

Clinical features of acute acquired comitant esotropia in the Chinese populations

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Abstract

Acute acquired comitant esotropia (AACE) is an unusual presentation of esotropia that occurs after infancy. This study was aimed to study the clinical features and the differences between children and adult patients with AACE in the Chinese populations.

This was a retrospective analysis of patients diagnosed with AACE over 4 years; 69 patients (25 females and 44 males) were identified. The patients were divided into 3 groups: < 10 year-old (n = 6, 8.7%), 10–18 year-old (n = 23, 33.3%), and ≥ 18 year-old (n = 40, 58.0%). Patients underwent medical history, brain and orbital computed tomography, and ophthalmological and orthoptic examinations.

The refractions of AACE patients varied among age groups: patients < 10 year-old had mild hypermetropia, while older children and adults showed moderate-to-high myopia ($P < .001$). The mean angles of esotropia were significantly larger in young children compared with older children and adults ($P = .005$). There was no significant difference in binocularity detected by either synoptophore or TNO stereoscopic testing among different disease durations. Stereopsis detected by synoptophore and TNO testing showed no significant difference at duration within half a year, but the stereopsis measured by TNO was significantly worse than that detected by synoptophore with extending disease duration ($P < .05$).

AACE seems to occur mostly in older children and adults in the Chinese population. Younger children with AACE seem to demonstrate a common trait of mild hypermetropic refractive errors, while myopia can be seen in older children and adult patients. The duration from onset to treatment of esotropia does not affect the preoperative binocularity.

Abbreviation: AACE = acute acquired comitant esotropia.

Keywords: acute acquired comitant esotropia, binocularity, Chinese population, refraction, stereopsis

1. Introduction

Acute acquired comitant esotropia (AACE) is an unusual presentation of esotropia that occurs after infancy. It is characterized by the acute onset of esotropia with diplopia.

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Ethics approval and consent to participate: This study adhered to the tenets of the Declaration of Helsinki and was approved by the ethics committee of the Beijing Tongren Hospital. The need for individual consent was waived by the committee because of the retrospective nature of the study.

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According to Burian and Miller,^[1] AACE can be divided into 3 distinct categories: Type 1 (Swan type) refers to an esotropia following the interruption of fusion by a period of monocular occlusion or vision loss; Type 2 (Burian–Franceschetti type) has no obvious underlying cause other than physical or psychological stress and this form often presents with modest hypermetropia and minimal accommodation; and Type 3 (Bielschowsky type) has been described in myopic subjects.

There are a number of reports about the characteristics and treatment of AACE.^[2–5] Goldman and Nelson^[2] reported 2 children who developed AACE without any evidence of trauma or neurological disorder; both were successfully treated using bimedial recession. Dawson et al^[3] reported 14 children with AACE treated using botulinum toxin. Ahmed and Young^[4] reported an interesting case of AACE in homozygous twins, suggesting a genetic predisposition. Clark et al^[5] reported 6 children with normal neurological examination. Lyons et al^[6] presented 10 children with AACE; 1 had a brain tumor and all showed hypermetropia. However, these studies were mainly performed in Caucasian populations and few studies focus on Asian populations. Indeed, there are profound differences between Caucasians and Asians concerning the eyes such as a higher incidence of myopia and glaucoma among Asians.^[7–10] Recently, Kemmanu et al^[11] reported a small case series of AACE in the Indian populations, in which 3 patients were found to have intracranial pathology. Chen et al^[12] studied 47 Chinese patients and showed that AACE was characterized by the sudden onset of concomitant nonaccommodative esotropia with diplopia in children, and that these children had a potential for normal vision. It has been suggested that AACE might be the result of a serious neurological disease, but there is a lack of evidence to confirm this theory.^[13] Nevertheless, no study regarding the

differences between children and adults is presently available among Chinese patients.

Therefore, the aim of this study was to examine the clinical features of AACE in a large series of Chinese patients, with specific attention to the differences among younger children, older children, and adults. In addition, the study aimed to identify the effect of the duration from onset to treatment of esotropia on binocular function.

2. Methods

2.1. Study design

This was a retrospective study of 69 consecutive patients with AACE diagnosed between January 2008 and December 2012 at the Strabismus and Pediatric Ophthalmology Service of the Beijing Tongren Hospital (China). This study adhered to the tenets of the Declaration of Helsinki and was approved by the ethics committee of the Beijing Tongren Hospital. The need for individual consent was waived by the committee because of the retrospective nature of the study.

2.2. Patients

Inclusion criteria were: a diagnosis of AACE (deviation in all directions of gaze differing by ≤ 2 prism diopters (PD) when primary deviations were ≤ 20 PD and by ≤ 5 PD when primary deviations were > 20 PD^[12]); no history of ophthalmic deficits or previous strabismus; no history of systemic disease or head trauma; and no neurological diseases proved by systemic neurological examinations. The patients who had a reduction in their esotropia with hypermetropic spectacle correction were excluded.

2.3. Data collection

Data were collected from the Strabismus and Pediatric Ophthalmology Service surgery registration system of the Beijing Tongren Eye Center. All the patients underwent a complete assessment including medical history, brain and orbital computed tomography (CT)/magnetic resonance imaging (MRI), and ophthalmological and orthoptic examinations. All the patients were followed up at 3 and 6 months at the outpatient clinic for examinations of eye position and stereopsis.

2.4. Ophthalmological examination

The ophthalmological examination included measurement of best-corrected visual acuity, slit-lamp assessment of the anterior segment, and dilated indirect ophthalmoscopy. Cycloplegic refraction was performed after instillation of 1% atropine eye drops in patients < 10 years and 1% tropicamide in patients aged 10 to 40 years. For patients > 40 years, refraction was performed without the use of a cycloplegic agent. The orthoptic examinations were performed by a single orthoptist, and verified by a strabismologist. Measurements included evaluation of ocular movements, angle of strabismus, and binocular functions. Angles of deviation were measured using the prism and alternate cover test at near (1/3 m) and distance (6 m) fixation. Binocular function was first measured by synoptophore and then TNO stereoscopic testing with the best visual correction in place.

The synoptophore examination consisted of testing simultaneous perception, fusion, and stereopsis using a synoptophore

model L-2510B/L-2510HB (Inami& Co Ltd, Tokyo, Japan). Simultaneous perception was detected with fusion slides subtending a visual angle of 11° horizontally and 8° vertically. Horizontal fusional vergence was measured with fusion slides subtending a visual angle of 8° horizontally and 11° vertically. Stereoacuity was evaluated with slides subtending a visual angle of approximately 10° . The result of simultaneous perception was recorded as positive if the patient had simultaneous perception or negative if the patient did not. For the patient who had fusional vergences, the fusional amplitude was measured. For the statistical analysis, it was also recorded as positive if the patients had fusion, and vice versa. The stereopsis on synoptophore was assessed with the only slide subtending a visual angle of approximately 10° and without further grading; therefore, the result was recorded as either positive or negative.

Stereoacuity was assessed using the TNO test (Lameris Ootech BV, Nieuwegein, The Netherlands) at a distance of 40 cm. Patients with a result of 60 s or less were considered to have normal stereoacuity. Patients with a result of 60 to 480 s were considered to have abnormal stereoacuity. If the patient was unable to demonstrate any random-dot stereopsis, the result was recorded as negative. The patients were followed up from 3 months to 4 years, with near stereoacuity ranging from 40 to 140 s.

2.5. Statistical analysis

Continuous variables are presented as mean \pm standard deviation and were analyzed using one-way ANOVA followed by all pairwise multiple comparison procedures using Bonferroni test. Categorical data are presented as frequencies and were analyzed with the Fisher exact test. The effects of duration between esotropia onset and ocular examination on binocularity were determined using the Pearson chi square test. Statistical analysis was performed using SPSS 13.0 (SPSS Inc, Chicago, IL). Two-tailed P values $< .05$ were considered statistically significant.

3. Results

3.1. Characteristics of the patients

Over the 4-year study period, 69 patients (25 females and 44 males) with AACE were identified. The mean age (\pm SD) of the 69 patients at the time of eye examination was 26.6 ± 12.4 (range, 4–62) years. The mean age at the onset of esotropia was 23.1 ± 11.7 years, with 6 cases being younger than 10 years (8.7%, younger children), 23 cases between 10 and 18 years (33.3%, older children), and 40 cases older than 18 years (58.0%). The mean time from onset of acute esotropia to eye examination was 23.1 ± 1.0 (range, 3–120) months. All the patients (even a patient with a cause of 10 years) could regain the normal binocular function after surgery and correction of eye alignment.

3.2. Ophthalmological characteristics

None of these patients had crossed fixation, monocular nasotemporal optokinetic asymmetry, latent nystagmus, dissociated vertical deviation, or oblique muscle overaction. Twenty-nine patients showed delay in abduction in both the eyes. Brain and orbital imaging (CT and/or MRI) was performed in all patients and found to be normal. The corrected visual acuity was 20/20 or better in both eyes of patients ≥ 6 years old, and 20/25 or better for the patients < 6 years old.

Table 1**Effect of age on the refraction of AACE patients.**

Groups	Younger children (≤ 10 y)	Older children (10–18 y)	Adults (> 18 y)
N (N with available data)	6 (5)	23 (20)	40 (32)
Spherical equivalent (mean \pm SD)	$+1.44 \pm 0.38$	$-4.31 \pm 1.95^*$	$-4.95 \pm 3.41^*$

Statistical analysis was performed using one-way ANOVA with Bonferroni test; N with available data, number of patients with refractive error record.

AACE = acute acquired comitant esotropia.

* $P < .001$ versus younger children.

The patients wore their refractive correction for at least 4 weeks of full-time use. None of them had a significantly reduced esotropic deviation for near or distance with the use of spectacle correction. For 48 patients (69.6%), the near and distance measurements were equal. In the remaining 21 patients (30.4%), the differences were within 10 PD (5 PD in 16 cases and 10 PD in 5 cases).

3.3. Association of refractive characteristics with age

Refraction was recorded in 57 of the 69 patients. The refractions of AACE patients varied between age groups. Five of the 6 younger children displayed mild hypermetropia (the record of 1 child was missing), ranging from 0.75 to 1.75 diopters (D) (mean hypermetropia of $+1.44 \pm 0.38$ D) in spherical equivalent. The records of 20 out of the 23 older children and of 31 out of the 40 adults could be found. In these 2 groups, moderate to high myopia was observed, ranging from -2.5 to -7.0 D and -2.0 to -11.0 D (mean myopia of -4.31 ± 1.95 D for older children and -4.95 ± 3.41 D for adults) in spherical equivalent, respectively. The spherical equivalent of both older children ($P < .001$) and adults ($P < .001$) was significantly different than that of the younger children, respectively (Table 1).

3.4. Association of angles of esotropia with age

For both near and distance, the mean angles of esotropia in younger children were significantly larger than those of older children and adults (distance: vs older children, $P = .037$; vs adults, $P = .001$; near: vs older children, $P = .030$; vs adults, $P = .001$). No significant difference ($P = .093$) in mean angle of esotropia could be observed between the older children and the adults (Table 2).

3.5. Disease duration

The duration from onset of esotropia to ocular examination was 3 to 120 months. For the binocularity detected by either synoptophore or TNO test, there was no statistically significant difference found among the groups with different durations (simultaneous perception: $P = .39$, motor fusion: $P = .74$; stereopsis

Table 2**Effect of age on mean angle of deviation in patients with AACE.**

	Younger children (≤ 10 y)	Older children (10–18 y)	Adults (> 18 y)
N	6	23	40
Distance	64.17 ± 12.54	$45.21 \pm 4.10^*$	$35.65 \pm 2.76^*$
Near	65.00 ± 12.04	$44.78 \pm 4.16^*$	$35.81 \pm 2.95^*$

Statistical analysis was performed using one-way ANOVA with with the Bonferroni test.

AACE = acute acquired comitant esotropia.

* $P < .05$ versus younger children.

on synoptophore: $P = .40$; TNO stereoacuity test: $P = .50$) (Table 3). The stereopsis detected using both synoptophore and TNO testing showed no significant difference at half a year of duration ($P = .10$), but stereopsis measured by TNO testing was significantly worse than that detected by synoptophore with increasing duration of the disease (0.5–1 year: $P = .003$; 2–3 years: $P = .006$; > 3 years: $P < .001$) (Table 4).

4. Discussion

AACE is an unusual presentation of esotropia that occurs after infancy and most studies are on Caucasian populations. Therefore, the present study aimed to study the clinical features and the differences between children and adult patients with AACE in the Chinese populations. Results showed that the refractions of AACE patients varied among age groups: patients < 10 year-old had mild hypermetropia, while older children and adults showed moderate-to-high myopia. The statistical significance in mean angles of esotropia was larger in young children compared with older children and adults. There was no statistical difference in binocularity detected by either synoptophore or TNO stereoscopic testing among different disease durations. Stereopsis detected by synoptophore and TNO testing showed no statistical significance at duration within half a year, but the stereopsis measured by TNO was significantly worse than that detected by synoptophore with extending disease duration.

AACE is believed to occur during infancy or early childhood,^[14] but some studies found that it can occur in older children and adults.^[5,11,14,15] Accordingly, in the present study,

Table 3**Effect of duration from esotropia onset to ocular examination on the binocularity of AACE patients determined using synoptophore and TNO testing.**

Tests	≤ 6 mo (N)	> 6 mo and ≤ 12 mo (N)	> 12 mo and ≤ 36 mo (N)	> 36 mo (N)	P
Synoptophore					
Perception					
Positive	12	16	19	14	.39
Negative	0	3	4	1	
Motor fusion					
Positive	10	16	17	13	.74
Negative	2	3	6	2	
Stereopsis					
Positive	8	13	14	13	.40
Negative	4	6	9	2	
TNO test					
Normal	3	1	3	1	.50
Abnormal	0	2	1	1	
Negative	9	16	19	13	

Pearson χ^2 test was used for statistical analysis, and the P value represented the comparisons of positive function in synoptophore or normal function in TNO test among the 4 groups.

Table 4

Effect of duration from esotropia onset to ocular examination on the stereopsis of AACE patients determined by using Synoptophore and TNO testing.

Duration	Positive (N)	Negative (N)	P
≤6 mo			
Synoptophore	8	4	.100
TNO test	3	9	
>6 and ≤12 mo			
Synoptophore	13	6	.003
TNO test	3	16	
>12 and ≤36 mo			
Synoptophore	14	9	.006
TNO test	4	19	
>36 mo			
Synoptophore	13	2	<.001
TNO test	2	13	

The Fisher exact test was used for statistical analysis, and the *P* value represented the comparisons of positive and negative between synoptophore and TNO test per duration.

the age at esotropia onset ranged from 3 to 62 years, with a mean age (\pm SD) of 23.1 ± 11.7 years. Six cases (8.7%) presented at < 10 years, 23 cases (33.3%) presented at 10 to 18 years, and 40 cases (58.0%) presented at >18 years. These findings suggest that in the Chinese populations, AACE is more frequent in older children and adults than in younger children. This is consistent with a previous Chinese study, in which mean age (\pm SD) at presentation was 26.6 ± 12.2 years.

The correlation of refraction of AACE patients among different age groups has been reported.^{16,16,171} In a paper that included 9 children (3.5–10 years old) and 1 adult (24 years old), 9 patients were hypermetropic and one 4.5-years child was emmetropic.¹⁶¹ Meanwhile, in a report on AACE in which the study population included both children and young adults (age at onset ranging from 3 to 28 years), all patients >10 years had myopia, while 4 out of the 8 patients <10 years had hypermetropia.¹¹⁶¹ In another study in which 11 participants were children (5 to 11 years old), 10 patients were hypermetropic, but only 1 child at the age of 10 was myopic.¹⁵¹ In a study of adult patients aged 18 to 70 years old, myopia was present in all but 1 patient.¹¹⁷¹ These studies indicate that among patients with AACE, younger children have mild hypermetropia, and adult patients always have myopia, but no obvious conclusion can be drawn for the older children (10–18 years old). The present study showed that children <10 years old had mild hypermetropia, and adult patients had moderate to high myopia at presentation of AACE, which is consistent with prior studies. In addition, older children (10–18 years old) also had moderate to high myopia, and no statistical significance could be found between this group and the adults.

The mean spherical equivalent refractive error was at least +1.22 diopters for children aged 3 to 6 years in China.¹⁸¹ It was -0.17 ± 2.09 diopters (median: +0.50 diopters, range: -11.75 diopters to +11.00 diopters) for children aged 4 to 18 years.¹⁹¹ The mean refractive error was -0.1 ± 1.75 diopters in Chinese adult aged older than 30 years, and these subjects could become more hyperopic with increasing age: from -0.78 ± 1.58 diopters within aged 30 to 39 years to 0.40 ± 1.90 diopters in those aged 60 to 64 years.¹¹⁰¹ In this study, we found that the younger AACE children had similar refractive error with the age-matched general Chinese children, while both the older children and adult AACE patients were more myopic.

In the present study, the patients <10 years old had a larger angle of deviation than older children and adults. This is likely

because the patients younger than 10 years, having hypermetropia, met the criteria of Type 2 AACE, which is characterized by a large angle of deviation. The mean deviations were 65.0 ± 12.0 PD for near and 64.2 ± 12.5 PD for distance among younger children, which was significantly larger than those reported by Sturm et al,¹¹⁸¹ but similar to those reported by Spierer.¹¹⁷¹ The measurements in adult patients were 35.6 ± 16.4 PD, showing a concordance with Spierer's report.¹¹⁷¹

It has been shown that the duration from the onset of strabismus to the start of treatment was not a critical factor for the restoration of normal stereoacuity.¹¹⁶¹ In the study by Schöffler and Sturm,¹¹⁹¹ despite a complicated course and long-lasting absence of stereovision, all patients eventually regained high-grade stereopsis. Sturm et al¹¹⁸¹ suggested that the interval between esotropia onset and surgery was similar in patients with normal stereopsis and those who demonstrated no or lower level of binocularity. In the present study, the postoperative near stereopsis was between 40 and 140 s. Moreover, for each group with different durations from onset to treatment of esotropia, the binocular functions of simultaneous perception, fusion, and stereopsis on synoptophore testing were retained in most patients. In addition, the stereopsis detected with synoptophore was better than that assessed by the TNO test. For the binocularity detected by either synoptophore (reflects distance stereopsis) or TNO testing (reveals near stereopsis), differences could not be found among the groups of different disease durations. For binocular animals viewing a three-dimensional scene, the left and right eyes receive slightly different information and the brain uses this "binocular disparity" to interpret stereoscopic depth. Neurons that are tuned to low spatial frequencies encode a relatively wide range of disparities, but with poor resolution. Conversely, cells tuned to high spatial frequencies have fine resolution, but are limited to processing a narrow range of disparities.¹²⁰¹ A leading theory concerning stereoscopic processing is a coarse-to-fine process that coarse disparity information constrains that of fine detail.^{121,1221} Therefore, among patients who had stereopsis detected by synoptophore but not on TNO testing, it is likely that the existence of coarse stereopsis detected by synoptophore preoperatively provides the potency of the recovery of the fine stereopsis detected by the TNO test postoperatively. However, additional studies are necessary to determine accurately these changes in patients with AACE.

It has been suggested that the term acute comitant esotropia of adulthood be restricted to older patients only and that it should be considered one of the subgroups of acute-onset esotropia.¹¹⁷¹ However, based on the results of the present study, at least in the aspect of refraction, angle of deviation, and binocularity, there was no statistical significance between older children and adults, but the 2 groups were significantly different from the younger children in refraction and angle of deviation.

Of course, the present study is not without limitations. Indeed, despite being the largest series reported so far, the sample size was small and from a single center. In addition, because of the retrospective nature of the study, data were limited to what was available in the patient records. Additional prospective studies are necessary to better describe AACE and its treatments.

In conclusion, considering the present study, AACE seems to occur mostly in older children and adults in the Chinese populations. Younger children with AACE seem to demonstrate a common trait of mild hypermetropic refractive errors, while myopia can be seen in older children and adult patients. The duration from onset to treatment of esotropia does not affect the preoperative binocularity.

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