Clinical Pearl: Orthopaedic Findings in Pediatric Non-Accidental Trauma

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Target Audience: Intended for any practitioner who sees children

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Federal law defines child abuse and neglect by the following definition:

‘at a minimum, any act or failure to act resulting in imminent risk of serious harm, death, or serious physical or emotional harm, sexual abuse, or exploitation of a child by a parent or caretaker who is responsible for the child’s welfare’

According to the National Child Abuse and Neglect Data System (NCANDS) published in 2007, 3.6 million cases of abuse or neglect were investigated. Of those just under 900,000 were proven abuse. And 1460 of the cases resulted in the death of a child. The data suggests that only around 50% of the deaths due to NAT are actually recorded as such.

The popular figure cited in the literature for NAT coming through the Emergency Department is 5-10% of all pediatric ER cases. Risk of death ranged from 5-25%. The overwhelming majority (50-80%) present with orthopedic trauma.

In the eleven years I have practiced in Grand Junction, no situation is more difficult to deal with than suspected NAT. If NAT is not recognized, the chance that the child will return to the ER dead has been reported at 5%. On the other hand, accusing a parent of NAT when it was truly an accident can devastate a family.

My goal in this article is to present some of the important orthopedic findings. It would be my hope that this was just a Segway toward learning more about a topic that has devastated many children in the Grand Valley over the past ten years.

Who Is The Population?

The vast majority (>60%) are less than 5 years of age. Of this group, greater than 60% are between 1-12 months of age.

NAT can be associated with all races, all socioeconomic backgrounds, and all age groups.

But there are certain risk factors that seem to be more prevalent. In our area, substance abuse is certainly a prominent one.
Others include but are not limited to:

- Lower socioeconomic status (yearly income of <$15K),
- First born, unplanned pregnancy, disabled child, stepchildren
- Single parent house holds
- Unemployed parents

**A Little Epidemiology**

NAT is the second leading cause of death in infants and children.

80% of the deaths from head trauma in children that are less than 2 years of age is NAT.

**Recognizing Fractures associated with Non Accidental Trauma**

There is no fracture pattern that is absolutely pathognomonic for NAT. But there are fractures that are highly correlated with NAT.

Although it is fairly easy to spot the child with multiple fractures at different stages of healing, this only accounts for 13% of the children presenting with NAT. The remaining are coming in with one fracture.

Recognizing NAT is similar to other areas of medicine. What brings you to a final diagnosis may not always be one feature of a disease, but the history and circumstance in which the disease presents itself.

For example, a spiral fracture of the femur in a 3-4 year old is not uncommon. The growing bone of the 3-4 year old seems to be particularly vulnerable to torsion. On the other hand, spiral fractures in a 6-month-old infant are very rare. Spiral fractures are commonly associated with accidental trauma. But not when a non-ambulatory infant is involved. So age of the child is very important.

**Motor milestones** are also equally important. Hearing that a 1 year old rolled off the middle of a bed and broke an arm is certainly possible. A one month old does not roll, so that same explanation is not plausible.

Certain **anatomical locations** are more concerning than others. The metaphyseal portion of bones in younger children, especially non-ambulatory child. Once again, they suggest a torsional mechanism associated with traction (increased force requirement).

But in contrast, the supracondylar humerus fractures in the 1-7 year olds are rarely associated with NAT. The mechanism is a fall on an outstretched, hyperextended elbow. Common mechanism for this age group, and an anatomic vulnerability in the elbow of kids at this age.

Below I have listed one of the best guidelines for assisting you in your recognition of NAT:

**Fractures With High Specificity:**

1. Femur fracture in a non-ambulatory child
2. Humeral shaft fractures in a child < 3
3. Sternal fractures
4. Metaphyseal corner fractures or bucket handle fractures
5. Posterior rib fractures
6. Digit Fractures in a non-ambulatory child
Mechanism is traction and twisting. Shaking the child by the wrist or ankle.

Planar injury through the primary spongiosum of the physis.

Often picked up at autopsy when not discovered with x-ray study.

These can be very hard to identify. Sometimes they are missed by the traditional skeletal survey. Don’t hesitate to ask the radiologist or orthopedist for additional views or other studies that may better elucidate the fracture.
Sometimes these are not discovered initially. The repeat skeletal survey done when NAT is suspected often helps to reveal the periosteal new bone associated with healing at 7-14 days. This depends on the child’s age.

Metaphyseal corner fracture off the medial side of the proximal humerus. This was the only radiographic evidence of a fracture in this 18-month child.

**Initial Radiographic Studies:**
Bone Survey (Kempe Series)

Needs to be done on mammography quality x-ray equipment. Technician must be well educated in the techniques and the views needed. Should be evaluated by a radiologist for quality and technique.
Practice recommendations:

There are orthopedic recommendations in the literature regarding suspicious fracture. The strongest recommendation is from the AAOS in 2009.

Recommendations from the 2009 American Academy of Orthopaedic Surgeons Clinical Practice guidelines for pediatric femur fractures:

-Children younger than 36 months with diaphyseal femur fractures should be evaluated for NAT-
(Level of Evidence II, Grade A recommendation)

Those of us who participate in the evaluation of NAT have learned several important things that we would like to call guidelines:

1. The evaluation of NAT works best as a team effort. ED attending, primary care provider, orthopaedists, radiologist, nurses, social workers, and sometimes law enforcement. Don’t hesitate to call a friend!

2. When in doubt, admit the child. It buys time for all of us to sort things out.

I give a more comprehensive NAT lecture several times a year. If you are interested in it, I am happy to come and do it for your group.
Reference:
1. Diagnostic Imaging of Child Abuse Third Edition  
   Edited by Paul Kleinman, MD
2. Rang’s Children’s Fractures, Third Edition  
   Dennis Wenger, MD and Maya Pring, MD
3. Rockwood and Wilkins’ Fractures in Children, Sixth Edition  
   James Beaty, MD and James Kasser, MD
4. AAOS 2009 Clinical Practice Guidelines for Pediatric Femur Fracture
5. National Child Abuse and Data System (NCANDS) 2007
   Ralph J. Riviello
7. Clinical Orthopedics and Related Research  
   Symposium: Nonaccidental Trauma in Children August 2015