Basic Optics of Near Low Vision Devices

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Examination sequence

- Case Hx
- VA's distance, near, continuous text
- Low Contrast acuity (Bailey-Lovie)
- Refraction
- Central field test (scotomas)
- Magnification response

Sequencing of optical prescribing

- Magnification response (high add or cctv)
- Does the patient require EV training?
  - Steady PRL?
- IF yes, Explain need for EV training
- Explore response to magnification on a couple devices to demonstrate concept and no magic glasses

WAIT

- Don't prescribe devices at this point in time
- Determine most successful strategy to incorporate devices at a later stage when EV training makes progress
- Discussion

Determining Necessary Magnification for Near

- Magnification Needed
- Convert to De (M times 2.5 D)
- Consider near treatment options

- ALL THEORETICAL

Categories of Optical Aids at Near

- Spectacle plane lenses (microscopes, high adds, SV near)
- Hand held magnifiers (2 ways to use)
- Stand magnifiers
- CCTV/Video Magnifiers
- Telemicroscope (near telescope)

Example

- Mrs. Smith wants to be able to read a book. Her best corrected visual acuity is 10/80.

  160/40 = 4x

  4 x 2.50D = +10.00D

  Reading distance?

Equivalent Power

- power of add predicted
- any lens or combination of lenses used to produce the power of add predicted
- whole optical system can be replaced by a single lens positioned such that the object is located at it's primary focal point

Equivalent Power

$$D_e = D_1 + D_2 - tD_1D_2$$

where

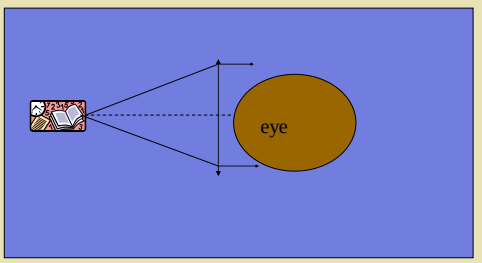
D_e = equivalent power

D_1 = power of lens in LV aid

D_2 = add or accommodation

t = separation between LVA and spectacle plane

Microscopes/High Adds



Microscopes/High Adds

- Lens at spectacle plane
- Object at focal length of lens: working distance = object distance
- image at infinity; one magnification created M_{RD}
- $D_e = D_1 + D_2 - tD_1D_2$
- $D_e = D_1$ (because D2 = 0)

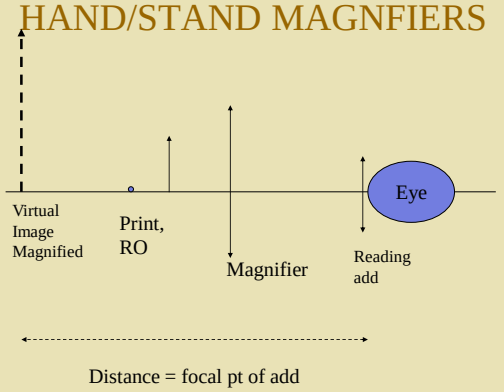
Microscopes/High adds

- 90 yof with BVA 10/200 wants to read great-granddaughters letters (RS80). She is a 4.00D myope.
- ROV?
- Add?
- M_{RD}?
- Final prescription of reading glasses?

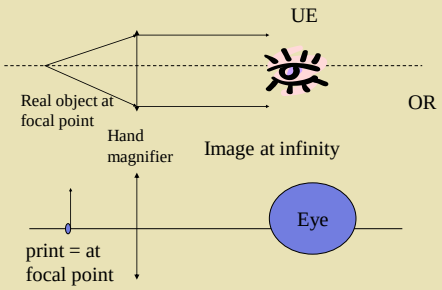
Another example

- 74 yof, BVA 10/120 with +1.00DS, wants to read 0.8M print and have her hands free.
- Single vision near glasses RX?
- Rated Mag = 16/4 = 4x (what magnifier is usually marked with from manufacturer)

HAND/STAND MAGNFIERS



Hand Magnifier: Object at focal point of lens (no add, fully corrected)



Easiest way to use Hand magnifiers

- Hold reading material at focal point of lens (1/D)
  - De = D_{HM}
  - image at infinity
  - magnification equation simplifies to M_{RD}
  - I.e. magnification is constant for any distance of the magnifier to eye - WOW!
  - Field of view changes with distance. How?

Easiest way to use Hand magnifiers

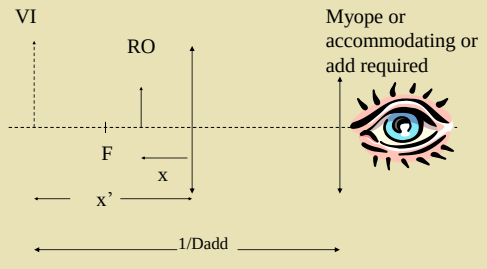
- Hold reading material at focal point of lens (1/D)
  - patient must use distance Rx since image is at infinity - **No ADD or accommodation**!!
  - patient can hold magnifier wherever he wants (as long as object is still at focal point of lens)

Example

- 82 yom wants to read the newspaper. His BVA is 10/80

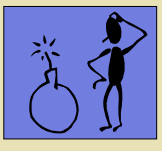
2nd way to use Hand Magnifiers

- Object is held inside the focal length of the lens
- image is then virtual and at a finite distance from the lens
- image is enlarged (lateral magnification is induced)
- user must use add (or use accommodation or is myopic) to see finite image clearly
- image must be located at the focal length of the add to be seen clearly



HM: object < f_{lens}

- $D_e = D_1 + D_2 - tD_1D_2$
- $D_1=D_{HM}$; $D_2= D_{add}$ **Starts to get ugly**
- or $D_e= D_{add} * m$
  - **Still ugly but slightly easier**



Hand Magnifiers

- +20.00D HM held 10cm from eye. Object at 3cm from the HM
- Equivalent power of system? Add required?
- HOW DO WE FIND x':

THIN LENS EQUATION

$1/x + D_{lens} = 1/x'$ Recall that x and x' are negative

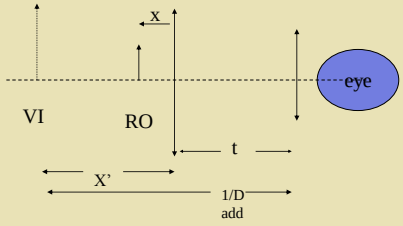
Clinical Rule

- One add's worth of power is lost from the maximum combined power for every focal distance of the **magnifier** that it is held away from the spectacle plane

Stand Magnifiers

- Same optics as case 2 with hand magnifiers
- Manufactured so that objects are inside the focal length of the lens (height of stand is object distance)
- must use an add or accommodation

Stand or hand magnifiers



Stand Magnifiers

- amount of add or accommodation required depends upon the position of the virtual image

Stand Magnifiers

- image created by the stand magnifier is at the focal point of the add/accommodation used
- the distance of the virtual image behind the lens will also determine the maximum add that can be used

So how do I prescribe a stand magnifier?

- calculate ROV and necessary add
- this is the equivalent power you need
- do a lot of measurements and calculations

or

- look at the prepared charts!
- Rule of thumb:

Telescopes Adapted For Near Viewing

Two Methods:

Reading Cap: Plus lens over objective

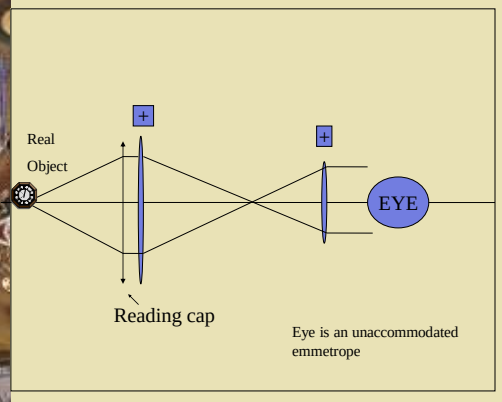
Extending the length of the telescope

Reading Cap

- Hold object at focal length of cap
- $M_{cap} = D_{cap}/2.5$ D (40 cm reference)
- De=Dcap*Mts

Advantage: Longer working distance than high add of same dioptric power

Disadvantage: Smaller FOV than high add

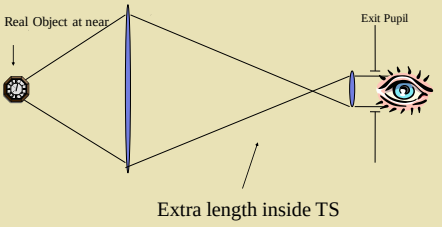


Consider Prescribing Over the Implantable Telescope

Extended length for near

- Extra length in telescope often called optical tube length
- Hard to calculate actual magnification created
- Spiral telescope has ability to be lengthened for near viewing at about 25-30 cm depending on telescope

Spiral Keplerian Telescope



NOT TO SCALE

CCTV

- Electronic Magnification

$$De = M_{screen} \times D_{add}$$

Where D_{add} = 1/distance of pt from screen

CCTV

- M_{screen} = actual letter height (mm)/magnified letter height

Prescribing for Near Viewing

Test for best add

- Equivalent Power

Microscopes or High Adds

- Aspheric monocular or single lens design
- Doublet – monocular
- Prism glasses
  - Full frame
  - Half eye

Microscopes and High Adds: Terms

- Working distance = distance from spec plane to reading material

- Full diameter = lens fills frame or usable lens space

Microscopes/ Doublets

- +8.00 D to +48.00D
- Special doublets above +12D can improve optical performance
  - Clear Image = Great quality
- No mobility with full diameter design

Binocularity

- Binocularity practical to +12.00D according to textbooks
- Clinically practical upper limit – some docs think +8 is max
- BI prism to aid in convergence
- Good for sustained near tasks

Binocularity

- Prentice Rule
  P= dD
  prism = d (cm) x Power of lens

  Clinical Rule:
  Amount of BI in each lens
  = add power +2

Finding the Near PD (For rx's<+9D)

- Several ways exist
- Ian Bailey recommends: decentering the lens 1.5mm for each diopter of add. If the distance PD is > than 65mm, decenter 1mm further.

Example

- Patient with distance PD of 62mm requires the use of a +6.00 D monocular add to read a textbook. What is the patient's near PD:

Example

- Answer: 6(1.5) = 9mm
  62-9 = 53 mm, so near PD should be set at 53mm

example

This method only determines the NPD. To create BI prism, more decentration would be necessary or prism can be ground in.

Prescribing On Center

- If prescribing monocular above +8 consider prescribing On-Center (at distance pd)
- Teach patient to view straight ahead
- Must move paper to read – not head!

Custom Microscopes and High Adds

- Prism Spectacles: Full Field or half eyes (+8 practical maximum)
- High plus aspheric (monocular)
- Microscopes (monocular) (typically over +8D)
  - Aspheric doublet (Clear Image)
  - Marked at Rated Mag (4D X Mag printed on side)

Microscopes and High Adds Types of Delivery

- Regular bifocals from local lab
  - (FT28 or FT35) can get to +8.00D add in CR39
  - (FT28 or FT35) can get to +4.00D add in **POLY (correction on handout)**
  - Round seg can get to +40D
  - Executive to +20D

Microscopes and High Adds Types of Delivery – low vision custom companies

- Multifocals (2X to 10X)
  - Frame should have adjustable nosepads
  - Segment should be set higher than a conventional bifocal (as high as lower pupil margin)
  - A monocular bifocal should never be decentered

Other Considerations

- What if patient doesn't respond to the theoretical ideal magnification?
- Have you considered the scotoma?
- Have you considered contrast sensitivity?
- Have you considered cognitive deficits
- Prior to ever introducing magnification, I like to try to predict how they will respond

Summary

- Know the general optics of your devices
- Know the optics of the eye – refraction
- Combine knowledge with clinical relevance and practicality
- = Confidence in prescribing
- Don't forget complexities of scotomas and consider entire rehabilitation plan