Exotropia in Pediatric Patients

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ABSTRACT

Purpose: The purpose of this study is to determine the clinical characteristics of pediatric (under age 13) patients with exotropia in terms of deviation magnitude, frequency, associated systemic and ocular conditions, and treatment options.

Methods: A retrospective chart review of pediatric patients with the diagnosis of exotropia, examined in the ophthalmology department of a children’s hospital over a one year period, was conducted.

Results: The yield was 787 charts, of which 403 had complete data. The primary reason for examination was eye turn noted (68%). The most common systemic condition associated with exotropia with was attention deficit/hyperactivity disorder (4%) and the most common ocular condition was retinopathy of prematurity (3%). The average deviation was 18.6 prism diopters at distance and 14.9 prism diopters at near. The majority of cases were managed by observation, followed by patching and surgery.

Conclusions: Exotropia is a binocular condition that may exist in isolation or in association with systemic conditions. Most cases in this study involved intermittent deviations. Further studies, including longer periods of observation and treatment are needed to determine the natural course and most appropriate clinical management.

INTRODUCTION

There are a limited number of studies in the optometric and ophthalmic literature regarding the clinical characteristics of pediatric exotropia. Some of these studies deal primarily with the classification of exotropia and oculomotor findings, while others also include information on refractive status and stereopsis. Other studies include information on systemic and ocular conditions. However, all studies are not without limitations. For example, some studies do not specify patient ages, while others are limited in data collection because of patient age.

The purpose of this study is to determine the clinical characteristics of pediatric (under age 13) patients with exotropia in terms of deviation magnitude, frequency, associated systemic/ocular conditions, and treatment options.

METHODS

A retrospective review of charts for patients under the age of 13 seen in the pediatric ophthalmology department of Cincinnati Children's Hospital Medical Center,
and diagnosed with exotropia, based on the following on ICD-9 codes, was conducted:

- 378.00 Exotropia
- 378.10 Divergent Strabismus
- 378.11 Monocular Exotropia
- 378.12 Monocular A Pattern Exotropia
- 378.13 Monocular V Pattern Exotropia
- 378.14 Monocular X or Y Pattern Exotropia
- 378.15 Alternating Exotropia
- 378.16 Alternating A Pattern Exotropia
- 378.17 Alternating V Pattern Exotropia
- 378.18 Alternating X or Y Pattern Exotropia
- 378.20 Intermittent Exotropia
- 378.23 Intermittent Monocular Exotropia
- 378.24 Intermittent, Alternating Exotropia

Systemic conditions were determined based on a review of system form filled out by the parent during the history and entered into the chart notes. Ocular conditions were determined based on a review of ocular diagnoses included in each patient’s chart. Refractive error was determined by cycloplegic refraction performed by the optometrist or ophthalmologist. For this study, classification of refractive error was based on that used in the Orinda Study, with some additions:

- Clinical Emmetropia -0.25 to +1.25 (includes astigmatism ≤ 1.00)
- Hyperopia ≥ +1.50 (includes astigmatism ≤ 1.00)
- Myopia ≥ -0.50 (includes astigmatism ≤ 1.00)
- Astigmatism ≥ 1.00 (includes hyperopia <+1.50 and myopia <-0.50)
- Anisometropia ≥ 1.00

Additional classifications included: hyperopia with astigmatism, myopia with astigmatism and pathologic myopia ≥6.00.

Visual acuity was assessed by recognition acuity: either Snellen or HOTV/Lea symbols. The acuity charts were presented on an M&S System (M&S Technologies, Niles, IL), which were calibrated for a 20 foot exam lane. A matching card for the Lea Symbol and HOTV tests was available, if needed. If visual acuity could not be assessed with an acuity chart, assessment was based on fixation preference: central, steady, maintained (CSM) or fixate and follow (F&F).

Measurement of the deviation was performed with cover testing and measured with prisms, either loose or bar, based on practitioner preference. If cover testing could not be performed, Hirschberg or Krimsky was used. The method of testing was not always noted in the chart. Data were only included
in this study where measurements at distance and near were recorded. Measurements were performed by a Certified Ophthalmic Assistant or Technician (COA or COT) or the attending doctor. In cases where the doctor assessed the deviation, those measurements were recorded for this study, otherwise, the COA’s or COT’s measurements were recorded.

Prior surgeries were determined by surgical history, as documented in the chart. For surgeries performed at the hospital, surgical reports were available for review. In cases where surgery was performed at an outside hospital, the records may or may not have been included in the chart. If the records were not available, the reason for the strabismus surgery was recorded as “unknown.”

RESULTS

Subjects

Over a one year time period, 787 patients with exotropia were examined. Of the 787 patients, 668 charts were available for review. Of those, 403 had complete data. Forty eight percent of patients were male and 52% were female. The average patient age was 6.5 years. The majority of the patients (195) were examined by an ophthalmologist only, 166 by an optometrist only, and 42 by both an optometrist and an ophthalmologist. Per department protocol, patients aged 3 and under were examined exclusively by ophthalmologists. See Figure 1 for a breakdown of patients by age.

Reason for Exam

Evaluation of an eye turn noted by the caregiver or pediatrician was the primary reason for the exam in 260 patients. In these cases, there was no complaint of blurry vision. In 110 cases, the children were seen for a failed vision screening either at school or at the pediatrician’s office, but the reason for referral was not noted in the report, and the caregiver was not aware of the reason for the referral. In these cases, the caregiver and patient did not notice an eye turn. In 12 cases, the primary reason for the examination was evaluation of an eye turn and blurry vision, and in another 18 the reason for examination was for evaluation of blurry vision alone. There were 3 patients who presented with unique complaints: 1 each with diplopia, head tilt and reading problems.

Table 1: Reasons for eye exam

<table>
<thead>
<tr>
<th>Reason for Exam</th>
<th>Number of Patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye turn noted*Includes 12 patients who also complained of blur</td>
<td>272</td>
<td>67.5%</td>
</tr>
<tr>
<td>Failed vision screening – no eye turn noted</td>
<td>110</td>
<td>27.3%</td>
</tr>
<tr>
<td>Burry vision only</td>
<td>18</td>
<td>4.5%</td>
</tr>
<tr>
<td>Other (double vision, head turn, reading problems)</td>
<td>3</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

Symptoms

Secondary symptoms were not consistently recorded in the patient record and, as such, are not included in the analysis. Secondary symptoms were recorded in the charts of only 2 of the optometrists. The most common symptoms included diplopia in 23 patients, headaches in 13 patients, head turn in 13 patients, and closing one eye/blinking in 6 patients. Other secondary symptoms included: “reading problems” (3 patients), eye pain (2 patients), and clumsy/poor depth perception (2 patients). The following symptoms were reported by one patient each: letters move when reading, tired with near work, problems copying from the board and light sensitivity.

![Figure 1: Breakdown of Patients by Age](image-url)
Systemic Conditions
The most common systemic condition was attention deficit disorder with or without hyperactivity (ADD/ADHD) in 18 patients, brain injury (from non-accidental trauma/“shaken baby,” brain surgery, brain tumor, and cerebral vascular accident) in 17, and developmental delay/autism spectrum disorder (ASD) in 17. Twelve patients had Cerebral Palsy (CP), while 7 had seizures. See Table 2 for a complete list of systemic conditions.

Table 2: Systemic Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Number of Children</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain Injury (Includes shaken baby)</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>ADD/ADHD</td>
<td>18</td>
<td>4.5</td>
</tr>
<tr>
<td>Developmental Delay/ASD</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Seizures</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Cerebral Palsy (CP)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Syndromes**</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Learning Disability**</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Maternal Drug/ETOH abuse</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Chromosomal anomaly (e.g. deletion, duplication)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Hearing loss</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Craniostenosis</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Chiari Malformation</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Hypotony</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Spina Bifida</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Non-Hodgkins Lymphoma</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Neurofibromatosis Type 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mental Retardation</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Torticollis</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hydrocephalus</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Sickle Cell Anemia</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Achondroplasia</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

** Syndromes included 2 CHARGE, 2 Trisomy 21 (Down), 1 each of Pierre-Robin and VATER
*** Includes 1 apraxia, 1 dyslexia

Table 3: Ocular Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Number of Children</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROP</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Nystagmus</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Cataract/prior cataract surgery</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Pathologic Myopia</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Optic Atrophy</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Retinal Trauma*</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Duane’s Retraction Syndrome</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Optic Nerve Anomaly</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Glaucoma</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Coloboma (includes 1 CHARGE)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Albinism</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cortical Visual Impairment (CVI)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>S/P Retinoblastoma Treatment</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Aniridia</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Toxoplasmosis</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Persistent Fetal Vasculature/ Persistent Hyperplastic Primary Vitreous</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Retinitis Pigmentosa</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Marcus Gunn Jaw Winking</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

* Includes: macular scar (2), RD/ruptured globe (2), macula hole (1)

Ocular Conditions
The most commonly encountered ocular conditions included retinopathy of prematurity (ROP) in 14 patients, nystagmus in 12, pathologic myopia in 7, cataract or prior history of cataract in 7 and optic atrophy in 6. Five patients had a history of retinal trauma. See Table 3 for a complete list of ocular conditions.

Refractive Measurement
Each eye of each patient, a total of 806 eyes, was assessed for refractive error. The majority of eyes, 259, had clinical emmetropia, followed by hyperopia and astigmatism in 167 eyes, and hyperopia in 163 eyes. Low myopia was present in 96 eyes, while myopia with astigmatism was present in 49 eyes and high myopia in 12 eyes. Mixed astigmatism was present in 43 eyes. Astigmatism alone was present in 17 eyes. Anisometropia, greater
than 1 diopter, was present in 71 children. See Figure 2 for a distribution of refractive error.

Visual Acuity

Visual acuity was unable to be assessed with recognition acuity in 69 children. Of these 69 children, asymmetric acuity was suspected in 9. Of the 334 able to be tested with recognition acuity, visual acuity was 20/30 or better in both eyes in 224 children, 20/30 or better in one eye and between 20/40 and 20/80 in the other eye in 55 children (3 due to ocular pathology in the poorer seeing eye), 20/30 or better in one eye and worse than 20/100 in the other eye in 11 children (8 due to ocular pathology in the poorer seeing eye). There were 22 patients (44 eyes) with bilateral decreased acuity of 20/40 or worse; 10 of these patients had decreased vision due to ocular pathology. Eliminating the cases where the decreased acuity was due to an organic cause, 15.5% of patients had moderate amblyopia and 1% had severe amblyopia. Just under 4% had bilateral amblyopia.

Deviation

The average distance deviation was 18.58 prism diopters (range orthophoria to 53 prism diopters) and the average near deviation was 14.85 prism diopters (range orthophoria to 60 prism diopters). The type of deviation was classified based on the difference between the near and distance deviations. Using the criteria of a deviation > 10 prism diopters difference from distance to near, the following categorizations were used: divergence excess, basic and convergence insufficiency. Practitioners did not differentiate a “true” from a “pseudo” divergence excess. In 276 patients, the deviation was intermittent. There were 212 patients with basic exotropia, followed by 136 with divergence excess and 55 with convergence insufficiency.

For both distance and near deviations, the greatest magnitude of exotropia was found in infants under the age of 1. For this age group, the average distance deviation was 27.71 prism diopters and the average near deviation was 25.71 prism diopters. There were 7 patients in this cohort. Only 2 patients had a constant deviation. None of these 7 patients had any ocular or systemic conditions. Of the infants, 1 patient had 2 surgeries during the time of this study (initially for esotropia and subsequently for exotropia), and 1 patient had surgery planned.

If all data from this age group are analyzed, including looking at incomplete data, the cohort included 31 infants under the age of 1. For 24 of these infants, the data were incomplete, in that cover test was not obtained at both distance and near. Of these excluded 24 infants, 8 patients had a history of ROP and 4 had neurological/developmental conditions (2 hydrocephalus, 1 Fetal Alcohol Syndrome and 1 Optiz Syndrome). Thus, 39% of the total infant cohort had either an ocular or neurodevelopmental condition. Of these 24 infants, 7 were noted to become orthophoric during the follow up period (range 2-7 months).
The smallest magnitude of deviation at distance was found in the 10 year old patients (average deviation 14.90 prism diopters). The smallest magnitude of deviation at near was found in the 2 year old patients (average deviation 12.42 prism diopters). In all age groups, except 8 year olds, the average distance deviation was greater than near.

**Prior Surgeries**
A history of prior strabismus surgery was reported by 72 patients. There were a total of 106 prior surgeries, for an average of 1.47 surgeries per patient. The number of prior surgeries ranged from 1 to 6. Of the prior surgeries, 44, were for esotropia, 41 for exotropia, and 5 for a vertical deviation. One patient had strabismus surgery for a cranial nerve VI palsy and another for a slipped muscle. In 14 patients, there was no information on the type of prior strabismus surgery.

**Treatment**
The majority of patients, 211, were treated with observation, followed by patching for anti-suppression in 80, surgery in 65, and prescription glasses in 45. Surgery was planned but not performed during the year of the study in 38 patients. Over minus lenses and vision therapy each were prescribed for 17 patients, and atropine for 14. In some cases, patients were treated with multiple methods.

**DISCUSSION**
In cases of childhood strabismus, studies have found that exotropia is less common than esotropia.\(^3\,^9\) Mohney looked at the medical records of all patients with strabismus under the age of 19 in Olmsted County, Minnesota.\(^3\) Approximately 33% had exotropia. Of those with exotropia, 51.7% had intermittent, 19.5% had convergence insufficiency, 14.6% had “abnormal central nervous system,” 8.2% had sensory, 3.9% had paralytic, and 1.9% had another form, which included 1 congenital. In another study over a 6 year period, Mohney & Huffaker found that the most common forms of exotropia were intermittent (42.7%), followed by central nervous system defects (21.3%), convergence insufficiency (11.5%), sensory (10.2%), undetermined (4.3%) and paralytic, congenital or resolving neonatal, all 2% or less.\(^4\) In the latter study, patients were primarily from rural Appalachia.

Mohney uses the term “abnormal central nervous system exotropia” to refer to exotropia in patients with documented neurological

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**Figure 4: Deviation by Age**

**Figure 5: Prior Strabismus Surgery by Deviation Type**

**Figure 6: Treatment Options**
abnormalities such as Cerebral Palsy, developmental delay, hydrocephalus, and autism. However, most text books do not make this differentiation, but do report that in cases of neurological disease, exotropia can present as a variable and constant deviation.

When looking at neonates, the ratio of exotropia to esotropia has been found to be 10:1. Other studies have found that 67% of infants under 10 months of age have exotropia. Still others report that exotropia is rare in infants without neurological or craniofacial defects. In children aged 1-2.5 years esotropia is three times more common than exotropia.

Constant exotropia has been associated with neurological and ocular anomalies. In one study, 70% of infants with a constant exotropia had a neurological anomaly and 70% had an ocular anomaly. Sethee found that in patients under the age of 6 with exotropia, 48% experienced hypoxia at birth and 50% had developmental or speech delays. In Sethee’s study, 78% of the patients had an intermittent deviation. In this study, all 7 infants were neurologically normal and only 2 had a constant deviation. However, this study included only cases where cover test data were complete. In reality, it may not always be possible to obtain measurements of the ocular deviation in infants at both distance and near, or to get an estimate of the magnitude of the deviation. If additional analysis on all infants, including those with incomplete data, is done, 24 additional infants can be added to the cohort. Including those additional patients, 39% of the infants had either an ocular or neurodevelopmental condition. Thus, it is possible that patients with ocular or developmental conditions may be more difficult to examine, and therefore, unable to determine an accurate alignment measurement at distance and near.

Looking at the entire infant cohort, including those with incomplete data, 22.6% of infants showed a resolution of the exotropia without treatment. This resolution rate is in line with other studies that have found that exotropia in neonates generally resolves within 6 months. One possible explanation for this finding is that exotropia in neonates may resolve as infants mature. Additionally, studies don’t always differentiate gestational age from birth age. For example, 2 months after birth, an infant born 10 weeks prematurely has a gestational age of 38 weeks. This infant will be developmentally different from a child born full-term and assessed at the same time. Using gestational age with premature infants would provide more reliable data.

Different methods for the classification of exotropia exist. Rutstein and Daum describe classification of exotropia based on frequency. Constant exotropias are subdivided into infantile, secondary (i.e. sensory due to loss of vision in one eye, or consecutive, in patients with refractive or surgical correction for esotropia), paretic, or deterioration of intermittent exotropia. Intermittent exotropias are subdivided into divergence excess (DE) (true or pseudo), basic or convergence insufficiency (CI). A pseudo or simulated divergence excess is a deviation whereby the patient uses accommodative convergence to help align the eyes, such that a near exo deviation can look smaller than it actually is. Once fusion is disrupted or accommodative convergence is removed, the deviation may be found to be equal magnitude at distance and near.

Wright classifies exotropias as intermittent, convergence insufficiency, sensory and congenital. He further divides intermittent types into basic, pseudo and true divergence excess. Wright includes convergence insufficiency as a separate type of exotropia and notes that these patients have a minimal, if any, distance deviation with a near phoria that intermittently breaks down into a tropia.

Fletcher and Silverman classify exotropia as “exophoria-tropia” for all intermittent deviations with the subcategories of con-
vergence insufficiency, equal distance and near, divergence excess, exotropia complete absence of fusion, paralytic exotropia, exotropia with ocular or central nervous system disease and secondary exotropia. Burian classifies exo deviations as latent, intermittent and manifest. Any of these forms can be classified as basic, divergence excess or convergence insufficiency. He also differentiates divergence excess into true and simulated. Similarly, Taylor and Hoyt, divide their discussion on exotropia into intermittent and comitant. Intermittent exotropia includes the subtypes of convergence insufficiency, basic, true and pseudo-divergence excess. They note that differentials for intermittent exotropia include exotropias that are sensory, infantile, associated with neurological disease or craniofacial syndromes. In the discussion of comitant exotropia, categories include: infantile, monofixational exotropia, exotropia with hemianopic visual field defects, and sensory exotropia.

For this study, the decision was made to classify exotropia according to differences in distance and near deviation, as this is what is done clinically. Basic exotropia was the most common type of deviation noted (53%), followed by divergence excess (34%) and convergence insufficiency (14%). Almost 3% of subjects had a sensory esotropia. At least 7% had a prior history of surgery for esotropia, making their exotropia a consecutive form. The clinical characteristics of sensory and consecutive exotropia are different. Sensory exotropia results from a unilateral sensory defect and results in a constant, unilateral turn, with a large angle deviation and suppression on sensory testing. Consecutive exotropia results from the surgical correction of an esotropia or high (>4.50 diopter) hyperopic correction. These patients may develop sensory adaptations such as anomalous correspondence. This study did not look at the percentage of patients with exotropia who had a high hyperopic refractive error.

Studies have differed on what is the most common classification of exotropia. The Pediatric Eye Disease Investigator Group (PEDIG) found that of a cohort of children with intermittent exotropia enrolled in a treatment study, 69% had basic, 22% pseudo DE, 5% true DE and 1% CI. Rutstein and Corliss found that in their sample of patients aged 1 to 72 with intermittent exotropia, 71% had basic, 15% had divergence excess, and 14% had convergence insufficiency. Jung and Lee found that 86.2% of a sample of children between the ages of 1 and 14 with intermittent or constant exotropia had basic exotropia, followed by 10.1% with pseudo divergence excess, 3.2% with convergence insufficiency and 0.5% with true divergence excess. Fletcher and Silverman found that out of a sample of 211 patients with exotropia, 75.8% had intermittent divergence excess, 6.6% related to disease, 4.3% constant, 3.8% secondary or consecutive, 3.8% paralytic, 3.3% intermittent convergence insufficiency, 2.4% intermittent basic. Chia et al found that of their cohort of 473 patients under the age of 16 with intermittent exotropia, 10% had convergence insufficiency, 55% had divergence excess and 27% had basic. Additionally, 4% of patients had an idiopathic exotropia, defined as a constant turn without a decrease in visual acuity or neurological disorders while an additional 4% had a secondary deviation due to decreased visual acuity or neurological disease.

The results of this study are in line with others that have found that intermittent exotropia is present in between 47.7 to 92% of patients with exotropia. In the current study, 68% of patients presented with an intermittent deviation. A limitation of prior studies is the lack of uniformity in definitions. For example, Mohney defined intermittent exotropia as an intermittent deviation, “or, if constant, not associated with dissociated strabismus and demonstrated 50 arc seconds or better of stereopsis.” In the current study, the determination of intermittency was based
solely on the cover test results, and did not include the results of stereopsis testing. The primary reason for this decision was the fact that the optometrists tested stereopsis with the Randot Stereo Test,® both Wirt Circles and Randot shapes, while the ophthalmologists tested stereopsis only with the Wirt circles from the Stereo Fly® book. (Both stereo tests available from Precision Vision, LaSalle IL). Additionally, in many patients, especially those under the age of 4, stereopsis testing was not even attempted.

In the current study, the average distance deviation was 18.6 prism diopters and the average near deviation was 14.9 prism diopters. These values are somewhat lower than reported by other studies. However, some studies reported the average magnitude of the deviation for each subtype of exotropia, or a specific subtype, instead of providing an overall average. In pediatric patients ages 1-14, Jung and Lee found a mean angle of deviation at near of 23.6 prism diopters and distance of 23.4 prism diopters, higher than in the current study.

Amblyopia is reported in approximately 2% of the population. Studies on patients with exotropia have found that between 5 to 21% of patients have amblyopia or a “strong fixation preference,” although in many cases, the method of VA testing or criteria for the diagnosis of amblyopia was not specified. The current study looked not at the diagnosis of amblyopia but at visual acuity levels. Using visual acuity levels, 15.5% of patients would be considered to have moderate amblyopia (20/30 or better in 1 eye and 20/40-20/80 in the other eye) and 1% severe amblyopia (20/30 or better in 1 eye and worse than 20/100 in the other eye). One reason for the high percentage of patients with possible amblyopia in the current study could be due to the fact that 32% of patients had a constant deviation. In deviations that are constant and unilateral, amblyopia would likely be present. Additionally, at least 11% of patients had a history of esotropia corrected by surgery. In this study, there were 13 patients with unilateral amblyopia who had a history of surgery for esotropia. As esotropia is often a constant and unilateral deviation, it is possible that some of these patients were amblyopic secondary to the history of esotropia, even if the eyes were intermittently exotropic after surgery. A final reason for the high percentage of patients with suspected amblyopia could be due to the fact that, technicians, with different levels of training, did the majority of visual acuity testing and acuity results were not always confirmed by the staff doctor.

Refractive error was not consistently reported in prior studies on patients with exotropia. Jung and Lee studied patients aged 1 to 14 years; 41% had astigmatism, 28.2% had myopia, and 25% had hyperopia, although the magnitude of the refractive errors were not reported. Chia et al. reported that myopia ≥ -0.50 was present in 43% of their sample and hyperopia ≥ +2.00 was present in 4%. In the current study, 32% of patients were emmetropic (-0.25 to +1.25). Astigmatism, alone or with myopia/hyperopia, was present in 34%, while 41% of patients had greater than 1.50 diopters of hyperopia, with or without astigmatism.

This current study looked at treatment options but not success of treatment. A review of 59 studies by Coffey et al found that for intermittent exotropia, success, defined by the individual studies’ authors, was obtained in 28% of patients treated with over minus lenses, 28% treated with prism, 37% treated with occlusion, 46% with strabismus surgery, and 59% with orthoptic vision therapy. In this study, where the majority of patients were examined by ophthalmologists, observation, patching and surgery were the most common treatment options. This study did not look at the success rates of the different treatment types.

**Limitations**

Limitations of the current study result from the fact that this was a retrospective
chart review involving care provided by both ophthalmologists and optometrists. As a result, documentation for some variables including VA, symptoms, refractive error and alignment was inconsistent or incomplete, eliminating many cases from the data analysis. Some of the reasons for incomplete data included: child too young or unable to respond to testing, child had difficulty maintaining fixation, or alternate tests were not attempted. In other cases, incomplete data may have been due to tests not being done, or poor documentation of the results. For example, not all charts noted laterality, frequency or magnitude of the deviation.

This study also involved COTs and COAs doing much of the testing. Testing was not done by a single examiner, so there could be variability in instructions, methods and results.

Another limitation of the study is that patient histories were based on parent reported data, thus, some reported medical conditions were likely underreported.

Finally, data only included patients seen during a 1 year period. Long-term analysis of the stability of the deviation and treatment successes/failures cannot be assessed in this limited time.

CONCLUSIONS

The results of this study are in line with other studies regarding the clinical characteristics of pediatric patients with exotropia in terms of the type of deviation and associated ocular and systemic conditions. This study also did not exclude patients with prior strabismus surgeries from the data analysis.

Unlike with other studies, this study provides an overview of the refractive error characteristics found in patients with exotropia. This study classified refractive errors in more detail than prior studies, and included classifications of refractive errors as is done clinically. In this cohort of children under the age of 13 with exotropia, the most common refractive error was clinical emmetropia, followed by hyperopia with astigmatism. The least common refractive error in this cohort was high myopia.

This study also provides a breakdown of the magnitude of the deviation at distance and near, by age. Overall, in this cohort, the average deviation at distance was found to be larger than the deviation at near. Thus, the importance of doing cover testing at distance, as well as at near, is emphasized. Additionally, the magnitude of the deviation was found to be highest in the infants than the other age groups for both distance and near.

Due to the limitation of data collection, future studies on exotropia should be prospective to ensure that data collection is uniform. Randot stereopsis testing should be included as a measure of sensory fusion. Additionally, the success of different treatment options, including vision therapy, should be assessed, to determine the best treatment in terms of stability of results, elimination of symptoms, improvement in stereoacuity and cosmesis.

REFERENCES


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