E6 – Medical Imaging in Pediatric Abuse

2026 Spring Symposium

Abstract

Child abuse is any act or failure to act on the part of a caregiver or parent, which results in, death, physical or emotional harm, sexual abuse or exploitation; or an act or failure to act that presents an imminent risk of serious harm. Shaken baby syndrome (SBS), also known as Abusive Head Trauma (AHT), occurs when a baby is violently shaken, causing the brain to hit the skull. This can result in bleeds, bruising, swelling, permanent damage, and death. Medical imaging such as Skeletal Surveys (SS) and Magnetic Resonance Imaging (MRI) can aid radiologists in suspected child abuse cases. These imaging scans can detect signs and patterns of abuse to help children.

*Keywords: m*agnetic resonance imaging (MRI), skeletal survey (SS), shaken baby syndrome (SBS), abusive head trauma (AHT)

Medical Imaging in Pediatric Abuse

Introduction

In the United States, over half a million children fall victim to domestic abuse and neglect each year. In 2023, 2,000 children died from abuse-related causes, with infants under one year of age experiencing the highest mortality (National Children's Alliance, 2022). Early detection is crucial for preventing further harm. Radiology plays a vital role in identifying both external and internal subtle injuries. Imaging not only aids in diagnosis but also helps reveal injury patterns and document evidence of trauma. This paper will discuss child abuse and shaken baby syndrome, and how MRI and diagnostic imaging are used to assist with diagnosis.

Discussion

What is Child Abuse?

Child abuse is defined as, any act or failure to act of a parent or caretaker which results in death, serious physical or emotional harm, sexual abuse or exploitation; or an act or failure to act which presents an imminent risk of serious harm (Centers for Disease Control and Prevention, 2023). According to the CDC, there are four common types of child abuse. These include neglect, physical, sexual, and emotional abuse. Neglect, defined as the failure to meet a child's basic needs, is the most common form, accounting for 74% of cases. Every year, roughly half a million cases of abuse are reported. In the United States, every 1 in 4 girls and 1 in 13 boys experience abuse (CDC, 2023).

What is Shaken Baby Syndrome?

Shaken baby syndrome (SBS), also commonly known as abusive head trauma (AHT) is the leading cause of abuse-related deaths in children under five. Approximately 300 infants

under the age of one die each year due to violent shaking. SBS is defined as a form of physical child abuse caused by violently shaking a baby or young child (Mayo Clinic, 2025).

Infants are especially vulnerable due to immature brain development, higher water content, partially myelinated neurons, and larger subarachnoid spaces. Violently shaking causes the child's head to whip back and forth, resulting in bruising, swelling, and bleeding inside the skull. Common symptoms include lethargy, irritability, difficulty breathing, seizures, and decreased levels of consciousness. Potential long-term damages include permanent brain damage, disability, vision problems, paralysis, or death.

Imaging Modalities that Aid in Diagnosis

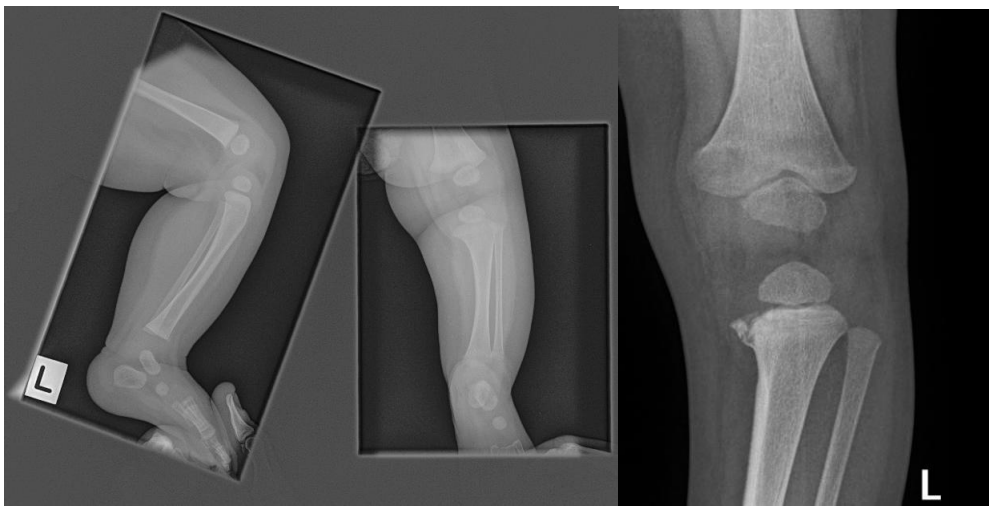
Skeletal Survey

A skeletal survey (SS) is a series of radiographs covering the entire body—including the skull, spine, ribs, pelvis, arms, and legs—used to detect fractures, especially hidden (occult) ones. Skeletal surveys are often used in suspected physical abuse (non-accidental trauma) and in evaluating bone diseases or infections. In infants, skeletal fractures are the second most common injury after bruising. Approximately 80% of abuse-related fractures occur in children younger than 18 months. Thorough evaluation is critical when abuse is suspected.

A study was conducted from 2002-2006 at the University of Pittsburgh evaluating skeletal surveys in suspected abuse cases. After excluding non-abuse cases, 703 surverys were analyzed, with a median patient age of eight months. Of the 703 exams, 10.8% were positive, with rib fractures being the most common unsuspected finding. The study noted that many children displayed signs of healing fractures, highlighting the recurrent nature of abuse. (Duffy et al., 2011 para. 6.)

The classic metaphyseal lesion fracture (the corner or “bucket handle” fracture), regardless of clinical history, is specific to abuse. Classic metaphyseal lesion fractures (CML) are a series of microfractures within the metaphyseal primary spongiosa caused by violent shaking. The following two images below show two separate patients with a metaphyseal corner fracture Kumar Sarangi, 2023).

Figures 1 & 2 show an x-ray of metaphyseal corner fractures



Radiopaedia metaphyseal-corner-fracture-1

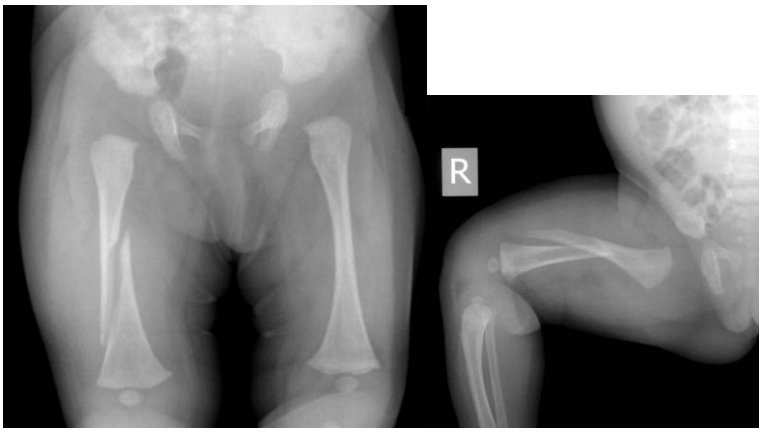
A two-view forearm exam in a 16-month-old child illustrates the importance of clinical correlation. The reported mechanism—a fall from a five-foot jungle gym ladder—was inconsistent with the child’s developmental abilities. Radiographs revealed three fractures: bowing, torus (buckle), and a complete oblique fracture, suggestive of non-accidental trauma (Glick, n.d.).

Figures 3 & 4 show an x-ray of a buckle fracture of a forearm

Radiopaedia forearm-fractures-toddler-1

Another very common fracture often seen in children are spiral fractures, caused by forceful twisting or jerking of an extremity. Spiral fractures are rarely caused by simple falls. If untreated, they may require surgical repair and carry risks such as nerve damage, infection, osteomyelitis, or sepsis. A spiral fracture of the femur in a non-weight-bearing infant is especially suspicious of abuse.

Figures 5 & 6 show spiral fractures of the femur



Radiopaedia https://radiopaedia.org/cases/proximal-femoral-fracture-pediatric?lang=us

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a non-invasive and non-radiating scanner that produces three-dimensional anatomical images. MRIs emit a powerful magnetic field; this magnetic field forces the body's protons to align. A radiofrequency is then emitted to the patient, once this occurs protons become excited. The stimulated protons then are spun out of their equilibrium. The radiofrequency field is then turned off, allowing the MRI sensors to detect the energy released as the protons begin to realign (National Institute of Biomedical Imaging and Bioengineering, n.d).

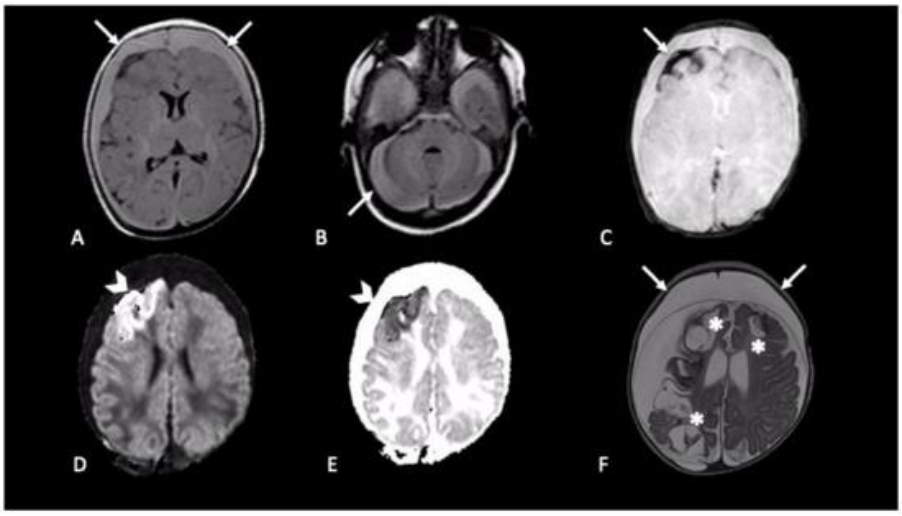
Abusive head trauma may be difficult to determine because not all injuries can be seen externally. Magnetic resonance imaging can be done on the infant's brain to determine small damages done. Retinal hemorrhages are defined as blood vessels of the retina bleeding into other areas of the eye. These types of hemorrhages are seen in about 70-95% of AHT cases. The image below shows, "Irregular thickening and hypointensity of bilateral posterior ocular globes, indicative of retinal hemorrhage (arrows)" in an axial slice (Cartocci et al., 2021 para. 14.). Although a hemorrhage does not automatically indicate shaken baby syndrome, the finding of retinal hemorrhage with inadequate clinical history raises suspicion.

Figure 7 shows a brain MRI of thickening of the ocular globes

Shaken Baby Syndrome: MRI Features in Abusive Head Trauma PMC7912837

Subdural hemorrhages are another common injury caused by tearing of bridging veins during rapid acceleration and deceleration. Blood is collected between the covering layer of the brain, the dura, and the surface of the brain. Symptoms in a child include seizures, irritability, vomiting, and a larger than normal head circumference (Cartocci, et al., 2021). Compared to a CT, an MRI is helpful in determining the age of the bleeding. With the deoxygenated process of the hemoglobin containing ferric iron, they are more susceptible to a magnetic effect. In the image below, a newborn was brought into the emergency room for emesis and fever. MRI demonstrated bilateral subdural CSF-blood collection (Cartocci, et al., 2021).

Figure 8 shows an MRI of subdural CSF-blood collection



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Conclusion

Imaging plays a crucial role in the evaluation of suspected child abuse, by revealing injuries that may be hidden, unexplained, or inconsistent with the child's history or developmental abilities. Imaging such as skeletal surveys and MRI help identify fracture patterns, intracranial injuries, and soft-tissue damages that are highly specific for non-accidental trauma. By documenting both acute and healing injuries, imaging not only enhances diagnostic accuracy, but also provides objective evidence that supports timely medical intervention and protective actions. Conclusively, imaging serves as an essential tool to ensure the safety, well-being, and justice of vulnerable children.

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