Early Predict the Outcomes of Refractive Accommodative Esotropia by Initial Presentations

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Background: The differential diagnosis between fully and partially refractive accommodative esotropia (Ac-ET) depends on outcomes after intervention with refraction correction. Whether the differences exist in terms of initial clinical features between these two variants has not been fully explored.

Methods: Children between the ages of 6 months and 8 years with esotropia and spherical equivalent greater than +3.00 (D) were included in this study. After wearing diopters glasses for at least 2 years, children were classified according to the indexed criteria into the fully Ac-ET group (group A, N=28) partially Ac-ET (group or the B, N=17). Six clinical parameters, including age at onset, age at first visit, visual acuity, refractive error, angle of esodeviation, and presence or absence of inferior oblique overaction at initial presentation were compared between these two groups.

Results: The angle of esodeviation (31.4 ±11.6 PD vs. 42.6 ±12.6 PD, $p = 0.004$) was significantly different between the fully and partially Ac-ET groups, while refraction (+5.79 ±1.84 D vs. +4.79 ±1.40 D, $p = 0.062$) had borderline significance. On the contrary, the age at onset (2.35 ±1.74 yrs vs. 2.01 ±1.96 yrs, $p = 0.539$), age at first visit (3.51 ±1.36 yrs vs. 3.01 ±1.70 yrs, $p = 0.285$), inferior oblique overaction (32% vs. 47%, $p = 0.317$), and visual acuity before (LogMAR: 0.40 ±0.25 vs. LogMAR: 0.34 ±0.25, $p = 0.544$) and after treatment (LogMAR: 0.057 ±0.079 vs. LogMAR: 0.051 ±0.19, $p = 0.088$) were similar in the two groups.

Conclusions: Children with a smaller angle of esodeviation and higher hyperopia were more likely belonging to fully Ac-ET, which can be treated with glasses without the need of surgical intervention. Early detection and early treatment of accommodative esotropia are needed to prevent strabismus and amblyopia.

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Key words: **accommodative esotropia, visual acuity, angle of esodeviation, hyperopia, inferior oblique overaction.**

Accommodative esotropia (Ac-ET) is the most common form of childhood strabismus.(1) It is manifested by convergent deviation of the eyes associated with activation of the accommodation reflex.

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If the accommodative esodeviations exceed the normal range, esotropia prevails. It can be caused by two pathological processes, hypermetropia or high accommodative convergence to accommodation (AC/A) ratio.[2] In our study, we excluded the children with high AC/A ratio and studied only those with refractive accommodative esotropia caused by high hyperopia. Ac-ET may occur at any age from 6 months to 7 years old, with an average age at onset of 2.5 years.[3] Early recognition of the disorder and early initiation of treatment help to prevent worsening of the disease. Fully Ac-ET may be corrected non-surgically with full cycloplegic refraction spectacles correction, but partially Ac-ET usually needs surgical treatment for the non-accommodative component after spectacles correction. A more direct and less time-consuming method is needed to aid in differentiating fully Ac-ET from partially Ac-ET. This study therefore attempted to find the differences in initial clinical parameters between fully and partially Ac-ET caused by high hyperopia, with the objective to prove that the initial presenting characteristics of Ac-ET might provide a hint for differentiation of these disorder and help guide future treatment.

METHODS

Patients

From June, 2000 to Dec, 2000, consecutive children between the ages of 6 months and 8 years who visited the Children's Clinics, Department of Ophthalmology of Chang Gung Memorial Hospital, with a spherical equivalent greater than +3.00D, astigmatism less than -1.50D, and an angle of esodeviation greater than 20 prism diopter (PD) without spectacles correction were enrolled in our study.[4] All children were applied with 2% cyclogyl once and 1% tropicamide twice, and then were examined one hour after the first eyedrop were given.[5,6] Children with previous ocular intervention, anisometropia (≥ 2.00D),[4,7] high accommodative convergence to accommodation (AC/A) ratio, any organic ophthalmic or systemic disease were excluded.

Treatment and follow-up

All children received full refraction correction by and well compliant with glasses wearing. Some children needed to patch the better eye because of unequal vision between right and left eyes. (more than 2 lines difference of Snellen chart) They were examined every 3 months and monitored for at least 2 years.[8,9] We recorded the following: age at first visit, age at onset, angle of esodeviation without glasses at first visit, angle of esodeviation with glasses at last visit, refraction with full cycloplegia, best corrected vision, and presence or absence of inferior oblique muscle overaction (IOOA). The children's vision was examined using the Snellen chart. The Snellen value was translated into a LogMAR scale, and was calculated by the LogMAR scale. After 2 years of management, children were divided into 2 groups according to the severity of esodeviation with spectacles correction. Group A (Gr A), the fully refractive Ac-ET group, included children with the residual esodeviation less than 10 PD; and group B (Gr B), the partially-refractive Ac-ET group, included children with the residual esodeviation greater than 10 PD.[10] Because the normal divergence fusional amplitude is 10 PD, we defined children with residual esotropia within 10 PD as fully refractive Ac-ET.

Statistical analysis

All continuous parametric variables were expressed as mean ± SD and compared by unpaired Student's *t* test. The Chi-square test was used for binary variables such as gender and presence or not of IOOA. A $p < 0.05$ was considered statistically significant.

RESULTS

After 2 years' treatment and follow up, 45 children were included in our study. Twenty-eight children were classified into group A (fully Ac-ET); 17 children were group B (partially Ac-ET).

Demographic features

The patient's demographic features are presented in Table 1. There were no significant differences between the groups in age at onset, age at first visit or gender.

Visual acuity

Twenty-seven out of 45 children were older than 3 years and their visual acuity (VA) could be checked at their first visit. The others were too young to undergo the Snellen chart test. The visual acuity at

the first visit of group A was LogMAR: 0.40 ±0.25 (Snellen VA= 20/50); in group B it was LogMAR: 0.34 ±0.25 (Snellen VA= 20/50 ~ 20/40), $p = 0.544$ (Table 2). Children under 4 years old with Snellen VA less than 20/33 or children older than 4 years old with Snellen VA less than 20/25 were defined as having amblyopia. The initial incidence of amblyopia in group A was 82% and in group B was 80%. We couldn't find significant differences in visual acuity and the rate of amblyopia between the two groups. After wearing glasses for 2 years, improvements in vision and decreases in the incidence of amblyopia were evident. The final vision of group A was LogMAR: 0.057 ±0.079 (Snellen VA= 20/25 ~ 20/22) and in group B was LogMAR: 0.051 ±0.088 (Snellen VA= 20/22), $p = 0.849$. The rate of amblyopia in group A was 24% and group B 30%.

Table 1. Demographic Features

	Group A Fully Ac-ET (n=28)	Group B Partially Ac-ET (n=17)	*p*
Girls/Boys	15 / 13	10 / 7	0.731
Age at 1st Visit (yrs)	3.51 ±1.36	3.01 ±1.70	0.285
Range (yrs)	1.50-6.83	1.00-7.75	
Age at Onset (yrs)	2.35 ±1.74	2.01 ±1.96	0.539
Range (yrs)	0.50-6.75	0.50-7.75	

Abbreviation: Ac-ET: accommodative esotropia.

Refractive status

The refractive status is shown in Table 3. We compared the refraction by mean refraction (OD/2 + OS/2), because children with anisometropia were excluded and the power of hyperopia were similar between the right and left eyes. There were borderline significant differences in refraction between groups. Thus, the children with fully refractive Ac-ET tended to have higher hyperopia than these with partially refractive Ac-ET.

Angle of esodeviation

The angle of esodeviation was examined without glasses at the first visit. We can see from Table 3 that the children with partially refractive Ac-ET had a lager angle of esodeviation than those with fully refractive Ac-ET.

Table 2. Visual Acuity (LogMAR)

Group	Group A Fully Ac-ET (n=17)*	Group B Partially Ac-ET (n=10)*	*p* (for BCVA)
BCVA at First Visit (LogMAR)	0.402 ±0.251	0.340 ±0.250	0.544
Rate of Amblyopia	14 / 17 (82%)	8 / 10 (80%)	
BCVA at Follow up (LogMAR)	0.057 ±0.079	0.051 ±0.088	0.849
Rate of Amblyopia	4 / 17 (24%)	3 / 10 (30%)	

Abbreviations: Ac-ET: accommodative esotropia; BCVA: best corrected visual acuity.
*Twenty-seven out of 45 children could be checked their vision.

Table 3. Refractive Error, Angle of Esodeviation, and Presence of Inferior Oblique Overaction

	Group A Fully Ac-ET (n=28)	Group B Partially Ac-ET (n=17)	*p*
Mean Refraction (D) (OD/2 +OS/2)	+ 5.79 ±1.84	+ 4.79 ±1.40	0.062
Range	(+3 ~ +10.5)	(+3 ~ +7)	
Angle of esodeviation at first visit (PD)	31.4 ±11.6	42.6 ±12.6	0.004
Range	(20 ~ 60)	(25 ~ 60)	
Presence of IOOA (n) (percentage)	9 (32%)	8 (47%)	0.317

Abbreviations: Ac-ET: accommodative esotropia; OD: right eye; OS: left eye; D: diopter; PD: prism diopter; IOOA: inferior oblique overaction.

Inferior oblique overaction (IOOA)

There were no significant differences in the presence of IOOA between groups (Table 3).

DISCUSSION

Ac-ET is the most common type of childhood esotropia. Mohney et al. reported that 52.9% of cases of childhood esotropia were Ac-ET.[11] Spectacles correction guided by the degree of full cycloplegic refraction remains the preferred treatment. It may permit a clear image, which reduces the power of accommodative esodeviation and also improves visual acuity.[12,13]

Some children may develop almost orthotropia with wearing glasses, but some won't. We defined the former was fully refractive Ac-ET, and the later was partially refractive Ac-ET. In our study, 28 of the 45 children (62.2%) were fully Ac-ET, 17 children (37.8%) were partially Ac-ET. In a report by Mulvihill et al., 41 of 103 children (39.8%) were fully Ac-ET and 62 children (60.2%) were partially Ac-ET.[14] Koc et al. studied the cases of infantile ET with accommodative component and found 48.6% of patients were fully Ac-ET and 51.4% were partially Ac-ET.[15] There was a higher incidence of fully Ac-ET in our study than in the other studies. This might be due to over definition of orthotropia as under 10 prism diopters (PD), which was somewhat looser than other reports.

Age at Onset

In most children, Ac-ET is noted before the age of 3 years.[16] In our study, the mean ages at onset were 2.36 and 2.01 years respectively (Table 1) which is similar to other reports. However, the mean ages at first visit were 3.51 and 3.01 years respectively, which were almost one year later than the age at onset. This might reflect that parents in Taiwan pay less attention to their children's ocular health than Western parents.

Visual acuity

Our study showed that there was no significant difference in initial visual acuity between children with fully refractive Ac-ET and those with partially refractive Ac-ET (Table 2). Eighty-two percent of those with fully refractive Ac-ET were amblyopic at their first visit, and this rate decreased to 24% after treatment. In those with partially refractive Ac-ET, the rate decreased from 80% to 30%. Koc et al. reported 61% of patients with early onset fully Ac-ET were amblyopic, decreasing to 22% with treatment; 47% of those with early onset partially Ac-ET were amblyopic, decreasing to 21% after treatment (Table 4).[15] There was a high incidence of amblyopia at beginning in most studies, but this dramatically decreased after treatment. The incidence of amblyopia was similar in many reports. Glasses are efficient to treat hyperopic amblyopia. Some studies have shown better visual acuity with earlier spectacles correction.[17,18]

Refractive status

Hyperopia may add an accommodative part to esodeviation, or hyperopia alone may be entirely responsible for esodeviation. Our study showed that fully refractive Ac-ET patients tended to have greater hyperopic refraction than those with partially-refractive Ac-ET (Table 3). However, Koc et al. reported no difference in refraction between children with early onset fully and partially Ac-ET (+4.44D vs. +4.18D) (Table 4).[15]

Angle of esodeviation

Our results revealed that patients with partially refractive Ac-ET had larger angles of esodeviation than those with fully refractive Ac-ET. Koc et al. had the similar results in patients with early onset refractive Ac-ET (Table 4). So, we may say that patients with partially Ac-ET have larger angle of esodeviation at initial visit either early onset Ac-ET (less than 6 months old) or normally onset Ac-ET (2.5 years). Surgical correction should be reserved for children with partially Ac-ET.[19,20] Patients with partially Ac-ET should undergo surgery based on the amount of residual esotropia while wearing full optical correction.[21,22] Bilateral medial rectus recession (BMR) is favored for esotropia correction.

Inferior oblique overaction (IOOA)

IOOA may be seen in children with strabismus. The incidence of IOOA varies with the type of strabismus. A previous report revealed a higher incidence of IOOA (about 72%) in infantile ET, and a lower incidence (about 34%) in fully Ac-ET.[23] In our study, 32% of patients with fully Ac-ET and 47% of those with partially Ac-ET had IOOA. Although,

Table 4. Comparison of Results Among Different Studies

Items	This Study	Koc's Study.[15] (Early onset Ac-ET)	Other Studies
Incidence of fully Ac-ET	62.2%	48.6%	39.8% (Mulvihill A et al.)[14]
Incidence of partially Ac-ET	37.8%	51.4%	60.2% (Mulvihill A et al.)[14]
Prevalence of Amblyopia before & after treatment in fully Ac-ET	82%→24%	61%→22%	
Prevalence of Amblyopia before & after treatment in partially Ac-ET	80%→30%	47%→21%	
Refractive status in fully and partially Ac-ET	Borderline significance (+5.79 D vs +4.79 D)	No difference (+4.44 D vs +4.18 D)	
Angle of esodeviation in fully and partially Ac-ET	Significant difference (31.4 PD vs 42.6 PD)	Significant difference (45 PD vs 54.84 PD)	
Rate of IOOA in fully Ac-ET	32%	11%	34% (Wilson ME et al.)[23]
Rate of IOOA in partially Ac-ET	47%	21%	
Rate of IOOA in infantile ET			72% (Wilson ME et al.)[23]

Abbreviations: Ac-ET: accommodative esotropia; D: diopter; PD: prism diopter; IOOA: Inferior oblique overaction.

there were no significant differences between the groups, the incidence of IOOA in partially Ac-ET (47%) was somewhat lower than in infantile esotropia (72%) and higher than in fully Ac-ET (32%). We speculate that partially refractive Ac-ET might have components of both fully refractive Ac-ET and infantile esotropia. Simultaneous correction of residual esodeviation and IOOA in patients with partially refractive Ac-ET may be accomplished during surgery. Some patients with fully Ac-ET showing obviously IOOA may need surgery despite of the fact that esodeviation can be corrected by spectacles.[24,25]

In this study, we found some differences among fully refractive Ac-ET and partially refractive Ac-ET at the patients' first visits. These with fully refractive Ac-ET had smaller angles of esodeviation, and tended to have higher refraction than those with partially refractive Ac-ET. We speculate that if children have higher hypermetropic esotropia, they may have a higher chance to be fully refractive Ac-ET which can be easily treated by glasses. On the other hand, if they have a larger angle of esodeviation on their first visit, they may be more prone to be partially refractive Ac-ET, which has more non-accommodative components. Since it is more difficult to correct esodeviation with glasses, these children may eventually need strabismus surgery. Thus, we might be able to make early predictions as to which patients will eventually require strabismus surgery.

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依屈光性調節性內斜視病人之最初臨床表現來預期治療結果

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背 景：屈光性調節性內斜視病人在治療2年後，依結果可分成純屈光性及部分屈光性兩組。而最初臨床表現之異同則尚未被深入研究。

方 法：由前來本院就診，年齡自6月至8歲之病患中，選取遠視大於+3.00D，合併有內斜視之病例。給予足夠度數的眼鏡矯正，經治療2年後，依治療的結果將病人分成純屈光性內斜視及部分屈光性內斜視兩組。比較兩組病人最初的臨床表現，如：發生年齡，就診年齡，視力，遠視度數，內斜視角度及下斜肌有無過強。

結 果：兩組病人在發生年齡 (2.35±1.74 歲比2.01±1.96 歲，$p=0.539$)， 就診年齡 (3.51±1.36 歲比3.01±1.70 歲，$p=0.285$)，視力 (LogMAR: 0.40±0.25 比LogMAR ：0.34±0.25， $p=0.544$) 及下斜肌過強的比例 (32% 比47% ，$p=0.317$) 並無統計上的差異。兩組病人的視力在治療後皆有顯著進步。而純屈光性內斜視病人的內斜視角度較小 (31.4±11.6 稜鏡角比42.6±12.6稜鏡角，$p=0.004$)，遠視度數亦有較深的傾向 (5.79±1.84 D 4.79±1.40 D，$p=0.062$)。

結 論：病人初次就診時，若遠視度數較高或是內斜視角度較小者，比較可能屬於純屈光性內斜視，治療後內斜視多可改善，較不需要開刀；若遠視度數較低或內斜視角度角度較大者，則比較可能屬於部分屈光性內斜視，於配鏡治療後，仍可能殘留內斜視角度，而需開刀矯正。

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關鍵字：調節性內斜視，弱視，屈光度數，斜視角度，下斜肌過強。

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