



BASIC RADIOLOGY IN PHYSICAL ABUSE OF CHILDREN

Introduction:

Pediatric radiologist Dr. John Caffey first described the association of long bone fractures and chronic subdural hematoma with child abuse. Most abusive fractures occur in children less than 3 years old; 80% of such fractures occur in children younger than 18 months. Abusive fractures may be multiple, of different ages, or solely determined by radiologic imaging. Two thirds of abused children have a positive radiologic finding which may be the first sign to alert the physician of child abuse. The role of imaging in cases of child abuse is to identify the extent of physical injury when abuse occurs, as well as to elucidate all imaging findings that point to alternative diagnoses. Radiographs should not replace either a detailed history or a comprehensive physical examination. For this medical alert, basic diagnostic imaging modalities useful for the detection, management and follow-up of suspected abusive trauma in children will be discussed.

What are the imaging modalities useful in diagnosing child abuse?

There are several imaging modalities that can be used such as:

1. Skeletal survey
2. Bone scan
3. CT scan
4. MRI

What is a skeletal survey?

This is the primary imaging study used in the global assessment of the skeleton in cases of suspected abuse used in children less than 2 years old. For patients more than 2 years old, x-rays of the specific sites of injury are done. However, it should be noted that as many as 50% of abused children would fail to show any skeletal injury at the time of presentation. Repeating limited views 2 weeks after the initial survey to reevaluate areas of concern is helpful to see healing of the fractures with callus formation.

The "baby gram" (a study that encompasses the entire infant or young child on 1 or 2 radiographic exposures) or abbreviated skeletal surveys have no role in the imaging of these subtle but highly specific bony abnormalities!

Table 1: Components of a skeletal survey

<ol style="list-style-type: none"> 1. AP and lateral skull 2. Lateral cervical spine 3. AP, lateral and oblique ribs 4. AP pelvis 5. Lateral thoracic-lumbar spine 6. Antero-lateral humeri, forearms, femurs, tibias and fibulas 7. Oblique hands 8. AP feet

Are there certain fractures in a child that are specific indicators of abuse?

Kleinman described fractures as having a high, moderate or low specificity for abuse as seen in Table 2.

Table 2: Specificity of fractures for physical abuse

HIGH	<ul style="list-style-type: none"> • Metaphyseal chip fractures • Bucket handle fractures • Rib fractures, especially posterior location • Scapular fractures • Spinous process • Sternum
MODERATE	<ul style="list-style-type: none"> • Multiple or bilateral fractures • Fractures of different ages • Epiphyseal separations • Vertebral body fractures and subluxations • Digital fractures • Complex or multiple skull fractures
COMMON BUT LOW	<ul style="list-style-type: none"> • Subperiosteal new bone formation • Clavicle fractures • Long bone shaft fractures • Linear, simple skull fractures

Are there specific imaging recommendations for suspected abusive fractures based on age?

Table 3: Imaging recommendation for skeletal injury ¹

Age	Imaging
0-12 months	Skeletal survey Follow-up skeletal survey (2weeks)
12months-2years	Skeletal survey or Bone scan
2-5 years	Skeletal survey or bone scan in selected cases where physical abuse is strongly suspected
5 years and older	Radiograph of individual sites of injury suspected on clinical grounds

What is a bone scan or skeletal scintigraphy?

A bone scan helps diagnose subtle or hidden bone fractures that may not show up on routine X-ray. Tiny amounts of tracers or radionuclides are used which accumulate in certain tissues, such as bones. Once introduced into the body, tracers emit waves of radiation that are detected by a special gamma camera. This camera produces images that are interpreted by radiologists or nuclear medicine specialists. The tracers may accumulate in certain areas of the bone, indicating one or more hot spots which may be caused by a fracture that is healing, bone cancer, a bone infection, or a disease of abnormal bone metabolism.

Bone scans are useful in detecting diaphyseal injuries and rib fractures. However, bone scan has limited sensitivity in detecting classic metaphyseal lesions of abuse, particularly when the lesions are bilateral, as well as subtle spinal injuries, features that carry a high specificity for abuse in infants

What are the uses of CT scan and MRI?

Computed tomography (CT) and Magnetic resonance imaging (MRI) are utilized in different parts of the body. CT without contrast should be done as initial imaging modality for the brain-injured infant and child. It is best for showing acute subdural, subarachnoid and interhemispheric hemorrhage routinely seen in shaken baby syndrome (SBS).

MRI is a useful adjunct to CT in evaluating head trauma, but its usefulness is limited by availability, difficult access in the critically ill patient and relative insensitivity to subarachnoid blood and fractures. MRI

can detect intraparenchymal lesions such as shearing injury. It is also helpful when the CT is inconclusive.

Can a fracture be dated?

Radiologic dating of fractures is an inexact science. The radiologic estimates of bone healing occur as a continuum with considerable overlap. Radiologic estimates of the time of injury are made in terms of weeks rather than days and a proficient radiologist can clearly differentiate recent from old fractures.

Periosteal reaction is seen as early as 4 days and is present in at least 50% of cases by 2 weeks after the injury. Remodeling of a fracture appears 8 weeks after injury. Most radiologists date fractures on the basis of their personal clinical experience, and the literature provides little consistent data to act as a resource.

Can we or should we X-ray children who died of suspicious circumstances?

Yes! Diagnostic imaging plays a critical role in cases of suspected fatal child abuse. The indications for skeletal survey are much the same as those for the forensic autopsy. The goal is to assist in determining the cause and manner of death. Postmortem skeletal survey is best performed before the autopsy and is quite useful in documenting long bone fractures.

References:

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