A Comparative Study of Chronic Subdural Hematoma in Patients With and Without Head Trauma

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Research

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Abstract

**Background:** Clinical features in chronic subdural hematomas (CSDH) patients with and without history of head trauma are not clear. Here, we seek to investigate difference of clinical characteristics in CSDH patients with and without head trauma.

**Methods:** Retrospectively collected clinical characteristics of CSDH patients, who were performed exhaustive drainage strategy in burr-hole craniostomy from August 2011 to May 2019. Divided patients into trauma and no trauma groups. Chi-square test or t-test was used to analyze differences of clinical characteristics between two groups. Multiple linear regression analysis was performed to analyze relationships between clinical characteristics and reduction of hematoma cavity and length of hospital stay in CSDH patients with trauma.

**Results:** 1,307 CSDH patients were collected. 805 patients occurred history of head trauma, 502 patients without it. Mean age of patients with trauma was 64.0 ± 16.1 years, while 61.5 ± 17.9 years in patients without trauma ($p=0.010$). More patients occurred hypertension in without trauma group than trauma group (40.2% vs 32.9%, $p=0.007$). Dizziness occurred in 29.2% patients with trauma, 23.1% in patients without trauma ($p=0.016$). Reduction of hematoma cavity after surgery in patients without trauma was less than ones with trauma ($p=0.002$). Length of hospital stay in patients with trauma was 7.9 ± 4.5 days, which was longer than patients without trauma (7.3 ± 3.7 days, $p=0.016$). No signicantly different densities of hematoma on CT, complications, mortality, recurrence rate and outcome were found between two groups.

**Conclusion:** Pathogenesis and some clinical characteristics occur differences in CSDH patients with and without trauma, but if we choose an optimal treatment method, such as our exhaustive drainage, and we can achieve the same effect.

**Background**

Chronic subdural hematomas (CSDH) generally increase with age and prevalent in older patients, especial in the population > 65 years old [1]. Many risk factors may contribute to the occurrence of CSDH, while the mechanism of CSDH is still unclear. Head trauma is regarded as a main cause of CSDH, and 30–75% of patients occurs a history of head trauma event within 3 months prior to hospital admission [2, 3]. However, some patients with CSDH could not be found any obvious cause. It is reported that arachnoid cysts, brain surgery, coagulation factors, ventriculoperitoneal shunt, and hypertension may paly roles in some spontaneous CSDH patients [4, 5]. According to these differences, some reports have found that CSDH patients with or without a history of head trauma display different clinical, radiologic characteristics and have different outcome [6–8]. However, these conclusions were arrived base on small cases, and occurred a high recurrence rate. Therefore, we should further analyze the outcome, clinical and radiological characteristics in CSDH patients with or without a history of head trauma base on a big data.
In this study, we retrospectively analyzed 1,307 patients with CSDH, and we found that age, a history of hypertension, dizziness symptom and interval from onset to admission occurred differences between CSDH patients with and head trauma. We also found that CSDH patients with or without a history of head trauma did not occurred differences in radiological characteristics, outcome, and recurrence rate, while CSDH patients with trauma occurred bigger reduction of hematoma cavity after surgery and longer length of hospital stay compared with CSDH patients without a history of head trauma. Therefore, our results are crucial to improve the clinical management and treatment of patients with CSDH.

**Methods**

The symptomatic CSDH was defined as a predominantly subdural collection with hypodense, isodense, or mixed-density in computed tomography (CT) scan, and patients with other causes identified during operation or subsequent treatment were excluded (e.g., empyema, arachnoid cyst). Finally, 1,307 patients with a primary or recurrent symptomatic CSDH confirmed on cranial imaging were collected from August 2011 to May 2019 at the department of neurosurgery in Beijing Tiantan hospital. No age was limited and an exhaustive drainage strategy in burr-hole craniostomy was carried out in all patients. All the clinical parameters (such as age, gender, past history, head trauma event) were collected. Complications after operation were also collected, including pneumonia, pulmonary embolism, heart failure, heart attack, stroke, fever, seizure and so on. Head trauma event was defined as occurring a history of head trauma within 3 months of the time of admission. At sixth month after patients discharged, CT scan was examined and modified Rankin scale (MRS) score was used to analyze patient’s outcome by two independent neurosurgeons through phone. MRS score of 0–3 indicated a good outcome, and a core of 4–6 indicated inferior outcome. Bender grade was used to analyze preoperative status of patients, while a CT grading system by Stanisic et al was utilized to classify the density of hematoma. Preoperative and postoperative hematoma volume was calculated by the Coniglobus formula. Informed consent from patients and ethics approval from the Institutional Research Ethics Committee were obtained.

**Statistical Analyses**

In all clinical parameters, means (± standard deviations) was used for continuous variables, while numbers of patients (percentages) for categorical variables. Chi-square test or t-test was used to analyze differences of clinical characteristics in CSDH patients with and without trauma. Multiple linear regression analysis was performed to analyze relationships between clinical characteristics and reduction of hematoma cavity and length of hospital stay in CSDH patients with trauma. Statistical analyses were performed by SPSS software version 17.0.0, while $p$-value < 0.05 was considered significant.

**Results**
Relationship between clinical characteristics and head trauma

To analyze differences of baseline characteristics in CSDH patients with or without head trauma, we divided patients into trauma group and no trauma group. As shown in Table 1. Gender ratio was 4.6:1 (661:144) male: female ratio in patients with head trauma, and 5.0:1 (419:83) male: female ratio in without head trauma group ($p = 0.530$). Mean age of patients with head trauma was 64.0 ± 16.1 years, while it was 61.5 ± 17.9 years in patients without head trauma, and a significant difference was found between the two groups ($p = 0.010$). Among the personal and past histories, we did not find any differences of smoking, drinking, diabetes, cardiac diseases, brain infarction, history of antithrombotic between CSDH patients with and without head trauma. But more patients occurred hypertension in without head trauma group than head trauma group (40.2% vs 32.9%, $p = 0.007$).
Table 1
Relationship between clinical characteristics and trauma in patients with chronic subdural hematoma

| Characteristics analyzed                  | Trauma (n) | p        |
|------------------------------------------|------------|----------|
|                                          | Yes (805)  | No (502) |
| Gender (Male: Female)                    | 661:144    | 419:83   | 0.530   |
| Age                                      | 64.0 ± 16.1| 61.5 ± 17.9| 0.010   |
| Personal / Past history                  |            | < 0.001  |
| Smoking                                  | 216(26.8)  | 133(26.5)| 0.893   |
| Drinking                                 | 155(19.3)  | 94(18.7) | 0.813   |
| Hypertension                             | 265(32.9)  | 202(40.2)| 0.007   |
| Diabetes                                 | 160(19.9)  | 97(19.3) | 0.807   |
| Cardiac diseases                         | 29(3.6)    | 20(4.0)  | 0.724   |
| Brain infarction                         | 93(11.6)   | 50(10.0)| 0.370   |
| History of antithrombotic                | 92(11.4)   | 52(10.4)| 0.548   |
| AC/V-P shunt n (%)                       | 68 (8.4)   | 47 (9.4)| 0.570   |
| Symptoms                                 |            |          |
| Headache n (%)                           | 479 (59.5) | 279 (55.6)| 0.162   |
| Dizziness n (%)                          | 235 (29.2) | 116 (23.1)| 0.016   |
| Limb weakness n (%)                      | 457 (56.8) | 260 (51.8)| 0.079   |
| Dysphasia n (%)                          | 80 (9.9)   | 42 (8.4) | 0.342   |
| Disturbance of consciousness n (%)       | 35 (4.3)   | 25 (5.0) | 0.595   |
| Interval from onset to admission         | 8.5 ± 6.3  | 11.5 ± 19.3| 0.001   |
| Bender grades                            |            | < 0.001  |
| 0                                        | 31 (3.9)   | 35 (7.0) |
| I                                        | 307 (38.1) | 249 (49.6)|        |
| II                                       | 431 (53.5) | 198 (39.4)|        |
| III                                      | 36 (4.5)   | 20 (4.0) |        |
| Unilateral/bilateral hematoma            |            | 0.068    |
| Left                                     | 314(39.0)  | 227(45.2)|        |
Headache was the most common symptom in the two groups (59.5%, 55.6%, respectively), and disturbance of consciousness was the least common symptom (4.3%, 5.0%, respectively). We found that dizziness occurred in 29.2% (235/805) patients with head trauma and 23.1% (116/502) in patients without head trauma, and a significant difference was identified between the two groups ($p = 0.016$). Others symptoms, such as limb weakness, dysphasia, were not found significant differences between the two groups. Furthermore, according to bender grades, more CSDH patients with head trauma was in II grade, while more CSDH patients without head trauma was in I grade ($p < 0.001$), suggesting that patients with head trauma occurred more severe condition. Average interval from onset to admission was 8.5 ± 6.3 days in patients with head trauma, 11.5 ± 19.3 days in patients without head trauma ($p = 0.001$).

Hematoma of CSDH patients displayed different densities on CT, such as hypodense, isodense, or mixed-density. We further analyzed the difference of hematoma density according to the CT grading system of Stanisic et al\textsuperscript{[10]}, and found that there were not significant difference between patients with and without head trauma. Furthermore, the sides of hematoma in patients with CSDH were also not occurred significant difference in the two groups. The average preoperative volume of hematoma was 99.6 ± 28.9 ML in head trauma group, and 99.2 ± 31.5 ML in no head trauma group ($p = 0.805$).

### Relationship Between Clinical Characteristics And Trauma After Surgery
According to our previous report [3], an exhaustive drainage strategy in burr-hole craniostomy was carried out for all patients after they been admitted. As shown in Table 2, the reduction of hematoma cavity after surgery was 58.9 ± 21.4% in head trauma group, and 55.2 ± 22.2% in no head trauma group (p = 0.002), suggesting that the brain plasticity of CSDH patients without head trauma event may worse than patients with head trauma event. After operation, the length of hospital stay in patients with head trauma was 7.9 ± 4.5 days, which was longer than patients without trauma (7.3 ± 3.7 days, p = 0.016).

| Characteristics analyzed          | Trauma (n)                | p      |
|----------------------------------|---------------------------|--------|
|                                  | Yes (805)            | No (502) |        |
| Reduction of hematoma cavity (%) | 58.9 ± 21.4            | 55.2 ± 22.2 | 0.002  |
| Symptom disappeared or alleviated (day) | 2.5 ± 1.9 | 2.7 ± 2.2 | 0.162  |
| Duration of drainage catheter (day) | 3.5 ± 1.8  | 3.4 ± 2.1  | 0.651  |
| Length of hospital stay (days)    | 7.9 ± 4.5             | 7.3 ± 3.7  | 0.016  |
| Use of urokinase                  | 434 (53.9)            | 271 (54.0) | 0.980  |
| Frequency of urokinase used       | 1.7 ± 0.9             | 1.6 ± 0.9  | 0.678  |
| Recurrence requiring reoperation  | 13 (1.6)              | 11 (2.2)  | 0.183  |
| Complications                     | 55 (6.8)              | 32 (6.4)  | 0.747  |
| Death (hospital stay)             | 4 (0.5)               | 4 (0.8)   | 0.490  |
| Death (in six month)              | 12 (1.5)              | 6 (1.2)   | 0.656  |
| Outcome (MRS)                     |                         |        | 0.233  |
| 0–3                               | 778 (96.6)            | 488 (97.2) |        |
| 4–6                               | 19 (2.4)              | 13 (2.6)  |        |

In our exhaustive drainage strategy, hematoma was drained by the catheter, which would be removed when drainage ceased. We found that duration of drainage catheter in head trauma group was 3.5 ± 1.8 days, while 3.4 ± 2.1 days in patients without head trauma (p = 0.651). Otherwise, urokinase was used to promote hematoma drainage in our strategy. There were no differences of use of urokinase and frequency of urokinase used between patients with and without head trauma.

A low recurrence requiring reoperation is one of the most important issue before choosing a suitable treatment for patients with CSDH. We found that the recurrence requiring reoperation in patients with head trauma was 1.6% (13/805), and 2.2% (11/502) in patients with head trauma. Interestingly, we did
not find significant difference between the two groups in recurrence rate. Patients with CSDH would occur some complications after operation, such as pneumonia, pulmonary embolism, heart failure, heart attack, stroke, fever, seizure and so on. We found that 6.8% (55/805) CSDH patients with head trauma occurred complications, and 6.4% (32/502) CSDH patients without head trauma had complications. We did not identify any differences between the two groups about complications. Furthermore, no matter in hospital stay or in sixth month after patients discharged, no significant differences occurred between them on mortality rate. The outcome in patients with head trauma was excellent as 96.6% ones obtained 0–3 MRS score. Meanwhile, patients without head trauma also had a favorable outcome, which 97.2% ones obtained 0–3 MRS score, and there was no difference compared with the trauma ones.

According to the above analyses, reduction of hematoma cavity after surgery in CSDH patients without trauma was less than ones with trauma, and we further analyzed which clinical parameters contributed to it by multiple linear regression analyses. As shown in Table 3, among CSDH patients with trauma, ones with AC/V-P shunt (B = 0.080, Beta = 0.103, p = 0.003) or unilateral hematoma (B = 0.068, Beta = 0.143, p < 0.001) would have a more reduction of hematoma cavity after surgery. Interestingly, patients with AC/V-P shunt or unilateral hematoma were younger (p < 0.01, respectively). Patients with a long interval from onset to admission (B = -0.005, Beta = -0.133, p < 0.001), long duration of drainage catheter (B = -0.011, Beta = -0.090, p = 0.009) and cardiac diseases (B = -0.085, Beta = -0.074, p = 0.031) would occur less reduction of hematoma cavity after surgery. Patients with cardiac diseases were older than ones without it (p < 0.001), while long duration of drainage catheter was also more common in older patients (p = 0.014).

| Characteristics analyzed                  | B     | Beta  | P      |
|------------------------------------------|-------|-------|--------|
| AC/V-P shunt                             | 0.080 | 0.103 | 0.003  |
| Interval from onset to admission         | -0.005| -0.133| < 0.001|
| Cardiac diseases                         | -0.085| -0.074| 0.031  |
| Duration of drainage catheter            | -0.011| -0.090| 0.009  |
| Unilateral/bilateral hematoma            | 0.068 | 0.143 | < 0.001|

Finally, we further analyzed the influencing factors of length of hospital stay in patients with head trauma (Table 4). We found that patients with brain infarction (B = 1.591, Beta = 0.114, p < 0.001) or a longer duration of drainage catheter (B = 0.709, Beta = 0.287, p < 0.001) would have a longer length of hospital stay, and complications would also cause patients with a longer length of hospital stay (B = 5.764, Beta = 0.326, p < 0.001).
| Characteristics analyzed | B   | Beta | P     |
|--------------------------|-----|------|-------|
| Brain infarction         | 1.591 | 0.114 | < 0.001 |
| Duration of drainage catheter | 0.709 | 0.287 | < 0.001 |
| Complications            | 5.764 | 0.326 | < 0.001 |

**Discussion**

There are very little literatures about investigating the differences or commons of CSDH patients with or without head trauma, and the results were controversial as they came out on the base of small samples. Here, we analyzed the clinical characteristics of CSDH patients with or without head trauma base on 1,307 patients, which was currently the largest sample size. As abnormal subdural collection of liquefied blood, the mechanism of CSDH is not clear. So far, one of the most commonly accepted mechanism of CSDH is that bridging veins, cortical arteries, or cortical veins are tearing after mild head injury with subsequent bleeding and creating hematoma\(^{[11]}\). Therefore, head trauma event is known as the most common risk factor in the occurrence of CSDH. To identify different clinical characteristics, recurrence, outcome of CSDH patients with and without head trauma, we divided 1,307 CSDH patients into trauma group and no trauma group. It was found that 61.6% ones occurred history of head trauma. Furthermore, we found that elder patients were more common with head trauma, which was difference compared with other reports\(^{[6,12,13]}\). The different results may be the reason that some elder patients did not notice or remember the history of mild head trauma. Otherwise, we found that reduction of hematoma cavity after surgery in CSDH patients with trauma was more than ones without trauma. Among CSDH patients with trauma, ones with AC/V-P shunt or unilateral hematoma had more reduction of hematoma cavity and were younger; patients with a long duration of drainage catheter and cardiac diseases occurred less reduction of hematoma cavity, and these patients were more common in older patients. All these results suggest that age is an important factor in the reduction of hematoma cavity in patients with trauma. The reason may be that, as brain atrophy with age, the brain would gradually lose its plasticity and did not show good re-expansion after removal of hematoma.

According to our previous reports and others literatures\(^{[3,7]}\), only 50–70% of CSDH patients occurred history of head trauma, suggesting that some others risk factors would also cause occurrence of CSDH. In fact, besides trauma, many risk factors have been identified in the process of CSDH, such as alcoholism, coagulopathies, cerebrospinal fluid shunts\(^{[5,14,15]}\). In no trauma group, we found that 40.2% patients had history of hypertension, which was significant difference compared with trauma group. It is suggested that hypertension plays important role in process of CSDH patients without trauma. The reason may be attributed to the fluctuation of blood pressure, which makes bridging veins, cortical
arteries, or cortical veins easier to be tore, suggesting that controlled hypertension is important for the prevention of CSDH.

Headache is the most common symptom in patients with CSDH \[^3\]. Patients with or without head trauma may appear different symptoms. It is reported that patients without head trauma had higher rate of muscle weakness \[^6\]. However, we did not determinate any difference on muscle weakness between two groups, and found that patients with head trauma displayed a higher rate of dizziness, while the other symptoms did not occur any differences. Otherwise, according to bender grade system, we found that patients with head trauma occurred more severe condition, which was consistent with some others reports \[^6\].

Hematoma density on CT can display different densities, such as homogeneous, separated, mixed density, high-density. It is reported that hematoma density occurred relationship with different clinical characteristics, and patients with high-density CT areas had the largest incidence of recurrence \[^16,17\]. Jun et al found that homogeneous density was mainly in patients with head trauma, while mixed density was in patients without head trauma \[^6\]. In our study, according to the different densities of hematoma on CT, we were classified them into 7 subtypes \[^10\], and found that there were not significant difference of hematoma density between CSDH patients with and without head trauma.

The complications, mortality, recurrence rate and outcome are important indexes to evaluate effect of a kind of treatment. It was found that patients without head trauma occurred a higher mortality than patients with head trauma \[^6\]. However, in our report, we found that 0.5% patients died in patients with trauma, and 0.8% in patients without trauma during hospital stay. Furthermore, 1.5% patients died during follow-up in trauma group, while 1.2% patients died in no trauma group. All these results did not occur significant differences, suggesting that mortality in a short-term or a long-term period was not difference in patients with or without trauma. A history of head trauma is correlated with poor outcome at long-term follow-up in CSDH patients \[^8\]. However, Jun et al found that CSDH patients without head trauma had poor outcome \[^6\]. The length of hospital stay in patients with head trauma was longer than patients without head trauma, and further analyses found that brain infarction, duration of drainage catheter, complications contributed to it. Furthermore, complication was the most significant factor among them, suggesting that a longer length of hospital stay may cause a poor outcome or more complications. However, we did not find that patients with head trauma occurred different outcome or complication compared with ones with head trauma. No differences of complications, mortality, recurrence rate and outcome were occurred in two groups. The major reason may be attributed to that we performed an exhaustive drainage strategy in burr-hole craniostomy for all patients \[^3\], which reduced hematoma to a maximum extent, reached a very low recurrence rate and good outcome. Otherwise, it is suggested that occurrence of CSDH in patients with and without trauma may occur different mechanisms, but if we choose an optimal treatment method, such as our exhaustive drainage, and we can achieve the same effect.
Conclusions
In conclusion, we analyzed the differences and commons of clinical characteristics between CSDH patients with and without head trauma. Our results are critical for a better management and treatment in CSDH patients with or without head trauma.

Abbreviations
CSDH
chronic subdural hematoma; MRS: modified Rankin Scale; CT: computed tomography;

Declarations

Acknowledgements
Not applicable

Authors’ contributions
YWO and WML designed research; XFY, XJL and QJ collected data; YWO drafted the manuscript. YWO takes the responsibility for the integrity of the data and the accuracy of the data analysis. BYL supervised project. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate
This study was approved by the Institutional Research Ethics Committee of Beijing Tiantan Hospital, Capital Medical University, China.
Consent for publication

Not applicable.

Competing interests

The authors declare that they have no conflicts of interest.

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