
A Three-Year Prospective Study of Repeat Head Computed Tomography in Patients with Traumatic Brain Injury



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BACKGROUND: A definitive consensus on the standardization of practice of a routine repeat head CT (RHCT) scan in patients with traumatic intracranial hemorrhage is lacking. We hypothesized that in examinable patients without neurologic deterioration, RHCT scan does not lead to neurosurgical intervention (craniotomy/craniectomy).

STUDY DESIGN: This was a 3-year prospective cohort analysis of patients aged 18 years and older, without antiplatelet or anticoagulation therapy, presenting to our level 1 trauma center with intracranial hemorrhage on initial head CT and a follow-up RHCT. Neurosurgical intervention was defined by craniotomy/craniectomy. Neurologic deterioration was defined as altered mental status, focal neurologic deficits, and/or pupillary changes.

RESULTS: A total of 1,129 patients were included. Routine RHCT was performed in 1,099 patients. The progression rate was 19.7% (216 of 1,099), with subsequent neurosurgical intervention in 4 patients. Four patients had an abnormal neurologic examination, with a Glasgow Coma Scale (GCS) of ≤ 8 requiring intubation. Thirty patients had an RHCT secondary to neurologic deterioration; 53% (16 of 30) had progression on RHCT, of which 75% (12 of 16) required neurosurgical intervention. There was an association between deterioration in neurologic examination and need for neurosurgical intervention (odds ratio 3.98; 95% CI 1.7 to 9.1). The negative predictive value of a deteriorating neurologic examination in predicting the need for neurosurgical intervention was 100% in patients with GCS > 8.

CONCLUSIONS: Routine repeat head CT scan is not warranted in patients with normal neurologic examination. Routine repeat head CT scan does not supplement the need for neurologic examination for determining management in patients with traumatic brain injury. (J Am Coll Surg 2014; 219:45–52. © 2014 by the American College of Surgeons)

An estimated 1.4 million Americans require hospital admission annually for management of traumatic brain injury (TBI).¹ Evidence-based guidelines have established

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the role of an initial head CT scan for evaluating patients with TBI.²⁻⁴ After evaluating the primary intracranial injury, the mainstay of treatment is focused on identifying the progression of the initial insult for which serial repeat head CT scans are routinely performed within 6 to 12 hours of the initial CT scan.⁵⁻⁹ However, with improvements in CT scan technology, minuscule changes in the initial hemorrhage are identified; their impact on therapeutic intervention remains unclear.

Studies advocating a routine RHCT argue that progression of the initial intracranial hemorrhage (ICH) can occur even in the absence of clinical deterioration, resulting in subsequent neurosurgical intervention.^{10,11} However, several recent studies have questioned this practice and have advocated the use of a routine RHCT scan only in nonexaminable patients and in patients without

Abbreviations and Acronyms

AIS	= Abbreviated Injury Score
GCS	= Glasgow Coma Scale
ICH	= intracranial hemorrhage
RHCT	= routine repeat head CT
TBI	= traumatic brain injury

an improvement in the neurologic examination.¹²⁻¹⁵ Given the higher cost and radiation risk associated with routine RHCT scans, the practice of routinely scanning all patients with TBI is being re-examined. However, a definitive consensus on the standardization of practice of a routine RHCT scan in patients with traumatic ICH remains controversial.

The aim of this study was to evaluate the utility of a routine RHCT in patients with TBI. We hypothesized that in examinable patients without neurologic deterioration, routine RHCT scan does not lead to neurosurgical intervention (craniotomy/craniectomy).

METHODS

After approval from the Institutional Review Board at the University of Arizona College of Medicine, we performed a 3-year (May 2010 through April 2013) prospective cohort analysis of all patients with TBI presenting to our level 1 trauma center.

Study population

We included the following patients in our study: patients aged 18 years and older, with blunt TBI, ICH on initial head CT, and a follow-up RHCT. Patients on antiplatelet or anticoagulation therapy, intoxicated patients, patients transferred from other institutions, and patients undergoing emergent neurosurgical intervention were excluded from the study.

Data collection

The following data points were prospectively recorded in each patient: patient demographics which included age; sex; race; ethnicity; mechanism of injury; vital parameters on presentation, which included systolic blood pressure (SBP), heart rate (HR), temperature, and Glasgow Coma Scale (GCS) score; neurologic examination on presentation, intoxication (drug or alcohol), details regarding antiplatelet and anticoagulation therapy; intubation; loss of consciousness; initial head CT scan findings; reasons and findings of RHCT; neurosurgical intervention details; hospital and ICU length of stay; discharge disposition; GCS score on discharge; and in-hospital mortality. We obtained the Injury Severity Score (ISS) and head Abbreviated Injury Scores (h-AIS) from the trauma registry.

Study protocol

The study protocol consisted of the following:

1. All trauma patients presenting to our level 1 trauma center with suspected TBI received an initial head CT scan. Patients with an ICH on initial head CT scan were enrolled.
2. Neurologic examination was performed in each patient by the trauma surgeon and/or by the neurosurgeon on presentation. Each patient underwent serial neurologic examinations every 2 hours to assess for a decline in neurologic status.
3. All patients received a routine RHCT scan 6 hours after the initial head CT scan.
4. Patients with deteriorating neurologic examination received an RHCT independent of the routine RHCT protocol.

Neurologic examination and head CT scan

Patients were stratified into 2 groups based on the reason for the RHCT: patients with routine RHCT and patients receiving RHCT due to neurologic decline. We defined abnormal (deteriorating) neurologic examination as altered mental status, focal neurologic deficits, abnormal pupillary examination, or a decline in GCS score. The initial and repeat head CT scans were reviewed by the on-call radiologist and then were reviewed again by a single investigator who was a trauma surgeon. The initial and repeat head CT scans were reviewed for presence of skull fracture and presence, type, and size of the ICH. Progression of RHCT scan was defined as increase in the size of the initial ICH or development of a new ICH on the first repeat head CT scan.

Outcomes measures

The primary outcomes measure was the need for neurosurgical intervention. Neurosurgical intervention was defined as craniotomy or craniectomy.

Statistical analysis

Data are reported as mean \pm standard deviation (SD) for continuous descriptive variables, median (range) for ordinal descriptive variables, and as proportions for categorical variables. We performed Mann-Whitney U and Student's *t*-test to explore for differences in continuous and ordinal outcomes variables among patients with routine RHCT and patients with RHCT due to neurologic decline. We used chi-square test to identify differences in outcomes between the 2 groups for categorical variables. Univariate analysis was performed to assess the association between factors and the need for neurosurgical intervention. Variables with a significant ($p \leq 0.2$) association per our univariate analysis were then used in

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