Impact of early mobilization on discharge disposition and functional status in patients with subarachnoid hemorrhage

A retrospective cohort study

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Abstract

Whereas early rehabilitation improves the patients' physical function in patients with cerebral infarction and hemorrhage, complications in the early stage are the main barriers in patients with subarachnoid hemorrhage (SAH). Therefore, the clinical impact of early rehabilitation in patients with SAH is not well documented. We sought to investigate whether early mobilization is associated with favorable discharge disposition and functional status in patients with SAH.

Hospitalization data of 35 patients (65.7 ± 13.7 years, 37.1% men) were retrospectively reviewed. The early and delayed mobilization groups were defined as those who had and had not participated in walking rehabilitation on day 14, respectively. We investigated whether patients were discharged or transferred to another hospital and assessed their functional status using the Functional Ambulation Categories, Ambulation Index, Glasgow Outcome Scale, and modified Rankin Scale scores.

Nine patients (69.2%) in the early mobilization group and one patient (4.5%) in the delayed mobilization group were discharged home directly ($P < .001$). In multivariate logistic regression analysis, early mobilization was independently associated with home discharge after adjustment using the World Federation of Neurosurgical Societies grade (adjusted odds ratio = 30.20, 95% CI = 2.77–329.00, $P < .01$). Early mobilization was associated with favorable functional status at discharge through multivariate linear regression analysis (standardized beta = 0.64 with $P < .001$ for the Functional Ambulation Category and beta = -0.62 with $P < .001$ for the modified Rankin Scale, respectively).

Early mobilization was associated with home discharge and favorable functional status at discharge. Larger prospective studies are warranted.

Abbreviations: AI = ambulation index, FAC = functional ambulation categories, GOS = Glasgow Outcome Scale, mRS = modified Rankin Scale, SAH = subarachnoid hemorrhage, WFNS = World Federation of Neurosurgical Societies.

Keywords: early ambulation, neurological rehabilitation, patient discharge, physical functional performance, stroke, stroke rehabilitation, subarachnoid hemorrhage (alphabetic order)

1. Introduction

Aneurysmal subarachnoid hemorrhage (SAH) is a life-threatening condition with an estimated mortality of approximately 35% to 50%.[1] Moreover, despite recent improvements in surgical and endovascular aneurysm repair, intensive care, and rehabilitation, survivors of SAH are faced with several complications.[2–4] More than half of them have functional disabilities at the time of discharge and are unable to return to premorbid living conditions.[5,6] Additionally, neurological impairment and activ-

ities of daily living affect their quality of life after hospital discharge.[7]

Early rehabilitation after the onset of neurological diseases, such as cerebral infarction, cerebral hemorrhage, and traumatic brain injury, can help improve physical function.[8–11] However, complications such as symptomatic cerebral vasospasm, rebleeding, or hydrocephalus can develop after SAH, and these complications are the main barriers to early rehabilitation.[3] Recently, the occurrence of complications and safety of rehabilitation during the early stage of SAH onset have been explored.[3,12] Karic et al reported that early rehabilitation from the first day after aneurysm repair did not increase complications such as cerebral vasospasm or hydrocephalus.[3] Olkowski et al reported that no complications or circulatory changes associated with early mobilization from the third day were observed.[12]

However, the relationship between early mobilization and outcomes in SAH remains unclear. To address the knowledge gap in the literature, we aimed to investigate the relationship between early mobilization and home discharge and functional status in patients with SAH.

2. Methods

We retrospectively reviewed hospitalization data of 35 consecutive patients with SAH who were admitted to Kyoto City Hospital and subsequently underwent rehabilitation from April 2013 to November 2015. Patients who died during hospitalization were excluded from the study: there were two patients during the study period who died after starting rehabilitation, in whom early mobilization could not be implemented due to unstable condition. The following parameters were extracted from the medical records: age, sex, severity at hospitalization (World Federation of Neurosurgical Societies [WFNS] grade, Hunt and Kosnik grade), Fisher grade, location of aneurysm, treatment (surgical clip ligation/endovascular coil embolization/preservation), days until rehabilitation, early or delayed mobilization, complications (symptomatic cerebral vasospasm/rebleeding/hydrocephalus), functional status at discharge (Functional Ambulation Categories [FAC], Ambulation Index [AI], Glasgow Outcome Scale [GOS], and modified Rankin Scale [mRS] scores), hospitalization period, and discharge disposition (home discharge or transferred to another hospital). The WFNS grade and Hunt and Kosnik grade are indicators of SAH severity incorporating neurological examination.[13,14] Early and delayed mobilizations were defined by the rehabilitation status on day 14 after admission, those who had (the early mobilization group) and had not (the delayed mobilization group) participated in walking rehabilitation, as the risk of symptomatic cerebral vasospasm was considered low enough after the 2-week period. FAC evaluates the walking abilities of patients and classifies them according to the level of human support required and walking quality. It comprises six steps ranging from 0 (nonfunctional ambulation) to 5 (independent).[15] AI classifies patients according to the walking time required to cover 25 ft (8 m), human support requirement, and walking aids; it comprises 10 steps ranging from 0 (asymptomatic, fully active) to 9 (restricted to a wheelchair, unable to transfer self independently).[16] GOS classifies patients according to the functional state of the patient and comprises five steps ranging from 1 (dead) to 5 (good recovery, able to return to work or school).[17] FAC, AI, GOS, and mRS scores were determined by the agreement of several physical/occupational therapists and a neurosurgeon. Rehabili-

tation was started immediately after hospitalization under the direction of a neurosurgeon. The permissible ambulation limit was determined by the neurosurgeon responsible for each patient. After the first walking rehabilitation, the patients were encouraged to stand and walk as much as possible, with the assistance of nurses or physical/occupational therapists. During this treatment, we carefully monitored the occurrence of any changes in consciousness and circulatory dynamics according to a published review.[18] According to this review, rehabilitation was not performed when new neurological symptom was present. There was no other contraindication to rehabilitation.

This study was conducted according to the principles of the World Medical Association and the Declaration of Helsinki and approved by the Kyoto City Hospital Clinical Research Ethics Review Board (approval number: 365). The requirement for written informed consent was waived because of the retrospective study design. Informed consent was obtained using the opt-out method.

2.1. Statistical analyses

Clinical characteristics, including disease severity, were analyzed using Student t-test, Mann-Whitney U test, and Fisher exact test. Univariate and multivariate logistic regression analyses were performed to identify factors associated with home discharge, considering the following factors: age, sex, WFNS grade, Hunt and Kosnik grade, Fisher grade, location of aneurysm, treatment, days until rehabilitation, early mobilization, and complications. A variable significantly ($P < .05$) associated with home discharge (i.e., WFNS grade and early mobilization) was employed in the multivariate analysis. Additionally, univariate and multivariate linear regression analyses were performed to evaluate the relationship between early mobilization and functional status (FAC, AI, GOS, and mRS scores). A variable significantly ($P < .05$) associated with functional status in the univariate analysis was employed in the multivariate analysis. In the multivariate analysis, each WFNS or Hunt and Kosnik grade was used as a measure of disease severity owing to limitations in the number of variables. All statistical analyses were performed using EZR (version 1.42),[19] and two-tailed $P < .05$ was considered significant.

3. Results

A total of 35 patients (13 men and 22 women) were included in the study, with an average age of 65.7 ± 13.7 years (Table 1). The early mobilization group consisted of 13 patients, whereas the delayed mobilization group included 22 patients. The median length until walking rehabilitation was 11.0 and 30.5 days in the early and delayed mobilization groups, respectively ($P < .001$). Nine patients (40.9%) in the delayed mobilization group did not start walking during hospitalization. The Hunt and Kosnik grade was higher ($P < .001$) in the delayed mobilization group. Other clinical characteristics were comparable between groups. The hospitalization period in the early mobilization group was 25.7 ± 3.7 days whereas 50.1 ± 37.5 days in the delayed mobilization group. One-third of the patients (28.6%) were discharged home, whereas 71.4% were transferred to other hospitals ($P < .001$). One patient (12.5%) with an aneurysm in the anterior cerebral arteries, seven patients (36.8%) with an aneurysm in the middle cerebral and internal carotid arteries, and one patient (20.0%) with an aneurysm in the vertebrobasilar arteries were discharged home ($P = .604$).

Table 1

Characteristics of patients.

	All patients n = 35	Early mobilization n = 13	Delayed mobilization n = 22	P value
Age (yr ± SD)	65.7 ± 13.7	62.9 ± 14.4	67.4 ± 13.0	.365
Men (%)	37.1	38.5	36.4	> .99
WFNS grade (%)				
I	20.0	38.5	9.1	.064
II	37.1	46.2	31.8	
III	5.8	0	9.1	
IV	20.0	15.4	22.7	
V	17.1	0	27.3	
Hunt and Kosnik grade (III–V, %)	54.3	23.1	72.7	< .001
Fisher grade (III or IV, %)	77.1	61.5	86.4	.116
Location of aneurysm (%)				
Anterior cerebral arteries	22.9	15.4	27.3	.943
Middle cerebral and internal carotid arteries	54.3	61.5	50.0	
Vertebrobasilar arteries	14.3	15.4	13.6	
Unknown	8.6	7.7	9.1	
Treatment (%)				
Surgical clip ligation	60.0	61.5	59.1	.785
Endovascular coil embolization	25.7	30.8	22.7	
Preservation	14.3	7.7	18.2	
Days until rehabilitation (days ± SD)	5.7 ± 5.8	4.2 ± 4.2	6.6 ± 6.4	.249
Complications (%)				
Symptomatic cerebral vasospasm	14.3	7.7	18.2	.630
Rebleeding	0	0	0	> .99
Hydrocephalus	11.4	0	18.2	.274
Outcomes (± SD)				
FAC	2.3 ± 2.0	4.2 ± 0.9	1.2 ± 1.5	< .001
AI	4.9 ± 3.2	1.9 ± 1.8	6.7 ± 2.5	< .001
GOS	3.6 ± 1.0	4.5 ± 0.7	3.0 ± 0.6	< .001
mRS	3.2 ± 1.7	1.5 ± 1.4	4.1 ± 0.8	< .001
Hospitalization period (days ± SD)	41.1 ± 32.1	25.7 ± 3.7	50.1 ± 37.5	.029
Home discharge (%)	28.6	69.2	4.5	< .001

AI = ambulation index, FAC = functional ambulation categories, GOS = Glasgow Outcome Scale, mRS = modified Rankin Scale, SD = standard deviation, WFNS = World Federation of Neurosurgical Societies.

In the univariate logistic regression analysis, a higher WFNS grade was associated with a lower probability of home discharge (odds ratio [OR] = 0.40 for one grade increase, 95% confidence interval [CI] = 0.18–0.89, P = .025), whereas early mobilization was associated with a higher probability of home discharge (OR = 47.20, 95% CI = 4.62–484.00, P < .01, Table 2). In the multivariate logistic regression analysis adjusted by WFNS grade, early mobilization was independently associated with home discharge (OR = 30.20, 95% CI = 2.77–329.00, P < .01).

The association between early mobilization and functional status was assessed using univariate and multivariate linear regression analyses. In the univariate analysis, the FAC score was associated with WFNS grade, Hunt and Kosnik grade, and early mobilization. The AI score was associated with WFNS grade, Hunt and Kosnik grade, Fisher grade, and early mobilization. GOS score was associated with WFNS grade, Hunt and Kosnik grade, Fisher grade, days until rehabilitation, early mobilization, and symptomatic cerebral vasospasm. The mRS score was associated with WFNS grade, Hunt and Kosnik grade, Fisher grade, and early mobilization (Table 3; Table, Supplemental Digital Content, http://links.lww.com/MD2/A746). Early mobilization was associated with favorable functional status at discharge in the multivariate linear regression analysis (standardized beta = 0.64 with P < .001 for the FAC score, beta = -0.62 with P < .001 for the AI score, and beta = -0.62 with

P < .001 for the mRS score, Table 4) after adjustment for the WFNS grade. The results from the analysis adjusted with the Hunt and Kosnik grade are shown in Table, Supplemental Digital Content, http://links.lww.com/MD2/A746, which indicated the same tendency as those with the WFNS grade.

4. Discussion

We retrospectively investigated the relationship between early mobilization and home discharge and functional status in patients with SAH. Early mobilization was associated with home discharge and favorable functional status (FAC, AI, GOS, and mRS scores) at discharge. These associations were statistically significant after adjusting for the severity of SAH.

One may speculate the mechanism underlying the association between early mobilization and better outcomes as a favorable effect of early mobilization. Cumming et al randomized patients with stroke (cerebral infarction or cerebral hemorrhage) to the very early (<24h) mobilization and control groups and found that the early mobilization group showed better physical function than those in the control group.[20] The authors suggested that increased physical activity minimized muscle loss and deterioration in cardiorespiratory function,[21] which may be one of the reasons for our results. Conversely, Hérisson et al could not detect any favorable effect of early sitting exercise in patients with

Table 2

Univariate and multivariate logistic regression analysis with home discharge.

	Univariate analysis			Multivariate analysis		
	OR	95% CI	p value	OR	95% CI	P value
Age	0.99	0.94–1.04	.656	–	–	–
Sex [Men]	1.19	0.26–5.34	.825	–	–	–
WFNS grade	0.40	0.18–0.89	.025	0.57	0.21–1.49	.250
Hunt and Kosnik grade	0.48	0.23–1.02	.055	–	–	–
Fisher grade	0.34	0.12–1.02	.140	–	–	–
Location of aneurysm						
[Anterior cerebral arteries]		(reference)	–	–	–	
[Middle cerebral and internal carotid arteries]	4.08	0.42–40.50	.229	–	–	–
[Vertebrobasilar arteries]	1.75	0.08–36.30	.718	–	–	–
[Unknown]	3.50	0.15–84.70	.441	–	–	–
Treatment						
[Surgical clip ligation]		(reference)	–	–	–	
[Endovascular coil embolization]	0.57	0.09–3.51	.546	–	–	–
[Preservation]	0.50	0.05–5.36	.567	–	–	–
Days until rehabilitation	0.95	0.82–1.11	.511	–	–	–
Early mobilization	47.20	4.62–484.00	< .01	30.20	2.77–329.00	< .01
Complications						
[Symptomatic cerebral vasospasm]	1.83	0.26–13.10	.545	–	–	–
[Hydrocephalus]	0.82	0.07–8.91	.867	–	–	–

CI = confidence interval, OR = odds ratio, WFNS = World Federation of Neurosurgical Societies.

acute ischemic stroke.[22] Standing, but not sitting, may be sufficient to promote antigravity activity in the lower limbs and may lead to recovery of physical function.[23] Young healthy adults had a 5% to 9% decrease in quadriceps muscle mass and 20% to 27% decrease in muscle strength after a 2-week bed rest,[24,25] and in elderly adults, the decline was three to six times.[26,27] Hence, in our study, which included relatively older population, early ambulation could avoid disuse syndrome, thereby achieving good functional status at discharge. Regarding the feasibility and safety of early mobilization in patients with SAH, Karic et al reported that complications such as vasospasm

and hydrocephalus were not increased in patients undergoing early mobilization.[3] This is in line with our results, although they did not refer to the functional outcome of early mobilization in this study. Olkowski et al also reported the feasibility of early (mean 3.2 days) mobilization after SAH, although they did not mention any outcome.[12]

4.1. Strengths and limitations

There are few reports investigating the association between early mobilization and outcome in patients with SAH, even though

Table 3

Univariate linear regression analysis with functional status.

	FAC			AI			GOS			mRS		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Age	−0.16	−0.07–0.03	.372	0.13	−0.05–0.11	.474	−0.02	−0.03–0.02	.903	0.11	−0.03–0.06	.546
Sex [Men]	0.03	−1.32–1.55	.876	−0.13	−3.19–1.50	.470	0.16	−0.38–1.01	.366	−0.19	−1.84–0.56	.285
WFNS grade	−0.53	−1.15–−0.32	< .01	0.48	0.38–1.80	< .01	−0.55	−0.58–−0.18	< .001	0.57	0.33–1.02	< .001
Hunt and Kosnik grade	−0.60	−1.41–−0.50	< .001	0.55	0.65–2.21	< .001	−0.56	−0.67–−0.21	< .001	0.56	0.36–1.56	< .001
Fisher grade	−0.32	−1.68–0.03	.057	0.40	0.32–3.03	.017	−0.37	−0.87–−0.05	.030	0.46	0.32–1.67	< .01
Location of aneurysm												
[Anterior cerebral arteries]		(reference)			(reference)			(reference)			(reference)	
[Middle cerebral and internal carotid arteries]	0.06	−1.67–1.90	.893	−0.16	−3.47–2.37	.702	0.13	−0.75–1.01	.761	−0.18	−1.84–1.19	.667
[Vertebrobasilar arteries]	0.17	−2.07–2.77	.770	−0.43	−5.45–2.45	.444	−0.10	−1.29–1.09	.865	0.01	−2.02–2.07	.980
[Unknown]	0.00	−3.45–2.29	.681	0.00	−5.52–3.86	.720	0.00	−1.24–1.56	.811	0.00	−2.81–2.06	.755
Treatment												
[Surgical clip ligation]		(reference)			(reference)			(reference)			(reference)	
[Endovascular coil embolization]	0.36	−0.65–2.58	.230	−0.26	−3.84–1.55	.395	0.11	−0.67–0.96	.724	−0.03	−1.49–1.33	.910
[Preservation]	0.00	−2.56–1.47	.587	0.00	−2.91–3.82	.784	0.00	−0.94–1.10	.880	0.00	−1.75–1.77	.991
Days until rehabilitation	−0.31	−0.21–0.01	.070	0.21	−0.08–0.31	.232	−0.48	−0.13–−0.03	< .01	0.26	−0.02–0.17	.125
Early mobilization	0.75	2.09–4.01	< .001	−0.71	−6.42–−3.10	< .001	0.71	0.92–1.91	< .001	−0.75	−3.40–−1.80	< .001
Complications												
[Symptomatic cerebral vasospasm]	−0.31	−3.66–0.12	.066	0.31	−0.20–6.00	.066	−0.41	−2.02–−0.24	.014	0.25	−0.43–2.83	.144
[Hydrocephalus]	−0.19	−3.35–0.95	.263	0.20	−1.45–5.59	.239	−0.21	−1.69–0.40	.220	0.29	−0.28–3.28	.095

AI = Ambulation Index, CI = confidence interval, FAC = Functional Ambulation Categories, GOS = Glasgow Outcome Scale, mRS = modified Rankin Scale, WFNS = World Federation of Neurosurgical Societies.

Table 4

Multivariate linear regression analysis with functional status.

	FAC			AI			GOS*			mRS		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
WFNS grade	−0.23	−0.67–0.03	.073	0.09	−0.51–0.91	.567	Not selected			0.18	−0.11–0.53	.186
Fisher grade	–	–	–	0.19	−0.38–2.00	.174	−0.23	0.13–−2.58	.015	0.21	−0.09–0.98	.099
Days until rehabilitation	–	–	–	–	–	–	−0.32	0.02–−3.84	< .001	–	–	–
Early mobilization	0.64	1.57–3.65	< .001	−0.62	−5.98−−2.33	< .001	0.54	0.21–5.22	< .001	−0.62	−2.95−−1.30	< .001
Complications												
[Symptomatic cerebral vasospasm]	–	–	–	–	–	–	Not selected			–	–	–
R²	0.58			0.52			0.67			0.63		

* Used step-wise method for multivariate linear regression analysis.

AI = ambulation Index, CI = confidence interval, FAC = Functional Ambulation Categories, GOS = Glasgow Outcome Scale, mRS = modified Rankin Scale, WFNS = World Federation of Neurosurgical Societies.

some studies referred to its safety or feasibility. The study results suggest that ambulation in the second week after the onset of SAH may stratify risk and predict discharge status. Early mobilization, including walking rehabilitation, may be beneficial. This study has several limitations. First, the lack of data regarding past medical history is a major limitation. History of hypertension, myocardial infarction, and liver disease were negative prognostic factors for unfavorable neurologic outcomes in a previous study, although the clinical importance of the severity of SAH in predicting outcome was much higher than that of past medical history.[28] Second, owing to the small number of participants, it may not be possible to exclude unmeasured confounders, although we adjusted the results with the severity of SAH. Our study results may not refer to causality, and therefore early mobilization may only reflect a better baseline condition.[29] Therefore, larger prospective studies are needed in the future, which may enable us to apply propensity matching or more precise adjustment.

5. Conclusion

Early mobilization was associated with home discharge and favorable functional status at discharge. Although the results are adjusted with the severity of SAH, larger prospective studies are warranted to investigate the causal relationship between early mobilization and outcomes.

Author contributions

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