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CASE REPORT: Occlusion therapy for amblyopia

Reduced visual function associated with amblyopia can be improved with occlusion therapy. A five-year-old boy with combined strabismus anisometropic amblyopia is treated with several types of occlusion therapy during a 10-month treatment program. Best corrected visual acuity improved from 20/200 to 20/50-.

History

Charlie received his first eye exam from a primary care optometrist at age five years. The chief complaint at that exam was crossed eyes. Examination, including cycloplegic refraction and dilated fundus exam, resulted in the following diagnoses: anisometropic hyperopia, astigmatism each eye, constant right esotropia, and OD amblyopia in the right eye. Charlie's optometrist found unremarkable ocular health and prescribed the cycloplegic refraction (OD +5.50 -1.00 180, OS +3.00-0.75 175), occlusion of left eye with an adhesive patch, and referred him to the Southern California College of Optometry, Optometric Center of Los Angeles for consideration of vision therapy (VT).

At the VT consultation, Charlie presented as a quiet, friendly five-year-old Latino boy who was compliant with the spectacle wear, but poorly compliant with occlusion. Pregnancy, birth, major developmental milestones and Charlie's general health were unremarkable. The strabismus onset per parental report was at age four — the eye turn was "not that noticeable and not always there." His parents sought eye care after noticing further progression and observing Charlie's eyes were much straighter with the glasses and that he sometimes looked over his glasses. She continued to be concerned about his poor vision with the right eye. Charlie's resistance and his inability to function with the patch over the left eye proved to be a challenge.

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Diagnostic Data

The VT consult led to a diagnosis of constant right esotropia that was partially accommodative and combined strabismic anisometropic amblyopia OD. Distance retinoscopy with the habitual glasses in place resulted in plano each eye and near point retinoscopy (monocular estimate method) was +0.25 each eye. These results confirmed that he was wearing the optimal spectacle prescription with the constant right esotropia measured 12 prism diopters compared to 25 without spectacle correction. During corrected monocular visual acuities (VA) at far, Charlie was slow to abduct OD upon covering OS. He used a random searching strategy and, after much pointing and prompting, he finally located and identified the single 10/100 HOTV letter. His decreased BCVA of 20/200 was further confirmed using the Wesson Psychometric Acuity cards (Optometric Extension Program). Charlie saw none of the 20/212 tumbling E targets at 10 feet. Abnormal counter interaction[1], a "crowding effect" on this test caused a worse VA than single letter presentation with HOTV. Near VA with Lea numbers (Precision Vision) was 20/200 – 2/5 at 40cm. Visuoscopy augmented the diagnosis of severe / deep amblyopia. It ranged from two to three degrees of steady nasal eccentric fixation. Sensory fusion testing using red lens in dark and lit room resulted in constant OD suppression.

The first step in the treatment plan was to initiate full time direct occlusion of the left eye in a manner that promoted compliance. To that end, 1% atropine sulfate ophthalmic ointment (Bausch & Lomb) was prescribed for left eye and the left spectacle lens was converted to plano DS. This type of direct occlusion, optical blur/pharmacological penalization, rendered Charlie's left eye undercorrected for distance by 5.50D sphere and 1.00 cylinder. Left eye was further penalized at near because of atropine induced cycloplegia. A strategic advantage of this type of occlusion was that Charlie could not circumvent it in any way.

Six days later, Charlie presented with a widely dilated left pupil, a preference to fixate with OD and a positive report from mother about his improved visual function as the days passed. Although the first full day was difficult for Charlie, on day 2 "he began playing with his brother as usual." His OD VA was 20/100 with single letter HOTV, 20/155 with Wesson Psychometric Acuity cards, and 20/160-1/5 at near. Another monocular vision test, contrast sensitivity, (M&S Technologies) was introduced and Charlie achieved 32% contrast with single 20/100 HOTV letters. At this same visit, Charlie's monocular saccades, pursuits and accommodation were tested and all were abnormal with OD. Visuoscopy again showed nasal eccentric fixation. Monocular color vision (Color Vision Testing Made Easy, Bernell) was normal for each eye.

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Weekend atropine ointment in the left eye continued for 12 weeks with progress evaluations occurring every 3 weeks. At the second visit, direct opaque occlusion of the left eye with a clip-on occluder (Bernell) was prescribed to be worn during near eye-hand activities (build puzzles, Legos, coloring books etc.). This home-based monocular VT was to be done two hours per day. This treatment plan led to slow and steady improvement in monocular vision to 20/80 HOTV, 20/97 Wesson Psychometric Acuity, and RS20/80 at 40cm. Contrast sensitivity was 25% with 20/80 letters. At the fourth visit, Charlie showed no improvement compared to the prior visit. Because of this plateau, treatment was intensified by implementing a formal office-based VT program. Office VT visits were scheduled once weekly for 60 minutes. The occlusion regimen was modified in the following way: Atropine ceased, the left sphero-cylinder spectacle lens was inserted, and a 20/100 graded occlusion foil (Eye Care and Cure) was applied to the back side of the left spectacle lens. Upon application, Charlie began to fixate with his right eye. Behind the occlusion foil, the left eye assumed an esotropic posture. This occlusion method, direct full time translucent with a graded filter, continued for 30 weeks. Ten weeks into the office-based VT program, the 20/100 occlusion foil was replaced with a 20/70 occlusion foil because his OD VA improved. Direct opaque occlusion continued to be employed part time for certain monocular VT procedures. For example, Hadinger brush VT[2] to improve foveal fixation OD were accomplished with OS completely occluded with an opaque elastic band patch.

Another type of occlusion filter was employed during office VT for several procedures. A filter was placed in front of Charlie's normal eye (OS) and conditions were arranged such that the normal eye (OS) could not see the target for the VT procedure because of the filter. But, OS saw all other items in the field. OD, the amblyopic eye, could see the VT target. This type of VT is known as monocular-fixation-binocular-field (MFBF).[3] One MFBF activity Charlie completed employed the right vectogram from the left/right pair of clown vectograms (Bernell). Charlie wore polaroid filter glasses with the right filter removed. Under these conditions, OD saw the clown vectogram, but, because of the left polarized filter, OS could not see the target. It looked blank when viewed with OS. Charlie located and identified the target details (letters of the alphabet) with the target in motion and at his threshold VA.

Charlie's VT continued for a total of 30 office visits. Sensory fusion testing during that time span resulted in additional diagnoses of anomalous correspondence and suppression. Periodic testing also showed improved monocular vision and slight improvements in binocular vision. Repeat cycloplegic refraction on visit 15 by Charlie's primary optometrist revealed no additional latent hyperopia and a minor change in the astigmatism. His VT program expanded to binocular VT procedures for esotropia (including sensory fusion). Corrective BO Fresnel was tried at week 10 and then again at his 30th VT visit. Charlie adapted to prism within 10 minutes of prism application. VT concluded when there were no further improvements in monocular and binocular vision between visit

25 and 30. Eye muscle surgery was discussed briefly for the residual esotropia, but the lack of cosmetic concern prompted the parents to decline. A maintenance occlusion regimen was assigned to prevent regression. Charlie's final best corrected VA with OD was 20/60 with Wesson Psychometric, 20/50-2/5 at far with a conventional full chart and 20/50 at 40cm.

Discussion

Functional amblyopia is a condition in which best corrected visual acuity is worse than 20/20 in the absence of disease and the presence of an amblyogenic factor such as constant unilateral strabismus or anisometropia.[4] Disease processes such as congenital cataract can cause amblyopia via form deprivation. Functional amblyopia is the most common cause of monocular vision impairment in children and young adults.[4] Its incidence is 0.4% per year during the preschool years resulting in a prevalence of 2% of the general population.[4]

With the best spectacle correction, the fulcrum of a treatment plan for amblyopia is arranging conditions so the patient purposefully uses the amblyopic eye to seek, identify and extract relevant visual information to guide action and thought. Occlusion of the normal eye (NE) readily accomplishes this arrangement. NE occlusion can be simple and straightforward. The patient can simply peel and stick an adhesive patch on face to cover NE. Alternative and more complex occlusion options and strategies shown in Table 1, Table 2, and illustrated in the previous case report. Clinicians select the occlusion form, type and schedule based on diagnosis and therapy is judiciously modified during treatment. Human factors come into play such as age, temperament of the child and parenting style. Another practical yet limiting factor is whether or not the child is a full-time eyeglass wearer. Clip-on and translucent occluders are impractical with patients who have no spectacle correction.

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After decades of research on occlusion therapy for amblyopia, the Pediatric Eye Disease Investigator Group (PEDIG) and their Amblyopia Treatment Studies[5] clarify the efficacy of various treatments for amblyopia with an emphasis on occulusion. One of their early studies showed that more occlusion is not necessarily better than less.[6] Young children (age three to seven years) with moderate amblyopia were separated into two groups. The first group was prescribed direct opaque occlusion for two hours per day and the other six. Both were instructed to engage in active eye-hand activities while occluded. After four months, the groups had similar gains in acuity. Another PEDIG study has shown that atropine penalization is on par with traditional opaque patching methods in terms of safety, efficacy and acceptance by patient/parent.[7] The question of age and amblyopia treatment has also been answered by PEDIG[8] and other studies. Without a doubt, the potential for improved vision in amblyopia is present at any age.[9-12] PEDIG is funded by the National Eye Institute and doctors of optometry are well represented on the research teams. The PEDIG public website (http://pedig.jaeb.org) is loaded with information including completed and ongoing research on amblyopia.

Table 1

Occlusion Types
LIGHT TRANSMISSION FORM OF OCCLUSION
Opaque adhesive patch, elastic band patch, clip-on occluder, sleeve occluder
Translucent graded filters (Bangerter foils, cling patch), nail polish on spectacle lens
Optical Blur atropine penalization, over-plus spectacle or contact lens, colored filter, polarized filter

Table 2

Occlusion Placement Occlusion Schedule
Direct Occlude Normal Eye (NE) Full Time 1 eye is occluded all waking hours
Indirect Occlude Amblyopic Eye (AE) Part Time Some waking hours both eyes have Alternating
Mix of occluding NE and AE no occlusion
Partial Occlude sector of visual field

Research recommend two hours of part time direct opaque occlusion of NE for any type of amblyopia, taking into account the challenges of compliance when prescribing occlusion therapy. If patient is a spectacle wearer, consider prescribing a clip-on occluder. If the patient is not a spectacle wearer, consider an adhesive patch or elastic band patch. An alternative to the 2-hour per day treatment plan, can be 15 hours per week of occlusion. This flexible schedule recognizes that there will be days when occlusion is not feasible and the child can make up for it on another day. If the child will not comply with opaque occlusion, atropine penalization is a very good second choice (see box for atropine penalization guidelines). Follow-up evaluations for amblyopia occlusion therapy answer a simple question: Has visual function with AE improved? If yes, continue the same treatment plan until the amblyopia is cured. Therefore, it is helpful to have multiple measures of visual function to properly modify treatment plans as necessary. For example, distance VA with a standard Snellen chart may show no change. But, improvements in visual function per contrast sensitivity and eye movements would lead to the overall conclusion that

indeed, sufficient progress has occurred to warrant continuation of the present treatment plan. It is also helpful to have distance and near VA charts with small increments between VA levels. A patient may improve from 20/200 to 20/160 but a VA chart that jumps from 20/200 to 20/100 will not show that increment of improvement. The Wesson Psychometric acuity cards have a broad range of small increments and control for the crowding effect.[1] The tumbling E optotypes expand the age range that can be tested. This test is my preferred method for measuring distance VA in amblyopia. If a progress evaluation shows no improvement in visual function on all measures and compliance has been good, then the treatment plan should be intensified. Increased hours of occlusion is one way, another is to enroll the patient in an active office-based VT program as was done with Charlie in the case report presented.

ATROPINE PENALIZATION METHOD OF OCCLUSION

Purpose: Cycloplegia to induce optical blur in normal eye so that amblyopic eye is used for visual tasks.

Method: 1% atropine sulfate solution (2, 5, or 15 ml) or ointment (3.5g) in normal eye. Maximal therapy is once daily dosage with minus add for normal eye. Standard therapy is one dose two days per week with or without minus adds.

Possible side effects: Allergic or irritation reaction of skin/conjunctiva, thirst, fever, tachycardia, irritability, cutaneous flush, somnolence, excitement, convulsions.[13]

Advantages: Inconspicuous, child cannot circumvent, compliance evident to clinician (mydriasis), ease of application for parents, latent nystagmus remains latent.

Disadvantages: Possibility of side effects, cannot easily suspend NE blur (e.g. remove patch) for visually demanding tasks such as reading or ball sports.

The progression is noted, form and schedule of the occlusion therapy can evolve during treatment toward simplicity for the doctor and the patient. Consider a first grader with anisometropic amblyopia with a best corrected VA of 20/80 in the amblyopic eye following six weeks of full-time SRx wear. Part-time direct opaque occlusion of NE with a clip-on occluder yields improvement to 20/50 over a two-month period. 20/50 VA may very well be sufficient for the child to function in school.[14] Occlusion therapy can intensify from part time direct opaque to full-time direct transluscent with a graded filter, eg 20/70, applied to NE. The filter is applied to the back side of the NE spectacle lens and the patient simply wears his or her glasses all waking hours as before. Check the patient in one month and if VA has improved further, let's say to 20/30, remove the 20/70 foil and apply a 20/50. Now, the child will be quite functional and further improvements can take place. At this stage of occlusion therapy, it is advisable to wait longer for the next progress evaluation. Improvement from 20/30 to 20/25 or 20/20 can take two to six months. This hypothetical case example of anisometropic moderate amblyopia represents the type of amblyopia that any primary care optometrist can manage. If amblyopia does not improve to 20/20 the patient should be referred to an optometrist who specializes in VT. If the child should also demonstrate normal binocular vision (stereopsis, second degree fusion, vergence skills) and be free of visual performance symptoms (e.g. difficulty keeping place while reading, difficulty copying) then the primary care optometrist does not need to refer the patient for VT.

Another consideration when prescribing occlusion therapy for amblyopia is whether or not to assign specific VT activities while occluded. Krumholtz and Fitzgerald researched this question and their study showed that occlusion therapy coupled with VT is superior to occlusion alone on 2 counts.[15,16] Stereopsis after treatment is better and regression of gains in visual function is less likely when VT augments occlusion therapy. There are also three pragmatic reasons to assign VT with occlusion. First, most parents are eager to assist with therapy and will ask for guidance regarding activities to do while their child is occluded. Mazes, coloring books, puzzles and snap-together toys are all activities that require the child to activate a wide range of visual skills which will promote and develop better visual function with AE. Second, the assigned activities can be a reward for the child. The parents can gift the child a new game or toy that can only be played while the occluder is in place. Compliance with occlusion improves if parents work on an activity with the child during occlusion time, (i.e. play tic tac toe with very small grids or build a puzzle together). Third, activities can be targeted to specific monocular skills that are deficient. Amblyopia is not just a VA deficit. Other monocular visual functions such as, saccades, pursuits, accommodation, spatial perception, contrast sensitivity, may also be underdeveloped.[17] VT can be prescribed that targets the deficient visual skills.

The final consideration in occlusion therapy for amblyopia is length of time for total course of occlusion therapy. After the amblyopia has been treated maximally and no further improvements are possible (or needed because monocular vision is normal), abrupt and complete termination of occlusion can lead to regression.[5,17,18] To prevent regression, assign part time direct occlusion for 10 hours per week. Recheck in six weeks. If no regression, taper to five hours per week for a month and then no occlusion. If regression occurs, carefully check binocularity and refraction. Refractive changes should

be compensated for and abnormal binocularity warrants VT emphasizing binocularity. If the optimal SRx is in place and binocularity is normal, some children need maintenance occlusion until they are 10-14 years old. Invariably, they will grow out of their susceptibility to regression. Regression is more likely during the first year after cessation of therapy, in constant unilateral strabismus and younger children.[5,18,19] It is less likely in cases of anisometropia, older children and patients with good binocularity.

Among the various conditions that can cause vision loss, amblyopia has the good fortune of being wholly preventable if its cause is diagnosed and treated at or near onset has great prognosis. Unlike age related diseases that cause vision loss (e.g. glaucoma, AMD), it has the unfortunate attribute of occurring early in childhood and saddling the individual with abnormal vision for a lifetime if untreated or treated too late. Individuals with amblyopia have a higher risk of vision loss in NE than in the general population in becoming blind.[5] Amblyopia decreases stereopsis which may detract from driving and near eye-hand tasks and cause occupational exclusions.[4] It also lowers surgical success rate for esotropia.[20]

The case report presented above, Charlie, demonstrates a suboptimal outcome because treatment began too late. Because Charlie's initial VA was so poor, his final best corrected VA was no better than 20/50, it is probable he had constant right esotropia and anisometropia for two or more years before his first eye exam. The esotropia was small enough in magnitude to escape detection by his pediatrician and his parents which led to a period of uncorrected refractive error. Two tests — cyloplegic retinoscopy and unilateral cover test — performed when he was an infant or even at age three years in compliance with recommended guidelines[21] could have led to earlier diagnosis and a better prognosis. It is incumbent upon all primary eye care providers to recommend routine comprehensive eye exams performed by a pediatric eye care provider at age six months and three years to prevent vision loss associated with amblyopia.

REFERENCES

1. Rutstein RP, Paum KM. Anomalies of binocular vision. Diagnosis and Management. St. Louis: Mosby, 1998: 21-23.
2. Cotter SA. Vision therapy techniques. In Coloroso EE, Rouse MW. Clinical Management of Strabismus. Boston: Butlerworth-Heinemann, 1993: 329-30.
3. Press LJ. Amblyopia therapy. In: Press LJ ed. Applied Concepts in Vision Therapy. St. Louis: Mosby, 1997:192-200.
4. Rouse MW, Cooper JS, Colter SA et. al. Care of the patient with amblyopia. St. Louis: American Optometric Association. 2004: 2.
5. Rutstein RP. Contemporary issues in amblyopia treatment. *Optometry* 2005; 76(10): 570-8.
6. Repka MX, Beck RW, Holmes JM, et. al. A randomized trial of patching regimens for treatment of moderate amblyopia in children. *Arch Opthalmol* 2003; 121:603-11.
7. Pediatric Eye Disease Investigator Group. Two-year follow-up of a 6-month randomized trial of atropine vs. patching for treatment of moderate amblyopia on children. *Arch Ophthalmol* 2005; 123: 149-57.
8. Pediatric Eye Disease Investigator Group. Randomized trial of treatment of amblyopia in children aged 7 to 17 years. *Arch Ophthalmol* 2005; 123:437-47.
9. Birnbaum MH, Koslowe K, Sanet R. Success in amblyopia therapy as a function of age: a literature survey. *Amer J Optom Physio Optics* 1977; 54(5): 269-75.
10. Wick B, Wingard M, Cotter S, Scheiman M. Anisometropic amblyopia: is the patient ever too old to treat? *Optom Vis Sci* 1992; 60(11): 866-78.
11. Mohan K, Saroha V, Sharma A. Successful occlusion therapy for amblyopia in 11 to 15 year old children. *J Pediatric Ophthalmol Strabismus* 2004; 41(2): 89-95.
12. Simmers AJ, Gray LS. Improvement of visual function in an adult amblyope. *Optom Vis Sci* 1999; 76(2): 82-87.
13. Jaanus SD, Carter JH. Cycloplegics. In Bartlett JD, Jaanus SD eds, *Clinical Ocular Pharmacology* 3rd ed. Boston: Butterworth-Heinemann, 1995: 167-72.
14. Langford A, Hug T. Visual demands in elementary school. *J Pediatric Ophthalmol Strabismus* 2010; 47(3): 152-6.
15. Krumholtz I, Fitzgerald D. Efficacy of treatment modalities in refractive amblyopia. *J Amer Optom Assoc* 1999; 70(6): 399-404.
16. Fitzgerald DE, Krumholtz I. Maintenance of improvement gains in refractive amblyopia: a comparison of treatment modalities. *Optometry* 2002; 73(3): 153-59.
17. Press LJ. Amblyopia. *J Optom Vis Develop* 1988; 19: 2-15.
18. Rutstein RP, Fuhr PS. Efficacy and stability of amblyopia therapy. *Optom Vis Sci* 1992; 69 (10): 747-54.
19. DeWeger C, Van Den Brom HJ, Lindeboom R. Termination of amblyopia treatment: When to stop follow-up visits and risk factors for recurrence. *J Ped Ophthalmol Strab* 2010; 47 (6): 2010.
20. Weakly DR. Holland DR. Effect of ongoing treatment of amblyopia on surgical outcome in esotropia. J Ped Opthalmol Strab 1997; 34 (5): 275-78.
21. Scheiman MM, Amos CS, Ciner EB. Pediatric eye and vision examination 2nd ed. St. Louis; American Optometric Association. 2002: 32.