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### Evaluation of Unexplained Bone Fractures in a 3-Month-Old Infant – A Case Report

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## INTRODUCTION

Child physical abuse is a significant cause of injury in infants and young children and can present in a variety of ways. This report will focus on the evaluation of pediatric fracture injuries. Bone fractures are a common childhood injury and are responsible for approximately 8-12% of all pediatric injuries.<sup>1</sup> Following soft-tissue injury, bone fractures are the second most common presentation in child abuse.<sup>2</sup> Approximately 80% of fractures caused by child abuse are seen in children under 18 months of age.<sup>3</sup> Abuse in infants and young children is serious, sometimes life-threatening, and is often recurrent until safety interventions occur. For these reasons, it is of paramount importance that providers strongly consider child physical abuse on the differential, along with metabolic bone disease and accidental traumatic injury, when evaluating fractures in young children and infants.<sup>1</sup> There are several bone fracture types known to be highly suggestive of physical abuse, including multiple rib fractures, classic metaphyseal lesions of long bones, femoral fractures in a non-ambulatory child, and scapular fractures.<sup>1</sup> Herein, we discuss a case of a 3-month-old child who was admitted to an academic medical center with multiple bone fractures and underwent a comprehensive medical evaluation by child abuse pediatricians and other subspecialties to assess for child physical abuse.

## CASE REPORT

A 3-month-old male previously healthy infant was admitted to the hospital with irritability and decreased right arm movement. The parents believed these symptoms were caused by the father adducting the infant's arm into a swaddle on the night prior to admission. Prior to this, the infant was reportedly at his baseline and consolable, without irritability, lethargy, seizures, vomiting, or paradoxical crying (crying when held). The parents denied any previous history of falls, motor vehicle collisions, bruises, or other injuries. A facial cheek bruise was identified on physical examination during the infant's hospitalization and the parents attributed it to the infant hitting his own face with his arm several days prior. In keeping with hospital policy for infants admitted with concerning injuries, a board-certified child abuse pediatrician was consulted due to the concern for physical abuse.

The infant was born at full term by vaginal delivery without any complications. He had met all age-specific developmental milestones. The infant lived at home with his parents and an older sibling, and the parents were his sole caregivers. There was no family history of bleeding/clotting disorders, bone disease, short stature, dental disease, hearing loss, or kidney disease. There was no history of exposure to domestic violence, previous involvement with child protective services, parental arrest or incarceration, parental substance misuse disorders, or previous physical abuse in the family.

On examination, the infant had normal vital signs. He appeared comfortable and in no acute distress. Physical examination was notable for a swollen right arm that was tender to palpation and passive movement, as well as a bruise on his right facial cheek. Occult visceral injury was ruled out with normal liver function tests, amylase, lipase, urinalysis, and complete blood count. Occult intracranial injury was ruled out with a normal head CT. Underlying bone disease was ruled out with normal 25-dihydroxyvitamin D, parathyroid hormone, calcium, phosphorus, alkaline phosphatase, and normal bone mineralization and morphology on x-ray studies. An osteogenesis imperfecta (OI) panel was sent to an outside laboratory and was found to be negative after the child was discharged. Retinal hemorrhages were ruled out with a dilated fundoscopic examination performed by a pediatric ophthalmologist.

## CASE REPORT (cont.)

On the skeletal survey, thirteen bone fractures at various stages of healing that involved the infant's right upper arm, right forearm, right hand, right shin, left upper arm, and left 2nd, 3rd, 4th, and 5th ribs were identified. A follow-up skeletal survey obtained after his hospitalization revealed no new skeletal injuries. This infant's injuries were most consistent with a medical diagnosis of severe child physical abuse, in the context of the infant's young age, preambulatory status, skin bruising, numerous bone fractures at varying stages of healing and in locations highly specific for child physical abuse, and in the absence of a medical history to explain the infant's injuries.



Figure 1. Right humerus fracture



Figure 2. Rib fractures

## DISCUSSION

In infants and young children with unexplained fractures, it is important to gather a thorough history with specific emphasis on presenting symptoms, including crying, irritability, lethargy, change in behavior or appetite, and vomiting; the circumstances of any injuries; when the child was last well and at baseline; a description of the days leading to the child's evaluation; birth and delivery history; past medical history; age-appropriate growth and development; family history, including histories of bleeding and bone disorders in the family; a comprehensive review of systems; and a social history that is inclusive of safety concerns and household violence. Factors that should raise concern for child physical abuse include: injuries in an infant or young child; injuries with no history or history that is vague and/or inconsistent with clinical findings; a delay in seeking medical attention; injuries in areas with high specificity for abuse including the torso, ear, neck, inside of the mouth, angle of the jaw, facial cheeks, eyelids, sclerae; patterned injuries; injuries involving multiple body systems, such as skin, bones, viscera, and brain; fractures at different stages of healing; evidence of frank neglect; and previous history of concerns regarding the child or siblings.<sup>1,4,5,6</sup>

For the medical evaluation of potential child physical abuse in young children, guidelines assist providers in navigating evidence-based recommendations to ensure that appropriate diagnoses are made and serious and/or occult injuries are not missed. In children under 2 years old, when there is concern for abuse, the American Academy of Pediatrics (AAP) recommends a radiographic skeletal survey (SS) be performed for injuries suspicious of child abuse.<sup>7</sup> SS is a key component in identifying occult bone injuries or osseous abnormalities, and it is typically paired with a follow-up skeletal survey (FUSS) two to three weeks following the initial imaging study in order to best assess for subtle bone injuries involving ribs, long bones, and other parts of the body. Additionally, all children under 1 year old with fractures suspicious of abuse should prompt a consideration for head imaging to identify occult abusive head trauma.<sup>1</sup>

## DISCUSSION (cont.)

Evaluation of occult abdominal trauma is also important – it has been shown that transaminitis (aspartate aminotransferase or alanine aminotransferase above 80 units/liter) and elevated lipase (above 100 units/liter) is specific and sensitive for visceral injury of all types and can be utilized to assist with decisions regarding abdomen and pelvis imaging studies.<sup>9</sup>

Consideration and exclusion of underlying organic causes of injuries should also be made when evaluating children for abuse concerns. This is why detailed history gathering is substantial. When assessing for birth and delivery injuries, it should follow a predictable time course and specific pattern. A child's developmental history, including if they are ambulatory or not, can make certain accidental histories plausible or not plausible. For example, infants and young children do not have the strength or coordination to self-inflict bruises, mouth and eye injuries, skeletal injury, intracranial injury, or visceral trauma. Important laboratory evaluation includes tests for bone metabolism (e.g. serum calcium, phosphorus, alkaline phosphatase, 25-OH vitamin D), endocrine etiologies (e.g. PTH), and sequence analysis of the *COL1A1* and *COL1A2* genes, as well as other genes less commonly implicated in pathology, to rule out osteogenesis imperfecta.<sup>1,4</sup> Ultimately, when considering the reported accidental mechanism of injuries in infants, physicians need to determine whether it has the potential to cause the child's injury and whether the child has the developmental capacity to have experienced the trauma described.

For our case, it was ruled that the infant's numerous injuries were most consistent with a medical diagnosis of child physical abuse. The accidental history provided – accidental arm bending during repositioning in father's arms – did not explain a right humerus fracture as typical care of a newborn would not cause significant injury. Moreover, the history provided left numerous bone fractures found on SS unexplained. Additionally, the mother provided multiple histories regarding normal care of a newborn, which should not result in bone fractures or facial bruises in healthy infants. Birth trauma was ruled out as a cause of the constellation of injuries identified, based on the healing pattern of his injuries. He did not have any family history or the clinical signs and symptoms of metabolic bone disease or other conditions. Laboratory assessment and radiologic evaluation fully ruled out rickets and OI as well.

Clinicians should include child physical abuse on the differential when an infant or young child presents with injuries. If there are concerns regarding potential child abuse, providers should consult a child abuse pediatrician and child protective services in accordance with mandatory reporting law, which will assist in ensuring the health and safety of children.

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