Incidence of Fractures Among Children With Burns With Concern Regarding Abuse
Marcus DeGraw, Ralph A. Hicks, Daniel Lindberg and for the Using Liver Transaminases to Recognize Abuse (ULTRA) Study Investigators

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Incidence of Fractures Among Children With Burns With Concern Regarding Abuse

WHAT’S KNOWN ON THIS SUBJECT: Despite the AAP recommendation for skeletal surveys for all children <2 years of age with concerns regarding abuse, some children with abusive burns do not undergo skeletal surveys.

WHAT THIS STUDY ADDS: The prevalence of fractures among children with burns concerning for abuse is high enough to warrant routine skeletal surveys, which supports the recommendation of the AAP.

abstract

OBJECTIVE: Consensus recommendations state that a radiographic skeletal survey is mandatory for all children <2 years of age with concern for physical abuse. It has been suggested that patients with burns may represent a special subgroup at lower risk for occult fractures, compared with other abused children. Our objective was to determine the prevalence of fractures in children referred for subspecialty abuse evaluations because of burns.

METHODS: We performed retrospective analyses of data collected as part of the Using Liver Transaminases to Recognize Abuse (ULTRA) research network. Data were collected for all children <5 years of age who were referred to 19 child protection teams for subspecialty child abuse evaluations over 1 year (N = 1676). We compared the rate of fractures in children presenting with burns with that in other children evaluated for abuse.

RESULTS: Of 97 children <24 months of age with burns, 18 (18.6%) were also found to have fractures. Among all 1203 children <24 months of age, 649 (53.9%) had fractures. Eleven children had multiple fractures, and 12 children had fractures with radiographic evidence of healing. Two children were noted to have classic metaphyseal fractures.

CONCLUSION: The rate of fractures in children who present with burns and concerns regarding physical abuse is sufficient to support the recommendation for routinely performing skeletal surveys for children <2 years of age. Pediatrics 2010;125:e295–e299
Inflicted injury is an important cause of morbidity and death for children.\textsuperscript{1–3} However, a significant proportion of abuse is missed, despite a high level of concern for abuse.\textsuperscript{4} Even in cases of noninflicted trauma, the limits of the history and physical examination findings in young children can make identification of injuries difficult.\textsuperscript{5–9} Injury identification is even more challenging in cases of potential abuse when the history information is absent or misleading.\textsuperscript{10,11}

The American Academy of Pediatrics (AAP) currently considers the radiographic skeletal survey as “mandatory in all cases of suspected physical abuse in children younger than 2 years.”\textsuperscript{12} However, some authors have suggested that abused children presenting with burns may represent a subgroup of children with less risk for fractures, compared with other abused children, and series of children undergoing skeletal surveys include few children presenting with burns.\textsuperscript{15} Reviews may stop short of the AAP recommendation, suggesting that skeletal surveys be “considered” for children presenting with burns.\textsuperscript{16}

A retrospective review of data for abused children at a single center by Hicks and Stolfi\textsuperscript{17} found that occult skeletal injuries were not uncommon, and the authors recommended routine skeletal surveys for children presenting with burns and concern for abuse. However, that study had 2 important limitations. First, it was a retrospective analysis of data from a single center, including only 36 patients with burns concerning for abuse. Second, it excluded from analysis children who ultimately were determined not to have been abused and children who did not undergo skeletal surveys. We reviewed data for 1676 children who underwent consultation with any of 19 subspecialty child abuse teams because of concerns for physical abuse, to determine the prevalence of fractures among children presenting with burns.

**METHODS**

We undertook a retrospective analysis of data obtained by the Using Liver Transaminases to Recognize Abuse (ULTRA) research network. Methods for the ULTRA study were described previously.\textsuperscript{18} Briefly, the ULTRA study was a prospective observational cohort study of 19 subspecialty child abuse consultation teams that enrolled 1676 children between April 1, 2007, and March 31, 2008. Each center obtained approval to collect data for the original ULTRA study from its local institutional review board. This retrospective analysis was determined to be exempt from review by the coordinating center institutional review board.

Eligible subjects for the ULTRA study were children <5 years of age who underwent subspecialty evaluation because of concerns for physical abuse. Consultation was considered to have occurred if a child abuse consultant had performed any of the following: (1) written a note in the medical record, (2) performed a physical examination, or (3) recommended diagnostic or therapeutic management. All subjects undergoing consultation were included, regardless of the ultimate level of concern regarding abuse. Data abstracted included a brief summary of the initial history given at presentation, demographic features, physical examination findings, results of laboratory studies, and descriptions of any identified injuries (including fractures and cutaneous injuries such as burns or bruises).

Data from the individual sites were entered into an Internet-based, central repository for data collection and management. Each center implemented an independent, redundant system for tracking the number of consultations undertaken. It was determined prospectively that data would be excluded from centers that failed to enroll >90% of consultations.

For each enrolled subject, child abuse consultants described all identified injuries and were asked specifically about the injuries used most commonly to determine the likelihood of abuse (cutaneous injuries including burns, fractures, traumatic brain injury, retinal hemorrhage, and abdominal injuries). For these injuries, investigators were required to note whether the injury was present, absent, or not evaluated for each child. Investigators determined what constituted sufficient evaluation for an injury. Our data did not include which tests (including skeletal surveys) were used to diagnose or to exclude an injury. Our data collection instrument did not include specific information about suspicion regarding bone fragility disorders, but no patients with burns were noted to have suspected bone fragility.

Prevalence is expressed as proportions with 95% confidence intervals (CIs). Comparisons between populations are expressed as odds ratios with 95% CIs.

**RESULTS**

Among 1676 children <5 years of age who underwent subspecialty evaluations because of concerns regarding physical abuse, 147 (8.8%) had burns identified and 755 (45.0%) had fractures. Of the 1300 children <24 months of age, 97 (7.4%) had burns and 667 (51.3%) had fractures. Although the number of consultations decreased steadily with increasing age, the number of children with burns peaked between the ages of 12 and 18 months (Fig 1). The proportion of boys among burned patients (58.5%) was similar to that in the overall sample (57.4%). Within the population of children <2 years of age (the age range in which the AAP recommends skeletal...
surveys for all children with concerns regarding physical abuse), the proportion of children who were not evaluated for fractures was significantly larger among children with burns (21 of 97 children) than among children without burns (57 of 1203 children; odds ratio: 5.56 [95% CI: 3.22–9.60]).

The most common location of burns was the extremities (Table 1), although other locations also were common. Scald injuries accounted for 61 burns (41.5%) among all subjects. Twelve cases were noted to be concerning regarding cigarette burns, and 12 others were noted to have recognizable patterns, including those of grates, cigarette lighters, clothes irons, and hair straighteners. Children with burns who were evaluated for abuse had a number of other injuries noted (Table 2).

Fractures were identified in 24 (16.3% [95% CI: 10.8%–23.3%]) of 147 children with burns, including 18 (18.6% [95% CI: 11.4%–27.7%]) of the 97 children with burns who were <2 years of age. Eleven children (7.5%) had multiple fractures. Locations of fractures are presented in Table 3. Two children, 3 and 4 months of age, were noted to have fractures described as classic metaphyseal lesions. Ten children were noted to have fractures with evidence of healing; their ages ranged from 4 to 57 months, with no clear trend. Although all except 3 of the initial histories contained complaints of burns, only 1 included complaints of swelling, tenderness, or decreased use of the affected extremity in proximity to the identified fracture (a 26-month-old child who was noted to have bruising and swelling of his ear over a nondisplaced occipital fracture).

**TABLE 1** Location of Burns

<table>
<thead>
<tr>
<th>Location</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremities</td>
<td>80 (54.4)</td>
</tr>
<tr>
<td>Perineum, buttocks, and genitals</td>
<td>38 (25.9)</td>
</tr>
<tr>
<td>Head and neck</td>
<td>36 (24.5)</td>
</tr>
<tr>
<td>Chest, back, and abdomen</td>
<td>29 (19.7)</td>
</tr>
<tr>
<td>Not listed</td>
<td>7 (4.8)</td>
</tr>
</tbody>
</table>

The total is >147 because some children had involvement of >1 area.

**DISCUSSION**

These data demonstrated that a significant proportion of children with burns who were evaluated because of concerns regarding physical abuse also demonstrated evidence of skeletal trauma. The prevalence of fractures in our population was similar to that noted by Hicks and Stolfi,17 who found fractures in 5 (14%) of 36 patients with abusive burns, despite the fact that we included all children evaluated for abuse, rather than only those who underwent skeletal surveys and ultimately were thought to have been abused. We chose to include all consultations because the decision to order a skeletal survey must often be made before the ultimate determination of abuse. It would be interesting to compare the rates and types of fractures in the subset of our cohort that was ultimately thought to be abused. Regrettably, we are aware of no validated, reliable scale with which to make this determination,19,20 especially given the potential for circular reasoning with the importance of finding fractures in determining the likelihood of abuse.21–23

Among children <2 years of age, all of whom had been referred for subspecialty evaluation of physical abuse, children with burns were more likely not to have been evaluated for fractures, which perhaps may reflect the perception that children with burns are at lower risk for fractures than are

**TABLE 2** Other Injuries Identified Among Children With Burns Who Were Evaluated For Abuse

<table>
<thead>
<tr>
<th>Injury</th>
<th>All Patients (N = 1676)</th>
<th>All Fractures (N = 755)</th>
<th>All Burns (N = 147)</th>
<th>Burns Plus Fractures (N = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutaneous injury (any)</td>
<td>887 (52.9)</td>
<td>319 (42.2)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bruises</td>
<td>605 (36.0)</td>
<td>210 (27.8)</td>
<td>37 (25.2)</td>
<td>12 (50.0)</td>
</tr>
<tr>
<td>Burns</td>
<td>147 (8.8)</td>
<td>24 (3.2)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Fractures</td>
<td>755 (45.0)</td>
<td>NA</td>
<td>24 (16.3)</td>
<td>NA</td>
</tr>
<tr>
<td>Traumatic brain injury</td>
<td>393 (23.4)</td>
<td>197 (26.1)</td>
<td>10 (6.8)</td>
<td>7 (29.2)</td>
</tr>
<tr>
<td>Abdominal injury</td>
<td>54 (3.2)</td>
<td>24 (3.2)</td>
<td>4 (2.7)</td>
<td>1 (4.2)</td>
</tr>
<tr>
<td>Retinal hemorrhages</td>
<td>151 (9.0)</td>
<td>58 (7.7)</td>
<td>1 (0.7)</td>
<td>1 (4.2)</td>
</tr>
</tbody>
</table>

Some cutaneous injuries (eg, lacerations, abrasions, or ligatures) were not noted separately. NA indicates not applicable.
other referred children. This raises the possibility that some children with occult fractures were not identified and the true proportion of children with fractures is actually higher than we report. None of the children with burns who were not evaluated for fractures had other injuries (eg, traumatic brain injury, retinal hemorrhage, or abdominal injuries) identified. It bears emphasizing that, the majority of children with identified fractures had no cutaneous injuries of any kind noted. Although it is possible that some investigators chose not to record bruises they considered to be nonspecific for the determination of abuse, our results are in agreement with those reported by Peters et al and with clinical experience suggesting that the presence of bruising is not useful in determining whether a fracture is present, or the mechanism for any identified injury. These data are subject to a number of limitations. First, because we did not determine prospectively which children underwent skeletal surveys, it is impossible to exclude the possibility that some fractures were identified through targeted radiographs or other imaging modalities (such as head computed tomography), rather than a complete skeletal survey. Several pieces of circumstantial evidence, however, suggest that the majority of children underwent dedicated skeletal surveys. Several children had multiple fractures identified, which would not have been demonstrated without a skeletal survey. Also, most fractures were spatially remote from the burns noted initially and many were in a healing stage, which suggests that clinical signs were unlikely to have prompted focused radiography.

As discussed previously, different participating sites had different thresholds for obtaining abuse consultations. If clinicians were more likely to refer cases with both burns and fractures, than our number would be an overestimate. Our study is subject to all of the limitations that accrue to any retrospective study, including a limited ability to evaluate specifically cases with the most interest. For example, we were unable to determine whether finding occult fractures influenced clinical or social management of the cases. Although many fractures that are common in or specific for abuse (eg, skull fractures, classic metaphyseal lesions, and rib fractures) require nothing more than conservative management, every documented injury in cases with concern regarding abuse has the potential to affect the perceived likelihood of abuse and the efforts that are able to be implemented to protect the child from future harm.

CONCLUSIONS
A significant proportion of burned children with concerns for abuse have concomitant fractures. As recommended by the AAP, skeletal surveys should be performed for all children <2 years of age with concerns for abuse, including those presenting with burns.

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