Clinical Refraction

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Objectives

Review concepts related to clinical refraction

Learn practical approaches to daily patient care

Retinoscopy

Very important for:

- Objective refraction determination
- Detecting optical aberrations (keratoconus)
- Opacities (PSC)

Useful for:

- Infants
- Wiggly children
- Adults and children unable to cooperate/poor at subjective refraction

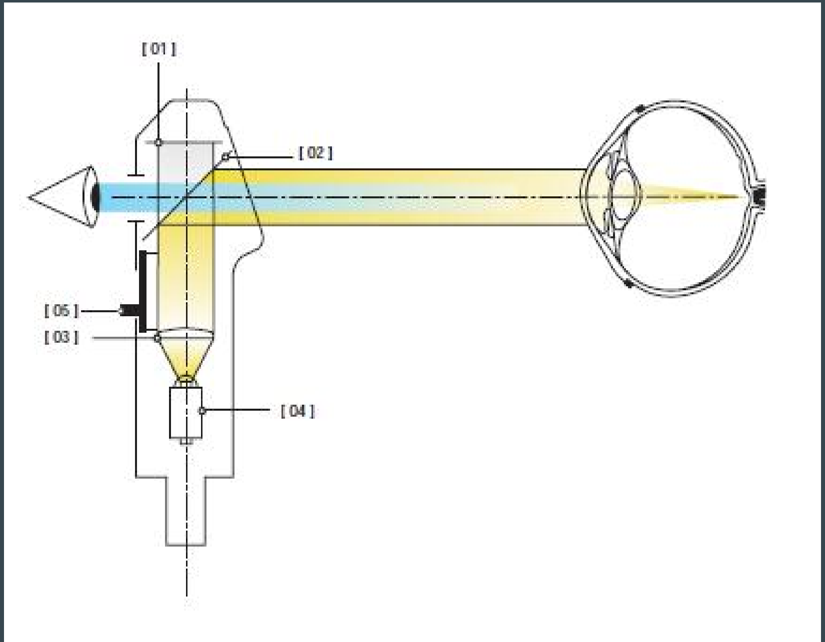
Retinoscopy

Use plano mirror setting

- Sleeve all the way down

Have pt fixate on large distance object

- Relaxed accommodation
- 20/400 letter
- May need to cycloplege kids



Retinoscopy

Three basic types of reflexes:

- “With” motion
- “Against” motion
- “Neutral” or no motion

Involves the “far point”

- The farthest away the eye can see clearly with accommodation entirely at rest is the FAR POINT (more on this later)

Retinoscopy and the Far Point

If the far point is BETWEEN the examiner and the patient, then divergence of the light rays occur

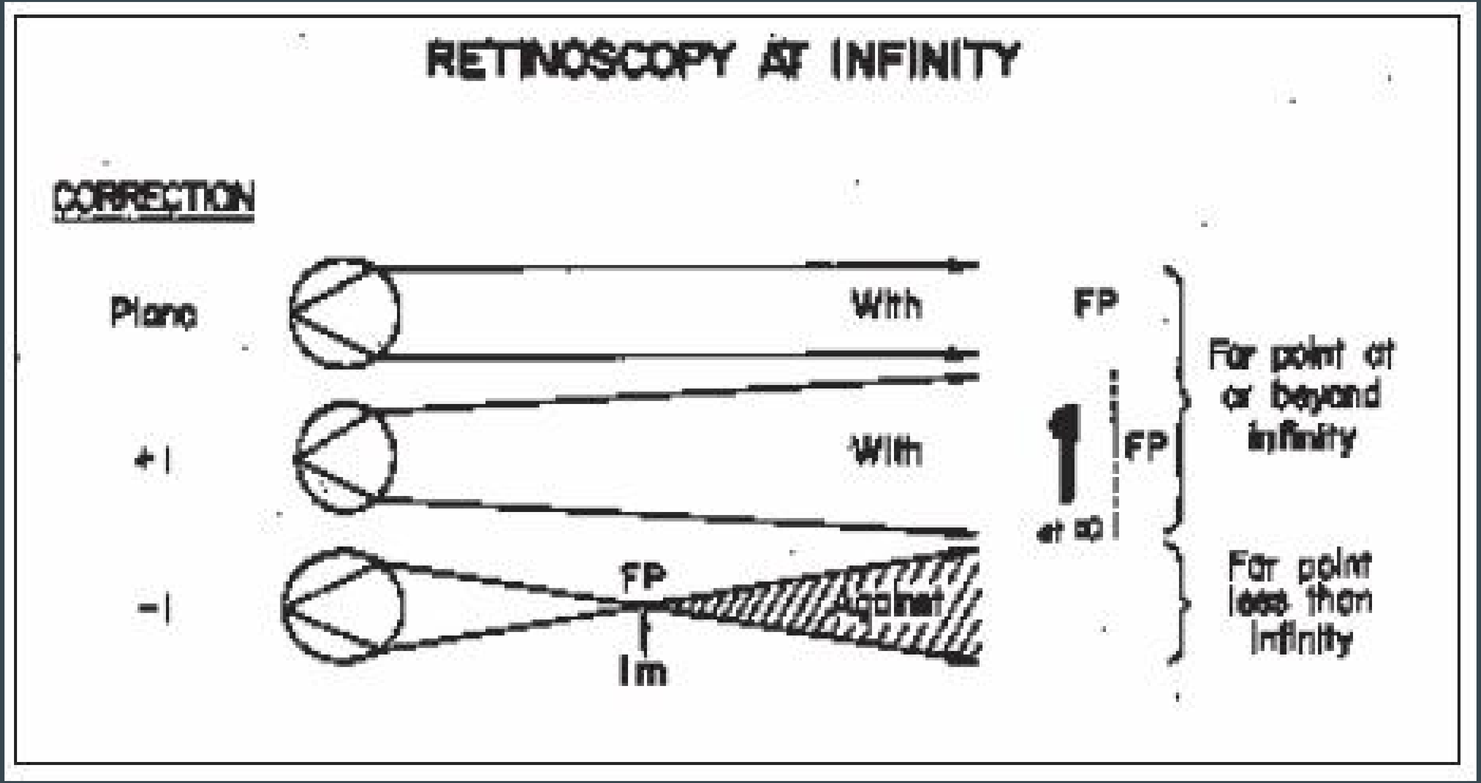
- “Against” motion

If the far point is is BEHIND the examiner, the light moves in the same direction of the sweep

- “With” motion

If the light fills the pupil and does not move, then NEUTRALITY is found

- Moving back would cause the far point to be between you and the patient, so AGAINST motion would be seen. Opposite if moving forward.



http://www.cyber-sight.org/bins/news_page.asp?cid=1-9436-9441-9482

Retinoscopy Quiz

You are using a retinoscope on Cloyd, your -2.00 D myopic patient

If you were sitting 100cm away, what motion would you see?

Cloyd’s far point: 1/D = 1/2 = 0.50m (or 50cm)
At 50cm, so the far point is between you and him:
“Against” motion

At 50cm, you would see “neutral”
At any distance closer than 50cm, you would see “with”

Retinoscopy

Characteristics of the reflex:

- Speed
  - The closer you are, the faster the reflex speed
- Brilliance
  - Brighter reflex as neutrality is approached
  - “With” reflexes are usually brighter than “against”
- Width
  - The reflex broadens as you approach neutrality

Retinoscopy

"With" motion - add plus

"Against" motion - add minus

Retinoscopy

Working Distance:

- Based on how far away you are from the patient
  - Inverse relationship
- Subtracted from the power of the correcting lens

If you are sitting___away	Then subtract:
50cm	2.00D
67cm	1.50D
100cm	1.00D

Retinoscopy

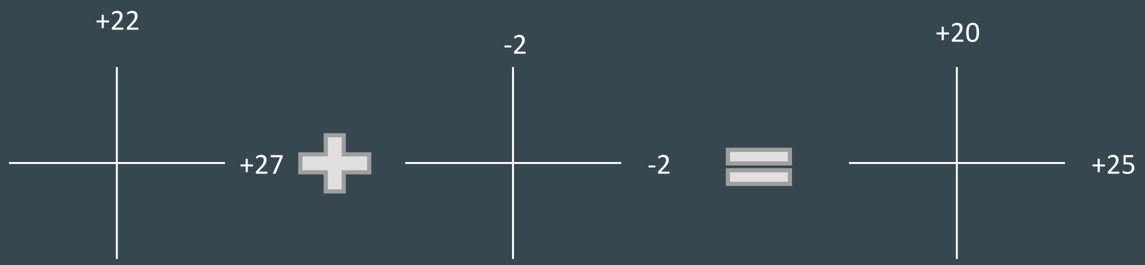
Finding the axis

- The eye is made up of two principal meridians
- Neutralize the *less plus* axis first
- Then, rotate the streak 90 degrees. You should see “with” motion
- Align the axis of the phoropter with your streak and add plus cyl until “neutral” is found

You are doing retinoscopy on an aphakic child with Down Syndrome. With the streak oriented horizontally you get a neutral reflex with a +22 D lens.

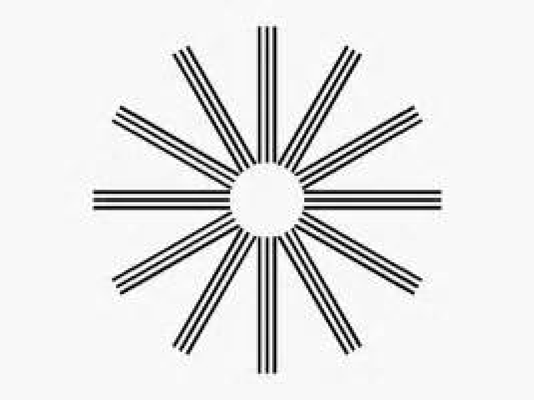
With the streak oriented vertically you get a neutral reflex with a +27 D lens.

Assume a working distance of 50 cm. What is the distance Rx of the child?



Answer: +20.00 +5.00 x 090

Subjective Refraction



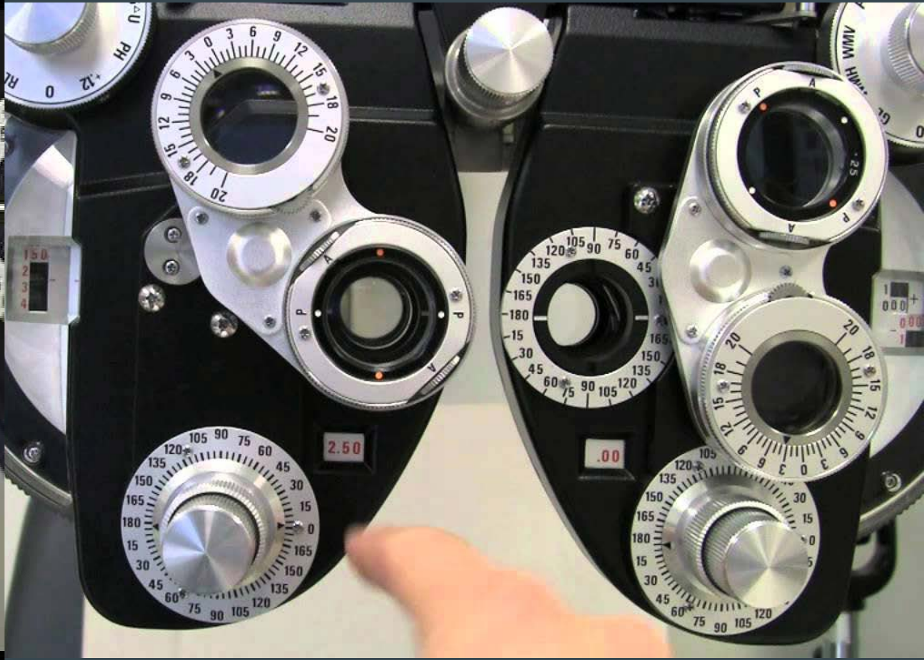
Astigmatic Dial Technique

- Rarely used
- Steps:
  - Fog the patient by adding more (+) sphere
  - Identify the blackest and sharpest lines
  - Add plus cylinder with the axis parallel to the blackest and sharpest line until all lines appear equal (plus cyl)
  - Reduce (+) sphere to un-fog the patient

Subjective Refraction - Cross-Cylinder Technique

By far the most common method

- Jackson cross cylinder
  - -0.25 +0.50 x 180
- Refine axis before refining power
  - Position the JCC’s principal meridians 45 degrees away from the correcting cyl
    - “Straddle the line”
  - “Chase the white” (plus cyl)
- Refine the power
  - Align the JCC with the principal meridians of the correcting lens



Axis refinement

Power refinement

Subjective Refraction - Cross-Cylinder Technique

Don't forget about spherical equivalent!

For every 0.50 change in cyl, make a 0.25 change in the sphere

$$\text{Spherical Equivalent} = \text{Sphere} + \frac{\text{Cylinder}}{2}$$

Example:

Natalie's Rx: +2.00 +3.00 x 180 What is the spherical equivalent?

2 + 3/2 = +3.50

Subjective Refraction - Refining the Sphere

Goal: The strongest (+) sphere (or weakest (-) sphere) that yields the best VA

Reduce (+) sphere until optimal VA is reached

- Watch out for “darker and smaller” = likely over-minused

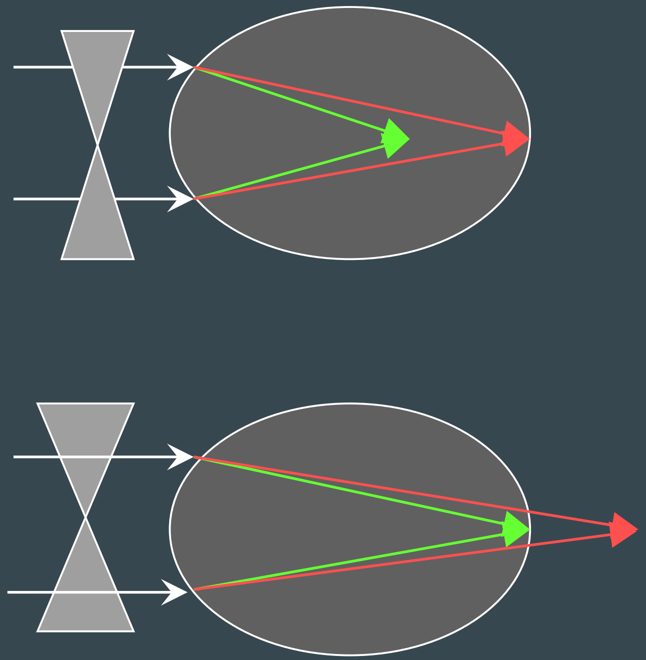
Duochrome Test

- RAM-GAP (red add minus, green add plus)
- Green has shorter wavelengths, red has longer
  - Green wavelengths focus anterior to red

A E T D

C N M H

R F T L



Red is darker and blacker.

By adding minus...

...then green becomes darker
and blacker

Subjective Refraction - Binocular Balance

Fogging

- Rarely used
- Uses a +2.00 D sphere over each eye and compare

Prism Dissociation

- Much more common
- Add vertical prism to one or both eyes to create two images
- Add plus to the clearest image

Prism Dissociation

"The top line is more sharp and clear"

OD has BD prism in front of it and sees this

F Z B D E

OS has BU prism in front of it and sees this

F Z B D E

If Base DOWN prism was in front of the right eye, then add +0.25 in OD until both lines appear equal in clarity.

A Final Word on Subjective Refraction...

Every 0.25 change is APPROXIMATELY equal to one improved line in VA

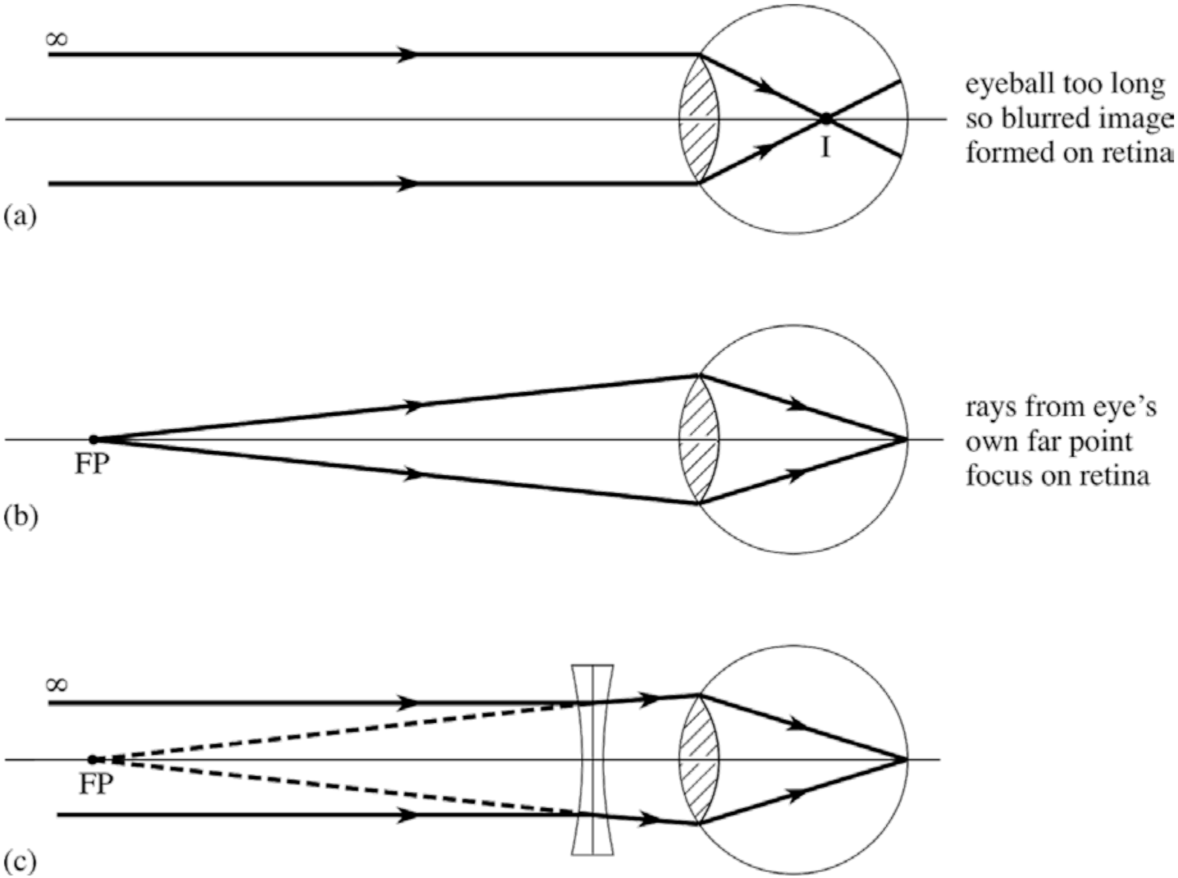
Example:

- Hedwig's habitual Rx and VA in OD: -1.50 DS 20/30
- Adding -0.25 should get him to about 20/25
- Adding another -0.25 should get him to about 20/20
- Expected refraction: -2.00 DS

Spectacle Correction of Ametropias

Far Point

- The farthest away the eye can see clearly with accommodation entirely at rest is the FAR POINT
  - For myopia: far point is between infinity and the patient
  - For hyperopia: far point is behind the retina
- To correct the ametropic eye the correcting lens must place its image (Secondary focal point – f_2) at the eye's far point.
- The image of the far point plane becomes the object that is focused on the retina


∞
I
eyeball too long
so blurred image
formed on retina
(a)
FP
rays from eye's
own far point
focus on retina
(b)
∞
FP
(c)

Vertex Distance

Changing the position of the correcting lens changes the relationship between F2 and the eye's far point

- Very important for prescriptions greater than +5.00/-5.00
  - Standard glasses vertex is 12mm
- Critical for contact lens prescribing

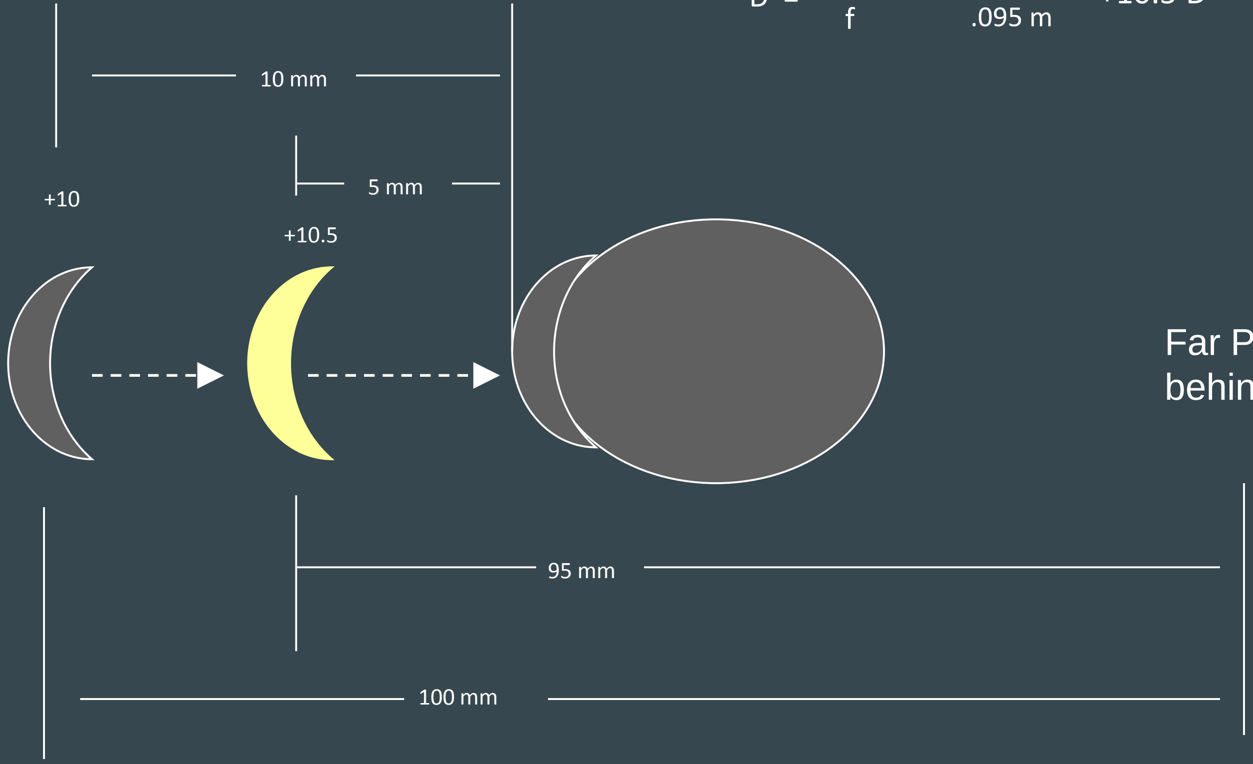
Following Example:

- Lonzo wears +10.00 glasses that sit 10mm in front of his eyes. If he prefers to wear those lenses at 5mm in front of his eyes, what power should you prescribe?

A +10.00 lens is moved from 10mm to 5mm away from the cornea

What power lens has a focal length of 95mm (9.5 cm)?

$$D = \frac{1}{f} = \frac{1}{.095\ m} = +10.5\ D$$



Far Point - 90mm behind the cornea

Prescribing for Children

Myopia

- Retinoscopy and cycloplegia are critical
- Children tolerate cylinder well
- Consider contact lenses for high minus or anisometropic eyes

Prescribing for Children

Hyperopia

- More complex than myopia - patient sometimes can’t see distance or near
- Often accompany strabismus and accommodation issues
- Retinoscopy and cycloplegia are *very* critical
- Except in cases of esotropia, “cut the plus”
    - Children may not be able to fully relax accommodation
- Children often tolerate cylinder and anisometropia well

Clinical Accommodative Problems

Presbyopia

- Gradual loss of accommodative amplitude

Accommodative Insufficiency

- Premature loss of accommodative amplitude
- Blurring of near objects, fatigue
- Require additional reading plus power
- Often simply due to uncorrected hyperopia

Clinical Accommodative Problems

Accommodative Excess

- AKA: ciliary muscle spasm
- Headache, brow ache, variable distance vision, very close near point
- Can occur after prolonged and intense periods of near work
- Can be difficult to refract; cycloplegia is necessary

AC/A Ratio

Accommodative Convergence/Accommodation Ratio

- How much do your eyes converge when you accommodate 1 D?
- Normal AC/A is 3:1 - 5:1

  i.e. for every diopter of accommodation, your eyes converge 3 - 5 prism diopters

How to measure: 2 ways

1. Heterophoria method
   - Move the fixation target from distance to .33 meters
   - Use an equation
   - Rarely used

AC/A Ratio

2. Gradient Method (more common) - two different ways to measure

A. Stimulate accommodation
   - Measure heterophoria at distance, then add -1.00, measure again
   - AC/A is the difference between the 2 measurements

B. Relax accommodation
   - Set the target at 0.33 m and measure the heterophoria
   - Add +3.00 D sphere, then measure again
   - The phoria difference divided by 3 is the AC/A ratio

AC/A Ratio Example

Larry has a measured phoria of 8 BI (8 prism diopters of exophoria) at distance

After adding -1.00 D, you measure 2 BI (2 prism diopters of exophoria)

What is Larry's AC/A?

6:1

Pt tends to converge a lot for every diopter of accommodation

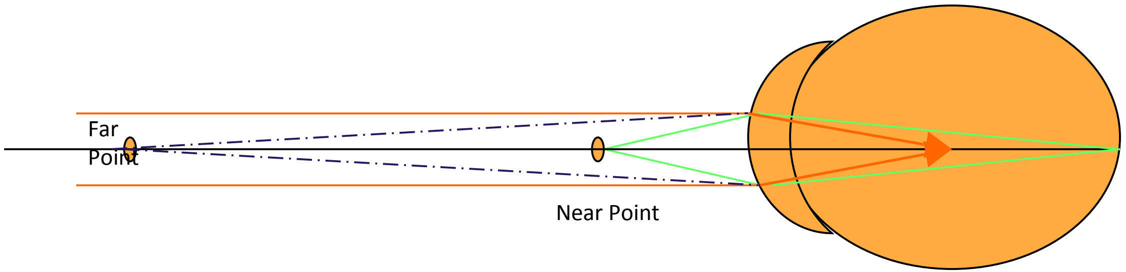
Pt may complain of eye strain at near

Accommodation

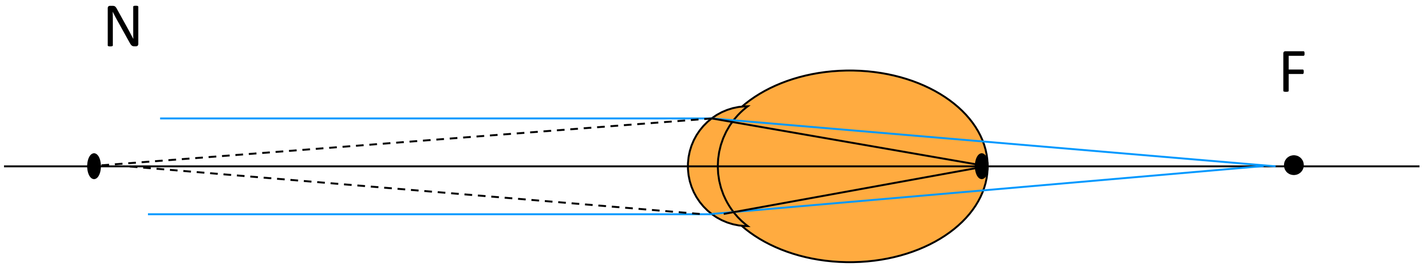
Accommodative Amplitude

- How much a patient can accommodate
- The dioptric difference between the near point and the far point

MYOPE



Hyperopia



Accommodation

Quiz:

Jerry's far point is 33cm. What is his refractive error? -3.00

Say Jerry can accommodate 4 diopters. Without glasses, what is his near point?

3.00D of myopia + 4.00D of accommodation = 7 D

f = 1/D

1/7 = .1428m = 14.28cm

Another Example

How much would Jerry have to accommodate (without glasses) to see something 20cm in front of his face?

Far point is 33cm (-3.00D myope)

Must accommodate to see something at 20cm (13mm closer than his far point)

1/.20 = 5 D. But since he is already has 3D of myopia:

5D - 3D = 2 D

Selecting an Add Power

Many different methods

From the patient's measured accommodative amplitude, allow ½ to be held in reserve

Example:

- If a patient has 2.00D of max accommodation, they can accommodate 1.00D comfortably

Selecting an Add Power

Example:

You determine that Shannon has 1.50D of max accommodation

0.75D may be comfortably contributed by the patient

At near, pt needs 2.50D of accommodation (40cm away)

Total amount of accommodation needed - pt's available accommodation =

add power needed

2.50D - 0.75D = +1.75 add

Types of Multifocal Lenses

Bifocals

- See the following picture

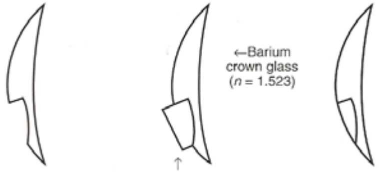
Trifocals

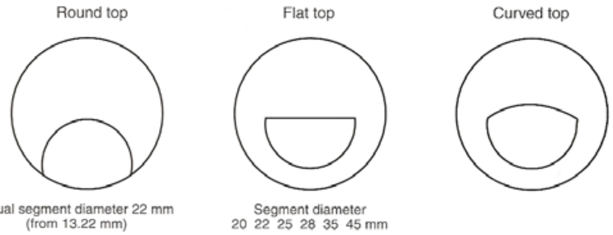
- Distance, intermediate, and near

PALs (Progressive addition lenses)

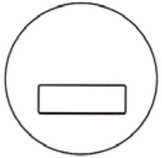
- Can provide clear vision at all ranges

Fused Bifocals



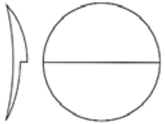


Ribbon segments

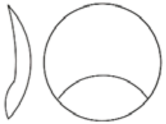


This fused bifocal is designed to permit distance vision viewing below the segment.

One-Piece Bifocals



Split lens (or "Benjamin Franklin") **bifocal**.
Correction for astigmatism is ground on the **concave** surface.



Ultex-type bifocals in segment diameters.

Ultex A	38 mm
Ultex AL	38 mm (up to 33 mm high)

Astigmatism correction is ground on the **convex** surface.

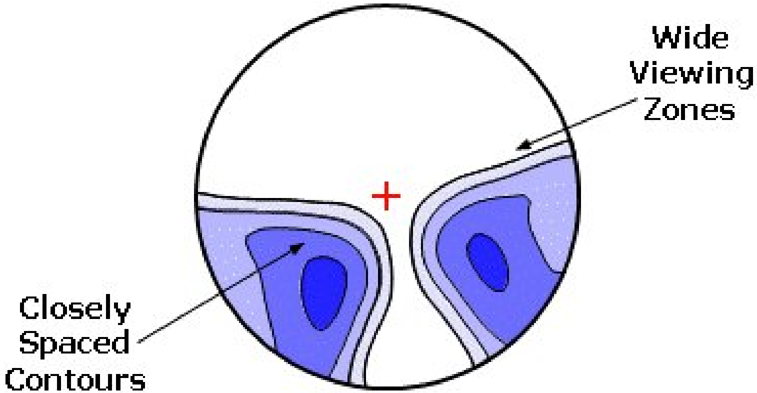
Anatomy of a PAL (Progressive Addition Lens)

4 types of optical zones

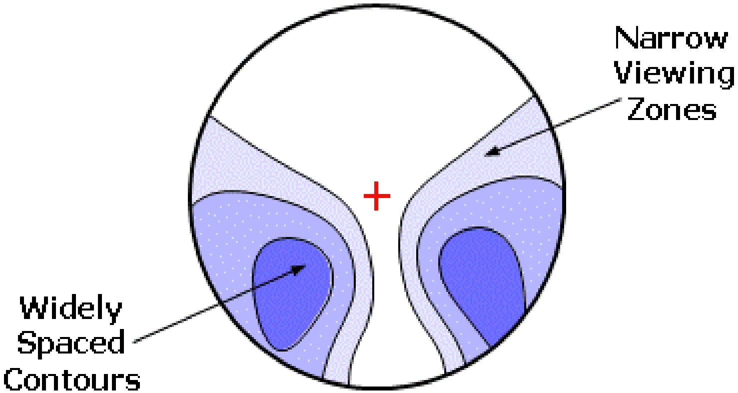
- Distance, intermediate (corridor), near, and peripheral distortion.

Drawback: some degree of peripheral distortion is present in ALL types of PALs

- “Hard Design” vs “Soft Design”
- Sand analogy



“Harder” Lens Design



“Softer” Lens Design

Ideal for:

- Advanced presbyopes
- Small, detailed near-work
- Large area for distance viewing
- Watchmakers

Ideal for:

- Early presbyopes
- General use
- Computer use

Prentice Rule

All lenses act like prisms when not looking through the optical center

$$\Delta = h\,\mathrm{D}$$

Δ = Prismatic effect (in prism diopters)

h = Distance from the optical center (in centimeters)

D = Lens power (in diopters)

Important

An easy way to look at glasses:

Plus Lens

Minus Lens

Image Displacement

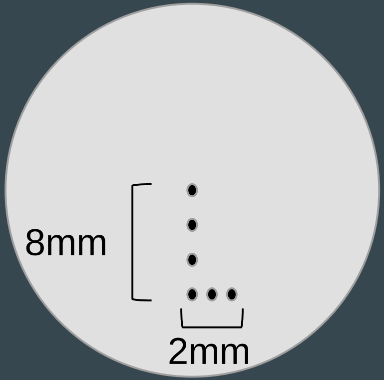
An unequal displacement of images

- Caused by different lens powers
- Occurs when you are not looking through the optical center

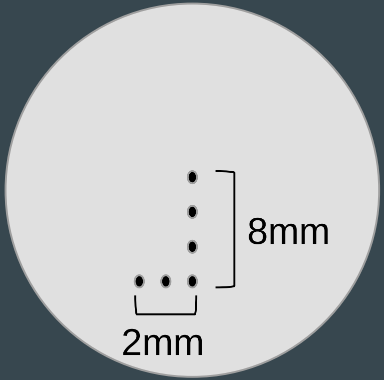
Let’s do an example…

Image Displacement

OD: +4.00 D



OS: +1.00 D



Vertical: 0.8 x +4.00 = 3.2 Δ BU
Horizontal: 0.2 x +4.00 = 0.8 Δ BO

Vertical: 0.8 x +1.00 = 0.8 Δ BU
Horizontal: 0.2 x +4.00 = 0.2 Δ BO

Induced phoria:
OD: 3.2 - 0.8 = 2.4 BU
OD: 0.8 BO + 0.2 BO = 1 BO

Image Displacement

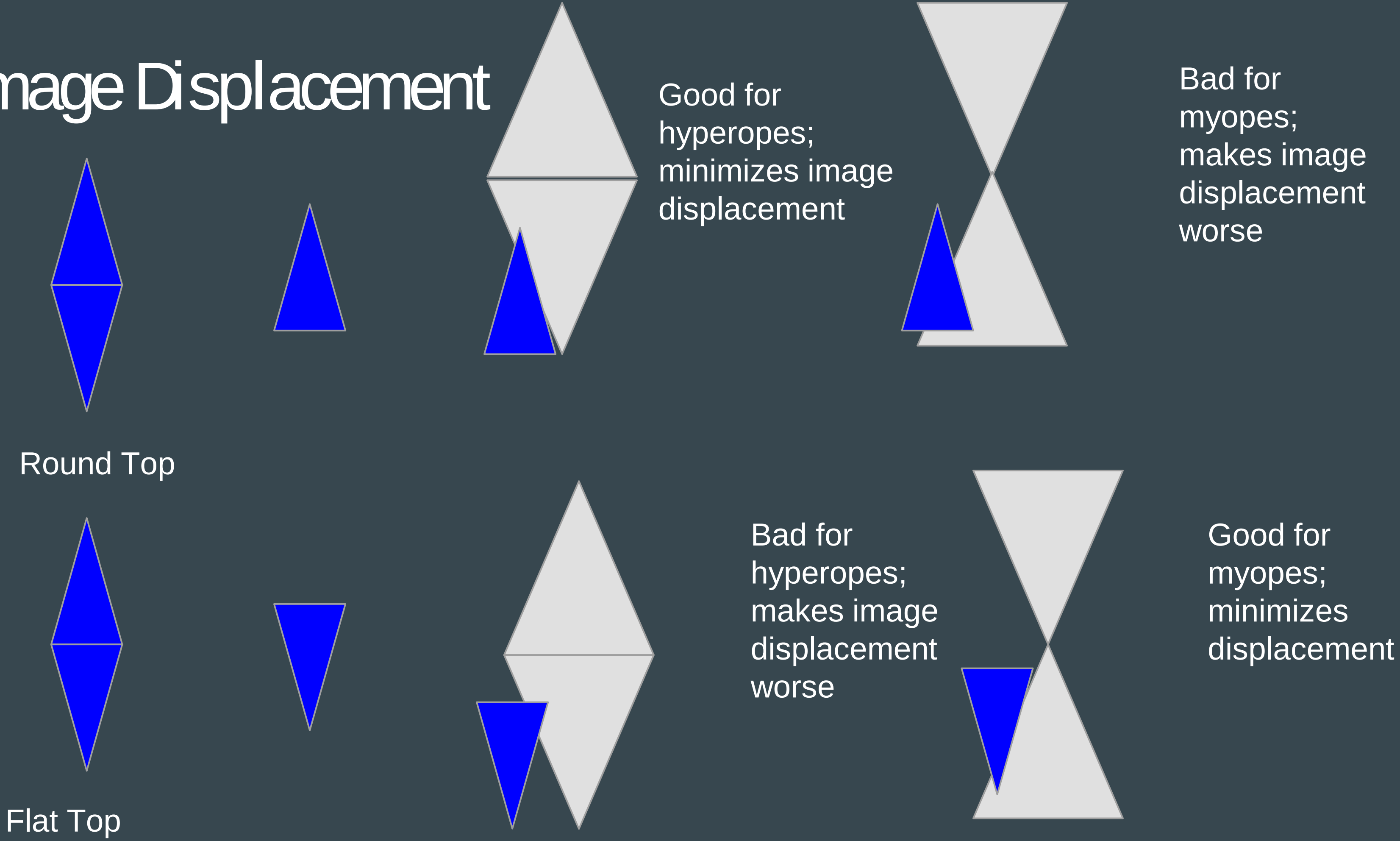


Image Displacement

Bottom line:

- Round-top bifocals work better on hyperopes
- Flat-top bifocals work better on myopes

Image Jump

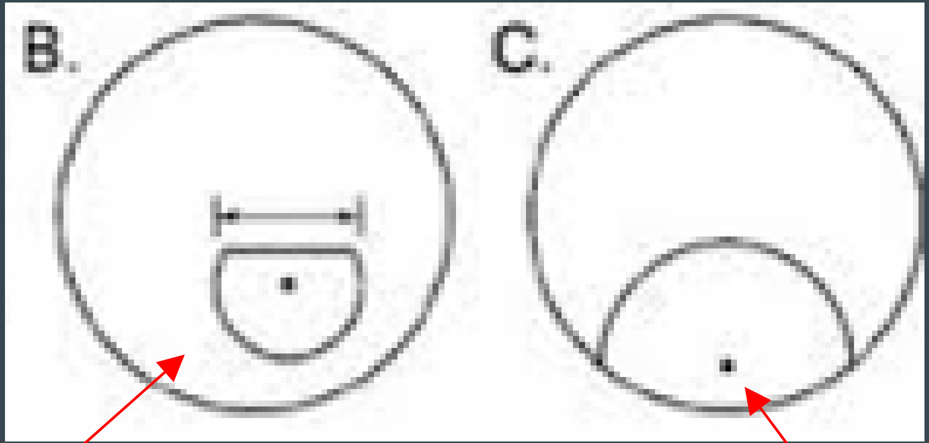
Results from the difference between prismatic effects of the distance and near portion at the junction line

- i.e. image moves when looking from distance portion to the bifocal

Jump depends only on the power of the seg and the location of its optical center

Important: “The closer the optical center of the segment approaches the top edge of the segment, the less the image jump is.”

- Flat top segments produce less image jump than round-tops



Less image jump

More image jump

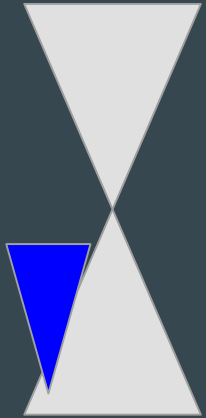
How to you combat image displacement and jump?

Press-on prisms

- Fresnel prisms are easy to try

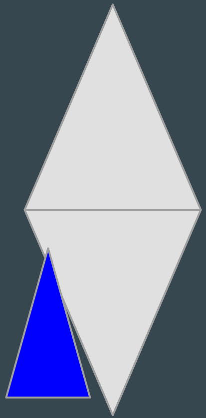
Slab-off

- Basically creating base-up prism over the more minus lens



Reverse slab-off

- Much more common method
- Add base-down prism over the more plus lens



How to you combat image displacement and jump?

Dissimilar segments

- i.e. round top in one eye, flat top in the other

Reading glasses

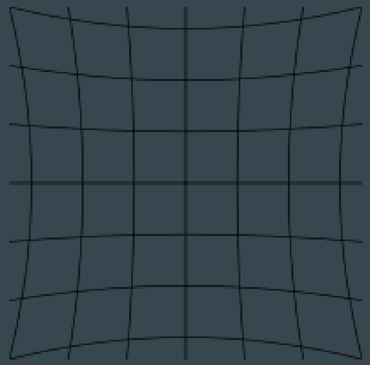
Contact lenses

Refractive surgery

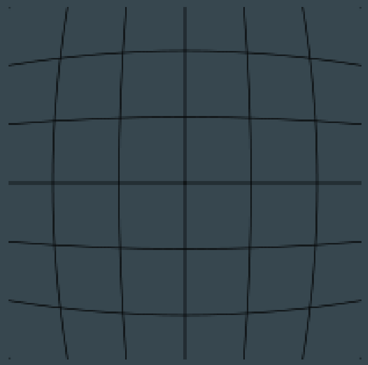
Prescribing Special Lenses

Aphakic Lenses

- Use retinoscope
- “Pincushion” distortion
- Recommend smaller lenses
- Best idea: contact lenses



Pincushion Distortion



Barrel Distortion

Therapeutic Use of Prisms

Vertical fusional amplitudes are usually small

- Prisms may be very helpful
- Usually prescribe the minimum amount to eliminate diplopia
- Trial with Fresnel prisms is useful

Horizontal heterophorias

- Usually require higher amounts of prism correction
- Watch for adaptation

Questions?