

OPTOMETRIC VISION THERAPY IN THE MANAGEMENT OF CONSECUTIVE INTERMITTENT EXOTROPIA WITH DISSOCIATED VERTICAL DEVIATION AND ANOMALOUS CORRESPONDENCE A CASE STUDY

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ABSTRACT

Consecutive exotropia refers to a manifest exodeviation following surgery to correct esotropia. Surgery is common for early onset esotropia, particularly congenital/infantile esotropia. Congenital/infantile esotropia is usually accompanied by several ocular phenomena, including: latent nystagmus, dissociated vertical deviation (DVD) and overaction of the extraocular muscles, especially the inferior obliques. Additionally, since there is a disturbance in normal binocular vision, anomalous correspondence (AC) is often present. Despite this poor or limited binocularity, interventions to increase fusional ability are possible and should be considered.

We discuss a case of a 12-year-old black female who presented with a moderate angle, consecutive, intermittent, alternating exotropia following bilateral strabismus surgery for congenital/infantile esotropia. Additionally, the patient manifested DVD and AC. Optometric vision therapy, performed in discrete stages, was instituted. It was highly successful in decreasing the frequency and magnitude of the horizontal deviation and in increasing fusional ability despite the presence of a DVD and AC.

KEY WORDS

accommodation, anomalous correspondence, binocular fusion, congenital/infantile esotropia, consecutive exotropia, dissociated vertical deviation, nystagmus, optometric vision therapy, stereopsis

INTRODUCTION

Consecutive exotropia is a manifest exodeviation following surgery to correct esotropia. It is not uncommon among patients presenting for a clinical evaluation of exotropia. Studies have shown the incidence rates of consecutive exotropia to be between 2% and 43%.¹⁻³ The time of onset can occur decades after the initial esotropia surgery.⁴ The magnitude of turn ranges from 5 to 15 degrees at distance and 5 to 20 degrees at near.⁵ Complications can include additional surgeries and further disturbances in preexisting, albeit limited, binocularity.^{4,6}

Surgical procedures, such as medial rectus advancement, medial rectus advancement and resection, lateral rectus recession or combinations of these techniques do not appear to improve the incidence of the exodeviation.⁴ The type of preoperative esotropia is also not found to be a significant factor in the development of consecutive exotropia.⁷ In the past, the following conditions were considered to be contributing factors for the development of consecutive exotropia: the presence of amblyopia, postoperative limitation of adduction, dissociated vertical deviation (DVD), an "A" or "V" pattern, absence of binocularity, and simultaneous surgery for multiple muscles.⁵ However, it has been proposed that major risk factors for consecutive exotropia include only medial rectus limitation and the "A" or "V" patterns.⁴

The "A" and "V" patterns are caused by an overaction of the superior and inferior obliques, respectively. The latter is a common finding in esotropia. Both inferior

obliques tend to be affected and present as frequently as 78% of the time.⁸ This extraocular muscle abnormality, along with latent nystagmus and DVD, are typically associated with congenital/infantile esotropia.⁹ Latent nystagmus and DVD associated with esotropia have been referred to as the congenital/infantile strabismus syndrome.¹⁰ Manifest nystagmus occurs in 10% of congenital/infantile esotropes, while latent nystagmus is seen in 16% of these individuals.¹¹ The Pediatric Eye Disease Investigator Group, however, has reported that only 3% of infants with the onset of esotropia between the ages of 4 and 20 weeks developed latent nystagmus.¹² Postoperatively, Lee et al. found nystagmus to be present in 32% of patients.²

The incidence of DVD associated with congenital/infantile esotropia is high. Von Noorden reported 51%.⁶ Similar occurrences have also been suggested even after surgical correction of the horizontal deviation.⁹ About 50% of the time, the vertical deviation develops by 12 months of age.¹³ The presence of DVD often suggests a failed mechanism of fusion.¹⁴ However, some patients with DVD demonstrate fusion if the method of testing involves stereopsis (third degree fusion), as compared to fusional amplitude testing (such as with an Amblyoscope or second degree fusion).⁹

Anomalous correspondence (AC) is the linkage of two non-corresponding retinal points in the visual cortex to produce a common visual direction. It can be present in congenital/infantile esotropia. AC allows binocular fusion and, in some cases, stereoscopic capabilities.¹⁵ The etiology of AC is unclear. One school of thought states that AC develops as a neural adaptation secondary to eye misalignment.¹⁶

The other school of thought proposes that AC develops from an innate neurological defect, perhaps genetic in nature, resulting in strabismus in early life.¹⁷ The presence of AC can complicate treatment; the most extreme complication is the development of horror fusionalis, an inability to fuse diplopic images when AC is disturbed or broken.

Similar to other forms of exotropia, there is no major consensus on the treatment of consecutive exotropia. Likewise, the success of treatment is defined differently by different practitioners. Ophthalmology generally defines success in terms of cosmesis: A "cure" is indicated when there is alignment of the eyes to within 10 prism diopters (pd) of orthophoria.^{4,9,18} Optometry, on the other hand, defines success on a more functional level. This includes the absence of diplopia, the attainment of clear and comfortable binocular vision, as well as acceptable cosmesis.¹⁹ Getz has suggested success when all levels of fusion and stereopsis have been obtained, and the misalignment of the eyes is less than 15 pd in all positions of gaze, and under all conditions.²⁰ We propose that a definition of success might also include: an increase in visual skills efficiency (increased fusional ranges, accommodative amplitudes and flexibility, accuracy of fixation and pursuit/saccadic eye movements); an increase in stereopsis (on global, local and random dot stereograms); elimination of diplopia and suppression and a decrease in the frequency of turn, and asthenopic symptoms.

The presence of DVD, latent nystagmus, "A" or "V" patterns, and AC associated with the pre-operative esotropia can reduce the success of treatment of consecutive exotropia. The decision to manage it with additional surgeries or with optometric vision therapy (VT) will depend largely on the patient's symptomatology and the function of his binocular system. If the patient is symptomatic with blur, headaches, asthenopia and difficulty concentrating while reading, clinical wisdom would suggest that there might be an accommodative component in addition to the exodeviation. In such cases, both lenses/prisms and optometric VT would be more appropriate. When the exotropia is intermittent, alternating and of small magnitude, prognosis for VT improves dramatically.^{21,22} If there is pre-existing fusion (peripheral fusion, global stereopsis), once again, prognosis improves.²² If there is deep suppression that is present in

all testing performed in-instruments and in free space, the prognosis is guarded. This is because suppression prevents facility of normal binocular fusion. However, suppression is relatively easier to treat than other sensory anomalies.¹⁹ The following case presents and discusses the optometric diagnosis and treatment of a patient with consecutive exotropia.

CASE REPORT History

A 12-year-old, black female presented on September 27, 2006 with complaints of an occasional outward deviation of her left eye. She had undergone strabismus surgery for congenital/infantile esotropia at the age of 11 months. The patient's mother was interested in improving her child's cosmesis, as well as her performance in reading. The patient experienced intermittent near blur, headaches, and difficulty with concentrating and comprehending what she read. She often avoided reading. The patient denied ever experiencing diplopia, but was aware of her eye turn at distance. Glasses had never been prescribed. Both the patient and parent were unable to recall when the symptoms were first noticed. Personal medical history was positive for asthma as an infant. Familial medical and ocular histories were unremarkable. There were no current medications, and no reported allergies.

Clinical Findings

Uncorrected distance visual acuities were 20/25 in each eye. At a nearpoint of 16 inches, acuities were J-1 for each eye. Refraction revealed: OD:-0.50 sphere, 20/20; OS:-.50 sphere, 20/20. Cover testing revealed 15 pd of intermittent alternating exotropia at distance and 20 pd of exophoria at near. The patient also manifested an asymmetric variable magnitude DVD; the OS DVD was greater than that of the OD at distance and near. Extraocular motility assessment revealed significant overaction of both inferior obliques in superior gaze with a corresponding "V" pattern, OU. Randot Stereogram,^a Stereo Fly^a and Wirt Circles^a testing at 16 inches indicated a total lack of stereopsis. Intermittent suppression of the OD was noted beyond 5 feet with the Worth-4-Dot Test^b, but flat fusion was demonstrated when the eyes were aligned at near. Correspondence testing with Bagolini lenses^b revealed the presence of harmonious anomalous correspondence (HAC) at near. When the patient viewed a distant large square of light with a red

filter over one eye, she reported a split field of half red and half white light; this confirmed the presence of AC at distance. Fusional vergence testing, at 16 inches, with the Clown vectogram,^a revealed a very limited range of fusion. There was questionable float, parallax, size and localization awareness. The monocular accommodative amplitudes and monocular accommodative facility with plus and minus 2.00 diopter lenses were moderately below age-normative data.

The pupil reactions were symmetric without an afferent pupillary defect. Internal and external ocular health was unremarkable.

Diagnoses

Based on the surgical history and findings, we made the following diagnoses: consecutive, intermittent, alternating exotropia; DVD; bilateral inferior oblique overaction with a corresponding "V" pattern, and HAC at distance and near.

Management

We recommended 24 sessions of VT to: reinforce and expand the range of anomalous fusional ranges; increase accommodative ability; decrease or eliminate the patient's symptoms of near blur, headaches and reading symptoms. Thus, the goal of therapy was to increase visual efficiency and comfort and decrease the frequency of deviation.

TREATMENT PLAN

The First 10 Weeks of VT

Therapy commenced on October 4, 2006 and consisted of 45-minute weekly in-office visits and 15-minute daily home training. The first five weeks were comprised of: anti-suppression activities; awareness of physiological diplopia; and appreciation of binocular luster and peripheral fusion with Quoit vectograms.^a The next five weeks consisted of convergence enhancement techniques with: Stereo Computer Multiple Choice Vergence,^c large, opaque eccentric circles (base-out);^d Brock String,^b and Clown vectograms.^a Emphasis was also placed on increasing fusional quality (float, localization and SILO). The perception of these properties can confirm reliability on vectogram performance.¹⁹ Home therapy consisted of all in-office therapy except for the vectograms.

First Re-evaluation

At the end of 10 weeks, both the patient and parent reported the decrease in: frequency of deviation and elimination of blur; headaches and difficulty concentrat-

ing. Re-evaluation on January 24, 2007 also showed a decrease in the amount of deviation; there were now 10 pd of intermittent alternating exotropia at distance and between 8 and 10 pd of exophoria at near. Binocular luster was appreciated in all positions of gaze. The patient was able to achieve flat fusion at all distances with the Worth-4-Dot test and up to 140 sec. of arc with the Wirt Circles. The patient was able to elicit prism bar fusional ranges at distance and near at this visit.

The Second 10 Weeks of VT

Techniques during this phase consisted of accommodative rock. These consisted of monocular followed by binocular, then binocular. Techniques to enhance fusional vergence ranges included: utilizing the lifesaver card^d at various near distances; developing vergence flexibility with the use of prism flippers. This entailed reading a sentence through base-in prism, then reading the next sentence through base out prism. The starting point was four base-in and seven base-out, and each was increased by one prism diopter at the next office visit. Other techniques included Base-in and Base-out Van Orden Star,^d Bernell Jump Vergence Cards,^b Computer Multiple Choice Vergence,^c Spirangle and Chicago Skyline Vectograms.^a Integration of the accommodative and binocular systems was done with eccentric circles in conjunction with binocular plus and minus lenses. VT was performed in free-space before moving into instruments. Techniques were performed at near, and gradually moved to distances of greater than 15 inches.

Second Re-evaluation

Re-evaluation on April 11, 2007 (20th session) revealed a further decrease in the amount of deviation (3 pd exophoria at distance and 6 pd exophoria at near) and the presence of a DVD was elicited only with prolonged occlusion. The “V” pattern present at the initial ocular motility testing now required prolonged alternate occlusion to be elicited. The patient was able to demonstrate stereopsis with the Stereofly^a (555 sec. of arc) and 40 sec. of arc with Wirt Circles.^a The patient was able to clear +/-2.00 flippers on accommodative facility OD/OS/OU at age expected levels, maintain fusion of the Chicago-Skyline Vectogram^a up to 15 feet and appreciate stereopsis when large anaglyphic opaque eccentric circles were projected at distances up to of 20 inches. The patient did report a slight distance vision

Tests	Initial Examination	First Re-evaluation (after 2.5 months of VT)	Second Re-evaluation (after 5 months of VT)
CT: Distance Near	15 X(T), DVD 20 XP', DVD	10 X(T), DVD 8-10 XP', DVD	3 XP, DVD 6 XP', DVD
Stereopsis RDS Stereo Fly Wirt Circles	None None None	None None 140" of arc	None 555" of arc 40" of arc
Vergence DBI DBO NBI NBO	Clown Vectogram None, suppression None, suppression None, suppression X/2/1	Clown Vectogram X/J/H, difficulty > 3ft* X/10/8* X/P/L* X/19/15*	Clown Vectogram X/N/K* X/24/22* X/L/J* X/23/16*
Worth 4 Dot	OD suppression > 5ft	Flat Fusion at all distances	Flat Fusion at all distances
Accommodative Facility +/-2.00 OD OS OU	3 cpm, difficulty (+) 4 cpm, difficulty (+) 5 cpm, difficulty and suppression (+)	20 cpm 20 cpm 0 cpm, difficulty (-)	20 cpm 21 cpm 8 cpm

CT=cover test
X(T)=intermittent alternating exotropia
XP'=exophoria at near
DVD=dissociated vertical deviation
RDS=random dot stereogram

DBI=distance base in vergence
DBO=distance base out vergence
NBI=near base in vergence
NBO=near base out vergence, ft=feet
CPM=cycles per minute

*On the Clown Vectogram ranges: X=no blur reported; the letters for the base in findings indicate the break and recovery values, and the greater the letter, the greater the range for each. The numbers for the base out findings indicate the same things.

blur while in the classroom. We prescribed the -0.50 sphere OU for distance viewing only. Table 1 presents a summary of the findings initially and over the course of therapy.

We dismissed the patient and scheduled a reevaluation in three months. Maintenance VT was programmed for the patient, with instructions to conduct the home techniques for 15 minutes on each of five days per week. The goal was to further stabilize the accommodative and fusional ranges and flexibilities that were attained by the VT.

DISCUSSION

Strabismus surgery is performed in an effort to improve binocular alignment and function. There are potential risks and sequelae similar to other forms of surgery. One such risk is overcorrection. It is not uncommon to develop consecutive exotropia after the first procedure to correct esotropia.⁷ Consecutive exotropia is problematic, as it can interfere with bin-

ocular functioning and, in turn, prevent the obtainment of single, clear, comfortable and efficient vision that is cosmetically acceptable.

The time between surgery to correct esotropia and the development of consecutive exotropia can take years. Folk, et al, found that 50% of patients developed postoperative exodeviations one year after surgery and 25% developed exotropia five years after surgery.⁷ Donaldson, et al reported similar results with the mean time of 4.7 years after surgery.⁴

Yazawa suggested the absence of follow up visits after surgery and the “spontaneous decrease of accommodative convergence with age” as possible reasons for delay in the development of consecutive exotropia.¹ However, others reported that development of consecutive exotropia is more likely due to medial rectus limitation and the presence of “A” or “V” patterns.^{7,23}

Griffin and Grisham proposed that there are long term associations in congeni-

tal/infantile esotropia that further contribute to abnormal binocular function.²⁴ These conditions include latent nystagmus, DVD, overacting inferior oblique muscles, and AC. However, the presence of DVD and/or AC does not always preclude fusion. Zak and Morin reported on patients with congenital/infantile esotropia who initially underwent corrective surgery between 5 and 24 months of age. They were corrected to within 10 pd of orthophoria and demonstrated a higher prevalence of fusion. Testing included Bagolini Lenses,^b the Worth-4-Dot Test^b and the Titmus Stereo Test.^a Seventy-two percent of these patients had a DVD.¹⁸ When surgery to correct the esotropia is performed at an earlier age, further loss of binocular vision may be prevented.^{18,25} In the Early vs. Late Strabismus Surgery Study (ELISSS), children who had surgery between the age of 6 to 24 months had better gross stereopsis (Titmus Stereo Fly) at 6 years old than those who had surgery between 32 to 60 months.²⁵ Our patient had surgery to correct congenital/infantile esotropia at 11 months and the magnitude of the postoperative deviation was not known. However, this patient's success at attaining fusion suggests that her postoperative deviation was smaller in magnitude than 15 pd as measured at the initial visit with us. The early surgery and the assumed small angle of deviation were favorable prognostic indicators. The finding of an intermittent exotropia provides a better prognosis because, at some point in time, the eyes are aligned. Other positive prognostic indicators include alternation and small magnitude turn. Alternation indicated that vision in neither eye was compromised since our patient attained 20/20 with each eye. The small angle of deviation is favorable because there is less effort involved to converge a few prism diopters and it is less cosmetically noticeable. Often with esotropia there is AC and impaired binocular fusion due to improper cortical cell development.^{16,26} When there is HAC, the angle of deviation equals that of the amount of change in visual direction. AC provides binocular cooperation. Herzau suggested that AC enables the strabismic patient to see with both eyes simultaneously without diplopia by utilizing both inhibition and anomalous fusion in the interest of the best possible perception.²⁷ He found that in contrast to normal retinal correspondence, AC visual directions are not fixed and can adapt to

spontaneous or post-operative changes to the angle of deviation. This supposedly allows surgeons to correct the strabismus without producing anomalous diplopia. Change can also be produced functionally. VT can alter the visual directions in AC.²⁷ Our patient initially demonstrated intermittent HAC. The first phase of therapy involved developing an awareness of diplopia and increasing fusional vergence ranges. The elimination of the suppression and enhancement of fusional vergence was essential to the development of more normal binocular vision more of the time. As therapy progressed, her need for AC decreased as evidenced by AC testing and the demonstration of lustre.

Treatment of consecutive exotropia can entail additional surgery, VT, or both. Success will depend on pre-existing fusional state and ocular anomalies. Additional surgical correction of consecutive exotropia is not uncommon. Results can vary and multiple surgeries are often required.^{1,4} In one study, 66% of patients developed significant exo-drifts in the first 6 weeks after surgery.⁴

VT has been shown to be highly successful with intermittent exotropia. Ziegler, et al, reviewed six studies where VT alone was used to treat this condition. They found that 62% of these patients achieved functional cure that included: clear, comfortable, single binocular vision present at all distances; the presence of stereopsis; a normal range of motor fusion, and a frequency of turn <1% of the time.²⁸ Galaway, et al, suggested that since the literature demonstrates success with VT, the least invasive of all treatments, it should be considered as the initial approach.²⁹ In a recent article, Yang, et al, reported the attainments of first to third degree fusion and orthophoria at all distances of gaze in a 28-month-old child with consecutive exotropia. The treatment consisted of full spectacle correction, direct patching and optometric VT.³⁰ We elected VT as the treatment plan with our patient because of the positive prognostic indicators.

We recommend that VT should be provided in stages to produce long-lasting, functional cures. Functional cures should significantly relieve associated blur, asthenopia, headaches, and inability to concentrate, as well as decrease the frequency of turn. Goals of therapy may include increasing accommodative amplitudes and facility (monocularly and binocularly), fusional ranges at distance and near, and stereoscopic acuities.

The first stage of therapy should emphasize anti-suppression, the development of lustre and physiological diplopia. The latter two phenomena encourage awareness of both eyes. After several sessions, peripheral fusion with the use of large vectograms such as Quoits^a should be used. Clinically, peripheral fusion is a powerful cue to alignment,³¹ often masking larger deviations, as evidenced by alternate cover testing. The next stage should emphasize convergence enhancement techniques such as eccentric circles, Brock String, and detailed vectograms such as the Clown target.^a We recommend that at this stage, the quality of fusion, entailing float, localization and SILO be stressed. Further therapy can consist of enhancement of accommodative abilities, from monocular to binocular and then binocular. Concurrently, techniques to increase fusional ranges, first at near, then at the intermediate range, and finally at distance, should be conducted. The final stage of therapy should emphasize integration of the accommodative and binocular systems. Techniques should increase fusional demands with plus and minus binocular lenses; e.g., base out with plus lenses, and base in with minus lenses. Therapy should also begin in free-space before moving into instruments. In this manner, the patient moves from the real world to more unnatural environments that require greater control of binocularity.³²

CONCLUSION

Management of our patient with optometric VT was instituted to treat an intermittent, alternating, consecutive exotropia, and found to be highly successful. There was a decrease in the frequency and magnitude of the horizontal deviation, an increase in fusional ability, and elimination of symptoms such as asthenopia and headaches. However, our case describes clinical findings for only one patient. A prospective randomized, controlled study with a larger sample should be investigated in order to shed light on the most effective treatment for complicated consecutive exotropia.

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SOURCES

- a. Stereo Optical Inc.
3539 N. Kenton Ave.
Chicago, IL 60641
- b. Bernell Corp.
4016 N Home St
Mishawaka, IN 46545
- c. Home Therapy System
5301 Superstition Mountain Drive #483
Gold Canyon, AZ 85218
- d. Keystone View (Nevada Capital Group, Inc)
2200 Dickerson Road
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