Article ▸ Where Do Eyes Turn? An Exploration of Non-surgical Methods for the Treatment of Infantile Esotropia

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ABSTRACT

Background: Historically, infantile esotropia was considered to be the result of a congenital muscle dysfunction. More recent evidence shows that the mechanism is in fact a disruption in the development of neural circuitry in the visual cortex occurring around three months of age. Training to inhibit sensory adaptations and to stimulate cortical mechanisms of binocularity becomes essential in the treatment of this condition. Such improvement is achievable by means of vision therapy. Despite this, surgical correction remains the primary treatment option employed.

Case Report: An eight-month-old presented with infantile esotropia. Upon discussion of surgical vs non-surgical treatment options with the parents, a resistance to surgery due to the potential risks associated with the procedure was revealed. Vision therapy became the sole and necessary treatment option. Efficacy and techniques of vision therapy for the treatment of strabismus in infants are discussed.

Conclusion: In certain instances, such as in this case report, there are contraindications or resistance to surgery. Understanding the use of vision therapy as an alternative to surgery is imperative in achieving ocular alignment and binocularity. There is a need for increased awareness in the profession of optometry regarding the mechanism by which infantile strabismus develops and the effectiveness of vision therapy in the infantile population. This awareness can allow better education for patients and parents and can provide a successful alternative to surgical correction.

Keywords: binasal occlusion, infantile esotropia, strabismus surgery, vision therapy

Introduction

Infantile esotropia is an early-onset strabismus presenting prior to six months of age. Although it is an acquired strabismus, the misnomer congenital esotropia is still widely used. It has a prevalence of 1 in 403 live births and accounts for 85% of all cases of strabismus in infants.[1,2] The exact etiology of infantile strabismus is unknown; however, risk factors include family history of strabismus, low birth weight, prematurity, and prenatal hypoxia. Typical presentation is a constant, large angle (>30pd) esotropia with low amounts of hyperopia (<3D); cross-fixation; limited abduction; no or mild amblyopia; monocular pursuit asymmetry; latent nystagmus; and absent or reduced binocular vision. Cross-fixation occurs when one or both eyes view the contralateral visual field. This enables viewing of a target moving across the visual field by switching fixation between the eyes rather than by making abducting eye movements. As a result, there appears to be a limitation in abduction, which may be mistaken for a CNVI palsy. With both eyes being used equally to view the respective contralateral visual fields, the incidence of amblyopia is low (<50% of cases). A bias toward nasalward pursuit movement can be seen in infantile esotropia due to a disruption in the development of the motion pathway.[3] This results in immature temporalward pursuit responses and a persistent favouring of nasalward motion and velocity perception. Associated findings commonly seen after two years of age include latent nystagmus, bilateral inferior oblique overaction, and dissociated vertical deviation.[2]

The sensitive period for the development of cortical binocularity and stereopsis has been established as three months of age.[4-8] This finding has been confirmed in several studies by evaluation of visual evoked responses in infants to random dot patterns. Over the next 15 months of life, the binocular system undergoes a period of rapid development that then slows to a progressive maturation until three years of age.[5,9] The onset of infantile esotropia during the sensitive period at 3-4 months suggests a disruption in the proper development of binocularity. Historically, authors have accepted the etiology to be a motor dysfunction.[3] However, this hypothesis fails to account for why the strabismus presents only at three months old and not at birth, why there is a persistent monocular nasalward pursuit asymmetry, and why motion perception and nystagmus are associated with this condition. Furthermore, Tychsen observed no anatomical extraocular muscle or orbital MRI variations in his investigation of esotropia in monkey subjects.[10] More recent literature considers the cause to be a disruption in the cortical signals for ocular alignment, relating either to a weakened disparity signal or to a heightened motion bias.[3]

Full cycloplegic refractive correction remains the standard of care for any child with strabismus. Additionally, surgical correction of infantile esotropia is presently the most widely used treatment option. The basis of this therapy is rooted in Chavasse's theory that weakened muscles are the cause for the strabismus rather than dysfunctional brain machinery and that surgical realignment is sufficient to re-establish the conditioned reflex for binocular fusion.[11]

Parks built upon this with his finding that binocular fusion is possible as long as the surgeon aligns the eyes within 2.5-5 degrees.[12] This pertains to the degree of disparity at which there is a peak response from neurons responsible for fusion. He also recognized a need for surgery approximately 60 days after the onset of the strabismus, which relates to the period of susceptibility of the binocular system. Many other studies have investigated the age at which surgery should be done to allow for the optimal prognosis for stereopsis. To date, no randomized clinical trials have been conducted. In a non-randomized trial, ELISSS, better stereopsis was reported at 6 years old in those children who underwent surgery between 6 and 24 months of age compared to those between 32 and 60 months of age.[13] However, these results are confounded by higher rates of reoperation and greater degrees of amblyopia in the early surgery group. The failure in achieving optimal surgical results and the need for multiple surgeries, regardless of age of correction, lies in the fact that the etiology of the strabismus is not muscular and is more than a conditioned reflex for fusion.[12] There is a dysfunction in the neural circuitry responsible for binocularity that requires training in order to be stimulated.

Improved knowledge about the cause of infantile esotropia has advanced the use of vision therapy as an alternative treatment. The goal of therapy is to activate the undeveloped sensory processes, rather than working to correct the function of the binocular system as is targeted in cases of later-onset strabismus.[14] In this younger age population, the challenge lies in effectively maintaining the interest of the infant and understanding the responses that are given. Targets of therapy include inhibition of cross-fixation, encouragement of abduction, and increased peripheral awareness. Literature outlining practicable techniques for the non-surgical treatment of esotropia has existed since the 1950s, with a central therapy involving the use of binasal occlusion to inhibit sensory adaptations such as suppression and anomalous correspondence.[11,15] Other exercises, outlined by Press, include abduction calisthenics, occlusion, and peripheral awareness activities, as well as the use of Gingham patterns to sustain cortical binocularity.[13] Literature on the use of vision therapy for infants exists only as case reports, denoting success.`

With the limited discussion in the optometric profession regarding vision therapy for infantile esotropia, surgical correction remains the most widely accepted treatment option. However, in certain cases, such as the one presented, there may be resistance to surgery. Whether for reasons relating to family values, hesitation in the face of the procedure, or patient contraindications to surgery, alternative therapies become mandatory in these cases in order to provide the child with the chance of developing binocularity.

Case Report

An eight-month-old female was referred to the clinic for assessment and management of an occasional right esotropia. A primary care optometrist made the referral with no supplementary referral sent to a pediatric ophthalmologist. The mother estimated that the eye turn began when the child was around three months old, and the turn appeared to occur more frequently when the infant was looking at near rather than at distance. Birth history was normal, the pregnancy was full-term, and birth weight was average. General medical history was unremarkable with no known CNS or systemic abnormalities and no recent history of illness or trauma. There was no family history of strabismus or other ocular conditions. The mother also noted that her child demonstrated the ability to reach and to grasp for objects at near, as well as to recognize faces from across the room.

Visit 1 (Baseline)

Hirschberg testing revealed an intermittent right esotropia at both distance and near. The deviation was present 90% of the time at both distances and was of greater magnitude at near. The patient demonstrated the ability to fix and follow with no apparent muscle restriction or nystagmus. Visual acuity testing by occlusion behaviour revealed a resistance to occlusion of the left eye but not the right, suggesting possible gross amblyopia. Dry retinoscopy revealed +2.50-2.00x090 in the right eye and +2.00-1.50x090 in the left eye. Pupils were reactive to light with no relative afferent defect. Ocular health was unremarkable with no media opacities detected. The patient was asked to return for a cycloplegic refraction to identify whether there was any refractive/accommodative component to the esotropia.

Visit 2

Initial testing at this exam revealed a constant right esotropia of 33pd with no repeatable occlusion resistance, as was observed at the baseline exam. Cycloplegic refraction using 1% cyclopentolate revealed OD: +2.50DS and OS: +2.50DS. With no additional hyperopia found, the diagnosis of infantile esotropia was made. Although no reduction in the magnitude of the strabismus was achieved with correction, full refraction was prescribed based on the concept of clarity of vision. The parents were educated on the condition and the long-term effects that forgoing treatment could have on their child's visual system and functioning, such as reduced depth perception and amblyopia, as well as the cosmetic implications. Treatment options discussed included surgical correction and vision therapy. The effectiveness of each method was outlined. Information was given both verbally in-office as well as in the form of a report that was sent home to the parents. The parents were given the opportunity to review and to discuss the different options and were scheduled for a follow-up appointment in one month.

Visit 3

When the mother returned one month later, she indicated she and her husband had decided to pursue non-surgical

treatment. As part of the vision therapy program that was developed, the patient was fit with binasal occlusion on her current spectacles. With one eye occluded at a time, scotch tape was placed on the front surface of the glasses over the nasal aspect of the lens such that they extended to the nasal pupil margin of the fixating eye. The shape of the occlusion was traced on the tape and then removed and placed on Bangerter foils. The shape was cut out of the foil and placed on the back surface of the patient's spectacle lenses. The mother was educated on the importance of her daughter's compliance with full-time spectacle wear and was encouraged to present targets moving across her daughter's visual field while the glasses were on to encourage abduction and peripheral awareness. An additional home exercise given involved spinning the infant in a chair to stimulate the vestibulo-ocular reflex and post-rotary nystagmus, thereby giving rise to abducting eye movements. Spinning in both directions was advised so that abduction of both eyes would be stimulated.

Visit 4

They returned in one month stating that they had not been compliant with spectacle wear or administering home exercises. The mother noted no improvement in the magnitude or frequency of the deviation. Testing at this exam revealed a constant right esotropia of 40pd with a strong fixation preference for the left eye. Limited abduction of the right eye was also observed. With success inhibited by the evident lack of participation from the patient and the parents, it was advised that a surgical treatment option be considered instead. The parents were hesitant toward surgical correction because she had shown adverse reactions to anaesthesia in the past and they were concerned about the effect that general anaesthesia might have on their daughter, especially in infancy. Given this fact, mother was re-educated on the importance of compliance with the vision therapy program should they choose to forgo surgical correction. Without cooperation there was no hope for improvement of the strabismus. There was an agreement to restart vision therapy. In an effort to improve the infant's compliance, total occlusion for one hour per day was initiated at this examination as an alternative to binasal occlusion. The mother was advised to try patching with either sticker or glasses patches depending on which the infant least resisted. Due to the wait time required for a surgical consult, a referral was made at that time to a pediatric strabismus surgeon. Should there have been no improvement in compliance or with the deviation, surgery might be reconsidered without further wait for a surgical consult.

Visit 5

Compliance with the patching regimen was reported. The mother remarked that when patching was begun, there was almost an instantaneous change in her daughter's behaviour as if she just came to realize that she had the ability to use both eyes. Upon examination, the strabismus was observed to be alternating, with no preference for either eye. Patching was discontinued, and binasal occlusion was restarted in order to ensure continued alternation and to prevent cross-fixation.

At the time of publication, the patient was still undergoing treatment, so no further follow up reports were available. The value of this case is not in its outcome, but in bringing awareness to circumstances when surgery is not the desired treatment option and alternative options must be considered. Another important point from this case is the necessity of proper education of the parents regarding the prognosis of the strabismus to ensure that they are motivated to comply with the therapy program.

Discussion

In most eye care circles, surgical correction is the primary treatment option for infantile esotropia. Studies investigating the optimal age for surgical correction advocate for surgery prior to two years of age in order to achieve better stereopsis.13,16,17 How to manage cases of infantile esotropia properly remains an uncertainty, with reports of reoperation rates up to 69%.2 With the increase in evidence supporting a neurological etiology, vision therapy has expanded in its use as a treatment option for infantile esotropia. Awareness of this alternative treatment is essential, particularly in cases where parents are opposed to surgical intervention.

Occlusion therapy was the primary method used for treatment of the strabismus in this case. Total occlusion of the deviating eye is a temporary treatment method that serves to break down sensory adaptations to the strabismus, such as suppression and anomalous retinal correspondence.15 Diplopia due to misalignment of the visual axes stimulates the development of sensory adaptations in order to eliminate visual confusion. Occlusion prevents diplopia and therefore sensory adaptations by establishing monocular viewing conditions. Binasal occlusion is a modification of this technique where there is selective occlusion of the temporal and foveal retinal areas. This is effective in the inhibition of cross-fixation seen in infantile esotropia. The occlusion may be created using scotch tape, Bangerter foils, or clear nail polish to stipple the lens. Selection of the appropriate method of occlusion should be dependent upon whichever method the child least resists by pulling or scratching off the lens. Application techniques for binasal occlusion vary with the type of strabismus, as well as among professionals. In cross-fixation, the occlusion is most commonly placed such that the temporal edge of the tape bisects the nasal edge of the pupil.15 Greenwald suggests applying asymmetric tape widths in the case of unilateral strabismus, where the fixating eye is occluded to the corneal reflex so that only peripheral viewing is possible.11 The deviating eye develops central viewing with concurrent central-peripheral integration. Over time, as the deviation transitions from constant to alternating and a reduction in the magnitude of the angle is observed,

the tape widths are decreased accordingly. In cross-fixation, where the eyes are used equally, the occlusion may be done unilaterally at first and then extended bilaterally if the infant shows cooperation with spectacle wear.14 Binasal occlusion is administered along with home exercises, where parents are encouraged to present targets moving across the child's visual field in order to stimulate peripheral viewing and to encourage abduction.

Samiguet-Badoche has reported success in the treatment of infantile esotropes less than 18 months old presenting with a constant deviation.15 Badoche employed the use of binasal occluders and daily home exercises conducted by the parents to train ocular motility. The results from his study of 384 patients revealed that 44% had a reduction in their strabismic angle to orthophoria, 15% achieved a cosmetic cure, and 41% required surgery to obtain ocular alignment. Furthermore, a concurrent treatment effect on the amblyopia was observed, with 90% achieving a full restoration in vision, 9% reducing to a mild degree of amblyopia, and 1% not realizing any improvement. Badoche also conducted a similar study including 151 infants less than 12 months old with infantile esotropia and cross-fixation. Seventy-five percent had correction in their strabismic angle and no longer required surgery. In addition, amblyopia was not present in 96% as a result of treatment.

The other treatment used in this case involved spinning the infant in order to stimulate the vestibulo-ocular reflex and thereby to induce post-rotary nystagmus. The rationale for this exercise relates to the undeveloped temporalward motion processing in infantile esotropia.3 Visual motion in infants is hypothesized to be a driving force for ocular alignment, along with visual disparity signals.3 Exotropia is commonly seen in neonates but resolves to orthophoria by three months of age.14 It is postulated that the nasally directed motion bias that is first to develop in infants drives the eyes away from a divergent position. Around three months, the temporalward motion input evolves, creating a balance in the motion pathway, and ocular alignment is achieved. In infantile esotropia, where the temporal motion processing fails to develop, the bias toward nasal motion persists, resulting in a convergent eye position and an opposition to temporalward eye movements. In the infantile esotrope's visual cortex, there is a greater number of nasal retinal inputs, as well as a dysfunction in the ordering of early monocular connections between temporal and nasal field neuron pairs.3 This coincides with the bias toward the nasal retina and nasalward motion. The objective of using this method to stimulate abducting eye movements involuntarily is to increase the neuronal response and connections associated with temporally directed motion in an effort to balance the input from the motion pathway. If balance can be achieved, a reduction in convergence and an increase in abduction may be observed.

The biggest obstacle to success with any vision therapy program relates to patient compliance. If the infant resists spectacle wear or adopts head movements to view around the occluders, or if the parents are not motivated to work with the child, then success is not likely.14 As was seen in this case, there was a lack of compliance on the part of the parents despite significant concern regarding surgery due to a possible adverse effect to anaesthesia. In these cases, incorporating in-office visits once or twice per week is a viable way to ensure that training is completed. Moreover, if the parents lack the confidence to conduct the home exercises, the optometrist or vision therapist can administer the therapy in office. If there is continued non-compliance, however, then surgical correction can be considered to allow the infant to achieve alignment and to develop some degree of stereopsis.

In cases of patient non-compliance with vision therapy, or where surgery is the preferred treatment method by the family, vision therapy should be considered as an adjunct to surgical intervention. Given that the primary dysfunction in strabismus is sensory, exercises to train the sensory aspect of binocular vision may increase success in stabilizing the alignment after muscle surgery. Pre- and post-surgical treatment of amblyopia and sensory adaptations, as well as training of abduction, foveal fixation, and peripheral awareness should be considered.

Conclusion

In the optometric profession, vision therapy is uncommonly used for the treatment of infantile esotropia. This is likely owing to the popularity of surgical correction in our society. However, more consideration must be given to the etiology. A neurological cause, rather than a motor one, has vastly different implications for treatment and prognosis. It is important that optometrists recognize the value of vision therapy as an effective treatment option for infantile esotropia. Presently, only case reports exist denoting the effectiveness of vision therapy for treating infantile strabismus. More research and clinical trials are necessary to reveal the validity and benefits of this treatment option.

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