## **Shaken Baby Syndrome**

The term "shaken baby syndrome" (SBS) was developed to explain those instances in which severe intracranial trauma occurred in the absence of signs of external head trauma. SBS is the severe intentional application of violent force (shaking) in one or more episodes, resulting in intracranial injuries to the child. Physical abuse of children by shaking usually is not an isolated event. Many shaken infants show evidence of previous trauma. Frequently, the shaking has been preceded by other types of abuse.

### Mechanism of Injury

The mechanism of injury in SBS is thought to result from a combination of physical factors, including the proportionately large cranial size of infants, the laxity of their neck muscles, and the vulnerability of their intracranial bridging veins, which is due to the fact that the subarachnoid space (the space between the arachnoid membrane and the pia mater, which are the inner two of the three membranes that cover the brain) are somewhat larger in infants. However, the primary factor is the proportionately large size of the adult relative to the child. Shaking by admitted assailants has produced remarkably similar injury patterns:

- The infant is held by the chest, facing the assailant, and is shaken violently back and forth.
- The shaking causes the infant's head to whip forward and backward from the chest to the back.
- The infant's chest is compressed, and the arms and legs move about with a whiplash action.
- At the completion of the assault, the infant may be limp and either not breathing or breathing shallowly.
- During the assault, the infant's head may strike a solid object.
- After the shaking, the infant may be dropped, thrown, or slammed onto a solid surface.

The last two events likely explain the many cases of blunt injury, including skull fractures, found in shaken infants. However, although blunt injury may be seen at autopsy in shaken infants, research data suggest that shaking in and of itself is often sufficient to cause serious intracranial injury or death.

### **Indicators and Symptoms**

Crying has come under increasing scrutiny as a stimulus for abusive activity. Because shaking is generally a response to crying, a previous illness causing irritability may increase the likelihood that the infant will be shaken. The occurrence of infant abuse is a product of a delicate balance between the severity of the stimulus of crying and the threshold for violent action by potential abusers. The effects of drugs, alcohol, and environmental conditions may trigger this interaction.

The average age of infants abused by shaking is 6 months. The physical alterations characteristic of SBS are uncommon in children older than 1 year. Many symptomatic shaken infants have CNS findings of seizures, lethargy, or coma. Many are resuscitated at home or en route to the hospital and arrive there in serious condition, with a tense fontanelle (the soft spot covered by a membrane, at the top of an infant's head, where the skull bones have not yet joined). Some patients have milder changes in consciousness or a history of choking, vomiting, or poor feeding. Although gross evidence of trauma is usually absent, careful inspection may reveal sites of bruising.

Most infants in whom shaking has been documented have retinal hemorrhage (bleeding along the back inside layer of the eyeball). Other intracranial injuries ascribed to shaking trauma include extra-axial fluid collections (fluid between the skull and brain, e.g., subdural hematoma), axonal shearing injuries at the gray-matter/white-matter interfaces (tearing of brain tissue), and cerebral edema (swelling of the brain).

# Diagnostic Recommendations in Cases of Suspected Shaken Baby Syndrome

Although retinal hemorrhage implies that shaking was a factor in causing an injury, physical examination, imaging studies, and pathological examination are needed to determine whether evidence of direct external trauma also exists. While medically such causative distinctions are not crucial to documenting physical abuse, legally, the mechanism of injury is useful for the physician confronted with the necessity of testifying as to the cause of a child's injuries.

All infants suspected of being abused should undergo a radiological skeletal survey. This should be performed with high-detail systems and with painstaking attention to technique. A single view of the entire infant ("babygram") is inadequate.

Repetition of skeletal imaging 2 to 3 weeks after the initial examination may provide evidence of a healing injury that was not apparent on initial studies, and should be performed in all infants when abuse is strongly suspected.

High-quality, state-of-the-art skeletal scintigraphy may be an important supplement to radiological skeletal surveys and has been advocated by some physicians as a primary screening tool in cases of suspected abuse. In the toddler and young child, scintigraphy poses a practical alternative to x-rays; however, caution should be exercised in using scintigraphy as a primary screening tool in infants.

All infants with clinical neurological findings should undergo cranial CT. This will be sufficient to define any surgically correctable condition.

Most patients should undergo MRI eventually to define the extent of the injury fully, determine the prognosis, and provide evidence for intervention and criminal proceedings.

Abdominal injuries are uncommon in abused infants, and imaging studies should be tailored to the specific clinical concern. CT and ultrasound are helpful in establishing whether internal abdominal trauma has occurred in infants thought to have been shaken.

### **Investigative Guidelines for Cases of Shaken Baby Syndrome**

The use of MRI has helped detect old and new intracranial injuries and has aided recognition of subtle instances of repetitive shaking.

Repetitive abuse has important legal and clinical implications. If abuse is repetitive, the child is at high risk for further injury unless legal action is taken. Establishing that there has been a pattern of abuse can also help in identifying potential perpetrators and may lead to increased legal penalties.

The fact that shaken children, and possibly their siblings, often have been previously abused should dispel the notion that shaking is an isolated and somewhat "unintentional" event.

From the perspective of the protection of the child or the criminal prosecution of the abuser, it is not as important to distinguish the precise mechanism of injury as it is to be certain that the event was nonaccidental.

Pediatricians should not be deterred from testifying when the cause of the non-accidental injury is not entirely clear.

Shaking a child creates an imminent risk for an acute injury.

Injuries that appear to be caused by shaking create a high index of suspicion of child abuse and should be followed by intensive efforts (e.g., skeletal survey, CT, and MRI) to identify concurrent and previous abuse of the patient and any siblings.

If an infant's injuries are fatal, an autopsy should be performed by a forensic pathologist. Autopsies of all infants who die of causes other than known natural illness should include thorough skeletal imaging.