Management of Significant Refractive Error

Abstract:

This case report is of a child who was referred to me by a practicing optometrist. This 3-year-old presented with an alternating esotropia of two-month duration. Her initial refractive status was that of a moderate high amount of hyperopia. Initial treatment included the prescribing of a bifocal and four vision therapy sessions. Over the course of the next year, the child’s prescription and refractive status decreased, and she was capable of maintaining alignment with a single vision partial prescription.

Case Report: Visit #1

A practicing optometrist referred AC, a 3-year-old Hispanic female, to me. She presented with a history of a constant esotropia, which was diagnosed by the referring doctor as alternating in nature. The deviation commenced as an intermittent alternating turn two months previously; but had gradually decompensated. AC was premature by a month with a birth weight of 5lbs. 3oz. Her mother was unaware of an APGAR test and unable to provide a score. The delivery was a natural one. She was the first child of a 25-year-old Hispanic mother. At birth AC was healthy and required no special medical attention. There were no other pre, peri or postnatal complications. AC sat at 5 months, began crawling and creeping at 6 months and walked unaided at 11 months. Subsequent milestones were within normal limits. AC took vitamins and iron for what was described as a slight case of anemia. She was not allergic to any medications. AC had one occasion of head trauma, when she fell out of bed, which occurred at 10 months of age. There were
no apparent residual affects of this accident. The only other significant family ocular and
health history was that of the mother’s partial ptosis and amblyopia.

The examination revealed the following data. Unaided distance visual acuity (VA) using a BVAT AO picture chart was right eye (OD) 20/30 and left eye (OS) 20/25. Seeing that the patient was a constant strabismic, there was no acuity taken with both eyes (OU). Initially, VA testing was OU, but it was noted that the deviation increased as the child read smaller lines of acuity, such that the OU acuity would have essentially been a monocular acuity. Consequently, in order to prioritize testing, only monocular acuities were taken. At near her VA was 20/30 (smallest line on this particular chart) in each eye. Unaided cover test at distance was 30° constant right esotropia and at near 35° constant right esotropia. There was a centration point at 2 inches. There were no extraocular muscle limitations, and binocular eye movements revealed a concomitant squint in all positions of gaze. Monocular light touching revealed a similar correlling (a circular finger movement around the target before the target was touched) performance with each eye. Keratoscope findings were spherical with a good tear film layer. Seeing that no significant corneal astigmatism was present, further quantifiable corneal curve measurements were not done. If a significant amount of astigmatism were found on retinoscopy, this area would have been revisited. At this point, dry retinoscopy was done. The result was:

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\begin{align*}
\text{OD} &+8.50 = -0.50 \times 180 \\
\text{OS} &+8.00 = -0.50 \times 180.
\end{align*}
\]
MEM retinoscopy done over this finding was plano OD and OS.
Using a trial prescription of a +8.00 diopter sphere OU, the cover test results were 5\(^\circ\) exophoria at a distance and 5\(^\circ\) alternating esotropia at near. When this trial prescription was reduced to a +5.50 diopter sphere OU, the distance cover test was 3\(^\circ\) esophoria, and the near cover test was a 5\(^\circ\) alternating esotropia. Continuing to evaluate potential prescriptions, the child’s VA using the same BVAT AO picture chart was assessed with different lens powers. The same picture chart was used for each of the following distance VAs:

- Using a +7.00 diopter sphere OU, yielded VA of OD 20/200 and OS 20/200,
- Using a +5.50 diopter sphere OU, yielded VA of OD 20/70 and OS 20/50,
- Using a +4.00 diopter sphere OU, yielded VA of OD 20/25 and OS 20/20.

In each instance the VA was taken within a minute or two after the trial lenses were put in place. Ideally, one might have preferred a greater lens adaptation period; however, the patient was a 3year old who had already had a fair amount of test time consumed and more testing was needed to be done.

The cyclo retinoscopy findings, done later in the exam, were:

- OD +8.50 = -0.50 x 180
- OS +7.75 = -0.50 x 180.

Ocular health was evaluated by using the biomicroscope and by a dilated fundus evaluation. Pupils were equal, round and reactive to light. There were no afferent defects. The horizontal corneal measurement was 11 \(\frac{1}{2}\) mm. Slit lamp findings of significance were scattered melanosis and a 2+ follicular reaction on the lower lid palpebral conjunctiva. Fundus evaluation was negative.
Case Assessment and Plan: The patient’s ocular health was essentially negative, except for her follicular palpebral conjunctival reaction. She was asymptomatic. Her mother was advised to use cool compress for this conjunctival condition. AC was diagnosed as an accommodative esotropia. The existence of a residual turn would be evaluated after the resolution of her refractive condition. The refractive status was essentially that of a moderate high hyperopia for which a prescription was needed. This was to be worn on a full time basis. A full prescription would result in a distance blur and consequently be rejected. Thus a partial distance prescription that would yield tolerable distance VA was chosen. A +4.50 diopter sphere OU was prescribed for distance.

The distance prescription did not resolve the remaining accommodative component of her esotropia. For near she required a more full prescription. Thus a +3.00 diopter add in the form of a ST 35 was prescribed. The complete prescription was OU +4.50 diopter sphere / add +3.00. The seg was set half way between the patient’s lower lid margin and her inferior pupillary border. As evidenced by her unaided VA, AC had some good accommodative capabilities. There was no amblyopia, and hopefully with this prescription she would attain and maintain alignment. During this visit, AC’s level of binocular skills was not tested. This was more the result of time constraints and patient fatigue. She was given an appointment for a 3-week follow-up visit. At that time her binocularity and alignment would be evaluated. The patient’s mother was instructed to get the prescription filled as soon as possible, thus avoiding any further strabismic adaptations.
Follow-up visit: Visit #2

AC returned in 3 weeks. She was now 3 years and 1 month of age. The mother reported that with the prescription AC’s eyes were straight and that AC reported seeing better. There were no other changes to the previous history. The Bruckner test through the distance prescription yielded an equal reflex, indicating alignment. Dry retinoscopy indicated a reduction of the gross hyperopia by a diopter. There also appeared to be an equalization of the refraction between the two eyes. Thus the probe lens prescription used for the remainder of this visit was OU +4.50diopter sphere / add +2.00. The rationale for using this probe prescription was the history of alignment, the dry refraction, and to see if the patient could perform at the same level with a reduced add. If she could do this, the lesser add would provide her with a greater clear near range without having the need to shift to the distance Rx. With this in place the distance cover test was orthophoria, and the near, done through the add, was orthophoria. Using the Keystone Basic Binocular series, AC had alternate suppression on plates 6 and 9. The Worth 4 Dot test at near was passed at first, but then the right eye suppressed, indicating an intermittency of alignment. AC did pass the 3 Figure test at near.

Assessment and Plan: With her prescription in place AC appeared straight, with some gross 2nd degree fusion at near, which was more stable with a lesser demand target. Her refraction seemed to be less hyperopia. However, she was aligned with her glasses, and she displayed fragile binocularity at near with a reduced probe add. Thus her prescription was not changed at this time. Her refraction was to be closely monitored in the future to see if the prescription could be reduced without altering alignment. AC was entered into a preschool vision therapy program. Here her progress would be monitored
for any significant changes in her status. She was also scheduled for a 3-month progress visit.

Preschool Vision Therapy: AC came for four sessions on consecutive weeks. Her age during this time was 3 years 2 months to 3 years 3 months. Due to appointment scheduling on the part of the patient, AC dropped from the program after a month. During the sessions activities centered on the awareness of simultaneous perception, 2nd degree fusion and gross 3rd degree fusion. The following is a list of the procedures used:

- Lite Brite using red/green filters and red, green and clear pegs,
- Keystone Fusion Games
- Optomatters OPT/cc2
- Stick and straw
- Felt red, green and black bears, while AC wore red/green filters.

Home therapy included using a Lite Bright as described above.

Over the 4-week period, AC binocular status improved to the point that on the last visit she passed the Synthetic Optics Fly. This Randot target subtends stereoacuity levels of 1200 second of arc (wings) to 780 seconds of arc (body). She was aligned with her glasses. Unfortunately, AC was lost to follow-up for the next 5 months. This occurred even with a number of attempts to schedule appointments.
Visit #3: (5 months later, AC is now 3 years 8 months)

AC returned for a progress visit. The chief complaint was that AC’s glasses were broken. This occurred about a month previously, and her mother attempted to hold the glasses together with tape. My impression was that in the last month the glasses were not worn on a consistent basis. The mother reported that AC’s eyes appeared straight even without the glasses. At the time of this visit, AC had a cold and was taking Tylenol. There were no other changes from the child’s previous history. She was not in any school program.

Using the picture chart on the BVAT, AC’s unaided VA was 20/20 OD, OS and OU. Her near unaided VA was 20/40 OD, OS and OU. Dry retinoscopy was +4.00 diopter sphere OD and OS. MEM over this finding was “at most” +0.50 in each eye. Unaided cover test at a distance was 8^ esophoria and at near 10^ esophoria. Using a +4.00 diopter sphere OU, the results were 6^ esophoria at a distance and 8^ esophoria at near. Though accommodative style targets were used, it seemed from these results that accommodation was not completely controlled. Unaided the Keystone Basic Binocular plates 6 and 9 were failed. Seeing that AC was supposedly aligned without any prescription, and she had good unaided VA, a probe prescription of +2.50 diopter sphere was used for the following tests:

Cover test at near with an accommodative target was a small amount of esophoria (not specifically measured)

She passed the 3 Figure test at near and distance
She passed the Worth 4 Dot at near
Near VA was 20/20 in OD, OS and OU.
Assessment and Plan: There had been a marked reduction in hyperopia. AC had good equal VA, and she was aligned with a reduced prescription. Unaided binocular test results did not substantiate her functional alignment. Thus without prescription, she may detune slightly and appear aligned. In the absence of full plus, she seems to be able to function binocularly and stay aligned. Her track record was that of some good accommodative control (implied from her VA, binocular responses in the absence of full plus, and her cover tests) and an ability to function with a partial prescription. Her VA had remained equal in each eye, which implies that in the interim without Rx, she at worst was an alternating esotrope, and at best she maintained alignment and fusion. My impression was that AC certainly had emmetropized some. Though judging from the magnitude of her initial refraction, it would seem highly unlikely that she would completely emmetropize. However, her past history needed to be considered in deriving a new prescription. The following were factors considered:

- Per her mother’s history, AC appeared straight without her glasses, even though the mechanism may have been more of learning to detune than that of gaining clear binocularity,

- With her glued together glasses it seemed unlikely that she could readily use the segment power, thus when she used the glasses she was most likely looked through the distance portion,

- The probe prescription yielded binocular responses,

- If +4.00 spheres was a full amount of plus, then +2.50 spheres would be an under correction of +1.50 sphere. This amount of hyperopia would fall within a normal range of age appropriate hyperopia. Obviously, it effect on alignment needed to be considered.
at this visit the child was at least somewhat debilitated for she had a cold. In this state she would be more likely test at a poorer level,

a thinner pair of glasses was more desirable from both a cosmetic and comfort aspect. As would be expected, her mother preferred thinner glasses.

the child was going to be very closely monitored. A one month follow-up appointment was made, and the mother was instructed to return ASAP if she noted an eye turn.

though AC’s near demand had increased with age, it is not as great and as concentrated as it would be for a school-aged child.

AC was prescribed a +2.50 diopter sphere OU as a single vision Rx to be worn full time. Her mother was advised that if she noticed an eye turn; she should return right away. Otherwise AC was to return for a follow-up visit in 1 month. At this visit alignment, refraction and VA were to be reassessed.

Visit #4: 1month later – AC is 3years 9 months old.

No change in history was reported. The mother reported that AC was aligned with and without the prescription. Aided distance VA using the Thumbling E Chart was 20/25 OD and OS, and 20/20 OU. Aided cover tests were orthophoria at a distance and at near. The near point of convergence had a break at 2 inches. Reach, grasp and release were good and equal in each eye. With prescription in place, AC passed the 3 Figure test and the Worth 4 Dot test at both distance and near. She passed TNO through 480 seconds of arc. She passed all the Wirt Animals and 1-6 of the Wirt Circles. Dry retinoscopy was OU +2.50 = -0.50 x 180. MEM over her glasses (+2.50 diopter sphere) was +1.00.
Assessment and Plan: AC had done very nicely with her new prescription. Her VA was good; she was aligned, and she had improved binocularity. There was no need to alter the prescription. AC was to return in 2 months. This appointment was designed to see if this visit’s findings could be duplicated, and to evaluate progress.

Visit #5: 2 months later – AC is 3 years 11 months

History was unchanged. Aided VA was 20/20 at distance and near with each eye and OU. With her prescription in place, she passed all Randot shapes and Wirt Circles through 40 seconds of arc. Using an accommodative target, she was 5^ esophoria at a distance and 7^ esophoria at near. Her over refraction was +1.00, and the MEM finding over her glasses was +1.00. Using a +1.50 add over her glasses, AC passed Wirt Circles through 25 seconds of arc.

Assessment and Plan: AC has done very nicely. AC had bifoveal stereoacuity with her present prescription. She was aligned with her prescription and had no present history of any deviation. She was still a preschooler and had lesser near demand than she would in the future. Therefore increasing the prescription based solely on stereopsis was not considered essential at this time. She should continue with her existing prescription. She was scheduled for a 3 month-progress visit.

As a note: AC next returned when she was 5 years old. She was still wearing the +2.50 sphere OU prescription. Her aided VA was 20/20 OD, OS and OU at distance and near. Unaided she was 20/20 at a distance. While she was reading the 20/20 line unaided at a
distance, her cover test was orthophoria. One would expect this finding to be esophoria. However, a number of factors might have contributed to this finding, i.e.

1. It was a dynamic test on a 5 year old in which there was an attempt to control accommodation; however, eye movements were involved, and a small amount of esophoria could have been missed.

2. The patient had a low AC/A.

3. Blur interpretation may have played a part, and thus accommodation may not have been completely controlled.

4. A combination of any of the above factors.

Aided cover tests were orthophoria at distance and \(5^\circ\) esophoria at near. Her over refraction was +1.00, and the MEM finding over her prescription was +1.25. Using the MEM finding as an add, she passed 20 seconds of arc. In the future with greater school demands, AC may be in need of an add, or some increase plus in her prescription. Her prescription was now changed to +3.50 sphere OU. The basis for the Rx change was her increasing academic demand, the deleterious potential of an under correction on learning, and the increased binocular performance with the increase in plus. One test, which needed to be done, was another cycloplegic refraction. This had been scheduled a couple of times. Unfortunately, AC had been lost to follow. Though the cycloplegic finding would probably have little effect on the case management, it would have served as a baseline indicator of the amount of hyperopic reduction. Other tests which were not performed, but could have been considered are the Peek-A-Boo or Keystone Skills Series, and prism bar vergences. If the patient hadn’t been lost to follow, these tests would have been done on future visits.
Discussion:

An overview of this case may provide some insights.

1. AC initially had a significant refractive condition. In retrospect the refraction found on the first visit may be questioned; however the finding was also measured by the cycloplegic retinoscopy. This would give the impression that the finding was accurate.

2. AC ability to emmetropize (to the extent she did) was probably in part a function of her flexibility of accommodation. This was probably also the reason for her gaining alignment with a partial prescription. Studies have shown that young children who are hyperopic and esotropic with poor accommodative skills tend not to emmetropize and are in need of full plus to aid binocular alignment. If AC didn’t become aligned with the initial prescription, I would have increased the plus (full plus if necessary) to achieve alignment.

3. One might think that AC was a little old to emmetropize to the extent that she did. Secondly, the magnitude of her refraction was beyond expected limits. However, neither component worked against her.

4. Balanced prescriptions eliminate image size difference and prismatic imbalances; thus equal lens powers were prescribed. Also small cylinders may be fleeting, consequently spherical prescriptions were found to be more desirable.

5. There is the question of how did AC function with the original bifocal? And what mechanism did she use to emmetropize? AC probably used the bifocal initially, but as she gained alignment she probably used it less and viewed from the distance portion
for more and more tasks. Eventually, she used the distance portion for all tasks. When her glasses broke, it would appear as though she did some viewing without a prescription. If her baseline refraction had decreased, being without her glasses for a short period of time may have fostered more emmetropization (effectively she was undercorrected). In viewing the case report, there was a 5-month period of time when she was lost to follow up care. During this period it would appear as though nature and nurture worked together to effect some emmetropization. How she used the glasses served as the vehicle.

6. A cycloplegic refraction would have been very helpful in putting this whole case into a complete package and would have been done had the child not been lost to follow-up care.

7. Though AC is bifoveal with her last prescription, her stereoacuity improves and her near esophoria decreases with an add. Thus with future academics, the near demand would increase, and the need for an add would have been closely monitored.

8. The prescribing of a spectacle prescription is both an art and a science. The doctor needs to be able to balance these two components. Case management will vary from philosophy to philosophy. Some may believe that this case should have been managed with maximum plus and stereoacuity. Others would manage this case with the least amount of plus that would satisfy the patient’s present demand. There are many instances when a prescription is derived solely on visual acuity, and stereoacuity is not measured. AC demonstrated bifoveal stereoacuity with 20 seconds of arc, thus at this point with increasing academic and learning demand the level of the Rx was increased. Though her potential was reached even with a prescription that would be considered an
under correction, the need to maximize her learning potential dictated the increase in plus.

9. This case is highly unusual, and in most instances would not have resulted in the dramatic amount of emmetropization which occurred. Overall this case had a very nice and better than initially expected outcome.