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Functional Outcome in Patients with Chronic Subdural Hematoma: Postoperative Delirium and Operative Procedure

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Abstract

Chronic subdural hematoma (CSDH) is a common neurosurgical condition and neurological condition improves after treatment in most patients. Recently more patients have poor prognosis because of aging of the population and presence of multiple comorbidities. The risk factors for poor prognosis, including postoperative delirium, were retrospectively evaluated to assess appropriate operative procedures. This study included 108 patients who underwent primary surgery from 2016 to 2017 at a single center. Operative procedures were drainage with or without irrigation. Functional outcome at discharge assessed the effect of various factors including postoperative delirium and operative procedure. Twenty-nine of 108 patients (27%) had worsened modified Rankin Scale (mRS) score at discharge, most with mobility disturbance or deteriorated cognitive function. Multivariate analysis found higher age (odds ratio [OR] = 5.13; 95% confidence interval [CI] = 1.0-1.14), poor pre-hospital mRS score (OR = 1.57; 95% CI = 1.0-2.46), and preoperative consciousness disturbance caused by CSDH (OR = 5.13; 95% CI = 1.27-20) were significant predictors of poor outcome. Operative procedure was not significantly related to functional outcome or recurrence, but irrigation was significantly related to postoperative delirium (OR = 4.83; 95% CI = 1.09-21.7). Patients with postoperative delirium were likely to require longer hospitalization stays (P = 0.028). Higher age, poor pre-hospital mRS, and preoperative consciousness disturbance caused by CSDH are the risk factors for poor recovery after CSDH. Irrigation is significantly likely to cause postoperative delirium and longer hospital stay.

Keywords: chronic subdural hematoma, functional outcome, operative procedure, postoperative delirium

Introduction

Chronic subdural hematoma (CSDH) is a common neurosurgical condition with increasing incidence and prevalence with higher age.[1)] Surgical evacuation is the gold standard of CSDH treatment, usually through craniotomy using the twist drill or burr-hole trephination and drainage, with or without irrigation,[2,3)] resulting in great improvements in neurological condition.[4)]

CSDH is generally considered to indicate a good prognosis, but poor outcomes have been reported, especially in older patients or with lower preoperative Glasgow Coma Scale.[5,6)] The frequency of poor outcomes has been increasing with the aging of the population.[7)] Therefore, the factors causing poor outcome should be reassessed to determine the appropriate management for these high-risk patients.

In general, postoperative delirium is associated with poor outcomes, longer hospitalization, greater costs, and higher mortality.[8-10)] Risk factors for postoperative delirium include pre-existing dementia, higher age, and functional impairment, as well as rapid decompression of CSDH.[11-13)] However, the correlation between operative procedures and postoperative delirium has not been investigated.

The present study evaluated the risk factors for poor outcome after CSDH including postoperative delirium, and assessed the appropriate operative procedure.

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Materials and Methods

Patients

This retrospective study included 108 consecutive patients (14 cases excluded from total 122 cases), 31 females and 77 males, aged 42-95 years (median 75 years), with CSDH who underwent surgery between January 2016 and December 2017 (Table 1). Patients with a history of shunt operation (1), craniotomy (2), and cerebrospinal fluid hypovolemia (5), or showed delirium preoperatively (6), were excluded. Patients previously treated with CSDH surgery were also excluded.

Operative procedure

All procedures were performed under local anesthesia. The procedure for burr hole drainage without irrigation was as follows: a burr hole was drilled and dura mater incision made, a small hole was opened in the outer membrane of the hematoma, and a silicone tube was inserted into the hematoma and connected to a gravity drainage system. The procedure for burr hole drainage with irrigation was as follows: a burr hole was drilled, the dura mater and outer membrane of the hematoma were dissected, a silicone drainage tube was inserted into the cavity, the hematoma was evacuated, and the cavity irrigated with warm physiological saline until the fluid became clear. Finally, a drainage tube was placed in the cavity and connected to a gravity drainage system. Draining of the hematoma was begun at the height of the craniotomy site, and gradually lowered during continued drainage. The catheter was removed by 2 days postoperatively in all cases. The decision, which procedure was taken was depended on each surgeon.

Data collection

Data were collected from the electronic and paper charts. Use of the data was approved by the local institutional review board (Rin-29-9). The following parameters were collected: previous diagnosis of dementia, symptoms, pre-hospital modified Rankin Scale (mRS),[14,15] operative procedure, hospitalization days, and mRS at discharge.

Postoperative delirium was diagnosed based on the presence of acute change in mental status and abnormal behavior such as agitation, irritability, hallucinations, and signs of overactivity in the autonomic nervous system.[11,16] We checked the record, mainly written by nurse, and the estimate those above findings in the database.

Functional outcome was evaluated by comparing the mRS at discharge and the pre-hospital mRS before onset of CSDH. The pre-hospital mRS was judged by the interview from patients' family or carer. The discharge to home or transportation to rehabilitation hospital was decided depend on patients and their family hopes, and the transportation to rehabilitation hospital was decided even if patients had recovered to pre-hospital ADL. Good outcome was defined as improved or unchanged mRS, and poor outcome as worsened mRS. Recurrence rate, days of postoperative hospitalization, and postoperative delirium were also evaluated. Recurrence was defined as radiologically confirmed symptomatic recurrence requiring operation within 90 days of initial admission.

Table 1 Baseline characteristics (N = 108)

Characteristics	Value
Age, median (range), years	75 (42-95)
Female sex, no. (%)	31 (29%)
Pre-hospital mRS, no. (%)	
0-1	82 (76%)
2-4	26 (24%)
Past history of dementia, no. (%)	16 (15%)
Consciousness disturbance, no. (%)	63 (58%)
Hematoma location, right:left:bilateral, no.	47:49:12
Drainage vs drainage with irrigation, no. (%)	56 (52%) vs 52 (48%)
In-hospital stay, median (range), days	12 (2-39)
Recurrence, no. (%)	12 (11%)
mRS at discharge, no. (%)	
0-1	77 (71%)
2-4	31 (29%)

mRS: modified Rankin Scale.

Univariate analysis used various tests, dependent on the type of data. The Mann-Whitney U test was used to compare groups and the chi-square test to compare categorical variables. Multivariate logistic regression-model analysis was used to investigate functional outcome and postoperative delirium. Multivariate analysis included the variables that were judged as statistically and clinically important. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for all variables in the logistic regression models to assess the effect of independent variables. The threshold for significance was $P < 0.05$, and all statistical analyses used EZR software.[17]

Results

Twenty-six (24%) of the 108 patients were disabled (mRS 2-4) on admission (Table 1). Sixteen patients (15%) had a history of dementia. Preoperative consciousness disturbance was caused by CSDH in 63 patients (58%). Burr hole drainage was performed in 56 patients, and burr hole drainage with irrigation in 52 patients. The hematoma was located in the right hemisphere in 47 patients, left hemisphere in 49, and bilaterally in 12. Median in-hospital stay was 12.0 (range 2-39) days. Slight to severe disability (mRS 2-4) was found at discharge in 31 patients (29%).

Postoperative delirium

Nineteen (18%) of the 108 patients suffered postopera-

Table 2 Summary of uni- and multivariate logistic regression analysis of potential risk factors associated with postoperative delirium

Variables	Univariate *P* value	Multivariate	
		OR (95% CI)	*P* value
Higher age	0.029	1.08 (0.99-1.16)	0.086
Male sex	0.053	30.40 (2.42-317)	0.007
Pre-hospital mRS	0.29	1.30 (0.67-2.51)	0.44
Past history of dementia	0.008	10.60 (1.06-107)	0.045
Consciousness disturbance	0.002	3.31 (0.61-18)	0.16
Drainage with irrigation	0.002	4.83 (1.09-21.7)	0.038
Right side hematoma	0.771	1.89 (0.28-12.5)	0.51

CI: confidence interval, OR: odds ratio, mRS: modified Rankin Scale.

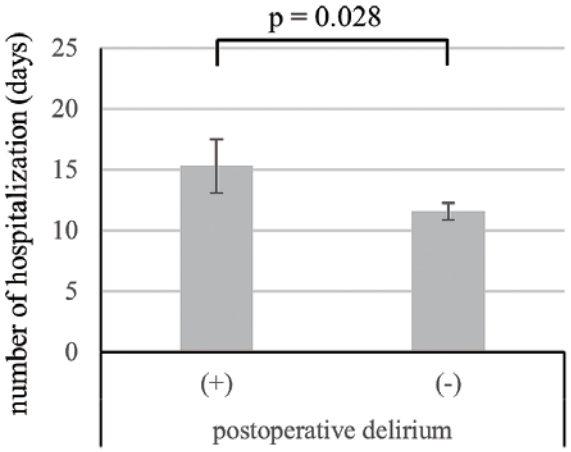

Fig. 1 Comparison of postoperative delirium and days of postoperative hospitalization. Delirium (+) group had significantly longer stay (15.6 days vs 11.6 days, *P* = 0.028).

tive delirium. The relationships between postoperative delirium and age, sex, pre-hospital mRS before onset of CSDH, history of dementia, site of hematoma, operative procedure, and preoperative consciousness disturbance caused by CSDH are shown in Table 2. Univariate regression analysis showed higher age, history of dementia, consciousness disturbance, and drainage with irrigation were associated with higher incidence of postoperative delirium. The proportion of patients with poor outcome at discharge was significantly higher in patients with postoperative delirium (47%) than patients without postoperative delirium (22%) ($P = 0.016$). The duration of in-hospital stay was significantly longer in patients with postoperative delirium (15.6 days) than in patients without postoperative delirium (11.6 days) ($P = 0.028$) (Fig. 1). Multiple regression analysis showed that male sex (OR = 30.4; 95% CI = 2.42-317; $P = 0.007$), history of dementia (OR = 10.6; 95% CI = 1.06-107; $P = 0.045$), and drainage with irrigation (OR = 4.83; 95% CI = 1.09-21.7; $P = 0.038$) were significantly related to postoperative delirium (Table 2).

Functional outcome at discharge

Twenty-nine (27%) of the 108 patients had worsened mRS at discharge, most with mobility disturbance or deteriorated cognitive function, and needed to be transferred for rehabilitation. Univariate analysis showed higher age, pre-hospital mRS before onset of CSDH, history of dementia, postoperative delirium, and preoperative consciousness disturbance caused by CSDH were associated with poor functional outcome (Table 3). Multivariate analysis found higher age (OR = 5.13; 95% CI = 1.0-1.14; $P = 0.046$), poor pre-hospital mRS (OR = 1.57; 95% CI = 1.0-2.46; $P = 0.049$), and consciousness disturbance (OR = 5.13; 95% CI = 1.27-20; $P = 0.021$) were significant predictors of poor functional outcome. Postoperative delirium and operative procedure showed no significant difference in functional outcome ($P = 0.93$ and $P = 0.97$, respectively). The proportion of patients with poor functional outcome at discharge was significantly higher in patients with pre-hospital mRS 2 and 3 (69% and 58%, respectively) ($P \leq 0.001$) (Fig. 2). Operative procedure was not significantly related to functional outcome or recurrence rate ($P = 0.76$) (Fig. 3).

Discussion

This study evaluated functional outcome after surgical treatment for CSDH, especially in terms of operative procedure and postoperative delirium. Our results showed that higher age, pre-hospital mRS 2 and 3 before onset of CSDH, and preoperative consciousness disturbance caused by CSDH were associated with poor functional outcome at discharge. Neither operative procedure nor postoperative delirium were associated with poor outcome at discharge, but irrigation was significantly likely to result in delirium. Patients with postoperative delirium had longer hospital stays than patients without delirium.

A previous study found that surgery can clearly improve the symptoms, but approximately one third of CSDH patients have persistent neuropsychiatric conditions and worse activities of daily living (ADL).[18] The indicators of

Table 3 Summary of uni- and multivariate logistic regression analysis of potential risk factors associated with functional outcome

Variables	Univariate *P* value	Multivariate	
		OR (95% CI)	*P* Value
Higher age	<0.001	5.128 (1.0-1.14)	0.046
Male sex	0.15	1.03 (0.291-3.64)	0.97
Pre-hospital mRS	<0.001	1.57 (1.0-2.46)	0.049
Past history of dementia	0.026	1.28 (0.284-5.78)	0.75
Postoperative delirium	0.016	1.07 (0.275-4.42)	0.93
Consciousness disturbance	<0.001	5.128 (1.27-20)	0.021
Drainage with irrigation	0.31	1.02 (0.341-3.04)	0.97

CI: confidence interval, OR: odds ratio, mRS: modified Rankin Scale.

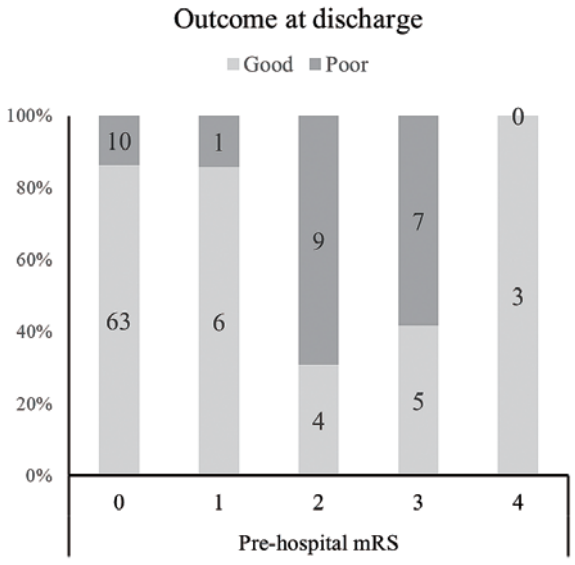

Fig. 2 Poor outcome at discharge by pre-hospital mRS score before onset of CSDH. High ratio of poor outcome was observed in patients with mRS 2 (69%) and 3 (58%). Good outcome = mRS score at discharge was improved or unchanged compared to pre-hospital mRS score before onset of CSDH; poor outcome = mRS score at discharge was worse.

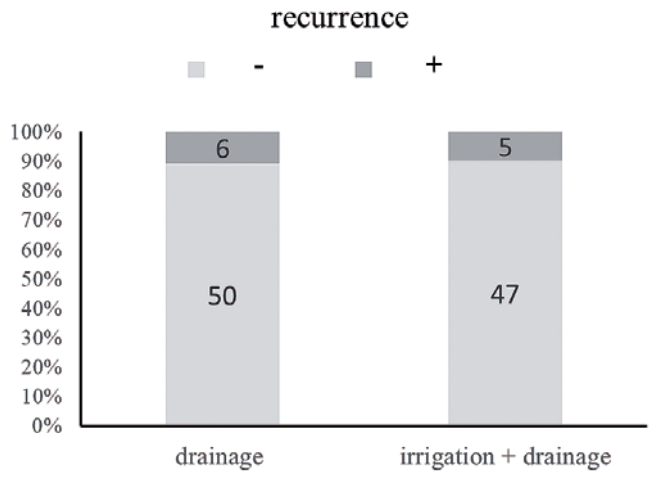

Fig. 3 Comparison of operative procedures and recurrence rate. Recurrence rate after drainage without irrigation was 11%, and after drainage with irrigation was 10%, with no significant difference (*P* = 0.76).

poor recovery are severe preoperative neurological disturbances, higher age, longer period from head injury to operation, and poor preoperative ADL.[5,6,9,19] These previous findings are consistent with our present results. Therefore, perioperative management is important to consider for older patients with multiple comorbidities.[20] Especially, patients whose mRS 2 and 3 were high risk patients who would be worsened their ADL after surgery.

Operative procedure and postoperative delirium

Meta-analysis of randomized control studies showed no significant difference in recurrence between drainage and drainage with irrigation.[2] Irrigation is frequently performed to evacuate the hematoma fluid and to ensure removal of vasoactive cytokines, inflammatory mediators, and fibrinolytic factors.[21,22] On the other hand, irrigation may cause rapid decompression of CSDH,[22] which can result in abrupt change in intracranial pressure, followed by transient hyperemia in the cerebral cortex beneath the hematoma.[12,13,23,24] Elderly patients are more likely to suffer hyperemia or hyperperfusion, and patients with hyperperfusion can develop acute agitated delirium.[12] The postoperative hyperperfusion could result the fatal intracerebral hemorrhage.[13] Drainage without irrigation has the advantage of gentle change in intracranial pressure during and after the procedure, and so is considered to reduce the risk of hyperperfusion.

The present study showed that the operative procedure was not correlated with the recurrence rate. However, drainage with irrigation was significantly correlated with postoperative delirium, and such delirium caused longer hospital stay. Consequently, drainage without irrigation is

appropriate for avoiding delirium in patients with previously reported high risks for delirium such as higher age and dementia. The populations of aged and poor ADL patients, who are at risk of poor outcome after treatment for CSDH, are increasing worldwide, so the best treatment for those patients must be considered.

Although the male sex was one of the risk factors for postoperative delirium in multivariate analysis, there were no previous reports that the sex itself was the risk factor. Previous stroke history or alcohol drink was the risk of the delirium.[11] Because these factors are obviously related with male sex, it might be confounding that male sex correlated with the postoperative delirium in present study.

Our retrospective study has several limitations. First, no randomization of operative procedure was performed, which may confound our results. The operative procedure was decided by each surgeon, which should be considered that the patients' clinical status, the imaging findings, or medications. Second, outcome was assessed at discharge and the duration of in-hospital stay ranged widely from 2 to 39 days (median 12 days). Patients with poor outcome tended to stay longer because many required postoperative rehabilitation. Some patients with longer hospitalization had recovered to the level of pre-hospital ADL, but most had not recovered. Third, we assessed the database analysis in present study, so some parameters; i.e., preoperative medication or imaging findings, could not be assessed adequately. Forth, the event number of present study was smaller rather than adequate multivariate analysis. Therefore, large number randomized controlled trials are required for further investigations.

Conclusions

mRS 2 and 3, and consciousness disturbance are risk factors for poor recovery after CSDH. Drainage with irrigation is a risk factor for postoperative delirium and longer hospital stay. Drainage without irrigation for CSDH may be the optimum treatment for high risk patients with delirium.

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Conflicts of Interest Disclosure

None.

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