Factors Affecting Postoperative Recurrence of Chronic Subdural Hematoma

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Objective: Considerable recurrence rates have been reported for chronic subdural hematoma (CSDH) following surgical evacuation. The aim of this study was to determine the independent factors and features of CSDH that are associated with postoperative recurrence.

Methods: Retrospective analysis of 136 consecutive patients diagnosed with CSDH who were surgically treated from September 2005 to December 2011 was performed. The demographic data, clinical characteristics, radiologic features were analyzed to clarify the correlation between independent variables and postoperative recurrence of CSDH.

Results: CSDH was resolved within 1 month following surgery in 51 patients (37.5%), between 1 to 3 months in 59 patients (43.4%), and past 3 months in 14 patients (10.3%). A total of 12 patients (8.8%) experienced recurrence of CSDH, and reoperation was performed in all recurred cases. The average duration between initial surgery and reoperation was 20.1 days. Delayed resolution and recurrence were more commonly presented in bilateral CSDH, but this data was not statistically significant. Large hematomas with maximum thickness over 20 mm were significantly correlated with higher recurrence rates of CSDH ($p=0.032$). In addition, the incidence of recurrence was significantly higher in the cases with high-density and mixed-density hematomas according to brain computed tomography (CT) findings ($p=0.0026$).

Conclusion: The thickness and density of the hematoma is significantly correlated with higher recurrence rates of CSDH. Discerning these risk factors could be beneficial in predicting the postoperative recurrence of CSDH.

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KEY WORDS: Chronic subdural hematoma · Recurrence · Risk factors · Reoperation.

Introduction

Chronic subdural hematoma (CSDH) is a relatively common disease, especially in the geriatric population, frequently encountered in neurosurgical practice. Formation of the outer membrane with an interior containing hyperosmolar blood collection causes development of CSDH, and the outer membrane has abnormally permeable microcapillaries leading to accumulation of exudation from the macrocapillaries in the outer membrane, therefore enlarging the area of the subdural hematoma. CSDHs have been reported to show good postoperative prognosis with relatively simple method of surgical treatment including burr hole trephination. Traditionally, burr hole trephination and evacuation of hematoma with closed drainage system has been widely accepted as the optimal treatment for CSDH. It is agreeable that surgical decompression offers a dramatic improvement of symptoms, and the procedure is relatively noninvasive and safe with satisfactory postoperative outcome in the majority of patients with CSDH. However, considerable recurrence rates have been reported ranging from 3 to 20% following surgical management. This clinical analysis evaluated the postoperative course of CSDH and the factors correlated with recurrence.

Materials and Methods

Retrospective analysis of 157 consecutive patients diagnosed with CSDH who were surgically treated from September 2005 to December 2011 was performed. 20 patients who were inadequately followed up and 1 patient in whom...
organization of CSDH was accompanied by brain tumor were excluded from the study. Consequently, total of 136 pa-
tients were included in the analysis. Diagnosis of CSDH was
confirmed by brain computed tomography (CT) in all cases.
The clinical features, brain CT findings, surgical results,
and postoperative status of the patients were serially ana-
lyzed. Initial neurological examination on admission was
performed with the Glasgow Coma Scale (GCS) score, and
thorough verification of clinical information of all patients
was conducted.

Single or two burr holes were trephined at the region of
maximal hematoma thickness under general anesthesia.
Subdural hematoma was evacuated and washed out by irri-
gation with warm physiological saline solution. Closed-
system drainage of the subdural hematoma cavity using
soft silicon drain was performed in all cases for 1 to 5 days.
Postoperative brain CT scans were obtained within 3 days
following surgery. Subdural drainage catheter was removed
following confirmation of near total removal of hematoma
on postoperative brain CT findings and definite improve-
ment of symptoms. Following surgery, all patients received
adequate intravenous volume supplementation, and were
educated to be cautious of head trauma and aggressive physi-
atical activities. All patients included in this study were
followed-up for more than 3 months postoperatively.

Periodic brain CT scans were performed on 1 week basis
until regression of subdural hematoma and recovery of pa-
tients to premorbid functional status were presented. The
recurrence of CSDH was defined as re-accumulation of the
hematoma located within the operated hematoma cavity
with effacement of the sulci markings on brain CT scans
obtained within 3 months postoperatively along with the re-
appearance of neurological symptoms including cognitive
dysfunction, motor weakness, or dysphasia. Recurred
CSDHs were surgically managed by drainage of hematoma
using previously trephined burr hole. Patients who present-
ed no remarkable neurological deficits or small amount of
residual hematoma were observed and closely followed-up.

Preoperative brain magnetic resonance imaging (MRI)
was evaluated in 8 patients. Although the number of patients
who underwent brain MRI study preoperatively was rela-
tively small, characteristic findings were compared between
patients without postoperative recurrence and patients who
showed recurrence of CSDH.

Independent variables evaluated in the analysis of factors
associated with recurrence of CSDH included the following
parameters: age and sex; history of seizure, head trauma;
underlying diseases; associated cerebrovascular disease;
cardiovascular disease; chronic alcohol intake; smoking histo-
ry; laboratory findings (coagulopathy and liver function ab-
normality); medication of antiplatelet or anticoagulant agents;
initial and postoperative brain CT findings (hematoma thick-
ness, density, laterality regarding ipsilateral or bilateral, de-
gree of midline shift, cerebral atrophy, location of drainage
catheter tip, and amount of postoperative pneumocephalus).

Statistical analysis was conducted through Pearson’s chi-
square test and the Student t-test with SPSS software (ver-
sion 14.0; SPSS Institute, Inc., Chicago, IL). In all analyses,
a p-value of less than 0.05 was considered as statistically
significant.

Results

The demographic data and clinical characteristics of 136
consecutive patients are summarized in Table 1. There were
98 male (72.1%) and 38 female (27.9%) patients with male
to female ratio of 2.6 : 1. The range of age was from 43 to
97 years with an average of 64.3 years. The initial neuro-
logical status of patients presented by GCS score on admis-
sion showed mean value of 12.4. Arterial hypertension was
the most common underlying disease presented in 41 pa-
tients (30.1%). Five patients (3.7%) had history of seizure,
among them 1 patient presented recurrence of CSDH. How-
ever, these clinical findings were not significantly correlat-
ed with the postoperative recurrence of CSDH (p>0.05).
The risk factors with comparison between recurred CSDH
and patients without recurrence are summarized in Table 2.

Resolution of CSDH was achieved within 1 month fol-

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of patients (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7 (58.3)</td>
<td>91 (73.4)</td>
</tr>
<tr>
<td>Female</td>
<td>5 (41.7)</td>
<td>33 (26.6)</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>62.3</td>
<td>67.1</td>
</tr>
<tr>
<td>Mental status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alert</td>
<td>7 (58.3)</td>
<td>85 (68.6)</td>
</tr>
<tr>
<td>Confused</td>
<td>2 (16.7)</td>
<td>20 (16.2)</td>
</tr>
<tr>
<td>Drowsy</td>
<td>2 (16.7)</td>
<td>14 (11.6)</td>
</tr>
<tr>
<td>Stuporous</td>
<td>1 (8.3)</td>
<td>4 (3.4)</td>
</tr>
<tr>
<td>Comatose</td>
<td>0 (0.0)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>History of head trauma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>10 (83.3)</td>
<td>95 (76.6)</td>
</tr>
<tr>
<td>Absent</td>
<td>2 (16.7)</td>
<td>29 (23.4)</td>
</tr>
<tr>
<td>History of seizure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>1 (8.3)</td>
<td>4 (3.2)</td>
</tr>
<tr>
<td>Absent</td>
<td>11 (91.7)</td>
<td>120 (96.8)</td>
</tr>
</tbody>
</table>

RG: recurrence group, NRG: nonrecurrence group

TABLE 1. Demographic characteristics and clinical findings of the patients in the recurrent group and the group with no recurrence
lowing surgery in 51 patients (37.5%), between 1 to 3 months in 59 patients (43.4%), and past 3 months postoperatively in 14 patients (10.3%). The recurrence of CSDH occurred in 12 patients (8.8%). There were 7 male (58.3%) and 5 female (41.7%) patients with recurrence of CSDH ranging in age from 62 to 85 years. Reoperation of recurred CSDH was performed in all 12 patients. The average interval between initial surgery and reoperation was 20.1 days. Following initial surgery, the recurrence of CSDH occurred within 1 week in 1 patient (8.3%), between 1 to 2 weeks in 5 patients (41.7%), between 2 to 3 weeks in 2 patients (16.7%), between 3 to 4 weeks in 1 patient (8.3%), and over 4 weeks in 2 patients (16.7%).

The recurrence of CSDH occurred on right cerebral convexity in 3 patients (25.0%), left in 7 patients (58.3%), and bilateral in 2 patients (16.7%). In regard with the laterality of hematoma, delayed resolution and recurrence were more commonly presented in bilateral CSDH. However, this data of difference was not statistically significant (p=0.453). Recurrence of CSDH was significantly more common in patients with hematoma with maximum thickness over 20 mm (p=0.032). The density of the hematomas according to brain CT findings were classified into high-density, mixed-density, iso-density, and low-density. The incidence of recurrence was significantly higher in the cases with high-density and mixed-density hematomas (p=0.0026) (Table 3). The recurrence of CSDH was relatively higher in the cases with midline shift over 10 mm. However, this difference was not statistically significant (p=0.765). There was no significant correlation between the recurrence of CSDH and the severity of cerebral atrophy (p=0.960).

Among the 8 patients evaluated preoperatively with brain MRI, 3 patients presented recurrence of CSDH. Signal intensity of CSDH on preoperative T1-weighted MRI was analyzed. 3 patients (37.5%) showed high signal intensity, and 5 patients (62.5%) revealed iso-signal intensity or low signal intensity on brain MRI. From the 3 patients with high signal intensity, 1 patient (33.3%) presented recurrence of CSDH, and out of the 5 patients who revealed iso-signal intensity or low signal intensity, 2 patients (40.0%) showed recurrence. Although this data was not statistically significant (p=0.492), the recurrence rate of CSDHs that exhibited iso-signal or low signal intensity on T1-weighted MRI was higher than in patients who showed homogenous high signal intensity on T1-weighted MRI.

Out of 136 patients, 32 patients (23.5%) underwent surgery with single burr hole trephination, and 104 patients (76.5%) with two burr hole trephination. The recurrence rates of CSDH in patients operated by single burr hole trephination and two burr hole trephination were 3.1% (n=1) and 10.6% (n=11), respectively presenting higher incidence of recurrence in surgeries with two burr hole trephination. However, this difference was not statistically significant (p=0.175) (Table 4). The mean duration of indwelling state of subdural drainage catheter was 4.8 days in patients with

### TABLE 2. The risk factors in 136 patients with chronic subdural hematoma

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Number of patients (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic alcoholism</td>
<td></td>
<td>0.274</td>
</tr>
<tr>
<td>Present</td>
<td>7 (58.3) 46 (37.1) 53 (38.9)</td>
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</tr>
<tr>
<td>Absent</td>
<td>5 (41.7) 78 (62.9) 83 (61.1)</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td>0.713</td>
</tr>
<tr>
<td>Present</td>
<td>3 (25.0) 41 (33.1) 44 (32.4)</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>9 (75.0) 83 (66.9) 92 (67.6)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td>0.625</td>
</tr>
<tr>
<td>Present</td>
<td>4 (33.3) 43 (34.7) 47 (34.6)</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>8 (66.7) 81 (65.3) 89 (65.4)</td>
<td></td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td></td>
<td>0.742</td>
</tr>
<tr>
<td>Present</td>
<td>2 (16.7) 15 (12.1) 17 (12.5)</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>10 (83.3) 109 (87.9) 119 (87.5)</td>
<td></td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td></td>
<td>0.216</td>
</tr>
<tr>
<td>Present</td>
<td>3 (25.0) 23 (18.5) 26 (19.1)</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>9 (75.0) 101 (81.5) 110 (80.9)</td>
<td></td>
</tr>
<tr>
<td>Prolongation of PT INR or aPTT</td>
<td></td>
<td>0.721</td>
</tr>
<tr>
<td>Present</td>
<td>2 (16.7) 16 (12.9) 18 (13.2)</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>10 (83.3) 108 (87.1) 118 (86.8)</td>
<td></td>
</tr>
<tr>
<td>Antithrombotic or</td>
<td></td>
<td>0.758</td>
</tr>
<tr>
<td>Anticoagulant</td>
<td>1 (8.3) 14 (11.3) 15 (11.0)</td>
<td></td>
</tr>
<tr>
<td>On medication</td>
<td>11 (91.7) 110 (88.7) 121 (89.0)</td>
<td></td>
</tr>
<tr>
<td>Not on medication</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RG: recurrence group, NRG: nonrecurrence group

### TABLE 3. Preoperative radiologic features of chronic subdural hematoma on brain computed tomography

<table>
<thead>
<tr>
<th>Radiologic features</th>
<th>Number of patients (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>3 (25.0) 37 (29.8) 40 (29.4)</td>
<td>0.453</td>
</tr>
<tr>
<td>Bilateral</td>
<td>2 (16.7) 19 (15.4) 21 (15.4)</td>
<td></td>
</tr>
<tr>
<td>Thickness</td>
<td></td>
<td>0.032</td>
</tr>
<tr>
<td>&lt;20 mm</td>
<td>4 (33.3) 76 (61.3) 80 (58.8)</td>
<td></td>
</tr>
<tr>
<td>≥20 mm</td>
<td>8 (66.7) 48 (38.7) 56 (41.2)</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td></td>
<td>0.0026</td>
</tr>
<tr>
<td>High</td>
<td>4 (33.3) 11 (8.9) 15 (11.0)</td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td>5 (41.7) 24 (19.4) 29 (21.3)</td>
<td></td>
</tr>
<tr>
<td>Iso</td>
<td>2 (16.7) 61 (49.2) 65 (46.3)</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1 (8.3) 28 (22.5) 29 (21.3)</td>
<td></td>
</tr>
</tbody>
</table>

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Previous studies propose higher recurrence rates in bilateral CSDH. However, this correlation was not statistically significant in our study. Even with statistical insignificance, bilateral CSDH could present rapid and progressive aggravation with increased intracranial pressure, and thus, surgical treatment should be considered earlier if indicated.

Although the statistical significance was not evident, patients operated with two burr holes showed relatively higher recurrence rates than those with one burr hole. According to results reported by previous studies, saline irrigation via two burr holes, which is generally considered more efficient in evacuating hematoma, may lead to accumulation of larger amount of postoperative subdural air, and act as a factor for recurrence of CSDH.

The density of subdural hematoma on brain CT scans was classified into 4 categories as high-density, mixed-density, iso-density, and low-density. In this study, significant correlation was evident between high and mixed density and the recurrence of CSDH. The density of hematoma on CT scan represents the proportion of fresh blood clots in hematoma cavity. Greater proportion of these fresh blood clots signifies active growth of vessels into the hematoma membrane and rebleeding into the hematoma cavity. According to previous study by Nomura et al., CSDH was classified into five categories in regard with brain CT findings as low-density, isodense, high-density, mixed-density, and layered types. They reported that the high-density and isodense types presented similarity in rebleeding presenting higher recurrence rates than the low-density types.

The signal intensity of subdural hematoma on brain MRI revealed characteristic finding suggesting that the recurrence of CSDH presented higher tendency in patients with iso-signal to low signal intensity on T1-weighted MRI. However, this data was not statistically significant. Tsutsumi et al. reported that the principal cause of recurrence of CSDH is likely to be the repetitive microhemorrhages from microvessels of the hematoma membrane. In cases of rebleeding, the fresh component of subdural hematoma is demonstrated as iso or low signal intensity on T1-weighted MRI. In this stage, microvessels of the hematoma membrane tends to easily rebleed, and be more vulnerable to recurrence of CSDH. Although our data was not statistically significant, CSDH presenting iso or low signal intensity on T1-weighted MRI may be more prone to recurrence.

From the 12 cases of re-operation due to recurrence of CSDH, 4 patients (33.3%) presented multilayered hematoma. There was a limitation regarding the fact that since brain

### Table 4: Comparison of recurrence rates in patients treated with one burr hole vs. two burr holes

<table>
<thead>
<tr>
<th>Factors</th>
<th>OBH</th>
<th>TBH</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>32</td>
<td>104</td>
<td>0.002</td>
</tr>
<tr>
<td>Recurrence</td>
<td>13</td>
<td>11</td>
<td>0.058</td>
</tr>
</tbody>
</table>

OBH: one burr hole, TBH: two burr holes

no recurrence, and 5.3 days in cases of recurred CSDH. There was no statistically significant correlation between the duration of subdural drainage catheter indwelling state and recurrence of CSDH ($p=0.356$).

### Discussion

CSDH generally develops in geriatric patients usually caused by relatively mild head trauma. Diverse methods of managements including conservative and surgical treatment through burr hole trephination and conduction of closed drainage system have been performed. In general, majority of previously reported literatures support surgical treatment of CSDH, proposing that burr hole trephination is a relatively simple and safe technique with reliable morbidity of 0 to 9.4%.

Postoperative recurrence of CSDH is not rare. Previous studies reported recurrence rates ranging from 9.2 to 26.5%, and in this study, recurrence rate was 8.8%. Various risk factors for recurrence of CSDH have been reported in previous studies, including advanced age, cerebral atrophy, bleeding tendency, chronic alcohol intake, bilateral location of hematoma, and postoperative pneumocephalus. However, these previously reported results have occasionally presented inconsistency. In this study, although older patients presented a higher tendency of recurrence, advanced age was not significantly correlated with the recurrence of CSDH.

Atrophy of cerebral parenchyma is a sequel of cerebrovascular accidents. Relatively small volume of cerebral parenchyma leads to enlargement of subarachnoid space, and thus, causing injuries induced by stretching of the bridging veins. This condition impedes postoperative brain expansion, and sustained rebleeding into the subdural hematoma cavity could act as a factor for recurrence of CSDH.

In conclusion, hematomas with greater thickness may present higher rates of recurrence since postoperative subdural space is larger than in smaller hematomas. Yamamoto et al. proposed that larger hematomas present greater tendency of recurrence since subdural space following surgical evacuation is larger than in smaller hematomas. In this study, although cerebral atrophy did not present statistically significant correlation with recurrence, large hematomas were significantly correlated with higher recurrence rates.
MRI scans were not performed in all patients, clear distinction between monolayered and multilayered hematoma was difficult to conclude. Previous studies reported that multilayered structure of CSDH is significantly correlated with higher recurrence rates, and certain articles supported conduction of craniotomy and complete removal of CSDH including hematoma membranes. Tanikawa et al. reported that CSDH with large amount of intrahematoma membranes presents higher recurrence rates, and that resection of the multilayered membranes, formation of a connection with all other compartments of CSDH, and evacuation of the hematoma could promote resorption of subdural fluid, leading to prevention of rebleeding. However, this proposal remains controversial.

This study was a retrospective and non-randomized study, and imposes certain limitations. Therefore, it is potentially subject to diverse biases and variations. Further analyses with larger size of samples would be necessary to clarify the definite risk factors for recurrence of CSDH.

**Conclusion**

Considerable proportion of patients treated surgically for CSDH presented postoperative recurrence. Certain risk factors influencing postoperative recurrence of CSDH were articulated in the present study. Large amount of hematoma evaluated by maximum thickness, and higher density on CT scans were significantly correlated with higher recurrence rates of CSDH. Discerning these risk factors could be beneficial in predicting the recurrence of CSDH following surgical treatment.

■ The authors have no financial conflicts of interest.

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