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Observation for isolated traumatic skull fractures in the pediatric population: unnecessary and costly

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ABSTRACT

Background: Blunt head trauma accounts for a majority of pediatric trauma admissions. There is a growing subset of these patients with isolated skull fractures, but little evidence guiding their management. We hypothesized that inpatient neurological observation for pediatric patients with isolated skull fractures and normal neurological examinations is unnecessary and costly.

Methods: We performed a single center 10 year retrospective review of all head traumas with isolated traumatic skull fractures and normal neurological examination. Exclusion criteria included: penetrating head trauma, depressed fractures, intracranial hemorrhage, skull base fracture, pneumocephalus, and poly-trauma. In each patient, we analyzed: age, fracture location, loss of consciousness, injury mechanism, Emergency Department (ED) disposition, need for repeat imaging, hospital costs, intracranial hemorrhage, and surgical intervention.

Results: Seventy-one patients presented to our ED with acute isolated skull fractures, 56% were male and 44% were female. Their ages ranged from 1 week to 12.4 years old. The minority (22.5%) of patients were discharged from the ED following evaluation, whereas 77.5% were admitted for neurological observation. None of the patients required neurosurgical intervention. Age was not associated with repeat imaging or inpatient observation ($p = 0.7474$, $p = 0.9670$). No patients underwent repeat head imaging during their index admission. Repeat imaging was obtained in three previously admitted patients who returned to the ED. Cost analysis revealed a significant difference in total hospital costs between the groups, with an average increase in charges of $4,291.50 for admitted patients ($p < 0.0001$).

Conclusion: Pediatric isolated skull fractures are low risk conditions with a low likelihood of complications. Further studies are necessary to change clinical practice, but our research indicates that these patients can be discharged safely from the ED without inpatient observation. This change in practice, additionally, would allow for huge health care dollar savings.

Trauma is the leading cause of morbidity and mortality in the pediatric population. Traumatic brain injury accounts for more emergency department visits, hospitalizations, and deaths in children compared to the adult population [1]. It is estimated that in the United States, as many as 500,000 pediatric patients are seen in hospital emergency rooms and trauma bays each year for concerns of traumatic brain injury [2]. Pediatric traumatic brain injury accounts for more than one billion dollars in total hospital charges annually in the United States, making it one of the most expensive diagnoses [3].

Pediatric patients with head trauma and a normal neurologic exam have a less than 5% incidence of intracranial injury, and rarely require neurosurgical intervention (1% of cases) [4]. Current evidence suggests that adults and children with head trauma who have a normal head computed tomography (CT) and normal neurological exam, may be safely discharged home without requiring hospital admission [4–9]. Despite identification of criteria to stratify pediatric patients who are at low risk of developing a clinically important traumatic brain injury, head CT scans are routinely performed in many centers for asymptomatic patients with suspected traumatic brain injury [10–13]. This has resulted in an increased number of patients with a normal neurologic exam being diagnosed with a skull fracture, without underlying intracranial hemorrhage or injury [10]. A recent study noted that approximately 78% of such pediatric patients are hospitalized for observation [14].

Despite data supporting discharge from the hospital for isolated skull fractures, there is reluctance to adhere to this recommendation

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by health care providers because of a relative paucity of data specific to pediatric populations [14–22].

1. Objectives

Our aims were to identify pediatric patients at our institution with a presenting diagnosis of an isolated skull fracture, and to determine their outcomes. Using this information we planned to evaluate whether inpatient observation was necessary, determine health care costs associated with an isolated skull fracture, and formulate a management algorithm. We hypothesized that an isolated skull fracture in a neurologically intact pediatric patient would correlate with a very low risk of neurological injury, and would not warrant routine follow up imaging. Further, we anticipated that unnecessary admission of these patients would significantly increase hospital costs.

2. Materials and methods

After obtaining IRB approval, we performed a single center retrospective review at a free-standing major metropolitan pediatric level-one trauma center. The medical records of all pediatric trauma patients presenting to the emergency department with *ICD-9* codes indicating head trauma (803.00, 803.01, 803.06, 803.09, 854.00, 959.00, 660890, and 727915) were reviewed from June of 2004 through June of 2014.

Inclusion criteria included patients presenting to the emergency department with CT of the head confirmed isolated non-displaced skull fractures secondary to blunt head trauma (Fig. 1), with a normal neurological examination. The neurologic exam was considered normal if no abnormality (no focal neurologic deficits, no witnessed seizures in the hospital setting, Glasgow Coma Scale (GCS) = 15) was found in reviewing the documented physical examinations from the Trauma, Emergency Department (ED), and Neurosurgery physicians evaluating the patient at the time of presentation. All examinations included a full evaluation of gross motor function, sensory function, cranial nerve function, GCS, retrograde memory, and antegrade memory as appropriate to the age of the patient.

Exclusion criteria included patients with penetrating head trauma, depressed skull fractures, skull fractures involving the skull base, presence of neurological deficits on physical examination, intracranial hemorrhage on imaging, pneumocephalus, or polytrauma.

Patient age, location of fracture, history of loss of consciousness, disposition of the patient after their emergency department stay, repeat imaging, evidence of intracranial hemorrhage, and any subsequent surgical interventions were recorded.

Hospital cost for the initial encounter was also analyzed. For this each patient's medical record was reviewed for the initial trauma encounter. Institutional cost codes listed for each patient encounter were referenced to set numerical values in order to generate the cost for that encounter. These costs were the flat fee that the institution paid. These fees do not take into account reimbursement from insurance companies. Total cost, observation cost, radiologic imaging costs, and other costs were compared among patients. Radiologic imaging costs included both plain films and CT scan. Other costs included, but were not limited to, costs from trauma activation, laboratory tests, medications, nursing, ED visit, pulse oximetry and vital sign monitoring, and other medical supplies used.

Graphs were generated using Excel. Statistical analysis was completed with One Sample Chi-squared Test, Wilcoxon Rank-sum Test, and Fisher's Exact Test using SAS Software version 9.4. Additional analysis using Students T-Test was done with Prism Graph Pad 6 Software. Differences were considered significant at $p < 0.05$.

3. Results

Over the 10-year period examined, 163 patients were identified as having a head trauma with a skull fracture. There were 71 patients that satisfied the selection criteria that were outlined for the study. Of these patients 56% were male and 44% were female. Patient ages ranged from 1 week old to 12.4 years old with an average age of 19 months. Sixty of the total seventy-one patients (85%) were aged less than three years of age (Fig. 2).

The majority (77.5%) of patients were admitted for inpatient neurological observation with serial neurological exams and 22.5% of patients were discharged from the emergency department with outpatient follow-up. There was no significant difference in the age of the patients who were discharged versus those that were admitted ($p = 0.9670$). The average age of the discharged patients was approximately 14 months and the average age of the admitted patients was 21 months. There was no significant difference seen in the type of fractures between those admitted and those discharged (Table 1). One patient had a report of seizure-like activity in the field; however, no activity was witnessed by any health

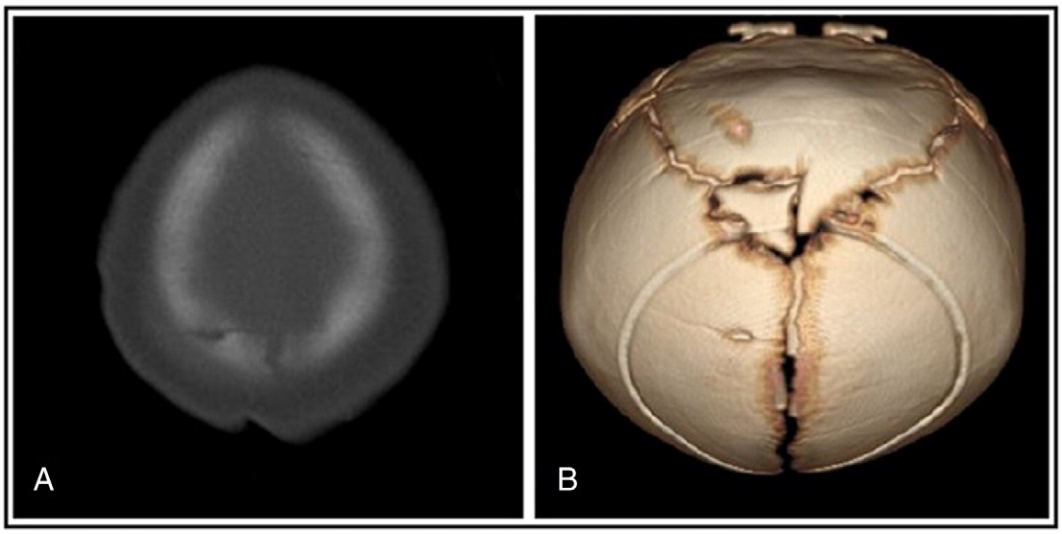

Fig. 1. Skull fracture imaging – patients that met the criteria for our study had isolated non-displaced skull fractures secondary to blunt head trauma. (A) Non-contrast CT of the head and (B) CT 3-D reconstruction demonstrate a right sided non-displaced occipital fracture.