Amblyopia (also known as “lazy eye”) is the most common cause of childhood vision impairment in the United States. It is so common in fact, that it is more prevalent than all other causes of vision loss in children combined. Its origin can be linked to refractive, strabismic, or deprivation causes. Amblyopia can present as unilateral or bilateral reduction in visual acuity, and early diagnosis and treatment is critical to avoid a poor visual prognosis. The natural course of untreated amblyopia will result in acuity reduction in the affected eye(s) along with binocular vision and accommodative disorders. It is important for clinicians to accurately diagnose amblyopia and initiate appropriate treatment as this is often a preventable cause of vision loss.

Amblyopia can be defined as reduced visual acuity in a healthy eye which is not immediately correctable by optical lenses. It is a leading cause of preventable blindness in the United States and is believed to have a prevalence of 1.6-3.6% in the population. Amblyopia can be unilateral or bilateral in its presentation and develops in childhood. There are various predisposing factors which can contribute to the development of amblyopia including significant refractive error, strabismus, structural abnormalities, or media opacities. Multiple authors have utilized varying best corrected acuity levels to define amblyopia. The Pediatric Eye Disease Investigator Group (PEDIG), consisting of over 120 pediatric ophthalmologists and optometrists in the United States and Canada, defined unilateral amblyopia as an eye that had at least a 3-line decrease in best corrected visual acuity in the amblyopic eye as compared with the fellow eye. In bilateral cases however, PEDIG utilized a criteria of bilateral refractive amblyopia of 20/40 to 20/400 best corrected binocular acuity in the presence of ≥ 4.00 D hyperopia by spherical equivalent and/or ≥ 2.00 D astigmatism in each eye.

There are few large scale studies that evaluate the distribution of subtypes of amblyopia in the population, but one such study, the Prevalence of Amblyopia in Ametropias in a Clinical Set-up, was published in 2006. In that study, 71.43% of amblyopia was unilateral and 28.57% was found to be bilateral. Further, the distribution of amblyopia was found to be 57.14% male and 42.86% female. In evaluating children entering the public school system in Germany, one study found the prevalence of bilateral amblyopia to be 0.5%.

Frequently, children will be asymptomatic when they initially present at the clinicians office as they are often unaware that their vision is abnormal. Parents are often shocked to discover that their child has a vision disorder and must be counseled regarding the etiology and prognosis for
amblyopia. Treatment can involve the use of optical lenses, vision therapy, surgical interventions, or a combination of the above. Previously, some had suggested that treatment must begin prior to some critical age in early childhood in order to have a successful visual outcome; however, recent research has proven that amblyopia can be successfully treated up to the age of 17. Although treatment can be initiated at any age, early detection and treatment still offer the best visual outcome.

**Case Report**

A 5 year old Indian boy presented in our office for a routine eye examination. His mother accompanied him and stated the reason for the examination was “just a routine pre kindergarten vision check”. The child had no visual complaints. The mother reported some mild myopia in the family, cataracts in both maternal grandparents, and type II diabetes in the maternal grandfather. This was the patient’s first eye examination, and he had passed a vision screening at the pediatrician’s office at the age of four. He had no significant medical health history, received vaccines at the appropriate schedule as recommended by his pediatrician, and took over the counter vitamins daily. The patient’s mother denied any allergies and represented that his developmental milestones were all “on age level”. The patient responded to questions in a manner appropriate for his age and was able to interact with the clinician. The patient’s mother reported that he was academically advanced and was beginning to read books independently, although he didn’t enjoy reading.

The patient’s visual acuity was assessed utilizing both Snellen letters and Lea symbols. His uncorrected distance visual acuity OD was 20/501 with Snellen testing and 20/60 with Lea testing. Uncorrected distance visual acuity OS was 20/60 with both Snellen and Lea testing. There was no improvement with a pinhole occluder. Near acuity was assessed utilizing Snellen testing at 20/60 OD and OS. Color vision testing with pseudoisochromatic plates was normal at 9 of 9 OD and OS and stereopsis (depth perception) was reduced at 70 sec of arc. Extraocular muscles were unrestricted in all gazes, and cover test demonstrated normal eye posture. Pupils were equal, round and reactive to light with no afferent pupil defect. Confrontation fields were full to finger count OU. Near point of convergence was to the nose and prism bar fusional reserves were -16/12 BI and -35/30 BO. Amplitude of accommodation was reduced to 5 diopters OD and 5.50 diopters OS utilizing a Sheard’s minus lens testing. Anterior segment evaluation by biomicroscopy revealed healthy anterior segment structures. Static retinoscopy revealed +4.00 - 0.50 x 180 OD and +4.00 sphere OS with no improvement in acuity. The patient was dilated/cyclopleged using one drop Proparacaine and one drop 1% Cyclopentolate. After 30 minutes, cycloplegic refraction revealed +5.50 -0.75 x 180 OD and +5.25 -0.50 x 180 OS. Acuity measurements through this Rx were still 20/60 OD, OS, and OU. Evaluation of the posterior segment by slit lamp with 78D lens and binocular indirect ophthalmoscopy revealed healthy fundus grounds, clear media, and cup-to-disc ratios of .2/.2 OU. There was no ocular pathology noted OU.

The refractive error was consistent with the diagnosis of bilateral refractive amblyopia, a form of amblyopia caused by a high but approximately equal uncorrected refractive error in both eyes.
The patient was prescribed spectacle correction of $+4.25 - 0.50 \times 180\text{ OD}$ and $+4.00 - 0.50 \times 180\text{ OS}$ to be worn full time. The patient and mother were counseled as to the importance of full time spectacle use and were educated on the etiology and prognosis for bilateral amblyopia of this nature. They were further counseled on the need for sports eyewear protection for any athletic endeavors. The patient was advised to follow up with our office 1 month after receiving the spectacles.

Follow up # 1

One month later the patient and both of his parents reported to our office in follow up. He was now in Kindergarten and was performing above grade average in all of his academic classes. The patient’s mother reported that he put on his glasses as soon as he woke up, that she often found him falling asleep with his glasses on at night, and that she never had to remind him to put on his glasses. The patient reported that he sees “much better with my glasses on”.

Corrected acuities with his current glasses were 20/30 OD and 20/40 $^{+1}$ OS utilizing Snellen acuity. Lea symbols were not utilized for repetitively assessing acuity at this or future visits as the patient had shown the ability to be consistent and accurate with Snellen acuity testing. Static retinoscopy yielded slightly more astigmatism OU with a refraction of $+5.50 -1.50 \times 180\text{ OD}$ and $+5.00 -1.25 \times 180\text{ OS}$. Acuity remained as stated above with this refraction. Stereopsis was still measured at 70 sec of arc and accommodative amplitude was measured at 6 diopters OD and OS with minus lens testing.

The patient and his parents were counseled on the good recovery he was making and were advised to continue wearing the glasses on a constant basis. They were informed that we may change his spectacle lenses in the near future if we found the increased level of astigmatism to be consistent over several office visits. They were instructed to return in two months.

Follow up # 2

The patient and both of his parents reported to our office in follow up after two months. There had been no change in his medical or ocular or family history from his last examination. He reported that he continued to “like his glasses” and wore them “all the time”. The parents reported that he continued to excel in school and that he expressed no visual complaints.

Corrected acuities with his current glasses were 20/30$^{+2}$ OD and 20/30$^{-1}$ OS utilizing Snellen acuity. Static retinoscopy yielded $+5.00 -1.25 \times 180\text{ OD}$ and $+5.00 -1.75 \times 180\text{ OS}$. Stereopsis was now measured at 50 sec of arc and accommodative amplitude was measured at 10 diopters OD and OS with minus lens testing. The patient was dilated/cyclopled using one drop Proparacaine and one drop 1% Cyclopentolate. After 30 minutes, cycloplegic refraction revealed $+5.50 -1.25 \times 180\text{ OD}$ and $+5.25 -1.75 \times 180\text{ OS}$. Acuity remained as stated above OD but improved to 20/30$^{+2}$ OS with this refraction.
The patient and his parents were counseled on the good recovery he was making. The spectacle lenses were changed to reflect the increase in astigmatism seen consistently over the previous two visits. The new spectacle lenses were +4.50 –1.00 x 180 OD and +4.25 – 1.50 x 180 OS. They were instructed to return in three months.

Follow up # 3

In four months the patient and both of his parents reported to our office in follow up. The patient had just completed his Kindergarten year in school and reported that he wore his glasses on a full time basis. He reported no difficulty in adjusting to his new lenses and reported no visual complaints. The parents reported that he passed the school nurses vision screening in the elementary school which had been conducted in May. The patient was noticeably taller than he was 6 months ago but had no other medical or family history changes.

Corrected acuities with his current glasses were 20/25-1 OD and 20/25 OS utilizing Snellen acuity. Static retinoscopy yielded +4.50 -1.75 x 180 OD and +4.50 –2.00 x 180 OS. The patient was better able to respond to subjective refractive techniques at this time and the subjective refraction revealed +4.00 – 2.00 x 10 OD and +4.00 – 2.00 x 180 OS with 20/25 OD and OS. Stereopsis remained at 50 sec of arc and accommodative amplitude was now within the normal range at 15 diopeters OD and 15.50 diopeters OS. New glasses were prescribed with an Rx of +4.00 – 1.75 x 10 OD and +4.00 – 1.75 x 180 OS. They were instructed to return in six months.

Follow up # 4

In six months the patient and his mother reported to our office for an annual comprehensive examination. The patient was now attending first grade in the public school system and was performing above grade level in each subject. He was an avid reader and had no visual complaints.

Snellen corrected acuities with his current spectacles were 20/20-1 OD and 20/20 OS in the distance and 20/20 OD and OS at 16 inches. Stereopsis was measured at 30 sec of arc. Amplitude of accommodation was 16 diopeters OD and OS, and he easily passed accommodative facility testing with +/-2.00 lenses. Anterior segment examination revealed healthy anterior segment structures. Manifest refraction revealed +4.00 – 1.75x 10 OD and +4.00 – 1.75 x 180 OS. The patient was dilated/cyclopleged using one drop Proparacaine, one drop and 1% Cyclopentolate. After 30 minutes, cycloplegic refraction revealed +5.00 -1.75 x 10 OD and +5.00 -2.00 x 180 OS. Acuity measurements through this Rx were 20/20 OD, OS, and OU. Evaluation of the posterior segment by slit lamp with 78D lens and binocular indirect ophthalmoscopy revealed healthy fundus grounds, clear media, and cup-to-disc ratios of .2/.2 OU. There was no ocular pathology noted OU.

The patient was instructed to continue with his current full time spectacle correction with sports goggles for athletic activities. They were instructed to return annually.

Discussion
Although different studies and different groups define amblyopia differently, it is often defined as a unilateral, or infrequently bilateral, condition in which the best corrected visual acuity is poorer than 20/20 in the absence of any obvious structural anomalies or ocular disease. In a definition such as this, amblyopia is characterized by reduced visual acuity alone. However, it might be more accurately defined as a collection of clinical findings including: poor monocular fixation, reduced contrast sensitivity, poor oculomotor skills, and reduced amplitude of accommodation.

The development of amblyopia involves the introduction of certain factors during the developmental stages of the visual pathways; specifically between birth and approximately 6-8 years of age. These factors, including visual deprivation, poor image clarity, and abnormal binocular development, induce an abnormal development of the visual pathways from a lack of a clear retinal image. The most important indicator for the extent of the amblyopia development appears to be the child's age when exposed to an amblyopia-inducing condition. With proper diagnosis and treatment, the prognosis for restoring visual acuity to 20/40 or better is very favorable.

Amblyopia is frequently classified into subtypes based on the underlying etiology. The most common classifications are Refractive Amblyopia (high refractive error in one of both eyes), Strabismic Amblyopia (eye turn), and Deprivational Amblyopia (an opacity like a cataract that prevents light from reaching the retina). In addition, there can be combined mechanisms for amblyopia involving more than one of these subtypes simultaneously.

In refractive amblyopia the uncorrected refractive error creates a blurred image on the retina. This blurred image, within the critical period of visual development, will result in abnormal nerve pathway development between the eye and the brain. This then produces the typical signs of amblyopia. Refractive amblyopia can be further subclassified by whether the significant refractive error is present in one eye only (anisometropic) or present in both eyes (bilateral or isometropic).

Bilateral refractive amblyopia, as was found in this presenting case, accounts for 1-2% of refractive amblyopia. It is caused by a significant uncorrected refractive error that is nearly equal between both eyes. PEDIG completed a study on bilateral refractive amblyopia and utilized the following criteria to define their patients: binocular best corrected visual acuity 20/40 to 20/400, cycloplegic refractive error in each eye of $\geq 4.00$ D hypermetropia (spherical equivalent) and/or $\geq 2.00$ D astigmatism. Presenting initial acuity measurements in bilateral refractive amblyopia can vary tremendously; however, the majority have initial best corrected visual acuity of 20/50 or better.

Anisometropic amblyopia is caused by a significant uncorrected refractive error in only one eye. In a similar manner to that found in bilateral cases, the refractive error causes a blurred image in the eye which disrupts the normal development of the visual pathway and visual cortex. Generally, the greater the degree of difference between the eyes (anisometropia), the more severe the amblyopia. According to the American Optometric Association Clinical Guidelines, anisometropic amblyopia can develop with difference between the eyes of more than 1.50
diopters of astigmatism, 1.00 diopter of hyperopia, or 3.00 diopters of myopia. The average best corrected visual acuity presenting in anisometropic amblyopia is approximately 20/60.

Strabismic amblyopia occurs when the eyes are misaligned prior to 6-8 years of age and transmit different images through the visual pathways. In order to eliminate the presence of double images, the brain suppresses the image from the strabismic eye thus resulting in the abnormal development of binocular vision. Amblyopia will develop especially in cases involving a constant unilateral strabismus. Most cases are associated with esotropia in infancy or early childhood. The average best corrected visual acuity in strabismic amblyopia is approximately 20/74.

Deprivation amblyopia develops when a significant physical obstruction prohibits the formation of a clear image on the retina and can occur in one or both eyes. Congenital cataract formation is the most frequent cause of form deprivation amblyopia but other conditions such as ptosis, other media opacities, or trauma could also result in this condition. Ideally, the obstruction should be removed within the first several months of life for the best possible visual outcome.

No matter what the cause, amblyopia left untreated has serious implications. Not only will a patient with untreated amblyopia experience the obvious loss in visual acuity in one or both eyes, but there is an increased risk of blindness in the amblyopic population. In many cases, loss of vision in the healthy eye can be attributed to trauma or acute disease. In addition, certain occupations do have visual acuity requirements in both eyes individually which may not be available to those with amblyopia. The treatment of amblyopia can help improve acuity, improve binocular function and decrease the risk of ocular injury and blindness.

In this case, the patient presented with bilateral refractive amblyopia and, as is typical in such cases, was treated with optical lens correction only. The optical correction allows for a crisp retinal image which can induce proper development in the visual pathway. Studies have revealed that patient’s may not obtain best visual acuity for 1-2 years after the initial diagnosis and treatment. In the PEDIG study on bilateral refractive amblyopia, visual acuity of 20/25 or better was achieved by 73% of children within one year of starting optical lens treatment. Occasionally contact lenses might be utilized as opposed to spectacles as in cases of extreme anisometropia or cases with cosmetic concerns. Other common amblyopia treatment options, such as occlusion therapy (patching), were not necessary in this case of bilateral, equal refractive error. Surgical intervention is reserved for cases where the strabismus is to be managed after amblyopia treatment or in rare cases of extreme anisometropic amblyopia in which LASIK is occasionally utilized after amblyopia treatment. Occlusion (patching) or penalization therapy (atropine drops) may be added should asymmetrical acuity remain after lens correction. In this case the patient’s oculomotor status, binocular vision status, and accommodative function all spontaneously improved and active vision therapy was not prescribed. However, active vision therapy has been demonstrated to shorten the time necessary to achieve the best visual acuity possible and should be considered when developing a treatment plan for amblyopic patients.

Amblyopia must be taken seriously and treated aggressively by practitioners. Uncorrected, amblyopia can result in loss of visual acuity and efficiency as well as restrictions within certain
careers. In addition, future ocular trauma or acute disease processes can have a devastating impact on an amblyopic patient’s life. This case demonstrates the role of patient history, clinical findings, and early diagnosis and treatment of bilateral refractive amblyopia. In this case, diagnosis was made during that period of rapid development of the visual pathways; and optical correction alone resulted in improvement in the patient’s acuity, binocular status, and accommodative function. Clinicians must accurately diagnose the underlying etiology of the amblyopia and begin appropriate treatment in order to maximize the probability for a successful visual outcome. The prognosis is generally good with appropriate optical correction, occlusion therapy, surgical intervention, and/or vision therapy as indicated. Since the prognosis is particularly good when amblyopia is diagnosed and treated at an early age, and since many young amblyopic patients do not have visual complaints, clinicians must educate parents as to the need for comprehensive evaluations in all children.

Dr. Friedman is the owner of Moorestown Eye Associates in New Jersey.

Bibliography


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Why Can’t My Child See Even with Glasses?

To receive two hours of continuing education credit, those taking the quiz must be AOA Associate members and answer 14 of the 20 questions correctly. This exam consists of multiple-choice questions designed to measure the level of understanding of the material covered in the continuing education article “Why Can’t My Child See Even with Glasses?” This article is worth two hours of continuing education credit from the Commission on Paraoptometric Certification. Expiration date: Dec. 31st of this year

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Select the option that best answers the question.

1. Amblyopia can be caused by
   a. Strabismus
   b. Refractive Error
   c. Congenital Cataract
   d. All of the Above

2. Most children with amblyopia will
   a. Complain of blur in one eye
   b. Complain of Double Vision (diplopia)
   c. Have no visual complaints
   d. Complain of blur in both eyes

3. The prevalence of amblyopia in the United States is
   a. Approximately 2% of the population
   b. Less than 1% of the population
   c. 5% of the population
   d. 25% of the population
4. Treatment of amblyopia can involve the use of
   a. optical lenses
   b. vision therapy
   c. surgical interventions
   d. a combination of the above

5. Amblyopia can rarely be improved to provide better than 20/40 acuity
   a. TRUE
   b. FALSE

6. Amblyopia involves
   a. Only reduced acuity
   b. Reduced acuity, poor oculomotor skills, reduced accommodative amplitude, poor contrast sensitivity
   c. Only reduced acuity and reduced contrast sensitivity
   d. Only reduced acuity and poor color vision

7. Which of the following factors would be most likely to cause amblyopia
   a. Glaucoma in a 60 yr old male
   b. A constant eye turn (strabismus) in one eye from birth
   c. A -1.00 Rx in both eyes in a 4 yr old
   d. A cataract in one eye in a 40 year old

8. Anisometropic Amblyopia develops from
   a. Eye turn in one eye
   b. High Refractive error in both eyes
   c. High Refractive error in one eye
   d. A large corneal scar that obscures the vision

9. Most cases of strabismic amblyopia involve
   a. Constant esotropia in one eye
   b. Intermittent exotropia that alternates between eyes
   c. Intermittent esotropia that alternates between eyes
   d. Constant exotropia in one eye

10. All of the following can cause deprivational amblyopia, except
    a. Cataract
    b. Ptosis
    c. Allergic conjunctivitis
    d. A large corneal scar

11. There is an increased risk of blindness in the amblyopic population
    a. TRUE
    b. FALSE

12. In bilateral refractive amblyopia, as was presented in this case, one can expect acuity to return to a normal or near normal level
    a. Immediately upon receiving glasses
    b. Within 3 months
    c. Within 1-2 years
    d. It cannot return to normal without surgical intervention
13. Comprehensive eye examinations for children
   a. Are not necessary until the child enters school
   b. Are only necessary when a child fails a pediatrician's screening
   c. Are only indicated with a child has a family history of amblyopia
   d. Are necessary for every child to rule out amblyopia

14. Anisometropic Amblyopia can also be described as
   a. Amblyopia caused by an eye turn
   b. Amblyopia caused by a similar high refractive error in both eyes
   c. Amblyopia caused by a large difference in refractive error between the two eyes
   d. Amblyopia caused by ptosis

15. Amblyopia is a leading cause of preventable blindness in the United States
   a. TRUE
   b. FALSE

16. The Pediatric Eye Disease Investigator Group defined unilateral amblyopia as
   a. an eye that had at least a 3-line decrease in best corrected visual acuity in the amblyopic eye as compared with the fellow eye
   b. an eye with corrected acuity of less than 20/100
   c. an eye that had a 5 line decrease in best corrected visual acuity in the amblyopic eye as compared with the fellow eye
   d. an eye with uncorrected acuity of 20/100

17. Which of the following Rx's in a 4 year old child would be most likely to lead to amblyopia
   a. -2.25 OU
   b. -1.00 OD, -1.25 -0.75 x 90 OS
   c. +6.00 OD, +1.25 OS
   d. +2.00 OD +2.25 OS

18. For the patient in question 17, would that patient have
   a. Isometropic amblyopia
   b. Anisometropic amblyopia
   c. Strabismic amblyopia
   d. Deprivational amblyopia

19. The most appropriate first line of treatment for amblyopia from a high bilateral refractive error in a child is
   a. LASIK
   b. Surgical Intervention
   c. Glasses correction
   d. Patching

20. Amblyopia can only be treated up to the age of 7
   a. TRUE
   b. FALSE