

Bioptic Telescope Spectacles for Driving by the Visually Impaired

An introduction for the North Carolina DMV Medical Board and Driver Examiners

Henry A Greene, OD, FAAO

Introduction

Bioptic telescopes are eyeglasses that contain miniature telescopes mounted toward the top of the eyeglass lens(es). They function in the same way as binoculars by enlarging images at a distance. While binoculars might be used continuously, drivers using bioptics look through their regular eyeglass lenses almost all of the time, and only sight through the telescope episodically and for brief periods of time.

Bioptic telescopes may help an otherwise competent visually impaired driver to be a safer driver by helping them to see further ahead to maintain lane position, see signs, signals, obstacles, traffic, pedestrians, etc. sooner and hence provide them more time to take appropriate driving actions. This benefit is expected to allow the driver to be safer on the road. Since the driver will use their regular vision (through conventional eyeglasses if required) more than 90% of the time, if they are not a competent driver without the bioptic, the telescopic device will not improve their ability to drive safely. In addition, not all competent drivers will be able to learn to use a bioptic effectively for driving for reasons including difficulty tracking and image stabilization of the magnified image, as well as other reasons.

North Carolina vision and bioptic regulations

In North Carolina, a visually impaired individual may be eligible to receive a restricted driver's license (usually 45 mph, no interstate and daylight driving only) with best-corrected visual acuity (BCVA) of as low as 20/100 without the use of a bioptic. With the competent use of a bioptic the visually impaired driver may be eligible for a less restrictive license usually addressing speed and interstate driving. On occasion and depending upon the vision loss diagnosis (such as albinism and cone dystrophy), night driving restrictions might also be lifted (although driving to and from work/school at night might be permitted a bit more leniently). Before the passage of the Bioptic Driving Law in July 2013, individuals with BCVA worse than 20/100 were ineligible to drive. Now, with the use of a bioptic, individuals with BCVA between 20/100 and 20/200 may be eligible to receive some restricted driving privileges.

Bioptic Vision Guidelines

1. If BCVA through conventional lenses (if needed) is 20/70 or better and that VA through the bioptic telescope is 20/40 or better:
 - a. Corrective lenses if required (code 1)
 - b. Bioptic required (code 54)
 - c. Daylight driving only (code 3)
 - i. Eligible for night driving pending approval letter from provider.
 - d. No speed or interstate restriction

2. If BCVA through conventional lenses (if needed) is worse than 20/70 but better than 20/200 and that VA through the bioptic telescope is 20/70 or better:
 - a. Corrective lenses if required (code 1)
 - b. Bioptic required (code 54)
 - c. 45mph/no interstate driving (code 2)
 - d. Daylight driving only (code 3)

The benefit of bioptic telescopes for the visually impaired driver

The challenge that the visually impaired encounter while driving is that they must get so close to a sign, signal, obstacle, or traffic that there may be insufficient time for them to make appropriate driving adjustments. The bioptic telescope allows them to see the target sooner, giving the driver more time to respond. In practice, the telescope increases the individual's ability to see further ahead by a factor of the power of the device. For example, a 4x telescope will allow the user to see a sign at 80 feet through their bioptic, while they would only be able to see it at 20 feet with their normal vision- a 4 times distance gain.

Recently and with the advent of GPS, the traditional purpose of prescribing bioptic telescopes for reading signs (way-finding) has been called into question. If the intention of a bioptic is to make the driver safer on the road, it is not obvious that higher magnification telescopes, with their inherent narrower fields of view, intended for sign reading, will be of as much value as lower power, wider field devices that will allow the driver to see a full lane on the road to be more aware of lane position, obstacles on the road and traffic and pedestrian patterns. In addition, higher power telescopes magnify image movement and even slight head and car movements can move the image enough to potentially undermine the benefit of the higher power telescope.

Types of Bioptic Telescopes and Fields of View

Bioptic telescopes are available as either small, Galilean optical designs which provide ample fields of view in lower powers (up to about 2.2x), and larger, heavier Keplerian design telescopes, which offer significantly wider fields of view- usually about 12 degrees and are available in powers from 3x to 6x.

User issues regarding bioptic telescopes

When individuals first look through a bioptic telescope they will notice that everything looks much closer (which is true) but the benefit to the individual is that it will allow them to see that much further away (by a factor of the power of the telescope).

Their other observation is that the field of view is narrower (just as it would be while looking through a binocular). Clinical experience shows that when fields of view are narrower than 10 degrees (about the width of one's upraised hand held at arm's length) it is difficult for the user to find what they are looking for. As a result, Galilean telescopes are usually prescribed when lower powers are required to achieve the desired acuity (preferably 20/40, but at least 20/70). When higher powers are required (usually above 3x) Keplerian telescopes are preferred as they provide markedly wider fields of view as compared to higher power Galilean designs.

Learning to use bioptics for driving

While driving, bioptics are used for brief spotting purposes -- in much the same way that we use side and rear view mirrors. Automobile mirrors are quite small, and in fact provide narrow fields of view themselves, quite comparable, in fact, to the field of view through a bioptic telescope. When we first learned to drive, most of us found mirrors difficult to use and we often preferred to turn our heads to make certain that the way was clear. Over time, using mirrors became easy and natural, and ultimately indispensable. The "learning curve" involved in using bioptic telescopes is much the same as that experienced when using mirrors.

Certified driving instructors and occupational therapists may have training and experience to help visually impaired individuals to learn to use their bioptic telescope for driving. It is often advisable, and required by the NC Bioptic Driving Legislation, that new bioptic drivers receive training in using their bioptic telescope for driving. Bioptic drivers who move to North Carolina from other states and already have a bioptic driver's license are not required to take bioptic driver training. One must appreciate the difference between a clinical driver assessment (provided in an office) and a behind-the-wheel driver assessment where an extended on-road assessment of driving fitness is provided. While a clinical evaluation may identify those who ought not drive, it cannot insure that the individual will pass an on-road test.

Understanding the visually impaired driver

Individuals born with visual impairments from disorders including albinism, nystagmus, photoreceptor dystrophies, optic nerve hypoplasia, coloboma, and those who develop vision loss at younger ages such as Stargardt's Disease usually develop a more robust and stable visual function than individuals who have experienced vision loss in their adult years (from AMD, diabetes or glaucoma, for example). Individuals who have reduced central vision usually develop an eccentric-viewing position (Preferred Retinal Locus or PRL). A well-established eccentric viewing position will support more stable visual functioning--important in extended visual activities such as driving. Individuals who have more recent vision loss, or more extensive disease, or are older, may not demonstrate consistent eccentric viewing, which may undermine their ability to drive safely (with or without the use of a bioptic).

As mentioned previously, individuals with BCVA between 20/100 and 20/200 were not eligible for a driver's license. With the bioptic driver legislation, they may, with the use of a bioptic, now be eligible for a restricted license. However, these individuals must be a competent driver without the use of a bioptic. Care must be taken to insure that such an individual will not purchase a bioptic solely with the expectation that it will allow licensure, when they would not be eligible to drive due to other reasons.

The Ring Scotoma

When looking through a bioptic telescope the enlarged image obscures some of the normal field of view. This area of lost vision is called the "Ring Scotoma." Because some visual information is missing while sighting through the bioptic telescope, there has been concern that the driver might not see a potential obstacle. This would certainly be an issue if the individual were to be looking through the bioptic all of the time, but as has been discussed, this is not the case. In fact, drivers miss visual information much more frequently and to a greater extent when they adjust the radio, the heater or air conditioner, or use their side or rear-view mirrors. As a result, the ring scotoma concern should not be considered any greater an issue than other normal activities performed while driving.

Focusing

Bioptics can either be fixed focus, manual focus or autofocus. When users are sighting through the bioptic for driving, they will be looking at distances greater than 20 feet away- a distance at which telescopes are at "optical infinity." At optical infinity everything is in focus from 20 feet and beyond without refocusing. As a result, if the sole purpose of a bioptic device is for driving, a fixed or manual focus device (that could have its focus locked in position if necessary) is all that is required. However, bioptic telescopes have applications beyond driving—in stores, classrooms, at work, while traveling, visiting museums, etc., and these activities are often at distances closer than 20 feet- distances where focusing is necessary. As a result, a visually impaired driver might elect to obtain a manual or autofocus device for the other applications for which it can be useful, while not focusing it while driving.

Who prescribes bioptic telescopes

Optometrists and ophthalmologists who specialize in low vision care prescribe bioptic telescopes. General eyecare providers usually do not provide such services. In addition to tests to determine the visual acuity response to telescopic devices a prognosis for a successful prescription should include tests for contrast, dominance (especially for one-eyed prescriptions), and dexterity with the use of the device.

References:

Bioptic telescopes meet the needs of drivers with moderate visual acuity loss.

Bowers AR, Apfelbaum DH, Peli E. Invest Ophthalmol Vis Sci. 2005 Jan;46(1):66-74.

Fu X, Luo G, Peli E. Telescope aiming point tracking method for bioptic driving surveillance, IEEE Transactions on Neural Systems & Rehabilitation Engineering, 2010;18 (6): 628 – 636

Doherty AL, Bowers AR, Luo G, Peli E. Object detection in the ring scotoma of a monocular bioptic telescope, Archives of Ophthalmology, 2011; 129(5):611-617

Luo G, Peli E. Recording and automated analysis of naturalistic bioptic driving. *Ophthalmic and Physiological Optics*, 2011; 31(3): 318-325. doi: 10.1111/j.1475-1313.2011.00829.x

Visually Impaired Drivers Who Use Bioptic Telescopes: Self-Assessed Driving Skills and Agreement With On-Road Driving Evaluation Cynthia Owsley,¹ Gerald McGwin, Jr,^{1,2} Jennifer Elgin,¹ and Joanne M. Wood³ Invest Ophthalmol Vis Sci. 2014 Jan; 55(1): 330–336.

Comparison of Visual Function in Older Eyes in the Earliest Stages of Age-related Macular Degeneration to Those in Normal Macular Health. Owsley C, Huisingsh C, Clark ME, Jackson GR, McGwin G Jr. *Curr Eye Res*. 2015 Aug 19:1-7.

A roadmap for interpreting the literature on vision and driving.

Owsley C, Wood JM, McGwin G Jr. *Surv Ophthalmol*. 2015 May-Jun;60(3):250-62.