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Refracting The Diseased Eye

Barbie O. M. Ejukonemu
Department of Optometry, Faculty of Allied Health Sciences,
College of Health Science, Bayero University, Kano, Nigeria
***Corresponding Email**: ejuks2001@yahoo.com.*

Abstract
Refractive error refers to ocular refractive status where images of objects of regard do not fall on the retina in a relaxed eye - the ametropic eye. Thus, objects are perceived as blur. Refractive error is an aberration in an otherwise normal physiological phenomenon and not a disease. Uncorrected refractive errors are the second most causes of blindness after cataract and the cause of almost half of visual impairment. Clinical refraction is a careful scientific procedure employed to correct refractive error. Given that refractive error is the most common reason patients present to the eye care practitioner, a lot of attention must be given to refraction. When an irreversible eye disease co-exist with refractive error, then correction of refractive error under this circumstance; refracting the diseased eye (RDE) become very challenging and painstaking. There will be likelihood of irregularities in the transparent refractive surfaces of the eye due to disease or surgery which make refraction difficult both for the patient and the examiner. Personal clinical experience of the author who is a low vision consultant and review of related literature from textbooks and journals are brought to bear in this article. This paper is a review of the RDE algorithm with delineation of these steps to enable an effective refractive end-point for the eye with disease. The paper will enable young Optometrists to deal with refractive error masquerading irreversible eye disease. It is also an essential reading for the low vision Optometrist in mastering the art and science of low vision refraction.

Keywords: *Refractive error, Eye disease, Refraction, Low vision refraction*
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Introduction

Refractive error is an ametropic condition. Ametropia is a refractive status where images of distant objects do not fall on the retina in the unaccommodating eye(Andrew, K. & Caroline, C. 2007) Refractive errors are physiological irregularities in the eye optical system that lead to the formation of imperfect retina images. Refractive error is not a disease. Blur circles thus formed on the retina result in the perception of objects as a blur. Refraction is the scientific and careful procedure employed to bring out-of-focus retinal images to focus on the retina to enable sharp retinal images and perception of objects as clear.

When refractive error co-exists with eye disease, vision is reduced to the extent of the degree of refractive error and severity of the disease. Refraction should only be carried out when the eye disease is cured and inactive (quiet eye). However, if the eye disease is irreversible, the component of vision loss due to disease is also irreversible. In this case, improvement in vision depends largely on correcting the component of vision loss due to refractive error by carrying out refraction in the diseased eye. It should be noted that vision loss may fall into the Low vision category.

According to World Health Organization (WHO) definition, a person with low vision has impairment of visual functioning even after treatment and/or standard refractive correction, and has a visual acuity(VA) of between less than 6/18 – PL, or a visual field of less than10^0 from the point of central fixation, but who uses, or potentially able to use, vision for the planning and/or executing of a task(Susana, T.,& Chung, L. 2011).

One very strong element of this definition is that low vision is not defined without treatment. This means the disorder or disease must be attended to either through drug therapy, refractive prescription, or surgery. There should be no active disease in the eye (quiet eye) for the definition to hold. The Visual acuity after treatment(exit acuity) for that quiet eye thus serves as the criteria for which low vision is defined not undermining the visual field from the point of central fixation. Moreover, the definition of visual impairment in the International classification of diseases (ICD 10th revision), is based on "best-corrected" vision.

Uncorrected refractive errors are the second most cause of blindness after cataracts and the cause of almost half of visual impairment(Serge, R., Donatelle, P., Sivio P., Mariotti, G., & Pokhae, P.2020). Given that refractive error is the most reason patients present to the eye care practitioner, a lot of attention must be given to refraction. Irreversible ocular pathology masquerades refractive errors in low vision. It is common for low vision patients to present with refractive error alongside eye disease causing decay in vision. Most importantly the refractive error component of the loss of vision must be dealt with and very commonly reduces the vision loss, migrate the patient to a better category of vision loss and possibly reside within the normal range. Studies in Nigeria reveal that 66% of children examined in schools for the blind had low vision, 18% had refractive errors and 15% had improved distant vision after refraction(Ejukonemu, B., O., M.2001).

Refracting the diseased eye, also referred to as low-vision refraction is a painstaking process. There will be the likelihood of irregularities in the transparent refractive surfaces of the eye due to disease or surgery which make refraction difficult both for the patient and the examiner. The clinician must be prepared to employ techniques different from routine refraction in refracting the eye with the disease. Proper refraction seldom moves patients from the low vision category. The benefits of improved vision from low vision refraction are huge among low vision patients; most times lead to social, psychological, and economic improvement. This way, there is improvement in quality of life and ultimately a more civilized society. This paper therefore outlines and explains the techniques employed in refracting the diseased eye.

Visual Acuity Charts in low vision refraction

Visual acuity is usually scored using Snellen or LogMAR charts. Most low vision patients especially children in schools for the blind cannot achieve entry acuity of 6/60 or LogMAR 1. It is instructive to move the chart, not the patient and maintain room illumination. Large print, single-letter charts can be used if your office is equipped. Projected charts are not movable. The disadvantage of projected charts is that they do not have larger optotypes and have poor contrast. Take VA binocularly first, then monocular. This motivates the patients as binocular acuity is better. If the patient can only see the 6/60 letter at 3m say, then the VA is 3/60. Similarly, LogMAR 1 seen at 2m is Log MAR 1.6. Note that lower LogMAR values denote better acuity. Low acuity comes with higher logMAR values. It is possible to estimate Near VA from Distant VA. Suppose Distance VA is 6/60 say, Minimum angle of Resolution (MAR) = inverse VA i.e. 60/6 = 10. Now, if near VA is scored at 40cm, then near VA =40/40x10 i.e. 40/400. Using the M notation, 1M letter subtends 5 minutes of arc at 1m. 40/400 = .4/4M. thus Near VA is estimated at 4M.

Counting fingers(CF) does not have value in Low vision evaluation as it does not quantify the vision that is available(Sherri, D., L.2015)

2. The Phoropter in Low vision refraction.

The trial frame has an advantage over the phoropter when refracting the eye with the disease. The eye with the disease may have a central field los; the phoropter may block the peripheral field and make refraction impracticable. The trial frame does not limit the field of vision as the phoropter.

4. Retinoscopy.

Perform retinoscopy(ret.) in the usual manner. You may encounter problems where there are media opacities, then you move off-axis in which case, you are performing eccentric retinoscopy. Eccentric retinoscopy is the norm in low vision as you will be scoping the eccentric retina, in patients with central field loss. Record findings in the usual manner. The reflex may be very dim, almost not seen in some cases. Put off all lights and move closer until a reflex is seen. You can do without the trial frame in some cases. If neutralizing a reflex in the right eye; with +6 D in your left hand at the spectacle plane, move close enough for a good reflex. It may be necessary to have an assistant beside you who helps out with lenses in the trial lens box. E.g. if a neutral is seen along meridian 120 @ 30cm i.e. 3.D working distance(100/30); and along meridian 30 @ 20cm i.e. 5 D(100/20) working distance, then your final ret. finding is

+3.00 -1.00 x 120 or +2.00 +1.00 x 30 in that eye

Autorefraction is very good in revealing high refractive errors especially high cylinders. Outside that, depending on your ret. findings. If you cannot see any ret. reflex, go ahead with subjective refraction using bracketing technique.

4. Lensometry

Your patient may present with spectacle or contact lens prescriptions with spherical power over and above the lensometer scale. Suppose the lensometer scale ends within +/- 25 D and the patient presents with a -30D lens. In order to surmount the difficulty in neutralizing this lens, a moderate trial lens of opposite power, say +10D is placed over the -30D lens on the lensometer. The effective power of the two lenses should be -20D(-30+10). The power to be read-off on the lensometer is -20D. -10D is now added to the lensometer reading to give a true back vertex power of -30D

5. Subjective refraction

Subjective refraction is usually performed at 6m and 4m in Snellen and logMAR charts respectively. Note that at 6m, accommodation is relaxed(F = 1/f = 1/6 = 0.016D approx. 0.0D). For the LogMAR chart F=1/4 = 0.25D approx.. 0.0D). You may wish to add -0.25 D to your final prescription if you refracted at 4m. The choice of 4m in LogMAR is due to room space which is more achievable with refraction at 4m.

If a patient can only see the 6/60 line at 2m, then perform refraction at 2m which is the best distance. Refraction at the best distance is the norm in refracting the diseased eye, particularly for patients in the profound or worse low vision category. Disregard telescopic refraction due to problems with the field of view.

Try to understand the patient and give instructions s/he can interpret easily. “Good or Bad” can be used instead of “Better or worse”. DO NOT GET FRUSTRATED IF VISION IS NOT IMPROVING WITH REFRACTION. If there is no ret. finding to start with, use bracketing technique thus; Introduce a +6D and a -6D lens and compare. If the patient prefers -6 for e.g. , reduce or increase minus power to get to your destination. You can use the Just Noticeable Difference (JND) technique. The amount of spherical power that enables the patient to elicit a change in clarity is the JND lens which can be determined thus; ask the patient to focus on the best line on the VA chart, say 20/200 line. The denominator of this VA is 200, the rule-of-thumb estimation says, use a 2 D lens as the JND (Eleanor. E., F.2000). Introduce a +1 and -1 lens. Note that the distance between +1 and -1 is 2. If the patient prefers the +1 lens, then place +2.D in the trial frame. Place -2 D if s/he prefers -1D lens and continue with refraction. When you are done with the sphere, go ahead and find a cylinder. Use high cylindrical power to find your cylindrical axis, find the cyl. power thereafter. The patient can find the cyl. the axis if you give appropriate instructions. The patient should rotate the cyl. nob on the trial frame either way and stop when the best clear position is reached. Use the Jackson Cross Cylinder(JCC) to refine axis cyl. axis and power. It is easier to use high JCC values. Use +1/-1 JCC instead of +0.5/-0.5. **Stenopaic slit** is of value when finding cylinders(Bailey, I. L.(1991) Proceed thus: Occlude one eye. On the non–occluded eye, place the slit on the trial frame and have the patient focus on the threshold acuity line. Rotate the slit until the patient reports clarity at say, 90^0. Keep the slit in place and introduce spherical lenses until threshold clarity at this 90^{th} meridian. Now turn the slit 90 degrees away until there is clarity in a new meridian i.e. 180^0 and repeat with spherical lenses till best VA. Suppose the findings are +6.00 @ 90 and +4.00@180, then final Rx is +6.00 -2.00 x 90 or +4.00 +2.00 x 180 Take this as objective Rx and continue with refraction.

If refracted was done at a distance of 2m say, and achieved 2/6 then the VA at 6m is 6/18 (Minimum angle of Resolution(MAR) for 2/6 is 3. VA at 6m = 6/6x3 = 6/18). This is the case with very high myopes. Place the chart back at 6m distance and continue with refraction. Once you are in sync with the patient, more lines will be gained down the chart. If the patient is slow with the response , have him focus on a single threshold optotype, then go and refine your Rx. You may gain more optotypes on the VA line and move into the next line. It is “UHURU” if you get the patient out of the Low vision category.

5. Contrast Sensitivity in low vision refraction.

Most VA charts used in the clinic have 100% contrast i.e. the letters are black while the background is white. A contrast sensitivity test can be used to monitor the progression of the disease and visual performance over time. It is therefore important to record the contrast threshold of the patient with your final refractive prescription in one visit so that you have an initial value to compare with, in another visit.

Consider a final refractive Rx thus:
RE: -6.00 -3.00 x 120, VA: 6/12 @ 100% contrast. This same eye may record a different acuity , with the same Rx, using a chart with lower contrast eg RE: -6.00-3.00 x 120, VA: 6/24 @ 25% contrast. Suppose a 6-month follow-up visit revealed the following:
RE: -6.00 -3.00 x 120, VA: 6/12 @ 100% contrast and 6/36 @ 25% contrast.
Here, vision with the same Rx is the same at 100% contrast in both visits, but different @ 25% contrast. The eye disease is getting worse, but this is not revealed with the normal VA chart @ 100% contrast!!

7. Low vision Refraction and ocular pathology.

Some ocular pathology has differing refractive error characteristics. It is important to understand the refractive error peculiarities in these eye diseases as this would lead to a faster and more effective refraction time.

Pseudoaphakia – Note that cyl powers and axes can change with follow-up. It is necessary to prescribe after about 4-week follow-up (4FU). Surgical astigmatism do fluctuate

- **Diabetic patients**:; Increase in blood sugar level could enable a myopic shift due to changes in crystalline lens refractive index
- **High myopia.** Retinoscopy may not be definitive. Ophthalmoscopy will come to rescue, then refract at best distance
- **Keratoplasty**: Look out for high cylinders

- **Albinism:** Look out for compound myopic astigmatism. Cyls are high and usually symmetrical
- **Keratoconnus**: look out for high cyls
- **Retinopathy of Prematurity**(ROP): Look out for myopia and keratoconus
- Coloboma and microcornea: look out for hyperopia
- **Marffan's syndrome**: Lens subluxation: Myopia and hyperopia.

Conclusion

Refracting the diseased eye also referred to as low vision refraction is a painstaking and time-consuming procedure. The clinician must be prepared to employ techniques different from routine refraction in refracting the eye with the disease. Furthermore, the clinician should be familiar with the refractive error characteristics of the eye disease for an effective refractive end-point. Proper refraction seldom moves patients from the low vision category, improving quality of life, and ultimately a more civilized society.

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