


Radiographic Imaging in the Evaluation of Child Abuse: Refining Practice Patterns

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Disclosures

I have no financial relationships with commercial interests to disclose.

Objectives

- Review what constitutes a skeletal survey
- Examine the current guidelines for when to order
 - Skeletal survey
 - Head CT
- Consider several recent advances in radiologic imaging
 - As Low As Reasonably Achievable (ALARA)
 - "Image Gently"
 - Fast MRI

What Is a Skeletal Survey?

Appendicular Skeleton

- Humeri (AP)
- Forearms (AP)
- Hands (PA)
- Femurs (AP)
- Lower legs (AP)
- Feet (AP)

Axial Skeleton

- Thorax (AP, lateral and L/R obliques)
- Pelvis (AP)
- Lumbosacral spine (lateral)
- Cervical spine (lateral)
- Skull (frontal and lateral)

A series of X-rays that encompasses the entire skeleton

American College of Radiology, 2014

Individual X-rays vs. Babygram

- Order individual X-rays.
- Do not order a babygram, which is a single image of the whole baby.

Indications for Skeletal Survey

- Suspected
 - **Physical abuse in infants and young children**
 - Skeletal dysplasia, syndrome and metabolic disorders
 - Neoplasia

Aged Based Recommendations for Skeletal Surveys

- Infants
- Young children
 - Current AAP recommendation <24 months
 - May be expanded to <36 month

American Academy of Pediatrics, 2012

Why Are Guidelines for When to Order a Skeletal Survey Important?

- | | |
|---|---|
| Overutilization <ul style="list-style-type: none">• Radiation• Potential discomfort for child and/or caregiver• Time• Costly to healthcare system | Underutilization <ul style="list-style-type: none">• Missed cases of abuse |
|---|---|

Missed Cases of Abuse

- A child who has been abused is more likely to be abused again compared to a child who has not.
- Some studies indicate that 10% of children who were not identified as being victims of abuse die from injuries that occur after being returned home.

Ravichandiran, et al., 2010

Yield of Skeletal Survey by Age

- Study design
 - Retrospective secondary analysis of an observational study
 - Measured rates of skeletal survey completion and fracture identification for children 0-60 months
 - Separated by 6-month cohorts

Lindberg DM, et al., 2014

Results of the Study

- 78% of the children had skeletal surveys performed.
- 18% had at least 1 new fracture identified.
- **New fracture identification rates were similar between children 12-24 months of age and 24-36 months of age.**
 - 12-24 months: 12%
 - 24-36 months: 10.3%
 - 36-48 and 48-60 months: <5%

Lindberg DM, et al., 2014

Conclusions

- Skeletal surveys identify new fractures in a significant percentage of children being evaluated by child abuse specialists.
- Data support
 - <24 months: skeletal survey is mandatory
 - 24-35 months: low threshold to obtain skeletal survey
 - 36-60 months: case by case

Lindberg DM, et al., 2014

Exceptions to the “Rules”

- Children with developmental delays
 - May not be able to communicate about their abuse (e.g., what hurts, when the abuse occurred, etc.)
 - Demineralization of bones due to disuse
 - Motor delays or intellectual disabilities
- Future studies should document development in addition to chronological age.

X-rays for Children > 36 months

Order specific views based on the child’s history and/or physical exam findings.

Follow-up Skeletal Surveys

- Recommended 10-14 days after the injury occurred.
 - Some fractures, particularly rib fractures, are only visible as they start to heal/form a callus.

The Utility of Follow-up Skeletal Surveys in Child Abuse

- Secondary analysis of data obtained by the Examining Siblings to Recognize Abuse (ExSTRA) research network
 - Children < 10 years of age
 - 20 US child abuse teams
- 2049/2890 (71%) of enrolled children had skeletal survey.
- 796/2049 (39%) had a follow-up skeletal survey.

Harper, et al., 2013

New Information Is Identified by a Follow-up Skeletal Survey

- 174/796 (21.5%) had new information identified.
 - 124/796 (15.6%) had at least 1 new fracture.
 - 55/796 (6.9%) had reassuring findings.
- A new fracture affected the perceived likelihood of abuse.

Harper, et al., 2013

New Fractures Affect the Perceived Likelihood of Abuse

- Estimated likelihood **increased** in 41 (33%) cases.
- Estimated likelihood remained at the maximum likelihood of abuse in 51 (41%) cases.
- Perceived likelihood of abuse impacts the child's disposition.

Harper, et al., 2013

Physical Abuse Is Common in Young Children With Fractures

- Diagnosis of physical abuse is made in
 - 20-25% of children < 12 months with a fracture
 - 6-7% of children 12-23 months with a fracture
- Concrete recommendations on which fracture scenarios should prompt ordering a skeletal survey do not exist.

Leventhal, et al., 2008

Guidelines for Skeletal Survey in Young Children with Fractures

- Multispecialty panel of experts was assembled.
- Panelists were provided a literature review on fractures in child abuse.
- Asked to use this information and their experiences to rate the **appropriateness** of performing skeletal surveys in 240 scenarios.
- Also asked to assess which scenarios indicated that a skeletal survey was **necessary**.

Wood, et al., 2014

Skeletal Survey Is Necessary in Children 0-23 Months Old if:

- History of confessed abuse
- History of injury occurring during domestic violence
- History of impact from toy/object causing fracture
- Delay in seeking care >24 hours in a child
- Additional injuries on PE unrelated to fracture
- No history of trauma to explain fracture
 - Except for the following fractures in an ambulatory child:
 - Distal buckle fracture of the radius/ulna
 - Distal spiral or buckle fracture of the tibia/fibula

Wood, et al., 2014

Skeletal Survey Is Necessary in All Infants with Any Type of Fractures

- **Except** in the following cases *if there are no additional concerns*:
 - Distal radial/ulna buckle fracture or toddler fracture of the tibia/fibula in a cruising child > 9 months with a history of a fall
 - Linear, unilateral skull fracture in a child > 6 months with a history of a significant fall
 - Clavicle fracture likely attributable to birth

Wood, et al., 2014

Skeletal Survey Is Necessary in Children 12-23 Months Old

With any of the following types of fractures:

- Rib fracture
- Classic metaphyseal lesion
- Complex skull fracture
- Humeral fracture with epiphyseal separation attributed to a short fall
- Femur diaphyseal fracture attributed to a fall from any height

The Guidelines Only Apply to Children

- Who do NOT have:
 - A verifiable mechanism of accidental trauma
 - Underlying bone fragility
 - A clear history of birth trauma

Neuroimaging in Suspected Child Abuse

- Head CT should be ordered for all infants < 6 months.
- Most order it for patients < 12 months.

Utility of Head CT in Children with a Single Extremity Fracture

- Retrospective chart review of children < 2 years of age who had a skeletal survey in the ED
- Searched for clinically and/or forensically significant head injury
- Determined rate of head CT relative to patient age and location of fracture
 - Proximal vs. distal
 - Upper vs. lower extremity

Wilson, et al., 2014

Conclusions of Wilson, et al.

- Clinicians should consider obtaining a head CT if:
 - Child < 12 months of age
 - Proximal extremity fractures
 - Previous evaluations for non-accidental trauma

Wilson, et al., 2014

Risks Related to Overutilization of Head CT Scans

- Risk of sedation
- Risk of identifying “incidentalomas”
- Increased risk of intracranial malignancy
 - Cumulative absolute risk is small, but real.

Pearce, et al., 2012

As Low As Reasonably Achievable

- Make every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical.
- Takes into account:
 - State of technology
 - Economics of improvements of the state of technology
 - Societal and socioeconomic considerations

U.S. Nuclear Regulatory Committee, 2015

“Image Gently” Campaign

- The Alliance for Radiation Safety in Pediatric Imaging began as a committee of the Society for Pediatric Radiology, but subsequently engaged:
 - American College of Radiologists
 - American Society for Radiologic Technologists
 - American Association of Physicists in Medicine

Don, et al., 2013

“Image Gently”

- Goal is to change practice by raising awareness of opportunities to lower radiation dose.
- Website contains information about:
 - What you can do dependent on your role in the team
 - Procedures and protocols for various types of imaging
 - Current events
 - Educational materials

Radiation Exposure

- Skeletal survey: 0.15-0.45 mSv (9 kg patient)
- In the US
 - Inhalation of air: 2.28 mSv/year
 - Ingestion of food and water: 0.29 mSv/year
 - Consumer items: 0.13 mSv/year

Drubach, et al., 2010

Natural Background Radiation Dose

Skeletal survey is equal to 3-10 weeks of natural background radiation.

FAST MRI

- Reduces the time it takes to scan the brain.
- Provides more dynamic images of the brain.
- Will likely impact the approach to imaging suspected victims of child abuse once it is widely available.

Feinberg and Setsompop, 2013

Summary

- Skeletal surveys consist of 19-22 individual images.
- Data support guidelines to consider skeletal survey mandatory in children <24 months and support a low threshold to obtain in children as old as 36 month.
- Follow-up skeletal surveys identify new information in about 20% of cases, which increases the estimated likelihood of abuse and, potentially, the disposition of the child.

Summary

- Recommendations on which fracture scenarios should prompt ordering a skeletal survey now exist.
- Routinely order neuroimaging for suspected victims <12 months old. (Some limit this to <6 months.)
 - Proximal extremity fractures and a previous evaluation for NAT should lower the threshold to order this.
- Recent advances in radiologic imaging:
 - ALARA
 - "Image Gently"
 - Fast MRI

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