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Understanding humerus fractures in young children: Abuse or not abuse?

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ABSTRACT

Fractures are the second most common abusive injury occurring in young children, particularly those under 2 years of age. The humerus is often affected. To better identify factors discriminating between abusive and non-abusive humerus fractures, this retrospective study examined the characteristics and mechanisms of injuries causing humerus fractures in children less than 18 months of age. Electronic medical records were reviewed for eligible patients evaluated between September 1, 2007 and January 1, 2012 at two children's hospitals in Chicago, IL. The main outcome measures were the type of fracture and the etiology of the fracture (abuse vs non-abuse). The 97 eligible patients had 100 humerus fractures. The most common fracture location was the distal humerus (65%) and the most common fracture type was supracondylar (48%). Child Protection Teams evaluated 44 patients (45%) and determined that 24 of those had 25 fractures caused by abuse (25% of the total study population). Among children with fractures determined to have been caused by abuse, the most common location was the distal humerus (50%) and the most common types were transverse and oblique (25% each); however, transverse and oblique fractures were also seen in patients whose injuries were determined to have been non-abusive. A younger age, non-ambulatory developmental stage, and the presence of additional injuries were significantly associated with abusive fractures. Caregivers did not provide a mechanism of injury for half of children with abusive fractures, whereas caregivers provided some explanation for all children with non-abusive fractures.

1. Introduction

Skeletal fractures account for 10–25% of childhood injuries (Sibert, Maddocks, & Brown, 1981; Landin, 1997). Fractures have the lowest incidence in infancy; the incidence increases as the child ages (Rennie et al., 2007) and becomes ambulatory. The majority of fractures in children involve the upper extremity (Rennie et al., 2007) and are a consequence of falls, motor vehicle crashes, or other non-abusive trauma. Occasionally, however, fractures can be caused by child physical abuse.

Fractures are the second most common injury caused by child abuse (Loder & Feinberg, 2007). Even though there is some evidence that the incidence of abusive fractures may be decreasing (Leventhal et al., 2007), skeletal fractures are diagnosed in up to a quarter of children who have been victims of physical abuse (Belfer, Klein, & Orr, 2001; Day et al., 2006). Fractures of the extremity,

Abbreviations: CML, classic metaphyseal lesion; CPT, child protection team

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specifically the humerus and femur, are the second most common location of fractures caused by abuse; most of these inflicted fractures occur in children less than 2 years of age (Loder & Feinberg, 2007). A systematic review of 32 studies (6 of which specifically looked at abusive humerus fractures) found that the probability of suspected abuse in a humerus fracture in a child under 3 years of age was between 0.48 (0.06–0.94) and 0.54 (0.20–0.88) (Kemp et al., 2008a).

The diagnosis of abuse related fractures is missed in 20–30% of young children at their initial medical visits (Ravichandiran et al., 2010; Thorpe et al., 2014). The diagnosis can be missed for a variety of reasons including incorrect interpretation of the radiographs, incomplete imaging, acceptance of implausible explanations, and because caregivers were not asked for detailed descriptions of the injury or about social concerns that place a child at increased risk for abuse. The diagnosis of abuse may be missed particularly in infants and toddlers because clinicians usually must rely on the caregiver's history and a caregiver may intentionally provide a false or misleading explanation for an injury that has been inflicted. O'Neill found that, in 95 of 100 cases of injuries caused by child abuse, the history was inaccurate or evasive (O'Neill et al., 1973). Failing to identify that a fracture resulted from an abusive injury can place a child at much higher risk of further abuse and even death (Fluke, Yuan, & Edwards, 1999; Levy et al., 1995).

Not only are infants and toddlers more vulnerable to fractures caused by abuse but children who have been abused are more likely to have multiple injuries when medically evaluated. Worlock compared the patterns of fractures caused by abuse and non-inflicted fractures in children less than age 12 years. He found that 80% of the fractures in abused children occurred in children less than 18 months old; none occurred in children over the age of 5 years. In his study, abused children had more than one fracture, ribs were common fractures, and other associated injuries were more commonly seen (Worlock, Stower, & Barbor, 1986).

All health care professionals, as mandated reporters, should be able to recognize the characteristics of fractures that are suspicious for abuse and initiate a report to state social services to prevent further injury that could be fatal (Fluke et al., 1999; Levy et al., 1995). We conducted a retrospective study to systematically examine the description of the mechanism causing a humerus fracture, the presenting symptoms, the age and developmental capability of the child, and the type and site of the humerus fracture, to determine if commonalities existed among specific type of injuries causing specific fractures at different stages of development in infants and toddlers. The goal of this retrospective analysis was to find commonalities that would help clinicians better discriminate between fractures caused by child physical abuse and unintentional fractures.

2. Methods

The clinical records for all children less than 18 months of age with a humerus fracture treated at Children's Memorial Hospital (now Ann & Robert H. Lurie Children's Hospital of Chicago, IL) and John H. Stroger, Jr. Hospital of Chicago (IL) during a 52 month period between September 1, 2007 and January 1, 2012 were reviewed retrospectively. Patients were identified through a medical record search using the International Classification of Diseases 9th revision diagnostic codes for humerus fractures (812, 818, 819, and 829). Only those patients with a definite fracture of the humerus were included in this study. Because all radiographs were read by board certified pediatric radiologists at both institutions, the official interpretation was used and radiographs were not further reviewed. The Institutional Review Boards from both hospitals approved the study.

Children with medical conditions that could predispose to bone fractures (gestational age < 28 weeks, osteogenesis imperfecta, rickets, osteopenia, or steroid therapy) or those whose fractures could be attributed to birth trauma or motor vehicle collision were excluded. Because a classic metaphyseal lesion (CML) is a well-described fracture that is highly specific for child abuse (Kleinman, Marks, & Blackbourne, 1986; Kleinman, Kleinman, & Savageau, 2004), children with a CML as their only humerus fracture were also excluded from this analysis. If the CML was not the only humerus fracture, it was recorded as an additional fracture.

Demographic information obtained from the record included age (in months) at the time of the injury, gender, race/ethnicity (white, black, Hispanic, and other), and type of insurance (public or private) as a proxy for socioeconomic status. Whenever available, the developmental history of the patient was recorded. Information on specific fracture location (proximal, mid-shaft, and distal) and type of fracture (buckle, transverse, spiral/oblique, supracondylar/condylar, and other) was recorded. Spiral and oblique fractures were grouped together because it may be difficult to differentiate between the two and consequently some radiologists group them together when writing their interpretation of the findings. Condylar fractures also were grouped together with supracondylar fractures, because the mechanisms causing the two fractures are similar.

The reason for seeking medical attention along with any history of injury and description of the mechanism of the injury was extracted from the record. Indirect witness of trauma (i.e., patient left on an elevated surface, cried and was found on the floor after an unwitnessed incident) were recorded as having a history of injury. If caregivers provided conflicting histories and/or the history changed in a significant manner (mechanism of incident changed), it was recorded as "changing history." If no history was given by the caregiver(s) to explain the injury, it was recorded as "no history of trauma." When no information was available in the record about the possible cause for the injury, it was recorded as "unknown." The different mechanisms recorded in the chart were divided into the following groups: fall from child's standing height, fall from sofa or bed (reported heights were between 1.5 and 3 feet), fall from a distance higher than a sofa or bed, and fall down stairs. Other groups included: "fall not specified" (no description of the fall recorded), "crush injury" (e.g., father fell on patient's arm after tripping while holding her) and "hyperflexion/extension injury" (e.g., mom grabbed arm to prevent patient from slipping off couch).

Every child had a medical evaluation, including a full history and physical examination by the primary service. Child Protection Team (CPT) protocols at both hospitals state that consultation by the CPT should be initiated for all children less than 12 months of

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