Protocol for the Care of Non-Accidental Trauma in the Child and Adolescent Population: Radiological and Traumatological Aspects

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ABSTRACT
Child and adolescent abuse is a violation of human rights and a major global public health problem affecting hundreds of millions of children and adolescents, with serious short- and long-term health consequences. One quarter of adults (22.6%) worldwide were victims of physical abuse during childhood; among them, 36.3% experienced emotional abuse and 16.3% experienced physical neglect, with no significant differences between boys and girls. However, the lifetime prevalence of childhood sexual abuse shows more marked differences, with rates of approximately 20% in girls and 8% in boys. This article describes the protocol used in our hospital for the diagnosis and management of bone injuries and compares it with the most recent systematic reviews published on the subject.
Keywords: Children; non-accidental trauma; radiological protocol.
Level of Evidence: IV

Protocolo para la atención del trauma no accidental en la población infantojuvenil: aspectos radiológico y traumatológico

RESUMEN
El maltrato de niños y adolescentes es una violación de los derechos humanos, además de un importante problema de salud pública mundial que afecta a cientos de millones de niños y adolescentes, y tiene graves consecuencias para la salud a corto y largo plazo. Una cuarta parte de los adultos (22,6%) del mundo sufrió abuso físico cuando eran niños; el 36,3% de ellos sufrió abuso emocional y el 16,3%, negligencia física, sin diferencias significativas entre niños y niñas, aunque la prevalencia de abuso sexual infantil a lo largo de la vida indica diferencias más marcadas (niñas alrededor del 20% y niños alrededor del 8%). Se describe el protocolo utilizado en nuestro hospital para el proceso de diagnóstico y tratamiento de las lesiones óseas, y se lo compara con las últimas revisiones sistemáticas publicadas.
Palabras clave: Niños; trauma no accidental; protocolo radiológico.
Nivel de Evidencia: IV

INTRODUCTION

We define non-accidental trauma (NAT) as trauma sustained by a child or adolescent who has been subjected to aggression by parents or guardians, by institutions, or by society, as well as all conditions resulting from such acts that deprive them of their rights and fundamental needs and hinder their optimal development.[1]

There are four basic types of abuse:

- Sexual abuse
- Emotional abuse
- Physical abuse
- Neglect or maltreatment

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Within these classifications, epidemiological data show that the clinical presentations prompting medical consultation are often accompanied by inconsistencies in the reported origin of the injuries and variability in how events are described. The rates of abuse by etiology are: neglect (59%), multiple types (13%), physical abuse (11%), sexual abuse (8%), emotional abuse (4%), and medical neglect (<1%).[2]

Although children of all ages and socioeconomic levels can suffer NAT, it occurs more frequently in the context of young first-time parents with unplanned pregnancies, in environments where substance abuse is present, in low-income families, or among parents with a history of being abused themselves.[3,4]

Imaging often plays an important role in detecting and documenting physical injuries. The type and extent of imaging performed in a child when abuse is suspected depend on the child's age, signs, symptoms (Figure 1), and other social considerations, such as being the twin or sibling of a physically abused infant. Establishing a diagnosis of child maltreatment requires distinguishing between anatomic and developmental variants and possible underlying metabolic or genetic conditions.[5]

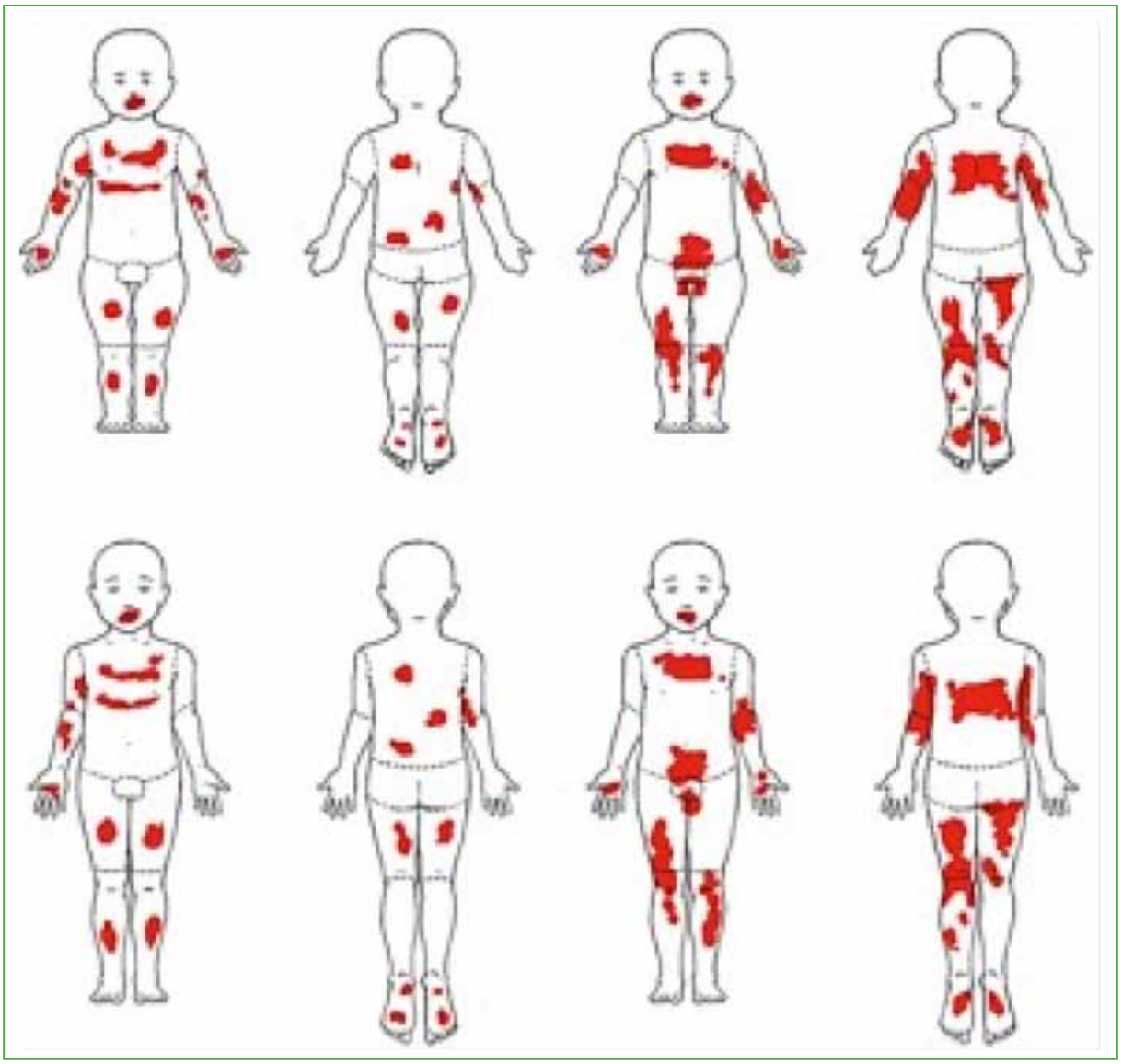

Figure 1. Areas hidden by hair or clothing where attention should be paid when assessing for soft-tissue injuries.

Between January 2023 and June 2024, 766 pediatric and adolescent patients with suspected NAT were evaluated in the hospital's Medium-Risk Service.

In 15.1% of cases (81 patients), physical abuse was suspected. Twenty-five of these patients required hospitalization (30%). Indicators for hospital admission included:

Need for urgent treatment requiring inpatient care.

Need for immediate protection of the minor while awaiting a temporary home or shelter.

Need to observe family dynamics during the assessment and diagnostic phase in severe situations.

Child evaluated in the hospital emergency department before completion of the assessment and treatment phase, in cases of severe maltreatment.

Given the high frequency of this situation, the following protocol was developed.

RADIOLOGICAL PROTOCOL FOR CHILDREN WITH SUSPECTED NAT (PEDIATRIC RADIOLOGY SERVICE)

When there is clinical suspicion, the Radiological Protocol for Children detailed in Table 1 is applied.

Table 1. Areas to be examined and recommended projections[8]

Skull*	Anteroposterior and lateral; additional Towne projection if clinically indicated
Thorax	Anteroposterior including clavicles, and oblique projections of both rib cages
Abdomen	Includes pelvis and hips
Spine	Lateral projection of the cervical, thoracic, and lumbar regions
Extremities	Anteroposterior view of both humeri, both forearms, femurs, tibiae, and fibulae. Hands: anteroposterior. Feet: dorsoplantar

*Skull radiographs should be obtained even if a CT scan has been performed.

1. In children <2 years of age, always request a skeletal survey as the preferred study. A "total body" or "babygram" is never indicated. If the chest radiograph raises doubts about rib injuries, consider a chest computed tomography (CT) scan.

When suspicion of NAT is high and the skeletal survey is normal, a repeat study should be performed 11–14 days later.

2. In children <1 year of age, always perform an urgent head CT scan.

3. In children >1 year with evidence of head trauma or neurological symptoms, perform an urgent head CT scan.

4. Consult with the Pediatric Radiology Service regarding the need for brain magnetic resonance imaging (MRI). Complete spine MRI and whole-body MRI should be performed 2–5 days after admission, regardless of whether the CT scan is normal. These must be interpreted by two pediatric radiologists. Follow-up brain MRI will be performed according to the initial findings and the patient's clinical evolution.

5. A skeletal survey may be indicated in children >2 years, in which case it will be performed preferentially and according to the patient's clinical presentation.

6. In a severe case with suspected NAT:

a) In twins or children <2 years, consider applying the same protocol used for the index case.

b) In siblings >2 years, imaging studies should be performed according to each child's clinical presentation.

7. In cases of thoracic or abdominal trauma, imaging studies will be decided jointly by the treating physician and the radiologist on call.

8. Deceased child: complete skeletal survey, and whole-body MRI and CT. The required radiographs are sent to the Radiology Department labeled as NAT so that all technicians know to perform, in a single session, all radiographs required by the protocol to detect possible injuries, without drawing the attention of accompanying family members.

DISCUSSION

Fractures are the second most common sign of physical abuse (25–50%), followed by burns (20%). It is estimated that 10% of trauma cases in children <3 years of age treated in emergency departments are non-accidental, but underreporting occurs due to minimization of the situation or failure to properly investigate the causes. In many instances, these patients are evaluated by a traumatologist as the first-line clinician, without support from a multidisciplinary team.[6-9]

Although many publications refer to specific fracture patterns for this condition, its presentation is similar to accidental trauma. However, clinicians must remain alert to the coexistence of these injuries with soft-tissue findings such as burns or bruising; moreover, the presence of this condition accompanied by retinal injuries is pathognomonic.[10]

The different stages of fracture evolution are what trigger red flags.[11]

In 2020, the Royal College of Paediatrics and Child Health[6] published a systematic review of fractures resulting from non-accidental trauma, summarized as follows:

1. Abuse-related fractures are more common in children <18 months than in those >18 months.
2. Abused children are more likely to present with multiple fractures than non-abused children.
3. Rib fractures without significant trauma, birth injury, or underlying bone disease have a high predictive value for abuse.
4. Femoral fractures due to abuse are more likely in children who are not yet walking (Figure 2).
5. Mid-shaft fractures are the most common type of femoral fracture in both abuse and non-abuse situations.
6. Supracondylar humeral fractures in children are typically associated with accidental injuries, whereas the most common humeral fractures due to abuse in children <5 years of age are spiral or oblique fractures (Figure 3).
7. Humeral fractures in children <18 months are more strongly associated with abuse than humeral fractures in older children.
8. Linear fractures are the most common skull fractures in both abuse and non-abuse cases.
9. Metaphyseal fractures are more common in cases of physical child abuse than in non-abuse, and have often been described in fatal abuse scenarios.
10. Most children with classic metaphyseal lesions have additional associated injuries, which are often multiple.
11. Fractures of the pelvis, hands, feet, and sternum can occur in physical abuse and require appropriate imaging for detection.

The accuracy of radiological estimates of the time elapsed since the injury is expressed in weeks rather than days. The different healing stages visualized on the skeletal survey are used to date the fracture as follows:

1. Resolution of soft-tissue injury: 1 week
2. Formation of new subperiosteal bone: 2 weeks
3. Loss of the fracture line and formation of soft callus: 3 weeks
4. Hard callus: 3–6 weeks
5. Remodeling: more than 3 months

Radiological evaluation in suspected physical abuse includes initial and follow-up imaging studies, performed during weekly monitoring of family members, specifically to maximize the detection of occult injuries.

Figure 2. Femoral injury in a non-ambulatory child.

Figure 3. Spiral fracture due to non-accidental trauma.

Specificity is defined according to the relationship between the fracture pattern and the mechanism of trauma (Table 2).

Bone scintigraphy is a useful study for detecting rib and vertebral fractures. Repeating it 2 weeks later may help identify occult injuries, but it is reserved only for highly suspicious cases with negative radiographs at the initial consultation.[12]

Table 2. Relationship between fracture pattern and specificity[13]

High-specificity fractures
• Metaphyseal injury: fracture at the junction of the metaphysis and physis (primary spongiosa). Mechanism: torsion or shear due to traction, i.e., when a child's limb is violently pulled or twisted.
Differential diagnosis: subepiphyseal metaphyseal radiolucencies may also arise from systemic diseases such as rickets or leukemia.
• *Corner fracture*: small metaphyseal avulsion. A notch is visible at the metaphyseal margin without significant epiphyseal displacement.
• *Bucket-handle fracture*: involves a large segment of the metaphyseal rim; a horizontal avulsion fracture of central and peripheral components, giving the appearance of a bucket handle.
• Rib fractures, especially posterior: uncommon as accidental injuries in childhood.
• Scapular fracture: more specific for abuse when associated with ipsilateral clavicular fracture. Not to be confused with the accessory ossification center of the acromial tip.
• Sternal fracture
• Fracture of vertebral spinous processes
Moderate-specificity fractures
• Epiphyseal separation or epiphyseal detachment: the most common is distal humeral transphyseal separation, followed by that of the hip.
• Multiple fractures at different stages of healing, particularly bilateral
• Fractures or subluxations of vertebral bodies
• Digital fractures
• Complex skull fractures
Low-specificity fractures
• Clavicle fracture
• Diaphyseal long-bone fracture
• Linear skull fracture

CONCLUSION

Within our fracture series, lower-limb fractures (70%) were the most frequent, and among these, long-bone fractures (femur 60%), findings consistent with those of other published series.[13,14]

Conflicts of interest: The authors declare no conflicts of interest.

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