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CASE SERIES

Pediatric Abusive Head Trauma: A Case Series in a Tertiary Hospital

Andreia Marinhas[1*], Ana Isabel Martins[1], Anabela Fazendeiro[2], Patrícia Lourenço[3], Filomena Freitas[4], Marta Machado[1] and Beatriz Maia Vale[5]

1Pediatrician, Hospital Pediátrico de Coimbra, Centro Hospitalar e Universitário de Coimbra, Portugal

2Psychologist of Child Protection Team, Hospital Pediátrico de Coimbra, Centro Hospitalar e Universitário de Coimbra, Portugal

3Nurse of Child Protection Team, Hospital Pediátrico de Coimbra, Centro Hospitalar e Universitário de Coimbra, Portugal

4Social Assistant of Child Protection Team, Hospital Pediátrico de Coimbra, Centro Hospitalar e Universitário de Coimbra, Portugal

5Pediatrics and Child Protection Team, Hospital Pediátrico de Coimbra, Centro Hospitalar e Universitário de Coimbra, Portugal

***Corresponding author:** *Andreia Marinhas, Hospital Pediátrico de Coimbra, Centro Hospitalar e Universitário de Coimbra, Aevnida, R. Dr. Afonso Romão, 3000-602 Coimbra, Portugal, Tel: 00351-239488700*

Abstract

Aim: Characterise cases of Abusive Head Trauma (AHT) over an 8-year period in a tertiary hospital in Portugal, including the main demographic and clinical characteristics, as well as long-term follow-up and sequelae.

Methods: Retrospective review of all cases of AHT admitted between 1st of January 2013 and 31st of December 2020 in a Portuguese pediatric tertiary hospital. We characterize all cases descriptively, about demographic, clinical and social characteristics.

Results: Between 2013 and 2020, 7 cases of abusive head trauma were diagnosed, 6 of which were boys. The mean age was 5 months and the reason for referral to the Child Protection Team (CPT) was always the subdural haematoma (SDH) and was mostly performed by the intensive care unit. SDH was present in all of them and cranial fractures in two. All had long-term sequelae.

Conclusions: Early identification and intervention to protect children have the potential to stop the abuse and secure the child's safety and in some cases, early recognition of abuse can be lifesaving. AHT, like any other type of maltreatment, has no pathognomonic lesions.

Keywords

Child abuse, Abusive head trauma, Subdural haematoma, Protection

Introduction

Child abuse (CA) is a global problem with serious life-long consequences. It refers to any non-accidental action or omission, perpetrated by parents, caregivers or others, which threatens the safety, dignity and biopsychosocial and affective development of the victim [1]. It can be physical and/or psychological abuse, sexual abuse, negligence and commercial or other exploitation, being negligence and physical abuse the two most reported [1,2]. Multiple forms of maltreatment often coexist. Based upon state and federal estimates, approximately 700,000 to 1,25 million children are abused or neglected annually and nearly 3 million children are placed at risk for harm in the United States. Approximately 18% of cases involve physical abuse. In the United States and developed European countries, the estimated prevalence of physical abuse at any time during childhood ranges from 5 to 16%, with as few as 5% of all episodes of physical abuse being reported to child protection agencies [3].

Abusive head trauma (AHT) is considered one of the most severe forms of childabuse (CA) with significant morbidity and mortality among children under one year

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of age. In Portugal the actual incidence is still unknown and probably undervalued and underdiagnosed, but international literature reports incidences between 14 and 40.5 per 100.000 children a year in several different countries and is fatal in nearly one-quarter of cases [4,5]. The diagnosis is characterised by the triad of retinal haemorrhage (RH), subdural haematoma (SDH) and encephalopathy. AHT includes inflicted cranial, cerebral and spinal injuries resulting from blunt force trauma, shaking or a combination of forces. The resultant brain injury may be primary or secondary. The classic injury pattern associated with shaking includes diffuse unilateral or bilateral SDH, diffuse multilayered retinal hemorrhages and diffuse brain injury with or without additional extracranial injuries. AHT presents with a wide spectrum of signs and symptoms. The clinical manifestations can vary from mild and nonspecific (such as vomiting and fussiness) to severe and immediately life-threatening.

The absence of a history of trauma and a paucity of external manifestations of injury can difficult the recognition of the inflicted nature of these injuries [6]. It is known that more than 25% of children with severe physical abuse had previous sentinel injuries missed by physicians, and over 80% of those sentinel injuries were bruises. Thus, it is crucial for the pediatric practitioner to havea high index of suspicionfor subtle findings that can indicate abuse and perform a careful evaluation as dictated by the clinical presentation [5]. AHT is a differential diagnosis of several common and frequent complaints of infants and young children, such as fussiness, vomiting or altered mental status. A complete medical evaluation, including a thorough skin examination, skeletal survey, head imaging and a timely ophthalmology consultation, remains the cornerstone of AHT assessment. Careful documentation of the reported history and referentiation to child abuse experts is needed.

We will present the cases of AHT over an 8-year period in a tertiary hospital in Portugal, with the main demographic and clinical characteristics, as well as long-term follow-up and consequences.

Results

Between 2013 and 2020, seven cases of abusive head trauma were diagnosed, six of which were boys. The mean age was 5 months (minimum age 8 days, maximum 8 months). Five of them were the first offspring, in one case there was a twin brother and there were no cases of single parenthood. Five of the cases were transferred from other hospitals. The reason for referral to the Child Protection Team (CPT) was always SDH and was mostly performed by the intensive care unit and neurosurgery department.

Regarding the clinical history, the main reason for admission to the emergency department was seizures and in the 8-day-old newborn was a parietal swelling. The most frequent symptoms associated were altered state of consciousness, irritability, vomiting and eating difficulties.

In five cases the symptoms were described as acute and in two there were symptoms with an evolution of at least one week. There was no trauma history, except in a child with description of a one meter high fall that did not justify the lesions.

The personal and pathological backgrounds of all were unremarkable. All were term newborns, without early admissions due to illness. Five children were cared for by the day nursery or baby-sitter and two were cared by family members. On clinical examination, there were external signs of trauma in one child only (bruises in thorax and back).

All children underwent brain imaging, mostly computed tomography (CT) and MRI. SDH was present in all of them, subarachnoid hemorrhage in three of them concomitantly and cranial fractures in two (parietal fracture), one of them a diastatic fracture with cerebral and cerebrospinal fluid herniation.

The SDH had different locations in three and different locations and evolution times in four. Fundoscopy revealed RH in six, bilateral in three skeletal survey revealed fractures in one child (metaphyseal).

Potential differential diagnoses as infection, coagulopathy or metabolic disease were excluded in all children. In the case of the twin brothers, an evaluation of the twin sister was also carried out, with brain image, skeletal survey and ophthalmological examination that were negative for the presence of lesions suggestive of maltreatment.

Six children required admission to an intensive care unit. The average length of hospital stay was 51 days, with a minimum of 15 days and a maximum of 112 days. As sequelae, all present psychomotor development delay, four have cerebral palsy, three have epilepsy and two have blindness. All maintain multidisciplinary follow-up.

The social evaluation identified as the main risk factors: history of parental abuse and lack of family support, unemployment, criminal record/substance abuse, sudden death in brother, twins and unwanted pregnancy. Identification of the aggressor was possible in one case (the baby-sitter).

The promotion and protection measures instituted by Child Protective Services were institutionalization in two, support by family members in four, and direct discharge home in one, after the absence of family risk factors.

Table 1 and Table 2 show the detailed characteristics of each case.

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Table 1: Clinical characteristics of pediatric abusive head trauma cases and complications.

	Presentation	Neuro-imaging	Features of subdural hematoma	Ophthalmoscopy	Skeletal screening	Total length of stay	Intensive care -duration	Neurosurgery Intervention
Case 1	• Seizure • Alteration of the state of consciousness • Decreased mobility of the left upper limb	CT • Subdural hematoma	• Sub-acute • Right cerebral convexity, interhemispheric, posterior fossa, bilateral	• Bilateral retinal hemorrhage	• No fracture	• 52 days	• No	• No intervention
Case 2	• Seizure • Irritability • Eating difficulties • Change in state of consciousness	CT + MRI • Subdural hematoma • Left parietal fracture • Hygroma • Cerebral edemae • Ischemia	• Sub-acute/chronic • Interhemispheric, bilateral cerebral convexity	• Left retinal hemorrhage	• No fracture	• 46 days	• 14 days • No ventilation needed	• Ventricular shunt + surgical drainage (due to hydrocephalus)
Case 3	• Change in state of consciousness • Generalized hypotonia • Thoracic ecchymosis • Vomit	CT + MRI • Subdural hematoma • Sub-arachnoid hemorrhage • Left fronto-temporo-parieto-occipital infarction	• Acute • Cerebral convexity, interhemispheric	• Without changes	• No fracture	• 65 days	• 8 days • Needing ventilation (6 days)	• Craniotomy + hematoma drainage
Case 4	• Seizure • Vomit • Eating difficulties	CT + MRI • Subdural hematoma • Sub-arachnoid hemorrhage	• Differet evolution times • Brain convexity	• Bilateral retinal hemorrhage	• No fracture	• 23 days	• 7 days • No ventilation needed	• No intervention
Case 5	• Seizure • Coma	CT + MRI • Subdural hematoma • Cerebral edemae • Hygroma • Ischemia	• Acute • Brain convexity • Interhemispheric • Bilateral	• Bilateral retinal hemorrhage	• No fracture	• 112 days	• 24 days • Needing ventilation (10 days)	• Surgical drainage (hygroma

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Case 6	• Left parietal swelling	CT + MRI • Subdural Hematoma • Subarachnoide hemorrhage • Left parietal fracture • Cerebral edemae • Brain contusion	• Acute • Multiple locations	• Left retinal hemorrhage	• Fracture: Distal metaphysis of the left radius	• 46 days	• 19 days • No ventilation needed	• Duroplasty + left parietal osteoplasty
Case 7	• Seizure • Hypotonia	CT + MRI • Subdural Hematoma • Subarachnoide hemorrhage • Left parietal vein thrombosis	• Sub-acute/Chronic • Interhemispheric • Different evolution Times	• Bilateral retinal hemorrhage	• No fracture	• 15 days	• 7 days • Needing ventilation	• No intervention

Discussion

Paediatrician and radiologist John Caffey first described the association of chronic SDH and long-bone fractures in 1946, but it was not until 1972 that he published a seminal paper describing the radiologic and clinical features attributed to shaking injuries. Ludwig and Warman first published the term "shaken baby syndrome". Injuries induced by shaking and those caused by blunt trauma have the potential to result in death or permanent neurologic disability, including static encephalopathy, mental retardation, cerebral palsy, cortical blindness, seizure disorders and learning disabilities [7,8].

AHT occurs mainly in children with less than three years, especially in the first year of life [4]. As in the literature, our results show that occurrence in the first year of life is predominant and that boys are more affected than girls [9,10].

SDH in infants is a rare event and is mainly attributable to trauma, with non accidental head injuries substantially outnumbering accidental injuries, as shown by a study carried out in autopsies of children under one year who had SDH [8]. Although there is not a particular pattern of cranial injury unique to AHT, certain findings, such as a SDH in certain locations (multiple, along the convexities or interhemispheric), cerebral ischemia, cerebral edema and skull fractures (co-occurring with intracranial injury) are more common in AHT than in accidental injury [5]. All our cases presented with SDH in different locations and/or different evolution times and two presented skull fractures (parietal) which reinforced the hypothesis of AHT.

Noncontrast head computerized tomography (CT) followed by conventional magnetic resonance imaging (MRI) is widely considered to be the first step in evaluating suspected AHT. In our cases, almost all children were evaluated by both imaging exams. MRI of the spine should also be considered to assess for ligamentous injuries or spinal subdural hemorrhage [5]. The mechanism of SDH in AHT is not fully understood but the most consensualtheory is that it resultsfrom the combination ofthe impact (contact) and the inertial (intracranial motion) forces in varying magnitudes and directions. It is assumed that during shakes, the brain, when moving, impacts directly on the internal surface of the skull covered by the dura mater. The mismatch between the movement of the skull and its content, as well as the impact of the brain on the inner surface of the skull, induce traction and lacerationof blood vessels, namely the bridge veins, causing SDH and the consequent increase in intracranial pressure (ICP). On the other hand, whenever injuries are associated with shakes by direct impact, in addition to the acceleration/deceleration forces, there is also a transfer of forces at the point of impact of the head, with injury and

Table 2: Demographic and social characteristics and long-term sequelae of pediatric abusive head trauma cases.

	Sex	Age	Social Evaluation	Caregiver	Child protection measure	Sequelae
Case 1	Masculine	5 months	No risk factors	Parents and educators	Placement with family member	• Global developmental delay
Case 2	Masculine	5 months	Twins Emigrant in another country	Parents and baby sitter	Support with family	• Global developmental delay • Cerebral Palsy • Blindness
Case 3	Masculine	1 month	No risk factors	Parents and grandmother	Institutionalization	• Global developmental delay • Cerebral Palsy • Epilepsy
Case 4	Masculine	7 months	Family history of abuse: Mother Absence of family support	Parents and educators	Support with family	• Global developmental delay • Cerebral Palsy • Epilepsy • Blindness
Case 5	Masculine	8 months	No risk factors	Parents and educators	Parents	• Global developmental delay • Cerebral Palsy • Epilepsy • Blindness
Case 6	Feminine	8 days	Unemployed parents Father: Criminal history/consumption Unwanted pregnancy	Parents	Institutionalization	• Global developmental delay • Right hemiparesis
Case 7	Masculine	8 months	No risk factors	Parents and educators	Support with family	• Global developmental delay

deformation of local structures, with edema of the scalp, cranial fractures, epidural hemorrhage and local vein damage with SDH. Rotation forces can lead to axonal damage diffuse (LAD), which contributes to cerebral edema [4-6].

When there is RH associated with SDH, the hypothesis of AHT becomes practically unequivocal. RH in AHT is predominantly bilateral, numerous, and extend to the periphery. RH is rare in non-AHT and is usually few, in the posterior pole, and only 10% extend to the periphery. It is important to note that no retinal finding is unique to AHT [11,12]. We found RH in all of our cases; four of them were bilateral, with 2 with permanent blindness, which demonstrates the violent nature of the impact caused. Although many cases of AHT do not demonstrate osseous injury, a complete skeletal survey should be performed in children younger than two years with concerns for AHT because occult fractures can occur in up to 42% of cases. The only case in which a skeletal fracture was diagnosed was in an 8-day-old newborn, a metaphyseal fracture of a long bone, and the most typical of child abuse. It should be noted that it was only diagnosed in the repetition of the skeletal survey 20 days after the first one. Fractures may be missed because radiography is performed before changes are obvious or the radiographic images are misread or misinterpreted [13]. Certain fractures have high specificity for or strong association with child abuse, particularly in infants, whereas others may haveless specificity. Rib fractures in infants, especially those situated posteromedially, and the classic metaphyseal lesions of long bones, have high specificity for child abuse. Classic metaphyseal lesions also have high specificity for child abuse when they occur during the first year of life [13].

Clinical manifestations of AHT vary with age, mechanism and specific types of injuries. Children present with variable neurological signs, from irritability to coma, with vomiting, seizures, or a bulging fontanelle or occasionally with occult injury identified as part of a child abuse evaluationfor extracranial injuries. Neurological symptoms were present in all our cases and were the main reason for admission to the emergency department [14]. In at least half of AHT cases, there is no history of trauma, which can contribute to misdiagnosis; in the remainder, a low-height fall usually is described. In our study only one child had a history of low energy trauma, that didn't justify the injuries presented.This is the great challenge in diagnosing AHT: the suspicion given the lack of evidence of a history of trauma or external injuries. If AHT is considered, a detailed diagnostic evaluation is necessary. Evaluation should include a comprehensive history, physical, laboratory testing, imaging and consultation with specialists. The evaluation should include a review of the timeline of the signs and symptoms leading up to admission (?)[7,15]. A history that does not include trauma or a fall from a low height is the most common history in cases of AHT and we have proven this once more in all our cases.

Any bruising in non-ambulatory infants should always raise the possibility of inflicted injury and is identified in about one-third of AHT patients [14]. Relatively minor injuries, such as frenulum tears or bruising in precruising infants (infants unable to pull to a stand and walk while holding onto something), may be the first indication to a caregiver or medical provider of child physical abuse. Minor injuries other than superficial abrasions are uncommon in normal, precruising infants and, when they are evident, should raise a concern for abuse [16]. In our series, only one child had evidence of external lesions: Bruises on the chest and back. This was one of the most serious cases, with longer hospital stay and the need for more complex surgical intervention. When a bruise is present, it should be considered as potentially sentinel for physical abuse if there is no predisposing disorder or plausible explanation. Particular attention should be given to "**TEN-4FACESp**" bruising and lesions (bruising of the torso, ears, and neck in children younger than 4 years or any bruising in an infant younger than four months). Oral injuries in infants, such as frenulum tears, may also accompany or precede AHT and should prompt consideration of abuse (Frenulum, angle of jaw, cheek, eyelid, subconjunctival hemorrhage and patterned bruises) [5,16].

If the diagnosis of AHT is being considered, other causes should be excluded. Accidental head trauma, birth trauma, bleeding diathesis, congenital conditions, neoplastic conditions, metabolic conditions, meningitis, connective tissue diseases and obstructive hydrocephalus are all in the differential. These conditions have similar findings as AHT and must be excluded [7].

Thus, one of the most important ways to intervene is trying to prevent the occurrence of abuse. Pediatric practitioners may help prevent AHT by carefully assessing for psychosocial risk factors often associated with abuse, by providing anticipatory guidance to new parents about the dangers of shaking and impact, by providing methods for dealing with the frustration of a crying infant and by providing access to prevention resources and supports [5]. Risk factors for infant abuse include maternal smoking, the presence of more than two siblings, low infant birth weight, being born to an unmarried mother and children with disabilities. Young, abused children who live in households with unrelated adults are at exceptionally high risk of fatal abuse, and children previously reported to CPT are at significantly higher risk of both abusive and preventable accidental death compared with peers with similar sociodemographic characteristics. It's also important that siblings, especially twins, and other young household members of children who have been physically abused are evaluated for child abuseand imaging should be considered for any siblings younger than 2 years, especially if there are signs of abuse [13].

Conclusion

Early identification and intervention to protect children can potentially stop the abuse and secure the child's safety. In some cases, early recognition of abuse can be lifesaving. AHT, like any other type of maltreatment, has no pathognomonic lesions. One must consider abuse to early recognize these situations and timely intervene to avoid danger to children at risk and the severe and irreversible consequences of AHT.

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Conflict of Interest

Authors have no conflicts of interest to declare.

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