
Roving ring scotoma & Jack-in-the-box phenomenon are few the most confusing aspects of optics in Ophthalmology.

If you have heard about these but couldn't understand them then this is the post for you, I will explain you these concepts in the most easy manner possible with diagrams.

Surgical treatment of cataract by removal of the crystalline lens of the eye results in an aphakic eye which has very different optical properties from the normal or phakic eye.

In particular, after the removal of the crystalline lens which accounts for about one-thirds of the eye's
optical power about 10 to 15 Diopters, the patient requires a spectacle lens about +10.00D to +15.00D.  

3 main modalities to correct aphakia:  
- Aphakic spectacles  
- Contact lenses  
- Intraocular lens (IOL). (now most widely used)

We are going to stress about few fascinating problems like Roving ring scotoma & Jack-in-the-box phenomenon due to Aphakic spectacles due to which they were replaced by the IOL.

**Aphakic Spectacles:**

To correct the refractive error in aphakia about 10 dioptres of convex lenses are required for distance vision and about 13 dioptres for near vision. Such high power lenses are associated with numerous physical and optical problems. The most important of these problems are:

1. **Magnification**: Each dioptre of convex power leads to about 3 % magnification of image and a difference of image size between the two eyes of about 7 % is tolerable. Thus 10 dioptre aphakic spectacles lead to about 30 % magnification of the image which give rise to *diplopia* i.e., two images of one object are seen one small (from normal eye) and other larger (from aphakic eye). Moreover, when the objects appear larger they appear falsely closer than reality, and this leads to physical in-coordination.

2. **Roving Ring Scotoma**: The edge of a convex lens acts as a prism and the higher the power of the convex lens the greater is the prism angle (alpha). The light falling on the prism bends towards its base by an angle alpha/2, therefore, greater the angle alpha the more will be the bending. In aphakic spectacles, the angle alpha being large, the light falling at the edge of the lens bends towards the center of the lens (base of prism) and does not reach the pupil and is, therefore, not seen. This results in an area of the visual field which is not visible to the patient, or scotoma. And because the edge of the lens is present all around the lens like a ring, so it gives rise to a ring shaped scotoma. The position of this scotoma is not fixed in the visual field because the eye keeps moving (or roving) in relation to the aphakic spectacle. Hence, the result is a roving ring scotoma.
3. **Jack-in-the-box Phenomenon**: The presence of the above scotoma leads to another interesting phenomenon. If an interesting object appears in the periphery of the patient's visual field, it appears blurred (because the light is passing from the side of the spectacle frame). The person tends to move his head towards the object in order to see it clearly. But as he turns the head, the object comes to lie in the area of scotoma and thus disappears. As he turns his head further so that the object comes to lie in front of the spectacle in the visible area and so reappears again clear and sharp. This sudden disappearance and sharp reappearance of the objects is called **jack-in-the-box phenomenon**.

4. **Pin Cushion Effect**: The magnification of image is more at the periphery of the lens due to prism effect. Therefore, all the objects appear stretched out at the corners like a **pin-cushion**.
5. **Spherical Aberrations**: The light converges more near the edge of the lens than at the center so the rays of light falling near the edge are brought to focus in front of the rays falling at the center. This results poor quality of image despite appropriate correction of refractive error.

6. **Chromatic Aberrations**: The shorter the wave-length the more is the refraction a ray of light undergoes. Therefore, in VIBGYOR the violet end undergoes greater refraction than the red end of the spectrum. This causes diffraction of light and makes the edges of white object appear rain-bow colored.

11 comments

1. **Anonymous** Said,
   I've searched for the explanation of this jack in the box phenomenon in many books and websites but nowhere did I find such an easy and clear explanation. Great job. Thanks a lot. Dr. Munneeb from Pakistan.
   Posted on May 12, 2009 5:35 PM

2. **Anonymous** Said,
   Now the phenomenon of jack in the box n roving ring scotoma is very much clear to me thru this explanation. Dr. NOreen from Pakistan.
   Posted on May 15, 2009 2:25 PM

3. **pradeep n rao** Said,
   super dude u are really a jack u rowed me around
   Posted on June 16, 2009 8:18 AM

4. **Anonymous** Said,
   great explanation. Dr. Sarita from India
   Posted on July 12, 2009 10:41 AM

5. **zulfz** Said,
   thank you so much.. finally i could understand dis phenomenon! FINALLY. great gob thnk u. dr.zulfeen frm india
6. **Anonymous** Said,
   thank u so much. i could finally understand dis phenomenon. finally! great job, thank u:) dr. zulfeen from india
   Posted on July 28, 2009 1:43 AM

7. **Kiru** Said,
   super o super
   Posted on August 2, 2009 7:51 PM

8. **Dr. Rajesh** Said,
   good explanation. outstanding
   Posted on August 19, 2009 2:42 PM

9. **Anonymous** Said,
   Very Good Explanation, Thank you
   Muhammed Kunzi, India
   Posted on October 9, 2009 11:48 PM

10. **Anonymous** Said,
    kindly give reference of your explanation
    Posted on May 26, 2010 4:22 PM

11. **Anonymous** Said,
    amazing job......thank you very much:)
    Erum Zafar Malik,
    Pakistan
    Posted on June 5, 2010 10:44 PM

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