Abusive Head Trauma

- First Case Report of the Use of Postmortem Wide-Angle Fundus Photography in Abusive Head Trauma
- Corrigendum to "Abusive head trauma: The body of the iceberg - A population-based survey on prevalence and perpetrators" [Child. Abuse. Negl. (2024) Mar; 149: 106660]
- Mediational analysis of severe retinal injury causation in children with acute closed head injury
- Data-driven standards for infant skull thickness distributions in computational modeling and analysis
- Association of left ventricular systolic dysfunction with outcome following pediatric traumatic brain injury
- Shaking into deficits: investigating behavioural and neuropathological outcomes associated with a novel preclinical model of infant abusive head trauma
- PARS PLANA VITRECTOMY FOR RETINAL DETACHMENT REPAIR AS A LATE COMPLICATION FOR PREVIOUS ABUSIVE HEAD TRAUMA
- Abusive Head Trauma

One of the important and usual missed causes of pediatric traumas is child abuse. This ominous phenomenon, which can be presented physically, psychologically, sexually, and emotionally has grown significantly in recent years. Many children are not diagnosed in the early stages of evaluation. Battered Child Syndrome is used to describe the clinical condition of the child serious physical abuse by parents or caregivers. Medical staff should always keep the syndrome in their mind for those brought to the emergency department with trauma. In a report, Pezeshki et al described a patient complained of dysphagia following a falling from a height and multiple epidural hematomas and a final diagnosis of battered child syndrome [1].

see Retinal hemorrhage in child abuse

Not uncommonly, intracranial bleeding is the first sign of a severe inherited coagulation disorder. In the presence of an unexpected intracranial bleeding after a minor trauma or without a clear history of the related events, physicians and caregivers may be confronted to the dilemma of a possible child abuse. It must be bear in mind that physical abuse and bleeding disorders can co-exist in the same child.

Hinojosa et al. reported the case of two siblings in whom a diagnosis of hemophilia coexisted with the presumption of a non-accidental head trauma. Child abuses were inflicted in both children with a spare time of 2 years. A diagnosis of mild hemophilia was prompted in the first sibling after initial NAHT, while inflicted trauma was evident in the second sibling after neuroimaging findings and concomitant lesions. Lessons from this case in co-existing bleeding disorders and inflicted trauma and legal implications derived will be discussed thereafter.The possibility of a bleeding disorder should be considered in all children presenting with unexplained bleeding at a critical site in the setting of suspected physical maltreatment, particularly intracranial hemorrhage (ICH) [2].

Abusive head trauma, also called shaken baby syndrome (or SBS), goes by many other names, including inflicted traumatic brain injury and shaken impact syndrome. All of these names mean the same thing: an injury to a child's brain as a result of child abuse.

see Cervical Spine in abusive head trauma.

Epidemiology

see Abusive Head Trauma Epidemiology.

Etiology

Abusive head trauma (AHT) can be caused by direct blows to the head, dropping or throwing a child, or shaking a child. Head trauma is the leading cause of death in child abuse cases in the United States. Because the anatomy of infants puts them at particular risk for injury from this kind of action, the majority of victims are infants younger than 1 year old.

Abusive head trauma (AHT) peaks during early infancy and decreases in toddler years. Infants and toddlers experience different injuries, possibly impacting the risk of mortality.

The average age of victims is between 3 and 8 months. However, the highest rate of cases occur among infants just 6 to 8 weeks old, which is when babies tend to cry the most.

How These Injuries Happen

Abusive head trauma results from injuries caused by someone (most often a parent or other caregiver) vigorously shaking a child or striking the child's head against a surface. In many cases, the caregiver cannot get the baby to stop crying and, out of frustration or anger, will shake the baby. Unfortunately, the shaking may have the desired effect: Although at first the baby cries more, he or she may stop crying as the brain is damaged.

Children with special needs, multiple siblings, or conditions like colic or GERD have an increased risk of AHT. Boys are more likely to be victims of AHT than girls, and children of families who live at or below the poverty level are at an increased risk for these injuries and other types of child abuse.

The perpetrators in about 70% of cases are males — usually either the baby's father or the mother's boyfriend, often someone in his early twenties. But anyone has the potential to shake a baby if he or she isn't able to handle stressful situations well, has poor impulse control, or has a tendency toward aggressive behavior. Substance abuse often plays a role in AHT.

When someone forcefully shakes a baby, the child's head rotates uncontrollably. This is because infants' neck muscles aren't well developed and provide little support for their heads. This violent movement pitches the infant's brain back and forth within the skull, sometimes rupturing blood vessels and nerves throughout the brain and tearing the brain tissue. The brain may strike the inside of the skull, causing bruising and bleeding to the brain.

The damage can be even greater when a shaking episode ends with an impact (hitting a wall or a crib mattress, for example), because the forces of acceleration and deceleration associated with an impact are so strong. After the shaking, swelling in the brain can cause enormous pressure within the skull, compressing blood vessels and increasing overall injury to the brain's delicate structure.

Normal interaction with a child, like bouncing the baby on a knee or tossing the baby up in the air, will not cause these injuries. But it's important to never shake a baby under any circumstances.

What Are the Effects? AHT often causes irreversible damage, and about 1 out of every 4 cases results in the child's death.

Children who survive may have:

partial or total blindness hearing loss seizures developmental delays impaired intellect speech and learning difficulties problems with memory and attention severe mental retardation cerebral palsy Even in milder cases, in which babies look normal immediately after the shaking, they may eventually develop one or more of these problems. Sometimes the first sign of a problem isn't noticed until the child enters the school system and exhibits behavioral problems or learning difficulties. But by that time, it's more difficult to link these problems to a shaking incident from several years before.

Signs and Symptoms In any abusive head trauma case, the duration and force of the shaking, the number of episodes, and whether impact is involved all affect the severity of the child's injuries. In the most violent cases, children may arrive at the emergency room unconscious, suffering seizures, or in shock. But in many cases, infants may never be brought to medical attention if they don't exhibit such severe symptoms.

In less severe cases, a child who has been shaken may experience:

lethargy irritability vomiting poor sucking or swallowing decreased appetite lack of smiling or vocalizing rigidity seizures difficulty breathing blue color due to lack of oxygen altered consciousness unequal pupil size an inability to lift the head an inability to focus the eyes or track movement

Diagnosis Many cases of AHT are brought in for medical care as “silent injuries.” In other words, parents or caregivers don't often provide a history that the child has had abusive head trauma or a shaking injury, so doctors don't know to look for subtle or physical signs. This can sometimes result in children having injuries that aren't identified in the medical system.

In many cases, babies who don't have severe symptoms may never be brought to a doctor. Many of the less severe symptoms such as vomiting or irritability may resolve and can have many non-abuse-related causes.

Unfortunately, unless a doctor has reason to suspect child abuse, mild cases (in which the infant seems lethargic, fussy, or perhaps isn't feeding well) are often misdiagnosed as a viral illness or colic. Without a suspicion of child abuse and any resulting intervention with the parents or caregivers, these children may be shaken again, worsening any brain injury or damage.

If shaken baby syndrome is suspected, doctors may look for:

hemorrhages in the retinas of the eyes skull fractures swelling of the brain subdural hematomas (blood collections pressing on the surface of the brain) rib and long bone (bones in the arms and legs) fractures bruises around the head, neck, or chest The Child's Development and Education What makes AHT so devastating is that it often involves a total brain injury. For example, a child whose vision is severely impaired won't be able to learn through observation, which decreases the child's overall ability to learn.

The development of language, vision, balance, and motor coordination, all of which occur to varying degrees after birth, are particularly likely to be affected in any child who has AHT. Such impairment can require intensive physical and occupational therapy to help the child acquire skills that would

have developed normally had the brain injury not occurred.

Before age 3, a child can receive free speech or physical therapy through state-run early intervention programs. Federal law requires that each state provide these services for children who have developmental disabilities as a result of being abused. After a child turns 3, it's the school district's responsibility to provide any needed additional special educational services.

As kids get older, they may require special education and continued therapy to help with language development and daily living skills.

Clinical Features

Patients with AHT present with various clinical features, including acute subdural hematoma, retinal hemorrhage, and extensive hemispheric hypodensity, which has recently been reproduced in a basic experimental model.

Diagnosis

Abusive Head Trauma diagnosis.

Differential diagnosis

A 2-month-old infant was found moribund in her crib. Postmortem computed tomography (PMCT) was performed before autopsy. As the baby had a severe subdural hematoma, retinal hemorrhage, and encephalopathy on PMCT, abusive head trauma (AHT) was tentatively diagnosed. At autopsy, no scalp hemorrhages or skull fractures were found; however, the classic triad of AHT was present, mainly on the right side. Additionally, there was dark red discoloration around the heart, and the liver, spleen, and pancreas were enlarged. Peripheral blood was macroscopically cloudy with marked leukocytosis. After careful histological examination, B-cell precursor acute lymphoblastic leukemia (ALL) was diagnosed. All the macroscopic lesions could be attributed to ALL. The manner of death was natural. This is the first report of infantile ALL mimicking AHT on PMCT images. This case demonstrates the importance of a comprehensive systematic approach to considering differential diagnosis when PMCT shows multiple intracranial hemorrhages suggestive of AHT in an infant [3)].

Treatment

Despite multidisciplinary treatment, the outcome is poor, and neurological sequelae often remain. However, functional recovery seems possible with aggressive rehabilitation.

Prevention

Abusive head trauma prevention.

Outcome

Pediatric abusive head trauma (AHT), still colloquially known as shaken baby syndrome, is a leading cause of morbidity and mortality among infants.

More than 10% of them die, and more than three-quarters of the survivors have long-term effects. Prevention is therefore essential. When a parent (or any person) is strongly upset by an infant's uncalmable crying, the best thing for them to do is to lay the child down in a supine position in his or her bed, leave the room, and then ask for help [4)]

Complications

Abusive head trauma(AHT) is a leading cause of severe traumatic brain injury in children under 2 years old.

Infantile acute subdural hematoma. In Japan, infantile acute subdural hematoma(hematoma type I)is a clinical form of hematoma that often occurs after 6-10 months when the child is able to walk. It is accompanied by backward fall, sudden loss of consciousness, pallor, spastic paralysis of the extremities, and retinal hemorrhage. A nationwide survey of infant acute subdural hematoma due to minor injury is currently being planned, and it is hoped that this would be comprehensive in Japan [5)]

There is a considerable risk of mortality associated with age at diagnosis in children with AHT.Children <2 and those 2-4-year-olds present with different types of injuries. The high risk of mortality in the 2-4 years old is unique to AHT. Efforts should be made to increase awareness about the risk of mortality and identify factors that can aide in a timely accurate diagnosis [6)].

Case series

Five cases of pediatric MMA embolization for cSDH were identified in the literature. Two were associated with arachnoid cysts, 2 with antiplatelet/anticoagulation therapy, and 1 with abusive head trauma. There were no adverse events, and all patients demonstrated clinical and radiological improvement on follow-up. At our institution, a previously healthy 8-year-old male was found to have a right-sided acute-on-chronic SDH during a headache evaluation. A diagnostic angiogram was performed to rule out a dural arteriovenous fistula, and right-sided MMA embolization was performed concurrently. Rapid clinical and radiological improvement was observed, with complete resolution by 6 months.

Conclusion: MMA embolization may represent a treatment option for pediatric patients with cSDH [7)]

In this retrospective multi-center study from three German university hospitals of a 10-year period, the initial neuroimaging material (CT or MRI) of 56 children (36 males, 20 females; age median 3.9 months) with medico-legally well-documented AHT was analyzed. SDCs were characterized by determining presence, location, extension, and visual appearance, by assigning to one of the five

entities, and by categorizing with three different classification systems, one of which represents a novel system based on focality and Mixed Appearance Pattern and especially developed for children with AHT. The data were correlated with demographic and clinical data. By means of court files, AHT cases were also sub-divided into confession (n = 14) and non-confession cases (n = 42) and then compared.

Results: Most cases showed a multifocal presence of SDCs (96.4%) and the presence of a Mixed Appearance Pattern (82.1%). The most common SDC entity was the heterogeneous variant of the SDHHy (66.1%). The cSDH occurred infrequently only (3.6%). Our novel classification system illustrates that unifocal SDCs rarely occur in AHT, and that more complex SDC patterns are common. In nearly all cases (94.6%), additional signs of recently caused brain injury were present beside the SDCs. Comparison between confession and non-confession groups did not reveal any significant differences, indicating that the diagnostic criteria of AHT are robust.

Conclusions: Although precise dating of SDCs based on initial neuroimaging alone remains unrealistic, the exact diagnosis of the SDC entity provide an important basis for differentiation between acute trauma and chronic post-traumatic state. Therefore, especially the confirmation or exclusion of subdural neomembranes, that define the cSDH, should be considered indispensable [8)]

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3 cases of suspected abusive head trauma with retinal hemorrhages on fundus examination and neuroimaging findings not necessarily suggestive of shaking injury. Previous studies have suggested that retinal hemorrhages are rare in patients without neuroimaging abnormalities. These cases demonstrate some common features (rib fractures, developmental delay, and history of abuse) that may increase suspicion for abusive head trauma. Our findings suggest a potential role for ophthalmic consultation in scenarios with high clinical suspicion for abusive head trauma without definitive neuroimaging evidence of head injury. The nonspecific neuroimaging features of these 3 cases highlight the importance of interpreting cases with global clinical context [9)].

Children with a confirmed abusive head trauma diagnosis between January 2018 to February 2021 were included in this single-center retrospective study. Patient demographics, survival, Glasgow Coma Scale score on admission, length of hospital stay, and intensive care unit stay were examined. Brain neuroimaging findings were categorized as classic and nonclassic findings. Spine MRIs were also assessed for spinal ligamentous injury, compression fracture, and hemorrhage. The $\chi 2$ test or the Wilcoxon rank-sum test was used for the analysis.

Results: One hundred two children (male/female ratio: 75:27; average age, 9.49; range, 0.27-53.8 months) were included. Subdural hematoma was the most common (83.3%) classic neuroimaging finding. Bridging vein thrombosis was the most common (30.4%) nonclassic neuroimaging finding. Spinal ligamentous injury was seen in 23/49 patients. Hypoxic-ischemic injury was significantly higher in deceased children ($P = .0001$). The Glasgow Coma Scale score was lower if hypoxic-ischemic injury ($P < .0001$) or spinal ligamentous injury were present ($P = .017$). The length of hospital stay was longer if intraventricular hemorrhage ($P = .04$), diffuse axonal injury ($P = .017$), hypoxic-ischemic injury ($P = .001$), or arterial stroke ($P = .0003$) was present. The intensive care unit stay was longer if intraventricular hemorrhage ($P = .02$), diffuse axonal injury ($P = .01$), hypoxic-ischemic injury ($P < .0001$), or spinal ligamentous injury ($P = .03$) was present.

Conclusions: Our results may suggest that a combination of intraventricular hemorrhage, diffuse axonal injury, hypoxic-ischemic injury, arterial stroke, and/or spinal ligamentous injury on

neuroimaging at presentation may be used as potential poor prognostic indicators in children with abusive head trauma [10)]

One hundred and ten eyes from 55 autopsies examined at an academic tertiary referral center over 21 years were tabulated for histopathology: subdural hemorrhage in the optic nerve sheath, intrascleral hemorrhage, any retinal hemorrhage, ora-extended hemorrhage, cherry hemorrhage, perimacular ridge, and internal limiting membrane tear. Select tissues with cherry hemorrhage were further examined by transmission electron microscopy.

Results: Sixty eyes were identified as “abusive head trauma” (cases), 46 as “alternative cause” (controls), and 4 as “abusive head trauma survivor”. Cases were legally verified or confirmed by confession in all except 1 case. All ocular histopathologic observations from cases were similar or more frequent in infants younger than 16 months of age. When present, a cherry hemorrhage and perimacular ridge were most often found together, and only with a torn internal limiting membrane. Both abusive head trauma survivor cases demonstrated severe optic nerve atrophy and macular ganglion cell loss.

Conclusions: Younger infants may be even more susceptible to damage from vitreomacular traction by rotational and/or acceleration-deceleration forces. Identifying cherry hemorrhages may aid abusive head trauma diagnosis. Survivor abusive head trauma pathology demonstrates unique, irreversible macular and optic nerve damage [11)].

References

1)
Pezeshki A, Rahmani F, Ebrahimi Bakhtavar H, Fekri S. Battered Child Syndrome; a Case Study. Emerg (Tehran). 2015 Spring;3(2):81-2. PubMed PMID: 26495388.
2)
Hinojosa J, Simó M, Armero G, Becerra MV, Alamar M, Candela S, Culebras D, Muchart J, Berrueco R. Hemophilia and non-accidental head trauma in two siblings: lessons and legal implications. Childs Nerv Syst. 2022 Oct 28. doi: 10.1007/s00381-022-05713-2. Epub ahead of print. PMID: 36303077.
3)
Unuma K, Makino Y, Yamamoto K, Hattori S, Arai N, Sakai K, Kitagawa M, Uemura K, Kanegane H. Fatal intracranial hemorrhage due to infantile acute lymphoblastic leukemia mimicking abusive head trauma. J Forensic Sci. 2021 Nov;66(6):2504-2510. doi: 10.1111/1556-4029.14815. Epub 2021 Jul 23. PMID: 34296766.
4)
Laurent-Vannier A. Shaken Baby Syndrome (SBS) or Pediatric Abusive Head Trauma from Shaking: Guidelines for Interventions During the Perinatal Period from the French National College Of Midwives. J Midwifery Womens Health. 2022 Nov;67 Suppl 1:S93-S98. doi: 10.1111/jmwh.13427. PMID: 36480666.
5)
Araki T. [Abusive Head Trauma]. No Shinkei Geka. 2021 Sep;49(5):1011-1023. Japanese. doi: 10.11477/mf.1436204484. PMID: 34615761.
6)
Nuño M, Ugiliweneza B, Bardini RL, Ozturk A, Stephenson JT, Magaña JN. Age-Related Mortality in Abusive Head Trauma. J Trauma Acute Care Surg. 2019 Mar 8. doi: 10.1097/TA.0000000000002255. [Epub ahead of print] PubMed PMID: 30865156.
7)
Paro MR, Ollenschleger MD, Fayad MF, Bulsara KR, Stoltz P, Martin JE, Bookland MJ, Hersh DS. Middle

Meningeal Artery Embolization for Primary Treatment of a Chronic Subdural Hematoma in a Pediatric Patient: A Systematic Review of the Literature and Case Report. Oper Neurosurg (Hagerstown). 2023 Jan 1;24(1):3-10. doi: 10.1227/ons.0000000000000446. Epub 2022 Nov 3. PMID: 36519875.
8)

Hahnemann ML, Kronsbein K, Karger B, Feld K, Banaschak S, Helmus J, Mentzel HJ, Pfeiffer H, Wittschieber D. Characterization of subdural collections in initial neuroimaging of abusive head trauma: Implications for forensic age diagnostics and clinical decision-making. Eur J Radiol. 2022 Dec 15;159:110652. doi: 10.1016/j.ejrad.2022.110652. Epub ahead of print. PMID: 36577185.
9)

Simon CL, Ude I, Levin MR, Alexander JL. Retinal hemorrhages in abusive head trauma with atraumatic neuroimaging. J AAPOS. 2022 Dec 11:S1091-8531(22)00786-8. doi: 10.1016/j.jaapos.2022.10.005. Epub ahead of print. PMID: 36516943.
10)

Orman G, Kralik SF, Desai NK, Singer TG, Kwabena S, Risen S, Huisman TAGM. An In-Depth Analysis of Brain and Spine Neuroimaging in Children with Abusive Head Trauma: Beyond the Classic Imaging Findings. AJNR Am J Neuroradiol. 2022 May;43(5):764-768. doi: 10.3174/ajnr.A7492. Epub 2022 Apr 7. PMID: 35393363; PMCID: PMC9089255.
11)

Breazzano MP, Unkrich KH, Barker-Griffith AE. Clinicopathological findings in abusive head trauma: analysis of 110 infant autopsy eyes. Am J Ophthalmol. 2014 Dec;158(6):1146-1154.e2. doi: 10.1016/j.ajo.2014.08.011. Epub 2014 Aug 12. PMID: 25127695.