

**You will see:**
- If slightly too close – dark arc at edge of lens
- If moderately too close – magnified view of iris, lid, lashes &/or sclera near the edge of lens

**THE COMMON AXIS**

**COMMON ERRORS IN BIO TECHNIQUE**

1. Condensing lens too close to patient’s eye (very common)
   Result: Lens not filled edge to edge → dark arc (shadow) on one or all edges of lens. Most common is a dark arc at bottom of lens.
   Solution: “Trombone” the lens

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**Lens Too Close vs. Lens at Proper Distance**

**Clinical Performance of BIO General**

- Alignment of all components is necessary to achieve a focused and “filled” view of fundus
- Axis of alignment (“common axis”) – you must stay on it!!!
- When searching the fundus (scanning) must stay on the common axis!!!
COMMON ERRORS IN BIO TECHNIQUE

2. Condensing lens dropped downward toward patient’s chin
   Result: Light is deviated out of pupil onto the inferior iris & lid → dark shadow at inferior edge of lens
   Solution: Trombone the lens; don’t let the lens drift downward as you retract it from the eye

3. BIO beam directed onto the patient’s forehead, not the pupil
   Result: Dark shadow in inferior part of lens
   Common causes/prevention:
   - Chin lifted up → keep chin down
   - BIO beam is not centered vertically into the center → center beam at initial adjustment
   - Lens not retracted far enough from eye → trombone the lens
   - Lens dropped → trombone the lens

4. Examiner to patient distance is too short
   Result: More difficult to attain/maintain binocularity & a “filled” lens
   Solution: Practice performing BIO at a comfortable distance

5. Overaccommodation (proximal accommodation)
   Result: Blurred fundus image
   To confirm: Move closer, if clearer this confirms
   Solution(s):
   - Remove BIO plus lenses in oculars
   - Try to perform BIO at closer distance
   - Use BIO glasses
   - Actively suppress your accommodation
COMMON ERRORS IN BIO TECHNIQUE

6. Lens tilted excessively
   Result: Blurred fundus image
   Solution: Keep the reflexes from the lens within 3 or 4 mm of each other

BASIC PRINCIPLES OF ORIENTATION AND LOCALIZATION IN BIO

1. Always position yourself 180° from the area of fundus that you wish to view for the most peripheral fundus views
2. Patient looks toward the area of fundus that you wish to view
3. Patient views as far from you as possible to get the most peripheral fundus view
4. Within a given fundus view all structures are shifted 180° from their anatomic (actual) location
5. Pivot yourself as a unit (maintain the common axis) toward the portion of the image that you wish to center in the lens

Example

If you wish to view the far temporal retina (temporal oral region) of the patient’s right eye:
1. Position yourself to the patient’s left
2. Patient looks to their right (away from you)
3. For the most peripheral view the patient looks as far to the right as possible
4. If you hold the lens with your right hand forefinger at top and thumb at bottom → the most peripheral retina will be closest to your thumb
5. If you wish to center something that you see at the bottom of the lens (closest to your thumb) then drop/crouch down (move toward your thumb) → MUST pivot yourself and the lens as a unit, maintaining the common axis at all times

SMALL PUPIL/PERIPHERAL FUNDUS PROBLEMS IN MAINTAINING A BINOCULAR VIEW AND WELL ILLUMINATED VIEW

- Small pupil
  - Difficult to image the viewing triangle through the patient’s SMAL pupil
- Peripheral fundus view
  - In viewing the central fundus – round pupil
  - In viewing the peripheral fundus – pupil is oval – more difficult to image the viewing triangle through
    - Superior or inferior peripheral fundus view – horizontally oval pupil
    - Nasal or temporal peripheral fundus view – vertically oval pupil

View of the patient’s far temporal retina OD; you are positioned to the patient’s left side & are holding the lens with your right hand
STRATEGIES FOR SMALL PUPIL, PERIPHERAL FUNDUS VIEWING

- Increase the lens to examiner distance → shrinks the viewing triangle
- Use small pupil setting → shrinks the viewing triangle
- Use a higher condensing power lens → magnifies the patient’s pupil
- Adjust the BIO beam downward if not already in the center of the lens