The Prevalence of Traumatic Brain Injuries After Minor Blunt Head Trauma in Children With Ventricular Shunts

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Study objective: We compare the prevalence of clinically important traumatic brain injuries and the use of cranial computed tomography (CT) in children with minor blunt head trauma with and without ventricular shunts.

Methods: We performed a secondary analysis of a prospective observational cohort study of children with blunt head trauma presenting to a participating Pediatric Emergency Care Applied Research Network emergency department. For children with Glasgow Coma Scale (GCS) scores greater than or equal to 14, we compared the rates of clinically important traumatic brain injuries (defined as a traumatic brain injury resulting in death, neurosurgical intervention, intubation for more than 24 hours, or hospital admission for at least 2 nights for management of traumatic brain injury in association with positive CT scan) and use of cranial CT for children with and without ventricular shunts.

Results: Of the 39,732 children with blunt head trauma and GCS scores greater than or equal to 14, we identified 98 (0.2%) children with ventricular shunts. Children with ventricular shunts had more frequent CT use: (45/98 [46%] with shunts versus 13,858/39,634 [35%] without; difference 11%; 95% confidence interval 1% to 21%) but a similar rate of clinically important traumatic brain injuries (1/98 [1%] with shunts versus 346/39,619 [0.9%] without; difference 0.1%; 95% confidence interval −0.3% to 5%). The one child with a ventricular shunt who had a clinically important traumatic brain injury had a known chronic subdural hematoma that was larger after the head trauma compared with previous CT; the child underwent hematoma evacuation.

Conclusion: Children with ventricular shunts had higher CT use with similar rates of clinically important traumatic brain injuries after minor blunt head trauma compared with children without ventricular shunts. [Ann Emerg Med. 2013;61:389-393.]

Please see page 390 for the Editor's Capsule Summary of this article.

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INTRODUCTION

In the United States, approximately 1 in 500 children has a ventricular shunt to drain excess or obstructed cerebrospinal fluid.[1,2] It is not known whether the presence of a ventricular shunt increases the risk of traumatic brain injury after blunt head trauma and therefore whether thresholds for obtaining cranial computed tomography (CT) scans after blunt head trauma should be different than for other children.

Previous investigators suggested that an association exists between ventricular shunts and risk of traumatic brain injury.[3-5] A ventricular shunt stretches the bridging veins or cortical arteries that normally adhere to the inner surface of the dura, potentially risking intracranial hemorrhage after minor blunt head trauma.[6] Three small retrospective series describe some patients with ventricular shunts and intracranial hemorrhages after blunt head trauma.[4-6] All children described in these series presented with signs or symptoms suggestive of traumatic brain injury. However, to our knowledge no large prospective cohort of children with ventricular shunts and blunt head trauma exists to precisely assess the risk of traumatic brain injury and to determine whether the risk differs from that of children without ventricular shunts. Because children with ventricular shunts are already exposed to repeated CT scans,[7] avoiding additional ionizing radiation exposure would be beneficial.

The Pediatric Emergency Care Applied Research Network (PECARN) previously conducted a prospective observational

*Participating centers and site investigators are listed in the Appendix.

Editor's Capsule Summary

What is already known on this topic

Previous case reports suggest increased risk of traumatic brain injury in children with ventricular shunts who sustain head trauma.

What question this study addressed

This study measured the prevalence of clinically important traumatic brain injuries in a cohort of head-injured children younger than 18 years with and without ventricular shunt.

What this study adds to our knowledge

Children with ventricular shunts had a rate of clinically important traumatic brain injuries (1/98; 1%) similar to that of those without (346/39,619; 0.9%) but higher rate of cranial computed tomography (CT) use (45/98 versus 13,858/39,634; 46% versus 35%).

How this is relevant to clinical practice

Routine cranial CT may not be indicated in head-injured children with ventricular shunts in the absence of other risk factors for traumatic brain injury.

study of more than 40,000 children with blunt head trauma. In this planned secondary analysis, we explored the relationship between the presence of a ventricular shunt and the risk of traumatic brain injury.

MATERIALS AND METHODS

Study Design

We conducted an a priori planned secondary analysis of children who were enrolled in a large prospective cohort study of children younger than 18 years and with blunt head trauma. Study patients presented to one of 25 emergency departments (EDs) participating in the PECARN (2004 to 2006). The study protocol was approved by the institutional review board at each participating site, with waiver of consent at some sites and verbal consent for telephone follow-up at others. Details of study methods have been described previously.[8]

Selection of Participants

Children presenting within 24 hours after blunt head trauma after nontrivial injury mechanisms were included. Patients with known brain tumors, preexisting neurologic disorders, bleeding disorders, or neuroimaging performed at a transferring hospital were excluded from the parent study and this substudy. We excluded from this substudy children with missing clinical data about the presence of a ventricular shunt. For this substudy, we focused on those with Glasgow Coma Scale (GCS) scores of 14 to 15 at initial ED presentation because these are the patients for whom the greatest controversy exists about the role of CT scans.

Data Collection and Processing

The treating emergency physician completed a standardized study data collection form at the ED visit, which included patient history, injury mechanism, symptoms, and signs. Clinicians were asked to indicate the presence or absence of a ventricular shunt.

Outcome Measures

Our primary outcome measures were the prevalence of clinically important traumatic brain injury and traumatic brain injury on cranial CT scan; our secondary outcome measure was the rate of CT use. Cranial CT scans were performed at the clinician's discretion and were interpreted by study site faculty radiologists, with external review for inconclusive cases. Children who were discharged from the ED without a cranial CT scan had clinical telephone follow-up by trained research staff between 1 week and 3 months from the initial ED visit.[8] We defined clinically important traumatic brain injury by the presence of one or more of the following: a traumatic brain injury resulting in death, neurosurgical intervention, intubation for greater than 24 hours, or 2 or more nights in the hospital for the management of the traumatic brain injury in association with a positive CT scan result. We defined a positive CT scan result as any of the following: intracranial hemorrhage or contusion, traumatic infarction, sigmoid sinus thrombosis, diffuse axonal injury, pneumocephalus, midline shift or signs of brain herniation, diastasis of the skull, or skull fracture depressed more than the table width of the skull.

Primary Data Analysis

We described the data by using descriptive statistics with 95% confidence intervals (CIs), where appropriate. We first performed a bivariable analysis comparing demographic and injury severity characteristics of children with initial GCS scores greater than or equal to 14 with and without ventricular shunts. We then compared rates of cranial CT use, positive CT results, and clinically important traumatic brain injuries for children with and without ventricular shunts. We used the Newcombe-Wilson continuity adjusted method because of low prevalence rates.[9] Finally, we performed multivariable logistic regression with generalized estimating equations to compare CT rates between patients with and without ventricular shunts. The generalized estimating equation models adjusted for clinical severity and for clustering of CT use by hospitals.

We performed the data analysis with SAS software (version 9.2; SAS Institute, Inc., Cary, NC).

RESULTS

Of the 57,030 eligible patients, 43,498 (76%) were enrolled in the parent study of blunt head trauma. We excluded 2,912