Sentinel Injuries
Subtle Findings of Physical Abuse

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KEYWORDS
- Sentinel injury
- Child abuse
- Pre cruising
- Infants
- Bruising
- Abusive head trauma
- Prevention

INTRODUCTION/CHARACTERIZE THE ISSUE/PROBLEM

A 7-week-old infant presented to an emergency room by ambulance after an episode of pallor, vomiting, and decreased responsiveness. Physical examination was significant for an ill-appearing infant with a weak cry. The head computed tomography (CT) showed bilateral, thin, acute, convexity subdural hemorrhages, and the skeletal survey showed acute and healing rib fractures, as well as a classic metaphyseal lesion and acute spiral fracture of the right tibia. Extensive retinal hemorrhages were also noted on dilated funduscopic examination. Following a comprehensive evaluation by the hospital-based child protection team, the child was diagnosed with abusive head trauma and fractures. In the medical history, the father reported a bruise adjacent to the infant’s mouth 2 weeks before admission, which he attributed to the infant bumping her head on her pacifier while he held the infant to his chest (Fig. 1). The father eventually confessed to abusing the infant on multiple occasions. If this initial sentinel

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injury had been identified as concerning for abuse and appropriate safety measures used, the subsequent severe injuries may have been prevented.

Musculoskeletal, intraoral, and skin injuries other than superficial abrasions are not expected in the normal care and handling of infants who have not yet achieved the developmental milestone called cruising, which is pulling to a stand and taking a few steps while holding on to an object. When such injuries occur in this population, the possibility of physical abuse should be considered because they are warning signs for abuse or sentinel injuries. A sentinel injury is a visible or detectable minor injury in a precruising infant that is poorly explained and therefore suspicious for physical abuse (Box 1). Sentinel injuries generally are not clinically significant from a treatment perspective because they typically heal quickly and completely without sequelae. Examples of such injuries include bruising, intraoral injury (eg, torn labial or sublingual frenum), radial head subluxation (ie, nursemaid’s elbow), and minor burns (Figs. 2 and 3).

Occult injuries such as rib fractures are not sentinel injuries since these are not readily detectable by a caregiver. Nonspecific skin findings such as transient reddening of the skin or superficial abrasions are also excluded because these may occur in the normal care of an infant. Superficial abrasions are common, unintentional injuries in infants (eg, fingernail scratches on the face of a neonate).

**EXTENT OF THE PROBLEM**

More than 3 million reports of child maltreatment are received by child protective services every year in the United States, approximately 18% of which are for physical

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**Box 1**

**Definition of sentinel injuries**

- Minor injuries, such as a bruise or intraoral injury (excluding skin abrasions)
- Precruising infant
- Visible or detectable to a caregiver
- Poorly explained and unexpected
abuse. Soft tissue injury, such as bruising, is the most common presenting feature of physical abuse in children and has been studied extensively in both nonabused and abused children.

Published research shows that soft tissue injuries other than abrasions are rare in normal infants who are not abused and often precede severe injuries in abused infants. The prevalence of sentinel injuries in precruising infants is difficult to ascertain because caregivers may not seek medical evaluation given the minor nature of these injuries. In addition, discovery of a sentinel injury by medical professionals during a routine physical examination or through the medical history may be undocumented if the injury is incorrectly interpreted as minor or trivial. Until recently, the prevalence of sentinel injuries in infants evaluated for child maltreatment was not known.

A previous history of a sentinel injury occurs at an alarming rate in infants who are evaluated for abuse by a hospital-based child protection team. In a recent study of infants less than 12 months of age who were evaluated for maltreatment, 27.5% of those with injuries diagnostic for physical abuse (eg, abusive head trauma, abdominal trauma, fractures, or burns) had a history of previous, minor injury described by a parent during the medical history. None of the infants who were evaluated for maltreatment and ultimately diagnosed as having an accidental injury, a medical condition that could be mistaken for abuse, or a normal variant had a previous history of sentinel

Fig. 2. Sentinel injury: 6-week-old abused infant with bruising on the forehead that had reportedly occurred from rolling into the crib slats. (Courtesy of LK Sheets, MD, Milwaukee, WI.)

Fig. 3. A 2-month-old severely abused infant who had a healing upper labial frenum injury as well as bite wounds, a liver laceration, multiple fractures in various stages of healing, retinal hemorrhages, and subdural hemorrhages. (Courtesy of LK Sheets, MD, Milwaukee, WI.)
injury. The most common type of sentinel injury was bruising, followed by intraoral injury. Sentinel bruises were typically located on the head or face, and 95% occurred in infants younger than 7 months (Box 2). Other researchers have also shown that the head and face are the most common sites for abusive injuries. In ambulating children, the head and face may also be bruised in unintentional traumatic events, such as falls down stairs. Although a study by Pierce and colleagues found no correlation between facial or head bruising and abuse in children less than 48 months of age, the study population included primarily mobile children admitted to an intensive care unit for trauma. However, in this study, bruising in infants less than 4 months of age was noted to be concerning for abuse.

CAUSES/CONTRIBUTORY OR RISK FACTORS

Although soft tissue injuries, such as bruising, are commonly seen in mobile children, injuries in precruising infants are rare. Before an infant is mobile, bruising does not typically occur during routine handling or normal activity. In several studies of precruising infants and infants less than 9 months of age, only 0% to 2.2% had bruising on well-child physical examinations. In the absence of an underlying medical condition or a clear and plausible history of an unintentional event, any injury beyond superficial abrasions in infants who are not yet independently mobile is concerning for child physical abuse. A plausible history should include an explanation of a discrete event in which the described mechanism is consistent with the type and severity of injury and the developmental capability of the child. For example, a forehead bruise in a 6-month-old infant who can sit independently may be plausible if the mother clearly recalls and provides a history of the child falling over and the head hitting a hard toy.

The pattern and location of bruising on the body also can be helpful in assessing the plausibility of injury in a child. Unintentional bruises in mobile children typically occur over bony prominences on the anterior aspect of the body, such as the knees, shins, or forehead, although an occasional bruise over soft parts of the body, such as the cheeks, abdomen, buttocks, or upper arms, can be seen in active children (Table 1). Abused children are more likely to have injuries on the soft parts of the body and on protected locations such as the neck, genitals, and inner thighs (Fig. 4). This information on the location of suspicious bruising can be applied in practice using the TEN-4 body region–based and age-based bruising

| Box 2
<table>
<thead>
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<th>Summary of key findings</th>
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<tr>
<td>A sentinel injury preceded severe abuse in 27.5% of cases</td>
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<td>A history of a sentinel injury is rare in infants evaluated for maltreatment and found to not be abused</td>
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<td>All sentinel injuries were observed by a parent</td>
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<td>Forty-two percent of the sentinel injuries were known to a medical provider but the infants were not protected from further harm</td>
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<td>Recognition of and appropriate response to sentinel injuries could prevent many cases of child physical abuse</td>
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clinical decision rule, which states that any bruising in a precruising infant or bruising on the Torso, Ears, or Neck of a child 4 years of age or younger should be considered signs of possible physical abuse. Multiple or clustered and patterned injuries including circumferential or linear patterns should also raise concern for inflicted injury. Patterned injuries typically occur from a crushing mechanism such as a human bite or through high-velocity impact, such as a looped cord or slap (Table 2).

<table>
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<tr>
<th>Characteristic</th>
<th>Typical</th>
<th>Concerning for Abuse</th>
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<td>Age/developmental stage</td>
<td>Independently mobile child</td>
<td>Pre cruising infant</td>
</tr>
<tr>
<td>Location (see Fig. 4)</td>
<td>Over bony prominences, especially over the knees and shins</td>
<td>Over soft parts of the body or unusual locations such as the cheek, ear, neck, buttock, abdomen, or hand</td>
</tr>
<tr>
<td>Pattern</td>
<td>Nonpatterned</td>
<td>Patterned (shape of an implement from high-velocity impact or from crush injury)</td>
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Table 1
Characteristics of bruises that should be considered when evaluating a child for possible abuse

Fig. 4. Atypical locations of bruises in normal, active children. Areas in black are atypical locations for bruising in an active child. Ranges of percentages of bruising in various body locations based on published research are included for nonabused1,2 and abused25 children.
Other soft tissue and musculoskeletal injuries, such as intraoral trauma and subluxation of the radial head, are uncommon and unexpected in precruising infants.\textsuperscript{27,28} Although an isolated finding of a torn labial or sublingual frenum is not diagnostic for abuse, intraoral injuries are found in a significant number of abused infants.\textsuperscript{27} Unless well-explained, an intraoral injury in a precruising infant should raise serious concerns about child abuse.

Although child physical abuse occurs in all geographic, ethnic, and socioeconomic settings, there are certain risk factors that increase the likelihood of maltreatment. One of the primary variables is age of the child. Young children, especially those less than 1 year of age, have the highest rate of maltreatment, at a rate that is more than twice that of other children: 21.9 per 1000 versus 9.2 per 1000, respectively.\textsuperscript{5} In hospitalized patients, the rate of serious physical abuse in children less than 1 year of age is 58.2 per 100,000, compared with 6.2 per 100,000 in general.\textsuperscript{26} The high rate of infant abuse may be related to several factors, including increased needs, complete dependence

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<th>Table 2: Mechanisms of patterned bruising</th>
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<td>Mechanism</td>
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<td>Crush: bruise at site of contact</td>
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<td>High-velocity impact: outline of implement</td>
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<td>Pressure changes: petechiae</td>
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<td>Incised wounds (cut): bruise along edges of wound</td>
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<td>Lacerations (torn skin with tissue bridges): bruise at edges of laceration</td>
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<td>Indirect forces (shearing): bruise distant to contact</td>
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<td>Dependent: bruise results in blood settling under the effects of gravity</td>
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\textsuperscript{Fig. 5. Crush injury: 3-month-old fatally abused infant with human bite injury on the thigh. (Courtesy of LK Sheets, MD, Milwaukee, WI.)}
on caregivers, and physical vulnerability. Crying, a commonly identified trigger among perpetrators, typically peaks in duration in the second month of life, although caregiver’s perception of and response to crying is a more important risk factor than the duration of crying.

Other risk factors for child physical abuse include young parental age, mental health disorders, substance abuse, and domestic violence. Low socioeconomic status has also been identified as a risk factor for physical abuse. Differences based on race have been suggested, although this may be caused by decreased recognition in children with darker pigmentation or variation in reporting practices. Bruising in abused and nonabused children does not differ by gender. Although these factors have been noted to increase risk in general, the health care professional should consider each case individually to determine the level of concern for abuse.

**SEQUELAE OF THE PROBLEM**

Although sentinel injuries by definition are not life threatening, multiple studies have shown an association between minor abusive injuries in precruising infants and later, more severe physical abuse. Although a sentinel injury may result from an initial, isolated incident of abuse, it may also precede escalation of violence toward the infant.
If not appropriately addressed, more severe physical abuse may result. Chronicity of infant physical abuse is also shown by perpetrator confessions in which perpetrators often admit to repetitive abuse in response to infant crying. Timely intervention is critical in these cases because the interval between sentinel injury and subsequent more serious abuse can range from a day to months.

**CLINICAL ASSESSMENT**

An accurate diagnosis of abuse may be missed by medical providers as a result of failure to consider abuse because of the subtlety of findings, perception of the injury as mild, or the presence of nonspecific symptoms. Bruises can be difficult to visualize because of their location on the scalp, behind the ear, or other less visible locations, and bruises may heal quickly and be difficult to detect, especially in darkly pigmented children. Some types of abusive injuries cause symptoms such as vomiting that may be mistaken for common childhood illnesses. Medical providers may misattribute bruises to self-inflicted trauma or normal care and handling in precruising infants, despite such injuries being unexpected. In the study on sentinel injuries, medical providers were reportedly aware of the sentinel injury in 41.9% of cases in which
the infant was subsequently abused again, but in some of these cases the possibility of abuse was not considered by the medical provider. Some medical providers also incorrectly assumed that abuse had been ruled out because no occult injuries were detected by injury surveillance studies, such as a skeletal survey.

Even when visible injuries are present, abuse may be missed by medical providers. In a study on missed cases of abusive head trauma, 37% of the missed cases had facial or scalp injuries when they first presented for medical care with symptoms that were later attributed to abusive head trauma. When the correct diagnosis of abuse was missed at initial presentation, 27.8% of the children were reinjured before a definitive diagnosis was made. Thus, the accurate identification of physical abuse in infants depends not only on thorough injury surveillance including detection of sentinel injuries and occult injuries but also on critical analysis of the diagnostic possibilities.

Given the risk of escalation and further harm or death from abuse, screening for sentinel injuries should be performed routinely during medical evaluations of infants, including well-child visits. If a sentinel injury is detected, a thorough history should be obtained, including an explanation for the injury as well as a review of birth, medical, developmental, family, and social histories. Careful physical examination also should be performed with written documentation of location, size, and pattern of any injuries as well as photodocumentation. The physical examination should include measurement of head circumference and careful inspection of the skin and oral mucosa, particularly of areas where injury is easily missed, such as the labial and sublingual frena, ears, scalp, anogenital area, hands, and feet. Furthermore, the level of concern for child abuse may be increased in the context of:

- Lack of or changing history
- History inconsistent with developmental stage
- History inconsistent with type or severity of injury
- Inappropriate delay in seeking care

**APPROACH/MANAGEMENT**

Infants with a history or examination finding of sentinel injury should undergo an urgent, comprehensive work-up to evaluate for occult injuries and, when appropriate, predisposing conditions. Even a single bruise in a precruising infant should prompt the medical provider to critically consider whether the history adequately explains the bruise. In precruising infants who are able to sit independently, a single bruise on the forehead and a clear and plausible history of an accident may not require further testing for occult injury unless there are other risk factors present. However, in this scenario, if there is no plausible history to explain the bruise, occult injury surveillance should be performed.

Cruising infants with bruises over bony prominences and a clear, plausible history to explain those injuries may not require injury surveillance unless there are other reasons to suspect maltreatment. However, if bruises are present in unusual or unexpected locations, are unusual in number or extent, or are patterned, occult injury surveillance should be strongly considered (Fig. 10).

Occult injury surveillance should include consideration of:

- Head CT in children less than 6 months of age and in those with abnormal neurologic findings
- Initial skeletal survey in children less than 2 years old
- Repeat skeletal survey 2 weeks after the initial skeletal survey
- Dilated ophthalmologic examination when abusive head trauma is suspected
Laboratory studies to screen for abdominal injury

Screening for occult drug injury

In addition, screening for predisposing conditions should be considered; for example, testing for bleeding diatheses if bruising is present. The medical assessment can then be formulated in the context of the reported explanation, physical examination findings, and diagnostic studies.

Sentinel injuries are often detected by the primary care provider as an incidental finding on examination or in the medical history. Evaluation for occult injuries may be completed in the primary care setting if laboratory and imaging services are available. If not, the infant may be referred to an emergency department or hospital. If no additional injury is detected on skeletal survey or head CT in an infant with a history or examination finding of a sentinel injury, abuse remains the primary diagnostic consideration because the sentinel injury may be the first and only injury from abuse. Therefore, a history or an examination finding of a sentinel injury should prompt a report to authorities for suspected abuse.

For the primary care provider, consideration of abuse as a diagnostic possibility can be extremely difficult, particularly when there is a close relationship with the family that is perceived to be at low risk of abuse. The primary care provider may also have concerns that subjecting a family to an investigation and the infant to a complete diagnostic evaluation is an excessive response to what seems to be a trivial injury. However, it is important to remember that any parent or caregiver may momentarily lose control and injure an infant, people other than the parents may have abused the child, safety of the infant is the paramount priority, the threshold for reporting suspected abuse does not require diagnostic certainty, and the risk of missing the diagnosis of abuse is potentially life threatening. Reporting a sentinel injury to authorities as suspicious for abuse and completing the diagnostic evaluation for abuse may be the only opportunity to prevent further abusive injury or even death of the infant. The approach to the family should be to inform them in a nonjudgmental style that reports for suspected abuse and further testing are required and represent standard medical practice.

Fig. 10. Algorithm to guide management of a precruising infant with bruising.
care under the circumstances. The family should be informed of the results of the diagnostic studies. If primary care providers are unable to report or conduct further testing because of the close relationship with the families, they should consult with the nearest child abuse pediatrician for further guidance. Even if authorities are unable to substantiate abuse or identify a perpetrator, the diagnostic evaluation and investigation are interventions that may change the behavior of an abusive caregiver and the trajectory of abuse. In this case, primary care providers should continue to provide routine care with ongoing careful observation for additional concerning injuries. Anticipatory guidance, education, and resources should also be provided to the family.

Screening for and identification of sentinel injuries as an early sign of abuse and intervention before escalation have the potential to prevent many cases of severe injury from abuse. Education of caregivers, investigators, home visitors, daycare providers, and medical professionals regarding the significance of these injuries in precrusing infants could promote secondary prevention. In this way, primary care providers can play a key role in improving child well-being and safety.

REFERENCES