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Implications of Acquired Monocular Vision (loss of one eye)

Acquired monocular vision will affect vision and the individual in several ways. There are two main issues which are uniformly and predominantly addressed by the published literature and authorities. The two primary deficits are loss of stereoscopic binocular vision and reduction of peripheral field of vision. Most of the ramifications and symptoms of monocular vision are a result of these two deficiencies.

Literature

According to Borrish, monocular vision versus binocular vision results in approximately a 25% decrease in the size of the field of view. Monocularity causes an absence of stereopsis which comes from the lack of comparison of retinal disparity present in binocular individuals. Monocular individuals will have decreased visual acuity (compared to their binocular counterparts) because of their lack of binocular summation. Binocular summation is the phenomenon by which people see better with both eyes together than by either eye alone. Monocular people will have an impairment in their orientation (to space) which results from a lack of kinesthetic cues arising from convergence (binocular "eye aiming") and accommodation (focusing).

Gunter von Noorden writes that the monocular cues of motion parallax, linear perspective, overlay of contours, distribution of highlights and shadows, size of known objects and aerial perspective can be be used for spatial orientation. He states, "The nature of non stereoscopic clues is that they are experiential and can be meaningful only when they are capable of being related to past experience."

According to von Noorden the advantages of binocular vision (and conversely the disadvantage to monocular vision) are in visual motor skills, better exteroception of form and color, and better appreciation of the dynamic relationship of the body to the environment, thereby facilitating control of manipulation, reaching and balance.

Brady writes the main problems in monocular vision are primarily attributable to a loss of stereopsis and a reduction of the peripheral field of vision. According to Brady, the loss of peripheral vision is between ten and twenty percent. He says these problems will manifest as difficulties in eye hand coordination, clumsiness, bumping into objects and/or people, ascending or descending stairs or curbs, crossing the street, driving, various sports and miscellaneous activities of daily living which require stereopsis and peripheral vision. Brady believes people may develop an increased awareness because of the monocular condition and that there is a better prognosis with onset at a younger age.

Brady raises additional concerns and issues for monocular individuals. One, the need for eye protection and safeguarding the good eye. Two, the need to have back-up prescriptions on hand. Three, the need to employ driving aids and techniques such as special mirrors, scanning with the head and eyes, and heightened awareness. Four, the implications of cosmesis. And five, the concerns for a prosthetic device.

Schein writes, "Individuals limited by loss of vision in one eye have difficulties in depth perception." "Determining the distance within three feet from the eye is extremely difficult and highly unreliable." "Beyond three feet, other distance cues can substitute for loss of binocular disparity, provided monocularly impaired individuals are free to move their heads, which allows them to obtain information about relative distances by taking more time than they would when visual images from both eyes can be superimposed, as they are with binocular vision." "Mishaps can occur when monocularly impaired persons are in heavy traffic unless the head is constantly moving from side to side to increase the visual field". He believes that rehabilitation is easier with an earlier age of onset, that a gradual loss of vision in one eye allows for better adjustments to the condition than sudden onset and that rehabilitation is less complicated with a total loss of vision than a

partial loss of vision. Regarding driving safety, Schein quotes a study by Keeney, et al. who state that, "nationwide, monocularly impaired individuals have seven times more accidents than the general population with which they were compared." Schein states, "Occupations most affected are those that require close work (e.g. barber, beautician, bartender, machinist, needle worker, surgeon); those that involve vehicle operation (e.g. airline pilot, bus driver, motorman); and any work demanding prolonged visual vigilance (e.g. air traffic controller)."

According to Linberg, "Recovery after loss of one eye requires an adjustment to monocular vision and resolution of a significant, serious emotional trauma." Linberg, Tillman and Allara surveyed 125 monocular patients by questionnaire regarding their recovery following the loss of vision of one eye. Their results showed: 85 of the 125 respondents reported that the loss had not changed their life in any permanent way; 7 reported persistent visual problems; 12 reported problems in employment; and 21 reported anxiety or poor self-image. Among 49 with sudden loss, 50% reported a less than one month adjustment period for driving, work, recreation, home acytivities, or walking. Ninety three percent of the people questioned reported their adjustment was completed by 1 year. The authors concluded, "most patients were able to resume everyday activities after a short period of adjustment. Problems with employment and self-image wre frequent, but visual problems were unusual."

Nicholas, Heywood and Cowey evaluated contrast sensitivity in one-eye subjects. They investigated the effects of early monocular enucleation on the dgree of development of contrast sensitivity in the remaining eye. They concluded that the remaining eye demonstrated enhanced contrast as compared to control subjects and that the earlier in development the eye was removed that the greater range over which contrast sensitivity was enhanced.

Marotta, Perrot, Nicolle, Servos and Goodale investigated the incidence of head movements in patients with one eye enucleated (monocular individuals) compared to binocular individuals with one eye covered during performance of a visually guided grasping movement. They concluded the enucleated patients generated more head movements to better utilize retinal motion cues to aid manual prehension.

Goltz, Steinbach and Gallie investigated incidence and magnitude of head turn in patients unilaterally enucleated at an early age (monocular individuals) compared to normal sighted individuals who had one eye patched. They concluded, "The direction of the head turn is "adaptive" because occlusion by the nose in the contraleteral field is reduced".

To summarize these authors, monocular vision as compared to binocular vision will impact the affected individual in several ways. Primarily are the loss of stereopsis and the reduction of peripheral vision. These will cause problems in eye hand coordination, depth judgments, orientation, mobility, and some activities of daily living such as playing sports, driving, climbing stairs, crossing the street, threading a needle etc. Most people with acquired monocular vision loss believe they have adapted to their condition by one year with many reporting the loss had not changed their life in any permanent way. Problems are frequently reported with regards to employment and self-image. A head turn in the direction away from the loss is an expected adaptation and serves to maximize the remaining field of vision. Contrast sensitivity in the remaining eye may be enhanced following monocular vision loss to "supernormal performance". Monocular individuals can be expected to demonstrate more head movements as a way of enhancing depth perception for eye-hand coordination tasks.

Occupational Concerns

As reported by Schein, occupations most affected by acquired monocular vision loss are those that require close work, vehicle operation and work demanding prolonged visual vigilance. Close work is generally regarded as visual tasks within approximately three feet of the individual. Beyond this distance the demands on the amount of accommodation (focusing) is minimal, convergence (ocular alignment) is minimal, and monocular cues to depth perception are increasing while stereoscopic (binocular) cues are decreasing. Various aspects of close work will affect the visual demands placed upon the individual by the task. These include: visual acuity demands, visual field requirements, contrast, direct area and background illumination, glare, location of task within the visual field, specific distance of viewer to task, degree of figure-ground discrimination required, degree of stereopsis required, ability to vary distance from and position relative to the task of regard, and the ergonomics of the task. Monocular versus binocular viewing with regard to aspects ofclose work are compared in the following chart. If there is no performance difference between the monocular and binocular they are rated "equal". If there is a disadvantage between the monocular and binocular, it is rated as "disadvantage" under the appropriate column. If there is a qualifier, e.g. mild, medium, or significant, then that term is placed along with disadvantage in the appropriate column.

	Monocular	Binocular
Visual acuity	mild to no disadvantage	
Visual field	medium disadvantage	
Contrast	equal	equal
Illumination		
direct area	equal	equal
background	equal	equal
Glare	equal	equal
Location of task	mild to no disadvantage	
Distance of task	mild to no disadvantage	
Figure-ground	equal	equal
Stereopsis required	significant disadvantage	
Non-variable distance	mild disadvantage	
Non-variable position	moderate disadvantage	
Fixed ergonomics	mild to moderate disadvantage	

Visual vigilance can be regarded as the degree of visual attention required by a particular task. As the degree of sustained visual attention required for detailed inspection of the demands of a close vision task increase, so does the demand upon the visual system. The visual skills required for such tasks differ for monocular versus binocular individuals and vary depending on the nature of the task. For monocular individuals, the visual skills required are: visual acuity, accommodation, visual field, and visual attention. Depending on the nature of the task, they may also include: depth perception, visual memory and visual perceptual abilities. For binocular individuals, the visual skills required are: visual acuity, accommodation, convergence, phorias, fusional amplitudes and ranges, visual field, and visual attention. Depending on the nature of the task, they may also include: depth perception, visual memory and visual perceptual abilities.

There is little to no difference in the visual skills required between monocular and binocular individuals for: visual acuity, accommodation, visual attention, visual memory and visual perceptual abilities.

Monocular individuals are disadvantaged with regards to visual field and, if the task requires, stereoscopic depth perception. Binocular individuals maybe disadvantaged with regards to phoria, convergence and fusional amplitudes and ranges.

Safety and Eye Protection

Safety concerns and precautions must be addressed to protect the remaining good eye in individuals with monocular vision loss. Even if such individuals require no lens prescription for visual acuity, they should wear protective eyewear with lenses made out of polycarbonate material. Polycarbonate is an industry standard for safety and eye protection. The individual will require multiple pair of safety type eyeglasses with polycarbonate lenses for the following reasons and purposes. There should be a minimum of two pair of each recommended as follows so if ever one is lost, broken or otherwise not available, then the individual will have a spare to wear so as not to go without the protection. Bifocal prescription may be necessary in addition to single vision lenses depending on the age, accommodation, and specific occupation and avocation needs of the monocular individual. Sunglasses for photophobia are recommended. Glasses for at night, especially night time driving with anti-reflective coating to enhance acuity, decrease reflection and decrease potential eye strain from glare are recommended. Special safety protection for sports are recommended if the individual engages in sports. Safety protection for the work place may be required in addition if the individual is engaged in any type of potentially hazardess environments. For non-work environments, eyeglass frames would be recommended to be manufactured out of sturdy ophthalmic materials and although not required by law, possibly meeting ANSI safety standards.

Driving

Monocular individuals face increased challenges with driving. These specifically relate to depth perception and peripheral vision.

Keeney, et al., state, "nationwide, monocularly impaired individuals have seven times more accidents than

the general population with which they were compared." He recommends monocularly impaired drivers be denied class 1 licenses, (commercial driver license for transport of people), and that they be warned by by their doctors regarding increased risk of accident with driving.

The visual requirements for driving vary by state, but most allow monocular driving and require the same in terms of visual acuity. While most states have visual field requirements, ***most / all states requirements for extent of visual field are met by the amount of monocular visual field.

Optical aids such as wide field mirrors and mirrors on both sides of the vehicle are recommended for the monocular driver. Training in and encouragement of head and eye movements for increased scanning and peripheral vision awareness are recommended. Undergoing a drivers' skill and safety evaluation by a certified driving specialist is recommended. If there is a problem, such specialists are typically trained to provide driving training to the individual to ensure their safe driving.

Depending on the individual and the evaluation by the driving specialist, certain restrictions for a specified, or permanent amount of time may be indicated. Such restrictions might include: special adaptive equipment (e.g. mirrors, automatic transmission only), daylight driving only, speed limitations, within certain distances from home, good weather restriction, and / or no highway driving. The person may be required to have their drivers license renewed and evaluated more often than otherwise.

Activities of Daily Living

Activities of daily living (ADL's) represent the activities that individuals encounter in regular everyday life. Such activities include: mobility, ambulation, cooking, household cleaning, home maintenance, car cleaning, car maintenance, reading, computer work, shopping, record keeping, hygiene, and clothes washing and ironing. Of the preceding; mobility, ambulation, maintenance, reading and computer work affect the monocular individual.

Regarding mobility and ambulation, the monocular individual, especially during their adaptation period may be expected to have difficulty. The would be as a result of depth perception affecting balance, and a decreased peripheral field of vision causing increased risk of bumping into objects. Both of these can be expected to improve over time and with rehabilitation. According to Linberg, et. al., most people can be expected to resume everyday activities after a short period of adjustment.

Regarding car and home maintenance, these can be affected by monocular vision to the degree that the task requires fine levels of eye-hand coordination and steropsis. In tasks that require these abilities, it is recommended that for those that are potentially dangerous be undertaken with caution, or be done by someone else.

Regarding reading and computer work, the monocular individual may have special concerns for these activities. Please refer to what is written above concerning close work as concerns for reading and computer work fall under that domain.

Regarding the remainder of the ADL's, none of them would be expected to pose any significantly greater degree of disadvantage to the monocular individual than to a binocular individual.

Future Risk

As the monocular individual has lost their visual "spare", they are at greater risk of future blindness. They must be educated in prevention, care and maintenence of their vision. To this degree, eye protection has been addressed above. It is recommended that eye safety be taught by an appropriate industrial vision specialist. It is recommended that education and counseling be supplied to the monocular individual regarding prevention, care and management of eye infection, disease and injury. The monocular individual is not at greater risk of eye disease, or infection (with the exception of sympathetic ophthalmia) than their binocular counterpart.

Hobbies

Monocular vision may affect performance and therefore enjoyment of some hobbies. There are only a certain few hobbies which would not be recommended and cautioned against for the acquired monocular vision individual (e.g. race car driving). The far majority can be performed and enjoyed. Among hobbies that would require adjustment from binocular vision to monocular vision are: golf, tying fishing flies, baseball, basketball, football, soccer, hockey, bike riding, skiing, mountain climbing, needle work and sculpting. Among hobbies where minimal to no adjustment would be expected from binicular vision to monocular vision are: rifle shooting, pool and billiards, playing musical instruments, photography, archery, stamp (art, coin etc.) collecting, astronomy, running, hiking, painting, swimming and writing.

Loss and Impairment

According to the PDR for Ophthalmology total loss of vision one eye constitutes a 25% impairment visual system and a 24% impairment whole man.

Cosmetic Issues

When the individual with monocular vision loss sustains a disfigurement of the impaired eye there are options available. Among them are: a cosmetic soft contact lens, a cosmetic rigid gas permeable contact lens, a scleral cosmetic contact lens, and enucleation of the eye and fitting of a prosthesis.

Rehabilitation

Absence of stereopsis does not mean the individual will have no depth perception. As Gunter von Noorden pointed out, there are monocular cues to depth that can be learned through experience. Problems with depth perception can be addressed by visual rehabilitation training for eye hand coordination, relative depth judgment and spatial orientation.

Many people other than monocular individuals have restricted peripheral vision (eg. from stroke or glaucoma). Techniques utilized with those patients in their visual rehabilitation would be extremely beneficial in teaching the monocular individual scanning, a heightened awareness of surround and preventing problems by avoiding certain situations (eg. night driving).

Sincerely,

Thomas Politzer, O.D., FCOVD, F.A.A.O.

Patients

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