Child Abuse

The Role of the Orthopaedic Surgeon in Nonaccidental Trauma

Ernest L. Sink MD, Joshua E. Hyman MD,
Travis Matheny MD, Gaia Georgopoulos MD,
Paul Kleinman MD

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Abstract

Background Child abuse presents in many different forms: physical, sexual, psychological, and neglect. The orthopaedic surgeon is involved mostly with physical abuse but should be aware of the other forms. There is limited training regarding child abuse, and the documentation is poor when a patient is at risk for abuse. There is a considerable risk to children when abuse is not recognized.

Questions/purposes In this review, we (1) define abuse, (2) describe the incidence and demographic characteristics of abuse, (3) describe the orthopaedic manifestations of abuse, and (4) define the orthopaedic surgeon's role in cases of abuse.

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E. L. Sink (✉), G. Georgopoulos
Department of Orthopaedic Surgery, University of Colorado,
The Children's Hospital, 13123 E 16th Avenue, Aurora,
CO 80045, USA
e-mail: sink.ernest@tchden.org

J. E. Hyman
Department of Orthopaedic Surgery, Columbia University
College of Physicians and Surgeons, Children's Hospital
of New York, New York, NY, USA

T. Matheny
Department of Orthopaedics, Harvard University, Children's
Hospital Boston, Boston, MA, USA

P. Kleinman
Department of Radiology, Harvard Medical School, Boston,
MA, USA

Methods We performed a PubMed literature review and a search of the Department of Health and Human Services Web site. The Pediatric Orthopaedic Surgery of North America trauma symposium was referenced and expanded to create this review.

Results Recognition and awareness of child abuse are the primary tasks of the orthopaedic surgeon. Skin trauma is more common than fractures, yet fractures are the most common radiographic finding. Patients with fractures who are younger than 3 years, particularly those younger than 1 year, should be evaluated for abuse. No fracture type or location is pathognomonic. Management in the majority of fracture cases resulting from abuse is nonoperative casting or splinting.

Conclusions The role of the orthopaedic surgeon in suspected cases of child abuse includes (1) obtaining a good history and making a thorough physical examination; (2) obtaining the appropriate radiographs and notifying the appropriate services; and (3) participating in and communicating with a multidisciplinary team to manage the patients.

Introduction

In 1946, Caffey [3] described six young children with femur fractures and subdural hematomas. There was no known history of trauma and caretakers made no strong statements regarding intentional injury. He speculated as to the possibility of inflicted injuries at the hands of caretakers. Kempe et al. [7] in 1962 published a landmark article regarding child abuse and termed it the "battered child syndrome." This term refers to the collection of injuries sustained by a child as a result of repeated mistreatment or beatings. This article is considered as the catalyst for heightening awareness of child abuse and neglect. Kempe et al. [7] further

proposed all physicians be required to report instances of child abuse. This led to the rapid development of mandatory reporting laws in all states. Silverman [21], a student of Caffey and collaborator of Kempe, made the first systematic report detailing the radiographic and clinical findings of unexplained fractures, clearly linking them to the acts of the parents and guardians.

The orthopaedic surgeon plays a critical role in the diagnosis and treatment of child abuse. Awareness and recognition are the primary functions of the orthopaedic surgeon. Fracture management is usually nonoperative splinting and casting. The patients may present in an outpatient clinical setting or the emergency room. The incidence has been estimated to be 10% of trauma evaluated in the emergency room for children younger than 3 years [10]. Eighty-five percent of the fractures occur in children younger than 3 years. Fractures are the second most common presentation after soft tissue and bruising [15]. One third of abuse patients will require orthopaedic treatment from fractures in which management is usually nonoperative splinting and casting [1].

In this review, we (1) define child abuse; (2) describe the incidence and demographic characteristics of child abuse; (3) describe the orthopaedic manifestations of child abuse, and (4) define the orthopaedic surgeon's role in cases of child abuse.

Search Strategy and Criteria

A PubMed literature search was performed, with an emphasis on diagnosis from an orthopaedic surgeon's perspective. The original outline for the manuscript was adapted from the Trauma Symposium presented at the Pediatric Orthopaedic Society of North America 2009 annual meeting in Boston, MA. A literature search was performed to expand on this outline. Searching "child abuse" on PubMed yielded 29,174 articles. Therefore, we limited our search to articles that pertained to the orthopaedic surgeon's role with regard to background knowledge, documentation, diagnosis, and specific fracture types. To perform this, we used the following keywords and phrases independently with a Boolean operator "AND" "fractures and child abuse," "orthopaedics and child abuse," and "infant and fractures of abuse." These limitations were based on what we believed was relevant to this discussion. With these keywords we reduced the number of articles to 1446 abstracts. The abstracts of all these articles were reviewed, and the articles used as references were recent and relevant to the aims of the manuscript. Finally, the Web site for the US Department of Health and Human Services, Children's Bureau, was searched to look at the latest demographic data and laws regarding child abuse.

Definitions

Official definitions of child abuse and neglect differ among institutions, government bodies, and experts. Each state is responsible for its own definition of abuse and neglect based on minimum standards set by federal law in the criminal context [10]. According to The Child Abuse Prevention and Treatment Act (CAPTA) amended by the Keeping Children and Families Safe Act of 2003 (Public Law 108-136) [28], the term "child abuse and neglect" means, at a minimum, "any recent act or failure to act, on the part of the parent or caretaker which results in death, serious physical or emotional harm, sexual abuse or exploitation, or an act or failure to act which presents an imminent risk of serious harm." The term "child" is defined within the statute as "a person under the age of 18 years, unless the child protection law of the state in which the child resides specifies a younger age for cases not involving sexual abuse."

The main different forms of abuse recognized by most states include the following [28]. Physical abuse (the focus of this review) is nonaccidental physical injury, from bruising to fractures to death. It can occur through forms of shaking, hitting, beating, kicking, burning, or other methods of physical harm to the child inflicted by a parent, caregiver, or the person who has responsibility for the child. This is considered abuse regardless of intention. Physical discipline such as spanking is not considered abuse, as long as it is "reasonable" and causes no bodily harm to the child. Sexual abuse is the fondling of a child's genitals, intercourse, incest, rape, sodomy, exhibitionism, and commercial exploration through prostitution of the production of pornographic materials. Psychological abuse is emotional abuse, verbal abuse, or mental injury. It includes acts or omissions by the parents or by other caregivers that have caused or could cause serious behavioral, cognitive, emotional, or mental disorders. Child neglect is the failure to provide for the child's basic needs. It can be physical, emotional, or educational. Examples of physical neglect are failure to provide food, clothing, or shelter. Also included is medical neglect, which is delay or refusal to seek health care.

While physical abuse is the most recognized form of abuse, and specifically what the orthopaedic surgeon may be focused on, all healthcare providers should be alert to the other forms of abuse listed above.

Incidence

The true incidence of child abuse is difficult to calculate. This is because the statistics on child abuse are very difficult to interpret since there is little consistency among

studies and reporting agencies on how information is collected. The definitions of abuse and the methods of counting the incidence of abuse vary from study to study. Some methods count only reported cases of abuse. Some statistics are based on estimates projected from small studies, while others are based on interviews. Also, different states have different laws and policies regarding validation of child abuse and neglect allegation. Since the estimates are based on actual patient encounters, the true incidence of abuse in homes is likely underestimated.

Although there are inaccuracies as noted above, the incidence from the Department of Health and Human Services is estimated at 10.3 in 1000 children [28]. From the report in 2008, there were approximately 49.4 referrals to Child Protective Services per 1000 children [28]. There were 3.7 million total referrals in 2008 [28]. An estimated 772,000 children were confirmed victims of maltreatment [28]. The types of abuse were as follows: 71.1% were due to neglect, 16.1% were physically abused, 9.1% were sexually abused, 7.3% were psychologically maltreated, 2.2% were medically neglected, and 9% had “other” types of abuse [28].

Those at greatest risk for abuse are first-born children, unplanned children, premature infants, stepchildren, and handicapped children [10]. Children are most commonly abused when they are younger than 1 year [13]. Of the victims in 2008, 48.3% were boys and 51.3% were girls [28]. Almost 50% of the patients (45.1%) were white, 16.6% were African American, and 20.8% were Hispanic [28]. Using the Kids’ Inpatient Database, Leventhal et al. [12] was able to report on the estimated incidence of children hospitalized with fractures secondary to abuse for the years 1997, 2000, and 2003. In the children younger than 36 months admitted for fractures, between 11.9% and 12.1% of cases were due to abuse. The incidence was greater for those children younger than 1 year, 24.9%, versus 2.9% for those 24 to 35 months old. The incidence of fractures caused by abuse was estimated at 15.3 per 100,000. The mean age of the abused was 6.6 months and 59% were male. The majority of patients (77%) were receiving Medicaid or had no medical insurance [12]. The most common nonorthopaedic injuries are contusions and brain injury. Looking at the same database from 2000, Loder and Feinberg [13] reported 3.5% of the abused children died mostly from brain trauma.

In a study by Starling et al. [23], the majority of the perpetrators were male (68%), and 45% were the biologic fathers. In most studies, males are responsible for 60% to 70% of the abuse cases [23, 25]. Interestingly, in one report, head trauma was inflicted by female babysitters in 17.3% of cases versus only 12.6% by mothers [23]. The age of the children abused by males was lower (mean, 4.5 months) than that of the children abused by females

(mean, 10 months). There were estimated 1530 child fatalities in 2006 and 1460 in 2005. This translates to a rate of 2.01 and 1.95 deaths per 100,000 children, respectively; more than 40% of these deaths had a prior or current involvement with Child Protective Services [28]. In 2008, the rate was reported as 2.33 fatalities per 100,000 children [27]. Abuse is second to sudden infant death syndrome as a cause of death in children between 1 and 5 months of age and second to accidental injury in children older than 1 year [14, 20]. Most of the abuse-related fatalities were associated with neglect (41.1%) and maltreatment types (31.4%) while physical abuse was associated with 22.4% of deaths.

When inflicted intracranial injuries are encountered, shaking is the most common purported mechanism. Shaking was reported in 68% of cases in a study of 81 perpetrators who admitted abuse. In this study, more than ½ of the cases did not involve any direct impact. In almost all of the children, symptoms were immediately described after the shaking incident [24].

Orthopaedic Manifestations of Abuse

Orthopaedic manifestations are recognized with a careful history, physical examination, and radiographic examination. Awareness is the most critical component to making a diagnosis, as abuse may be a cause with any different anatomic injury [15]. Pediatric training programs provide more training in child abuse than emergency medicine, family medicine and, likely, orthopaedic programs [22]. Abuse may be missed, as physicians search for the high-specificity indicators such as “corner fractures” (described below) whereas a careful history and physical examination would raise suspicion [8, 26]. Although there are suspicious fractures, abuse cannot be determined by a single fracture alone [26]. In a review of emergency department charts in a study by Oral et al. [17], there was inadequate documentation of the cause of fractures in children at risk of abuse. Also, there was poor documentation that abuse was ruled out in the children at risk of abuse [17]. Many abuse victims are exposed to an emergency medicine physician, pediatrician, and orthopaedist; therefore, effective communication of suspected abuse among specialties may aid in ruling out abuse when considering the injury etiology.

The history of the injury needs to be complete in all children when looking for indicators of abuse, but specifically in children younger than 3 years [11, 12, 18]. With abuse, there may be poor correlation between the stated mechanism and the injury [15]. A vague history can also raise suspicion. If the information provided by the parent is lacking in details and contains contradictory statements,

the provider should have increased suspicion. A delay in seeking care should also raise suspicion [9]. Finally, the developmental stage of the child is important when considering the possibility of abuse [6]. For example, a femur fracture in a child that is not yet walking age should alert the physician to potential abuse, whereas it is often related to minimal trauma in a toddler. It should again be emphasized the history should be carefully documented. Specific information to document in the medical record should include presence of a witness, history of a previous injury, review of the past medical history, other injury description, time to presentation, and whether or not the injury is consistent with the development of the child [17].

The orthopaedic surgeon should perform a thorough physical examination in all children with fractures, especially if they are younger than 3 years [11, 12, 18]. The skin needs to be examined closely, as findings of trauma such as bruising are more common than fractures and can be obscured by clothing. Burns are present in 10% to 25% of cases, and 50% to 75% of abuse victims have bruising [15]. The entire body should be included in the examination, as the location of bruising is often on the buttocks, trunk, back of the head, and back of the legs. The bruising can often be in different stages and colors similar to that of fractures in different stages of healing.

Radiographic interpretation is critical to the diagnosis of abuse but should be analyzed in context with the history and examination. Skeletal injuries are the most common findings noted on imaging studies in cases of child abuse. In infants, they result from various forms of manual assaults. Multiple fractures in different stages of healing are present in more than 70% of abused children younger than 1 year [11]. In contrast to the central nervous system and other visceral injuries, skeletal trauma is not life threatening but often critical to the diagnosis. A skeletal survey should be ordered if there is any suspicion of abuse (Table 1). Multiple AP, lateral, and oblique views are preferable to an AP “baby-gram.” Good rib radiographs including oblique views are important as part of the survey because rib fractures have the highest probability for abuse, although only 36% are visible on skeletal survey [6, 9]. Oblique views are important because rib fractures are usually located posterior (Fig. 1). A Towne's view of the skull may be added in cases of suspected head trauma and skull fractures [2]. Bone scans can also be diagnostic in cases of suspicion when there is a negative skeletal survey and there is a high index of suspicion. Repeat radiographs a few weeks later can also be ordered when initial scans were negative and there is still suspicion [5].

Many fractures carry a low specificity for abuse; therefore, it is critical to correlate fracture findings with the history and physical examination. In infants, certain injuries are sufficiently characteristic to point strongly to abuse,

Table 1. The skeletal survey

Radiographic views of bones included in skeletal survey

AP skull*
Lateral skull*
Lateral cervical spine
AP thorax†
Lateral thorax†
AP pelvis
Lateral lumbar spine
AP humeri
AP forearms
Oblique hands
AP femurs
AP tibias
AP feet

* Towne's and both lateral views of the skull advised if head injury suspected; † oblique views of the ribs recommended.

Fig. 1 An oblique view of the ribs on skeletal survey shows posterior rib fractures (arrows) and a clavicle fracture (arrow) from abuse.

including classic metaphyseal lesions, rib fractures, and bruising [12, 26]. Many of the most specific injuries are subtle, so meticulous technique is vital to detect the fractures. It is important to understand no fracture on its own can distinguish an abusive versus nonabusive situation [6]. In addition, there is no diaphyseal fracture pattern typical of abuse. Diaphyseal fractures can be transverse, oblique, or spiral. In general, metaphyseal fractures conforming to the classic metaphyseal lesion are less common than diaphyseal fractures, but when present, are highly specific for infant abuse [5, 12, 25]. Physeal fractures conforming

to the Salter-Harris classification are uncommon, except for transphyseal fractures of the distal humerus [10].

The specificity of radiographic findings for abuse vary (Table 2). Fractures that have a high specificity are the

Table 2. Specificity of radiographic findings

Specificity	Injury
High	Classic metaphyseal lesions
	Rib fractures, especially posterior
	Scapular process fractures
	Spinous process fractures
	Sternal fractures
Moderate	Multiple fractures, especially bilateral
	Fractures of different ages
	Epiphyseal separations
	Vertebral body fractures and subluxations
	Digital fractures
	Complex skull fractures
Low	Pelvic fractures
	Subperiosteal new bone formation
	Clavicular fractures
	Long-bone shaft fractures
	Linear skull fractures

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classic metaphyseal lesion, which may be projected in a “corner fracture” or “bucket handle” pattern, rib fractures, particularly posteromedial in location, and scapular fractures. Kleinman et al. [8] described the pathology of metaphyseal fractures on postmortem examination. The fracture is through the primary spongiosa, the region of the metaphysis next to the physis where the physeal cartilage is replaced with mineralization. This translates to a radiographic appearance of a transverse radiolucency within the subphyseal region that on oblique views may have a bucket handle appearance. If the periphery of the fracture is thicker than the center on oblique views, it gives the classic metaphyseal corner fracture (Fig. 2) [8].

Fractures that are common but have a lower specificity for abuse include long-bone shaft fractures, clavicle fractures, and linear skull fractures (27% of fractures in children younger than 3 years). The femur (18% of all fractures in children younger than 3 years) and humerus (10.5% of fractures in children younger than 3 years) are the most common long-bone fractures [13, 27]. All fracture patterns (transverse, spiral, and comminuted) can occur in abuse. Only 12% to 13% of femur shaft fractures are due to abuse in children younger than 3 years [4, 19]. In children younger than 1 year, up to 30% of femur fractures are reportedly from abuse [12]. Therefore, a femur fracture is not specific and can often be accidental, but it is still critical abuse be ruled out when children younger than 3 years present with a femur fracture. Humerus diaphyseal

Fig. 2A–B (A) A radiograph shows an example of a metaphyseal “corner fracture” (arrow) that is highly specific for abuse of the distal femur. (B) The radiographic appearance of a transverse radiolucency “bucket handle” within the subphyseal region of a distal tibia visualized on skeletal survey is shown.

fractures in those younger than 3 years may be seen with abuse but are also nonspecific [27].

A variety of naturally occurring diseases and accidental injuries can be confused with abuse. Different etiologies and diseases that result in a fracture, such as osteogenesis imperfecta (OI), may be brought up in legal proceedings. The differential diagnosis of abuse includes the following: accidents, developmental variants, syndromes, and metabolic disorders. OI is an example of a metabolic disorder that is often discussed when abuse is considered. Many of these nonabuse conditions can be easily ruled out. Findings such as metaphyseal "corner fractures," retinal hemorrhages, and rib and skull fractures are not typical of OI. A systematic review by Kemp [5] in 2008 was conducted to answer "what features differentiate fractures resulting from abuse from non-abusive trauma." The features are multiple fractures, a child with a rib fracture (70% chance of abuse), femur fractures seen before walking age, humerus shaft fracture in a child younger than 3 years, and an infant or toddler with a skull fracture. Also, a family history of blue sclera, osteopenia, wormian bones, and dental involvement are part of OI. Milder forms of OI may be present, making it harder to determine a diagnosis. Thus, taking a good documented history and clarifying the mechanism of fracture are critical parts of making a diagnosis of mild OI versus abuse. A skin biopsy looking for abnormalities of Type I collagen can detect OI in up to 85% of cases.

Orthopaedic Management

We emphasize the first steps in management are recognition, diagnosis, and reporting to the appropriate service or agency. Management of cases of abuse requires a multi-specialty team approach, including Child Protective Services. Many children will be admitted to a medical service, and the orthopaedic surgeon will be responsible for fracture management. The orthopaedic surgeon should communicate the clinical followup plan to both the primary team and social services. Return clinical visits may also be directed by social services, so again the recommended treatment and followup should be effectively communicated.

Fracture management is often nonoperative splinting, casting, and ensuring the child's comfort. Femur fractures in children younger than 6 months can be managed with either a spica cast or Pavlik harness. There is no difference between the two methods, except there are slightly more skin problems in spica casting [17]. Femur fractures in patients aged 6 months to 5 years should be treated with early spica casting. Midshaft humerus fractures can be managed with splinting alone. Displaced transphyseal distal humerus fractures not already healing should be

treated similar to a supracondylar fracture, with closed reduction and percutaneous pinning. Those fractures that already have callous should be observed if the child is comfortable. Clinical followup will be needed to observe any remodeling or need for future malunion treatment. Since the majority of fractures are in children younger than 3 years of age, there is a large potential for fracture remodeling. Therefore, long-term functional deficits and the need for corrective surgery are rare.

Legal Aspects

Recognition is the first priority. If abuse is at all suspected, it is important to initiate further workup. The orthopaedic surgeon has a duty to notify social services in any case of suspected abuse. A reporter only needs reasonable suspicion, not certainty. The cost of not acting on suspicion is worse than a false suspicion and possible embarrassment. The orthopaedic surgeon should inform the family that there is a duty to notify the appropriate agency as part of the routine treatment. They should describe that every patient with this fracture or of this age goes through the same process as part of the care regardless of the mechanism. It should come across as routine standard of care without inferring guilt. Unless there is malicious intent in reporting, the physician is immune from lawsuits for the act of reporting. This is why documentation is important. Abuse is estimated to reoccur in 30% to 50% of patients if left unreported and 5% of those cases will result in death [10]. Families will not often present to the same emergency room twice, so there may be only one chance to report the injury. All 50 states mandate the reporting of child abuse. Each hospital should have a local protocol with a child protective team that is activated in suspicious cases.

Documentation of the injuries or the suspected injury is crucial. Some suggestions to improve documentation from a legal perspective include use of an electronic medical record, drawings, or a body map of the injuries and evidence of various stages of healing. It is important to use factual data only; if there is a documentation error, make an addendum. Never change the original text. A clear treatment plan with well-documented followup should be in place as soon as possible. Many of these children are placed in custody of other caregivers; therefore, a clear plan will assist with appropriate followup.

Discussion

The orthopaedic surgeon should be aware of the different forms of child abuse: physical, sexual, psychological, and

neglect. The Department of Health and Human Services has estimated all abuse cases at 10.3 in 1000 children [28]. Physical abuse is the most recognized and responsible for 16.1% of all confirmed victims of maltreatment in 2008 [28]. In this review, we discussed the orthopaedic surgeon's role in child abuse and presented a review of the current literature with an emphasis on diagnosis of abuse.

The literature provides limited answers to some questions. First, the incidence from the trauma database and the government is based on reported cases only; therefore, the true incidence is likely underestimated. Second, there is very little literature derived from the orthopaedic surgery literature except review articles. The majority of the literature is from the medical specialties. Third, there is no literature to guide the orthopaedic surgeon on how to approach a family when there is suspicion for abuse.

Children at greatest risk for abuse are first born, unplanned, premature infants, stepchildren, and handicapped children. Abuse can occur at any age, although the most common age of physical abuse in children is less than 1 year. The perpetrators are mostly male and 45% are biologic fathers. More than 40% of deaths had a prior or current involvement with Child Protective Services. The most common mechanism of physical abuse is shaking [23]. Head trauma is the most common cause of death [22].

The most common manifestation of abuse is skin trauma or bruising, and the second most common is fractures [9]. No fracture type or location is specific for physical abuse, although some fractures have more suspicion than others [5]. Multiple fractures at different stages of healing are present in 70% of abuse children younger than 1 year [10]. Rib fractures have the highest probability of abuse [5]. Metaphyseal injuries are less common but carry a high specificity for abuse [12]. Long-bone fractures are more common yet are less specific for abuse. Only 12% to 13% of femur fractures in children younger than 3 years are secondary to abuse [3, 18]. Other diseases such as OI have to be ruled out in cases of abuse. In a systemic review by Kemp [5], multiple fractures, a rib fracture, femur fracture before 3 years of age, and a skull fracture in a toddler point more to abuse. A skeletal survey should be ordered in cases suspicious for abuse including oblique views of the ribs [6]. There are a few studies showing poor documentation of abuse; therefore, accurate and complete documentation in the younger child with a fracture is important [16].

The first task of the orthopaedic surgeon is recognition. Patients will present in the clinic and the emergency room. Obtaining a good history and taking into account the developmental age of the child are critical. The physical examination needs to include the whole body. In cases where abuse is suspected, there is a duty to obtain the appropriate radiographs and notify the appropriate services. The majority of fracture care in cases of abuse is

nonoperative casting or splinting. The orthopaedic surgeon is part of a multidisciplinary team. There should be clear communication with the remainder of the team and social services as to the appropriate followup.

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