

NON-ACCIDENTAL INJURY IN CHILDREN – DIAGNOSTIC IMAGING

Pediatric Trauma III

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PURPOSE

The aim of the lecture is to illustrate radiological findings of injuries raising suspicion of non-accidental injury (NAI) in children and to present an imaging approach for the diagnostic work-up.

INTRODUCTION

Child abuse includes physical abuse, sexual abuse, psychological abuse, and, most commonly, neglect. It is estimated that 4 million children each year are abused in the U.S. and 2000 children each year die as a result of abuse. When all cases of child abuse and neglect are studied, the incidence of physical evidence documented by diagnostic imaging studies is relatively small. However, imaging studies are often critical in the assessment of infants and young children with evidence of physical injury. Radiologic evaluation of injury patterns can be of major importance in the diagnosis of child abuse.

The majority of physically abused children will present in one of three ways in the radiology department:

- 1) Children with high clinical suspicion of NAI.
- 2) A radiological exam reveals lesions not consistent with the given history.
- 3) A radiological exam for another reason (e.g. abnormal head growth) reveals lesions raising suspicion of NAI.

Depending on age and presentation different imaging strategies should be adopted.

IMAGING STRATEGIES

1) Child two years of age or younger with a clinical suspicion of abuse but no focal signs or symptoms.

Although skeletal injuries rarely pose a threat to the life of the abused child, they are often the strongest radiologic indicators of NAI. The most basic imaging examination is therefore the skeletal survey, which should determine a level of specificity based on the nature, location and chronicity of injury. High specificity lesions include classic metaphyseal lesions, posterior rib fractures, scapular fractures, spinous process fractures and sternal fractures. The classic metaphyseal lesion represents the most specific lesion of NAI. Its radiologic appearance has been characterized as “corner” or “bucket handle” fracture. Moderate specificity lesions comprise multiple fractures, fractures of different ages, epiphyseal separations, vertebral body fractures and sublaxations, digital fractures and complex skull fractures. Low specificity lesions include clavicular fractures, long bone shaft fractures, linear skull fractures and subperiosteal new bone formation.

The use of a radionuclide bone scan remains controversial. It may offer an adjunct to the skeletal survey in selected cases, particularly in children older than 1 year.

Recent evidence suggests that a follow-up skeletal survey approximately 14 days after the initial study increases the diagnostic yield.

If the skeletal survey reveals bony lesions suggestive of child abuse the child should undergo cranial MRI (or CT).

2) Child two years of age or younger with a clinical suspicion of abuse, a history of head trauma but no focal signs or neurologic symptoms.

The child should be evaluated as described above. A CT of the brain in a child with a normal neurological exam often does not alter the child’s clinical course. However, depending on the level of suspicion and the need for documentation the child should undergo cranial MRI or CT.

3) Child up to the age of five years with neurologic signs and symptoms, and suspicion of abuse with or without other physical findings.

The precise timing of the scans will be dictated by clinical judgement and circumstances in each individual case. As soon as possible a cranial CT must be undertaken as it is readily

available, rapidly performed and usually demonstrates well abnormalities that require emergency surgical intervention. If the CT is negative or indeterminant, MRI should be performed to detect infarction, hemorrhage or subacute and chronic injury.

If the CT findings are positive subsequent studies are necessary to more fully delineate all abnormalities, determine the timing of the injuries, and monitor their evolution. Cranial MRI should be performed to make use of its superior sensitivity for detecting ischemic changes, hemorrhage in the subacute stage, contusions and shear injuries. Sonography via the anterior fontanelle in young infants has a limited role in the evaluation of non-accidental head injuries. High-resolution cranial ultrasound exams can provide useful information about the presence or absence of convexity subdural or subarachnoid collections. Subcortical white matter tears in the frontal and anterior parietal parasagittal regions can be demonstrated with this technique.

Subdural hematomas of different ages, severe brain lesions and skull fractures not explained by the severity of the trauma as well as subcortical shearing injuries should raise suspicion of NAI. Important differential diagnoses such as coagulopathy and metabolic disorders have to be excluded.

If the child is two years of age or younger a skeletal survey should be performed. In the 2- to 5-year-old group the decision to perform a skeletal survey or bone scan must be handled individually based on the specific clinical indicators of abuse.

If clinical findings indicate spinal cord or nerve root injury, MRI of the spine is warranted. Complex fractures of the spine should be evaluated with thin-section CT and multiplanar reformatted images as in accidental injury.

4) A child of any age with visceral injury that is discrepant with the history, physical examination and laboratory findings.

The evaluation and management of the acute thoracoabdominal injury in victims of child abuse is the same as for children with accidental injuries (see also Prof. Riccabona's lecture "Significant pediatric (multiple) trauma – imaging modalities, approaches, and algorithms, with special regard to low dose CT protocols"). However, when an infant or child sustains serious injury to the chest or abdomen inconsistent with the given history, investigation of potential child abuse is warranted. Especially pancreatic injuries, duodenal hematomas, adrenal hemorrhage, bowel perforation and trauma associated with rib fractures heighten the

suspicion of NAI. If there is significant suspicion of abuse and the patient is two years of age or younger a skeletal survey should be performed. The screening skeletal survey or bone scan has little value in children older than 5 years. In the 2- to 5-year-old group the decision to perform a skeletal survey or bone scan must again be handled individually.

5) A child with unexpected and unexplained neurological abnormalities, intracranial hemorrhage, blood-stained cerebrospinal fluid or retinal hemorrhage.

If the child is two years of age or younger, an investigation with a skeletal survey is warranted after the unexpected abnormality has been identified by CT or MRI. From age 2 to 5 years a skeletal survey or a bone scan should be considered. Depending on the findings in the initial study subsequent studies are necessary to more fully determine all abnormalities. At least one cranial MRI should be performed.

CONCLUSION

Imaging studies are often critical in the assessment of the injured infant and young child and they commonly provide support for allegations of child abuse. Especially in infants and very young children with NAI, where externally visible injuries are often absent, imaging studies are sometimes the first indication of abuse.

In order to achieve the highest accuracy in detecting NAI, imaging protocols have to be adapted according to the clinical presentation and the age of the child. The role of the radiologist is to recognize lesions suggesting NAI but also to be aware of certain conditions that are known to have imaging features that may mimic NAI.