

## **Abusive Head Trauma in Children: The Extent and Clinical Characteristics**

Fadheela T Al-Mahroos, MD, MHPE\* Eshraq A Al-Amer, MD, ABMS (Peds)\*\*  
Hakima A Al-Hashimi, FFR RCSI, MHPE\*\*\* Adel M Abdulla, MBBS, ABP\*\*\*\*  
Nabeel Hameed, MD\*\*\*\*\*

**Background:** Abusive head trauma (AHT) is the leading cause of death in child abuse. Knowledge about AHT in Bahrain is lacking. The objectives are to identify the extent of AHT in Bahrain, victims' characteristics and the clinical features.

**Setting:** Child Protection Unit, Salmaniya Medical Complex.

**Design:** Retrospective review.

**Method:** Abusive head traumas were evaluated between 2000 and 2009. Victims' characteristics, patterns of presentation and result of investigations were recorded. SPSS version 17 for Windows was used for data management and statistical analyses.

**Result:** Twenty-three patients with the diagnosis of AHT were identified. In 18 (78%) the age is one year or below; 16 (70%) were males. No plausible explanation for the head injuries was given in 16 (70%) patients. Vomiting was seen in 13 (56.5%), seizures in 13 (56.5%), altered state of consciousness in 12 (52%), irritability in 12 (52%), difficulty of breathing in 9 (39%), coma in 8 (35%), apnea in 4 (17%), choking episodes in 3 (13%) and two were dead on arrival. The total death after AHT was four (17%). Subdural hemorrhage was identified in 19 (83%), cerebral hemorrhage in 17 (74%) and retinal hemorrhage in 13 (56.5%).

Evidence of blunt impact were bruises in 13 (56.5%), skull fractures in 9 (39%), localized scalp swelling in 5 (22%) and subgaleal hematoma in 2 (9%).

**Conclusion:** AHT is associated with a high morbidity and mortality. The presenting symptoms of AHT are non-specific; therefore, maintaining a high index of suspicion is paramount. All children presenting with a life-threatening event or head injuries without a plausible explanation should undergo a multidisciplinary assessment for AHT. A prospective national study is required.

*Bahrain Med Bull 2011; 33(4):*

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\* Consultant Pediatrician and Associate Professor

\*\* Pediatrics Specialist

\*\*\* Consultant Radiologist and Assistant Professor

\*\*\*\* Consultant Pediatrician and Pediatric Intensivist

\*\*\*\*\* Consultant Neurosurgeon

Salmaniya Medical Complex, Ministry of Health

College of Medicine and Medical Sciences, Arabian Gulf University

Kingdom of Bahrain

Email: fadheela@batelco.com.bh

Abusive head trauma (AHT) is the most serious form of child physical abuse (CPA) and is the leading cause of death among the victims<sup>1,2</sup>. Traditionally, shaking baby syndrome (SBS) is the term used to describe head injuries in infants with the classical SBS triad of subdural hemorrhage (SDH), retinal hemorrhage and acute encephalopathy. Head injury may be the sole manifestation of AHT; however, it is frequently associated with skeletal injuries.

The first description of AHT was in 1946 by John Caffey who described six children with chronic subdural hematoma and long bone fractures<sup>3</sup>. However, the association between the injuries and inflicted trauma was not clear until the two landmark articles about shaking baby syndrome were published in the seventies<sup>4,5</sup>.

The exact mechanism of injuries in AHT is unknown<sup>6</sup>. The most accepted mechanism of injury is acceleration-deceleration and rotational forces which results from shaking and leads to shearing injury. This leads to the rupture of the bridging veins between the brain surface and the dural sinuses. The blood spreads into the inter-hemispheric fissure and along the entire cerebral hemisphere. It is speculated that the larger subarachnoid space in infants allows for more movement between the brain and the dura and leads to susceptibility of ruptured veins.

The mechanism of SBS has been a subject for debate, but the main support for shaking as the mechanism of injury came from reports of AHT cases in which the perpetrators admitted abusive shaking<sup>7-10</sup>. In a French study, shaking was described by the perpetrators as extremely violent and was repeated on average 10 times because it stopped the infant's crying<sup>11</sup>.

SBS limits the mechanism of abuse to shaking and does not consider other mechanisms. Therefore, a less mechanistic term 'abusive head trauma' (AHT) was proposed by the American Academy of Pediatrics, the new term is more inclusive of other mechanisms of injury such as blunt impact, while it considers SBS as a subset of AHT<sup>12</sup>.

In addition, to the primary trauma, it is well recognized that secondary brain injury is caused by hypoxia, ischemia and metabolic cascades<sup>13,14</sup>. Furthermore, concomitant cervical spine injury can sometimes be found in severe cases<sup>15</sup>. The consequences of AHT include death or permanent disability, cerebral palsy, mental retardation, blindness, seizure disorders, impaired development and learning difficulties.

Knowledge of AHT in child abuse victims in Bahrain is lacking. Identifying the extent of the problem and its characteristics is important to increase professionals' awareness and improve recognition. The aim of this study is to identify the extent of AHT in Bahrain, victims' characteristics and the clinical features.

## **METHOD**

AHT was defined as any case of head injury resulting from a substantiated or suspected child physical abuse involving shaking with or without blunt head impact. A structured data collection form was used. The CPU records were retrospectively reviewed for all cases of AHT evaluated by the Child Protection Unit over the last 10 years, 2000-2009.

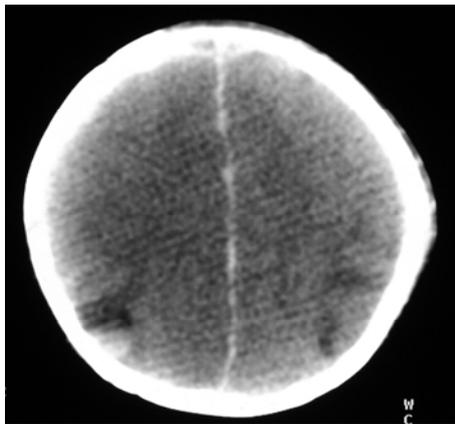
Child's characteristics, presentation, nature of injuries and results of investigations were recorded. All cases of accidental trauma were excluded. SPSS version 17 for Windows was used for data management and statistical analyses. Institutional scientific and ethical approval for this research proposal was obtained from the Health Research Committee at Salmaniya Medical Complex.

## RESULT

Twenty-three children were identified with the diagnosis of AHT during the ten years of the study (2000-2009), 16 (70%) were males and 7 (30%) were females. Age distribution revealed that 18 (78%) children were one year or below, table 1. One child was 10 years old and sustained concussion with a brief loss of consciousness. A six year-old child had evidence of shaking without blunt impact. Thirteen (56.5%) were Bahrainis and 10 (43.5%) were Non-Bahrainis. No plausible explanation was given for the head injuries in 16 (70%) patients.

**Table 1: Age Distribution of Abusive Head Trauma Children (N=23)**

Age	Number (%)	Average age
≤ one year	18 (78)	4.5 months
3 years	2 (9)	3 years
5-6 years	2 (9)	5.5 years
10 years	1 (4)	10 years



**Figure 1: Brain Scan of Ten-week-old Infant Showing Diffuse Brain Edema Causing Compression of the Lateral Ventricles, Loss of Gray-white Matter Differentiation, Inter-hemispheric and Subdural Hemorrhages and Bilateral Posterior Brain Contusions**

Table 2 is showing the clinical presentations of the victims. Ventilatory support was required in 7 (30%) patients. Four patients (17%) died, two were dead on arrival. Various injuries are shown in table 3 and figures 1-4.

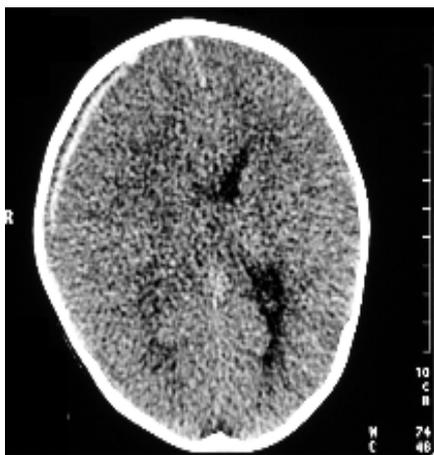
**Table 2: Clinical Presentations of Abusive Head Trauma**

Signs & Symptoms	Number (%)
Vomiting	13 (56.5)
Seizures	13 (56.5)
Altered state of consciousness	12 (52)
Irritability	12 (52)
Difficulty breathing	9 (39)
Coma	8 (35)

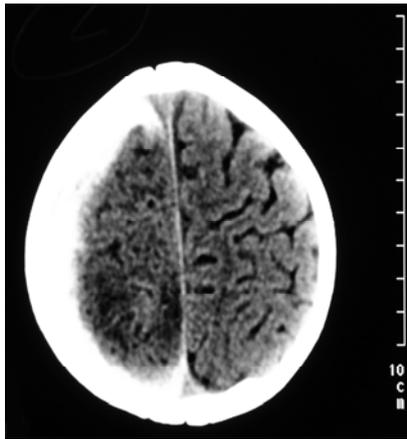
Apnea	4 (17)
Choking episodes	3 (13)
Dead on arrival to ER	2 (9)

**Table 3: Spectrum of Injuries Associated with AHT**

<b>Findings</b>	<b>Number (%)</b>
Bruises	13 (56.5)
Localized scalp swelling	5 (22)
Skull fracture	9 (39)
Extensive Subgaleal hematoma	2 (9)
Subdural hemorrhage	19 (83)
Cerebral hemorrhage	17 (74)
Subarachnoid hemorrhage	8 (35)
Brain edema	8 (35)
Retinal hemorrhage	13 (56.5)



**Figure 2: Non-contrast CT scan of the Brain of One-year-old Male Infant, at First Presentation Showing Acute-on-chronic Right Subdural Hematoma with Marked Mass Effect and Midline Shift**



**Figure 3: Non-contrast CT scan of the Brain of One-year-old Male Infant, 3 Weeks after First Presentation Showing Re-bleed at the Right Fronto-parietal Subdural Space**



**Figure 4: MRI Brain T2 Weighted Sequence of One-year-old Male Infant, 3 Weeks after First Presentation Showing Right Bleed on Sub-acute Subdural Hematoma with Brain Volume Loss**

Thirteen (56.5%) had retinal hemorrhage, out of which 4 (31%) had diffuse multilayer hemorrhage and was associated with bleeding into the vitreous. Two children had lost their vision with mental retardation and seizure; a six-year-old child is in a vegetative state. Extensive subgaleal hematoma was seen in two cases; in a three-year-old girl, it was associated with localized 4 x 4 cm occipital alopecia caused by hair pulling, which caused massive bleeding and drop in hemoglobin to 6 g/dL.

Other causes of retinal hemorrhages in an infant, such as birth trauma, accidental head injury, subarachnoid hemorrhage, coagulopathy, leukemia, infections and arteriovenous malformations were ruled out. Abusers were males in 11 (48%) cases, females in 8 (35%) cases and unknown gender in 4 (17%). Surgical intervention was required in 11 (48%) cases. Seventeen (74%) were reported to police and/or reported directly to Public Prosecution in 11 (48%).

## **DISCUSSION**

This is the first study of AHT children in Bahrain. The result of this study is consistent with previously published research in highlighting the lack of plausible history, the severity of brain and eye injuries and the high morbidity and mortality rate<sup>12,13</sup>. Non-specificity of signs and symptoms of AHT mandate a high index of suspicion by health care providers. This study

probably represents the “tip of the iceberg” of a larger pool of traumatized children with less severe injuries who were not brought for medical care or managed as other illnesses.

The result of this study is compatible with international research findings, which consistently revealed that the majority of AHT victims are below one year of age<sup>1,2</sup>. The relatively large head size and weaker neck muscles make the infant more susceptible to injury from violent shaking. However, in this study, a six-year-old boy who sustained severe subdural hematoma and extensive hypoxic-ischemic injury without evidence of blunt impact, shaking was suggested as the most likely mechanism of injury. Similarly, SBS has been reported in older children by other researchers<sup>16</sup>. These findings have legal ramifications and emphasize the need for considering shaking as a possible mechanism of injury in older children with AHT.

In this study, victims were mainly males (70%), similar to other studies<sup>1,2,17</sup>. However, in a study of accidental and non-accidental injuries, male predominance was found and has been attributed to the larger head size of males compared to females<sup>18</sup>. The lack of plausible explanation in 70% of the patients is a typical scenario observed in AHT cases. The absence of history of injury has been considered as a pointer to AHT<sup>19</sup>.

In general, the symptoms of AHT are non-specific and can mimic many other early childhood disorders. In this study, the most common presentations were vomiting and seizures (56.5% each) followed by altered state of consciousness and irritability (52% each). Although, a small subdural hematoma can be silent or present with minor signs and symptoms, large hemorrhage can present as a life-threatening event. In this study 35% presented with coma and 17% with apnea and the case fatality rate was 17%. Other studies of AHT have reported a similar trend<sup>17,20</sup>.

Brain edema is an ominous sign, which was seen in 35% of the patients including the four fatal cases. Cerebral edema has been attributed to the higher vasoreactivity and metabolic rate in infants and children. The brain is also secondarily injured due to hypoxia and impaired circulation<sup>21</sup>. None of the patients, in this study, showed an evidence of arachnoid cyst, aneurysms or dural arterio-venous malformation<sup>22,23</sup>. Subgaleal hematoma is rare and in one patient it resulted from severe hair pulling causing a localized alopecia.

Retinal hemorrhage is one of the cardinal features of AHT, which was recognized in nearly 85% of cases<sup>24</sup>. In this study, 56.5% of the children had retinal hemorrhage. In some patients, the retinal hemorrhage is diffuse, multilayer and associated with bleeding into the vitreous. This led to lost vision in two of the survivors. Retinal hemorrhage is attributed to the repetitive acceleration-deceleration with or without blunt head impact with the vitreo-retinal traction as the major factor in its pathogenesis<sup>25</sup>. In severe cases, it may lead to splitting of the retinal layers (retinoschisis); the extent of eye injury has been associated with the severity of brain injury<sup>26</sup>.

Other suggested contributing factors to retinal hemorrhage are the effects of increased intracranial and/or increased intrathoracic pressure, which can occur in AHT. This is believed to cause hemorrhage through the resistance to venous outflow from the eye. However, the pattern of hemorrhages in the abused child is more random and does not seem to follow the venous distribution<sup>24-26</sup>.

Mild retinal hemorrhage can be caused by other disorders such as infection, vasculitis, osteogenesis imperfecta, increased intracranial or increased intrathoracic pressure from other causes. However, these disorders can be differentiated from AHT based on the history and the presence of other clinical features and diagnostic investigations. Furthermore, the severe hemorrhagic retinopathy, especially with retinoschisis is seen almost exclusively in abusive head

injury. The exception is the severe road traffic accidents and fatal crush injury to the head, which have been reported to cause severe retinal hemorrhage<sup>27</sup>. A systematic review of the diagnostic accuracy of various ocular signs for AHT confirmed that intraocular hemorrhage in infants, particularly bilateral, extensive and multilayered are highly specific (94%) for AHT<sup>28</sup>.

Most mild retinal hemorrhages in AHT resolve without long-term consequences. However, visual loss might occur due to occipital cortical damage, optic nerve injury, full-thickness retinal detachment, vitreous hemorrhage and macular scarring. Extensive intraocular hemorrhage in young infants associated with acute brain injury and in the absence of a history of severe accidental trauma or underlying medical cause, AHT must be considered until proven otherwise<sup>29</sup>. Identification of ocular abnormalities requires a full retinal examination by fundoscopy using indirect ophthalmoscope. In addition, postmortem examination of the eyes and orbits are essential for establishing the underlying etiology<sup>30</sup>.

In this study, the abusers were males in 48% of cases, females in 35% and unknown gender in 17%. It is well established that fathers are significantly more likely than mothers to be the perpetrators of AHT<sup>31</sup>. This underscores the importance of involving fathers in educational and preventive programs.

This study is limited by highly selected sample of AHT. These results are most likely to underestimate the size of the problem. The quality of retrospectively collected data depends greatly on the quality of the documentation in medical record. Finally, although SMC is the main secondary and tertiary care center on the Island; however, less severe cases may have not been referred to SMC; therefore, a national registry for AHT is needed.

## CONCLUSION

**AHT is associated with high morbidity and mortality. The symptoms of AHT are non-specific; therefore, maintaining a high index of suspicion is paramount. All children presenting with life threatening event or head injury without a plausible explanation should undergo a full multidisciplinary assessment for AHT. A prospective national study is required to establish the incidence of AHT accurately and to identify risk factors and plan preventive measures.**

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**Author Contribution:** All authors share equal effort contribution towards (1) substantial contributions to conception and design, acquisition, analysis and interpretation of data; (2) drafting the article and revising it critically for important intellectual content; and (3) final approval of the manuscript version to be published: Yes

**Potential Conflicts of Interest:** No

**Competing Interest:** None, **Sponsorship:** None

**Submission date:** 30 March 2011 **Acceptance date:** 25 August 2011

**Ethical approval:** SMC Research Committee.

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