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ORIGINAL ARTICLE

Hip Fracture Patients Referred for Rehabilitation After Surgery: Identifying Clinical Predictors for Ambulation

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ABSTRACT

Background and objectives: Hip fracture patients received rehabilitation in tertiary hospital to maximize recovery after surgery. These patients achieve different ambulation status at the point of discharge. We conducted a prospective study identifying clinical factors affecting ambulation distance achieved and predictors influencing need for walking aid.

Materials and methods: One hundred twenty-one hip fracture patients with hip surgery were studied during their course of inpatient rehabilitation in Singapore. Outcome measures at discharge included ambulation distance and patients who needed walking aid at the point of discharge.

Results: The mean cohort age was 74.6 ± 9.9 years. Seventy-three (60.3%) were the neck of femur fractures and the rest were intertrochanteric fractures. Eighty-seven (72%) had a caregiver. The mean admission functional independence measure (FIM) score was 82 ± 18. Majority (86%, n = 104) did not develop cardiac complications or urinary infection (80%, n = 97) after surgery. The average rehabilitation days were 21 ± 11. The mean ambulation distance was 56.7 ± 54.0 meters. The majority (81%, n = 98) needed walking aid at discharge despite rehabilitation. The positive predictors for better ambulation distance were the absence of renal impairment (B = 25.7, p = 0.022), a higher admission FIM (B = 1.1, p <0.01) and those who can walk without assistance at discharge(B = 60, p <0.01). The positive predictors for walking without aid after rehabilitation were those who do not require a caregiver (B = 0.26, p <0.01), a shorter duration of inpatient rehabilitation (B = 0.01, p = 0.07), and those with more motor FIM gain (B = 0.01, p = 0.028).

Conclusion: This hip fracture study highlights the clinical relevance of identifying positive predictors for ambulation status after surgery. Hip fracture rehabilitation units can consider these predictors to assist in devising their rehabilitation programs.

Keywords: Ambulation, Fracture, Rehabilitation.

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BACKGROUND

Patients with osteoporotic hip fractures often decline in physical function and dependency after hip surgery.[1-4] Rehabilitation after hip surgery is essential and effective in maximizing functional recovery and in early community re-integration.[5] Early rehabilitation is widely practiced and the rationale involves improving ambulation status and self care, and prevention of further disability.[6] Early inpatient rehabilitation services to the hip fracture patients after surgery has been associated with a higher proportion of patients returning to pre-fracture mobility.[7] Evaluation of pertinent functional outcomes during this early period allows prediction of self-care in the community. These outcomes include ambulation statuses such as walking distance and the ability to walk independently with or without aid. Assessing ambulation for hip fracture patients after surgery may also predict the ability to achieve instrumental activities-of-daily-living in the community.[8]

Functional independence measure (FIM) is one of the widely used outcome measures for physical and cognitive disability in rehabilitation.[9] FIM provides a uniform system of measurement of disability based on the International Classification of Functioning, Disability, and Health (ICF) and focuses on the burden of care. Items are scored based on the level of assistance to perform activities of daily living. Many studies highlighted the clinical relevance of FIM in functional assessment of hip fractures; they used the admission (AFIM) and discharge (DFIM) scores to report and predict functional outcomes.[10] One study categorized a group of hip fracture patients with FIM scores into two and found the group with AFIM scores of 75 and below was associated with poorer functional outcomes.[11] Another study used DFIM and motor FIM gain as acute functional outcomes.[12] Many were also issued walking aids.

There is limited information on hip fracture subjects in Singapore on ambulation distance and the numbers who need walking aid at discharge.[13,14] This study aims to identify predictors for these two outcomes.

MATERIALS AND METHODS

We conducted a prospective cohort study of patients with hip fracture admitted acutely to the Department of Orthopedic Surgery in Singapore General Hospital from 2012 to

2014. These patients had either unilateral neck of femur fracture or intertrochanteric fractures and received surgical followed by early referral to the inpatient rehabilitation team before discharge to the community. Criteria for acceptance into rehabilitation include medically stable cases and those who could partial weight-bear over the fracture site. Exclusion criteria were those who are unfit for surgery, hip fracture with etiologies not related to fall, cases who are non-weight bearing after surgery; or those who declined rehabilitation.

There were 121 postsurgical hip fracture patients who fit these criteria over a 2 year period. All the 121 patients were included, and clinical data were recorded in a custom designed rehabilitation. The clinical parameters chosen were based on review of previous hip fracture studies and their related predictors of functional outcomes. In this study, the acute functional outcomes were ambulation distance and those who can achieve ambulation without aid after a trial of rehabilitation.

Demographics charted include age, gender, ethnicity and preexisting comorbidities (hypertension, diabetes, cerebrovascular accident, ischemic heart disease, renal impairment or diagnosed dementia prior to hip fracture). The premorbid ambulatory status was categorized into patients who ambulate independently and those ambulating with walking aid. Assistive devices include walking stick, narrow or broad-based quad-stick or walking frame. Hip fracture patients were classified into those who sustained a neck of femur fracture (NOF) or intertrochanteric fracture (IT). The former received either hemiarthroplasty (unipolar and bipolar) or total hip replacement surgery. The latter group had either proximal femoral nail antirotation (PFNA) or dynamic hip screw fixation. The mean time in days from sustaining a hip fracture to the time of receiving hip surgery was recorded. Complications charted after hip surgery include cardiovascular events such as arrhythmia, cardiac related-hypotension or acute coronary syndrome, urinary tract infection, pneumonia and lower limb deep venous thrombosis (DVT). All patients received intermittent pneumatic compression in between therapy sessions and those with a high index of suspicion of DVT were sent for lower limb ultrasound vascular imaging. The mean drop in hemoglobin (g/dL) after surgery was defined as the difference in hemoglobin level before the surgery and within 48 hours after surgery. Individuals who required caregiver after surgery were documented and their caregivers participated in the caregiver training during the period of rehabilitation.

The Department of Rehabilitation Medicine in our center uses FIM as the main general functional outcome measure and is an FIM-accredited facility. All physicians, nurses, and therapists who perform FIM assessments were trained in FIM scoring. The FIM was collected at the point of admission (AFIM) and discharge (DFIM) and scored serially on a weekly basis. The scale consists of 13 items of physical domains and 5 items of cognitive domains where each item is scored from a scale of 1–7.[10] A score of 1 represents total dependence, and 7 indicates complete independence. On admission to rehabilitation, the medical assessment was conducted by the Physician-in-charge and nurses. This was followed by scoring of admission FIM (AFIM) by the respective physiotherapist (PT) and occupational therapist (OT) assigned to each of these patients. Both the PT and OT each provided an hour of therapy daily from Monday to Friday. During the course of rehabilitation, FIM scores were scored weekly by the same PT and OT. DFIM scores were assessed by the same group of rehabilitation clinicians on the day of hospital discharge. Motor FIM gain is defined as the difference between the physical domains of the DFIM and AFIM. All the FIM scores were entered into the hospital electronic record system. The physician-in-charge verified the AFIM and DFIM of every hip fracture patients using the hospital electronic record system at discharge. As patients need to travel outdoor for daily functional activities and outpatient day rehabilitation, ambulation distance was chosen as one of the outcome measures. The ambulatory distance at the point of discharge was defined as the walking distance (in meters) a hip fracture patient can achieve (with or without the use of walking aid) at the point of discharge from rehabilitation.[15] The ambulatory status at discharge was dichotomized into those who could ambulate with or without aids. The rehabilitation LOS (RLOS) refers to the length of inpatient rehabilitation stay in the dedicated rehabilitation unit and excludes the days spent in intensive care after hip surgery. All these patients were initiated on rehabilitation as early as postoperative day.[1] Descriptive statistics for quantitative variables were presented as mean, standard deviation (SD) and n (%) for categorical variables. The clinical variables included in this model were correlated with the three outcome measures. Independent t-test and one-way analysis of variance were used in the analysis of group means. Chi-square test was applied for categorical variables. Multiple linear regression analysis was performed to determine the variables associated with ambulation distance, DFIM and rehabilitation LOS. Statistical analysis was done using statistical package for social sciences (SPSS) software version 20. Statistical significance was reported in two-tailed and determined at p values <0.05. Confidence intervals are reported at 95%. The study was approved by the Hospital Centralized Review Board.

RESULTS

Demographics

The mean age of the cohort was 74.6 ± 9.9 years. Ninety-seven (80.2%) were premorbid ambulant without aids. Eighty-six (71.1%) were female. The two most common comorbidities were hypertension (n = 85, 70.2%) and diabetes (n = 42, 34.7%) (Graph 1.) Nearly 60.3% (n = 73) were NOF fractures and the rest were IT fractures. The most common surgery performed was hemiarthroplasty (n = 59, 48.8%) for NOF fractures followed by dynamic hip screw insertion or proximal femoral nail anti-rotation for IT fractures (n = 52, 43.0%). Eighty-seven subjects in this cohort (71.9%) required a caregiver after undergoing hip surgery. For medical complications, seventeen (14%) subjects developed cardiac-related complications after hip surgery that required medical treatment whereas twenty-four (19.8%) required treatment for urinary tract infection (UTI). None developed deep vein thrombosis or pneumonia.

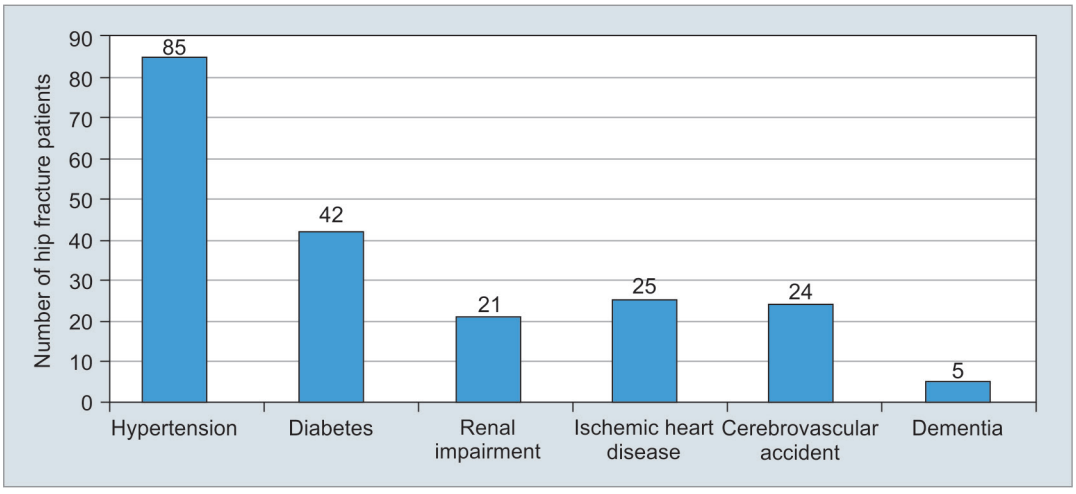
The mean postoperative hemoglobin was 9.7± 1.7 g/dL. The mean drop in hemoglobin was 1.7 ± 1.0 g/dL. The mean AFIM and DFIM were 82.1 ± 18.1 and 94.2 ± 19.9 respectively. The mean motor FIM gain was 12.0 ± 7.4. The mean ambulation distance achieved by this cohort at the point of discharge was 56.7 ± 54.0 meters, and 23 (19%) do not require any walking aid at the point of discharge (Table 1). Univariate analysis was performed identifying positive predictors (age, renal impairment, caregiver, urinary tract infection, subcomponents of FIM and assistance for ambulation) before advancing to multivariate analysis (Table 2).

In the first multivariate model on ambulation distance, factors associated with increased ambulation distance were patients without renal impairment ($p = 0.022$), those who higher FIM score on entry into rehabilitation ($p < 0.001$) and those who successfully completed the inpatient rehabilitation without the need for walking aid at discharge ($p < 0.001$). In the second model on predictors for ambulation without aid at discharge, those who needed less time in rehabilitation ($p = 0.007$), achieved greater motor FIM gain during rehabilitation ($p = 0.028$) and those who do not need caregiver assistance for ambulation ($p = 0.001$) (Table 3).

DISCUSSION

Walking recovery after hip fracture surgery had been extensively studied previously with outcome measures such as time-up-and-go, gait speed, and independent walking.[11,16,17] There is limited information regarding the ambulation distance that has implications for walking outdoor. We decided to explore this outcome measure at the point of hospital discharge as patients in our study needed to travel outdoor for their daily functional ability and to attend outpatient day rehabilitation.

In Singapore, 50 m is a reasonable estimation for community ambulation whereas 500 m is the benchmark in Finland.[18,19] Early multidisciplinary rehabilitation can improve outcomes such as walking ability and participation after joint replacement surgery.[18] Given that our study cohort received rehabilitation promptly after surgery, many of the hip fracture patients would be able to achieve reasonable ambulation distance. At the point of discharge, those without renal impairment fare better. This concurs with a study from Christine et al. revealing poor functional outcome for their hip fracture patients with kidney disease. Higher AFIM score is a positive predictor of ambulation in a previous study.[10,15] The rehabilitation team could adopt a checklist in the hip fracture pathway and include these factors at the start of the rehabilitation program. Patients having most of these factors could be stratified into a group where the special emphasis on improving walking distance is considered. This includes more therapy time on endurance training during walking, lower limb strengthening exercises, and



Graph 1: Pre-existing comorbitidities of hip fracture patients who went through surgery

Table 1: Demographic and clinical profile of the hip fracture patients who had received surgery.

Variables	*All (n = 121)* n (%)
Mean age (years)	74.6 (SD 9.9)
Premorbid ambulation status	
Ambulate independently	97 (80.2)
Ambulate with walking aid	24 (19.8)
Gender	
Female	86 (71.1)
Male	35 (28.9)
Ethnic groups	
Chinese	106 (87.6)
Malay	9 (7.4)
Others (Indian, Eurasian)	6 (5.0)
Pre-existing co-morbidities	
Hypertension	85 (70.2)
Diabetes	42 (34.7)
Renal impairment	21 (17.4)
Ischemic heart disease	25 (20.7)
Cerebrovascular accident	24 (19.8)
Dementia	5(4.1)
Types of fracture	
NOF	73 (60.3)
IT	48 (39.7)
Types of hip surgery	
Hemiarthroplasty	59 (48.7)
Dynamic hip screw/PFNA	52 (43.0)
THR	10 (8.3)
Days from fracture to surgery	5.0 (SD 4.3)
Post operative haemoglobin (g/dL)	9.7 (SD 1.7)
Drop in hemoglobin(g/dL)	1.7 (SD 1.0)
Caregiver required	
Yes	87 (71.9)
No	34 (28.1)
Ambulation without assistance at discharge	23 (19%)
Mean RLOS (days)	21.0 (SD 10.9)
Mean motor FIM gain	12.0 (SD 7.4)
Mean total FIM on admission	82.1 (SD 18.1)
Mean total FIM on discharge	94.2 (SD19.9)
Mean ambulation distance (m)	56.7 (SD 54.0)
Required walking aid at discharge	98 (81%)
Medical complications	
Cardiac complications	17 (14)
UTI	24 (19.8)

SD, Standard deviation, NOF, Neck of femur, IT, Intertrochanteric, PFNA, Proximal femoral nail anti-rotation; THR, Total hip replacement

Table 2: Univariate analysis of the demographics and factors associated with the ambulation distance and need for walking aid at discharge

Clinical factors	*Mean ambulation distance (meters)*	*p value*
Gender		
Female	55 ± 52	0.598
Male	61 ± 60	
Age		
≥ 75	44 (± 41)	0.07*
< 75	71 (63)	
CVA		
No	59 (± 57)	0.312
Yes	47 (± 36)	
Renal impairment		
Yes	37 (± 40)	0.03*
No	61 (± 56)	
HTN		
Yes	53 (± 52)	0.240
No	66 (± 59)	
Caregiver		
Yes	48 (± 45)	0.023*
No	80 ± (68)	
UTI after surgery		
Yes	35 (± 24)	0.024*
No	62 (± 58)	
Cardiac complications		
Yes	56 (± 56)	0.843
No	59 (± 42)	
FIM on admission		
≥80	67 (± 58)	0.001*
<80	32 (± 34)	
Ambulation		
Walks without help	105 (± 89)	0.004*
Walks with assistance	45 (± 38)	

Clinical factors	*No aid*	*Walking aid*	*p value*
Caregiver	11	76	0.009*
Age	74	75	0.594
Renal impairment	5	16	0.364
CVA	5	19	0.499
HTN	17	68	0.440
RLOS (days)	18	22	0.044*
Cardiac complication	2	15	0.523
UTI	3	21	0.277
FIM on admission	82	83	0.081

*signifies *p* value significant (*p* <.05); RLOS, Rehabilitation length-of-stay; CVA, Cerebrovascular accident; HTN, Preexisting hypertension; UTI, Urinary tract infection after surgery; FIM: Functional independence measure

power training. Secondly, goal setting is an important aspect of rehabilitation.[20] Trainers could take all these factors into consideration with exploring goals of walking distance with their patients.

Walking aid is frequently issued to the majority of hip fracture patients; however the subset of patients that can successfully be discharged without one has never been evaluated either routinely.[21] We explored predictors for independent walking without aid and results revealed those who can walk independently achieve further walking distance. Patients who needed less period for inpatient rehabilitation and those with more FIM gain have a higher likelihood of discharge without aid. This is valuable information for physiotherapists to consider weaning off walking aid as part of their hip fracture pathways for higher functioning patients. Thomas et al. revealed that most hip fracture patients are issued walking aids with lack of review of

Table 3: Variables that are significantly associated with ambulation distance and the need for walking aid using multiple linear regression analysis (R^2 = 46.8%)

Variables	*Coefficient (95% CI)*	*p value*
Ambulation distance (metres)		
1. Age	–0.63 (–1.47 to 0.22)	0.147
2. Without renal impairment	25.8 (3.82 to 47.53)	*0.022
3. UTI after surgery	12.12 (–8.80 to 33.00)	0.253
4. Requiring a caregiver	–8.63 (–27.51 to 10.26)	0.367
5. Admission FIM	1.13 (0.66 to 1.60)	*< 0.001
6. No assistance for ambulation	60.00 (39.97 to 80.07)	*< 0.001
Achieved ambulation without aid at discharge		
1. RLOS	–0.10 (–0.17 to 0.03)	*0.007
2. Achieved more motor FIM gain	0.012 (0.01 to 0.023)	*0.028
3. Requiring a caregiver	–0.26 (–0.42 to 0.11)	*0.001

*signifies *p* value significant (*p* <.05); CVA = cerebrovacular accident, UTI = urinary tract infection, FIM = Functional Independence Measure, RLOS = rehabilitation length-of-stay

their requirement. We hope our study can trigger more future studies to consider evaluating the need for a walking aid as part of functional outcome assessment in hip fracture patients graduating from their inpatient program.

Limitations

Firstly, several known variables and validated outcomes were not included in our review. These are pain score, muscles strength, distance-limited walk tests and balance assessments.[22,23] Secondly, we did not assess cognitive status in detail and these could have affected functional outcomes as previously reported.[24,25] In particular, we relied on past medical history from case records to determine if the hip fracture patients had pre-existing dementia. We did not assess in detail cognitive impairments such as postoperative delirium or utilize screening tools such as the Mini-Mental State Examination on these hip fracture patients. Thirdly, the small sample size in our study may not have detected significant predictors of functional outcomes and this should be validated with future prospective multi-center studies. Lastly, it is unclear if we could extrapolate these results to those who declined inpatient rehabilitation.

CONCLUSION

Our study highlights the importance of identifying clinical factors in hip fracture patients affecting ambulation distance, and the need for walking aid after inpatient rehabilitation. Hip fracture clinical pathways and the process of triaging of patients into suitable rehabilitation sites could be further improved by taking these factors into consideration when designing rehabilitation protocols. Future studies could include evaluating factors determining the need for walking aid after a course of hip fracture rehabilitation program.

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