Article ▸ Bioptic Telescope Driving and Low Vision Rehabilitation: A Review

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ABSTRACT

Background: Driving, often a goal for patients with low vision, is associated with personal independence for many individuals. Oftentimes, an optometrist may be the first person who informs a patient that they do not meet visual acuity requirements for driving. In this respect, it is important for optometrists to be familiar with the laws in their individual states and if permitted, to consider whether their patients may be candidates for bioptic telescope systems for driving.

Methods: A literature search was performed to review bioptic telescope driving and driving safety in patients with low vision.

Results: Bioptic telescope systems can improve the viewing of street signs and traffic signals while driving for patients with reduced visual acuity. There is a need for further research with respect to bioptic driving safety in order to establish effective licensing procedures for individuals with low vision.

Conclusions: Individuals are often directed to cease driving when their acuity becomes reduced below a certain level. In many states, however, these individuals may qualify for licensure with a bioptic telescope system. Therefore, optometrists have the opportunity to change lives through identifying, evaluating, and/or prescribing bioptic telescope systems for potential bioptic driving candidates, thereby enabling certain individuals to continue driving and thus to maintain their independence.

Keywords: bioptic telescope system, driving, driving safety, low vision rehabilitation, ring scotoma

Introduction

Driving is often a major goal for patients with low vision, both in continuation of driving and obtaining initial licensure. For many individuals, driving signifies more than simply a mode of transportation, it also represents independence and personal identity.[1] As such, cessation of driving has been associated with depression,[1-3] entrance into long-term care facilities,[4] and decreased health-related quality of life.[5] The impact of being unable to drive may be especially pronounced in rural areas, where public transportation and paratransit options are limited.[6] In view of these concerns, it is important for licensure policies to be evidence-based so as not to exclude potentially safe drivers.[7]

Visual Requirements in Driving

Vision is highly important for driving, which is reflected in the visual requirements for licensure. Visual acuity is the only visual factor that is required in all states for driver's licensure, even though it has been shown to have either a weak or insignificant association with motor vehicle collision rates across studies.[8-10] Although not ubiquitously measured across states, other visual factors have also been studied with regard to driving safety, including visual fields, glare sensitivity, contrast sensitivity, and visual attention. A study of Pennsylvania drivers by Decina and Staplin highlighted the multifactorial nature of driving safety, as visual acuity and visual fields individually were not predictive of collision rates. However, the combination of visual acuity, visual fields, and contrast sensitivity was significantly associated with increased motor vehicle collision rates.[8]

Contrast Sensitivity

The association of contrast sensitivity with driving safety has been the subject of numerous studies. Owsley et al. found that in a population of older drivers with cataracts, contrast sensitivity deficits were independently associated with motor vehicle collisions when adjusted for demographics, cognitive status, driving exposure, and other types of visual impairment.[11] However, the role of contrast sensitivity and motor vehicle collisions is not definitive; the SEE study showed that contrast sensitivity was not associated with crash rates.[9] Rather, glare sensitivity, visual field loss, and poor performance on the Useful Field of View predicted crash rates.[9] Of note, however, the SEE study found that study participants with contrast sensitivity poorer than 1.35 log contrast sensitivity were more likely not to drive or to cease driving within eight years from the baseline examination, which may bias results.[9] This is consistent with other studies, including those by Freeman et al.,[12] Freeman et al.,[13] Keay et al.,[14] and Emerson et al.,[15] which found that contrast sensitivity impairment was associated with driving

restriction and cessation. This suggests that contrast sensitivity has a tangible, real-world impact on driving to the extent that drivers modify their behavior due to contrast sensitivity loss.

Visual Fields

Studies equivocate on the role of visual fields in motor vehicle collisions, which may be due to variability in defining visual field loss, variability in testing procedures, and variations between drivers related to compensatory strategies used to adapt to their field loss.[7] In the SEE study, visual field loss was shown to be predictive of crash rates; loss of the central and lower peripheral visual field was associated with driving cessation, with visual field loss in the lower peripheral visual field being most predictive of future motor vehicle collisions.[9] Tanabe et al.[16] found that individuals with severe primary open angle glaucoma (defined as having a mean deviation of -10 dB or poorer in the worse eye with a 30-2 visual field using the Swedish Interactive Threshold Algorithm Standard Strategy) had a higher likelihood of motor vehicle collision involvement as compared to those with mild/moderate glaucoma or to controls. This is consistent with findings by McGwin et al.,[17] which suggest that individuals with glaucoma with severe pattern deviation defects in the binocular visual field have an increased risk for at-fault motor vehicle collisions.

Importantly, other studies have suggested that the extent of visual field loss by itself is not predictive of driving safety, as a driver's ability to compensate for their field loss differentiates between safe and unsafe drivers. Wood et al.[18] found that head movements into the blind field, lane-keeping stability, extent of eye movements, and less sudden braking differentiated between safe and unsafe drivers among individuals with hemianopic or quadrantanopic visual field defects. Similarly, Kasneci et al.[19] found that lane-keeping, gap judgments, and eye, head, and shoulder movements differentiated between passage of a driving test in individuals with hemianopic visual field loss or advanced glaucoma. Overall, the increased risk of crash rates conferred by visual field loss found in other studies may theoretically be neutralized through compensatory behaviors while driving, and thus individual evaluation of driving performance may be a more valid measure of driving safety in individuals with field loss.

Useful Field of View (UFOV)

In contrast to traditional visual field tests, which measure the area of detection of an isolated target, the Useful Field of View measures an individual's useful functional field through quantifying processing speed (detection of an isolated central target), divided attention (simultaneous detection of a central and peripheral target), and selective attention (simultaneous detection of a central and peripheral target in the presence of distractors).[20] This assessment has been shown to be highly associated with crash rates in many studies, with the divided attention task being the most predictive subtest of crash involvement in the SEE study.[9] Wood et al.[20] found that the selective attention subtest best predicted driving performance in the presence of distractors in older adults. Cross et al.[10] also found that performance on the Useful Field of View was consistently associated with motor vehicle collisions, with a significant association when Useful Field of View performance was impaired by thirty-five percent or higher.

Visual Acuity

In contrast, studies have shown little or no association between visual acuity and crash involvement. While the SEE study found that glare sensitivity, visual field loss, and poor performance on the Useful Field of View predicted crash rates, they did not find an association between visual acuity and crashes.[9] Similarly, Cross et al.[10] found that there was no association between visual acuity and motor vehicle collision rates. Visual acuity, a static measurement of central acuity in high contrast conditions, is the only defined requirement for licensure in many states. However, it does not simulate the real-world environment of driving, which is dynamic, with varying levels of contrast and luminance, and demanding attention to multiple aspects of the visual field.[7]

Approximately 3.4-16.5 million Americans are visually impaired, with most cases having between 20/50 and 20/200 acuity.[21,22] Although visual acuity criteria vary across states, 20/40 is commonly used as a minimum standard.[21] Thus, based on their visual acuity, these individuals may be precluded from driver's licensure even though visual acuity has not been shown in studies to be predictive of driving safety. From a functional standpoint, however, reduced visual acuity may impact an individual's ability to view street signs and traffic signals. A bioptic telescope system addresses these concerns and has been found to be useful by drivers with low vision.[23]

Bioptic Telescope Driving

What is bioptic driving?

In a bioptic telescope system, a telescope is mounted typically in the superior aspect of the spectacle lens. For the majority of the time while driving, patients view through the carrier lenses of the system and view only briefly (approximately 2 seconds) through the telescope system for viewing street signs, traffic lights, and other distance obstacles.[21] Generally, bioptic telescope systems have between 2x and 4x magnification and provide a field of view between 6 and 16 degrees.[21]

Bioptic Telescope Driving Laws by State

Bioptic telescope driving is permitted in most states, with laws on bioptic driving continuing to evolve and to expand.[21,22] In many states, an individual may use a bioptic telescope system for meeting the visual acuity criteria (for example, an individual with 20/100 acuity who would otherwise not be able to qualify for a driver's license can meet the visual acuity criteria if he/she is able to see at that level through the telescope system). In other states, an individual who does not meet the visual acuity criteria will not be able to use a telescope system

to meet the criteria, but those individuals who already meet the visual acuity criteria without the use of a telescope can use bioptic telescope systems for improved visualization of distance objects while driving.

States vary greatly in the laws regarding bioptic driving, including requirements for minimum visual acuity through the carrier lenses, acuity in the telescope, and visual field.[21,24,25] Overall, most states specify a minimum acuity through the carrier in the 20/100 to 20/200 range, with the minimum acuity through the telescope generally in the 20/30 to 20/50 range.[22,24,25] Many states specify a visual field requirement (generally in the range of at least 110-140 degrees); however, some states do not have a visual field requirement or may have differing requirements for monocular as opposed to binocular patients.[24,25] There may be additional requirements such as maximum magnification of the telescope, behind-the-wheel training, color vision, and passage of a written/road test depending on the state.[24,25] Another variation between states is whether night and freeway driving for bioptic drivers is permitted.[21] Practitioners should consult with their state's department of motor vehicles for specific vision requirements in their state.

Determination of Potential Candidacy for Bioptic Driving

It is generally thought that good candidates for bioptic driving have congenital, stable impairments with full peripheral fields. The majority of bioptic drivers across the few surveys of bioptic drivers are middle-aged or younger, although it is difficult to determine whether this may be due to selection bias on behalf of practitioners in presenting bioptic telescopes to their patients.[7,21] There is not a national database of bioptic drivers, and there is minimal data to date on the characteristics of bioptic drivers.[21] Thus, there is insufficient evidence definitively to delineate which visual and demographic characteristics make an individual a good candidate for bioptic driving in terms of successfully obtaining a driver's license and driving safety. Theoretically, those individuals with visual characteristics that have been shown to impact driving safety adversely in studies of drivers who do not use bioptic telescopes (such as reduced contrast sensitivity, poor performance on the Useful Field of View, and reduced visual fields without compensatory strategies) would likely have poorer safety and performance when driving with a bioptic telescope, although there is insufficient evidence to draw definitive conclusions and/or to affect licensure policies at this time.

Obtaining a License with a Bioptic Telescope

In general, becoming a licensed driver with a bioptic telescope system is a process occurring over many visits and requiring collaboration with other professionals. First, the optometrist or ophthalmologist determines that a patient may benefit from a bioptic telescope system for driving (which will depend on the bioptic telescope driving laws in their state and the patient's individual characteristics). Next, potential candidates will be prescribed an appropriate bioptic telescope system that enables them to meet the state's bioptic driving criteria (such as visual acuity through the carrier lenses and telescope, as well as maximum magnification of the telescope system).

In order to be proficient in the use of a bioptic telescope while driving, individuals generally must receive training in the use of the telescope in a stationary environment (such as aligning and spotting distance targets), as well as training in the use of the telescope while a passenger in a car and behind the wheel.[21]

Occupational therapists, vision rehabilitation specialists, and certified low vision therapists (CLVT) usually provide training in the general use of the bioptic telescope system, while certified driving rehabilitation specialists (CDRS) provide training in the use of the telescope in a driving environment.[21] After the CDRS determines that the patient is proficient in driving with the telescope, the patient generally is then evaluated by the state licensing agency to determine whether the license will be granted.[21]

Safety of bioptic driving?

As bioptic telescope drivers primarily view through their carrier lenses when driving and only view through their telescope system for about 5% of the time,[23] they are for the most part driving using their reduced vision. However, as previously mentioned, visual acuity has weak to no association with driving safety.[7-10] Therefore, assumptions with respect to bioptic driving safety cannot be based on visual acuity; instead, other factors should be considered, such as the use of the telescope itself, as well as other aspects of visual function.

Historically, concerns regarding bioptic telescope use for driving include reduced field of view through the telescope and the presence of a ring scotoma due to the edge of the telescope.[26-28] These concerns are theoretical and have not been substantiated by evidence related to driving safety. Doherty et al.[29] found that there was no significant difference in fellow eye detection rates within the area of the ring scotoma with and without a monocular bioptic telescope. This suggests that the ring scotoma induced by the telescope does not preclude a patient from seeing surrounding traffic while driving; however, further research is needed in a real-world environment. From a functional standpoint, Wood et al. found that bioptic drivers show proficient driving skills in an evaluation of on-road driving performance.[30] Twenty-two of 23 bioptic drivers in the study were rated as safe drivers with no differences as compared to controls in detection of pedestrians, scanning, speed, gap judgments, braking, indicator use, or obeying traffic signs and signals.[30] Thus, these studies individually suggest that the bioptic in itself does not have a negative impact on driving performance; however, further research is warranted.

Most studies of driving safety with respect to motor vehicle collision rates are over 20 years old, and therefore updated research is needed in order to incorporate updated technology

and bioptic training procedures.[21] Some studies have found an elevated rate of motor vehicle collisions as compared to controls.[26,31,32] However, a recent study in 2012 by Vincent et al.[33] found that new bioptic telescope drivers between the ages of 25 and 35 with congenital visual impairments who completed an eight-week pilot bioptic training program did not show a higher rate of being involved in at least one accident and committing at least one offense as compared to drivers with similar license restrictions or the regional population. Thus, this study suggests that there is not an increased risk of accidents and offenses with bioptic drivers meeting the study group characteristics. Although some previous studies have demonstrated elevated accident rates, they did meanwhile find some positive characteristics of bioptic drivers.[26,31,32] In separate studies in California, Janke and Clarke found that bioptic telescope drivers had a lower rate of citations as compared to normal drivers.[31,32] Also of note, Janke found that bioptic drivers had a lower rate of accidents as compared to those with other medical impairments.[30,31]

It is unknown which factors contributed to increased risk in the studies that found an elevated risk of motor vehicle collisions in bioptic drivers, i.e., whether it was due to the use of the bioptic, the driver's visual impairment, or other factors.[21,34] In view of the lack of consensus in the literature, the absence of specific knowledge of the distinct factors contributing to elevated risk, and that there was not an increased bioptic driver accident rate in the most recent study, bioptic telescope systems should still continue to be permitted for driving. Further research is warranted in the field of bioptic telescope driving and driving safety in order to establish evidence-based licensure procedures.

Conclusion

Drivers with low vision find bioptic telescope systems useful in driving. In many cases, optometrists have the opportunity to change the lives of their patients with low vision through identifying and evaluating appropriate bioptic driving candidates. In this regard, certain individuals may be able to gain driver's licensure with a bioptic telescope system, and thus maintain their independence and quality of life.

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