〈Regular Article〉

The role of surgical evacuation for spontaneous supratentorial intracerebral hemorrhage

Miki TANIGUCHI, Yumi KIMURA, Toshinari MEGURO
Toru FUKUHARA, Shigeki ONO

Department of Neurosurgery 2, Kawasaki Medical School General Medical Center, Kawasaki Medical School

ABSTRACT　**Background**: The role of surgical evacuation for spontaneous intracerebral hemorrhage (ICH) has been only poorly established. As previous reports have frequently concluded unremarkable benefits for functional recovery following ICH surgery, many neurosurgeons show low enthusiasm for surgical options. Another important axis of post-surgical recovery, consciousness, should also be considered; however, the analysis of consciousness recovery has rarely been reported, possibly due to the lack of an adequate consciousness scale for the recovery phase. In order to allow careful assessment of the consciousness recovery, we conducted the following study to clarify the effects of surgical ICH evacuation.

Methods: This retrospective study included consecutive adult patients with spontaneous supratentorial ICH admitted to our hospital between 2016 and 2023. Among the 543 patients with spontaneous ICH, the surgical treatment option was offered only to patients with severe consciousness disturbance due to supratentorial ICH, ICH with a volume > 30 ml, located less than 1 cm beneath the cortex, and no involvement of the brain stem. Thus, 41 patients whose families wished to proceed with surgery, were included in the surgically treated group and 37 patients whose families refused surgery regardless of indication, were included in the medically treated group. Statistically analyzed variables possibly affecting the 90-day mortality (primary outcome), or functional recovery and consciousness recovery (secondary outcome), were extracted as follows: (a) pre-admission variables [age, sex, body mass index (BMI), current oral antiplatelet and/or anticoagulant medication, and receiving regular dialysis] and (b) clinical variables obtained upon deciding whether to undergo ICH evacuation surgery [pupil abnormality, three subset scores of the Glasgow Coma Scale (GCS), the side of ICH, compressed brain stem by ICH, ICH volume, and whether surgically treated or not].

Results: Significant differences were observed between the surgically and medically treated groups. In the surgically treated group, the patients were significantly younger, BMI was a

Corresponding author
Miki Taniguchi
Department of Neurosurgery 2, Kawasaki Medical School General Medical Center, Kawasaki Medical School, 2-6-1 Nakasange, Kita-ku, Okayama, 700-8505, Japan

Phone : 81 86 225 2111
Fax : 81 86 232 8343
E-mail: taniguchi828miki@yahoo.co.jp

significantly higher BMI, and the hematoma tended to be right-sided. As for the 90-day mortality, two of the 41 patients died in the surgically treated group, while 20 of the 37 patients died in the medically treated group, which was significantly worse in the log-rank test. In multivariate Cox regression analysis, four variables were found to protect against mortality: female sex, better eye component of the GCS at decision-making, lower ICH volume, and surgical treatment. As for functional outcomes, younger age, better verbal component of the GCS and lower ICH volume led to better function. With regards to consciousness recovery, younger age, better motor component of the GCS and surgical treatment led to better outcomes.

Conclusions: This is the first study to report the role of ICH evacuation surgery in improving consciousness and reducing mortality. Neurosurgeons should pay careful attention to postoperative consciousness recovery, which is an important justification for recommending surgical management, even if functional recovery seems improbable.

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Key words：Consciousness Recovery, Intracerebral hemorrhage, Modified Rankin Scale

INTRODUCTION

How significant recovery can be achieved by surgical evacuation of intracerebral hemorrhage (ICH) is of key interest to neurosurgeons when deciding the operative indication. Life extension may not be the only priority in current society[1], and previous reports have focused predominantly on the functional activities of daily living (ADL) after ICH evacuation surgery[2-5]. Indeed, most related reports have concluded that surgery for ICH is less recommended owing to poor functional recovery.

Functional recovery is an important goal for neurosurgeons; however, a considerable number of family members of patients with ICH desire survival, even without the expectation of functional recovery. For these patients, consciousness recovery and further cognitive improvements are of key importance. Nevertheless, few studies have focused on consciousness recovery as an outcome after ICH[1, 6, 7]. We considered the lack of an adequate rank scale for consciousness in the chronic stage as one of the reasons for this.

The "Coma Recovery Scale-Revised" (CRS-R) has been widely used to evaluate consciousness recovery in the chronic stage after neurological insults, including cerebral stroke[8]. This scale is composed of six subsets; each subset has four to seven ranks describing the improvement steps. This scale is specifically designed to assess consciousness, but is relatively complicated and time-consuming; thus, it is not practical for use in the quick assessment of patient recovery[9]. With reference to this scale, we have recently invented the simplified consciousness rank scale, named "Kawasaki Consciousness Recovery Scale (K-CRS)"[10]. The medical staffs are able to rank the patient's consciousness level from "Coma" (rank 1) to "Conscious state"(rank 6). Adopting this rank scale for consciousness recovery, in addition to the modified Rankin Scale (mRS), which is the most conventional rank scale to assess functional recovery, this retrospective study aimed to investigate the role of surgical ICH evacuation on both consciousness and functional recovery.

SUBJECTS AND METHODS

Study Population

After obtaining approval from the Institutional Review Board of Kawasaki Medical School on March 9, 2024 (approval number: 6337-00), the medical records of patients admitted to our hospital for non-traumatic spontaneous ICH between

July 2016 and June 2023 were retrospectively reviewed. Any identifiable information of the patients, including name, address, and telephone number, were not extracted for the study, in order to anonymize the data prior to analysis. During these 7 years, 543 patients were admitted to our hospital because of spontaneous ICH without any known organic etiologies, such as rupture of intracerebral aneurysms, arteriovenous malformations, or brain tumors.

Decompressive ICH evacuation surgery was considered in cases of severe consciousness disturbance and operable hematoma. Severe consciousness disturbance was defined as either a subset of the Glasgow Coma Scale (GCS) score at 1-2 on the verbal or eye-opening response upon admission, or deterioration within 24 h after admission. The operable hematoma was located less than 1 cm beneath the cortex, including the insular cortex; more than 30 ml hematoma volume (XxYxZ/2 method, using length, width, and height of hematoma) for supratentorial ICH was considered for evacuation. A hematoma extending from the subcortex or putamen to the thalamus was considered operable; however, a hematoma extending massively to the brainstem was considered inoperable. Since this study aimed to highlight the effect of ICH evacuation surgery on function and consciousness outcomes, infratentorial ICH evacuation was excluded to avoid the heterogeneous effects of hematoma location.

In total, 98 patients were selected as candidates for supratentorial ICH evacuation surgery. Among them, any surgical option was not offered to 10 patients owing to the high risk of major surgery; these were as follows: unstable vitals (three patients), acute respiratory distress syndrome (two patients), severe diabetes mellitus with HgbA1c > 10% (three patients), and decreased platelet counts of less than 80,000/μl. After these exclusions, ICH evacuation surgery was considered to be performed in 88 patients. Six of these patients were subsequently excluded because of low pre-onset ADL (mRS score > 2). In one patient also excluded from the study, bilateral intraventricular cerebrospinal fluid drainage was performed under local anesthesia based on the family members' desire. Among the remaining 81 patients, 43 underwent ICH evacuation surgery; however, operative consent could not be obtained from the families of 38 patients who were managed conservatively without ICH evacuation surgery. At the 90-day follow-up, sufficient detailed data to judge the K-CRS rank could not be obtained from two patients treated with surgery and one patient treated without surgery; all of whom were transferred to nursing facilities at that time. Thus, a total of 41 patients were included in the surgically treated group, while 37 patients were included in the medically treated group.

Surgical Procedure

The purpose of ICH evacuation surgery is to release intact brain tissue from further compression by ICH in order to reduce intracranial pressure and save lives. Among the 41 patients enrolled in the surgically treated group, 36 underwent open craniotomy under general anesthesia. In 29 patients, a question-mark incision of approximately 4-6 cm by 6-8 cm in the frontotemporoparietal region, starting from 2 cm anterior to the tragus, was made behind the hairline; for the remaining 7 patients, a 6 cm linear incision was made for smaller circular craniotomy, per the surgeon's preferences. Successively to craniotomy and opening dura matter, transcortical approach was performed, except in 3 patients who underwent the trans-sylvian trans-insular approach for putaminal hemorrhage. The site of cortical incision was individualized based on the ICH location. After corticotomy of 10-15 mm, a brain spatula was used to explore the hematoma cavity; once it reached the hematoma cavity, the ICH was removed carefully with a microscope. At the completion of the ICH evacuation, complete hemostasis and a well-decompressed brain were confirmed. Because further brain edema was anticipated with possible preexisting brain herniation, decompressive craniectomy was additionally performed in 13 patients.

For 5 patients in the surgically treated group, neuroendoscopic ICH removal was performed when a neuroendoscopy specialist (S.O.) was available. This surgery was performed under local anesthesia, except in two patients who underwent general anesthesia for endotracheal intubation, which was preferred due to severe consciousness disturbances. During this procedure, a 4 cm linear skin incision was made and an endoscopic sheath was inserted via a burr hole. ICH evacuation was performed gently by inspecting all angles of the hematoma cavity. When a bleeding point was encountered during endoscopic hematoma removal, monopolar coagulation was performed for hemostasis. Evacuation was completed when sufficient shrinkage of the hematoma cavity was observed.

Consciousness Evaluation

Consciousness recovery during hospitalization was assessed using our proposed scale, the K-CRS[10]. This scale consists of six ranks in the sequential order: 1: "Coma", 2: "Vegetative state (VS)", 3: "Minimally conscious state (MCS), lower level", 4: "MCS, higher level", 5: "Emergence from MCS", and 6: "Conscious state"; those ranks were basically determined by the combination of six CRS-R subsets. In the K-CRS, "Coma" and "Conscious state", both of which are not mentioned in the CRS-R, are defined[10].

Evaluated Variables

The primary outcome of this study was in-hospital mortality within 90 days (90-day mortality), while the secondary outcome was recovery status after ICH. The recovery status was ranked with the mRS for function and with the K-CRS for consciousness. The recovery statuses were determined 90 days following ICH onset. If the patients had already been discharged to a rehabilitation facility, their medical records were reviewed by one of the authors; the ranks were then scored retrospectively.

Variables possibly affecting primary and secondary outcomes were extracted from the medical records as follows: (a) pre-admission variables [age at admission, sex, body mass index (BMI), current oral antiplatelet and/or anticoagulant medication, and receiving regular dialysis] and (b) clinical variables obtained upon deciding whether to undergo ICH evacuation surgery, since the clinical variables tend to worsen over time [pupil abnormality, three subset scores of the GCS, namely eye component of the GCS (GCS-E), verbal component of the GCS (GCS-V), and motor component of the GCS (GCS-M), the side of ICH, compressed brain stem by ICH, and ICH volume calculated using the XxYxZ/2 technique]. Whether these variables affected the outcomes, including surgical treatment, was statistically analyzed, as described below.

Statistical Analysis

The clinical characteristics of the surgically and medically treated groups were compared. For numerical variables, including age, BMI, and ICH volume, the unpaired Student's t-test was used for comparison. For ordinal variables, including the three GCS subsets, the non-parametric Mann-Whitney U test was used. For other categorical variables, the frequencies in each group were compared using the 2 × 2 Chi-square test.

The difference in the primary outcome (90-day mortality) between the two groups was analyzed using the univariate log-rank test. Subsequently, the effects of all variables on the primary outcome were examined multivariately using the Cox proportional hazards regression model (forced entry method) to estimate the hazard ratio for 90-day mortality.

For the secondary outcome, the effects of all variables were initially examined separately. For numerical and ordinal variables, the correlation between the mRS (0 to 5) and the K-CRS (1 to 6) ranks was examined using the univariate non-parametric Spearman's rank correlation coefficient test. For categorical variables, the non-parametric Mann-Whitney U test was applied to compare the differences in these ranks. Significant variables in the univariate analyses were further examined multivariately using a multiple linear regression model (forced entry method). In the analyses of secondary outcomes, patients who died within 90 days were excluded, although dead patients could be ranked as 6 in the mRS.

Results were considered statistically significant at $P < 0.05$, wherein all P-values were two-sided. All statistical analyses were performed using IBM SPSS Statistics software (version 28.0.1.0).

RESULTS

Clinical Characteristics Comparison

Table 1 shows a comparison of the clinical characteristics between the surgically (41 patients) and the medically (37 patients) treated groups. In the surgically treated group, the patients were significantly younger (surgically treated group: 65.0 ± 13.9 years; medically treated group: 78.6 ± 12.0 years, $P < 0.001$ using the unpaired Student's t-test), and BMI was significantly higher (surgically treated group: 22.6 ± 4.2; medically treated group: 20.5 ± 3.7, $P = 0.015$ using the unpaired Student's t-test). In the surgically treated group, the hematoma tended to be right-sided (right: 26, left: 15) whereas in the medically treated group, it tended to be more left-sided (right: 14, left: 23). This distribution was significantly different ($P = 0.041$ using the 2 × 2 Chi-square test).

Table 1. Comparison of clinical characteristics between the groups.

Variables		Surgically treated (41 patients)	Medically treated (37 patients)	p value
Age (years)		65.0 ± 13.9	78.6 ± 12.0	* < 0.001
Sex (M:F)		26 : 15	17 : 20	** NS
BMI		22.6 ± 4.2	20.5 ± 3.7	*0.015
Anti-platelet / coag. med.		11	12	** NS
Dialysis		3	3	** NS
Pupil abnormalities		21	1	** NS
GCS-E	1	2	20	*** NS
	2	14	14	
	3	4	2	
	4	0	1	
GCS-V	1	29	29	*** NS
	2	4	7	
	3	2	1	
	4	5	0	
	5	1	0	
GCS-M	1	9	1	*** NS
	2	1	9	
	3	7	2	
	4	10	14	
	5	10	11	
	6	4	0	
ICH side (R:L)		26 : 15	14 : 23	**0.041
ICH volume (ml)		178 ± 89.3	180.8 ± 97.5	* NS
Compressed brain stem		25	20	** NS

* analyzed using the unpaired Student's t-test; ** analyzed using the 2 × 2 Chi-square test;
*** analyzed using the Mann-Whitney U test.

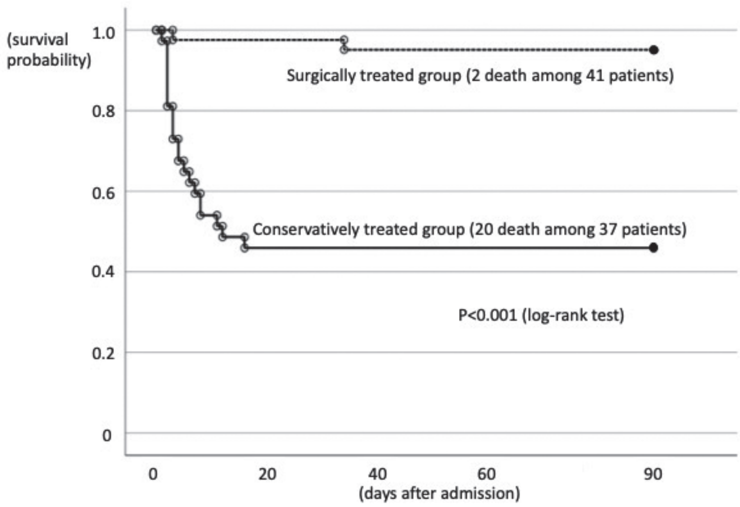

Fig. 1. Kaplan-Meier plots of patients with supratentorial ICH, indicating 90-day mortality (primary outcome). Significant difference is observed between groups (P < 0.001 using the log-rank test).

Primary Outcome (90-day mortality)

Fig. 1 shows the difference in the 90-day mortality between the two groups. Two of the 41 while 20 of the 37 patients in the surgically and medically treated groups, respectively, died, yielding a significant difference (P < 0.001 using the log-rank test). In the multivariate Cox regression analysis, all evaluated variables were included; thus, four variables were found to protect against mortality, as follows: surgical treatment (Exp (B) 105.7, P < 0.001), female sex (Exp (B) 0.024, P < 0.001), better GCS-E at making decisions (Exp (B) 0.096, P = 0.025), and lower ICH volume (Exp (B)1.02, P = 0.022).

Secondary Outcome (functional and consciousness recovery)

Regarding the functional outcome assigned to the mRS, 35 of the 56 patients (62.5%) were ranked as 5 (severe disability), 16 (28.6%) as 4 (moderately severe disability), three (5.4%) as 3 (moderate disability), and only two (3.6%) as 2 (slight disability). None of the patients improved to rank 0 or 1 at 90 days after admission. In the univariate analyses of numerical/ordinal variables using the Spearman's rank correlation coefficient test, younger age (Rs = 0.53, P < 0.001), better GCS-V at making decisions (Rs = -0.32, P = 0.018), and lower ICH volume (Rs = 0.37, P = 0.005) led to better functional outcomes. Table 2 shows the distribution of the mRS ranks, compared for each categorical variable using the Mann-Whitney U test, for which no significant differences were observed. Then, three significant variables in univariate analyses, namely age, GCS-V, and ICH volume, were examined multivariately, using a multiple linear regression model (the forced entry method), and all variables were found to be significant (age; beta = 0.453, P < 0.001, GCS-V; beta = -0.359, P = 0.002, ICH volume; beta = 0.247, P = 0.026).

Regarding consciousness recovery, 10 of 56 patients (17.9%) remained in rank 2 (VS), 14 (25.0%) in rank 3 (MCS, lower level), nine (16.1%) in rank 4 (MCS, higher level), 11 (19.6%) in rank 5 (Emergent from MCS), and 12 (21.4%) improved to rank 6 (Conscious state). None of

Table 2. Distribution of the mRS ranks by categorical variables (univariate analyses).

Variables		mRS Number of patients #Rank				* p value
		2	3	4	5	
Total (56 survived patients)		2	3	16	35	
Group	Surgically (39)	2	3	12	22	NS
	Medically (17)	0	0	4	13	
Sex	Male (28)	1	3	8	16	NS
	Female (28)	1	0	8	19	
Anti-platelet / coag. med.	Yes (16)	0	1	3	12	NS
	No (40)	2	2	13	23	
Dialysis	Yes (3)	0	0	0	3	NS
	No (53)	2	3	16	32	
Pupil Abnormality	Yes (21)	0	1	5	15	NS
	No (35)	2	2	11	20	
ICH side	R (32)	1	2	11	18	NS
	L (24)	1	1	5	17	
Compressed brain stem	Yes (27)	0	1	7	19	NS
	No (29)	2	2	9	16	

* analyzed using the Mann-Whitney U test.
#No patients returned to ranks 0 or 1 on the mRS.

Table 3. Distribution of the K-CRS ranks by categorical variables (univariate analyses).

Variables		K-CRS Number of patients #Rank					* p value
		2	3	4	5	6	
Total (56 survived patients)		10	14	9	11	12	
Group	Surgically (39)	6	9	4	8	12	0.04
	Medically (17)	4	5	5	3	0	
Sex	Male (28)	3	9	4	6	6	NS
	Female (28)	7	5	5	5	6	
Anti-platelet /coag. med.	Yes (16)	4	6	3	2	1	0.035
	No (40)	6	8	6	9	11	
Dialysis	Yes (3)	0	2	0	1	0	NS
	No (53)	10	12	9	10	12	
Pupil Abnormality	Yes (21)	4	8	2	3	4	NS
	No (35)	6	6	7	8	8	
ICH side	R (32)	6	7	4	7	8	NS
	L (24)	4	7	5	4	4	
Compressed brain stem	Yes (27)	7	8	2	5	5	NS
	No (29)	3	6	7	6	7	

* analyzed using the Mann-Whitney U test.
# No patients were ranked 1 on the K-CRS.

the patients remained in rank 1 (Coma). In the univariate analyses for numerical/ordinal variables, younger age ($Rs = -0.51$, $P < 0.001$) and better GCS-M at making decisions ($Rs = 0.27$, $P = 0.044$) were associated with better consciousness recovery. Table 3 presents the distribution of the K-CRS ranks for each categorical variable. In the univariate analyses, surgical treatment ($z = -2.06$, $P = 0.04$), and no current oral antiplatelet and/or anticoagulant medication ($z = -2.10$, $P = 0.035$) led to a better consciousness outcome. These four significant variables were subsequently examined multivariately, using a multiple linear regression model (the forced entry method); three variables (younger age, better GCS-M at admission and surgically-treated) were found to be significant (age;

beta = -0.474, P < 0.001, GCS-M; beta = 0.414, P < 0.001, surgically-treated; beta = -0.246, P = 0.035).

DISCUSSION

The role of surgery as a treatment option for ICH has been debated as the functional recovery achieved by surgery is considered to be marginal. According to the Japan Stroke Guidelines 2021 (revised in 2023)[11], surgery should not be considered in patients with minor hemorrhage (volume < 10 ml) or with mild neurological symptoms. Although the guidelines indicate several conditions in which open surgery is allowed as a treatment option, no conditions have been described as recommended for surgery. Brain tissue damage during the accessing and removal of ICH during open craniotomy should be considered as a possible factor related to the deterioration of patient functional outcome[12]; thus, the primary purpose of ICH evacuation surgery is to save lives. Recently, it has been argued that less-invasive surgeries, including neuroendoscopic ICH removal[13] or the cortical sulcus approach[14], can achieved better outcomes by reducing intact brain tissue damage. In our surgical series of ICH evacuations, neuroendoscopic surgeries were performed on only limited occasions, and the number of endoscopic surgeries was not sufficient for statistical analysis of postoperative outcomes. After the further accumulation of neuroendoscopic procedures, we will aim to perform a study to evaluate the benefits of these outcomes.

This study confirmed several protective variables against mortality, functional disability, and consciousness disturbance at 90 days after ICH onset. Undergoing ICH evacuation surgery, female sex, better GCS-E at making decisions, and smaller ICH (> 30 ml in volume) may reduce mortality. Functional recovery may be better if the patient is younger, the GCS-V is better, and the ICH is smaller. With regards to consciousness disturbances, younger age, better GCV-M, and ICH evacuation surgery resulted in a higher chance of recovery. To summarize the surgical role of each outcome, which is the primary concern of this study, ICH evacuation surgery helps reduce mortality but does not improve function. Interestingly, our study showed that surgery helped improve consciousness. To the best of our knowledge, this is the first study to demonstrate the beneficial role of ICH evacuation surgery for consciousness recovery.

Spontaneous ICH has been reported to result in 25-48% early case fatality[15]. Although ICH evacuation surgery significantly improved the 90-day mortality in our study, the surgical impact on mortality differed among several previous reports. Probably, one reason why such inconsistent results occur may be from the different evaluation timing. Abulhasan *et al.*[4] showed that emergent surgical evacuation of ICH reduced the 30-day mortality by 71%, whereas Mendelow *et al.*[2] reported no significant difference in 6-month mortality regardless of ICH evacuation surgery. The outcome setting of this study was the 90-day after admission. With a longer follow-up period, the surgical benefit on mortality may become unclear, even in our patient cohort. Another factor affecting the high mortality rate in the medically treated group in our study could be the withdrawal of life-sustaining treatment, which could mediate mortality among patients with ICH[16]. In our department, early withdrawal from the respirator or abandonment of medical treatment was not intended, even after the refusal of surgery; however, the negative decision against aggressive treatment, as chosen by the family members, may possibly deter the regular daily treatment of the physician away from the life-sustaining direction.

Functional recovery has been uniformly reported to be poor even after ICH evacuation surgery[2, 4, 15, 17]; hence, surgical options against ICH have not been widely encouraged. Our current study also confirms the miserable functional recovery of only 12.8% (five of 39 patients) in ranks 2 or 3 on the mRS, even with aggressive ICH evacuation. Younger age, better GCS-V and a lower ICH volume promoted functional recovery, but ICH evacuation surgery did not. This result suggests that the functional outcome is almost fixed by the condition at admission, and that any treatment option will not improve patient function.

It should be noted that, even without functional recovery, we often encounter patients whose cognition improves considerably. Patients' families frequently hope for survival if the patient recovers cognitive function. Therefore, in addition to the functional analysis of patients with ICH, cognition is another important recovery axis to be evaluated; although, the study of cognition after ICH is believed to be less frequent[18]. Kazim *et al.*[19] extensively reviewed 18 studies reporting cognition after ICH and identified heterogeneous tools for its analysis. Compared with the functional outcome analyses, in which the mRS[3, 4, 5] or Glasgow Outcome Scale[2, 20] seem to be utilized as standardized rank scales, the rank scales on cognition seem to vary. As for studies dealing with the surgical role of ICH on cognitive outcome, we identified only two reports; both of which found no improvement in cognition after ICH surgery[21, 22]. We presume that longer periods after the ICH onset are necessary to regain meaningful cognitive ability, which is feasible for objective cognitive evaluation.

In this study, we analyzed consciousness outcomes because consciousness recovery is an indispensable prerequisite for proper cognitive evaluation. To address the early recovery stage of cognitive function, consciousness should also be evaluated; however, reports on consciousness outcomes after ICH are limited. Fukuhara *et al.*[1] previously analyzed consciousness outcomes in three rankings: VS, MCS, and emergent from MCS. Yang *et al.*[6] defined the recovery of consciousness as a GCS-M score of 6. Gomez *et al.*[7] ranked consciousness into four rankings; comatose, VS, MCS, and command-following. In this study, we first utilized our proposed consciousness ranking scale, the K-CRS, to focus on recovery after ICH evacuation surgery. Importantly, this study revealed that surgery improves the consciousness of patients with ICH, in addition to younger age and better GCS-M scores. In the surgically treated group, 12 patients (30.8%) recovered to rank 6; "Conscious state"; although, none of the patients in the medically treated group achieved rank 6. It is believed that among the patients who recovered to MCS (rank 3 or 4), a significant number continued to improve up to 12 months after onset[23, 24]. Therefore, more patients could benefit from ICH evacuation surgery in terms of consciousness over a longer follow-up period. Indeed, we should note that "conscious state" does not necessarily mean "fully orientated"; however, even if some disturbances in the cognition persist, appropriate responses to the family, even only in basic conversation, may satisfy them. Such lives, even when functionally disabled, should be recognized as meaningful, especially if family members hope for recovery.

The current study had several limitations. Initially, this study was to be conducted as a case-control (surgically versus medically treated) study; our major concern was the role of surgery. However, there were significant differences in age, BMI, and the side of ICH between the surgically and medically treated groups. Since refusal to undergo surgery tends to increase with age, patients in the medically treated group were significantly older. It has been reported that the BMI is generally lower among elderly patients[25]. As for more left-sided ICH in the medically treated group, this difference may have resulted from the prognostic explanation at admission. We often mention the negative influence of left-sided ICH on cognitive prognosis due to language area involvement. Thus, more family members may refuse surgery if the ICH is left-sided. Although these deviations between the case and control groups may have occurred in the retrospective analysis, we need to be cautious when comparing the two groups. To avoid the effects of these deviations between groups, we performed a multivariate analysis on all patients as one group. However, among all the analyzed 78 patients, 17 were over 85 years of age, and only three family members wished to proceed with the surgery. Considering this small number of patients, the efficacy of ICH evacuation surgery on consciousness recovery is not conclusive for the very elderly in the current study. Since the randomization of very elderly patients for ICH evacuation surgery is not realistic, successive data accumulation with careful consciousness evaluation is required for further analysis when very elderly patients are hospitalized for ICH evaluation.

CONCLUSIONS

To our knowledge, this is the first study to demonstrate the importance of ICH evacuation surgery in improving patient consciousness. Thus, neurosurgeons should remind themselves firmly that even with poor functional outcomes, surgery should still be considered, since cognitive recovery may still be expected.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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