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Explaining refractive errors by formula in practice for optician

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Abstract
Globally, 19 million children are living with vision impairment and approximately 12 million children have a significant, uncorrected refractive error [1]. Children in China are affected about 78% of myopia [2]. In Vietnam, the percentage of children with refractive errors is from 15-40 %, and about 3 million children needed glasses [3]. The ratio of Ophthalmologist/Optician /1000 people in Vietnam are low. In training refractive errors for optician some considerations are necessary. This paper introduces some formula for explaining in diagnosis refractive errors for optician in practice.

Keywords: refractive errors, myopia, hyperopia, presbyopia, astigmatism

Introduction

1. Blurry vision: The first question in eye care for check- up vision is why do people cannot see not well? His/her vision is blurry? The problem may be come from the eyeball to behind the eyeball such as optic nerve, to brain.

1.1 At the eye: The visual acuity can be measured through pinhole with 1mm diameter: * If: His/her vision is up this is a refractive errors.
+ Blurry a far distance this is often a refractive spherical lens which can be corrected by: minus lens (myopia) or plus lens (hyperopia)
+ Blurry at a near distance for reading on people who is 40 year-old and over which can be corrected by plus lens: presbyopia.
+ Blurry one direction with Parent clock this is an astigmatism with cylindrical lens or sphero cylindrical lens. Retinoscopy / Skiascopy can be done by Optometrist.
* If: His/her vision is not change, this is an eye diseases need to be transfer to ophthalmologist checks up from cornea to retin by using biomicroscopy/fundoscopy and radiography for diagnosis. Causes of inflammation included; tumor; trauma; degeneration; gene.
1.2 Behind the optic nerve: The problem may be caused by cortical brain injury with visual field alternation, ophthalmologist with radiography can be checked up.
2. Incomplete vision: The second question is often met that is why people sees double images (diplopia), sees incomplete (hemianopia) lesion in the brain? Causes: inflammation there are tumor; trauma; degeneration.
2.1 At the eye: Crossed eye (strabismus) caused by crossed-axis visual function deviation; pupillary axis (cornea-crystalline lens) and the optical axis / chiasma peripheral neuropathy.
2.2 Behind the eye: From optic nerve to brain there are: papilledema/ excavation of papilla /optic nerve atrophy. Signs of hemorrhage, exudate, paralysis. Caused by lesion of central nervous system)
3. Distortion vision: The third question is distortion of image. It is the aberrations in vision.

In summary: Measurement of Visual Acuity

- Visual acuity increases with pinhole, refractive errors/ retinoscopy/ skiascopy should be done
- Visual acuity does not increase with the pinhole, it is suspected eye diseases from cornea, uvea, lens, glaucoma, retina, papillae (inflammation, edema, concave, atrophy...) macula (inflammation, degeneration, trauma…); vascular (inflammation, obstruction, hemorrhage) retina (hemorrhage, exudate, trauma, degeneration) can be detected.

This paper introduces some formula for explaining in diagnosis refractive errors for optician in practice.

2. Proposed formula

From these reasons using formula in explaining refractive errors was proposed as follow:

1. L = axial length of the normal eyeball and i = image on retina/emmetropia
2. i = point image= emmetropia
3. La<L=>La=myopia and ia = image on front of the retina
4. Lb>L=>Lb=hyperopia and ib= image on behind the retina
5. ia (on front of retina)& ib (on behind of retina) = point images= myopia or hyperopia (spherical lens correction)
6. d1 = vertical corneal diameter and i1 = image on front of the retina
7. d2 = horizontal corneal diameter and i2 = image on front of the retina
8. d1>d=L=>Simple myopic astigmatism & i on the retina-i2 front of retina
9. d1,d2>L=>compound myopic astigmatism & i1, i2 on front of retina
10. d3 = vertical corneal diameter and i3 = image on behind of the retina
11. d4 = horizontal corneal diameter and i4 = image on behind of the retina

12. d3<d=L=>simple hyperopic astigmatism & i on the retina, i3 on behind of the retina
13. d3,d4<L=>compound hyperopic astigmatism & i3, i4 on behind of the retina
14. d1>L>d3=>mixed astigmatism & i1 on front of the retina and i3 on behind the retina- d1;d2>L>d3,d4=>mixed astigmatism
15. i1-i2 & i3 -i4 =dash-line images=astigmatism (cylindrical lens correction)

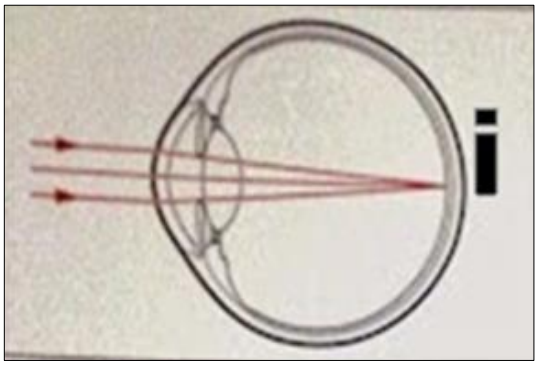

Fig 1: Emmetropia L=d=>i on retina

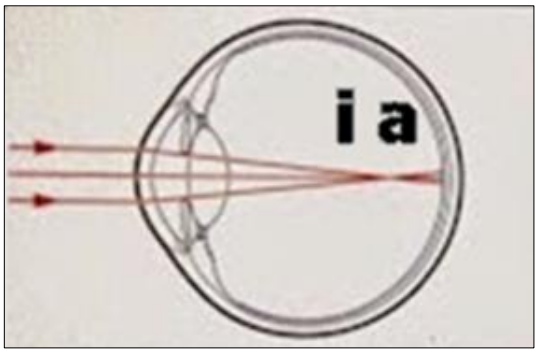

Fig 2: Myopia= La>Li a on front of retina

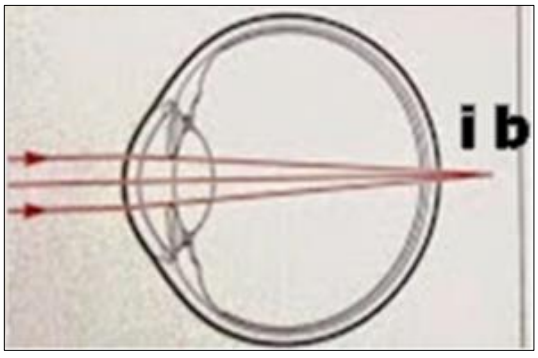

Fig 3: Hyperopia= Lb<L ib on behind of retina. I-ia-ib=point images

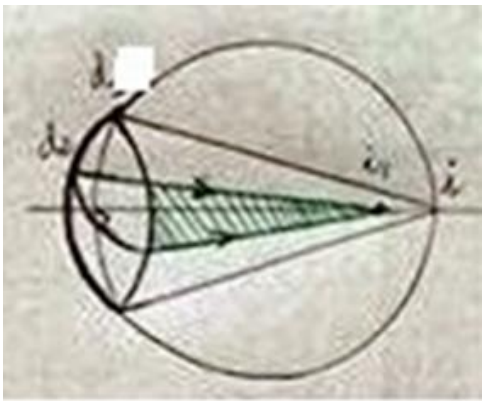

Fig 1: Simple myopic astigmatism L=d<d2=>I on retina & i2 on front of retina

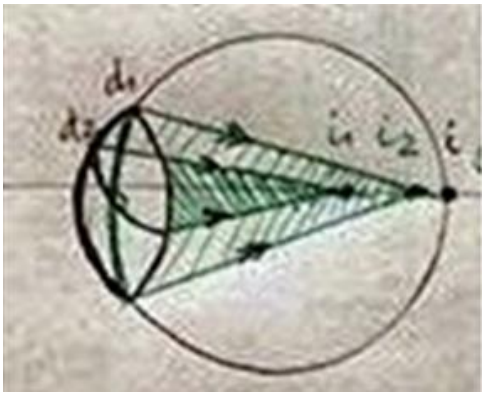

Fig 2: Compound myopic astigmatism L<d1<d2=> i1 & i2 on front of retina

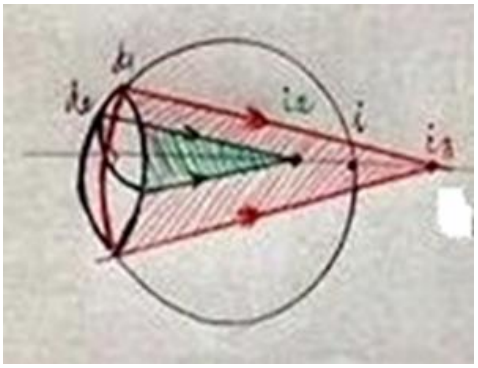

Fig 3: Mixed astigmatism d3, d4<L<d1, d2+> i1; i2 on front of retina & i3; i4 on behind of retina. I1-i2-14=dash-line images.

Explaining details

1. Emmetropia: If: d= L: All light rays focus i on retina. =>Emmetropic eyes.
2. Myopia-hyperopia: If: Lb <L <La: Myopia-hyperopia eye. + La> L=> Rays focus ia on front of retina=>

Nearsightedness /corrected by minus spherical lens. + Lb <L => Rays focus ib on behind of retina=> Farsightedness /corrected by plus spherical lens.

3. Astigmatism eye: 10 Categories

3.1. If d1 ≠ d2 caused by corneal scar, corneal cone=>irregular astigmatism.

3.2. d1 ⊥ d2 Perpendicular angle (90 degrees)=>regular astigmatism.

3.3. d1> d2 =>Vertical Astigmatism (rules)

3.4. d2> d1 =>Horizontal Astigmatism (against-rules)

3.5. D1∠ oblique angle d2 =>Oblique Astigmatism (135degrees±15)

3.6. L=d< d1 =>Simple myopic astigmatism/Rays focus i on retina and i1 on front of retina.

3.7. L=d >d3 =>Simple hyperopic astigmatism/Rays focus i on retina and i3 on behind of retina.

3.8. L< d1<d2 =>Compound myopic astigmatism/Rays focus i1/i2 on front of retina

3.9. L>d3>d4 =>Compound hyperopic astigmatism/Rays focus i3/i4 on behind of retina.

3:10. d1 <L<d3 =>Mixed astigmatism/ Rays focus i1 on front of retina and i3 on behind of retina.

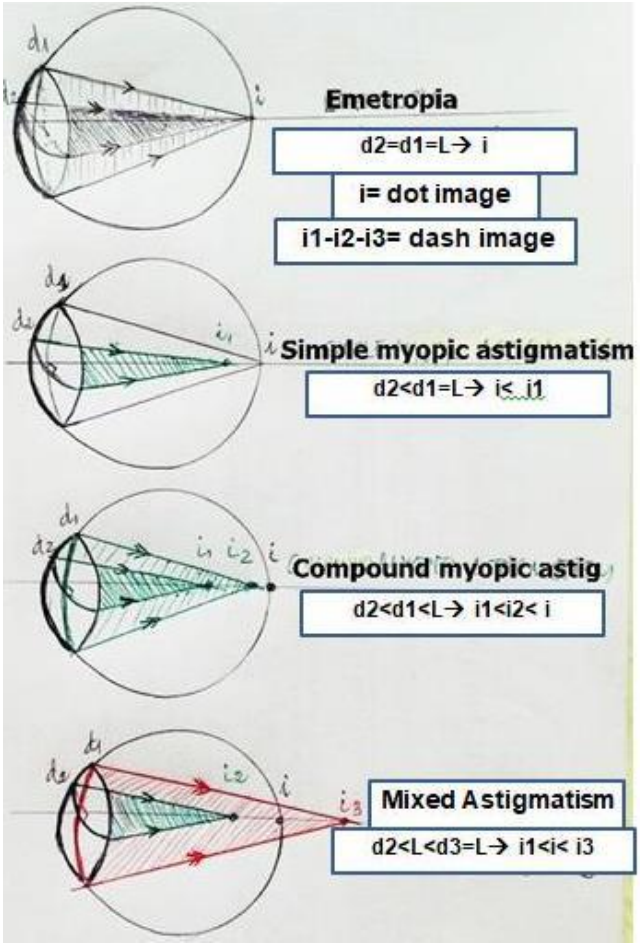

Fig 4

There are 5 clinical astigmatisms from 3.6 to 3.10

1. Simple myopic astigmatism. Ex= $-1.00x180^0$
2. Simple hyperopic astigmatism. Ex= $+2.00x90^0$
3. Compound myopic astigmatism. Ex =$-1.00(-0.50x180^0)$; $(-2.25x90^0)(-0.50x180^0)$
4. Compound hyperopic astigmatism. Ex=$+1.00(+0.50x90^0)$; $(+2.25x90^0)(+4x150^0)$
5. Mixed astigmatism. Ex= $(+1.75x150^0)(-4x60^0)$; $-2.25(+4x150^0)$

In practice: How to transpose a lens prescription

1. From positive sphero-cylindric lens to negative sphero-cylindric lens:

Add powers + change sign + change axis

$-2.75(+0.50x90^0)$ => $-2.25(-0.50x180^0)$

2. From cross formula to sphero-cylinder lens:

Select one power + add power after change sign + change axis

$(+1.75x150^0)(-2.25x60^0)$=> $+1.75(-4x60^0) = -2.25(+4x150^0)$

Remember in spectacles wearing the cylinder lens is more easily acceptable than spherical lens

3. Conclusion

The first step is measurement of Visual Acuity:

- Visual acuity increases with pinhole, retinoscopy/ skiascopy must be done by optometrist/optician to define refractive errors: myopia, hyperopia and astigmatism.
- Visual acuity does not increase with the pinhole, it is suspected eye diseases: from cornea, uvea, lens, glaucoma, retina, papillae (inflammation, edema, concave, atrophy...) macula (inflammation, degeneration, trauma…); vascular (inflammation, obstruction, hemorrhage) retina (hemorrhage, exudate, trauma, degeneration.) must be detected by ophthalmologist

The second step is to remember the formula mentioned above for explaining refractive errors as well as for diagnosis and using spectacles in practice.

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