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JCAHPO Regional Meetings
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Better One or Two?—Jackson Cross Cylinder Testing Made Easy

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Course Objectives

• Define the use of Jackson Cross Cylinder for either plus or minus cylinder exams
• Understand how to maintain spherical equivalent when performing refinement
Financial Disclosure
I have no financial interest in this topic—it is just something I like to do!

First, a brief review of basic optics
Optics in Ophthalmology

• Nature and property of light itself

• Uses laws of geometry to design lenses (spectacles, cameras, etc.)

• Physiology of vision and seeing

Refractive Errors

• Ametropia indicates that there is a refractive error
  • Myopia (near sightedness)
  • Hyperopia (far sightedness)
  • Astigmatism
  • Presbyopia
Astigmatism

• One meridian is flatter and perpendicular (90° away) from the steeper meridian
• Two focal
• Regular astigmatism is correctable with spherocylindrical lenses

Astigmatism

• Focal lines may be anterior or posterior to the retina or any combination
• Requires for one meridian and to correct remaining error in the meridian 90 degrees away
Astigmatism

• Significant changes in astigmatism over a 1-3 year period are likely due to or possibly due to keratoconus, chalazion or other ocular pathology.

Fig. 3-31 Sturm’s conoid. This represents the astigmatic interval between the two focal points of a spherocylindrical lens.
Circle of least confusion

- The circle of least confusion represents the dioptric average of the spherocylinder
- In refraction, the conoid of Sturm is collapsed so that both the vertical and horizontal foci are on the retina
- We will go back to this concept when we talk about cylinder power

Spherical Equivalent

- Spherical Equivalent is “a ball-park figure for the amount of dioptric power in a spherocylinder. It is a substitute sphere that represents the best correction the patient with astigmatism can obtain without the cylinder.”

- Cassin: Fundamentals for Ophthalmic Technical Personnel
Calculating spherical equivalent

To calculate the spherical equivalent of a prescription:
1. Ignore the axis
2. Take half of the cylinder and combine it algebraically with the sphere

Math rules:
If the signs are different, use the sign of the larger number

Now you try these:

+ 2.25 🔺+1.50 🔺x 045 • +3.00
Plano 🔺-2.50 🔺x 180 • -1.25
-1.00 🔺-1.00 🔺x 025 • -1.50
-2.00 🔺+4.00 🔺x 013 • plano
Spherical Equivalent

+ 0.25 – 0.50 = plano
- 0.25 + 0.50 = plano

- You will see why this is important later

Determining Axis and Cylinder Power

• Some practitioners use an astigmatic dial to find the axis
• Retinoscopy is a helpful tool
• Jackson Cross Cylinder (JCC) is considered the most accurate
Jackson Cross Cylinder

- Dr. Edward Jackson—1887
- Modified Stokes lens with axes fixed perpendicular to each other

Jackson Cross Cylinder

- Based on the theory of obliquely crossed cylinders
- Two cylindrical elements of typically 0.25 D with opposite signs, crossed at 90 degrees
- Rotated so that the mean power of the lens remains zero
• The crossed cylinder allows you to present two lenses to the patient:
  • One will increase the interval of Sturm
  • The other will decrease it

• The zero mean power of the crossed cylinder ensures that the circle of least confusion remains on the retina for both presentations
Advantages and Disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• JCC is a sensitive method for determining cylinder axis and power in both high and low degrees of astigmatism</td>
<td>• Some patients may have trouble with the sequential presentation of the JCC</td>
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</tbody>
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Phoropter circa 1865
Refinement
1. Sphere first
2. Refine axis
3. Refine cylinder power
4. Refine sphere

SAPS
JCC—Worst practices

• Not using it or using it incorrectly
• Presenting lenses too quickly
To dim or not to dim?

- Show the patient an acuity line about 2 lines bigger than the one they read with their best sphere
- Warn the patient that this lens will make the letters a little blurry
- Have the patient concentrate on just one letter on the line
Determining the axis

• After best sphere is obtained, flip the JCC in place so that the plus and minus axes straddle the correcting cylinder axis
• The knurled knob should be in the same position as the arrow indicating the axis on the cylinder axis dial

Determining the axis

• “Now I am going to show you some lenses in pairs. Most of the time both will be blurry. I want you tell me the one you prefer or if they look the same.”
Determining the axis

• When the JCC is rotated, the patient is presented with two effective cylinder axes, one of which will be closer to the patient’s real axis than the other.
• This is the axis they should prefer.

Cylinder Axis

• In cylinder, you will follow the white dot
• In cylinder you will follow the red dot
Determining the axis

• Estimated rotation of the cylinder axis for different cylinder powers when using the JCC
  +/- 0.25 JCC (Bennett & Rabbetts 1998)

<table>
<thead>
<tr>
<th>Power of correcting cylinder</th>
<th>Estimated initial rotation needed in degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>30</td>
</tr>
<tr>
<td>0.50</td>
<td>20</td>
</tr>
<tr>
<td>0.75</td>
<td>15</td>
</tr>
<tr>
<td>1.00-2.00</td>
<td>10</td>
</tr>
<tr>
<td>2.25+</td>
<td>5</td>
</tr>
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</table>

Determining the axis

• As you show the patient the pairs of lenses, rotate the axis appropriately according to the amount of cylinder in the direction of the dot (in minus cylinder or white dot in plus cylinder).
Determining the axis

• Using these axis changes or similar ones, each axis step plus the patient’s response is remembered, the amount of axis change is halved after the direction of the axis changed is reversed.
• This is called bracketing.

Determining the axis

• Continue offering pairs of lenses until the lenses look about the same (equally blurred)
• Use a bracketing technique as the direction is reversed
Determining the axis

What do you do if they always pick the same lens?

- Try “tricking” them by reversing the choices
- Remember “same” is a valid choice (and desirable at times)
Determining cylinder power

- Once the axis is refined, then the JCC is rotated so that the dots align with the axis
- \( P = \text{power} \)

Determining cylinder power

- You don’t need to give the patient any new directions, you may just keep going
- Once again you are looking for better 1, better 2 or about the same
Refining cylinder power

cylinder
• If the patient prefers the lens with the dot, give minus power, if they prefer the white dot take away power (0.25D)

• Plus cylinder
• If the patient prefers the lens with white dot give more power, if they prefer the red take away power (0.25 D at time)

A little pearl for you

• When you are just learning to use the JCC for power determination it is easier if you flip back to the lens they prefer so you can “see” the dot

• Courtesy OMA student
Cylinder power

• Always give the lesser amount of cylinder power if they are not sure (if both look the same)

Maintaining spherical equivalent

• For every 0.50 D change in cylinder power, you must adjust the sphere by 0.25 D
  • +0.25 –0.50
  • -0.25 +0.50
Maintaining spherical equivalent

- This is important because it allows the image to stay on the retina
- Conoid of Sturm stays collapsed
Challenges

• Patients do not give perfect answers
• Patients providing unreliable responses
• Patients with reduced visual acuity
• Communication

• Patients providing unreliable responses
• Patients with reduced visual acuity
Most common errors

- Using a fast presentation time in older patients whose response time may be slower than adults
- Using different presentation times for the two positions
- Making large changes in axis in an eye with high cylinder power

And finally

- Once you are happy with the cylinder axis and cylinder power, finish up by refining the sphere
- Duochrome testing and/or binocular balancing may be done
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