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CE Credit - Case Report(s) & Topic Review

Reaching 20/20 with Vision Therapy: Vision Therapy in Managing Moderate Refractive Amblyopia after Patching

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Refractive amblyopia is typically managed with a full correction of the refractive error followed by monocular occlusion in unilateral cases until visual acuity has plateaued. However, there is less emphasis on recovery or improvement of stereopsis as well as other visual functions. Moreover, there often remains some reduction in visual acuity even after a full course of patching. This case explores some of the benefits and clinical and subjective changes observed when vision therapy is implemented as a further course of management after the cessation of patching. The benefits of vision therapy in promoting binocularity, visual acuity, and stereoacuity is discussed.

INTRODUCTION

Refractive amblyopia occurs when consistent blur or vision loss secondary to an uncorrected refractive error in one or both eyes leads to decreased vision and abnormal development of the visual cortex.[1] This condition is typically considered a diagnosis of exclusion as amblyopia is only confirmed when there is a consistent reduction in visual acuity that cannot be attributed to any ocular pathology. Moreover, the acuity reduction does not immediately or always resolve with optical correction. Mild amblyopia is typically defined as a visual acuity of 20/25 to 20/30 in the amblyopic eye(s); moderate amblyopia presents in the range of 20/40 to 20/80 visual acuity, and severe amblyopia presents with a visual acuity at 20/100 or worse. Recent pooled data suggests that the worldwide prevalence of amblyopia amongst children is 1.36%, with a slightly higher predilection for boys compared to girls and variability from country to country.[1]

To date, the primary course of management once there is a suspected refractive amblyopia is to first fully correct for the refractive error, followed by intermittent periods of patching or pharmacological blurring to promote use of the amblyopic eye once improvements in visual acuity have stabilized.[2-4] However, there often still remains a mild reduction in refractive error and stereoacuity even after a full course of optical correction and patching.[5,6]

In this case report, a twenty-week course of vision therapy was found to improve monocular visual acuity as well as stereopsis in a 9-year-old boy with non-strabismic, monocular refractive amblyopia and a history of patching. The benefits and limitations of vision therapy as a means of treatment when no further improvements have been observed with spectacle correction and patching are discussed.

CASE REPORT

A 9-year-old Caucasian boy presented with concerns of clumsiness, losing place while reading, headaches, and blurred vision in the left eye that was present at both distance and near. His medical and family history was unremarkable for any systemic diseases, although he presented with a speech delay that was noticed from an early age and a diagnosis of a learning disability at 7 years old. He did not have any allergies and was not taking any medications. His ocular history included spectacle wear since 5 years of age, when he was first diagnosed with amblyopia at his first routine eye examination.

Records from the patient's previous primary care optometrist indicated monocular visual acuities of 20/20 in the right eye and 20/40 in the left eye prior to patching for 2 hours a day, 5 days a week. The patient had been patching for approximately 6 months at age 8 and had since discontinued patching.

His habitual spectacle correction was +4.25/-1.50x040 in the right eye and +7.00/-2.50x170 in the left eye and had been worn for the past 15 months prior to the examination. A cycloplegic refraction had been performed one month prior by the primary care optometrist, which revealed a wet subjective refraction of +5.50/-2.00x025 in the right eye, and +7.25/-3.00x180 in the left eye. Entering aided visual acuities were 20/20 in the right eye and 20/30 in the left eye, using crowded Snellen letters at distance, and 0.4M in the right eye and 0.6M in the left eye. With single uncrowded Snellen letters, visual acuity improved to 20/25 in the left eye.

Cover test revealed an orthophoric posture at distance and 6 prism diopter exophoria at near. Near point of convergence was 9, 8, and 10cm, with a recovery point of 12, 15, and 14cm. Global stereopsis with Randot targets was 250 seconds of arc with one error, and local stereopsis mea-

Table 1. Clinical findings from initial assessment.

	Distance	Near
Habitual VA (OD)	20/20 (crowded)	0.4M
Habitual VA (OS)	20/30 (crowded) 20/25 (single letter)	0.6M
Cover Test	Ortho	6 XP
Worth 4 Dot	Flat fusion all lighting	Flat fusion all lighting *OS Suppression with +/-2.00 overtop*
Near Point of Convergence	**Break:** 9/8/10cm **Recovery:** 12/15/14cm	
Stereopsis	**Global:** 250"	**Local:** 50"
Vergences	x/10/8 BIN x/12/8 BOUT	x/18/14 BIN x/25/20 BOUT
Vergence Facility	>10 cycles per minute (12BIN, 3BOUT)	

Table 2. Clinical findings from initial assessment (continued).

	OD	OS
Retinoscopy	+5.00/-2.00x015	+7.00/-3.00x180

sured with Wirt circles was 50 seconds of arc. Worth 4 Dot testing revealed flat fusion at all distances, in both light and dark illumination, but suppression of the left eye with +2.00 and -2.00 lenses overtop. Vergence facility was 10 cycles per minute. Extraocular muscle movements, pupils, confrontational visual fields, and anterior segment findings were unremarkable. Table 1 lists relevant clinical findings.

Accommodative amplitudes were 12D in the right eye and 10D in the left eye with the Push-up method. Static unfogged retinoscopy revealed +0.50D in the right and left eye overtop the habitual correction, and +5.00/-2.00x015 in the right eye and +7.00/-3.00x180 unaided with static unfogged retinoscopy. It was noted that the retinoscopy reflex in the left eye was subjectively darker than the right eye, but no scissoring reflex was observed. Accommodative accuracy was +0.75D in the right eye and +0.50D in the left eye. Monocular accommodative facility was 9 cycles per minute in the right eye and 7 cycles per minute in the left eye. Binocular accommodative facility was 8 cycles per minute. Saccades and pursuits were assessed via the NSUCO oculomotor test protocol and oculomotor control was further evaluated with the Developmental Eye Movement test. Table 2 outlines the refraction, accommodative findings, and oculomotor findings.

DIAGNOSIS AND MANAGEMENT

The patient was diagnosed with mild refractive unilateral amblyopia in the left eye with a history of moderate amblyopia, and secondary mild convergence insufficiency. This diagnosis was supported by the patient's history of anisometropic refractive error and reduced visual acuity in the left eye that improved with uncrowded letters, a receded near point of convergence greater than 5 centimeters.

While there was reduced monocular accommodative facility, accommodative amplitude, and increased lag of accommodation in the left eye compared to the right eye, this was not clinically sufficient to substantiate a diagnosis of accommodative dysfunction.

Moreover, oculomotor findings based on the NSUCO test of saccades and pursuits were within normal limits for the patient's age. While the Developmental Eye Movement results were outside normal limits, the difficulty with the first portion of the testing which evaluates random automaticity of naming substantiated the patient's pre-existing learning disability diagnosis.

No changes were made to the habitual correction, as trialing increased plus lenses overtop the habitual prescription did not improve refractive error or stereopsis findings. Vision therapy was recommended, with emphasis on anti-suppression, vergence and accommodative therapy. Goals for this patient were to improve visual acuity in the left eye and reduce the frequency of his headaches.

The patient completed ten sessions of vision therapy over the course of 12 weeks. After ten sessions, a progress check was conducted. Table 3 and 4 outline the follow-up examination findings. At this visit, visual acuity in the left eye improved to 20/20 with uncrowded single Snellen letters, and stable at 20/30 with crowded Snellen letters. Near visual acuity improved to 0.5M in the left eye. Cover test findings remained unchanged; near point of convergence was now 6 and 7 cm. Local stereopsis was 50 seconds of arc as measured with Wirt circles. Accommodative amplitudes were 10D in both eyes.

Static unfogged retinoscopy remained relatively stable. Accommodative accuracy was +0.50D in the right and left eye, with a stable duller reflex noted in the left eye. Worth 4 Dot testing revealed flat fusion that remained stable with +2.00 and -2.00 flippers overtop. Monocular accommodative facility was 8 cycles per minute in both eyes, with a binocular accommodative facility of 8 cycles per minute.

After the follow-up appointment, both the patient and the patient's parents had noticed subjective improvements in hand-eye coordination, balance, and reading. The pa-

ACCOMMODATION	**Accuracy**	+0.75D	+0.50D (duller reflex)
	Facility	9 cpm	7 cpm
		8 cpm OU	
	Amplitude	12D	10D
		Notable undershooting >50%, marked head	
	Saccades	movement **NSUCO:** Ability 5, Accuracy 3, Head Movement	
		3, Body Movement 4	
OCULOMOTOR CONTROL	**Pursuits**	Notable saccadic intrusions and head/ body movement **NSUCO:** Ability 4, Accuracy 3, Head Movement	
		3, Body Movement 4	
	DEM	Vertical: <1% (remaining UTA)	

Table 3. Clinical findings after ten sessions of vision therapy.

	Distance	Near
Habitual VA (OD)	20/20 (crowded)	0.4M
Habitual VA (OS)	20/30 (crowded) **20/20 (single letter)**	0.5M
Worth 4 Dot	Flat fusion all lighting	Flat fusion all lighting *No suppression with +/-2.00*
Near Point of Convergence	**Break:** 6/7/7 cm **Recovery:** 10/10/9 cm – difficulty sustaining	
Stereopsis	**Global:** 250" (2/3)	**Local:** 50"

Table 4. Clinical findings after ten sessions of vision therapy (continued).

		OD	OS
Retinoscopy		+5.00/-1.50x015	+7.00/-2.00x165
ACCOMMODATION	**Accuracy**	+0.50D	+0.50D (duller reflex)
	Facility	8 cpm	8 cpm
		8 cpm OU	
	Amplitude	10D	10D

OCULOMOTOR CONTROL	**Saccades**	Notable undershooting >50%, less head movement **NSUCO:** Ability 5, Accuracy 3, Head Movement 4, Body Movement 5
	Pursuits	Notable saccadic intrusions but minimal head and body movement **NSUCO:** Ability 5, Accuracy 3, Head Movement 4, Body Movement 5
	DEM	Vertical: 10% (remaining UTA)

tient's headaches and blur were resolved. At this stage, extensive counselling with the patient and parents emphasized that while improvements were noted, it would be difficult to predict whether or not further improvements in vision and stereoacuity could be achieved with additional vision therapy sessions. However, the patient's parents were eager to attempt a further ten week course of vision

Table 5. Clinical findings after twenty sessions of vision therapy.

	Distance	Near
Habitual VA (OD)	20/20 (crowded)	0.4M
Habitual VA (OS)	**20/20-2 (crowded)**	0.4M
Near Point of Convergence	**Break: 4, 5, 4 – immediate recovery**	
Stereopsis	**Global:** 250" (2/3)	**Local: 30"**

Table 6. Clinical findings after twenty sessions of vision therapy (continued).

		OD	OS
Retinoscopy (overtop habitual)		+0.50/-1.00x050	+0.50
ACCOMMODATION	**Accuracy**	+0.50D	+0.50D (duller reflex)
	Facility	8 cpm	8 cpm
		8 cpm OU	
	Amplitude	11D	10D
OCULOMOTOR CONTROL	**Saccades**	**NSUCO:** Ability 5, Accuracy 4, Head Movement 4, Body Movement 5	
	Pursuits	**NSUCO:** Ability 5, Accuracy 4, Head Movement 4, Body Movement 5	
	DEM	Vertical: 17% (remaining UTA)	

therapy to determine whether further visual progress could be made.

After an additional ten sessions of vision therapy conducted over thirteen weeks, the patient and his parents returned for a follow-up appointment to assess his progress (Table 5, Table 6). At this visit, visual acuity in the left eye improved to 20/20 with the crowded Snellen chart in the distance and 0.4M with some noted difficulty at near, a clinically significant improvement from the previous visit. Moreover, there was a further improvement in the near point of convergence, which was now maintained up until 4cm with immediate recovery. Stereopsis as measured with Wirt circles was 30 seconds of arc with the habitual correction.

Static retinoscopy was performed overtop the habitual prescription, which revealed +0.50/-1.00x050 overtop the right eye and +0.50 overtop the left eye. This over refraction, when trialed overtop with loose lenses, did not improve the monocular visual acuity nor the local stereopsis. Table 6 outlines the accommodative and oculomotor findings. Accommodative accuracy, facility, and amplitudes remained stable, with a slight increase in amplitude measured in the right eye from 10D at the previous progress check to 11D. Oculomotor control was improved based on the NSUCO protocol, with increased subjective accuracy of both saccades and pursuits. The patient was still not able to complete the DEM at this time, although it was noted that the time taken to read letters vertically had improved.

At this appointment, it was deemed that the unilateral refractive amblyopia was resolved as the patient was able to achieve 20/20 visual acuity in the amblyopic eye with crowded Snellen letters. Moreover, the convergence insufficiency noted at the initial assessment was also fully resolved, as the patient was able to comfortably maintain convergence until 4 to 5 centimeters without significant difficulty. The patient graduated from vision therapy with maintenance exercises. The patient and the parents were counselled about the importance of resolution of signs via clinical testing versus symptoms; while we had noted improvements in visual acuity and stereopsis at this visit, the bulk of symptoms experienced by the patient had been mostly resolved at the previous progress check. Again, no changes were made to the habitual prescription even though the patient's prescription was almost two years old, as no improvements were noted in the visual acuity nor stereopsis with trialled lenses.

The patient was advised to follow-up in three months to monitor for any changes in prescription, but was otherwise advised to return to their primary care optometrist for regular annual eye exams.

DISCUSSION

Amblyopia is widely known as a reduction in visual acuity in one or both eyes, but can also have broad impacts on other measures of vision. For instance, a common effect of amblyopia is a diminished ability to recognize visual targets when crowding is present, known as the crowding effect.7 However, other components of vision that are less commonly measured can be impacted as well, such as contrast sensitivity and fine motor skills.8 Moreover, non-strabismic amblyopic patients tend to have a higher likelihood of larger exodeviations and astigmatism, indicating some possible correlations between amblyopia's impacts on vergence.[7]

Prior to confirming a diagnosis of amblyopia, it is crucial to rule out other ocular pathology first, such as keratoconus which can present with similar clinical signs such as a reduction in visual acuity and increased refractive error and astigmatism. Thus, a thorough examination of the anterior segment and a detailed case history is warranted prior to confirming a diagnosis of amblyopia.

In this case, the patient was diagnosed with residual mild refractive amblyopia from anisometropic high hyperopia which had been historically managed with a full refractive error and patching. Fully correcting for refractive error is considered the gold standard in management and treatment of amblyopia, with PEDIG's landmark studies demonstrating three lines of improvement in visual acuity in an average of 18 weeks with just optical correction alone for both moderate and severe unilateral refractive amblyopia.[2] This is followed by intermittent occlusion or penalization of the non- amblyopic eye in cases of unilateral refractive and strabismic amblyopes. In the PEDIG trials, a mean treatment visual acuity of 20/30 in moderate amblyopes were achieved after two hours of daily patching.[2]

However, patients and their families often have concerns about social implications and difficulties associated with cooperation when patching is prescribed. Although this patient was prescribed patching over the course of a six-month period, this patient reported a severe aversion to patching, citing more realistic patching schedules of 30 minutes a day, 3 to 4 days a week. Practitioners have often resorted to other methods of occlusion, such as the application of Bangerter foils to achieve a similar effect whereby the non-amblyopic eye is penalized while still promoting peripheral fusion.[8,9] When improvement is no longer possible with patching, it is important that patients are provided with alternative options for intervention.

Moreover, while optical correction and patching have been demonstrated to improve visual acuity, its benefits in improving other measures such as stereopsis and contrast sensitivity have been less well studied. In anisometropic amblyopia, stereopsis is still typically present compared to strabismic amblyopia.[6] However, stereopsis is ultimately reduced compared to non-amblyopic patients. This is key when considering that fine motor skills tend to correlate with stereoacuity rather than amblyopia severity, and that the degree of vision reduction secondary to amblyopia is not necessarily a predictor of one's stereoacuity.[10]

Vision therapy uses several concepts to improve binocularity and promote further strengthening of the amblyopic eye, such as anti-suppression therapies (monocular fixation in a binocular field and dichoptic stimuli), perceptual learning to improve contrast sensitivity and fine discrimination, and appreciation of stereopsis which requires that both eyes work together.[11] Not only is use of the amblyopic eye promoted, but also tasks requiring fine, detailed work in order to develop visual discrimination, contrast sensitivity, and Vernier acuity are employed.[12]

Unlike patching, where visual input is completely focused on the non-amblyopic eye, vision therapy employs strategies such as dichoptic viewing. Dichoptic viewing involves separating inputs to either eye such that the visual information being processed in each eye is separate. This can be achieved in several different ways, such as by adjusting the contrast and luminance of one input compared to the other, or by a means called monocular fixation in a binocular field (MFBF), where the amblyopic eye is able to view both the central task and the periphery, while the non-amblyopic eye only able to view the periphery and unable to see a near task.

A study conducted by Bossi et al. In 2017 found that "balanced binocular viewing therapy", or BBV, involving dichoptic viewing of movies and games over the course of 8 weeks, was correlated with 2-3 lines of improvement in visual acuity and a mean improvement of 165 seconds of arc for stereoacuity in anisometropic refractive amblyopes.[13] Binocular video game therapy play has been observed with improvement in mean visual acuity, but participants in these studies failed to play these games for the fully prescribed duration, and VA improvement was not clinically greater than patching.[11]

Moreover, a recent trial comparing the use of MFBF compared to patching in youth with ansiometropic refractive amblyopia identified a greater clinical improvement in visual acuity by 5 lines in the group with visual training with MFBF compared to the group that had patched over the course of six months.[14] However, the improvement in visual acuity was not found to be statistically significant, suggesting that while certain vision therapy training may not be superior over patching, it results in similar outcomes.

Thus, vision therapy is one alternative when patching regimens are unsuccessful, as similar outcomes can be observed compared to patching in terms of improvement in visual acuity. While these gains in acuity may not necessarily be greater than that achieved with patching, it still highlights the potential benefits and impacts of vision therapy for refractive anisometropic amblyopia.

In this case, a 20 session course of vision therapy targeting anti-suppression, vergence, and accommodative therapy with emphasis on perceptual learning and improvement of visual skills was found to improve the patient's visual acuity by one line, and stereopsis from 30 seconds of arc to 20 seconds of arc. It is possible that the reduced stereopsis was impacted by an underlying imbalance in monocular accommodative findings and the patient's convergence insufficiency; however, this would not be anticipated to affect distance visual acuity. Thus, there was a discrete improvement in both the patient's ability to converge as well as the patient's binocularity after a course of vision therapy.

Overall, vision therapy promotes binocularity and places a greater emphasis on other measures of visual function aside from visual acuity. Concurrent training and improvement of other non-strabismic binocular vision disorders can also be targeted; in this case, there was a discernable improvement in the patient's near point of convergence and oculomotor control alongside visual acuity and stereoacuity improvements. Moreover, the literature also suggests that these improvements are retained for at least one to two years based on typical follow-up appointments conducted after vision therapy.[15]

Ultimately, there are similar concerns to patching when it comes to vision therapy and adherence, and there still lacks sufficient evidence in the way of randomized controlled trials. The current evidence suggests that while vision therapy is not superior to patching, it can achieve similar improvements in visual acuity. More trials are needed to better understand which dichoptic parameters such as fellow-eye masking, binocular integration, or adjustment of contrast and luminance are most relevant for amblyopia therapy.

CONCLUSION

Amblyopia is a condition of the visual system that affects more than just visual acuity. Thorough management of amblyopia should include close monitoring of stereopsis and overall binocularity. Moreover, this case report highlights the use of vision therapy in conjunction with other conventional standards of treatment for refractive amblyopia, particularly in cases when there is a plateau in improvement with a full refractive correction and occlusion with patching.

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