Abusive Head Trauma

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KEYWORDS

- Child abuse • Abusive head trauma
- Pediatric traumatic brain injury • Shaken baby syndrome
- Nonaccidental trauma

Child physical abuse that results in injury to the head or brain has been described using many terms, which have evolved over the past half-century or more. These items have included the battered child syndrome, whiplash injuries, shaken infant or shaking impact syndrome, and nonmechanistic terms such as abusive head trauma or nonaccidental trauma.[1–7] This evolution has occurred as the spectrum of injuries—and the mechanisms that are potentially responsible for them—have been studied in increasing detail in multiple clinical series from around the world, as well as with pathophysiologic and biomechanical modeling. Because children may present with varying histories, physical findings, and radiologic findings, the terms ''inflicted head injury,'' ''nonaccidental trauma,'' and ''abusive head trauma'' are used in this article to reflect those constellations of injuries that are caused by the directed application of force to an infant or young child resulting in physical injury to the head and/or its contents. These injuries most often include subdural and/or subarachnoid hemorrhage, with varying degrees of neurologic signs and symptoms. A high proportion of children also present with retinal hemorrhages, physical or radiologic evidence of contact to the head, upper cervical spine injuries, and skeletal injuries. These features are described in more detail in the following section.

Use of the more general terms reflects an attempt to avoid the pitfalls of assuming the exact mechanism of injury; the general terms also encompass a wide range of traumatic forces, which are potentially harmful and can result in different patterns of neurotrauma. These forces include: blunt force trauma, acceleration/deceleration (inertial) forces, penetrating trauma, and asphyxiation.

EPIDEMIOLOGY

Establishing incidence data for abusive head trauma has been challenging, in part because of the definitional issues noted; however, several studies have attempted to examine issues of epidemiology. Early studies revealed that inflicted injuries

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make up a significant portion of traumatic brain injury in children younger than 2 years of age, and such injuries account for serious morbidity and mortality in that group.[8,9] When compared with accidental head injury, the hospital length-of-stay and medical costs incurred from abusive head trauma are higher.[10]

A recent study out of North Carolina found an incidence of inflicted brain injury in the first two years of life of 17.0 per 100,000 person-years.[11] Another prospective study from Scotland during 1998–1999 found an annual incidence of 24.6 per 100,000 children younger than 1 year (a higher rate than a previous 15-year retrospective study done in the same county).[12] The authors of that study suggested that the discrepancies between the prospective and retrospective study outcomes reflect the challenge of tracking the problem caused by lack of a single international classification of diseases (ICD) code to describe the medical findings.

This challenge and others were addressed at a 2008 symposium and later summarized in articles to a supplement to the *Journal of Preventative Medicine.* The symposium was convened, in part, to discuss definitional issues regarding inflicted brain injury, as well as methods for measuring its incidence. In his commentary, Alexander Butchart, PhD, argues that determining the epidemiology of child maltreatment will help elucidate the issue as a public health concern and lead to the formation of larger scale prevention efforts.[13]

MECHANISMS

In 1946, Dr. John Caffey first recognized a possible traumatic association between head injuries and fractures in infants.[14] In the following three decades, important work by Silverman,[15] Ommaya,[16] and Guthkelch,[3] contributed to the acknowledgment of child abuse as a medical condition. Noting that many of his patients presented without a clear mechanism of trauma to explain their injuries, in 1974, Caffey coined the term "the whiplash shaken infant syndrome."[4] He used the term to describe the constellation of injuries that includes subdural hematoma, long bone fractures, and retinal hemorrhages; these are symptoms that, in the absence of a reasonable history of trauma or other medical condition, are still considered hallmarks for abusive head injury. The idea that shaking might be causative was first proposed by Norman Guthkelch, a neurosurgeon who, working with pediatricians and social workers, obtained some histories of violent shaking as a part of the injury scenario.[3] In contrast, Caffey's initial concept was that shaking might be injurious even when performed by well-meaning caretakers as a generally accepted form of discipline, because of the presumed inherent fragility of young infants.[17] These authors were aware of experiments in primates, whose heads were subjected to large magnitude angular decelerations involving crashes in high-velocity sleds, leading to unconsciousness and subdural hemorrhage.[18] Thus, the idea of angular deceleration as the causative mechanism for subdural hematoma was hypothesized as the necessary mechanism in infant shaking injuries.

Over the ensuing decades, other authors noted a high incidence of contact injuries, including scalp hematomas, skull fractures, and brain contusions, in abused infants; the injuries were visible either clinically, radiologically, or at autopsy.[19–21] Biomechanical models of young infants were developed that suggested that even violent manual shaking caused angular decelerations that were very low compared with those required to cause concussive or hemorrhagic injury in primates, but that inflicted impacts were associated with angular decelerations that were approximately 50 times greater and within the range thought more likely to be associated with brain injury.[19,22] It was suggested that physical evidence of impact might not be seen if the deformable