Headache in Traumatic Brain Injuries From Blunt Head Trauma

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abstract

OBJECTIVE: To determine the risk of traumatic brain injuries (TBIs) in children with headaches after minor blunt head trauma, particularly when the headaches occur without other findings suggestive of TBIs (ie, isolated headaches).

METHODS: This was a secondary analysis of a prospective observational study of children 2 to 18 years with minor blunt head trauma (ie, Glasgow Coma Scale scores of 14–15). Clinicians assessed the history and characteristics of headaches at the time of initial evaluation, and documented findings onto case report forms. Our outcome measures were (1) clinically important TBI (ciTBI) and (2) TBI visible on computed tomography (CT).

RESULTS: Of 27 495 eligible patients, 12 675 (46.1%) had headaches. Of the 12 567 patients who had complete data, 2462 (19.6%) had isolated headaches. ciTBIs occurred in 0 of 2462 patients (0%; 95% confidence interval [CI]: 0%–0.1%) in the isolated headache group versus 162 of 10 105 patients (1.6%; 95% CI: 1.4%–1.9%) in the nonisolated headache group (risk difference, 1.6%; 95% CI: 1.3%–1.9%). TBIs on CT occurred in 3 of 456 patients (0.7%; 95% CI: 0.1%–1.9%) in the isolated headache group versus 271 of 6089 patients (4.5%; 95% CI: 3.9%–5.0%) in the nonisolated headache group (risk difference, 3.8%; 95% CI: 2.3%–4.5%). We found no significant independent associations between the risk of ciTBI or TBI on CT with either headache severity or location.

CONCLUSIONS: ciTBIs are rare and TBIs on CT are very uncommon in children with minor blunt head trauma when headaches are their only sign or symptom.

WHAT'S KNOWN ON THIS SUBJECT: Although headache is a common symptom after minor blunt head trauma in children, controversy exists whether the presence of headache increases the risk of traumatic brain injury.

WHAT THIS STUDY ADDS: Clinically important traumatic brain injuries are rare, and traumatic brain injuries on computed tomography are very uncommon in children with minor blunt head trauma when headaches are their only sign or symptom.

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Blunt head trauma in children results in >500 000 emergency department (ED) visits annually in the United States.[1] Most blunt head trauma in children is minor, defined by Glasgow Coma Scale (GCS) scores of 14 or 15, with a very low risk of clinically important traumatic brain injuries (ciTBIs).[2,3] Computed tomography (CT) scans must be used judiciously in children with minor head trauma, balancing the need to identify important injuries with the risks of radiation-induced malignancy.[4,5]

Children with minor blunt head trauma frequently present to the ED with histories of headaches.[2,3] Although headache is common, controversy exists whether its presence or absence helps discriminate between those who do and do not have traumatic brain injuries (TBIs). In a previous meta-analysis, the presence of headache (when not severe or persistent), regardless of other symptoms or signs of TBI, was not associated with an increased overall risk of intracranial hemorrhage on CT, although it did modestly increase the risk of neurosurgery.[6] Severe or persistent headache also moderately increased the risk of TBI on CT.[6] Pooled estimates and previous studies, however, have not provided the risk of TBI when headache is the only sign or symptom.

Headache has variably been included in prediction rules of TBI in children with blunt head trauma.[7] In the Pediatric Emergency Care Applied Research Network (PECARN) prediction rule for children 2 to 18 years, those with histories of severe headaches are classified as not being at very low risk of ciTBIs.[2] The presence of a severe headache, however, does not necessarily indicate that a patient is at high risk of TBI (TBI on CT or ciTBI), particularly in the absence of other signs or symptoms of TBI (ie, isolated headache). To more fully understand the risk of TBI (ciTBI or TBI on CT) in common subgroups of patients, we aimed to determine the risk, types, and clinical implications of TBIs in children who have headaches after blunt head trauma, particularly those who have isolated headaches. Additionally, we aimed to determine the relationship between the severity, location, and timing of headache with the risk of TBI. Finally, we sought to determine the risk of TBI when severe headache was the only PECARN prediction rule variable present.

METHODS

We performed a planned secondary analysis of data from a prospective observational cohort study conducted at 25 centers in the PECARN network from June 2004 to September 2006. The study was approved by each site's institutional review board. Full details of the study have been published previously.[2]

Population

In the main cohort study, we enrolled children younger than 18 years with GCS scores of 14 to 15 after nontrivial blunt head trauma who presented to the ED within 24 hours of the initial injury. We defined trivial trauma as that resulting from ground level falls or running into stationary objects with no evidence of head trauma other than scalp abrasions or lacerations. We excluded patients with penetrating head trauma, preexisting neurologic disease impeding clinical assessment, patients transferred to the ED with neuroimaging already obtained, and patients with bleeding disorders or ventricular shunts. We did not assess for the presence of headache in patients who were either physically unable to speak or preverbal, including but not restricted to all patients younger than 2 years.

Patient Assessment and Variable Definitions

Clinicians completed standardized history and physical examinations before cranial CT (if obtained) and documented the findings onto study case report forms. Headache was defined as any complaint of pain to the head at the time of ED evaluation (ie, a history of headache that had resolved was not considered a headache for purposes of analysis). For those patients with headaches, clinicians assessed headache severity (categorized as mild/barely noticeable, moderate, severe/intense, or unclear), timing of onset (before the head injury, within 1 hour of the injury, 1–4 hours after injury, >4 hours after injury, or unknown), and headache location (diffuse, only at site of injury, at occiput only and clearly due to restraining backboard, other, or unclear). Two clinicians independently evaluated a convenience sample of 4% of patients to assess interobserver agreement of clinical findings.[8]

Definitions of Isolated Headache

We defined isolated headache in 2 ways based on the absence of other specific clinical findings on initial ED history and physical examination (Table 1). The first definition (termed "extensive" definition of isolated headache) was based on an extensive list of variables potentially associated with TBI, and the second definition was based solely on the variables in the PECARN prediction rule for children 2 to 18 years.[2] We analyzed the data based on these 2 definitions of isolated headache as the literature suggests that clinicians often assess children from the vantage point of having either no signs or symptoms other than a single finding of concern (extensive definition) or having no signs or symptoms other than headache defined solely by the age-specific PECARN prediction rule variables.[9,10] One difference between the 2 definitions is that the extensive definition does not consider the mechanism of injury, because it is not in itself a symptom or sign of TBI, and we wished the extensive definition to reflect patient clinical characteristics alone. However,

TABLE 1 Definitions of Isolated Headache

Extensive Definition: No Signs or Symptoms Other Than a History of Headache of Any Degree in Children 2–17 y (Up Until 18th Birthday)	PECARN Rule Variable Definition: No Signs or Symptoms Other Than a History of Severe Headache Defined by the PECARN Prediction Rule Variables for Those 2–17 y (Up Until 18th Birthday)
Patient met all of the following:	Patient met all of the following:
No history of LOC	No history of LOC
GCS score of 15	GCS score of 15
No signs of altered consciousness[a]	No signs of altered consciousness[a]
No signs of basilar skull fracture	No signs of basilar skull fracture
No palpable skull fracture	No severe mechanism of injury[b]
No history of vomiting	No history of vomiting
Acting normally per parent/guardian	
No seizure after the head trauma	
No amnesia	
No scalp hematoma or other traumatic scalp finding (eg, abrasion or laceration)	
No neurologic deficits (eg, motor or sensory abnormalities)	

GCS, Glasgow Coma Scale; LOC, loss of consciousness.

[a] Sleepiness, agitation, slow to respond to verbal communication, repetitive questioning.

[b] Motor vehicle crash with patient ejection, death of another passenger, or rollover; pedestrian or bicyclist without helmet struck by a motorized vehicle; falls >5 feet; or head struck by a high-impact object.

because severe mechanism of injury is 1 of the factors in the PECARN prediction rule, patients with headaches and severe mechanisms of injury did not meet the PECARN rule-based definition of isolated headache.

Outcomes

We had 2 outcomes: (1) ciTBI and (2) TBI on CT. We defined ciTBI as death due to TBI, neurosurgical procedure, intubation for at least 24 hours for TBI, or hospitalization for 2 or more nights due to the head trauma in association with TBI on CT. We defined TBI on CT as any acute traumatic intracranial finding or a skull fracture depressed by at least the width of the table of the skull. Cranial CT scans were obtained at the discretion of the treating providers. We completed follow-up procedures for all patients discharged from the ED to determine outcomes.[2]

Analysis

We summarized the data by using counts, percentages, and 95% confidence intervals (CIs) for categorical variables and medians and interquartile ranges for continuous variables. We analyzed outcomes in the following groups: (1) all patients with histories of headaches after the traumatic event who also had other signs or symptoms suggestive of TBI (ie, nonisolated headaches); (2) patients with isolated headaches–extensive definition; and (3) patients with PECARN-isolated severe headaches (ie, severe headaches with no other factors in the PECARN head trauma rule for those 2–18 years). We also assessed the risk of TBI in those with severe headaches plus 1 other PECARN prediction rule finding to determine the incremental risk of ciTBI of 1 other PECARN variable in addition to severe headache. For all analyses, we excluded patients who had missing documentation of any PECARN prediction rule factor for children 2 to 18 years. For the isolated headache–extensive definition, we also excluded patients from the analysis if they had >1 other of the extensive findings missing or marked as unknown. We calculated κ statistics and 95% CIs for the presence of headache and headache severity, and used the Fleiss-Cohen weighted κ with standard quadratic weights for headache severity.

We conducted an exact multivariable logistic regression analysis to assess whether TBI on CT was less likely in those with isolated compared with nonisolated headaches, adjusted for the severity of mechanism of injury. We also conducted 2 multivariable logistic regression analyses in all patients with headaches (combining the isolated and nonisolated groups) to assess the association between the 2 TBI outcomes and the severity (categorized as mild or moderate/severe) and location (categorized as diffuse or localized) of headache. A localized headache was defined by a headache only at the site of injury, at the occiput only and clearly due to backboard, and other. We were unable to run multivariable models to assess the effect of timing of the headache due to low risk of the 2 TBI outcomes in the ">1 hour after injury" group. For these 2 analyses, we excluded patients whose headaches started before the head injury. We adjusted for all variables included in the extensive definition of isolated headache and also included the age of the patient (categorized as 2–<5 years, 5–10 years, or >10 years). Seizure after head trauma and neurologic deficits were not included in the regression models due to low prevalence of these predictors. All variables were entered as dichotomous variables in the regression models except age, which was entered as the noted 3-level categorical variable. Additionally, we adjusted for time from injury to time of ED evaluation in hours (categorized as <1 hour, 1–4 hours, or >4 hours), because time from injury potentially influences the relationship between the severity of the headache and the outcomes.

We used sequential regression models to impute for missing data used in the multivariable logistic regression analyses. We limited imputation to those patients with headaches. We used linear regression models to impute continuous variables and generalized logistic models to impute categorical variables.[11]

We used SAS/STAT software (version 9.3; SAS Institute, Inc, Cary, NC) for all analyses and imputed missing values for regression models by using IVEware (University of Michigan, Ann Arbor, MI).[12] Because this was a secondary analysis of the parent cohort study, we did not estimate sample size needs for this analysis.

RESULTS

We enrolled 43 904 patients in the parent cohort study (77.0% of the 57 030 eligible patients; Fig 1). Of 27 495 children 2 to 18 years, 12 675 (46.1%) had headaches. The presence of headache (k = 0.60; 95% CI: 0.54–0.65) had good interobserver agreement, and headache severity (k = 0.65; 95% CI: 0.61–0.70) had substantial agreement. Of 12 567 children with headaches and complete data available for analysis, 2462 (19.6%) had isolated headaches–extensive definition. The characteristics of patients with nonisolated headaches and isolated headaches–extensive definition are detailed in Table 2. Clinicians obtained CTs for 6589 of 12 675 patients (52.0%) with headaches in general and 456 of 2462 (18.5%) of those meeting the extensive definition of isolated headache.

Table 3 demonstrates the risk of ciTBI and TBI on CT separately for patients with isolated headaches–extensive definition and nonisolated headaches, including the risk of TBI based on the severity, location, and timing of the headaches. No patients with isolated headaches had ciTBIs, irrespective of the severity, location, or timing. For comparative purposes, ciTBIs occurred in 0 of 2462 (0%; 95% CI: 0%–0.1%) patients with isolated headaches–extensive definition versus 162 of 10 105 (1.6%; 95% CI: 1.4%–1.9%) patients with nonisolated headaches (risk difference, 1.6%; 95% CI: 1.3%–1.9%). In addition, TBIs on CT occurred in 3 of 456 (0.7%; 95% CI: 0.1%–1.9%) children with isolated headaches–extensive definition versus 271 of 6089 (4.5%; 95% CI: 3.9%–5.0%) children with nonisolated headaches (risk difference, 3.8%; 95% CI: 2.3%–4.5%). After adjusting for mechanism of injury severity, the odds of TBI on CT (0.14; 95% CI: 0.03–0.41) remained lower in those with isolated headaches–extensive definition compared with nonisolated headaches.

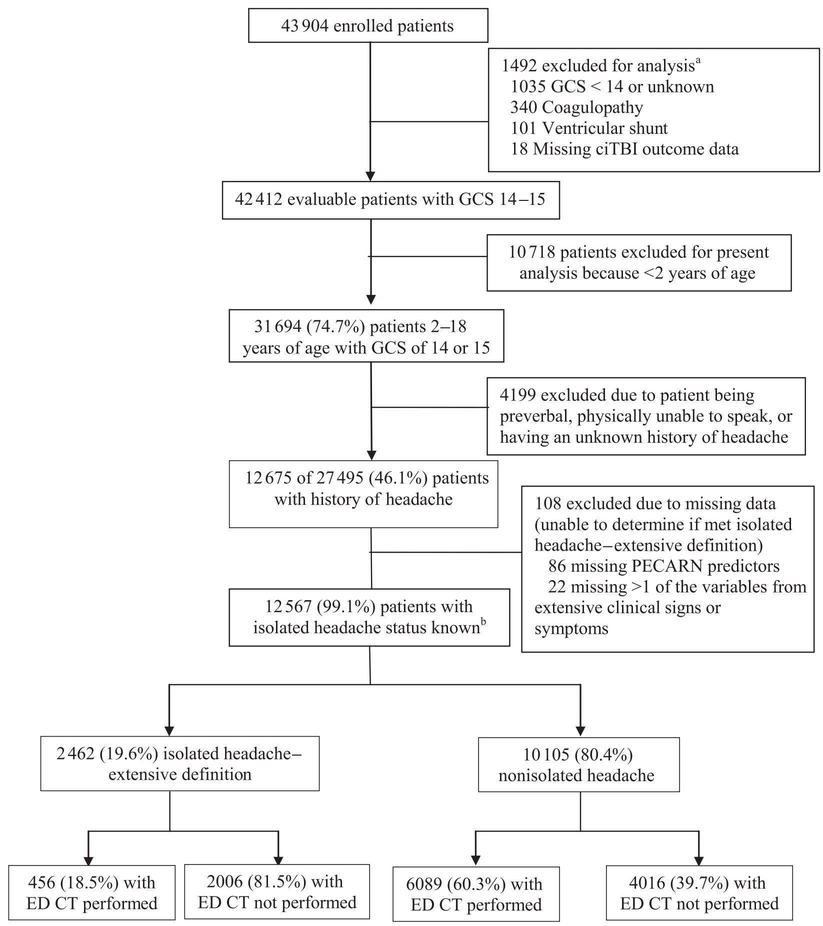

FIGURE 1
Study population. [a]Two patients had ventricular shunts and coagulopathies. [b]In this study, 11 293 of 12 567 patients (89.9%) were discharged from the ED, of whom 8935 (79.1%) completed telephone or mail follow-up. For the remaining 2358 (20.9%) medical records, trauma registries, process improvement reports, and morgue records were reviewed. CT, computed tomography; ED, emergency department; GCS, Glasgow Coma Scale.

Of the 2387 (97.0%) patients discharged from the ED, we completed telephone or mail follow-up on 1859 (77.9%) and chart review, trauma registry and quality improvement record review, and morgue review for the rest (528 of 2387; 22.1%). Among those with telephone (*n* = 1798) or mail (*n* = 61) follow-up, 207 had returned to a physician before follow-up, with 147 (7.9%) having headaches at the time of follow-up. Of these 207, 35 (16.9%) subsequently had cranial CTs or MRIs, with none having ciTBIs. One patient contacted by mail had a follow-up CT or MRI that was reported to them as abnormal, but further details were unavailable and no interventions were required. This patient had a normal CT on the initial ED visit. We do not have long-term follow-up on the patients with isolated headaches.

We present the specific TBIs in patients who met the extensive definition of isolated headaches in Table 4 and the clinical

TABLE 2 Clinical Characteristics of Children With Headaches

	Nonisolated HA, *n* = 10 105	Isolated HA–extensive definition, *n* = 2462
Median age (interquartile range)	11.9 (7.6–15.1)	12.4 (8.7–15.5)
Male patient *n* (%)	6678 (66.1)	1331 (54.1)
Mechanism of injury, *n* (%)		
Sports	1510 (14.9)	365 (14.8)
Fall from standing/walking/running	1340 (13.3)	215 (8.7)
Fall from elevation, *n* (%)	1329 (13.2)	230 (9.3)
<3 feet	437 (32.9)	71 (30.9)
3–5 feet	557 (41.9)	107 (46.5)
6–10 feet	199 (15.0)	41 (17.8)
>10 feet	77 (5.8)	7 (3.0)
Unknown height	59 (4.4)	4 (1.7)
Assault	1266 (12.5)	331 (13.4)
Motor vehicle crash	954 (9.4)	637 (25.9)
Object struck head—accidental	616 (6.1)	182 (7.4)
Bike collision or fall from bike while riding	609 (6.0)	84 (3.4)
Walked or ran into stationary object	463 (4.6)	64 (2.6)
Pedestrian struck by moving vehicle	368 (3.6)	55 (2.2)
Other wheeled transport crash	289 (2.9)	38 (1.5)
Fall down stairs	268 (2.7)	60 (2.4)
Bike rider struck by automobile	180 (1.8)	35 (1.4)
Other	851 (8.4)	165 (6.7)
Unknown	62 (0.6)	1 (0.04)

HA, headache.

characteristics of these patients in Table 5. No patient with an isolated headache–extensive definition had a ciTBI, and none had an epidural or subdural hematoma or a subarachnoid hemorrhage on CT.

To include all patients in the multivariable analyses, we imputed missing values and analyzed multiple imputed data sets. The imputation rates for the variables included in the regression are listed in Supplemental Table 8. We imputed 10 data sets, fit multivariable logistic regression models to each data set separately, and combined the results by using accepted methods.[13] To examine the appropriateness of imputed data values, we examined the distributions of all variables imputed and compared them to the distributions of these variables without imputation; the distributions were similar.

For all patients with headaches, the headache severity was not independently associated with the presence of ciTBI or TBI on CT on regression analyses, although the CIs were somewhat wide (Table 6). We were unable to run multivariable models with moderate and severe headache as separate categories due to the smaller numbers in the severe group compared with the other groups. Similarly, we were unable to include an analysis of headache timing due to the small number of outcomes in the >1 hour after injury group.

Finally, Table 7 presents the risk of TBIs in patients with isolated severe headaches based on the PECARN prediction rule factors only. The addition of other single predictors in the PECARN rule in addition to severe headache did not noticeably or consistently change the risk of ciTBI or TBI on CT, although the CIs for the estimates were relatively wide. One patient with a PECARN-isolated severe headache (but not isolated headache–extensive definition) had

TABLE 3 Risk of TBI in All Patients With Nonisolated Headaches and Isolated Headaches–Extensive Definition

Headache characteristic	Nonisolated headache, *N* = 10 105		Isolated Headache–Extensive Definition, *N* = 2462	
	ciTBI[a] *n*/*N* (%, 95% CI)	TBI on CT *n*/*N* (%, 95% CI)	ciTBI[a] *n*/*N* (%, 95% CI)	TBI on CT *n*/*N* (%, 95% CI)
Any headache	162/10 105 (1.6; 1.4–1.9)	271/6089 (4.5; 3.9–5.0)	0/2462 (0; 0–0.1)	3/456 (0.7; 0.1–1.9)
Severity of headache				
Mild/barely noticeable	25/3936 (0.6; 0.4–0.9)	59/1652 (3.6; 2.7–4.6)	0/1264 (0; 0–0.3)	2/122 (1.6; 0.2–5.8)
Moderate	81/4595 (1.8; 1.4–2.2)	133/3244 (4.1; 3.4–4.8)	0/982 (0; 0–0.4)	1/254 (0.4; 0–2.2)
Severe/intense	23/707 (3.3; 2.1–4.8)	33/614 (5.4; 3.7–7.5)	0/91 (0; 0–4.0)	0/50 (0; 0–7.1)
Unclear/missing	33/867 (3.8; 2.6–5.3)	46/579 (7.9; 5.9–10.5)	0/125 (0; 0–2.9)	0/30 (0; 0–11.6)
Onset of headache				
Before head injury	0/63 (0; 0–5.7)	0/31 (0; 0–11.2)	0/25 (0; 0–13.7)	0/3 (0; 0–70.8)
Within 1 h after injury	129/8388 (1.5; 1.3–1.8)	220/5082 (4.3; 3.8–4.9)	0/2013 (0; 0–0.2)	3/374 (0.8; 0.2–2.3)
1–4 h after injury	2/471 (0.4; 0.1–1.5)	4/252 (1.6; 0.4–4.0)	0/143 (0; 0–2.5)	0/36 (0; 0–9.7)
>4 h after injury	0/124 (0; 0–2.9)	1/74 (1.4; 0–7.3)	0/49 (0; 0–7.3)	0/10 (0; 0–30.8)
Unknown/missing	31/1059 (2.9; 2.0–4.1)	46/650 (7.1; 5.2–9.3)	0/232 (0; 0–1.6)	0/33 (0; 0–10.6)
Location of headache				
At occiput only and clearly due to backboard	0/61 (0; 0–5.9)	2/46 (4.3; 0.5–14.8)	0/29 (0; 0–11.9)	0/4 (0; 0–60.2)
Only at site of injury	76/5247 (1.4; 1.1–1.8)	126/2611 (4.8; 4.0–5.7)	0/1196 (0; 0–0.3)	0/158 (0; 0–2.3)
Diffuse	42/2573 (1.6; 1.2–2.2)	75/1930 (3.9; 3.1–4.8)	0/655 (0; 0–0.6)	2/165 (1.2; 0.1–4.3)
Other	10/843 (1.2; 0.6–2.2)	14/598 (2.3; 1.3–3.9)	0/270 (0; 0–1.4)	1/66 (1.5; 0–8.2)
Unclear/missing	34/1381 (2.5; 1.7–3.4)	54/904 (6.0; 4.5–7.7)	0/312 (0; 0–1.2)	0/63 (0; 0–5.7)

ciTBI, clinically-important traumatic brain injury; CT, computed tomography; TBI, traumatic brain injury.

[a] ciTBI definition: death, neurosurgical procedure, intubation for at least 24 h for TBI, or hospitalization for 2 or more nights due to the head trauma in association with TBI on cranial CT.

TABLE 4 TBIs in Children With Isolated Headaches (Extensive Definition)

Type of TBI	*n*/*N* (%, 95% CI)
ciTBI	
Hospitalization ≥2 nights for head trauma, with TBI on CT	0/2462 (0; 0–0.1)
Neurosurgery	0/2462 (0; 0–0.1)
Intubation for TBI ≥ 24 h	0/2462 (0; 0–0.1)
Death due to TBI	0/2462 (0; 0–0.1)
TBI on CT[a]	
Cerebral hemorrhage/intracerebral hematoma	1/456 (0.2; 0–1.2)
Pneumocephalus	2/456 (0.4; 0.1–1.6)
Cerebral contusion	1/456 (0.2; 0–1.2)

[a] One patient had 2 types of TBIs on CT.

neurosurgery for skull fracture elevation. This 13-year-old child was running when a pipe struck his head. On examination, he had a temporal/parietal scalp hematoma in addition to a severe headache. The CT demonstrated a cerebral hemorrhage/intracerebral hematoma, pneumocephalus, and a depressed skull fracture greater than the skull width.

DISCUSSION

In this analysis of a large cohort of children with minor blunt head trauma, headache was a common complaint, with many patients having no other signs or symptoms suggestive of TBI. There were no ciTBIs and very few TBIs on CT when the headaches were isolated, irrespective of its time of onset, severity, or location. This strongly suggests that CTs are not indicated in most children with headaches and no other signs or symptoms of TBI after blunt head trauma, and a period of observation may be warranted before CT decision-making. Clinicians appeared comfortable not obtaining CTs in those with isolated headaches as the minority of these patients had CTs obtained. TBIs were more frequent, however, in children with headaches in the presence of other signs or symptoms of TBI. In children 2 to 18 years with isolated severe headaches based on the PECARN prediction rule factors, the overall risk of ciTBI was also very low, although 1 patient underwent neurosurgery.

Previous data on the clinical importance of headaches in children with minor blunt head trauma are challenging to summarize due to marked differences in study populations, methodologies across studies, and predictive variable and outcome definitions.[6,14–17] In a systematic review, "any headache" had a pooled negative likelihood ratio (LR) of 0.91 (95% CI: 0.78–1.01) and positive LR of 1.26 (95% CI: 0.97–1.61) for intracranial injury on CT.[6] "Severe or persistent headache" had a similar pooled negative LR of 0.92 (95% CI: 0.87–0.99) but did have a positive LR of 4.35 (1.07–12.35) for intracranial injury. In that systematic review, the lack of any headache decreased the risk of neurosurgery, with a pooled LR of 0.27 (95% CI: 0.19–0.38).[6] It should be recognized, however, that the systematic review provided test characteristics for children with headaches who may or may not have had other clinical findings (eg, vomiting, etc). The current study builds on previous data by providing estimates of TBI risk when headaches are present in isolation.

Although headache appears to have a limited role as an independent discriminator for TBI, most previous TBI prediction rules for children with minor head trauma include headache, severe headache, or persistent headache as either a factor that decreases the risk of TBI when absent (for rules to identify low-risk patients) or increases the risk when present (if the rule was created to identify high-risk patients).[2,3,7,18–23] The inclusion of headache in some prediction rules suggests that it occasionally helps identify patients with TBIs who are not easily captured by more discriminating predictors.

Finally, although the absolute risk of TBI (both ciTBI and TBI on CT) appeared to increase with increasing headache severity, the multivariable logistic regression analysis did not bear out this relationship. This lack of a clear association differs from previous data, which suggest that increased headache severity increases the risk of TBI.[6] This may be explained by the fact that no previous study has adjusted for the all the factors included in our analyses, including the time between injury and ED evaluation. Our assessment of headache at 1 point in time resulted in an inability to specifically assess for persistence or increasing headache severity while in the ED.

The study had certain limitations. In addition to only assessing headache at 1 point in time, we had too few outcomes to precisely estimate the association between TBI and the severity and timing of headache. Additionally, clinicians obtained CTs on the minority of children, with bias

TABLE 5 Characteristics of Children With TBIs Who Had Isolated Headaches—Extensive Definition

Age, y	Mechanism Specifics	Headache Severity	Location of Headache	TBI on CT	ciTBI
11	Accidentally struck in left ear with golf club	Mild/barely noticeable	Diffuse	Pneumocephalus	None
13	Bike collision	Mild/barely noticeable	Diffuse	Cerebral hemorrhage/intracerebral hematoma	None
14	Fell from top of car traveling ~25 mph	Moderate	Unknown/missing	Cerebral contusion, and pneumocephalus	None

ciTBI, clinically-important traumatic brain injury; TBI, traumatic brain injury.

TABLE 6 Multivariable Regression Analysis Assessing Relationship Between Location and Severity of Headache, and TBI

	ciTBI Adjusted OR (95% CI), *N* = 12 587	TBI on CT Adjusted OR (95% CI), *N* = 6555
Severity of headache		
Mild/barely noticeable	Reference	Reference
Moderate/severe	1.55 (1.00–2.40)	0.97 (0.72–1.32)
Location of headache		
Diffuse	Reference	Reference
Localized	1.22 (0.82–1.80)	1.11 (0.82–1.50)

Variables adjusted for in both multivariable analyses along with the reference group: altered mental status (reference = no), acting normally per parent (reference = yes), history of loss of consciousness (reference = no), history of vomiting (reference = no), any scalp hematoma (reference = no), other traumatic scalp findings (reference = no), palpable skull fracture (reference = no), clinical signs of basilar skull fracture (reference = no), amnesia (reference = no), age (reference = >10 y), time from injury to ED evaluation in hours (reference = >4 h).
ciTBI, clinically-important traumatic brain injury; CT, computed tomography; OR, odds ratio; TBI, traumatic brain injury.

TABLE 7 Risk of TBIs With PECARN-Isolated Severe Headaches (ie, Isolated Severe Headaches Based on the PECARN Prediction Rule Variables), Plus the Addition of 1 Other PECARN Prediction Rule Variable

PECARN Prediction Rule Variables	ciTBI, *n*/*N* (%, 95% CI)	TBI on CT, *n*/*N* (%, 95% CI)
Isolated severe HA	3/209 (1.4; 0.3–4.1)	4/128 (3.1; 0.9–7.8)
Severe HA plus altered mental status[a]	2/74 (2.7; 0.3–9.4)	2/65 (3.1; 0.4–10.7)
Severe HA plus history of LOC	0/121 (0; 0–3.0)	1/107 (0.9; 0–5.1)
Severe HA plus clinical signs of basilar skull fracture	0/3 (0; 0–70.8)	0/3 (0; 0–70.8)
Severe HA and history of vomiting	1/69 (1.4; 0–7.8)	1/60 (1.7; 0–8.9)
Severe HA and severe mechanism of injury[b]	0/27 (0; 0–12.8)	0/21 (0; 0–16.1)

ciTBI, clinically-important traumatic brain injury; HA, headache; LOC, loss of consciousness; TBI, traumatic brain injury.
[a] Defined as a GCS score of 14, agitation, sleepiness, slow to respond to verbal communication, or repetitive questioning.
[b] Motor vehicle crash with patient ejection, death of another passenger, or rollover; pedestrian or bicyclist without helmet struck by a motorized vehicle; falls >5 feet; or head struck by a high-impact object.

likely toward those with more severe findings and higher risk of TBI. Because this bias would likely inflate the risk of TBI on CT, the overall risk of TBI on CT given isolated headache is likely lower than we report. Our main outcome, ciTBI, however, is not dependent on obtaining CTs. Therefore, we were able to more accurately determine associations for our primary, and more important, outcome.

CONCLUSIONS

ciTBIs are rare and TBIs on CT are very uncommon in children with minor blunt head trauma when headaches are their only sign or symptom.

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VIRTUAL SPINNING: *I like to bicycle. However, cycling in Vermont is more than a bit challenging several months of the year. While a few diehards continue to commute on bike regardless of the weather, most others retreat indoors where they ride stationary resistance trainers or participate in spinning classes. Spinning classes involve riding a stationary bike in a group setting and include an instructor, visualization, a variety of movements, and usually loud music. One of my friends is an ardent spinner. She usually spins every other day. I went with her to a spin class once. Just before we got on the bike she gave me good advice. "Remember," she said, "this is not a ride but a workout." While the class was interesting, she moved away and we have not trained together since.*

As reported in The Wall Street Journal*, new technologies may allow us to become virtual workout partners. A recently founded spinning studio sells bikes with monitors that allow spinners to live-stream studio classes from home. That means that, in addition to the spinners in the studio, several others from around the country could be participating at the same time. Those spinning at home can see friends in the studio and follow electronic leaderboards that display calories consumed, distance ridden, and pedal resistance of all participants. While it might be tempting to slack off if riding at home, the instructor can also see the leaderboard statistics and encourage more active participation. Spinners like the new technology as it allows them flexibility and helps maintain friendships.*

I am not sure I am quite ready to invest almost $2,000 in such a specialized spinning bike to take virtual classes with my friend, but the idea is attractive.

Noted by WVR, MD

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Headache in Traumatic Brain Injuries From Blunt Head Trauma

Peter S. Dayan, James F. Holmes, John Hoyle Jr, Shireen Atabaki, Michael G. Tunik, Richard Lichenstein, Michelle Miskin, Nathan Kuppermann and for the Pediatric Emergency Care Applied Research Network (PECARN)

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