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ORIGINAL PAPER

Optimizing rehabilitation strategies for elderly patients with femoral fracture – a prognostic perspective

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ABSTRACT

Introduction and aim. Femoral fractures in elderly people significantly impact their functional recovery and independence. Identifying reliable prognostic markers upon admission can facilitate optimal resource allocation and improve rehabilitation outcomes. This study aims to evaluate the predictive significance of pre-injury functional status, comorbid conditions, and cognitive function in determining independent living one year after injury.

Material and methods. This retrospective observational study involved 132 consecutive patients over the age of 60 years who had suffered femoral fractures and were admitted to a specialized geriatric orthopedic unit. Prior to hospitalization, all patients were capable of independent living. Upon admission, three key prognostic indicators were evaluated: (1) the level of pre-injury performance in activities of daily living (ADL); (2) the absence of comorbidities that could hinder recovery; and (3) cognitive function, measured by a Pfeiffer mental questionnaire score above 7. The relationship between these prognostic factors and the ability to live independently one year after injury was examined using odds ratios (OR) with 95% confidence intervals (CI).

Results. Among patients who possessed all three positive prognostic factors, 92% maintained independent living status after one year. In contrast, individuals with one, two, or three unfavorable predictors exhibited progressively lower rates of independent living, recorded at 96%, 82%, and 55%, respectively. The median duration of hospitalization within the first year varied across these groups, averaging 23, 74, 91, and 96 days, respectively. Furthermore, one-year mortality rates were found to be associated with the presence of comorbid conditions: 0% among those with only a femoral fracture, 14% in patients with one or two additional conditions, and 24% for those with three or more comorbidities.

Conclusion. Simple and robust admission predictors including pre-injury ADL performance, absence of significant comorbidities, and preserved cognitive function can effectively estimate long-term functional outcomes in patients with femoral fracture in elderly people. These findings support the optimization of rehabilitation resources to improve recovery and promote independent living.

Keywords. cognitive function, elderly rehabilitation, femoral fracture, independent living, prognostic factors

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Introduction

Femoral fractures are one of the common musculoskeletal injuries, especially in the elderly population. With the increase in life expectancy and the elderly population in various countries, the incidence of femoral fractures is also rising.[1,2] This injury can have a significant impact on the patient's quality of life, considering the importance of the femoral in supporting the body and aiding mobility.[3] Therefore, attention to the aspects of medical treatment, rehabilitation, and social support becomes increasingly important to ensure optimal recovery for the patient.[4,5]

In recent decades, various advances have been made in surgical procedures for femoral fractures, including internal fixation techniques, the use of more advanced implants, and joint replacement procedures for certain cases.[6,7] In addition, specialized rehabilitation programs have also been developed to help patients regain motor functions after surgery.[8] Social support, both from family and healthcare services, also plays an important role in patient recovery, especially in improving adherence to rehabilitation therapy and reducing the risk of postoperative complications.[9–11]

One of the crucial aspects in the management of femoral fractures is the assessment of prognosis from the moment the patient first enters the healthcare facility.[12] This assessment can help allocate resources more optimally, thus increasing the efficiency of the healthcare system.[13] Factors such as the patient's age, overall health condition, mental status, and ability to perform daily activities (Activities of Daily Living/ADL) before the injury can be important indicators to determine the most appropriate management strategy.[14–16]

Previous studies have identified various factors that can influence clinical outcomes in patients with femoral fractures, including patient characteristics and treatment approaches applied.[17] Analysis of these factors allows identification of key challenges in care and helps to formulate more effective health policies. However, there are still gaps in research on how the condition of patients before experiencing an injury can affect treatment outcomes and recovery. Therefore, this study focuses on evaluating the condition of patients before injury when they are first treated, to provide deeper insights into the factors that contribute to the final recovery outcomes of patients with femoral fractures.

Aim

This study aims to identify key prognostic factors that influence the likelihood of independent living one year after a femoral fracture in elderly patients. Specifically, it evaluates the impact of preinjury functional status, comorbid medical conditions, and cognitive function upon admission in predicting long-term recovery outcomes. By establishing reliable predictive markers, this research seeks to optimize rehabilitation resource allocation and improve post-fracture care strategies for older adults.

Material and methods

Study design

This study is a retrospective observational study that evaluates patients over 60 years of age who live independently and have been treated in a specialized orthopedic unit with 10 beds due to femoral fractures. This unit has a higher nurse-to-bed ratio compared to standard orthopedic wards (1.6 beds vs. 1.2 beds) to prevent patient isolation and enhance physical and mental activation. During the year 2023 to 2024, a total of 132 patients, consisting of 79 women and 53 men, were treated in this unit. Patients are treated until they show improvement or can be discharged home. All medications that are recognized to exert effects on the central nervous system must be avoided to the greatest extent possible. The patient is scheduled for surgery at the earliest opportunity; however, procedures during the night must be avoided. A sample size calculation was performed based on previous studies that assessed functional recovery in elderly patients with femoral fractures. Using a power of 80% and an effect size of 0.5, the required sample size was determined to be at least 120 participants, ensuring adequate statistical power to detect significant associations.

Inclusion criteria were: (1) age >60 years, (2) independent living before hospitalization, (3) no history of severe neurological or psychiatric disorders affecting cognition, and (4) ability to communicate and provide consent. Three prognostic factors were evaluated at admission: (1) preinjury activities of daily living (ADL) using the Katz Index, (2) absence of comorbid medical conditions that could impede recovery, and (3) cognitive function scores greater than 7 on the Short Portable Mental Status Questionnaire (SPMSQ).

Functional status was assessed using the Katz index of Independence in ADL. This index assesses six fundamental self-care tasks, including bathing, dressing, toileting, transferring, continence management, and eating. The scale categorizes individuals from A (completely independent) to G (entirely dependent), where a score of B or above signifies maintained functional independence. The Katz index has been widely validated, demonstrating strong inter-rater reliability and predictive validity in assessing functional decline in older adults. Cognitive function was evaluated using the Short Portable Mental Status Questionnaire (SPMSQ), a 10-item screening tool that assesses orientation, memory, and basic problem solving abilities. The total score ranges from 0 to 10, with 0–2 errors classified as normal cognition, 3–4 errors indicating mild cognitive impairment, 5–7 errors suggesting moderate cognitive impairment,

and 8 or more errors reflecting severe cognitive impairment. A score of >7 was used as the cutoff point, as previous research has shown that people with fewer errors tend to have better rehabilitation outcomes and greater independence after fracture.

Previous studies indicating that an ADL score of B or higher is associated with a significantly higher likelihood of independent living after rehabilitation, while an SPMSQ score of >7 has been associated with preserved cognitive function and better rehabilitation outcomes.[14,16,18] Medical conditions at the time of admission were classified according to whether additional health problems or injuries, apart from the fracture, which could complicate the rehabilitation process. These included conditions such as stroke, emphysema, uncontrolled diabetes, or fractures in other limbs.

Data collection

Data were collected from patient medical records, including general medical conditions, functional levels (ADL), and cognitive levels (SPMSQ). The Katz index and SPMSQ are standard assessment tools used in the orthopedic unit as part of routine admission procedures for elderly patients. These measures are incorporated into patient records to guide rehabilitation planning and predict long-term functional outcomes. Additionally, patients were advised to avoid medications known to affect the central nervous system (CNS) to the greatest extent feasible. This precaution was taken to minimize possible confounding effects on cognitive and functional evaluations, as CNS-active drugs, such as sedatives, antipsychotics, and certain analgesics, can alter cognitive function, alter alertness, and affect motor coordination. By limiting their use, cognitive function (SPMSQ) and activities of daily living (Katz index) more accurately reflected patients' baseline and recovery status rather than transient drug-induced effects. Furthermore, we recorded the functional status of the patients after discharge from the hospital, their living conditions, and whether the patients were readmitted to the hospital within one year after the injury.

Data analysis

The percentage of patients who maintained independent living at home one year after the fracture was analyzed in relation to different covariates using logistic regression. Covariates were gradually incorporated and the significance of each predictor was expressed as odds ratios with 95% confidence intervals. To identify factors that influence the total number of days of hospitalization within a year, an analysis of variance was performed. Before analysis, this variable underwent a logarithmic transformation to achieve a more normalized distribution.

Ethical approval

This study has received ethical approval from the Health Research Ethics Committee with number 368.6/II.3.AU/F/KEPK/II/2023. All respondents received complete information about the purpose and procedures, and their participation was voluntary. The researcher ensures the confidentiality of the respondents' personal data and that it is only used for the purposes of this study. Written consent was obtained from each respondent before data collection began.

Results

The study included 132 patients, consisting of 79 women (59.8%) and 53 men (40.2%). The mean age was 74.3 ± 6.8 years (range: 61–89 years). Most of the patients (68%) lived with family members, while 32% lived alone. The majority (81%) had at least one comorbid condition, with hypertension (47%) and diabetes mellitus (29%) being the most common. The educational levels varied, with 35% having only primary education, 40% completing secondary education, and 25% attaining higher education.

Table 1 shows the distribution of patients according to ADL levels, general medical conditions, and cognitive function. Three independent factors were identified that predicted the probability of independent living after one year (Table 2): an ADL level of at least B, the absence of comorbidities that could hinder rehabilitation, and an SPMSQ score greater than 7. When each predictor is simply categorized by its presence or absence, the predictive accuracy remains largely unaffected.

These three characteristics correspond to distinct subgroups with varying healthcare needs. Covariance analysis indicates that evaluating activities of daily living, overall health status, and cognitive function can help predict both the length of initial hospitalization and the total number of hospital days in the first year after the fracture. Table 3 illustrates the proportion of patients who continued to live in their own home one year post-fracture. Patients who passed away were categorized along with those who neither returned home upon discharge nor remained at home after one year. In particular, only 2% of the people who met all three positive criteria required long-term institutional care. To assess the predictive value of different factors, we examined variables such as age, sex, fracture type, social network size, frequency of social interactions (more than once a month), living alone, use of mobility aids, receipt of home care services, and the ability to perform essential daily activities like cooking, cleaning and shopping within a limited time frame. However, no other factors demonstrated stronger predictive power. Figure 1 illustrates the association between the number of favorable predictors and the total days inpatient during the first year following the fracture, showing both the median and percentile distributions.

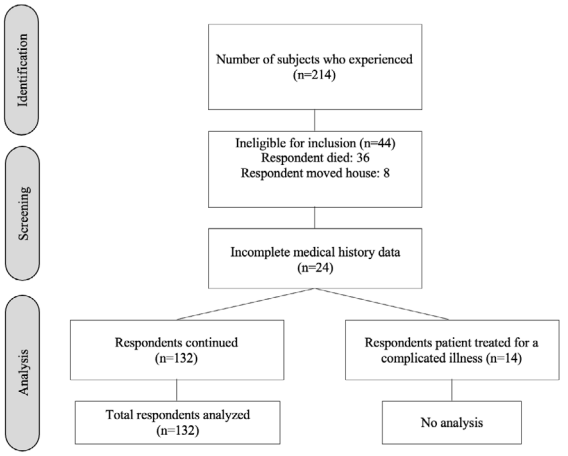

Fig. 1. Flow diagram for participant assignment in this study

Over the year, 30 individuals died, with ten fatalities occurring during the initial hospitalization. The predicted mortality upon admission was solely based on the number of preexisting medical conditions. Fractures alone (n=56) demonstrated a mortality rate of 0%. The death rate was 14% when one or two additional disorders were identified (n=125); however, with three or more additional diagnoses (n=51), it increased to 24% ($p<0.001$; chi-square analysis).

Table 1. Distribution of 132 patients according to pre-injury activities of daily living (ADL), general medical condition, and cognitive function[a]

	n (%)	Mean age (year; range)	Mean initial hospital stay (days, SD)	Mean hospital stay during the year (days, SD)	Discharge to own home (%)	At home after one year (%)
ADL function						
Good*	105 (79.5)	80.2 (60–84)	15 (12)	23 (34)	91	81
Dependent	37 (20.5)	84.1 (65–82)	20 (15)	73 (62)	52	33
Concomitant medical conditions**						
Yes	65 (49.2)	81.5 (60–84)	19 (15)	25 (27)	97	89
No	67 (50.8)	78.9 (60–82)	13 (8)	89 (112)	75	61
Cognitive function						
Lucid***	103 (78.1)	79.2 (60–82)	14 (9)	39 (52)	98	85
No lucid	29 (21.9)	81.6 (65–84)	21 (16)	92 (97)	52	43

[a] * – the patient was at least able to dress and undress independently (A or B on the Katz et al. (1963) graded scale),
** – impairing rehabilitation (Ceder et al. 1980),
*** – >7 points on the Pfeiffer (1975) ten-item questionnaire

This study explores the association between the number of favorable prognostic factors and the total number of hospitalization days among patients with femoral fractures, regardless of their specific diagnosis, within the first year after injury. The outlined sections represent the median values and encompass 50% of the data, corresponding to the interquartile range. The whiskers extend to the lower and upper limits of the box, adjusted by ±1.0 times the width of the box. Asterisks denote data points positioned beyond the box limits by ±1.5 times the width of the box, while circles indicate values exceeding the box limits by ±3.0 times the width of the box.

Table 2. Predictors for independent living one year after hip fracture

	Odd ratios	95% CI
ADL	3.5	1.3–9.1
General condition	2.9	1.3–6.1
Mental condition	2.4	1.9–4.9

Table 3. The outcome and use of health care resources during the year after fracture were related to the number of positive predictors

Positive predictors	n	Mean initial hospital stay (days, SD)	Mean hospital stay during the year (days, SD)	Discharge to own home (%)	At home after one year (%)
0	22	22 (15)	109 (96)	55	27
1	40	22 (17)	76 (91)	80	63
2	72	17 (11)	53 (74)	82	76
3	92	12 (7)	23 (23)	96	92

Discussion

Various indicators for prognosis after femoral fractures have been identified in research aimed at uncovering generally significant characteristics, including variables related to care. Research shows that overall health of the patient and the level of activity before fracture have a significant impact on the final outcome. According to Chow (2023), diagnosis, the number of activities of daily living (ADL), and the level of patient orientation were important factors for postoperative function. Many publications also identify age as a major predictor.[19]

In this study, separate inclusion of age did not improve the precision of the prediction for outcomes related to daily activities, overall health, and mental status.[20] This indicates that the three components used are sufficient to represent the biological age of the patients.[21] Surprisingly, the evaluation of ADL function and cognitive condition one week after surgery did not improve the prediction.[18,22] This reinforces findings in modern orthopedic care showing that show pre-fracture condition is a major factor in determining patient prognosis.[23]

Several studies have documented parameters related to mortality in the context of femoral fractures. Age and comorbidities are often identified as predictors of mortality, but several studies also show a relationship between mortality and walking ability.[24] Additionally, poor cognitive status has also been associated with an increased risk of mortality.[25,26]

Understanding these factors is crucial to optimal utilization of rehabilitation unit resources. Patients with

a very good prognosis do not require intensive care that is more needed by patients with a moderate prognosis.[27,28] In addition, understanding the predictive importance of these patient characteristics allows for more effective comparisons between different treatment modalities.[29] It is important to note that these findings currently lack sufficient precision to warrant the exclusion of patients with a poor prognosis from rehabilitation initiatives intended to enhance their functional recovery after fractures.

The three initial indicators associated with the need for hospitalization or institutional care after a femoral fracture do not show a significant correlation with one-year mortality.[30] This is consistent with the occurrence of other diagnoses related to fractures, and the management of these conditions imposes a significant strain on patients.[31,32] This pressure may become an unbearable burden when combined with other medical conditions, but it is often well tolerated by individuals who previously lived independently, regardless of their age.[33]

When the patient is admitted to the hospital, it is recommended to use the Katz ADL and Pfeiffer SPMSQ assessments together with standard medical history and physical examination documentation.[34] These assessment tools provide clear and reliable data that can be used to improve the allocation of available rehabilitation resources. Furthermore, this tool can also be beneficial in evaluating the effectiveness of various treatment methods, allowing a more structured and evidence-based approach in the treatment of patients with femoral fractures. The findings of this study emphasize the importance of early screening for functional and cognitive status prior to injury in elderly patients with femoral fractures. By integrating Katz's ADL and SPMSQ assessments into standard admission protocols, healthcare providers can improve rehabilitation planning and optimize resource allocation. These results advocate for structured rehabilitation strategies tailored to patient-specific prognostic factors, which may improve long-term independence outcomes. Although this study focuses on ADLs, comorbidities and cognition, other important factors such as social support, type of surgical intervention, and access to post-discharge rehabilitation have not been studied and can affect recovery. In addition, this study was conducted in a specialized orthopedic unit, which can limit generalization. Rehabilitation compliance was not systematically assessed, which could affect results. Future research should address these limitations by including a broader patient population and additional confounders.

Conclusion

This study emphasizes that the condition of the patient before experiencing a femoral fracture has a significant impact on the postoperative prognosis. Factors such as the level of activity before injury, overall health, and the patient's mental state have proven to be more relevant to determine rehabilitation outcomes compared to age individually. Initial evaluation using the Katz ADL scale and Pfeiffer SPMSQ provides accurate data and can help with care planning and more effective allocation of rehabilitation resources. Furthermore, although age and comorbidities are often associated with mortality, this study shows that walking ability and cognitive status are also factors that cannot be overlooked in predicting postoperative outcomes. The use of a more focused approach on patient characteristics allows for the optimization of more personalized care and rehabilitation.

Declarations

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Author contributions

Conceptualization, E.B.S., P.A.W.S. and E.S.; Methodology, E.B.S. and P.A.W.S.; Validation, P.A.W.S., E.S. and A.D.A.; Formal Analysis, P.A.W.S. and E.S.; Investigation, E.B.S.; Resources, E.B.S. and P.A.W.S.; Data Curation, P.A.W.S. and A.D.A.; Writing – Preparation of Original Draft, E.B.S. and P.A.W.S.; Writing – Review & Editing, P.A.W.S.; Visualization, P.A.W.S.; Supervision, E.B.S.

Conflicts of interest

All author declare have no conflict of interest.

Ethics approval

This study was approved by the local ethics committee (Health Research Ethics Committee in Universitas Muhammadiyah Gombong, date: February 11, 2023 decision number: 368.6/II.3.AU/F/KEPK/II/2023).

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