VIEWPOINTS:

APPROACHES TO AMBLYOPIA THERAPY

Occlusion and full refractive correction are integral components of traditional amblyopia therapy. Occlusion may be full- or part-time, and may or may not be accompanied by active vision therapy. In this issue, Dr. Kelly Frantz, of the Illinois College of Optometry, describes an approach to amblyopia therapy that includes refractive correction, occlusion, and active vision therapy. Dr. Arnold Sherman, of SUNY College of Optometry, describes an alternate approach that emphasizes treatment of the underlying binocular dysfunction, with minimal refractive correction and no occlusion.

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RATIONALE FOR REFRACTIVE CORRECTION, OCCLUSION & ACTIVE THERAPY FOR AMBLYOPIA TREATMENT

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Abstract

This paper explains the role of full refractive correction, judicious use of occlusion, and vision therapy activities in the treatment of functional amblyopia. Depending on the type of amblyopia (e.g., anisometropic or strabismic), recommendations for occlusion and therapy activities vary. Amblyopes are treated most efficiently when therapy is directed toward a given patient's specific visual skills deficits.

Key Words

amblyopia, anisometropia, strabismus, occlusion, refractive correction, vision therapy, visual training

Refractive Correction

High bilateral hyperopia or astigmatism[1] and large amounts of anisometropia[2-5] are accepted causes of amblyopia. In the case of uncorrected, high isoametropia, the presence of bilaterally blurred retinal images results in bilateral amblyopia. In significant anisometropia, the consistently blurred retinal image in the more ametropic eye and the resultant abnormal binocular interaction can lead to unilateral amblyopia. It therefore follows that removing these causative factors by correcting the refractive error is a first step in amblyopia management. In contrast, if a child under 4 years of age shows significant anisometropia, there is a strong possibility that the anisometropia could reduce in magnitude and not produce amblyopia.[6] In such a case, the anisometropia and visual acuity should be monitored and an anisometropic correction only be prescribed if there is at least 1 diopter of anisometropia consistently present over three visits at three-month intervals, or acuity testing indicates that amblyopia is developing.[7]

A number of authors recommend full correction of any ametropia in amblyopic patients, especially if there is anisometropia or astigmatism, to produce equally clear retinal images.[3,7-9] For prescribing purposes, refraction should be performed using cycloplegia,[3,10] and other objective techniques should be employed because amblyopic eyes have reduced control of accommodation and these patients' subjective responses are poor.[11] If there is any doubt that the patient will accept the full plus refractive finding, or if prescribing full plus would have a negative impact on eye alignment (e.g., turning an exophore into an exotrope), the correction may be reduced by an equal

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TREATMENT OF AMBLYOPIA WITHOUT FULL REFRACTIVE CORRECTION OR OCCLUSION

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Abstract

An alternative method of amblyopia therapy is presented. The therapy requires neither occlusion nor a full optical correction and emphasizes elimination of fine suppression and the development of high levels of binocularity. Case reports illustrate the effectiveness of this therapy.

Key Words

amblyopia, adaptive refractive error syndrome, amblyopic anisometropia, undercorrection, non-occlusion, binocular success index

Amblyopia has been clinically defined as a reduction of best corrected monocular visual acuity to 20/40 or worse, and more than one Snellen line difference between the two eyes, in the absence of disease.[1] The condition is typically present in strabismus and/or anisometropia, with approximately 1/3 of amblyopes falling in each category.[1] Sherman[2] found that 44% of amblyopes have strabismus without anisometropia, 33% demonstrate anisometropia without strabismus, and 22% have both strabismus and anisometropia.

The treatment of amblyopia has not changed significantly in almost 250 years. Commonly, the non-amblyopic eye is fully occluded to improve visual acuity of the amblyopic eye in addition to use of a full optical correction. Conventional wisdom dictates that these are the two most important elements in amblyopia therapy.[3] However, it is often found that good results are not obtained due to non-compliance with occlusion and/or failure to wear the optical correction. Further, when significant improvement in visual acuity is obtained, it is frequently lost after termination of treatment.[4] For example, Rutstein and Fuhr[5] report that 67% of amblyopes followed for one year after cessation of therapy lost some of the acuity gain during this period, regardless of age.

Loss of acuity improvement following cessation of therapy likely results from a failure to treat the underlying binocular vision disorder, persistence of which reinforces suppression and leads to recurrence of amblyopia. I propose that the visual acuity loss in amblyopia is only the monocular symptom of a binocular problem that must be addressed and totally eliminated. Once that is achieved, visual acuity will not regress but rather will continue to improve with time.

The purpose of this paper is to describe an alternative method of amblyopia therapy. This treatment is extremely effective and, because it requires neither occlusion nor full optical correction, achieves excellent patient compliance at all ages. Treatment emphasizes elimination of fine central suppression and thus results in a high level of binocularity with retention or even improvement of visual acuity after active therapy is completed.

Binocular Interference and Adaptive Refractive Error Syndrome

If binocular interference is the major etiological factor in amblyopia development, treatment must be designed to eliminate it and achieve binocular cooperation. The binocular difficulty includes suppression as well as other adaptations that patients make to avoid binocular vision, and may include an increase in refractive error in the amblyopic eye to facilitate suppression and eliminate binocular confusion. I have reported a case of a hyperopic, anisometropic patient with a refractive error of the amblyopic eye of +3.50 D that reduced to Plano over a two-year period after therapy was instituted.[6]

I have termed this Adaptive Refractive Error Syndrome[6] or Amblyopic Anisometropia.[7] Correction of such ametropia is often counterproductive; it causes further adaptation resulting in a higher refractive error and it also facilitates suppression. This is often found in hyperopic anisometropic patients exhibiting esotropia. For example, if the full refractive correction with cycloplegia in a 2-year-old with constant left esotropic amblyopia is OD +3.00 D and OS +4.50 D, the refractive error will often increase if the full correction is prescribed. In con-

trast, in my experience, treatment to normalize binocular function (with minimal or no refractive correction) will often lead to reduction in refractive error and improvement in visual acuity.

Dobson et al.[8] report that esotropic infants given spectacles show a significant smaller decrease in hyperopia than non-esotropic infants with equivalent hyperopia who are not given spectacles. This suggests that, in the presence of binocular vision, the emmetropization mechanism operates to reduce refractive error if corrective lenses are not provided. A recent report by Ingram et al.[9] states that the process of emmetropization appears to be impeded by wearing a hyperopic correction from 6 months on. The incidence of strabismus was less and acuity, after treatment, significantly better in a subgroup of patients who did not wear their glasses.

Wick et al.[10] address the binocular aspects of amblyopic patients. They report an average improvement in visual acuity of 92.1%, with no regression of visual acuity, in a retrospective study of 19 patients that included a strict protocol for sequential management of anisometropic amblyopia. The protocol consisted of the following four steps:

1. Full refractive correction
2. Added lenses or prism when needed to improve alignment of the visual axes
3. Direct occlusion two to five hours a day
4. Active vision therapy to develop monocular acuity and improve binocular visual function.

Non-Compliance in Amblyopia Patients

Common reasons that patients fail to wear the full refractive correction include:

1. Cosmetic appearance of glasses, especially when lenses are of unequal thickness
2. Rejection of the prescription due to blur, diplopia, and spatial distortion caused by magnification effects and by induced prismatic effect away from the optical centers of the lenses
3. Better or similar visual acuity without the glasses.

The common reasons for non-compliance for occlusion include the following:

1. Difficulty functioning in school and other daily activities due to significantly reduced acuity
2. Danger in playing sports, crossing the street, or riding a bicycle
3. Cosmetic appearance and psychological effect of wearing a patch in public.

Treatment of Amblyopic Patients

Treatment regimens that emphasize occlusion and full-time use of glasses are frequently plagued with non-compliance. Non-compliant patients often discontinue therapy, and consequently achieve little or no success. On a pragmatic basis, I have developed a treatment program that requires neither occlusion nor full-time use of glasses. I have found that such a treatment program not only produces greater compliance, but also achieves excellent results, frequently with reduction in anisometropic refractive error as well as normalization of visual acuity and binocular vision.

This treatment program can be summarized as follows:

1. No occlusion
2. Significantly reduced lens prescription
3. Lenses to be worn during therapy procedures only
4. Active in-office vision therapy, twice a week (45-minute sessions)
5. Home therapy five times a week, on the days not in the office (15-30 minutes per day)
6. Therapy emphasizes monocular central activities with the amblyopic eye within a binocular visual field.

The initial lens prescription is a substantial undercorrection of the objective refractive status, and is used only during office and home therapy. The undercorrection is designed to allow peripheral fusion and stereopsis to be maintained, and to permit the patient to perform in-office therapy techniques. For example, the patient previously discussed had an objective refractive status of OD Plano, OS +3.50 sph; his initial training prescription was OD Plano, OS +1.00 sph.

Therapy consists of monocular activities centrally with the amblyopic eye, within a binocular peripheral field. This therapy teaches the patient to use the amblyopic eye to initiate fixation and focus in order to gather, process, and respond motorically to central visual information within a binocular field (peripheral fusion), and to create an alternating strabismus as a preliminary step to binocularity in a strabismic amblyope.[11] It is limited to the 95% of amblyopic patients who do not have steady eccentric fixation. This treatment has been termed "Monocular Fixation in a Binocular Field."[12]

Many procedures to train monocular function in a binocular field are performed using red/clear filters with the clear filter in front of the amblyopic eye. Target materials are printed with red ink. If the amblyopic eye suppresses when such materials are used, the target will not be seen. Such procedures can also be conducted with green/clear filters, red-green glasses, or Polaroid filters as long as the filter in front of the amblyopic eye allows the patient to perceive the central target, while the filter in front of the other eye allows the patient to see the rest of the field but not the central target.

Improvement is obtained in two areas as the patient learns to use the amblyopic eye in these situations: enhanced binocular function with reduced suppression, and improved visual acuity. Therapy continues with binocular procedures to eliminate suppression, improve fusion quality and range, and develop both gross peripheral and fine central stereopsis. Many patients demonstrate a reduction of refractive error and effectively are no longer anisometropic.

Criteria for Success

Successful therapy is not limited to improved visual acuity. Binocularity must be established. Improvement in visual function leads to enhanced performance in tasks relating to vocation, avocation, academics, sports, and driving.

The "Amblyopia Success Index" (ASI), formulated by Meyer et al.,[13] is calculated by using the denominator of the Snellen fraction for each visual acuity (VA) designation in the formula:

$$ASI = \frac{\text{Initial VA - Final VA}}{\text{Initial VA-Test distance}} \quad X\ 100$$

For example, if initial acuity was 20/60 and improved to 20/30, the ASI would be:

$$ASI = \frac{60\text{-}30}{60\text{-}20} X\ 100 = \frac{30}{40} X\ 100 = 75\%$$

I propose an additional criteria to include binocular improvement in a similar way, using seconds of arc for Wirt Stereopsis (WS). The "Binocular Success Index"

$$BSI = \frac{\text{Initial WS - Final WS}}{\text{Initial WS - Maximum WS}} \quad X\ 100$$

For example, if initial stereo was 100 seconds of arc and improved to 30 seconds of arc, the BSI would be:

$$BSI \quad \frac{100\text{-}30}{100\text{-}20} X\ 100 = \frac{70}{80} \quad X\ 100 = 88\%$$

I suggest that the average of the two indices is more appropriate to indicate success in amblyopia.

CASE REPORT #1

JK 7.9 Male

INITIAL EVALUATION

Uncorrected VA
OD 20/25
OS 20/80

Objective Refraction
OD +0.25 sph 20/20
OS +2.00 = -1.25 x 10 20/80

Subjective Refraction
OD Plano 20/20
OS +1.50 = - 1.00 x 30 20/50

Stereopsis
30 seconds of arc

Training glasses
None

POST VT
Uncorrected VA
OD 20/20
OS 20/30

Objective Refraction
OD +0.50 20/25
OS +1.00 = -1.25 X 30 20/30

Subjective Refraction
OD -0.25 20/20
OS +0.75 -0.50 X 10 20/30

Stereopsis
20 seconds of arc

ONE YEAR POST VT

Uncorrected VA
OD 20/20
OS 20/25

Objective Refraction
OD -0.25 sph
OS +0.75 -0.25 X 60

Subjective Refraction
OD Plano 20/20
OS -0.25 x 45 20/25

Stereopsis
20 seconds of arc

Amblyopia Success Index

$$\frac{(50\text{-}25)}{(50\text{-}20)} = \frac{25}{30} \quad X\ 100 = 83\%$$

Binocular Success Index

$$\frac{(30\text{-}20)}{(30\text{-}20)} = \frac{10}{10} \quad X\ 100 = 100\%$$

CASE REPORT #2

ME 13 Female

INITIAL EVALUATION

Uncorrected VA
OD 20/20
OS 20/50

Previous glasses, can't wear due to blur and asthenopia
1. OD +2.00
   OS +4.00
2. OD +3.00 -0.50 X 80
   OS +4.50 -1.00 X 70

Cover Test $\underline{cc}$
DV Intermittent 10Δ left esotropia
NV 20Δ left esotropia
Unsteady central fixation OS

Cycloplegic Objective Refraction
OD +4.25 -0.50 X 90
OS +6.25 -1.50 X 90

Cycloplegic Subjective Refraction
OD +4.00 -0.50 X 90 20/20
OS +5.50 -1.50 X 70 20/30

Stereopsis
40 seconds of arc

Training glasses
OD +1.00
OS +2.50

POST VT AND ONE YEAR POST VT
(Findings were the same)

Uncorrected VA
OD 20/20
OS 20/25

Cover Test $\underline{sc}$
Esophoria all distances

Cycloplegic Objective Refraction
OD +3.00 -0.75 X 90
OS +5.00 -1.50 X 90

Non-Cycloplegic Subjective Refraction
OD +1.75 20/20
OS +2.50 -1.00 X 90 20/20-3

Stereopsis
20 seconds of arc

Current glasses worn only for critical visual activities
OD +1.00 20/20
OS +2.50 20/20-3

Amblyopia Success Index

$$\frac{(30\text{-}20)}{(30\text{-}20)} = \frac{10}{10} = \quad X\ 100 = 100\%$$

Binocular Success Index

$$\frac{(40\text{-}20)}{(40\text{-}20)} = \frac{20}{20} = \quad X\ 100 = 100\%$$

Conclusion

Amblyopia therapy is extremely successful with judicious treatment of the binocular problem, and can be readily accomplished without occlusion and without a full optical correction. Most patients' visual acuity with the amblyopic eye continues to improve after active therapy is completed. Refractive error tends to decrease on reevaluation, and subsequent changes in lenses must be made. Binocular training procedures must be programmed at home, and continued once a week for approximately 15 minutes in order to ensure continued function without suppression of the previously amblyopic eye.

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amount for each eye.[12] For example, if the full refractive correction is OD +3.00 and OS +6.00, but right eye acuity through the full prescription is reduced and improves to 20/20 with +1.50, the prescription may be reduced to OD +1.50 and OS +4.50. Keeping the full amount of anisometropic correction allows each eye to have the same stimulus to accommodation as well as equally focused retinal images. The concern over aniseikonia with large anisometropic correction does not frequently become a problem clinically.[8] Despite the fact that such anisometropia generally is due to axial length differences,[13] and that Knapp's law would predict minimum aniseikonia with spectacle correction,[14] aniseikonia has been shown to be minimized in high anisometropia by prescribing contact lenses.[15,16]

Occlusion

Use of direct occlusion (occluding the preferred eye) in the treatment of unilateral amblyopia allows stimulation of the amblyopic eye, and precludes such adaptations as suppression and anomalous correspondence.[17] Occlusion reduces inhibition from the dominant eye.[1] Occlusion alone can be effective in treating young amblyopes[18,19] even if there is eccentric fixation.[20,21] However, active therapy (discussed below) combined with occlusion is considered more efficacious,[3,21] and particularly necessary for patients over 10 years of age with anisometropic amblyopia.[12] Although constant direct occlusion generally has been shown to allow a shorter treatment time than part-time occlusion,[8] part-time occlusion often is indicated for other reasons. For example, constant occlusion may result in a strabismic deviation of the occluded eye.[22] Thus, part-time occlusion may be the most prudent option for patients with binocular vision.[23]

If the patient has constant strabismus and is young enough not to object to the cosmesis of a patch, constant occlusion may be used. For children through age 6, however, it is wise to alternate the eye being occluded on a daily basis so that occlusion amblyopia does not develop. The patch is placed over the dominant eye one day for each year of the child's age, and then switched to the other eye for one day each cycle.[8,17] For example, a 3-year-old would wear the patch three days on the dominant eye, followed by one day on the amblyopic eye, with this cycle repeating. It is usually necessary to use an adhesive patch to prevent the child from removing it, and it may be helpful to apply the patch just before the child awakens so there is less resistance to the procedure.[3] In practice, part-time occlusion of young children often is better accepted by the parent and the child; it may produce equal success if combined with active therapy and it reduces the risk of occlusion amblyopia.[24] The recommended patching time per day is one - six hours.[25]

For patients over 6 years of age, alternation of the occluder is not needed. However, indirect occlusion (occluding the amblyopic eye) may be helpful to disrupt steady eccentric fixation if other fixation activities (see below) are not successful.[23] In addition, constant occlusion is seldom used because of the patient's visual demands (e.g., school) requiring use of the dominant eye.

Occlusion most often is total, allowing no form vision. In certain cases, partial occlusion is beneficial for reducing (while not eliminating) competition from the dominant eye.[26] Partial occlusion may be accomplished by fogging the dominant eye with plus lens power or by using Bangerter Occlusion Foils,[a] which are designed to yield specific acuity levels from 20/20 to 20/200. Partial occlusion methods are particularly appropriate for anisometropic amblyopes to preserve and enhance whatever binocularity is present. The dominant eye must be fogged to an acuity level below that of the amblyopic eye to ensure that the amblyopic eye has a sufficient acuity advantage to maintain fixation.[1] The fogging may be reduced gradually as the amblyopic eye's visual acuity improves. As with total occlusion, partial occlusion is most effective when combined with active therapy.[27] If visual function in the amblyopic eye is sufficient to allow the patient to perform everyday activities, the fogging spectacle or contact lens may be worn full time. However, acuity initially may be too poor for the patient to fixate with the amblyopic eye when there is any competition from the dominant eye. Thus, the level of acuity and binocularity must be considered before prescribing partial occlusion.

Active Therapy

Vision therapy allows practice of particular visual skills under conditions that provide the patient with feedback. This feedback, along with the gradually increasing demand of the activities as improvement occurs, enables the patient to learn control of visual functions such as accommodation and oculomotor skills. Therapy activities may be used initially with direct occlusion and later adapted for biocular or binocular conditions. Further, therapy ideally is directed toward a patient's specific deficient skills; it may vary for anisometropic as opposed to strabismic amblyopes.[9] A minimum of 30 minutes of therapy per day is suggested.[12]

Anisometropic amblyopes have reduced contrast sensitivity in proportion to their reduced optotype acuity,[1,28] impairing resolution of high spatial frequency targets. This defect leads to poor form discrimination. Therapy activities should require resolution of details,[1] as do proofreading, hidden pictures/words, and counting of progressively finer lines. In addition, these amblyopes have impaired accommodative function, with reduced accommodative accuracy,[29] sustaining ability,[1] and amplitude,[30] and increased accommodative reaction time.[1] Near/far fixations and lens rock may be used for treatment, progressing from gross to fine changes to reduce depth of focus, from large simple targets to smaller, crowded ones, and from a gradually increasing stimulus to one that changes in large steps.[1]

Strabismic amblyopic eyes demonstrate spatial distortion[31] and uncertainty, which results in a loss of precision for judging target position.[32] They also show more contour interaction with stimuli adjacent to a fixated target than do the eyes of anisometropic amblyopes.[33] Furthermore, these eyes have deficient oculomotor skills, including unsteady[34] and eccentric[35] fixation, increased saccadic latency[36] and reaction time for eye-hand coordination,[37] and reduced pursuit accuracy.[38] Remediation of these defects centers around eye-hand coordination activities and foveal tagging with entoptic phenomena or afterimages[39] to provide precise feedback regarding eye position. Activities such as fast-pointing, mazes and pattern duplication should use targets that gradually decrease in size while crowding increases to improve accuracy of localization.[1] Deficient accommodative skills in strabismic amblyopes may be treated as described for anisometropes, although some improvement is expected

even without specific treatment, as foveal fixation becomes more accurate.

For all anisometropic amblyopes, and for those strabismic amblyopes capable of developing binocularity via vergence therapy or compensating prism, therapy should include "monocular fixation in a binocular field" techniques.[11] This phase of therapy may begin once the two eyes have developed equal monocular visual skills, and usually when the amblyopic eye's acuity has reached approximately 20/70.[23] Permitting peripheral stimulation of the dominant eye while only the amblyopic eye receives central stimulation helps to reduce the dominant eye's inhibition of the amblyopic eye[11] and generally allows further acuity improvement.[25] Many standard therapy techniques can be performed under conditions in which colored filters permit both eyes to see peripheral contours while only the amblyopic eye sees the central details.[11]

The final phase of therapy involves integrating visual functions by improving vergence, and binocular oculomotor and accommodative skills. Patients achieving bifoveal fixation without significant suppression are likely to maintain the acuity and visual skills improvement.[18] In contrast, those who continue to have unilateral strabismus, even if the deviation is small, are susceptible to regression.[18,40,41] These patients may require a small amount of maintenance occlusion to preserve the acuity and skills developed.[40,41]

In conclusion, it generally is appropriate to provide amblyopes with full refractive correction, frequently using contact lenses if there is significant anisometropia. Prescription adjustments should be made as refractive changes occur during therapy (often due to the patient's improved subjective responses). The use of selected forms of occlusion, and as acuity improves, colored filters (to allow monocular fixation in a binocular field), in conjunction with specific therapy techniques tailored to the patient's deficient skills, is recommended for efficient and effective remediation of amblyopia.

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Footnote

a. Available from the Fresnel Prism & Lens Company, 24996 State Road 35, Siren, WI 54872 (1-800-544-4760)

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