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Shedding new light on rapidly resolving traumatic acute subdural hematomas

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ARTICLE INFO

Article history:
Received 9 February 2017
Received in revised form
1 May 2017
Accepted 25 May 2017
Available online xxx

Keywords:
Subdural hematoma
Rapid resolution
ASDH
RRASDH
Neurotrauma
Traumatic brain injury

ABSTRACT

Background: Rapidly resolving acute subdural hematomas (RRASDHs) have been described in case reports and case series but are still poorly understood. We hypothesized that a cohort analysis would confirm previously reported predictors of RRASDH including coagulopathy, additional intracranial hemorrhage, and low-density band on imaging. We also hypothesized that rapid resolution would be associated with improved trauma outcomes.
Methods: We reviewed all nonoperative acute subdural hematomas (ASDHs) treated at our center from 2011 to 2015. Inclusion criteria were ASDH on computed tomography (CT), admission Glasgow coma score >7, and repeat CT to evaluate ASDH change. RRASDH was defined as reduced hematoma thickness by 50% within 72 h. Clinical data, CT findings, and trauma end points were analyzed for the RRASDH and nonresolving groups.
Results: There were 154 ASDH patients included, with 29 cases of RRASDH. The RRASDH group had a lower rate of comorbidities than the nonresolving group (58.6% *versus* 78.4%, $P = 0.03$) and a lower rate of prehospital anticoagulation (7.7% *versus* 37.1%, $P = 0.004$). Previously reported predictors of RRASDH did not differ between the groups, nor did any clinical outcome measures. When compared with patients who experienced rapid growth (>50% increased width in 72 h), the RRASDH group had lower mortality (3.4% *versus* 23.5%, $P = 0.04$).
Conclusions: To our knowledge, this is the largest review of RRASDHs. We identified two previously unrecognized factors that may predict resolution; however, previously reported predictors were not associated with resolution. We also found no relationship between RRASDHs and improved standard trauma outcomes, calling into question the clinical significance of RRASDH.

Introduction

Acute subdural hematoma (ASDH) is a common consequence of traumatic brain injury, occurring in between 12% and 30% of cases.[1-3] ASDH carries with it a significant mortality risk, typically reported in the literature as between 40% and 70% depending on presenting clinical factors such as level of consciousness.[3,4] Because many patients with ASDH undergo

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0022-4804/$ – see front matter
http://dx.doi.org/10.1016/j.jss.2017.05.106

immediate operative decompression, the opportunity to observe the natural history of the condition only arises in the subset of patients chosen for nonoperative management. Given the well-known risks of ASDH, there has been great interest in identifying clinical factors to help risk stratify patients for hematoma progression and clinical outcomes.

In recent years, the phenomenon of rapidly resolving ASDH (RRASDH) has gained attention. Generally, an ASDH is thought to take weeks to months to resolve spontaneously.[5] However, several case reports and case series have demonstrated that there is a subset of patients for whom ASDH resolves rapidly, within hours to days, as evidenced by computed tomography (CT) assessment.[6-11] These reports have suggested numerous factors that may help predict rapid resolution including presence of concurrent subarachnoid hemorrhage or cerebral contusion, presence of cerebral edema on CT, higher Glasgow Coma Score (GCS) on admission, laboratory evidence of coagulopathy, and presence of a "low-density band" between the hematoma and the skull on CT imaging.

These observations have led to the development of two primary hypotheses to attempt to explain the etiology of RRASDHs. One hypothesis is that resolution is a result of redistribution of the blood products, caused by either the presence of additional bleeding or cerebral swelling leading to increased intracranial pressure (ICP).[12-14] It is also been suggested that normal, in-hospital patient activities such as coughing and agitation might lead to transient ICP spikes and encourage redistribution of the hematoma.[6] A second hypothesis, thought to be supported by the association of RRASDHs and the so-called "low-density band" on CT, is that resolution results from dilution of the hematoma by cerebral spinal fluid (CSF) due to the tears in the arachnoid membrane. Increasing brain swelling and ICP then leads to washout of the blood products by CSF.[15] Finally, it has been suggested that clinical coagulopathy could contribute to resolution in both of these proposed etiologies.

We sought to further clarify the predisposing factors for rapid resolution by using more rigorous analytics, thus adding to our understanding of the clinical entity of RRASDHs and the mechanisms by which it might occur. Furthermore, we aimed to investigate clinical outcomes associated with RRASDHs to determine the significance of rapid resolution for patient outcomes. We hypothesized that a cohort analysis would confirm previously reported predictors of RRASDHs including coagulopathy, additional intracranial hemorrhage, and low-density band on imaging. We also hypothesized that rapid resolution would be associated with improved trauma outcomes.

Materials and methods

After obtaining institutional review board approval, we reviewed the charts of all patients with a diagnosis of traumatic ASDH treated at our urban, university-based trauma center for a 5-year period from 2011 to 2015. Trauma patients admitted with a diagnosis of ASDH, an admission Glasgow Coma Score (GCS) >7, and a repeat CT scan to evaluate ASDH progression or regression were included in the study. Patients with only a single CT scan were excluded, as were patients with missing documentation, vulnerable populations, and those who underwent surgical decompression. Patients who underwent decompression were excluded to better understand the natural history of this condition and define the scope of and rates of resolution without operative intervention and hematoma evacuation to complicate our analysis.

For the resulting cohort of patients, the following variables were collected from our institutional trauma registry: age, gender, diagnoses, admission GCS, mechanism of injury, injury severity score, length of stay (LOS), intensive care unit (ICU) LOS, ventilator days, discharge destination, and mortality. The electronic medical record was then used to collect detailed CT findings, CT scan timing data, presentation clinical characteristics, and pertinent laboratory findings. All ASDH measurements were performed by a single investigator to maintain consistency and are reported in their greatest axial dimension, the measure used both clinically in our institution and in the existing literature on this subject. Presence or absence of a "low-density band" on CT was also determined by a review of the imaging by a single investigator. Other CT-obtained characteristics such as presence/absence of skull fractures, presence of additional bleeds, and ASDH location were based on the radiologist report. Rapid resolution was defined, as it has been in several previous studies in the trauma literature, as a decrease in axial hematoma thickness by at least 50% in 72 h.[7-9] Rapid growth was similarly defined as an increase in thickness of 50% in 72 h.

We then compared the patients who experienced rapid resolution of their hematoma with those who did not and attempted to identify predictive factors for rapid resolution, including those previously reported in the literature. Specifically, we looked at the presence of the so-called "low-density band," concurrent cranial fractures, other hemorrhage in addition to the index ASDH, cerebral edema, midline shift, location of ASDH, and laboratory evidence of coagulopathy. We also looked at clinical factors such as reported loss of consciousness, comorbidities, and prehospital anticoagulation. To further evaluate the clinical importance of rapid resolution, we compared standard trauma outcome variables between the resolving and nonresolving groups. Finally, we performed a subset analysis comparing the patients who experienced rapid hematoma growth to those who had rapid resolution. These groups were also compared with respect to the aforementioned variables to identify associated predictive factors and differences in clinical outcomes.

All statistical analyses were performed using Stata 13 software (StataCorp, College Station, TX). We compared continuous variables using a *t*-test and categorical variables using a Pearson's chi-squared test. Statistical significance was defined as a P value of less than 0.05. Data are reported as mean values ± standard error of the mean or as raw numbers and percentages.

Results

We identified 154 patients who met our inclusion criteria; these patients had a diagnosis of ASDH, an admission GCS > 7, and their hematomas were managed nonoperatively. Overall, this cohort had a mean age of 59.7 ± 1.8 years and was 72.1%