Master's Thesis of Clinical Medical Sciences

Determinants of Long-term Outcome Following Clinical pathway for Rehabilitation after Hip Fracture

임상경로에 따라 재활 치료를 받은 고관절 골절 환자의 장기 결과의 결정 요인

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Graduate School of Medicine
Seoul National University
Clinical Medical Sciences Major

Ji-ho Kang

Abstract

Objectives: To evaluate the major determinants of successful functional outcomes following rehabilitation programs based on standardized clinical pathways after hip fracture surgery in older adults.

Methods: This was a retrospective cohort study performed in a tertiary rehabilitation facility. A total of 220 patients who had received unilateral hip fracture surgery were followed up from immediately post- to 6 months post-operation. Clinical pathways for rehabilitation included early, individualized rehabilitation, education for activities of daily living, review of general medical conditions, and arrangement of discharge settings. One geriatric rehabilitation specialist consecutively checked ambulatory function using 3-level grading, and patients were classified into good recovery and poor prognosis groups based on their ambulatory function at 6 months post-surgery. Logistic regression analysis was also performed with seven representative variables (age, sex, bone mineral density, Mini-Mental Status Examination (MMSE), Berg Balance Scale (BBS), premorbid ambulatory function, and length of hospital stay).

Results: A total of 86.8% of patients could walk with or without assistance at 6 months after surgery and 75.5% of patients involved in the rehabilitation program were classified into the good recovery group in this study. The good recovery group showed higher MMSE and BBS scores than did the poor prognosis group. The factors of the model most strongly correlated with recovery were MMSE and BBS.

Implications/impact on rehabilitation: This study showed that a well-designed rehabilitation program could improve ambulatory function in elderly patients after hip fracture surgery and that cognitive impairment and poor balance control may inhibit the recovery of ambulatory function.

Keyword：hip fracture, clinical pathway, rehabilitation program
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Table of Contents

List of Tables and Figures

Tables

Figures

Introduction

Hip fracture is a geriatric disease with multiple predisposing factors that may lead to falls, such as osteoporosis, weakness, and dizziness. The incidence of hip fracture differs by country. In South Korea, the age-standardized annual incidence rate of hip fractures in 2003 was 104.06 per 100,000, including 146.38 per 100,000 for women and 61.72 per 100,000 for men [1, 2]. Older people have a 5- to 8-fold increased risk of mortality during the first 3 months after hip fracture, and increased annual mortality persisted over time in both women and men following hip fracture [3]. Likewise, hip fractures, which mostly result from falls related to multiple predisposing risk factors in geriatric populations, are a major public health problem.

To achieve ambulatory function after surgical treatment, multi-disciplinary rehabilitation has been highlighted by geriatric and inpatient rehabilitation units. Multidisciplinary rehabilitation for hip fractures includes early mobility and self-care training, postoperative management monitored by a geriatrician, high-frequency additional occupational therapy combined with physical therapy, and accelerated discharge. Furthermore, home-based rehabilitation is required to decrease complications, to reduce transfers to intensive care units or nursing homes, and to improve walking ability. Halbert et al. (2007), in their review of randomized trials, reported that multidisciplinary rehabilitation decreased the likelihood that patients with hip fracture would have a poor outcome, including death or admission to a nursing home, by an additional 16% compared with traditional rehabilitation [4]. Recently, effective clinical pathways have been introduced for rehabilitation programs in many types of geriatric disease [5, 6]. Many studies have explored the effects of postoperative rehabilitation in hip fracture, and several clinical pathways for postoperative rehabilitation of hip fracture have been proposed [4, 7–9]. However, clinical pathways for the rehabilitation of acute hip fracture in Korea has not been well established due to the limited integration of care among orthopedic, geriatric, and rehabilitation specialties. Therefore, specialized inpatient rehabilitation services are not properly administered to patients with acute hip fracture in most general hospitals. For this reason, we developed clinical pathways for the rehabilitation of acute hip fracture, and patients with acute hip fracture have been involved since the program's inception.

In this study, we examined characteristics of patients involved in the clinical rehabilitation pathway for hip fracture to identify factors associated with functional outcomes.

Materials and Methods

Subjects

This was a retrospective cohort study performed in a tertiary rehabilitation facility. Between November 2009 and December 2015, 883 patients who had received unilateral hip fracture surgery and were transferred to the Department of Rehabilitation Medicine, and who agreed to be enrolled in the study were registered. We recruited 220 patients who met the following inclusion criteria: (1) hospitalization period between November 2009 and December 2015; (2) duration of inpatient rehabilitation >1 week; (3) age ≥65 years; (4) acute unilateral hip fracture (femur neck, intertrochanteric, subtrochanteric); and (5) time interval between onset of injury and operation ≤2 weeks. Surgical treatments included bipolar hemiarthroplasty, total hip arthroplasty, and open reduction and internal fixation (Fig. 1). Patients who had elective hip surgery due to osteoarthritis, infected hip, or avascular necrosis, and those who were readmitted due to peri-prosthetic fracture or prosthetic loosening were excluded. After patients were transferred to the Department of Rehabilitation Medicine, they participated in the Rehabilitation program for Hip fracture Functional Outcome Study (ReHipFOS) (Fig. 2).

Clinical rehabilitation pathway

ReHipFOS, the clinical pathway for rehabilitation evaluated in this study, includes early individualized rehabilitation, education for activities of daily living (ADLs), review of general medical conditions, appropriate management, establishment of further plans, and arrangement for discharge settings. The rehabilitation and education elements of this clinical pathway included transfer and gait training with an assistive device, education about hip precautions in ADLs, functional training for independent ADL, strengthening exercises for the hip girdle muscles, stretching exercises to increase flexibility of the lower extremities including the hip muscles, and fall-prevention education. Specifically, patients were involved in physical therapy twice a day and occupational therapy once a day for at least 20 minutes during the hospital day. Patients who were unable to walk before the surgery exercised on the tilt table, standing frame, and parallel bars, and patients who were able to walk before the surgery employed increased weight bearing according to the type of surgery and began walking at an early stage. When ambulatory function improved, cane gait was initiated and lower extremity strengthening exercises were performed using isotonic exercise equipment and Theraband. Patients were also trained to improve balance using balance equipment. The study protocol was approved by the Institutional Review Board of the Seoul National University Bundang Hospital, Republic of Korea (IRB number: B-1101-119-110).

Functional evaluation

To evaluate ambulatory function, one geriatric rehabilitation specialist consecutively checked patient ambulatory function during the premorbid stage, after transfer to rehabilitation medicine, at discharge, and at the 6-month follow-up using 3-level grading of ambulatory function according to Functional Ambulation Classification (level 3: Ambulation is independent and without supervision or physical assistance from another person. The patient may use assistive devices (except parallel bars), orthoses, and prostheses; level 2: Individual is able to walk at least 10 feet outside the parallel bars with physical assistance from only one person. Mechanical assistance from any device or ambulation aid (except parallel bars) may be used; level 1: Individual's ambulatory function does not reach level 2). Several measures were used to evaluate functional and cognitive status. To evaluate functional characteristics, we recorded data on premorbid mobility status, Dual-energy X-ray absorptiometry (DEXA) bone densitometry, length of hospital stay, and the following instruments:

i) Modified Barthel Index (MBI): The MBI measures the individual's performance on 10 ADLs [10]. The scores for each item in the MBI are based on the amount of physical assistance required to perform the task, and the items are summed to give a score ranging from 0 to 100.

ii) Mini-Mental Status Examination (MMSE): This screening test is a brief, objective measure of cognitive functioning [11]. The MMSE has a maximum score of 30 points, and the questions are grouped into seven categories, each representing a different cognitive domain or function.

iii) Geriatric Depression Scale (GDS): The GDS is the most commonly used depression self-report scale and consists of 30 items [12]. The items, which have yes or no answers, have been useful in distinguishing depressed from normal subjects based on characteristics of depression in elderly populations.

iv) The 10-m walk test: This test is a simple gait assessment that can be used to determine walking speed. For the test, the time taken to walk 10 m is measured using a stopwatch, and walking speed is calculated by dividing the distance covered by the time (m/sec) [13].

v) Berg Balance Scale (BBS): The BBS was developed as a performance-oriented measure of balance in elderly individuals [14]. The items include simple mobility tasks and more difficult tasks. The BBS consists of 14 items that scored on a scale of 0 to 4; the maximum total score is 56.

Data analysis

We compared ambulatory function during the premorbid state and at 6 months after surgery and classified patients into two groups accordingly. The patients who had ambulatory function above the assisted level that had not deteriorated after surgery were classified into the good recovery group, and the others, including patients whose ambulatory function was at level 1 before and after surgery, were classified into the poor prognosis group. We used the Mann–Whitney test, Kruskal–Wallis test, and Chi square test to compare groups. A multiple logistic regression analysis was used to identify variables that had significant effects on ambulatory function.

Results

Demographic data

The demographic characteristics of patients are listed in Table 1. Of the 220 patients (mean age, 80.6 ± 7.4 years; 61 males and 159 females), 108 had fractures on their right side, and 112 on the left. A total of 114 patients had previous hip surgery. The mean body mass index (BMI) was 21.4 ± 3.9, and mean T-score of bone mineral density was -3.1 ± 1.2. With regard to cognitive functioning, the mean MMSE score was 19.4 ± 7.2, and the mean Clinical Dementia Rating (CDR) was 1.0 ± 1.0. The mean BBS was 18.7 ± 15.3, and the mean time taken to walk 10 m was 59.9 ± 52.5 seconds. In addition, the mean GDS was 11.2 ± 7.6. The patients were classified into three groups based on each of the following characteristics: level of fracture (114 intertrochanteric; 102 femur neck; 4 subtrochanteric); type of operation (157 bipolar hemiarthroplasty; 7 total hip replacement arthroplasty; 56 open reduction and internal fixation); and discharge setting (109 home; 95 secondary rehabilitation hospital; 16 nursing home).

Recovery of ambulatory function after hip fracture

Ambulatory function at each time period is listed in Table 2. Although 93.6% of patients could walk with or without assistance (independent ambulation: 81.8%; assisted ambulation: 11.8%) in the premorbid state, only

72.3% could do so (independent ambulation: 1.8%; assisted ambulation: 70.5%) when they were transferred to rehabilitation medicine. A total of 85.5% of patients could walk with or without assistance (independent ambulation: 35.0%; assisted ambulation: 50.5%) at discharge, and 86.8% of patients could do so (independent ambulation: 70.9%; assisted ambulation: 15.9%) at 6 months after surgery. Premorbid ambulatory function, the type of fracture, and the type of surgery did not have significant effects on the prognosis for ambulatory function after hip fracture.

Change in ambulatory function between premorbid and POD 6 months

Of the 220 patients, 166 were included in the good recovery group, and 54 in the poor prognosis group (Fig. 3). Of 180 patients whose ambulatory function was level 3 before surgery, 136 patients (75.6%) remained at level 3 after surgery. Of 26 patients whose ambulatory function was at level 2 before surgery, 21 (80.8%) improved from level 2 to 3 or remained at level 2. In addition, of the 14 patients whose ambulatory function was level 1 before surgery, 9 (64.3%) improved to level 2 or 3, i.e., good recovery.

Of the 180 patients whose ambulatory function was level 3 before surgery, ambulatory function deteriorated to level 1 or 2 in 44 (24.4%) after surgery. Of the 26 patients whose ambulatory function was level 2 before surgery, the ambulatory function of 5 (19.2%). decreased to level 1. Five patients whose ambulatory function remained at level 1 from before to after surgery belonged to the poor prognosis group.

The demographic characteristics of each group are listed in Table 3. The good recovery group showed higher MMSE and BBS, but lower CDR than the poor prognosis group. There were no significant differences between the two groups except in MMSE, BBS, and CDR.

Factors influencing ambulatory function at the 6-month follow-up

The results of stepwise multiple regression analysis for ambulatory function after hip fracture are summarized in Table 4. We used the backward elimination method with seven independent variables (age, sex, bone mineral density, MMSE, BBS, premorbid ambulatory function, and length of hospital stay). The highest proportion of explained variance in ambulatory function after hip fracture was seen for the model that included MMSE and BBS ($R^2 = 0.180$). The model factors most predictive of recovery were MMSE ($b = 0.344$, $p < 0.001$) and BBS ($b = 0.190$, $p = 0.023$).

Table 1. Patients demographics

Age (yr)	80.6 ± 7.4
Sex	
Male	61
Female	159
Laterality	
Right	108
Left	112
BMI (kg/m2)	21.4 ± 3.9
T-score of bone mineral density	-3.1 ± 1.2
MMSE	19.4 ± 7.2
CDR	1.0 ± 1.0
MBI	33.1 ± 20.1
BBS	18.7 ± 15.3
GDS	11.2 ± 7.6
Time taken to walk 10 m (sec)	59.9 ± 52.5
Previous hip surgery	27
Level of fracture	
Intertrochanteric	114
Femur neck	102
Subtrochanteric	4
Type of operation	
Bipolar hemiarthroplasty	157
Total hip replacement arthroplasty	7
Open reduction and internal fixation	56
Time interval (days)	
Onset of injury to operation	5.6 ± 7.3
Operation to start of physical therapy	7.8 ± 6.1
Admission to discharge	27.8 ± 36.0
Discharge setting	
Home	109
Secondary rehabilitation hospital	95
Nursing home	16

Values are presented as the mean ± standard deviation.

BMI, Body Mass Index; MMSE, Mini–Mental State Examination; CDR, Clinical Dementia Rating; MBI, Modified Barthel Index; BBS, Berg Balance Scale; GDS, Geriatric Depression Scale.

Table 2. Recovery of ambulatory function after hip fracture

Clinical judgment (points)	Premorbid	Transfer	Discharge	6-month follow-up
Independent ambulation (3)	180 (81.8%)	4 (1.8%)	77 (35.0%)	156 (70.9%)
Assisted ambulation (2)	26 (11.8%)	155 (70.5%)	111 (50.5%)	35 (15.9%)
Non-ambulatory (1)	14 (6.4%)	61 (27.7%)	32 (14.5%)	29 (13.2)

Table 3. Differences between the good recovery and poor prognosis groups

	Good recovery (n = 166)	Poor prognosis (n = 54)
Age (yr)	80.2 ± 7.4	81.9 ± 7.2
Sex		
Male	46	15
Female	120	39
Laterality		
Right	83	25
Left	83	29
BMI (kg/m^2)	21.2 ± 3.8	21.7 ± 4.4
T-score	-3.1 ± 1.2	-3.0 ± 1.2
MMSE	20.6 ± 6.7*	15.5 ± 7.1
CDR	0.8 ± 0.9*	1.4 ± 1.1
MBI	35.2 ± 19.7	26.5 ± 19.6
BBS	21.4 ± 15.3*	10.9 ± 12.1
GDS	10.6 ± 7.3	13.4 ± 8.2
10-m walking speed (sec)	58.5 ± 44.7	64.6 ± 72.7
Previous hip surgery	21	6
Level of fracture		
Intertrochanteric	89	25
Femur neck	73	29
Subtrochanteric	4	0
Type of operation		
Bipolar hemiarthroplasty	117	40
Total hip replacement arthroplasty	6	1
Open reduction and internal fixation	43	13
Time interval (days)		
Onset of injury to operation	5.4 ± 8.0	6.3 ± 4.3
Operation to start of physical therapy	7.6 ± 5.6	8.3 ± 7.3
Admission to discharge	32.4 ± 46.9	36.5 ± 22.0
Discharge setting		
Home	87	22
Secondary rehabilitation hospital	67	28
Nursing home	12	4

* $p < .01$

Values are presented as the mean ± standard deviation.

BMI, Body Mass Index; MMSE, Mini–Mental State Examination; CDR, Clinical Dementia Rating; MBI, Modified Barthel Index; BBS, Berg Balance Scale; GDS, Geriatric Depression Scale

Table 4. Factors influencing ambulatory function at 6-month follow-up

	Δf	β	R^2	F
Ambulatory function				
(Constant)	1.792	-	0.180	15.470
MMSE*	-	0.344	-	-
BBS**	-	0.190	-	-

* $p < 0.001$, ** $p < 0.05$

MMSE, Mini–Mental State Examination; BBS, Berg Balance Scale

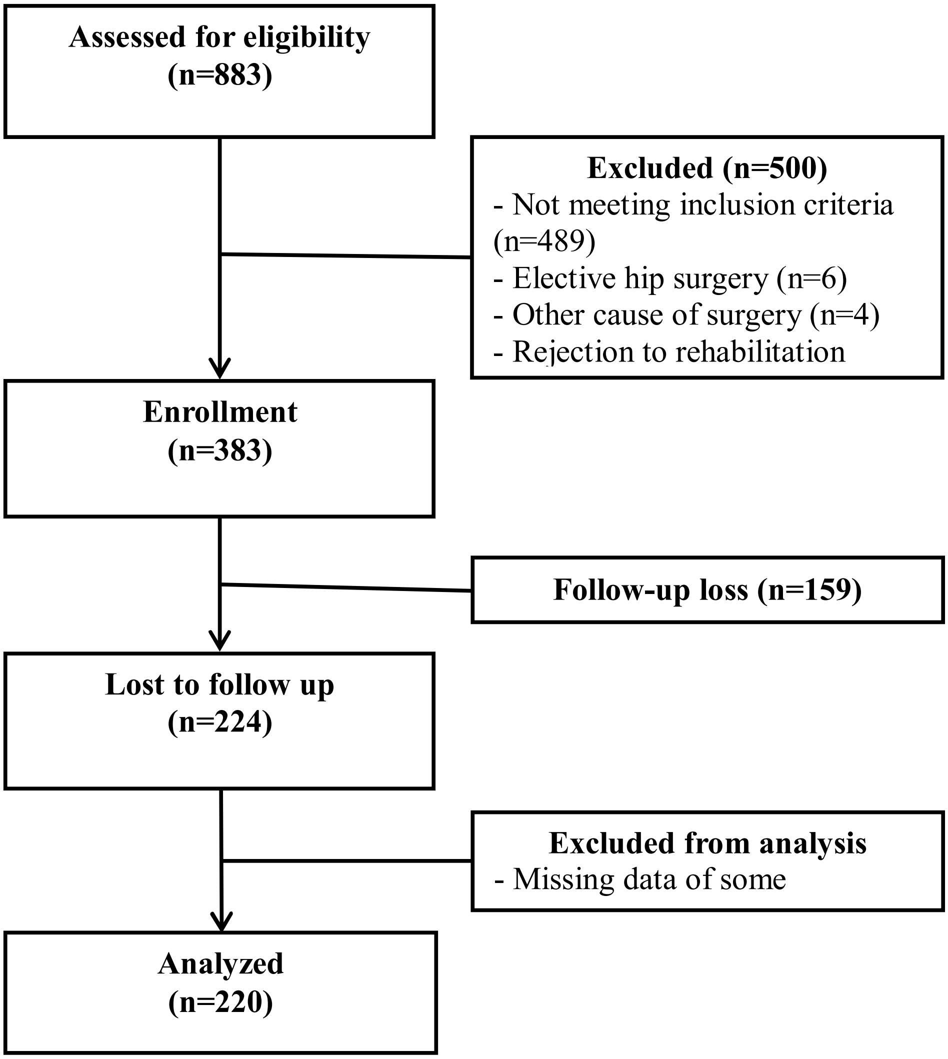


Figure 1. Flow chart of subject recruitment

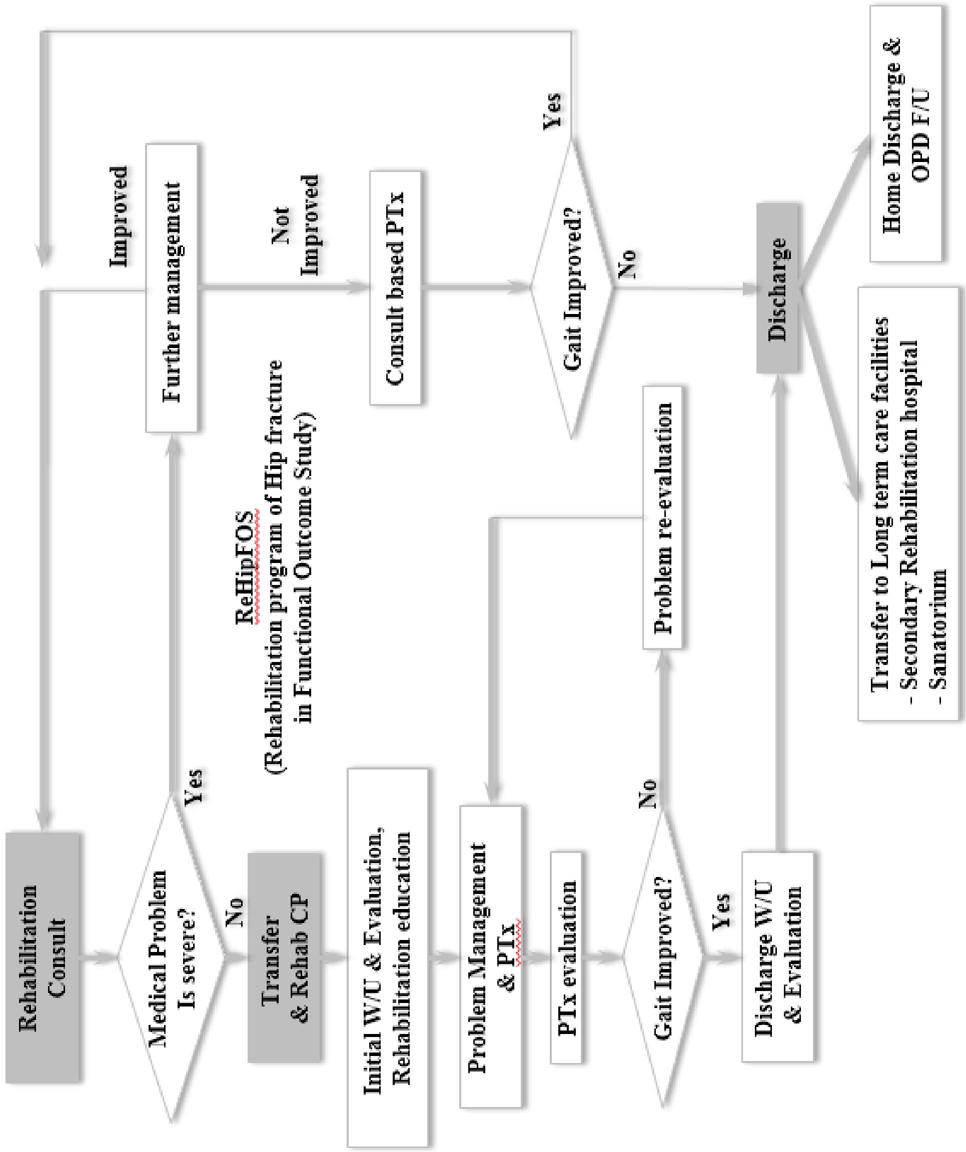
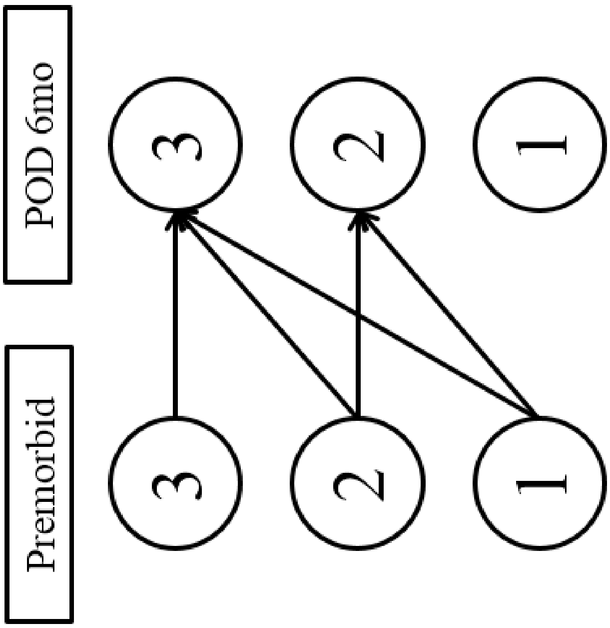


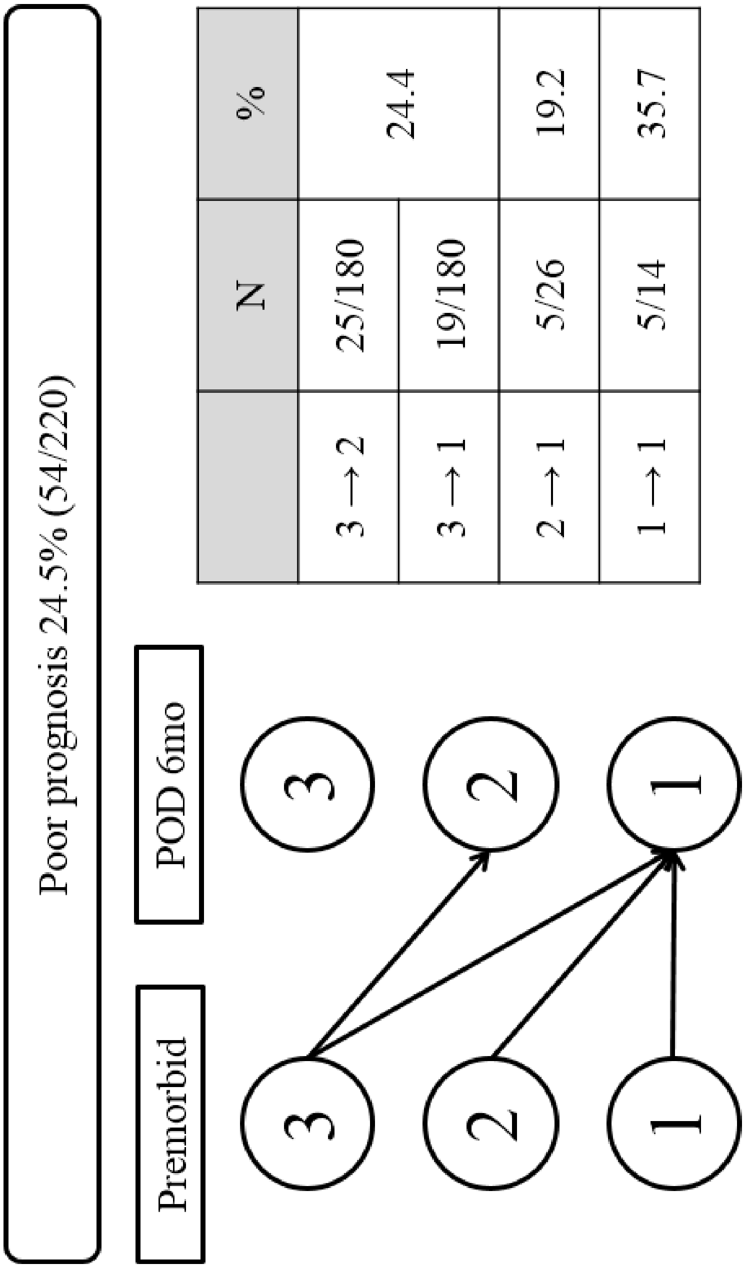
Figure 2. Clinical pathway

Good recovery 75.5% (166/220)



	N	%
3 → 3	136/180	75.6
2 → 3	15/26	80.8
2 → 2	6/26	
1 → 3	5/14	64.3
1 → 2	4/14	

Figure 3-(1). Change of ambulatory function between premorbid and 6-month follow-up in good recovery group



	N	%
3→2	25/180	24.4
3→1	19/180	
2→1	5/26	19.2
1→1	5/14	35.7

Figure 3-(2). Change of ambulatory function between premorbid and 6-month follow-up in poor prognosis group

Discussion

Only 72.3% of hip fracture patients could walk with or without assistance (independent ambulation: 1.8%; assisted ambulation: 70.5%) when they were transferred to rehabilitation medicine, but 86.8% of patients could do so (independent ambulation: 70.9%; assisted ambulation: 15.9%) at 6 months after surgery.

In our study, 75.5% of patients involved in the ReHipFOS program gained good ambulatory function. In a previous study, it was difficult to achieve functional ambulatory recovery in hip fracture patients [15]. Koot et al. (2000) reported that 64 of 177 (36%) patients had regained the level of mobility that they had before the injury at 4 months follow-up. Miller's (1978) retrospective analysis of outcomes in 360 patients with fractures of the hip showed a return to preinjury ambulatory status in 51% of patients [16, 17]. Kitamura et al. (1998) reported that at 1-year follow-up in Japan, 67% of hip fracture patients who underwent ambulation training after surgery, but who were not involved in a postoperative rehabilitation protocol specific to hip fracture, recovered to pre-surgery ambulatory status [18]. In the present study, the prognosis for functional recovery in hip fracture patients was better than that in previous studies.

According to several guidelines for hip fracture treatment, after hip fracture surgery, patients should receive a coordinated multidisciplinary rehabilitation program; furthermore, it is important that rehabilitation start from the time of admission [19, 20]. However, current clinical pathways operating in countries other than Korea are mostly developed and maintained by orthopedic surgeons and physicians, and the focus is on reducing mortality, the length of hospital stay, and medical complications [21–24]. Furthermore, there are no proper and systematic rehabilitation protocols for hip fracture patients in Korea. In our clinical pathway, rehabilitation is systematically organized and managed by the geriatric rehabilitation doctor, with a focus on recovery of ambulatory function. In this study, we established clinical pathways considering various aspects of hip fracture, and these resulted in significantly improved ambulatory function at 6 months after surgery.

Unlike the findings of previous studies, where the patients who were older, had cognitive impairment, or had poor ambulatory function prior to hip fracture exhibited poor functional recovery, in this study, functional recovery in hip fracture patients was associated with cognitive function and balance control upon transfer to rehabilitation [15–18, 25]. The mean age of our poor prognosis group was not statistically different from that of the good recovery group, although it tended to be somewhat higher. Of the 220 patients, 26 (11.8%) had level 2, and 14 (6.4%) had level 1 preoperative ambulatory function at the initial classification. This imbalance in the number of patients in these groups may explain why significant results were not obtained for improvement relative to the premorbid state.

There are several limitations to this study. First, we initially evaluated 883 patients, but only 220 patients (57.4%) visited the outpatient clinic of the Department of Rehabilitation for follow-up 6 months after surgery. The reason for the relatively low follow-up rate may be that patients with improved ambulatory function did not wish to visit the outpatient clinic, or other patients with poor ambulatory function might no longer be interested in visiting the outpatient clinic. Therefore, it is possible that these patients' prognosis was over- or underestimated. Second, patients' ambulatory function was evaluated using a 3-level grading system based on ambulatory function according to the Functional Ambulation Classification. The grading criteria were very clear, and all patients enrolled in this study were checked by one geriatric rehabilitation specialist. Third, the difference between the good recovery group and poor prognosis group was arbitrary, and the cutoff value was not clear. Finally, we did not compare the results of treatment with the prognosis of patients in a control group who had hip fracture and surgery, but were not involved in the ReHipFOS program. In this study, all patients enrolled were transferred to the Department of Rehabilitation, and all were involved in a proper rehabilitation program. Therefore, we could not directly compare the effects of ReHipFOS with results of no treatment. For this reason, prospective comparative studies are required.

Conclusions

This study showed that a well-designed clinical pathway for hip fracture could restore ambulatory independence in most elderly patients. Furthermore, based on our results, the major determinants of poor ambulatory function after hip fracture include cognitive impairment and poor balance.

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국문 초록

목적 : 노인 환자에서 고관절 골절 수술 후 표준화 된 임상 경로를 기반으로 한 재활 프로그램에 따른 성공적인 기능적 결과의 주요 결정 요인을 평가하고자 한다.

방법 : 이 연구는 제 3 차 재활 시설에서 시행 한 후향적 코호트 연구이다. 일측성 고관절 골절 수술을 받은 총 220 명의 환자를 수술 직후부터 수술 후 6 개월까지 추적 관찰 하였다. 재활을 위한 임상 경로에는 조기, 개별화 된 재활, 일상 생활 활동을 위한 교육, 일반적인 건강 상태 검토 및 퇴원 환경 설정이 포함되었다. 외래에서 노인 재활 전문의 한 명이 3단계 등급 분류법을 사용하여 보행 기능을 평가했으며 환자는 수술 후 6 개월에 통원 기능에 따라 회복이 양호한 그룹과 예후가 나쁜 그룹으로 분류되었다. 로지스틱 회귀 분석은 7 가지 대표 변수 (연령, 성별, 골밀도 검사, 간이정신상태검사 (MMSE), 베르그 균형 척도 (BBS), 수상 전 보행 기능 및 입원 기간)를 사용하여 수행되었다.

결과 : 총 86.8%의 환자가 수술 후 6개월 째 도움 여부와 상관없이 걸을 수 있었고, 재활 프로그램에 참여한 환자의 75.5 %는 이 연구에서 좋은 회복 그룹으로 분류되었다. 회복이 좋은 군은 예후가 나쁜 군보다 MMSE와 BBS 점수가 높았다. 회복과

가장 밀접하게 관련된 모델의 요인은 MMSE와 BBS였다.

재활에 대한 시사점 / 영향 : 본 연구는 고관절 골절 수술 후 노인 환자에서 잘 설계된 재활 프로그램으로 보행 기능을 향상시킬 수 있으며 인지 기능 장애와 균형 감퇴 조절이 보행 기능 회복을 저해 할 수 있음을 보여주었다.

주요어 : 고관절 골절, 임상 경로, 재활 프로그램

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