Dedicated Retinal Examination in Children Evaluated for Physical Abuse without Radiographically Identified Traumatic Brain Injury

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Objective To determine the rate of retinal hemorrhages in children evaluated for physical abuse without traumatic brain injury (TBI) by diagnostic imaging.

Study design This study was a prospectively planned, secondary analysis of the Examining Siblings to Recognize Abuse (ExSTRA) research network, and included only index children who presented with concerns for abuse. Subjects were eligible for the parent study if they were less than 10 years old and evaluated by a Child Abuse Physician for concerns of physical abuse. Child Abuse Physicians recorded results of all screening testing and determination of the likelihood of abuse in each case. For this analysis, we examined the results of dedicated retinal examinations for children with neuroimaging that showed no TBI. Isolated skull fractures were not considered to be TBI.

Results The original ExSTRA sample included 2890 index children evaluated for physical abuse. Of this group, 1692 underwent neuroimaging and 1122 had no TBI. Of these 1122 children, 352 had a dedicated retinal examination. Retinal hemorrhages were identified in 2 (0.6%) children. In both cases, there were few (defined as 3-10) hemorrhages isolated to the posterior poles; neither was diagnosed with physical abuse. The presence of facial bruising, altered mental status, or complex skull fractures was neither sensitive nor specific for retinal hemorrhage identification.

Conclusions Forensically significant retinal hemorrhages are unlikely to be found in children evaluated for physical abuse without TBI on neuroimaging, and such children may not require routine dedicated retinal examination. *(J Pediatr 2013;163:527-31)*.

Abusive head trauma (AHT) is the leading cause of mortality in abused children.[1] Proper diagnosis of AHT is important for many reasons, including to ensure the protection of the child from repeated abusive events.[2] Making the diagnosis of AHT, however, can be complicated because young victims are unable to provide their own history and the history offered by caregivers is often incomplete or misleading. The identification of occult injuries, including retinal hemorrhages, can improve the detection of abuse in children who present with concerning injuries.[3-8]

Retinal hemorrhages are present in 80%-85% of cases of AHT and are uncommon in non-AHT.[6,9,10] The detection of characteristic retinal hemorrhage, defined as numerous, multilayered, and extending to the periphery, is considered to be forensically significant as a cardinal sign of the acceleration-deceleration injuries that can be associated with AHT.[11,12] Other patterns of retinal hemorrhage can be seen in a variety of conditions, including accidental and inflicted injury. Few retinal hemorrhages clustered around the posterior pole have been identified in children with non-AHT and in critically ill children without trauma, and are therefore not specific for AHT.[12,13] Retinal examinations performed by physicians who are not pediatric ophthalmologists are not sufficiently sensitive to detect retinal hemorrhage and, as a result, dedicated retinal examination by a pediatric ophthalmologist is recommended for all children in whom there is concern for AHT.[14]

However, controversy exists about whether the retinal exam is useful in children with concern for abuse when neuroimaging does not reveal intracranial hemorrhage. In 2004, Morad et al described 9 children with altered mental status who were diagnosed with physical abuse and in whom there was retinal hemorrhage despite a normal initial computed tomography (CT) scan.[15] Since then, experts have debated which children with concern for abuse require dedicated retinal examination in the absence of brain injury on neuroimaging.[16-18] Some physicians obtain dedicated retinal examination for some or all children with concerns for physical abuse even when brain injury is not present (ie, in the setting of children with multiple non-cranial injuries).[16]

AHT	Abusive head trauma
CAP	Child Abuse Physician
CT	Computed tomography
ExSTRA	Examining Siblings to Recognize Abuse research network
TBI	Traumatic brain injury

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A retrospective review of data from a multi-center study found that less than 1% of 282 children with concern for physical abuse without brain injury on neuroimaging had characteristic retinal hemorrhage.[16] The authors suggested that a dedicated retinal examination may not be necessary in a child with normal mental status, no facial injury, and no radiographic evidence of brain injury. This study was limited because details of the patients with retinal hemorrhage were not described, and the determination of which retinal hemorrhage were considered to be "characteristic" may have varied between investigators.[16] A consecutive case series of children from a single center found two cases of non-characteristic retinal hemorrhage in 194 children without brain injury on neuroimaging, both of whom had facial bruising.[17] This study also suggested that complex or occipital skull fractures should join facial bruising or altered mental status as an indication for dedicated retinal examination in the absence of brain injury.

Because adults who physically abuse children are unlikely to seek out centers of excellence in child abuse evaluation, abused children are often seen initially in community emergency departments, and outside of normal business hours, where access to pediatric ophthalmological evaluation may require transfer or admission to the hospital, each of which carry increased cost to the patient. By better targeting this limited resource, we can help to ensure that children most likely to benefit from dedicated retinal examination will receive it.

We sought to prospectively determine rates of retinal hemorrhage in a multi-center sample of children evaluated for physical abuse who did not have brain injury on neuroimaging and to determine the significance of abnormal mental status, facial bruising, and complex or occipital skull fractures.

Methods

This is a prospectively planned secondary analysis of the Examining Siblings to Recognize Abuse (ExSTRA) research network, the complete methods of which have been described previously.[19] Briefly, the ExSTRA research network prospectively collected data from January 15, 2010-April 30, 2011 on all children <10 years old who underwent subspecialty consultation for concerns of physical abuse by 20 US child abuse teams. Each participating center enrolled more than 90% of eligible subjects as determined by monthly audits. Each participating center and the data coordinating center obtained approval for the parent study with a waiver of informed consent from their local institutional review board. This secondary analysis of de-identified data was determined to be exempt from review as human subjects research.

Subjects were included in this secondary analysis if they were less than 120 months (10 years) old and received subspecialty consultation by a Child Abuse Physician (CAP) to determine likelihood of physical abuse. Although the main objective of the parent study was to determine rates of injury among contact children, this analysis included only index children, and no siblings or contacts were eligible. For eligible subjects, CAPs indicated whether neuroimaging was performed and the results of any neuroimaging completed. Traumatic brain injury (TBI) was defined as any radiologic evidence of intracranial trauma, including subdural, subarachnoid, or epidural hemorrhage, brain contusions, and/or brain edema. Patients with isolated scalp contusions and/or skull fractures did not qualify as having TBI. CAPs documented whether a dedicated retinal examination was obtained and if retinal hemorrhage were found. When retinal hemorrhage were reported, CAPs recorded the number of hemorrhages (grouped as 1-2, 3-10, 10-30, 30-100, or >100), whether single or multiple layers of the retina were involved, distribution of hemorrhages (posterior pole only, to periphery, to ora serrate, or other), and presence or absence of retinoschisis. Characteristic retinal hemorrhage was defined as retinal hemorrhage that is numerous, multilayer, and extends to the periphery.[11,12] CAPs also recorded their perceived likelihood of abuse based on a previously published 7-point scale; a score of 6 or 7 was considered 'high likelihood.'[20]

Results

Of the 2890 children, 1692 (58.5%) underwent neuroimaging and 1122 (38.8%) did not have TBI. Of the 1122 children without TBI, 352 (31.4%) from 19 centers underwent dedicated retinal examination; they form the main cohort for this analysis. Children who had retinal examination were younger than those who did not (Table I). Rates of injuries that were suggestive of physical abuse are shown in Table II. Among the 352 children who underwent neuroimaging and did not have TBI, only 2 (0.6%, 95% CI 0.1-2.0) children had any retinal hemorrhage identified (Figure). These cases are summarized below:

Case 1

A 2.9-month-old male presented to the emergency department after being found unresponsive with no history of trauma. His Glasgow Coma Score was 3 and he was admitted to the pediatric intensive care unit where he later died. He had no cutaneous injuries, no fractures on skeletal survey, and no TBI. His dedicated retinal exam revealed a few (3-10) single-layer retinal hemorrhages in the posterior pole of the right eye. These retinal hemorrhages were felt by the CAP to be nonspecific for abuse. Autopsy results were not

Table I. Demographics of the ExSTRA cohort and study group

	ExSTRA cohort (n = 2890)	Study subjects without TBI with dedicated retinal examination (n = 352)	Subjects without TBI without dedicated retinal examination (n = 770)
White (%)	1821 (63.0)	216 (61.4)	503 (65.3)
Male (%)	1687 (58.4)	221 (62.8)	447 (58.1)
Age in mo, median (range)	21.9 (0-118)	8.5 (2-92)	11.9 (0-100)