

# AMERICAN ACADEMY OF PEDIATRICS

## Shaken Baby Syndrome: Inflicted Cerebral Trauma

Committee on Child Abuse and Neglect

Physical abuse is the leading cause of serious head injury in infants.<sup>1</sup> While physical abuse has in the past been a diagnosis of exclusion, data regarding the nature and frequency of head trauma consistently support a medical presumption of child abuse when a child younger than 1 year of age has intracranial injury.

Shaken baby syndrome is a serious form of child maltreatment, most often involving infants younger than 6 months of age.<sup>2,3</sup> It occurs commonly, yet it is frequently overlooked in its most subtle form and underdiagnosed in its most serious expression. Caretakers may misrepresent or have no knowledge of the cause of the brain injury. There is often an absence of externally visible injuries. Given the initial difficulty of identifying a shaken infant and the variability of the syndrome itself, the physician must be extremely vigilant regarding any brain trauma in infants and be familiar with the radiologic and clinical findings that support the diagnosis of the shaken baby syndrome.

### HISTORICAL

In 1972, pediatric radiologist John Caffey<sup>4</sup> popularized the term "whiplash shaken baby syndrome" to describe a constellation of clinical findings in infants, which included retinal hemorrhages, subdural and/or subarachnoid hemorrhages, and little or no evidence of external cranial trauma. One year earlier, Guthkelch<sup>5</sup> had postulated that whiplash forces caused subdural hematomas by tearing cortical bridging veins. While many have added breadth to Caffey's findings, a challenge to the presumption that the shaking alone is the sole source of the trauma has come from Duhaime et al,<sup>6</sup> who found in laboratory settings that the force of rapid deceleration of a shaken head hitting any surface, such as a bed or pillow, may be the basis for most of these serious injuries. The investigators found evidence on autopsy to support the shake-plus-impact model of injury. This statement relates to children with signs of having undergone shaking, whether or not additional injuries are present.

### ETIOLOGY

While caretakers may be unaware of the specific injuries they may cause by shaking, the act of

shaking/slamming is so violent that competent individuals observing the shaking would recognize it as dangerous. Shaking may seem to be a proportionate response to the tension and frustration frequently generated by a baby's incessant crying or irritability.<sup>7</sup> Caretakers at risk for abusive behavior generally have unrealistic expectations of their children and may exhibit a role reversal, whereby the parents expect their needs to be met by the child.<sup>8</sup> Additionally, parents with psychiatric difficulties or those who are experiencing stress as a result of environmental, social, biologic, or financial situations may also be more prone to impulsive and aggressive behavior. In some cases it is not clear whether there was an intent to inflict serious harm on the infant by shaking or a desire to stop the crying. In other cases, the careless disregard for the child's safety and the force required to account for the intracranial and extracranial injuries suggest an intent by the caretaker to severely injure, if not kill, the infant or child.

### UNINTENTIONAL VERSUS INFLICTED INJURIES

Homicide is the leading cause of injury-related deaths in infants (those younger than 1 year of age).<sup>9</sup> Serious injuries in infants, particularly those that result in death, are rarely unintentional unless there is another clear explanation, such as trauma from a motor vehicle crash. Billmire and Myers<sup>1</sup> found that when uncomplicated skull fractures were excluded, 95% of serious intracranial injuries and 64% of all head injuries in infants younger than 1 year of age were due to child abuse. Bruce and Zimmerman<sup>3</sup> document that 80% of deaths from head trauma in infants and children younger than 2 years of age were the result of nonaccidental trauma. In large groups of physically abused children, brain trauma has represented from 7% to 44% of the injuries.<sup>10</sup>

### CLINICAL FEATURES AND EVALUATION

Shaken baby syndrome is characterized as much by what is obscure or subtle as by what is immediately clinically identifiable. A shaken infant may suffer only mild ocular or cerebral trauma. The infant may have a history of poor feeding, vomiting, lethargy, and/or irritability occurring intermittently for days or weeks prior to the time of initial health care contact. The subtle symptoms are often minimized by physicians or attributed to mild viral illnesses, feeding dysfunction, or infant colic. Most often one caretaker is aware of the true etiology of the injuries and the others are not. There appears to be a spectrum of the

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The recommendations in this statement do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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shaken baby syndrome in infancy, and mild cases may never be diagnosed.

The caretaker who violently shakes a young infant, causing unconsciousness, may put the infant to bed, hoping that the baby will later recover.<sup>3</sup> Thus the opportunity for early therapeutic intervention is often lost.<sup>11</sup> When brought to medical attention, the shaken infant typically is convulsing or comatose, not sucking or swallowing, unable to follow movements, and not smiling or vocalizing. The comatose state may be unrecognized by caretakers and even by some medical providers who may assume that the infant is sleeping or lethargic. Such infants often have respiratory difficulty, progressing to apnea or bradycardia, requiring cardiorespiratory resuscitation.<sup>2,3</sup>

There should be a meticulous search for evidence of other injuries such as bruises. Any such injuries should be documented with photographs and examined sequentially, looking for progression of these bruises or the delayed appearance of other bruises. In 75% to 90% of the cases, unilateral or bilateral retinal hemorrhages are present but may be missed unless the child is examined by a pediatric ophthalmologist or experienced physician who is familiar with the hemorrhages, has the proper equipment, and dilates the child's pupils.<sup>2,3,12</sup> The number, character, and size of retinal hemorrhages following shaking injury vary from case to case. Retinal and vitreous hemorrhages and nonhemorrhagic changes including retinal folds and traumatic retinoschisis are characteristic of shaken baby syndrome.<sup>12,13</sup>

At times the diagnosis is confused with meningitis and a spinal tap yields bloody cerebrospinal fluid.<sup>2</sup> Centrifuged spinal fluid that is xanthochromic should be interpreted to be the result of past cerebral trauma. Because of confusing respiratory symptoms, chest roentgenograms often are obtained, and they may be normal or show unexplained rib fractures. Because blood is lost to the intracranial space, the shaken infant is typically mildly to moderately anemic.<sup>14</sup> Clotting dysfunction should be assessed initially and followed up. Hemorrhagic disease of the newborn due to vitamin K deficiency can present as intracranial bleeding in infants older than 1 month.<sup>15</sup> Elevated transaminase levels may indicate occult liver injury.<sup>16</sup>

### RADIOLOGY

Computed tomography (CT) has assumed the first-line role in the imaging evaluation of the brain-injured child. It adequately demonstrates those injuries needing urgent intervention, although some false-negative studies occur, particularly early in the evolution of cerebral edema.<sup>17</sup> The initial CT evaluation should be performed without intravenous contrast and should be assessed by using bone as well as soft tissue windows. Computed tomography is generally the method of choice for demonstrating subarachnoid hemorrhage, mass effect, and large extraaxial hemorrhages.<sup>17</sup> It may need to be repeated after a time interval or if the neurologic picture changes rapidly.<sup>18</sup>

Magnetic resonance imaging (MRI) is of great value as an adjunct to CT in the evaluation of brain injuries in infants.<sup>19</sup> Owing to the lack of universal availability of the technology, the physical limitations of access to

MRI when life support is required for the critically ill infant or child, and insensitivity to subarachnoid blood and fractures, MRI is considered complementary to CT. Sato et al<sup>17</sup> have demonstrated a 50% improvement in detection of subdural hematoma using MRI as compared with CT. The ability to detect and define intraparenchymal lesions of the brain is substantially improved by the use of MRI. In Sato and coworkers' study<sup>17</sup> CT did not miss any surgically treated injuries that were detected by MRI. Magnetic resonance imaging and CT can date injuries and substantiate repeated injuries by documenting changes in the chemical states of hemoglobin in the affected areas.<sup>17</sup>

A skeletal survey including the long bones, skull, spine, and ribs should be obtained as soon as the infant's medical condition permits. Skull films are complemented by the CT bone windows in the detection of skull fractures. In one retrospective series of abused children, skull films were slightly more sensitive and improved the confidence of diagnosis of skull fracture as compared with CT.<sup>17</sup> Skull fractures that are multiple, are bilateral, or cross suture lines are more likely to be nonaccidental.<sup>20</sup> Single or multiple fractures of the midshaft or metaphysis of long bones or rib fractures may be associated findings. Specialized views coned down may be needed to delineate subtle fractures.<sup>19</sup> A skeletal survey should be repeated in 2 weeks to better delineate new fractures that may not be apparent until they begin to heal (a process that does not begin for 7 to 10 days).<sup>19</sup>

### PATHOLOGY

The cranial cerebral injuries documented in abused children depend on the force or severity of the shake or shake plus impact and the time elapsed from the injury. Subdural hemorrhage caused by shearing forces disrupting small bridging veins over the surface of the brain is a common result of shaking.<sup>4,5</sup> Such hemorrhage may be most prominent in the interhemispheric fissure and minimal over the convexities of the hemispheres.<sup>3,10</sup> However, cerebral edema with or without subarachnoid hemorrhage may be the only finding. Visible cerebral contusions are unusual, but diffuse axonal injury is probably frequent.<sup>21</sup> Isolated or concomitant hypoxic-ischemic damage may result in mild to severe cerebral edema initially and cerebral atrophy and/or infarction as a later finding. Extracerebral fluid collections over the surface of the brain, cerebral atrophy, and cystic encephalomalacia are common late sequelae.<sup>18</sup> Previous reports of benign subdural effusions remain unsubstantiated since multidisciplinary evaluations in those cases were lacking.<sup>22</sup>

### OUTCOME/CONSEQUENCES

There is an extraordinarily high incidence of morbidity and mortality among infant victims of shaking.<sup>14,18</sup> In one series, of those infants who were comatose when initially examined, 60% died or had profound mental retardation, spastic quadriplegia, or severe motor dysfunction. Others who initially had seizures, irritability, or lethargy with no lacerations or infarctions of brain tissue, who did not have severe

intracranial pressure increases, had subtle neurologic sequelae or persistent seizures.<sup>18</sup> When these severely injured children survive, they may be blind or have chronic subdural fluid collections, enlarging ventricles, cerebral atrophy, encephalomalacia, or porencephalic cysts.<sup>18</sup> The consequence of shaking to infants who do not come to medical attention is presently unknown.

#### CLINICAL/COMMUNITY MANAGEMENT OF NONACCIDENTAL HEAD INJURIES

Suspicion of serious head injury as a result of maltreatment must be reported immediately to the appropriate authorities to provide for a thorough investigation before the issues become clouded by time and comparison of explanations by caretakers. The clinical team should include a physician who can immediately resuscitate and stabilize the baby while diagnostic radiologic studies are being done. Specialists in pediatric radiology, neurology, neurosurgery, and ophthalmology, as well as a pediatrician specializing in child abuse, should form the diagnostic team. In rural or medically underserved areas where one or more of these specialists are not available, a regional consultation network for child abuse cases should be developed. Careful follow-up by this same team is necessary to document and treat ocular and neurologic sequelae of the trauma. A pediatrician who works with a Child Protection Team should be available to take a broad but detailed history from the caretakers. Information regarding symptom onset, as well as information regarding the chain of caretakers, needs to be quickly passed on to mandated law enforcement and child protection investigators. Physicians can provide interpretation of the likely scenario, timing, and nature of the injuries involved. If notified promptly, investigators may be able to provide reciprocal service by exploring the probable scene of the injury and eliciting information from the caretaker prior to the time that defensive reactions have developed. A psychosocial assessment of the caretakers should be a part of this comprehensive team approach. Siblings or other children, when abuse occurs in settings outside of the home, may have findings of inflicted trauma or repeated shaking.<sup>23</sup> Therefore, child protection assessments need to be available immediately to ensure the current and future safety of these children.

#### PREVENTION

As a part of anticipatory guidance, the pediatrician should ask about parental stress and their response to the crying infant as well as advise parents regarding the risks of shaking. The efficacy of home visitation programs in preventing intrafamilial physical abuse is established. Nationwide home visitation programs have been recommended by the US Advisory Board on Child Abuse and Neglect.<sup>24</sup> Showers<sup>25</sup> has evaluated "Don't Shake the Baby" cards, and others have developed flyers and used billboard displays to increase public awareness of "The Shaking Shocker." Whether or not these educational efforts will prevent stressed adults from shaking babies needs to be evaluated. The prevention of extrafamilial abuse in out-of-

home settings is more problematic. Careful checking of references, frequent unannounced visits, and conversations with others using the same caretaker may be valuable, but there are no data available to verify the efficacy of these preventive measures as there are for home visitation programs.

#### SUMMARY

The shaken baby syndrome is a clearly definable medical condition. It requires integration of specific clinical management and community intervention in an interdisciplinary fashion.

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