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Awareness of exodeviation in children with intermittent exotropia

Sarah R. Hatt, D.B.O., David A. Leske, M.S., and Jonathan M. Holmes, B.M., B.Ch.
Department of Ophthalmology, Mayo Clinic, Rochester, MN

Abstract

Purpose—To describe how children with intermittent exotropia (IXT) are aware of their exodeviation.

Methods—24 children with IXT, aged 5 to 17, median 10.5 years, were recruited. Individual interviews with the child were audiotaped and transcribed. Interviews were based on 10 open-ended questions and discussion was encouraged. Transcripts were reviewed to identify phrases describing the child's awareness of the exodeviation as distinct from phrases describing the way intermittent exotropia affects their quality of life. Phrases were reviewed to identify specific topic areas and the type and frequency of topics was analyzed.

Results—19 (79%) of 24 children expressed awareness of the exodeviation. 120 phrases were extracted and 18 topic areas identified. The most frequently mentioned topics were *Comments from others* [15 (63%) of 24], *General awareness of deviation* [10 (42%) of 24], *Ocular sensation* [10 (42%) of 24] and *Correction of exodeviation by blinking* [7 (29%) of 24].

Conclusions—In our study, most patients with IXT were aware of their eye condition, but patient experience varied. In individual interviews, children described awareness of their eye condition mainly due to comments from others. Awareness of ability to correct the exodeviation by blinking was common and may be related to mechanisms used to control IXT.

Keywords

Intermittent exotropia; awareness; blinking

Introduction

Intermittent exotropia in childhood is different from most types of childhood onset strabismus in that intermittent exodeviation typically coexists with normal binocular single vision (BSV). Nevertheless, children with basic or distance types of intermittent exotropia do not typically report diplopia when they are misaligned (Clarke, 2007, Cooper & Medow, 1993, Santiago et al., 1999, von Noorden & Campos, 2002). The actual visual experience of children with IXT has not been extensively described. Understanding the nature and type of awareness children with IXT have of their exodeviation may help improve our understanding of mechanisms associated with ability to control the deviation. We previously reported identification of quality of life concerns by interviewing children with IXT and their parents (Hatt et al., 2008a). In this present study we report children's descriptions of awareness of IXT, taken from the same interviews.

Patients and Methods

Institutional Review Board approval was obtained and the parent of each child gave informed consent before participating. Children aged 8 years or older provided informed assent. All procedures and data collection were conducted in a manner compliant with the Health Insurance Portability and Accountability Act.

Patients

As reported previously (Hatt et al., 2008a), children with previously unoperated IXT, were identified in outpatient clinics and by searching clinical databases. The parents of consecutive eligible children attending outpatient clinics were informed about the study during their appointment and offered the opportunity to participate. In addition, parents of children who had previously been seen for IXT and were scheduled for future appointments were contacted by telephone and asked if they would attend specifically to participate in the study. Of the 24 recruited children (age range 5 to 17, median 10.5 years), 17 were female and for 21, race was reported as 'White.' Patients with convergence insufficiency type exotropia (near angle 10 prism diopters greater than distance), co-existing ocular pathology or neurodevelopmental delay were excluded. Patients were required to be comfortably conversant in English in order to be included in the study. Median angle of deviation by alternating prism cover test at distance was 20 prism diopters (pd) (range 10 pd to 40 pd). Median near stereoacuity was 40 (range 40 to nil) seconds of arc on the Frisby test and 40 (range 40 to nil) seconds of arc on the Preschool Randot test. Median distance stereoacuity was 20 (range 20 to 80) seconds of arc on the Frisby Davis Distance (FD2) and 150 (range 60 to nil) seconds of arc on the Distance Randot test. One patient had measurable distance stereoacuity (80 seconds of arc) using the FD2 with no measurable stereoacuity using near stereoacuity tests. For all 24 patients, control was assessed using a previously described scoring system rating ability to control on a 6 point scale (Mohny & Holmes, 2006). For 22 of the 24 patients the control assessment was repeated a total of 3 times over the exam. Consistent with a previous report from our research group, (Hatt et al., 2008b) we found control to vary considerably, even over the 15–20 minute examination. In 9 of the 22 patients with 3 control assessments, control varied from a phoria (0 to 2 on the scale) on one assessment to spontaneous tropia (3 to 5 on the scale) on the next and vice versa. Because single measures of control, performed as described, may be misleading, we elected not to report control as a marker of severity in this study.

Methods

As described previously (Hatt et al., 2008a), individual interviews with the child were conducted and audiotaped. All interviews were conducted by the same research orthoptist (SRH). A series of 10 open-ended questions (i.e., questions that could not be answered by a simple 'yes' or 'no' response, Table 1) were used as the basis for the interview and discussion was encouraged for each question. As some of the questions (e.g. question 4 'Tell me how your eyes feel', Table 1) encouraged children to describe awareness of their eyes, the interview data allowed us to simultaneously explore the child's awareness of their eyes as well as the previously described quality of life concerns (Hatt et al., 2008a). The duration of interviews ranged from approximately 2 to 5 minutes depending on the individual. In most cases the parent was present during the interview but parents were asked to not interrupt or to influence what the child was saying. The child was positioned so as to be in direct eye contact with the interviewer, usually with their back towards their parent.

Interviews were transcribed, transcripts reviewed, and phrases describing awareness of the exodeviation were recorded for each child. To fully represent how children in this study were aware of IXT we also included phrases describing awareness in association with

symptoms or concerns. For this reason, a small number of phrases (n=18) had also been designated quality of life concerns and were therefore included in our previous report. (Hatt et al., 2008a) Responses were reviewed to identify themes or topic areas. Once data collection was complete, 2 investigators reviewed the final list of phrases for all children. Similar phrases, or phrases describing the same phenomenon, were then grouped together by consensus between the 2 investigators. The 2 investigators then agreed on labels for each group of phrases, using labels that best described the specific topic area. Topic frequency was analyzed by individual patients. Topics were only counted once per patient whether mentioned once or multiple times.

Results

A total of 120 phrases pertaining to awareness of IXT were extracted from the interviews and 18 topic areas were identified. Of the 24 children, 19 (79%) expressed at least one aspect of awareness of their exodeviation. For five (21%) of the 24 children there were no phrases indicating any awareness of their eye condition. The median age of the five children who were not aware of the exodeviation was not significantly different to the median age of the 19 children who did express awareness of IXT (9 versus 11 years, $P=0.2$).

Topic frequency

Overall frequency of the 18 topic areas is shown in Table 2. The most frequently mentioned topic was *Comments from others* [15 (63%) of 24] with phrases such as 'My parents used to say "you are not looking straight at me"...that is how I got to noticing it,' 'Sometimes my friends say "your eye is doing that thing again,"' and 'I don't even really notice it until some people make comments sometimes.' Phrases indicating *General awareness of exodeviation* were mentioned by 10 (42%) of the 24 children using phrases such as 'It feels like I have less control over it,' 'Sometimes they (*eyes*) go across to the side,' and 'Feels like the lazy eye goes really bad and then after a while it goes normal.' Ten (42%) of 24 children were aware of a specific *Ocular sensation* e.g. 'It feels like my eye is moving but this eye is just staying the same,' 'Sometimes when it wanders off it feels like it is tightening,' and 'sometimes they (*eyes*) feel funny and different.' Of the 10 children who mentioned *General awareness of exodeviation*, 6 also mentioned an *Ocular sensation*.

Awareness of *Correction of exodeviation by blinking* was mentioned by 7 (29%) of the 24 children, using phrases such as 'Blinking helps me to keep straight,' 'I just blink and it goes back to normal again,' 'I don't know how it goes back in but it does if I blink fast,' and 'It looks fine again when I blink.'

Age and awareness of IXT

Overall, the number of topics mentioned per child ranged from 0 to 10 (median 3). There was a positive correlation between the number of topics mentioned and the age of the child ($r=0.41$, $P=0.05$).

To further analyze topics for an age effect, we divided children into 3 age groups: 5 to 7 years, 8 to 12 years and 13 to 17 years. These age groups were chosen as they parallel those used for common pediatric quality of life instruments such as the PedsQL (Varni et al., 2007). For each age group we examined the proportion of children mentioning the four most frequently mentioned topics (*Comments from others* (n=15) (Figure 1A), *General awareness of deviation* (n=10) (Figure 1B), *Ocular sensation* (n=10) (Figure 1C), and *Correction of exodeviation by blinking* (n=7) (Figure 1D). *Ocular sensation* (Figure 1C) was mentioned more frequently by children in older age groups ($P=0.03$) but, none of the other comparisons were statistically significant ($P>0.06$ for each comparison).

Discussion

Interviews with children with IXT show most children in this study were aware of their exodeviation, although individual experience varied. The most frequently mentioned area of awareness was *Comments from others*. Many children also expressed a *General awareness of exodeviation* and various *Ocular sensations*. Interestingly some children also volunteered awareness of ability to *Correct the exodeviation by blinking*. Overall, we found older children expressed more types of awareness of their exodeviation than younger children.

We found that more children described awareness of their exodeviation due to *Comments from others* than through changes in their visual experience. For three of the 15 children who mentioned awareness due to *Comments from others*, no other topics were mentioned, indicating this was the only means by which they were aware of their eye condition. Previous studies have shown that children are aware of physical differences such as skin color and body size by 3 to 5 years of age. (Cramer & Steinwert, 1998, Gunthrope, 1998, Kenney, 1998) Paysee et al (Paysse et al., 2001) found that, using dolls with strabismus, children demonstrated awareness that strabismus was present from approximately 6 years of age. The youngest children in our study were 5 years of age, so our finding of frequent awareness of IXT due to *Comments from others* is consistent with Paysee et al. (Paysse et al., 2001)

There appear to be few data on how awareness of strabismus, and resulting comments or behaviors, may change throughout childhood. Overall, our data showed an increase in awareness of IXT with increasing age although, with the exception of *Ocular sensation*, this was not statistically significant for individual topic areas. It is likely that, for an individual child, the level of awareness may vary depending on family and social dynamics and the child's personality. It is also possible that increased ability to articulate may have influenced increased awareness in older children. An increasing awareness of exodeviation with age might lead to an increase in quality of life concerns as the child gets older, which may in turn influence timing of intervention in IXT. It is difficult to use our data to determine whether there is any direct relationship between awareness and health-related quality of life, since comparing the number of comments may not be valid. Interestingly health-related quality of life concerns were characterized by worry or being bothered by the symptom or manifestation of IXT, (Hatt et al., 2008a) whereas awareness may or may not have been accompanied by worry or bother. Longitudinal evaluation of awareness and quality of life concerns in children with IXT would be helpful in assessing the evolution of these concerns as children mature.

Some children in our study expressed a *General awareness of exodeviation* or experienced some form of *Ocular sensation* associated with the exodeviation. Interestingly, these more general visual sensations were mentioned more frequently than specific symptoms sometimes associated with IXT. Symptoms such as diplopia and asthenopia, are reported to occur in some older children with IXT (Santiago et al., 1999, Wright, 1995) but were rarely reported by children in the present study. Diplopia was only mentioned by one child (although one additional patient was found to have diplopia on examination) and none of the 24 children who were interviewed mentioned or complained of symptoms that might be described as asthenopia. Monocular eye closure is a common association with IXT (Campos & Cipolli, 1992, Santiago et al., 1999, Wang & Chryssanthou, 1988, Wiggins & von Noorden, 1990) and has been explained as a possible compensation for diplopia (Santiago et al., 1999, Wang & Chryssanthou, 1988) or photophobia (Campos & Cipolli, 1992, Wiggins & von Noorden, 1990) but awareness of eye closure was only mentioned by three children in our present study. It is possible that children with IXT close one eye more often than they are aware. Nevertheless, consistent with previous reports (Santiago et al., 1999, Wright,

1995), we found that some children [6 (25%) of 24] were aware of blurred vision in association with the exodeviation. Also, panoramic vision has been reported in association with IXT (Cooper & Feldman, 1979) and was mentioned by three children in our study. It is possible that by using open-ended questions we identified fewer reports of these symptoms than if we had used specific, direct questioning.

Awareness of ability to *Correct the exodeviation by blinking* was mentioned quite frequently. Previous studies have shown that blinking is associated with a small convergence reflex (Ginsborg & Maurice, 1959, Peli & McCormack, 1986, Riggs et al., 1987, Stella, 1968) and can change the dynamics of horizontal and vertical saccades (Rambold et al., 2002). The association of blinking with a convergence reflex was described by Stella in 1968 as aiding refusion in patients with intermittent exotropia (Stella, 1968) and Khawam et al (Khawam et al., 2003) suggested patients with IXT may have an exaggerated blink convergence relationship, enabling refusion of considerable amounts of exodeviation. This relationship between blinking and convergence might explain why children in our study reported blinking as a means of correcting their exodeviation. Interestingly, a study of causes of excessive blinking in children by Coats et al, reported IXT to be the cause of excessive blinking in 11 (11%) of 99 children.(Coats et al., 2001) Clinically, it is our experience that patients will blink to attempt refusion when decompensated during cover testing or when assessing fusional amplitudes. Further study of the association between blinking, convergence and ability to control an exodeviation may prove useful in improving our understanding of mechanisms used to aid control of IXT.

The relatively small numbers of patients in our study may have limited our ability to detect the complete range of types of awareness in IXT and findings may also have been influenced by the larger proportion of female patients. Nevertheless, interviews revealed areas of awareness such as blinking that are not frequently reported. It is possible that the nature of our questions may have led children to report awareness that they had not actually experienced. Nevertheless, open questions facilitated discussions that would not have occurred had we used questions that led to yes/no responses, and many children responded 'nothing' or with a blank stare to some questions, suggesting they were not easily led. Larger numbers of patients would also have improved our ability to comment on the relationship between age and the type and frequency of awareness of exodeviation. Another potential weakness of our study is that in assigning phrases to topic areas it is possible that in some cases a phrase might have been allocated to more than one topic, but we chose the most relevant topic by consensus. Finally, our study was originally designed to determine quality of life concerns (Hatt et al., 2008a) and not specifically 'awareness', although some of our questions (Table 1) would be expected to elicit awareness.

Most patients with IXT appear aware of their eye condition, but patient experience varies from child to child. Most children were aware of their eye condition due to *Comments from others*, rather than due to visual symptoms. Frequent mention of ability to correct the exodeviation by blinking may indicate the type of mechanisms used to control IXT and may prove useful in understanding the nature of the condition.

References

1. Campos EC, Cipolli C. Binocularity and photophobia in intermittent exotropia. *Percept Mot Skills*. 1992; 74:1168–1170. [PubMed: 1501986]
2. Clarke MP. Intermittent exotropia. *J Pediatr Ophthalmol Strabismus*. 2007; 44:153–157. [PubMed: 17542436]
3. Coats DK, Paysse EA, Kim DS. Excessive blinking in childhood: A prospective evaluation of 99 children. *Ophthalmology*. 2001; 108:1556–1561. [PubMed: 11535449]

4. Cooper J, Feldman J. Panoramic viewing, visual acuity of the deviating eye, and anomalous retinal correspondence in the intermittent exotropia of the divergence excess type. *Am J Optom Physiol Opt.* 1979; 56:422–429. [PubMed: 517633]
5. Cooper J, Medow N. Intermittent exotropia, basic and divergence excess type. *Binocul Vis Strabismus Q.* 1993; 8:187–216.
6. Cramer P, Steinwert T. Thin is good, fat is bad: How early does it begin? *Journal of Applied Developmental Psychology.* 1998; 19:429–451.
7. Ginsborg BL, Maurice DM. Involuntary movements of the eye during fixation and blinking. *Br J Ophthalmol.* 1959; 43:435–437. [PubMed: 13850233]
8. Gunthrope, WW. Skin color recognition, preference and identification in interracial children: A comparative study. Lanham, MD: University Press of America, Inc; 1998.
9. Hatt SR, Leske DA, Adams WE, Kirgis PA, Bradley EA, Holmes JM. Quality of life in intermittent exotropia: Child and parent concerns. *Arch Ophthalmol.* 2008a; 126:1525–1529. [PubMed: 19001219]
10. Hatt SR, Mohny BG, Leske DA, Holmes JM. Variability of control in intermittent exotropia. *Ophthalmology.* 2008b; 115:371–376. [PubMed: 17629562]
11. Kenney KE. Awareness of and preference for physical characteristics among caucasian kindergarten children. Dissertation Abstracts International Section A: Humanities and Social Sciences. 1998; 59:1073.
12. Khawam E, Zein W, Haddad W, Haddad C, Allam S. Intermittent exotropia with high ac/a ratio: Is it a bane to surgical cure? Some facts and fictions of the two clinical tests: Occlusion of one eye and the use of +3.00 spherical lenses. *Binocul Vis Strabismus Q.* 2003; 18:209–216. [PubMed: 14653774]
13. Mohny BG, Holmes JM. An office-based scale for assessing control in intermittent exotropia. *Strabismus.* 2006; 14:147–150. [PubMed: 16950743]
14. Paysse EA, Steele EA, McCreery KM, Wilhelmus KR, Coats DK. Age of the emergence of negative attitudes toward strabismus. *J AAPOS.* 2001; 5:361–366. [PubMed: 11753256]
15. Peli E, McCormack G. Blink vergence in an antimetropic patient. *Am J Optom Physiol Opt.* 1986; 63:981–984. [PubMed: 3799812]
16. Rambold H, Sprenger A, Helmchen C. Effects of voluntary blinks on saccades, vergence eye movements, and saccade-vergence interactions in humans. *J Neurophysiol.* 2002; 88:1220–1233. [PubMed: 12205143]
17. Riggs LA, Kelly JP, Manning KA, Moore RK. Blink-related eye movements. *Invest Ophthalmol Vis Sci.* 1987; 28:334–342. [PubMed: 8591916]
18. Santiago, AP.; Ing, MR.; Kushner, BJ.; Rosenbaum, AL. Intermittent exotropia. In: Rosenbaum, AL.; Santiago, AP., editors. *Clinical strabismus management principles and surgical techniques.* Philadelphia: W.B. Saunders Company; 1999. p. 163-175.
19. Stella SL. The association of blinks and refraction in intermittent exotropia. *Am J Optom Arch Am Acad Optom.* 1968; 45:465–471. [PubMed: 5243950]
20. Varni JW, Limbers CA, Burwinkle TM. How young can children reliably and validly self-report their health-related quality of life?: An analysis of 8,591 children across age subgroups with the pedsql 4.0 generic core scales. *Health & Quality of Life Outcomes.* 2007; 5:1. [PubMed: 17201920]
21. von Noorden, GK.; Campos, EC. Exodeviations. In: von Noorden, GK.; Campos, EC., editors. *Binocular vision and ocular motility theory and management of strabismus.* St. Louis: Mosby; 2002. p. 356-376.
22. Wang FM, Chryssanthou G. Monocular eye closure in intermittent exotropia. *Arch Ophthalmol.* 1988; 106:941–942. [PubMed: 3390058]
23. Wiggins RE, von Noorden GK. Monocular eye closure in sunlight. *J Pediatr Ophthalmol Strabismus.* 1990; 27:16–20. [PubMed: 2324913]
24. Wright, K. Exotropia. In: Wright, K., editor. *Pediatric ophthalmology and strabismus.* St Louis: Mosby Year Book; 1995. p. 195-202.

Figure 1.

Proportion of children mentioning most frequent topics according to age groups: 5 to 7 years (n= 5), 8 to 12 years (n= 11) and 13 to 17 years (n= 8). The data suggest that *Comments from others* (A) *General awareness of deviation* (B) and *Ocular sensation* (C) and *Correction of exodeviation by blinking* (D) were mentioned more by older children but only *Ocular sensation* (P=0.03) was statistically significant, possibly due to small sample sizes.

Table 1

Interview questions for children with intermittent exotropia (Hatt et al., 2008a).

1. What bothers you about your eyes?
2. How are your eyes different from other children's eyes?
3. What things are hard to do because of your eyes?
4. Tell me how your eyes feel?
5. What do other children say to you about your eyes?
6. What do grown ups say to you about your eyes?
7. What do you wish you could change about your eyes?
8. How much do you worry about your eyes?
9. What do other people think about you?
10. Is there anything else about your eyes that bothers you or that you want to tell me?

Table 2

Frequency of topics expressed by children with intermittent exotropia regarding their awareness of the exodeviation.

Topic area	Number of patients (%)
Comments from others	15 (63%)
General awareness of exodeviation	10 (42%)
Ocular sensation	10 (42%)
Correction of exodeviation by blinking	7 (29%)
Awareness of deviation due to blurry vision	6 (25%)
Correction of exodeviation (not blinking)	6 (25%)
Exodeviation triggered by fatigue	3 (13%)
Monocular eye closure	3 (13%)
Panoramic vision	3 (13%)
Appearance to self	2 (8%)
Exodeviation triggered by daydreaming	2 (8%)
Exodeviation triggered by staring	2 (8%)
Parent has to remind to correct IXT	2 (8%)
Visual phenomenon	2 (8%)
Double vision	1 (4%)
Exodeviation triggered by watching TV	1 (4%)
Eye fatigue	1 (4%)
Relationships	1 (4%)