

# Article • Management of Divergence Excess Exotropia with Overminus Lens Therapy

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## ABSTRACT

**Background:** Intermittent exotropia is an outward misalignment of the eyes that is occasionally manifested when fusional mechanisms are exhausted. It can be preceded by an exophoria and can potentially worsen over time if left untreated. Treatment includes surgical and non-surgical options. Factors to consider in determining the optimal treatment plan may include the patient's age, cosmesis, and binocular status, as well as the frequency and magnitude of the deviation.

**Case Report:** This case illustrates the use of overminus lens therapy as a passive treatment for intermittent exotropia of the divergence-excess type in a three-year-old female. Treatment resulted in stable visual acuities, decreased frequency of the exotropia, and improvement in distance stereoacuity.

**Conclusion:** Overminus lens therapy can be an effective treatment for intermittent exotropia of the divergence-excess type, especially for young patients who may not respond well to other treatment options. Close monitoring of these patients is essential for early treatment intervention with the goal of preserving and enhancing binocular vision.

**Keywords:** divergence excess, exodeviations, intermittent exotropia, overminus lens therapy

## Introduction

Exotropia is characterized by an outward or divergent misalignment of the eyes. This condition is more prevalent in females than males and in areas that are closer to the equator, such as the Middle East, Africa, and Asia.<sup>1,2</sup> Exodeviations can vary in the age of onset; however, 30-75% of the time, they occur within the first few years of life.<sup>3-6</sup> It should be noted that transient exodeviations are common in normal infants and usually resolve by 4-6 months of age.<sup>7,8</sup> The most common type of exotropia is an intermittent exotropia, in which the exodeviation is only manifested part of the time. Many parents of children with exotropia will report that "something looks off" with their child's eyes or the child looks like they are daydreaming when looking off in the distance. Symptoms may include asthenopia,

photophobia, and diplopia. These symptoms can be exacerbated by fatigue, inattention, or illness. Some children will be asymptomatic, especially if the frequency of the deviation is low or the deviation occurred at an early age when sensory adaptations develop. Due to the intermittent nature of this strabismus, many of these patients still have good binocularity and stereoacuity at near. For younger patients, parents and clinicians may choose to postpone surgical intervention until the patient is older and more accurate measurements of the deviation can be obtained.

## Case Report History

CF was a three-year-old white female who enjoyed dancing and playing soccer. Her mother brought her in for an evaluation due to the

concern of CF's "eyes turning out sometimes." Onset was about two years prior, when CF's mother noticed her daughter closing her right eye in bright light and her father noticed an associated outward eye turn of the right eye. The mother also noticed her daughter closing her left eye occasionally but not as often as the right. The mother estimated the frequency of the eye turn to be about 10-20% of the time with fair cosmesis. When CF's parents noticed an outward eye turn, they would tell their daughter to "use both eyes," and CF would immediately "fix her eyes so they looked straight." CF's last comprehensive eye examination was more than one year before with an ophthalmologist. A review of faxed medical records indicated a cycloplegic refraction of +0.50DS OU and normal ocular health findings OU. Alternating exotropia was also diagnosed at that visit, and 2-4 hours of alternate patching every day was prescribed. She was followed every 2 months by the ophthalmologist for about a year. At her last visit with the ophthalmologist, patching was discontinued, and it was recommended that she have "R+R" (unilateral medial rectus muscle resection and lateral rectus muscle recession) surgery of the right eye. CF's mother did not want to pursue surgery at that time. The mother reported that patching seemed to decrease the frequency of her daughter's eye turn, but it did not completely resolve at the cessation of patching therapy. She expressed an interest in finding an alternative treatment for her daughter's intermittent outward eye turn in hopes of postponing or eliminating the need for surgery.

CF's ocular history was significant for a resolving stry that was currently being treated by her pediatrician with Maxitrol ophthalmic ointment. She was not taking any other medications aside from vitamins, and no known drug allergies were reported. She was reported to be in good health with no current medical conditions. The family ocular history included cataracts, glaucoma, macular

degeneration, and unspecified vision loss. The family medical history included allergic disorders, arthritis, cancer, high cholesterol, diabetes, hypertension, and migraines.

### **Diagnostic Evaluation**

CF's uncorrected distance visual acuities were 20/25 OD and 20/25 OS. Uncorrected near visual acuities were 20/30 OD and 20/30 OS. Visual acuities were measured with HOTV, single letter with crowding-bar presentation at distance and HOTV at near. Dry retinoscopy revealed refractive errors of plano-0.50x160 OD and +0.25-0.50x010 OS. Objective near point of convergence was found to be 6cm. Cover testing revealed >45 prism diopters constant alternating exotropia with no observed preference in fixation at distance and 20 prism diopters intermittent (10%) comitant right exotropia at near. Objective prism bar fusional vergence ability was found to be 12 BI and 12 BO at near. During Worth 4-Dot testing, the patient reported seeing 4 dots at near, suggesting normal fusion, and 2 red dots at distance, suggesting OS suppression. She also appreciated 100" of lateral disparity and 250" of random dot stereopsis with the Randot stereo test at near. The Lang II stereo test was also performed at near, with patient appreciation of 200" of random dot stereopsis.

Due to patient fatigue, she returned for a cycloplegic refraction and the completion of her ocular health evaluation at a second visit a week later. Entering visual acuities at this visit were 20/25 OD and 20/25 OS. Extraocular muscles were unrestricted in all fields of gaze OU. Confrontation fields were full to finger counting OU. Pupils were equal, round, and reactive to light in both eyes with no afferent pupillary defect. Digital pressures were soft and equal OU. Slit lamp evaluation of the anterior segment was significant for a small, elevated, round lesion on the upper left eyelid margin. No discharge, tenderness, or hyperemia was noted. Bulbar conjunctiva

was white and quiet OU. Corneas were clear OU. Irides were brown and flat OU. Anterior chambers were deep and quiet with grade 4 angles OU based on Van Herick estimation. Two drops of 1% cyclopentolate and one drop of 1% tropicamide were instilled, each 5 minutes apart, to perform a cycloplegic refraction and dilated fundus exam. Wet retinoscopy was performed 30 minutes later and revealed a manifest refraction of +0.75-0.50x010 OD and +0.75-0.75x150 OS with no change in acuity. Fundus examination was performed using a slit lamp and a 90D lens, as well as by binocular indirect ophthalmoscopy. The posterior segment was found to be healthy with no pathology and showed fully intact peripheral retinas OU.

CF's primary diagnosis was exotropia (constant alternating exotropia at distance and intermittent right exotropia at near) of the divergence-excess type. She was also diagnosed with a resolving external hordeolum on the upper OS eyelid. It was recommended that she continue treatment and follow-up on the hordeolum as instructed by her pediatrician and to report any changes. The eyelid lesion was expected to be self-limiting. Although her entering visual acuities were 20/25 OU instead of 20/20, this was considered to be a normal visual acuity response based on the patient's young age, unremarkable patient history, and good ocular health findings from her examination.

The patient's mother was counseled on possible treatment options for intermittent exotropia, which included prism, patching therapy for anti-suppression, vision therapy, overcorrecting minus lenses, and surgical correction. The mother reported a plateau response to patching therapy and did not want to pursue surgery at that time. Since CF's deviation was intermittent in nature and she exhibited good binocularity at near, immediate surgical correction was not mandatory. Although vision therapy can help improve

fusional vergence ability, the prognosis of vision therapy at her young age was guarded due to poor reliability of subjective responses and understanding of therapy techniques. Due to the large magnitude of her distance deviation, correction with prism spectacles was not elected at the time. Her mother consented to instituting overminus lens therapy for her daughter, with the goal of decreasing the frequency of the exodeviation and maintaining binocularity.

The following overminus lenses were trialed in-office and prescribed for full-time wear:

OD: -2.00 DS    DVA 20/25    NVA 20/30  
OS: -2.00 DS    DVA 20/25    NVA 20/30

Initial cover testing with the overminus lenses revealed >45 prism diopters constant alternating exotropia with no observed preference in fixation at distance and 18 prism diopters intermittent (10%, OS preferred) alternating exotropia at near. As it may take time for the patient to adapt to the new accommodative demands of the lenses, a one-month follow-up visit was recommended to determine the effectiveness of treatment. CF's mother was also instructed to bring her daughter back earlier if symptoms or worsening of the deviation was noticed.

### **Follow-up Visit 1 (One Month After Initiating Treatment with Overminus Lenses)**

Good compliance with spectacle lens wear was reported. CF's mother did not notice any change in the frequency of the eye turn, and no symptoms were reported. Entering visual acuities with the overminus lenses remained stable, with distance visual acuities of 20/25 OD and 20/25 OS. Near visual acuities were 20/30 OD and 20/25 OS. Initially, objective near point of convergence was found to be to the nose. After 5 attempts, near point of convergence receded to 4 centimeters; no diplopia was reported. Cover testing revealed

>45 prism diopters intermittent (80%, no fixation preference noted) alternating exotropia at distance and 12 prism diopters exophoria at near. During Worth 4-Dot testing, CF reported seeing 4 dots at near, suggesting normal fusion, and 3 green dots at distance, suggesting OD suppression. Random dot stereopsis was found to be stable with appreciation of 250" with the Randot stereo test at near and 200" with the Lang II stereo test. CF was also able to appreciate up to 100" of random dot stereopsis with the distance Randot stereo test. Although CF's mother did not notice any change in the frequency of her daughter's exotropia, examination findings indicated a positive response to the overminus lens therapy. It was recommended that CF continue with full-time wear of her overminus lens spectacles. Her mother was informed that her daughter might be weaned off the overminus correction in the future and might be a good candidate for vision therapy as she matured. Instructions were given to bring the patient back in three months for a follow-up visit and to return earlier if symptoms or worsening of the deviation was noticed.

### **Follow-up Visit 2 (Four Months After Initiating Treatment with Overminus Lenses)**

Good compliance with spectacle lens wear was reported. No significant change to CF's personal eye or medical history was reported. Her mother stated that she seldom observed an eye turn except when her daughter was tired. CF's mother felt that the frequency of the eye turn was "not worse or better" from her previous visit. Entering visual acuities with the overminus lenses remained stable with distance visual acuities of 20/25 OD and 20/25 OS. Near visual acuities were 20/20 OD and 20/25 OS. Initially, objective near point of convergence was found to be to the nose. After 5 attempts, CF's near point of convergence receded to 3 centimeters; no diplopia was reported. Cover testing revealed >45 prism

diopters intermittent (75%, OS preferred) alternating exotropia at distance and 14 prism diopters exophoria at near. During Worth 4-Dot testing, CF reported seeing 4 dots at near, suggesting normal fusion, and "flashing" between 3 green dots and 4 dots at distance, suggesting intermittent OD suppression. Random dot stereopsis was found to be stable with appreciation of 250" with the Randot stereo test at near and 200" with the Lang II stereo test. She was also able to appreciate up to 60" of random dot stereopsis with the distance Randot stereo test. CF's mother was counseled on her daughter's continual positive response to the overminus lens therapy in stabilizing her intermittent exotropia. Her visual acuities remained stable, and improvements in distance stereoacuity were noted. As long as no deterioration of CF's vision or binocularity was detected, it was recommended that she continue to wear her overminus spectacles full-time and continue to practice gross convergence activities at home. Her mother was counseled on the importance of close, long-term monitoring of her daughter's intermittent exotropia. It was recommended that she continue to be monitored in three-month intervals and to return earlier if symptoms or worsening of the deviation was noticed. The possibility that her daughter might be weaned off the overminus correction in the future and might be a good candidate for vision therapy as she matured was reiterated.

### **Discussion**

The primary cause for the development of exotropia is debatable, with abnormal sensory, motor, anatomical, or innervational factors being considered.<sup>3</sup> Some theories suggest that exodeviations occur due to an imbalance between mechanical and innervational factors that disrupt convergence and divergence mechanisms (i.e., excessive tonic divergence or insufficient convergence innervation).<sup>3,4,9</sup>



Intermittent exotropia can comprise up to 85% of all exotropias and is commonly preceded by a stage of exophoria.<sup>3,10</sup> According to Burian's classification system, intermittent exotropia can be further categorized into four groups: (1) convergence insufficiency when the near deviation is greater than the distance deviation by 10 diopters or more, (2) basic intermittent exotropia when the near and distance deviations are within 10 diopters of each other, (3) divergence excess when the distance deviation is greater than the near deviation by 10 diopters or more, and (4) simulated or pseudo-divergence excess when the patient initially manifests a divergence excess deviation but later exhibits a basic intermittent exotropia after 30-60 minutes of monocular occlusion.<sup>11</sup> Our patient was diagnosed with intermittent exotropia of the divergence-excess type, which is most commonly diagnosed in children.<sup>3</sup>

Based on reported symptoms of an exodeviation, a possible differential diagnosis to be considered was Duane's syndrome, which has been categorized into three types: I, II, III. The most common is type I, in which the patient would exhibit limited or no abduction, possible slight restriction in adduction, globe retraction and palpebral fissure width narrowing of the affected eye. In contrast, type II would exhibit limited or no abduction with possible slight restriction in abduction. Type III would involve restrictions in both abduction and adduction. Many patients with Duane's syndrome could appear non-strabismic in primary gaze but strabismic in lateral gazes. This condition occurs more frequently in the left eye than the right and is more prevalent in females than males.<sup>12</sup> Our patient did not exhibit any of the characteristics consistent with Duane's syndrome during our examination.

Significant uncorrected refractive error was also ruled out in this case. Patients with uncorrected myopia would have a decreased

accommodative demand at near, leading to less accommodative convergence. This understimulation of convergence can be associated with the development of an exodeviation, according to Donders.<sup>13</sup> In cases of uncorrected hyperopia, it is important to take into account the patient's age, the amount of hyperopia, and the patient's AC/A ratio when deciding on treatment. Correction of low amounts of hyperopia in patients with high AC/A ratios may lead to an increase in the exodeviation due to a decrease in accommodative demand and thus a decrease in accommodative convergence. Correction of moderate to high amounts of hyperopia ( $\geq 3D$ ) has been shown to cause resolution of intermittent and constant exotropia in a case study on seven exotropic children.<sup>14</sup> In these cases, the cause of the exodeviation was attributed to poor accommodative effort or sustainability of the accommodative demand needed to compensate for the hyperopia, resulting in image blur. Uncorrected anisometropia or astigmatism may also contribute to the development of exodeviations since it can cause unequal or blurred retinal images, leading to an impediment to binocular fusion.

Patients with intermittent exotropia may present with or without symptoms. Common symptoms include transient diplopia, asthenopia, and photophobia or monocular squinting in bright sunlight.<sup>15,16</sup> These symptoms could potentially have an adverse effect on a child's behavior or academic performance. Fortunately, most patients with intermittent exotropia are asymptomatic.<sup>17</sup> Many of these patients develop sensory adaptations early in childhood, such as suppression or covariation in retinal correspondence, in order to avoid diplopia. A patient who covaries will exhibit normal retinal correspondence when they are phoric and anomalous retinal correspondence when they are tropic.<sup>17</sup> Due to the intermittent nature of this condition, most patients will still have good binocularity and stereoacuity

part of the time, usually at near, and good monocular acuities.

Treatment for intermittent exotropia may include surgical intervention, botulinum injections, prism, part-time patching therapy, vision therapy, or overminus lens therapy. Surgical intervention or botulinum injections may be warranted if there is poor cosmesis, worsening of the angle, an increase in frequency of the deviation, or a compromise to binocularity and less-invasive treatments are unsuccessful. The main concern with the first several options is the possibility of developing monofixation syndrome from consecutive esotropia, leading to the loss of binocularity.<sup>12,18</sup> Part-time patching therapy may be prescribed as a form of passive anti-suppression treatment. If there is a fixation preference, 4-6 hours of patching of the dominant eye can decrease the frequency of the exotropia.<sup>19</sup> If there is no fixation preference, alternate patching is usually prescribed, and the patient is monitored closely, commonly in 2- to 4-month intervals, in order to check for improvement. If no improvement is noted, patching is usually discontinued.<sup>3</sup> Prescribing base-in neutralizing or relieving prism can help to increase binocular fusion.<sup>20,21</sup> It is often combined with vision therapy, and the prism power is usually titrated as convergence ability improves. About a 28% success rate has been reported for prism therapy, with better responses in patients manifesting 20 prism diopters or less of exotropia.<sup>21,22</sup> It is a temporary solution that is usually preceded by surgical intervention or orthoptics. Orthoptics or vision therapy is an active treatment aimed at improving a patient's control over their deviation and enhancing sensory fusion ability. Techniques may include diplopia awareness training and various convergence exercises. Vision therapy requires a significant time commitment and may be more effective for patients who are motivated and mature enough to understand

and perform the therapy techniques. About a 59% success rate has been reported with orthoptics, a limited aspect of vision therapy.<sup>22</sup> An alternative passive treatment option for intermittent exotropia is overminus lens therapy. The basis of this treatment is that the minus lenses increase accommodative effort, leading to an increase in accommodative convergence, thus decreasing the angle of exotropia. Due to the underlying principle behind this treatment, it may work best in patients with a high AC/A ratio and normal accommodative function. Although the influence of minus lenses on the development or progression of myopia has been a topic of concern, previous studies have suggested that there is no significant difference in refractive error changes between patients treated with overminus lenses and those without.<sup>23-25</sup> As much as 52% success rate has been reported with the use of overcorrecting minus lenses to treat intermittent exotropia of the divergence-excess type.<sup>23</sup>

The primary visual goal for treatment of intermittent exotropia is the preservation and enhancement of binocularity. Close monitoring is important in order to detect changes early so that treatment interventions can be initiated if necessary. The distance Randot stereo test can be a useful tool for monitoring patients with intermittent exotropia of the divergence-excess type. Appreciation of distance random dot stereopsis can help to confirm the frequency of the exodeviation, as well as to measure changes in binocular status. In general, the prognosis for intermittent exotropia is good. The frequency of the exodeviation may increase with time if left untreated, but fusion is usually maintained.<sup>3,26</sup> A study done by Von Noorden found that over a 3.5-year follow-up period, 75% of 51 untreated patients showed progression, 9 % stayed the same, and 16% improved.<sup>1</sup>

## Conclusion

Overminus lens therapy can be an effective treatment for intermittent exotropia of the divergence-excess type, especially for young patients who may not respond well to other treatment options. Close monitoring of these patients is essential for early treatment intervention with the goal of preserving and enhancing binocular vision.

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