Anisometropic Amblyopia: Nonsurgical Treatment

Claire Castleberry Hennessey, C.O.

ABSTRACT

Introduction: Anisometropia is the leading cause of amblyopia, and research suggests that it too often goes undiagnosed and untreated. To assist with early detection of amblyogenic risk factors (media opacities, strabismus, and/or refractive error), the vision screening committee of the American Association for Pediatric Ophthalmology and Strabismus (AAPOS) has developed vision screening guidelines. Any child that meets these failure/referral criteria should be referred for further ophthalmological evaluation to prevent the onset of amblyopia.

Timing of Treatment: The exact time at which to prescribe glasses correcting significant anisometropia is somewhat unclear. However, the child’s age and the type and degree of anisometropia that is present can be useful in predicting possible insults to the developing visual system.

Treatment Method: Various amblyopia treatment modalities and how successful they are in complete vision restoration have been explored recently. Refractive adaptation, six hours of daily patching, weekend-only use of atropine and combining atropine with optical penalization have all been proven effective at treating moderate amounts of anisometropic amblyopia. The risk factors for each method, the type and degree of anisometropia, and the patient’s age and level of visual acuity should all be considered when choosing the best treatment plan for the patient.

INTRODUCTION

Anisometric amblyopia is characterized by a decrease in best corrected visual acuity in one eye as a result of significantly different refractive errors between the two eyes. The eye that ultimately provides a more blurred image to the visual cortex develops amblyopia. Several authors have suggested that anisometropia is the leading cause of amblyopia and is responsible for approximately 50% of all cases. Without the presence of ptosis or strabismus as a visible warning sign, these patients may...
be diagnosed significantly later in life, and unfortunately some go untreated.\textsuperscript{3,4}

GUIDELINES FOR DETECTING AMBLYOGENIC RISK FACTORS

Due to an absence of universally accepted guidelines for preschool vision screening, the vision screening committee of AAPOS has developed responsible, evidence-based guidelines for the detection of amblyogenic risk factors. Any patient who meets these criteria after vision screening should be referred for further ophthalmological evaluation. The purpose of screening guidelines is to reduce the number of unnecessary referrals of normal children while successfully detecting the risk factors (media opacities, strabismus, and/or refractive error) before they cause amblyopia. The guideline for anisometropia is a greater than 1.50 diopter spherical or cylindrical refractive error in one eye as compared to the other eye. The complete list of guidelines is endorsed by AAPOS, the American Association of Certified Orthoptists (AACO), the American Academy of Ophthalmology (AAO), the American Academy of Pediatrics (AAP), and the American Academy of Family Practice (AAFP).\textsuperscript{5}

TIMING OF TREATMENT

In the development of refractive errors, in the development and prevention of amblyopia, and in successful amblyopia treatment, age clearly makes a difference.\textsuperscript{3} Our current literature does not clearly state at what age one should correct a refractive error that could potentially cause amblyopia. However, understanding the onset and duration of the critical periods can help predict the type and severity of visual deficits that result from specific insults to the developing visual system. Deprivation, strabismus, and anisometropia appear to exert their influences on the developing visual system at different times.\textsuperscript{6} For example, sensitivity to binocular correlation reaches adult levels before peak contrast sensitivity to high frequency targets. This means that strabismus will influence neural processing before anisometropia.\textsuperscript{6,7} Also, high degrees of hyperopia and astigmatism in newborns are known to improve considerably by one year of age.\textsuperscript{3} Therefore, it is reasonable to wait until age one to prescribe glasses correcting anisometropia that could potentially cause amblyopia.

The appropriate timing of treatment to successfully prevent anisometropic amblyopia not only depends on the patient’s age but also on the type and degree of anisometropia that is present. The information in the Table was taken from a paper by Holmes and Clarke describing the degrees of refractive error thought to induce amblyopia in children at age two to three years old with anisometropia. In hyperopic anisometropia, they suggest that glasses be given for a difference greater than or equal to 1.50 diopters. In astigmatic and myopic anisometropia, they feel that a dif-

<table>
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<tr>
<th>Type of Anisometropia</th>
<th>Prescribing Guidelines (Ages 2 – 3 Years)</th>
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<tbody>
<tr>
<td>HYPEROPIA</td>
<td>&gt;= 1.50 Diopters</td>
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<tr>
<td>ASTIGMATISM</td>
<td>&gt;= 2.00 Diopters</td>
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<tr>
<td>MYOPIA</td>
<td>&gt;= 2.00 Diopters</td>
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ference greater than or equal to 2.00 diopters should be corrected.8

TREATMENT METHODS

Refractive Adaptation

To determine and prescribe the appropriate refractive correction, which is the first step in treating anisometropic amblyopia, a cycloplegic refraction using cyclogyl should be performed. Recent research suggests that once the patient is wearing the appropriate glasses, it is reasonable to wait for spontaneous improvement before instituting patching or atropine therapy.1,8–9 Progressive improvement in acuity for up to 18 weeks after refractive correction alone has been reported in some patients with anisometropic amblyopia. This spontaneous improvement in visual acuity with spectacles alone is termed “refractive adaptation” and is best explained by Mitchell and Gingras.8 They state that the important action is to restore the ability of the amblyopic eye to transmit a clear visual image in an absolute sense, not relative to the normal eye.9

Steele et al. analyzed the characteristics of 28 patients whose anisometropic amblyopia was successfully treated with spectacles alone. They suggest that patients around five years of age with a milder degree of anisometropia (1.00 diopter to 2.00 diopters) and a moderate amount of amblyopia (20/60 to 20/100) may have the best chance of achieving resolution with spectacle correction alone. In their study, the mean time to resolution was 5.8 months, and patients with astigmatic anisometropia took longer to improve. Best corrected initial visual acuity was the only factor that was significantly associated with time to resolution, and the mean final visual acuity as a whole was 20/25.1

Another study specifically examined recovery from astigmatism-related amblyopia following the introduction of spectacles. The results showed that refractive correction alone could not completely resolve amblyopia from high astigmatism. However, there was strong evidence to support that vision in astigmatic children is significantly improved immediately following the introduction of appropriate spectacle correction.10

Patching

Once spontaneous correction has subsided with spectacles alone, patching or atropine penalization may be used to deprive the patient’s better seeing eye of visual input, forcing use of the amblyopic eye. Patching has been the “gold standard” treatment for centuries, yet until recently, the amount of patching prescribed has been based on individual preference. Some studies support the argument for full-time patching, recommending a week of full-time occlusion per year of age.8 For example, a two-year-old who is patching full-time requires follow up visits every two weeks to monitor the improvement in visual acuity of the amblyopic eye and to prevent occlusion amblyopia in the patched eye. A 2005 study by Scott et al. suggests that full-time occlusion produces excellent results. They showed that 79% of 600 patients achieved vision of 20/30 or better or three lines of improvement. The results also demonstrate that full-time patching produces equal vision at a faster rate as compared to alternative forms of therapy. Surprisingly, the patients’ parents stated that social anxiety and compliance was not an obstacle, and in fact some found it easier to patch during school hours when it could be monitored by a teacher. In this study, occlusion amblyopia occurred in a large percentage of patients (25%); however, all cases were reversible except one where instructions were not followed by the parents.11

Part-time patching allows for more time between follow-up appointments and may
be more tolerable than full-time occlusion. A prospective study by the Pediatric Eye Disease Investigator Group (PEDIG) investigated the number of hours of daily patching that are needed to successfully treat amblyopia. They determined that six hours of daily patching are sufficient to successfully treat 20/40 to 20/100 amblyopia. Seventy-nine percent of the enrolled patients achieved vision of 20/30 or better or a three or more line improvement. Also of interest, this study’s results do not support the notion that treatment of moderate amblyopia is less successful with increasing age.12

While patching is an effective treatment for anisometropic amblyopia, it is not without risks. First, occlusion amblyopia can be produced in the patched eye, and one particular study, as discussed earlier, reported it occurring in up to 25% of patients who patched full-time.11 Second, some children have poor compliance with patching because of the social ramifications. In a recent PEDIG study, it was reported that patching contributes to significant social anxiety, especially in older children.12 Also, once patching is successfully weaned, visual decline in the once amblyopic eye can occur. The rate of this visual decline has been reported to be between 24–75%.1 It is also worth noting that some children are allergic to the adhesive patches and periorcular skin irritation can result. Finally, because patching interrupts binocularity, it is thought that induced strabismus can occur especially if the patient has fragile fusion. This concept has definitely influenced decision making for many ophthalmologists and orthoptists on whether patients with poor control of their strabismus should be prescribed full-time occlusion, part-time occlusion, or atropine. Several studies suggest that induced strabismus may not be as much of a concern as previously thought.13,14 Holbach et al. studied 50 esotropic patients and the changes in alignment following full-time occlusion therapy for strabismic amblyopia. Angle measurements of 21 esotropic patients who had not been treated with occlusion served as a comparison. Either a decrease or increase of five or more prism diopters in the esotropic angles occurred in about the same percentage of patients in the two groups at near and distance fixation. Therefore, they suggest that it is unlikely that occlusion, per se, caused alignment variations in the patients undergoing patching therapy.13 Similarly, a two-year, prospective study by Repka et al. found that patching and atropine penalization is infrequently associated with the development of significant strabismus. This investigation showed 14% of 161 previously orthotropic children developed a microstrabismus; however, only five (3%) developed a strabismus greater than eight prism diopters. In fact, some patients with strabismus at baseline demonstrated an improvement in ocular alignment after amblyopia therapy. Fourteen percent improved to orthotropia, and nearly one-half of patients reduced their angle to eight prism diopters or less.14

Atropine

For over a century, atropine penalization has typically been used as an alternative to patching but not as a primary treatment modality. One percent atropine blocks parasympathetic innervation of the pupil and ciliary muscle in the preferred eye causing pupillary dilation and temporary loss of accommodation. The blurring that occurs with atropine is much greater in hyperopic eyes since accommodation can no longer correct the blur.8 In the past, it has been suggested that since atropine will generally blur to 20/200 visual acuity, it typically works best in patients whose amblyopic eye is 20/100 or better.15

Until recently, it has been generally accepted that the treatment of amblyopia becomes less effective with increasing age. PEDIG investigations, however, have de-
terminated that the response to atropine is similar across the age range of three to less than seven years of age. The lack of an association between age and treatment effect led PEDIG to conclude that atropine may have a role in treating patients older than seven years with anisometropic amblyopia.15

How frequently atropine should be administered to effectively treat anisometropic amblyopia has also been examined recently and there is some controversy. A PEDIG study found that weekend-only use of atropine is just as effective as daily use. In the study, there was no demonstrable advantage of the daily regimen in either magnitude or rapidity of improvement after four months of treatment.16 On the other hand, Arnold et al. suggests that daily atropine is necessary to achieve adequate visual blur at near fixation. They showed that the cycloplegic effect of 1% atropine wears off in less than 48 hours.17

Atropine can also be used in conjunction with optical penalization to treat anisometropic amblyopia. The hyperopic spectacle correction over the preferred eye can be reduced to enhance atropine’s blurring effect. In 2002, Kaye et al. studied 42 children whose amblyopia was treated with combined atropine and optical penalization. They found that the combination of the two had a more rapid effect of decreasing the amblyopia than atropine alone. However, they also concluded that the combined effect may produce a higher incidence of occlusion amblyopia than if atropine is used independently.18

Although atropine is successful in treating anisometropic amblyopia, it is not without risks. Reduced visual acuity in the sound eye can occur similar to occlusion amblyopia, which can result from patching. Recent literature suggests that this is not common and is easily reversible.8,16 Decomposition of a previously controlled accommodative esotropia is also of concern. As the patient attempts to accommodate with the preferred, atropinized eye, the esotropia can decompensate to a larger angle that does not resolve once the patient is weaned from the drug. Finally, although rare, a patient may be allergic to atropine and will have some or all of these symptoms: flushed face, low-grade fever, dry mouth, rapid heartbeat, and delirious behavior.

CONCLUSIONS

In conclusion, anisometropia is the leading cause of amblyopia and too often goes undiagnosed and untreated. To help ensure that children who possess a potentially significant refractive error are properly referred for a more in-depth evaluation, the AAPOS vision screening committee designed guidelines to help detect amblyogenic risk factors. The purpose is to prevent unnecessary referrals of healthy children and to identify and treat the risk factors prior to the development of amblyopia. Deciding when to prescribe glasses correcting significant anisometropia and choosing an effective amblyopia treatment modality can be a bit complicated:

I. It is reasonable to wait until age one year to correct significant anisometropia because the critical period for peak contrast sensitivity to high frequency targets has a later onset, and hyperopic refractive errors have a tendency to improve considerably within the first year of life.

II. In two to three year olds, it is more important to consider the type and degree of anisometropia before prescribing spectacles.

III. Prior to instituting patching or atropine therapy, it is reasonable to see if spectacles alone will completely resolve the amblyopia.

IV. If patching or atropine is eventually required for complete vision restoration, six hours of daily patching
and weekend-only atropine use has been proven effective at treating moderate degrees of anisometropic amblyopia.

V. Combining atropine with optical penalization may expedite amblyopia treatment, but it may also increase the chances of occlusion amblyopia.

Finally, patching and atropine are definitely effective at treating anisometropic amblyopia, but one must consider the age of the patient, type (hyperopic, myopic, or astigmatic) and degree of anisometropia, and level of visual acuity before deciding which treatment will be most effective.

REFERENCES


**Key words:** anisometropic amblyopia, nonsurgical treatment, refractive adaptation, patching, atropine penalization