ORIGINAL PAPER

Nagoya J. Med. Sci. **85**. 455–464, 2023
doi:10.18999/nagjms.85.3.455

The association between early rehabilitation and ambulatory ability at discharge in patients with hip fractures at acute-phase rehabilitation wards: a survey of the Japan Association of Rehabilitation Database

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ABSTRACT

This study aimed to examine the effectiveness of early rehabilitation in patients with femoral neck fractures admitted to acute care settings in Japan using the data registered with the Japan Association of Rehabilitation Databases (JARD). We included data for 401 patients (out of 3088 patients) aged ≥ 65 years (85 males, 316 females) from nine hospitals who sustained a femoral neck fracture between July 2005 and September 2015. Using the number of days until surgery or the number of days until the start of rehabilitation or both as the explanatory variables, and the indoor mobility at discharge as the outcome variable, we calculated the adjusted rate ratio (ARR) and 95% confidence interval (CI) using Poisson regression analysis (age, sex, cognitive impairment, concurrent symptoms, and previous history of fracture adjusted as covariates). The ARR for independent walking at the discharge of the early-rehabilitation group (starting rehabilitation within two days after the injury) was significantly higher (ARR: 2.01, 95% CI: 1.34–3.02) than that of the non-early rehabilitation group. These results suggest that early acute-phase rehabilitation after a femoral neck fracture in older patients allows for better ambulatory ability at discharge, regardless of the time to surgery.

Keywords: early rehabilitation, multi-institutional joint research, femoral neck fracture

Abbreviations:
JARD: Japan Association of Rehabilitation Database
ARR: adjusted rate ratio
CI: confidence interval
FIM: Functional Independence Measure

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INTRODUCTION

A 2012 survey conducted in Japan reported an estimated 175,700 new patients with femoral neck fractures, which represents a 3.3-fold increase since 1987.[1] With an increasing incidence, 40–50% of patients with femoral neck fractures are not able to return to their pre-injury independence in activities of daily living (ADLs).[2,3] Eventually, the constant rise in the number of post-fracture bedridden older patients warrants the need for greater caregiving measures and resources, making it a major problem for the current super-aged Japanese society. The number of patients with femoral neck fracture is projected to increase worldwide, which has resulted in rising concerns regarding the need for competent rehabilitation to achieve functional independence.[4,5]

Many reports concerning the prognosis of patients with a femoral neck fracture support the use of early surgical interventions after injury (within 24 hours to 4 days) in terms of reduced complications, increased survival rates, and shortened hospital stay.[6,7] However, only a few studies have elucidated the effects of early rehabilitation, with only one of them focusing on the effect of the clinical pathway.[8] Among the limited evidence highlighting the effects of early rehabilitation, a four-month-long observational study by March et al compared patients who were not introduced to a clinical pathway (mobilization within 48 hours) (n = 455) to those who were (n = 481) and reported that the latter had a reduced hospital length of stay from 11 days to 9 days.[9] Likewise, Tallis et al also reported positive effects of an early mobilization program (from postoperative day 1) in terms of reduced length of hospital stay from 19.3 days to 11 days in patients aged > 50 years. Under this program, the start of postoperative mobilization, ie, the number of days between the operation and walking for the first time, was preponed by a day (from 4.3 days to 3.0 days).[10]

So far, the literature supporting the effects of early rehabilitation after femoral neck fractures remains indeterminate about two crucial aspects. First, there is insufficient evidence focusing on the relationship between early rehabilitation and the recovery of physical function, especially gait.[11] Second, most reports have relied on data from single facilities, limiting the generalizability and external validity of these findings.

Therefore, in the present study, we used a multi-facility participatory database to investigate the relationship between early rehabilitation and the improvement in ambulatory ability at discharge in older patients who had sustained femoral neck fractures.

METHODS

The present study used registered databases documented by multiple facilities and listed with the Japan Association of Rehabilitation Databases (JARD).[12-14] One of the major objectives of building this database is to provide fundamentals for cohort comparative studies, the findings of which can serve as high-level evidence next to those from randomized controlled trials, as per Sackett's rules of evidence and grades of recommendation.[15] We gathered data for patients who sustained femoral neck fracture and were registered with the JARD between July 2005 and September 2015 and screened them for suitability to our selection criteria – patients aged ≥ 65 years, direct admission to an acute care hospital within seven days from the injury, rehabilitation started within 14 days after the injury, and having pre-injury indoor mobility of at least "walking while holding onto something". Those who had any missing or abnormal values were excluded. Data from the non-acute phase patients or facilities registering < 30 cases were not included due to suspected underreporting of fracture cases (Figure 1).

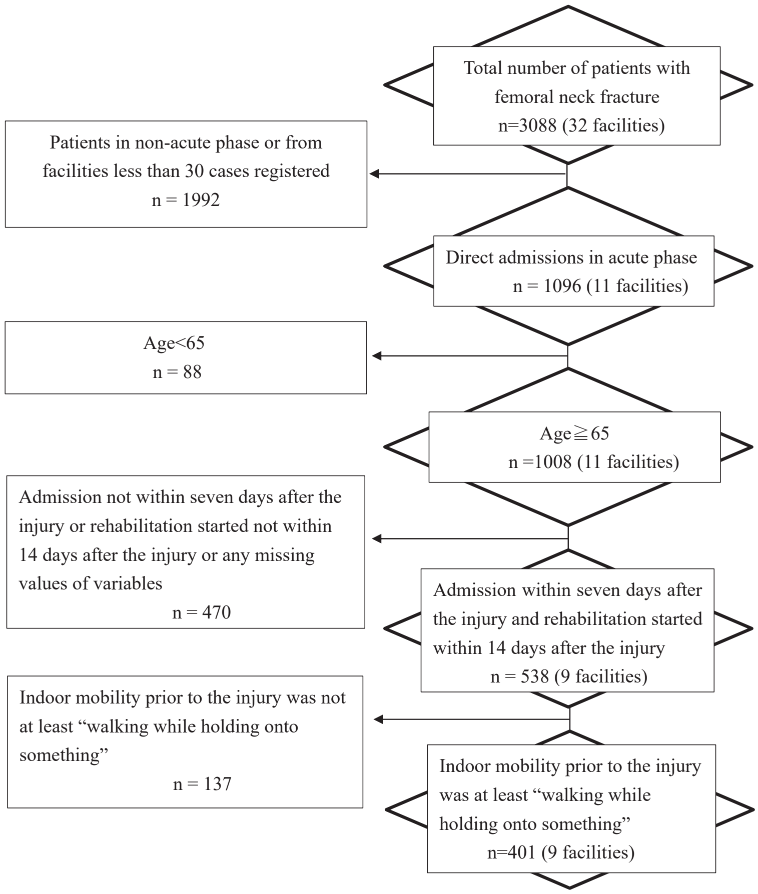

Fig. 1 Flow chart showing the procedure for selecting subjects for analysis

We used 'indoor mobility at discharge' as an outcome variable, while the number of days from the injury to the start of rehabilitation and the number of days from the injury to surgery[16] were used as explanatory variables. The following variables were adjusted as covariates during the analyses: age,[17] sex,[18] cognitive impairment,[19] concurrent symptoms,[20] and previous fracture history, time spent on rehabilitation per day, and the total score of motor Functional Independence Measure (FIM) items at the start of the rehabilitation. Indoor mobility at discharge was defined as "walking on their own," "walking with a cane," or "walking while holding onto something," which was collectively referred to as "independent walking at discharge". The use of "the walker," "the wheelchair," and "the one not walking" was defined as "non-independence".

For the current study, the patients were categorized into two groups based on the timing of surgery/starting rehabilitation – the "early surgery/early rehabilitation" group (within zero to two days from the injury) and the "non-early surgery/non-early rehabilitation" group (after three or more days post-injury. Additionally, the patients were stratified into the following five age groups – 65–74 years, 75–79 years, 80–84 years, 85–89 years, ≥ 90 years). Time spent on rehabilitation per day was categorized by the number of units (1 unit = 20 minutes of rehabilitation) into three categories (≤ 1 unit, 1.001–2 units, and ≥ 2.001 units). The total score of motor FIM items at the beginning of rehabilitation was also stratified into three groups – 13–18, 19–28, and ≥ 29.

Statistical analyses

Each variable of the "early surgery/rehabilitation" and "non-early surgery/rehabilitation" groups was compared using the Student's t-test for continuous variables and a Chi-squared test for categorical variables. To investigate the relationship between gait prognosis and early rehabilitation, we calculated the adjusted rate ratio (ARR) and 95% confidence intervals (CI) using Poisson regression analysis. For 'indoor mobility at discharge' as an outcome variable, we set the number of days from the injury to the start of rehabilitation or surgery as an explanatory variable, while adjusting for age, sex, cognitive impairment, concurrent symptoms, history of a previous fracture, time spent on rehabilitation per day, and the total score of motor FIM items at the start of rehabilitation. Since the number of cases who could independently walk at discharge was not too small (not < 15%), we could not calculate the prevalence ratio using an odds ratio obtained by logistic regression analysis.[21,22] Thus, we computed the ARR and 95% CIs using the Poisson regression analysis in three models, all of which were intended to investigate the degree of involvement of both 'number of days from the injury to surgery' and 'number of days from the injury to the start of rehabilitation' on the primary outcome "independent walking at discharge". Model 1 limited the explanatory variables only to the number of days until the start of rehabilitation, Model 2 limited the explanatory variables only to the number of days until surgery, and Model 3 used both variables as explanatory variables.

SPSS version 2.02 (IBM Inc, Armonk, NY) was used for all statistical analyses, and the significance level was set as < 5%.

Ethics

The data used in the present study were obtained from daily clinical practice to improve rehabilitation therapy and did not include any personal information since it was anonymized at the source. The study protocol follows the ethical guidelines for epidemiological studies and was approved by the Research Ethics Review Board of the Japanese Association of Rehabilitation Medicine.

RESULTS

Descriptive statistics

Of a total of 3088 patients with a femoral neck fracture and data registered between July 2005 and September 2015 with JARD, 401 patients (85 male, 316 female; mean age: 84.3 ± 7.2 years, range: 65–103) from nine hospitals satisfied the selection criteria. Table 1 presents the demographic characteristics of these patients. There were 149 (37.2%) patients in the early surgery group (average number of days from the injury to the surgery = 3.92 ± 2.73 days) and 252 (62.8%) patients in the non-early surgery group. Likewise, there were 203 (50.6%) patients in the early-rehabilitation group (average number of days from the injury to the start of rehabilitation = 4.49 ± 3.93 days) and 198 (49.4%) patients in the non-early-rehabilitation group.

Table 1 Comparison of early rehabilitation and non-early rehabilitation groups

		Early rehabilitation group (0–2 days)		Non-early rehabilitation group (3days–)		*p*
		n	(%)	n	(%)	
Total number of subjects		203	(50.6%)	198	(49.4%)	
Days from the injury to surgery	Early surgery group	132	(88.6%)	17	(11.4%)	<0.001
	Non-early surgery group	71	(28.2%)	181	(71.8%)	
Age	65–74	27	(57.4%)	20	(42.6%)	0.63
	75–79	22	(51.2%)	21	(48.8%)	
	80–84	48	(51.6%)	45	(48.4%)	
	85–89	64	(52.0%)	59	(48.0%)	
	90–	42	(44.2%)	53	(55.8%)	
Sex	Male	36	(42.4%)	49	(57.6%)	0.09
	Female	167	(52.8%)	149	(47.2%)	
Dementia (Yes/No)	No	101	(53.4%)	88	(46.6%)	0.29
	Yes	102	(48.1%)	110	(51.9%)	
History of fracture (Yes/No)	No	165	(51.9%)	153	(48.1%)	0.32
	Yes	38	(45.8%)	45	(54.2%)	
Complications (Yes/No)	No	187	(50.4%)	184	(49.6%)	0.76
	Yes	16	(53.3%)	14	(46.7%)	
Rehabilitation unit/day	Over 2.001 units/day	94	(90.4%)	10	(9.6%)	<0.001
	1.001–2,000 units/day	102	(42.9%)	136	(57.1%)	
	Less than 1.000 unit/day	7	(11.9%)	52	(88.1%)	
Total score of motor FIM items at the start of rehabilitation	Over 29	109	(85.2%)	19	(14.8%)	<0.001
	19–28	56	(42.4%)	76	(57.6%)	
	13–18	38	(27.0%)	103	(73.0%)	
Ambulatory ability at discharge	Independent	86	(72.9%)	32	(27.1%)	<0.001
	Non–independent	117	(41.3%)	166	(58.7%)	

FIM: Functional Independence Measure

Regarding mobility at the time of discharge, 118 (29.4%) patients were independently walking (on their own or with a cane or while holding onto something), out of which, 86 (42.4%) patients belonged to the early-rehabilitation group and 32 (16.2%) were from the non-early-rehabilitation group. Furthermore, compared to the non-early rehabilitation group, the early-rehabilitation group had shorter intervals from the injury to surgery, spent more time on rehabilitation daily, and had a higher total score of motor FIM items at the start of rehabilitation (Table1). Figure 2 shows the distribution of motor FIM scores at discharge with respect to the number of days from the injury to the surgery/start of rehabilitation. Regarding the time to rehabilitation, a distinctive difference was observed between the distribution of motor FIM at discharge up to two days after the injury and thereafter. The average motor FIM scores at the discharge for the early surgery (58.23 ± 22.48) and rehabilitation (60.89 ± 21.42) groups were greater than that of the non-early surgery (45.14 ± 23.30) and rehabilitation (37.99 ± 20.35) groups ($p < 0.001$).

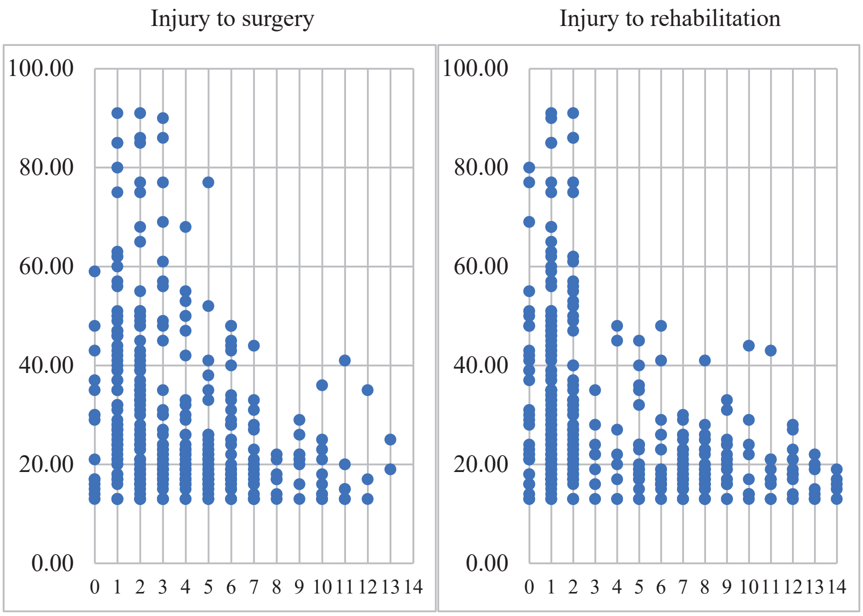

Fig. 2 Scatter plot showing the distribution of motor FIM scores at discharge
Vertical axis denotes motor FIM at discharge. Horizontal axis denotes the number of days from the onset of hip fracture (injury) to surgery (left) and rehabilitation (right).
FIM: Functional Independence Measure

Poisson regression analysis

As per the Poisson regression analysis performed after adjusting all the covariates (Table 2), in the case of Model 1, the ARR for independent walking at discharge was significantly higher in the early rehabilitation group (ARR: 2.01, 95% CI: 1.35–2.99). Whereas, in the case of Model 2, the ARR for independent walking at discharge was low (ARR: 1.25, 95% CI: 0.91–1.70). Lastly, in the case of Model 3, the change in the coefficients was small (number of days until the start of rehabilitation: ARR: 2.01, 95% CI: 1.34–3.02; number of days until surgery: ARR: 1.01, 95% CI: 0.74–1.37). For the other related covariates, there was a significant relationship between independent walking at discharge and age, dementia, and the total motor FIM score at the start of the rehabilitation, ie, younger patients, who did not have dementia and had a higher total motor FIM score at the start of rehabilitation, had a higher chance of getting to walk independently at discharge.

Table 2 Poisson multivariate analysis to calculate adjusted rate ratio for predicting independent walking at discharge

		Model 1			Model 2			Model 3		
		ARR	(95% CI)	p	ARR	(95% CI)	p	ARR	(95% CI)	p
Days from the injury to the start of rehabilitation	Non-early rehabilitation group	1.00						1.00		
	Early rehabilitation group	2.01	(1.35–2.99)	<0.001				2.01	(1.34–3.02)	<0.001
Days from the injury to surgery	Non-early surgery group				1.00			1.00		
	Early surgery group				1.25	(0.91–1.70)	0.162	1.01	(0.74–1.37)	0.969
Age	65–74	1.00			1.00			1.00		
	75–79	0.825	(0.57–1.20)	0.315	0.85	(0.58–1.25)	0.412	0.83	(0.57–1.20)	0.318
	80–84	0.558	(0.39–0.80)	0.001	0.58	(0.40–0.83)	0.003	0.56	(0.39–0.80)	0.001
	85–89	0.585	(0.41–0.84)	0.004	0.61	(0.42–0.89)	0.011	0.58	(0.41–0.84)	0.004
	Over 90	0.283	(0.16–0.50)	<0.001	0.29	(0.16–0.50)	<0.001	0.28	(0.16–0.50)	<0.001
Sex	Male	1.00			1.00			1.00		
	Female	1.03	(0.71–1.50)	0.873	1.04	(0.72–1.52)	0.819	1.03	(0.71–1.50)	0.876
Dementia (Yes/No)	No	1.00			1.00			1.00		
	Yes	0.48	(0.34–0.68)	<0.001	0.51	(0.36–0.72)	<0.001	0.48	(0.34–0.68)	<0.001
History of fracture (Yes/No)	No	1.00			1.00			1.00		
	Yes	0.92	(0.65–1.30)	0.642	0.87	(0.61–1.24)	0.436	0.92	(0.65–1.30)	0.641
Complications (Yes/No)	No	1.00			1.00			1.00		
	Yes	0.58	(0.28–1.21)	0.147	0.56	(0.27–1.19)	0.132	0.58	(0.28–1.21)	0.147
Rehabilitation unit/day	Over 2.001 units/day	1.00			1.00			1.00		
	1.001–2.000 units/day	1.318	(1.00–1.73)	0.047	1.18	(0.87–1.60)	0.299	1.32	(0.99–1.76)	0.057
	Less than 1.000 unit/day	1.126	(0.58–2.18)	0.724	0.87	(0.44–1.73)	0.694	1.13	(0.58–2.21)	0.727
Total score of motor FIM items at the start of rehabilitation	Over 29	1.00			1.00			1.00		
	19–28	0.741	(0.53–1.04)	0.087	0.62	(0.43–0.89)	0.009	0.74	(0.52–1.05)	0.094
	13–18	0.496	(0.30–0.81)	0.005	0.40	(0.24–0.64)	<0.001	0.50	(0.30–0.81)	0.005

ARR: adjusted rate ratio
FIM: Functional Independence Measure
Model 1 explanatory variable: Days from the injury to the start of rehabilitation.
Model 2 explanatory variable: Days from the injury to surgery.
Model 3 explanatory variables: Model 1 + Model 2.

DISCUSSION

In this observational study using large-scale databases from multiple clinical settings, we observed that even after adjusting for multiple variables, the ARR of independent walking at discharge was higher in patients undergoing early rehabilitation (within the first three days after injury) than for those who receive an intervention (surgery/rehabilitation) after the first three days. These results indicate that patients sustaining femoral neck fractures, who start early acute-phase rehabilitation, are more likely to attain functional independence at discharge, corroborating the functional benefits of early rehabilitation. Although previous studies have suggested the importance of early rehabilitation in patients with femoral neck fractures in reducing the duration of hospital stay, the effect on the ambulatory ability at discharge has not been elucidated so far.

There are two probable reasons for this significant association between early rehabilitation and better ambulatory ability at discharge observed in the present study. First, early intervention (surgery or rehabilitation) improves functional outcomes at discharge by preventing the development of disuse syndrome, which is expected to occur in the acute post-traumatic phase, especially in older adults whose physiological and functional reserves are limited.[23,24] Decreased activity in old age causes joint stiffness and muscle weakness; further inactivity due to injury may worsen the situation by causing malnutrition, depression, and diminished ability to carry out ADLs and maintain mobility. A higher prevalence of sarcopenia has been reported in patients with hip fractures, which underscores the importance of early rehabilitation in older patients.[25,26] The range of motion (ROM) of the hip and knee joints is restricted on the injured side, but the non-injured limb can be used to perform active joint ROM training, as well as general mobility and strength training. A previous systematic review stated that lower-limb progressive resistance exercise improves functional outcomes after the surgery.[27] Therefore, starting early rehabilitation may promote independent ambulation at discharge. Furthermore, implementing coordinated rehabilitation involving multidisciplinary personnel reportedly maximizes the effects on functional outcomes.[28] A second reason for the observed correlation is the possible role of physiotherapy and rehabilitation interventions in improving the patient's mental function. According to Dobkin et al, a single daily bout of performance-related feedback for that day's walking speed over a short distance led to significantly faster speeds at discharge compared with well-matched participants who did not receive any feedback.[29] Previously mobile and healthy patients, who experience a sudden loss of ambulatory ability due to a fall, are expected to feel depressed due to possible concerns regarding the surgery and its consequences, with an indefinite fear of becoming bedridden. Hence, starting rehabilitation in the earlier acute period can provide psychological reinforcement to the patients who may feel distressed about their situation and help them stay motivated for independent walking.

There were certain limitations to the present study. Out of a total of 3088 cases registered in the JARD, we could only include 401 patients in the final analysis due to the stringent inclusion criteria, which were set to minimize the heterogeneity of the study sample. Furthermore, since fracture severity and classification were not required for registration in the database, they were not adjusted in the analyses. Also, we could not adjust important covariates, such as the rehabilitation schedules and training details (time, duration, or intensity), since the data belonged to multiple care facilities and the rehabilitation programs were different in each acute setting. Controlling such possible confounders may further influence the results. Further analyses with a larger sample size and considering the aforementioned possible confounding factors may improve the quality and strength of the evidence presented in the current study.

CONCLUSION

Results of this large-scale multi-centered observational study including patients who sustained hip fractures support the use of early rehabilitation (within three days of injury) to attain functional independence at discharge. These results corroborate the importance of early rehabilitation for functional recovery in elderly patients who are more prone to disuse syndrome and psychological deterioration due to injury and activity restrictions.

ACKNOWLEDGMENT

We would like to express our gratitude to all the PTs, OTs, MSWs, and MEs of the medical facilities associated with JARD who provided the data.

The authors state that the contents and conclusions of this report do not reflect the views of the organizations of JARD, but the view of the individual presenter.

CONFLICT OF INTEREST

We declare no conflict of interest related to this study.

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