

Prevalence of Neurological Abnormalities from Neuroimaging in Acute Acquired Comitant Esotropia

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ABSTRACT

OBJECTIVE This study aimed to determine the prevalence and characteristics of patients with acute acquired comitant esotropia (AACE) who had abnormal findings on neuroimaging.

METHODS A retrospective review of data from patients diagnosed with AACE who had an onset age of greater than six months, cycloplegic refraction of less than +3.00 spherical diopters, and had undergone neuroimaging between 2014 and 2024 was conducted.

RESULTS A total of 45 patients, 28 males (62.2%) were included in the study. The overall mean age was 10.2 years, and the mean angle of deviation was 36.11 prism diopters (PD) for distance and 36.1 PD for near. Of the 45 patients, 43 (95.6%) had normal neuroimaging and 2 (4.4%) had abnormal neuroimaging. Abnormal findings consisted of a small vascular anomaly in one patient and an arachnoid cyst in another. The mean age at onset was 5.5 years in the abnormal neuroimaging group and 8.8 years in the normal neuroimaging group ($p = 0.46$). The mean near angle of deviation was 27.5 PD versus 36.8 PD ($p = 0.21$) in patients with abnormal and normal neuroimaging, respectively. The mean distance deviation was 25 PD and 36.9 PD ($p = 0.19$) in the abnormal and the normal neuroimaging group, respectively. No patients demonstrated associated abnormal neurological symptoms or signs.

CONCLUSIONS No predictive factors associated with abnormal neurological findings were identified as statistically significant. Despite the infrequency of abnormal neuroimaging findings in AACE and the absence of identified predictive factors, clinicians should remain aware of the possibility of underlying brain abnormalities.

KEYWORDS strabismus, esotropia, acute acquired comitant esotropia, neurologic manifestations, neuroimaging

INTRODUCTION

Acute acquired comitant esotropia (AACE) is characterized by an acute onset of esodeviation without any limitation in ocular motility. It is essential to distinguish AACE from infantile and

accommodative esotropia (1). AACE is a relatively rare condition, affecting approximately 0.3% of pediatric strabismus cases (2, 3). The etiologies of AACE have been reported to include functional, systemic, and intracranial diseases. Recently,

an increased prevalence of functional AACE has been noted, which is believed to be linked to excessive near work associated with the use of digital devices (4), particularly during the COVID-19 pandemic (5-7).

AACE is classified into three types (8). Type I (Swan type) is attributed to loss of fusion commonly triggered by monocular occlusion. Type II (Burian-Franceschetti type) refers to idiopathic AACE, often precipitated by physical or psychological stress with minimal hyperopia of less than +3.00 diopters (D). Type III (Bielschowsky type) is associated with myopia. Some researchers classify AACE into seven types (2), which includes a neurological AACE subtype associated with intracranial pathologies.

Additionally, many studies have found that AACE is associated with neurological pathologies that require neuroimaging. Some reports suggest that the risk of neurological disease is comparable in both comitant and incomitant esotropia (9).

Various neurological diseases have been associated with AACE, including medulloblastoma, astrocytoma of the corpus callosum and cerebellum, pontine glioma, hydrocephalus, cerebellar ataxia, Arnold-Chiari malformation, idiopathic intracranial hypertension, myasthenia gravis, and thalamic lesions (10). Therefore, some researchers emphasize that intracranial issues may contribute to AACE and recommend using MRI as a diagnostic screening tool (6, 11, 12).

Some studies have suggested the characteristics of AACE that may indicate underlying neurological diseases may assist physicians in determining when to prioritize neurological evaluations and consider brain magnetic resonance imaging (MRI). Intracranial disease associated with AACE has been linked to factors such as A or V pattern esotropia, greater esodeviation at distance, recurrence of AACE, nystagmus, and abnormal ocular or neurological signs (e.g., headache, cerebellar imbalance, weakness, or papilledema) (2, 10, 13, 14). However, many studies report that coexisting or underlying neurological diseases were not found in patients with isolated AACE, suggesting that neuroimaging may not be necessary (1, 15, 16). This has resulted in a controversial debate on whether or not MRI is necessary for children with AACE. In light of this uncertainty, some clinicians routinely obtain neuroimaging in all

patients diagnosed with AACE to assure patient safety, whereas others reserve imaging for high-risk patients or those with abnormal neurological symptoms or signs.

Currently, there is no consensus on guidelines for considering further neuroimaging in AACE. Physicians must weigh the likelihood of detecting abnormal results against the risks of radiation exposure, the potential adverse effects of general anesthesia in uncooperative patients, and cost-effectiveness, particularly in public health settings.

Although many studies have been performed in Caucasian populations (17-20), the number of studies has increased in Asian populations (5, 21-24). Racial differences may affect the prevalence and characteristics of patients with abnormal neurological conditions associated with AACE. The higher prevalence of myopia in Asian populations may also be a relevant factor.

Considering the limited data on the prevalence and characteristics of neurological AACE in Asian populations and the lack of consensus on neuroimaging indications, understanding the prevalence of abnormal neurological findings and the characteristics of ocular manifestations, along with associated systemic signs and symptoms in patients in Asian populations with AACE who have neurological pathologies could guide physicians in making decisions regarding further investigation.

METHODS

The data were collected using International Classification of Diseases (ICD)-10 codes for patients diagnosed with convergent comitant strabismus (H50.0), intermittent heterotropia (H50.3), unspecified strabismus (H50.9), and diplopia (H53.2) at Chiang Mai University (CMU) hospital between June 2014 and June 2024.

The inclusion criteria were age at onset greater than six months, cycloplegic refraction of less than +3.00 spherical equivalent, and having undergone brain MRI or computed tomography (CT) interpreted by radiologists. Exclusion criteria were any abnormalities of the ocular structures, a history of ocular surgery or trauma, a reduction in esotropia with hyperopic spectacle correction, pre-existing neurological diseases, congenital neurological pathologies, and cases of AACE without brain CT or MRI evaluation.

Data collection included general demographic information, ocular findings (best-corrected visual acuity, age at and duration of onset, presence of diplopia, angle of deviation for near and distance, anterior and posterior segment examination, ocular motility, cycloplegic refraction, sensory test results, presence of nystagmus, presence of an A or V pattern, and systemic findings (history of systemic involvement such as papilledema, nausea, vomiting, developmental regression, reduced coordination, dizziness, headache, and tinnitus). Associated neurological signs were also recorded, including impairment of other cranial nerves and ataxia. Neuroimaging findings were obtained from brain CT with or without contrast and brain MRI.

Data analysis and statistical methods included descriptive data presented as mean or median. Categorical variables are reported as numbers and percentages. To compare continuous variables between patients with normal and abnormal neuroimaging, an independent t-test was used for normally distributed data, whereas a Mann-Whitney U test was applied for non-normally distributed data. Chi-square or Fisher's exact test was used to analyze categorical variables, depending on the distribution. Predictive factors for abnormal neuroimaging were assessed using odds ratios and 95% confidence intervals (CI). A $p < 0.05$ was considered statistically significant, and all analyses were performed using Jamovi version 2.3.28.0 (The Jamovi Project, Sydney, Australia).

Institutional ethics approval was obtained from the Faculty of Medicine, CMU. All data were fully anonymized.

RESULTS

A total of 2,835 patients were identified based on these ICD-10 codes. Among these, 236 patients met the criteria for AACE of whom 45 patients (19.1%) had undergone neuroimaging, as shown in Figure 1.

Of the 45 patients who underwent neuroimaging, 23 patients (51.1%) underwent a brain CT without contrast, 18 patients (40.0%) underwent a brain CT with contrast, and 4 patients (8.9%) underwent brain MRI, as shown in Figure 2.

Many of the neuroimaging procedures (81.0%) were not from our center. Among the 45 patients who underwent neuroimaging, neurological abnormalities were identified in 2 patients (4.4%). All abnormal findings were detected through brain CT, as shown in Figure 3.

Among the 45 patients with AACE who underwent neuroimaging, the mean age was 10.2 years, with a median age of 8 years and a maximum age of 32 years. The median ages for the normal and abnormal neuroimaging groups were 8 years and 6 years, respectively. The patients were divided into three age groups: < 10, 10-18, and > 18. The majority of cases (31 patients, 68.8%) occurred in those under 10 years old. Additionally, there were more male patients, including 28 boys (62.2%). The underlying diseases identified included G6PD deficiency, anemia, and sinusitis. No medication was used to treat those underlying diseases. No significant differences in baseline characteristics were observed between the abnormal and normal neuroimaging groups, as shown in Table 1.

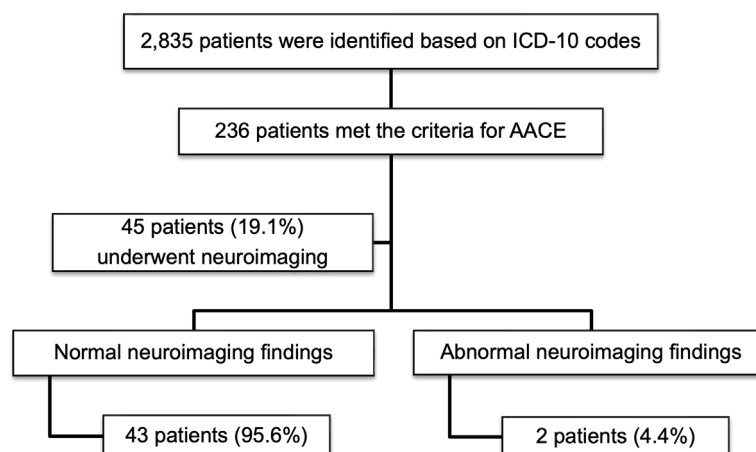
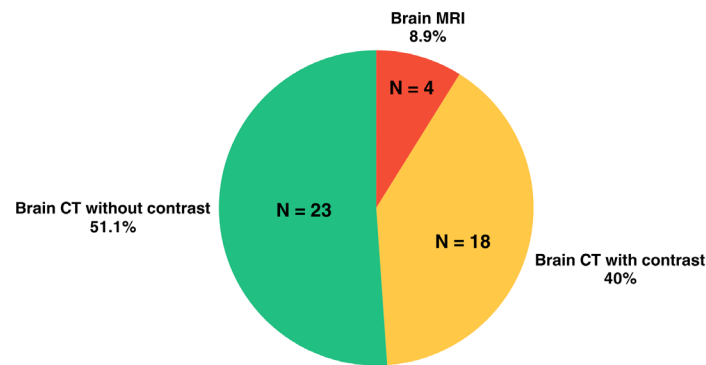


Figure 1. Patient selection flowchart for AACE identified from ICD-10 codes: of 236 patients who met the AACE criteria, 45 underwent neuroimaging. Of those, 2 (4.4%) had abnormal neuroimaging findings.



CT, computed tomography; MRI, magnetic resonance imaging, N, numbers

Figure 2. Distribution of neuroimaging procedures among 45 patients with AACE: brain CT without contrast was the most common modality (23 patients, 51.1%), followed by brain CT with contrast (18 patients, 40.0%), and brain MRI (4 patients, 8.9%).

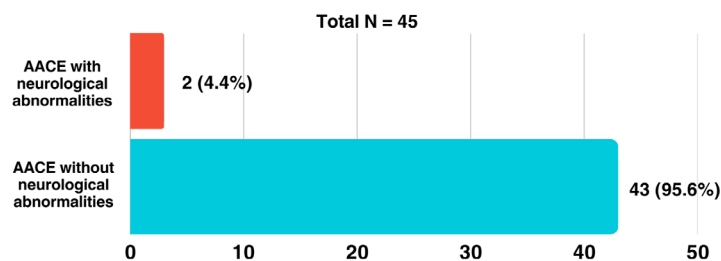


Figure 3. Prevalence of abnormal neuroimaging findings in AACE, identified in 2 of 45 patients (4.4%) who underwent neuroimaging.

Table 1. Demographic data of AACE patients with abnormal and normal neuroimaging

Characteristics	Total (N, %)	Abnormal neuroimaging (N, %)	Normal neuroimaging (N, %)	p-value
Age (years)				0.38
Mean	10.2	6	10.4	
Median	8.0	6	8	
Min, max	2, 32	6	2, 32	
Age group				1.00
< 10 years	31 (68.8)	2 (100.0)	29 (67.4)	
10–18 years	7 (15.6)	0 (0.0)	7 (16.3)	
> 18 years	7 (15.6)	0 (0.0)	7 (16.3)	
Gender				0.52
Male	28 (62.2)	2 (100.0)	26 (60.5)	
Female	17 (37.8)	0 (0.0)	17 (39.5)	
Underlying diseases				1.00
Present	2 (4.4)	0 (0.0)	2 (4.7)	
Absent	43 (95.6)	2 (100.0)	41 (95.3)	
Medication used				N/A
Present	0 (0.0)	0 (0.0)	0 (0.0)	
Absent	45 (100.0)	2 (100.0)	43 (100.0)	

N, number; N/A, not applicable

For ocular findings, the overall mean and median ages at onset were 8.7 and 7 years, respectively. The mean age at onset was 5.5 years in the abnormal neuroimaging group and 8.8 years in the nor-

mal neuroimaging group. The median duration of esotropia prior to the first outpatient visit was approximately 5 months. Symptoms of diplopia were reported in 25 patients (55.6%). A history

of intense near work was recorded in 7 patients (15.6%), all in the normal neuroimaging group. No patients had nystagmus or abnormalities in the anterior or posterior segment upon ocular examination. The overall mean angle of deviation at near was 36.1 prism diopters (PD). The overall mean near deviation was 36.8 PD in the normal neuroimaging group and 27.5 PD in the abnormal neuroimaging group. The overall mean distance deviation was 36.9 PD in the normal group and 25 PD in the abnormal neuroimaging group. Neither A nor V patterns were observed. A total of 27 out of 45 patients (60.0%) underwent sensory

testing (Worth 4-Dot). Diplopia was observed at near in 18 patients (66.7%) and at distance in 17 patients (63.0%), all of whom were in the normal neuroimaging group. The remaining patients in both groups reported suppression of conflicting information from one eye or the other. The overall spherical equivalent cycloplegic refraction demonstrated a mean of -0.04 D in the right eye and +0.21 D in the left eye. No significant differences in ocular findings were found between the two groups, as shown in Table 2.

No associated abnormal neurological symptoms or signs were observed among the patients

Table 2. Ocular findings in AACE patients with abnormal and normal neuroimaging

Characteristics	Total (N = 45)	Abnormal neuroimaging (N = 2)	Normal neuroimaging (N = 43)	p-value
Age at onset (years)				0.46
Mean	8.7	5.5	8.8	
Median	7	5.5	7	
Min, max	1, 32	5, 6	1, 32	
Duration of onset (months)				0.71
Mean	17.6	6.3	18.2	
Median	5	6.3	5	
Min, max	0.1, 216	0.5, 12	0.1, 216	
Diplopia, n (%)				0.58
Present	25 (55.6)	1 (50.0)	24 (55.8)	
Absent	20 (44.4)	1 (50.0)	19 (44.2)	
Near work history, n (%)				1.00
Present	7 (15.6)	0 (0.0)	7 (16.3)	
Absent	38 (84.4)	2 (100.0)	36 (83.7)	
Presence of amblyopia	7 (15.6)	0 (0.0)	7 (16.3)	1.00
Near deviation (PD)				0.21
Mean	36.10	27.5	36.8	
Median	35	27.5	35	
Min, max	7, 70	25, 30	7, 70	
Distance deviation (PD)				0.19
Mean	36.11	25	36.9	
Median	35	25	35	
Min, max	15, 70	25	15, 70	
Sensory tests at near (N=27), n (%)				0.33
Diplopia	18 (66.7)	0 (0.0)	18 (69.2)	
Suppression	9 (33.3)	1 (100.0)	8 (30.8)	
Sensory tests at a distance (N=27), n (%)				0.37
Diplopia	17 (63.0)	0 (0.0)	17 (65.4)	
Suppression	10 (37.0)	1 (100.0)	9 (34.6)	
Spherical equivalent (OD) (D)				0.90
Mean	-0.04	+0.13	-0.05	
Median	+0.38	+0.13	+0.38	
Min, max	-9.63, +2.00	-0.13, +0.38	-9.63, +2.00	
Spherical equivalent (OS) (D)				0.49
Mean	+0.21	+1.19	+0.17	
Median	+0.63	+1.19	+0.50	
Min, max	-10.75, +2.25	+0.63, +1.75	-10.80, +2.25	

D, diopters; N, number; N/A, not applicable; OD, oculus dexter (right eye); OS, oculus sinister (left eye); PD, prism diopters

in this study, including dizziness, tinnitus, ataxia, other cranial nerve impairments, abnormal cerebellar signs, developmental regression, reduced coordination, and there were no symptoms or signs of increased intracranial pressure such as nausea, vomiting, headache, or papilledema.

The analysis found no significant differences in any characteristics considered as potential predictive factors, including gender and age at onset, between the abnormal and normal neuroimaging groups ($p > 0.05$), as shown in Table 3.

Among the patients with AACE who underwent neuroimaging, abnormal neurological imaging findings were identified in 2 patients as described below.

Case #1

A 6-year-old Thai boy was referred from a provincial hospital with a history of horizontal diplopia two weeks prior. There was no history of previous trauma. At presentation, he had an esotropia of 25 PD at both distance and near by the alternate prism cover test. His Snellen visual acuity was 6/9, OU. The Worth 4-Dot test demonstrated alternate suppression, predominantly in the right eye. His cycloplegic refraction was +1.25 -2.75 x 20, OD and +2.50 -1.50 x 170, OS. A brain CT conducted at a private hospital revealed a small vascular anomaly, with no mass detected. The anomaly was observed and no further management was required. The patient was scheduled for bilateral medial rectus recession.

Case #2

A 6-year-old Thai boy presented with a history of esotropia for one year. He was generally healthy with normal growth and development and had no underlying medical conditions. He reported no symptoms such as headache, vomiting, seizure, or weakness. His Snellen visual acuity was 6/9, OU. Cycloplegic refraction was +0.50 -0.25 x 175 OD and +0.75 -0.25 x 5 OS. His eye examination showed esotropia of 30 PD by the Krimsky test. Grade I inferior oblique overaction was observed in both eyes. A brain CT without contrast performed at Chiang Mai University hospital revealed an extra-axial cerebrospinal fluid density lesion in the right middle cranial fossa, most likely an arachnoid cyst. Neurosurgery and pediatric specialists were consulted, and a brain MRI was performed. The MRI revealed a stable-sized arachnoid cyst

Table 3. Predictive factors for abnormal neuroimaging in patients with AACE who underwent neuroimaging

Predictive factors	Adjusted odds ratios	95% confidence interval	p-value
Gender	NE	NE	NE
Age at onset	0.799	(0.799, 1.414)	0.44

AACE, acute acquired comitant esotropia; NE, not estimable

measuring 5.5 x 5.0 x 5.1 cm located at the right anterior temporal and inferior frontal regions. The mass effect caused posterior displacement of the right anterior temporal lobe and anterosuperior displacement of the right inferior frontal lobe, resulting in compression of the frontal horn of the right lateral ventricle and a 0.4-cm leftward bowing of the midline structures. No brain herniation was observed. The patient underwent cyst excision, and the postoperative diagnosis was an arachnoid cyst at the right sylvian cistern (type I). Bilateral medial rectus recession is planned for the patient when the angle of deviation stabilizes.

DISCUSSION

Since the COVID-19 pandemic, the prevalence of AACE has increased significantly, likely due to increased screen time and intense near work prompted by lifestyle changes in the COVID era (5-7). Older children and adults have been reported to be more susceptible to AACE than younger children (25). In our study, the mean and median ages of the patients were relatively young, at 10.2 years and 8 years, respectively. The patients were classified into three age groups (16): under 10 years, 10 to 18 years and over 18 years old. In this study, 68.8% were in the group under 10 years of age. This finding is consistent with previous studies which reported mean ages of 4.7 years (2), 5.5 years (1), 9.8 years (15), and 10.8 ± 8.6 years (16). However, several other studies have reported AACE in older age groups with a mean ages of 32.35 ± 24.40 years (13) and 22.9 ± 16.1 years (5). Notably, all patients with abnormal neuroimaging in our study were younger than 10 years old, although this difference did not reach statistical significance. The mean age in the abnormal neuroimaging group was 6 years, which is younger than the mean age of 7.1 years (range 3-13 years) reported in previous studies (9, 20, 23, 26).

The overall mean age at onset in our study was 8.7 years. In the group with neurological abnor-

malities, the mean age was 5.5 years, which was lower than the overall average but not statistically significant. This is comparable to a previous study that reported a mean age of 4.7 years (2, 3).

The duration of esotropia prior to the outpatient visit in this study varied widely, ranging from 1 day to 216 days. This is consistent with a study that reported a mean duration of 15 ± 3.8 days and a range of 1–180 days (2).

Intense near work is associated with AACE. A history of prolonged near work was reported in only 7 patients, all with normal neuroimaging findings. Due to the retrospective nature of the study, however, information extracted from patient charts may have been incomplete, especially in regard to specific subjective details.

In all cases, both anterior and posterior segment examinations were unremarkable. Additionally, no abnormal neurological signs, nystagmus, or A or V pattern which have been reported in previous studies were noted (2, 10, 13, 14). The degree of esotropia varies greatly among different studies and populations. In this study, the mean angles of deviation at near and distance were 36.10 PD and 36.11 PD respectively, which aligns with a study by Buch et al. that reported a similar moderate degree of deviation (37 and 35 PD) (2). However, these findings contradict several previous studies that reported lower angles of deviation (5, 13, 15, 27), with one study suggesting age differences as a possible explanation (13). On the contrary, a study by Montriwet reported a greater angle of esotropia in younger individuals, with a distance deviation of 43.57 ± 9.77 , 51.54 ± 8.75 , and 30.14 ± 12.39 PD observed in younger children, older children, and adults, respectively (16). The mean angles of esotropia at near fixation in the three age groups were 43.57 ± 9.37 , 51.15 ± 9.39 , and 31.43 ± 12.15 PD.

In our study, we found that the abnormal neuroimaging group demonstrated smaller deviations at near and distance compared to the normal neuroimaging group, with values of 27.5 PD and 25 PD at near and distance. In contrast, the normal neuroimaging group showed larger deviations of 36.8 PD and 36.9 PD at near and distance, although this difference was not statistically significant. This may be due to the smaller sample size in the abnormal neuroimaging group. These findings are in contrast to a study that reported a greater

angle of deviation at distance ($> 40\%$) as a considerable risk factor for the presence of intracranial pathology (2).

The prevalence of intracranial abnormalities varies in different studies and currently there is no consensus on neuroimaging for AACE. Among the 45 patients in this study who underwent neuroimaging, neurological abnormalities were identified in 2 patients (4.4%). All abnormal findings were detected through brain CT. This prevalence is similar to that reported in several studies e.g., a study by Buch et al. that found a prevalence of 6% among 48 patients (2), Dotan et al. which reported a prevalence of 5% among 20 cases (15), and a study by Mittendorf et al. which found one out of 21 patients (4.7%) with abnormal but insignificant MRI findings (1). In contrast, no abnormal neuroimaging findings were identified in patients with AACE in any of the three series (28–30). Montriwet also reported no neurological abnormalities in 36 patients with AACE (16). This lack of findings is consistent with Iimori et al., who reported that intracranial diseases were entirely excluded through brain MRI or CT for all 41 patients included in their study (31). In contrast, a study by Surachatkumtonekul et al. on acquired esotropia found abnormalities in a total of 64 out of 117 cases (36.2%) although their study included all cases of acquired esotropia, not exclusive to AACE (13).

Various factors influence the selection of imaging modalities, including the limited availability of MRI, extended wait times for MRI appointments, the timing of MRI interventions, and the necessity for pediatric deep sedation. In settings where these factors are a concern, brain CT may be a more viable option for screening neurological abnormalities. While CT may not offer the fine, detailed information provided by MRI, it remains highly effective in detecting significant lesions that can play a critical role in guiding appropriate primary management decisions, especially in regions with limited resources, such as Thailand.

It can be observed that the majority of patients in this study were imaged at the referring hospital (81.0%), primarily to rule out life-threatening conditions, with CT being the most frequently used due to its greater availability prior to referral. The imaging was done prior to obtaining cycloplegic refraction results. Among the patients in the present study, some with normal neuroimaging

were excluded because subsequent cycloplegic refraction revealed hyperopia greater than +3.00 D spherical equivalent.

Concomitancy in acute-onset esotropia does not rule out an underlying serious neurological condition; therefore, the decision whether to perform neuroimaging or not should not be based only on concomitancy (12, 28). Notably, even rare conditions such as Lhermitte–Duclos disease have been reported to manifest as typical AACE, characterized by strict comitancy, even when accompanied by other focal neurological symptoms (32).

Abnormal neuroimaging findings in this study included one case of a small vascular anomaly and an arachnoid cyst in the right anterior temporal and inferior frontal regions, findings which had not been reported in previous studies. Other studies with a similar mean age of patients with AACE have identified conditions such as hydrocephalus, pontine glioma, and thalamic glioma (2).

Previous studies have reported associations between AACE and neurological disorders, including Arnold–Chiari syndrome, hydrocephalus, thalamic lesions, myasthenia gravis, and certain types of seizures (3, 5, 9, 10, 12, 33, 34), brain tumors (19), medulloblastoma, brainstem or cerebellar tumors, medullary pilocytic astrocytoma, cerebellar astrocytoma, Chiari I malformation, idiopathic intracranial hypertension, cerebellar ataxia (9, 10, 12, 23, 28, 33–35), inflammation, degenerative conditions, and vascular lesions (13).

An important observation from this study is that the absence of any signs of increased intracranial pressure such as headache, vomiting, diplopia and blurry vision does not rule out neurological abnormalities. This was demonstrated in case #2 who presented as a generally healthy young child without any abnormal symptoms other than acute esotropia but who had a large arachnoid cyst causing ventricular compression and bowing of midline structures, requiring urgent neurosurgery. Thus, it is important for physicians and ophthalmologists to be aware of the possibility of significant intracranial lesions despite the absence of symptoms or signs of increased intracranial pressure in AACE patients, especially young children who may not be able to completely express their symptoms.

No characteristics observed in the two patients with abnormal neuroimaging findings were sig-

nificantly different from those in patients with normal neuroimaging findings, and no predictive factors were identified that could suggest a higher likelihood of neuroimaging abnormalities. This is consistent with reports of neural abnormalities without abnormal neurological signs, such as several brain tumors, including cerebellar astrocytomas, cerebellar medulloblastomas, pontine gliomas, and astrocytoma of the corpus callosum with hydrocephalus (2, 9, 10, 12, 13, 15, 34, 36).

Since none of the neuroimaging abnormalities in this study offered a convincing explanation for AACE, these results were most probably incidental findings. This observation is consistent with research conducted by Srimanan (37), which reported abnormal neuroimaging findings in 4 out of 99 cases (4.04%), including an old intracranial hemorrhage, a cavernoma, a suspected meningioma, and a saccular aneurysm; however, none of these pathologies provided a definitive explanation for the esotropia deviation. Despite their incidental nature, some of these findings may represent life-threatening conditions.

This study was conducted prior to the publication of the 2025 Asia-Pacific consensus statement (38) which advocates for selective brain MRI based on specific red flags such as nystagmus, superior oblique overaction, A-pattern deviation, neurological symptoms (for example, headache, ataxia, or papilledema), onset after 6 years of age, significant distance–near dissociation, recurrence, or atypical presentation in children under 4 years of age. Nonetheless, our findings underscore that abnormal neuroimaging results can be present in patients with AACE even in the absence of any risk factors or focal neurological deficits.

Consequently, the decision to pursue neuroimaging should follow a multifactorial approach that balances rigorous screening for neurological signs in accordance with current recommendations with the risk of missing potentially life-threatening incidental pathologies in otherwise asymptomatic individuals. Furthermore, the affordability and accessibility of MRI, the standard neuroimaging modality, remain significant barriers in many developing countries. The use of brain CT as an alternative diagnostic tool necessitates a careful recognition of its inherent diagnostic limitations.

Our study has several limitations. Notably, brain CT was the predominant imaging modality,

consistent with real-world practice and resource availability. However, CT is not the gold standard for neuroimaging in AACE and exhibits lower sensitivity for detecting lesions in the posterior fossa and subtle brainstem abnormalities, which are more reliably detected with MRI. Accordingly, our results may underestimate intracranial pathologies, leading to an underrepresentation of neuroimaging abnormalities in AACE. In addition, the small number of patients with abnormal neurological findings may have affected the statistical analysis, significantly limiting the reliability and validity of the regression analysis. Multivariable results should be interpreted cautiously due to possible overfitting and limited power. These findings are hypothesis-generating rather than definitive. Furthermore, missing or incomplete data due to the retrospective nature of the study represents a significant limitation. Larger prospective studies are needed for developing future guidelines regarding the role of neuroimaging in AACE patients of all age groups.

CONCLUSIONS

Although neurological abnormalities are infrequent in children with AACE, clinicians must remain aware of the possibility of underlying brain abnormalities despite the absence of neurological symptoms, focal signs, or evidence of increased intracranial pressure. While brain MRI unequivocally remains the diagnostic gold standard, the selection of a neuroimaging modality warrants consideration of multiple factors, including resource availability, and the specific risk-benefit profile of alternative modalities within different clinical settings.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest to report.

AUTHOR CONTRIBUTIONS

T.J.: data collection, conceptualization, visualization, interpretation of data, writing — original draft, writing — review and editing; A.S.: data collection and interpretation of data; W.S.: data collection and interpretation of data; J.S.: data collection and interpretation of data; S.A.: data collection and interpretation of data; A.W.: conceptualization, visualization, interpretation of data, writing — review and editing, and final approval.

All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT

According to the policy implemented during this study, the ethics committee does not permit the authors to share the data with other entities. The datasets used and analyzed for the current study are available from the corresponding author upon reasonable request.

INSTITUTIONAL REVIEW BOARD STATEMENT

This study was approved by the Ethics Committee of the Faculty of Medicine, Chiang Mai University (study code, OPT-2568-0377 and date of approval, June 10, 2025).

INFORMED CONSENT STATEMENT

Not applicable.

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