The association between nutrition and the functional outcomes of elderly women with acute vertebral compression fractures

Short title: The outcomes of elderly women with vertebral fractures

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Abstract

Background

Vertebral compression fracture (VCF) is a major injury that occurs in elderly individuals. The aim of this study is to predict the functional outcomes of elderly female patients with acute VCF based on their nutritional status.

Methods

A total of 69 female patients with acute VCF were included in the present study. The age, fracture location, body mass index, grasping power, the amount of the patient's daily nutritional intake, Mini-Mental State Examination (MMSE) score and nutritional status (determined from laboratory findings) were evaluated at the time of admission. After in-hospital rehabilitation, the patients were divided into two groups based on their motor Functional Independence Measure (mFIM) scores at the time of discharge. A multivariable logistic regression analysis was performed to identify factors that predicted the outcome.

Results

The patients were divided into the high mFIM (score $\geq$79, n = 36) and the low mFIM (score <79, n = 33) groups. The multivariate logistic regression analysis showed that the amount of the patient's nutritional intake and the MMSE score were associated with the outcome.

Conclusions

The cognitive status and the amount of the patient's nutritional intake were associated with the prognosis of elderly women with acute VCF.

Keywords: vertebral compression fracture, outcome, nutrition, cognitive status

Introduction

The societies of most countries are rapidly aging. Japan has long been considered a super-aging society. Fractures are currently among the most frequent accidents suffered by elderly individuals. Elderly women in particular are likely to suffer fractures from relatively slight trauma due to osteoporosis. Fractures may cause the patient to be bedridden and restrict a patient's ability to perform activities of daily living (ADLs). Vertebral compression fracture (VCF) is one of the most common types of fracture in elderly individuals. A low bone density and low bone quality are considered to be risk factors for VCF in elderly women[1), 2)]. There are numerous reports on the risk factors for VCF among elderly women[3)]. In our experience, thin and inactive women show more difficulty in recovering their ability to perform ADLs after VCF. Thus, we consider the physical, nutritional and mental state to have a great influence on the outcome of these patients. We hypothesized that simple examinations, without the measurement of the bone density or bone quality, could be used to predict the recovery of the ability to perform ADLs among patients with acute VCF who were treated in hospital.

The aim of the present study was to investigate whether the nutritional status and mental status could predict the outcomes of elderly female patients with acute VCF.

Materials and Methods

Participants

The participants included 69 elderly women (>75 years of age) with acute VCF who were treated in our affiliated hospital, Hidakakai Hidaka Rehabilitation Hospital from April 2012 to March 2014. The diagnosis of VCF was confirmed based on X-ray films or MRI. All patients were able to walk independently without an assistive device, such as a cane or walker, and had no other neuromuscular, cardiopulmonary or osteoarticular disorders before the injury. All patients were capable of oral feeding from the time of their admission to the hospital.

The study protocol was approved by the Institutional Review Board of our hospital (IRB No. 2016 - 049).

Physical therapy

Participants were confined to a bed for one week after the injury and gradually left the bed with a trunk orthosis. Physical therapy was administered by licensed, experienced physical therapists soon after the patient's admission to the hospital. The participants received training sessions for one hour each day according to their level of pain.

Physical therapy was carried out seven days a week. The session included muscle strengthening exercises and walking exercises, according to the walking ability of the patient.

Assessments

We evaluated the following baseline characteristics for all patients: age, region of fracture (thoracic or lumbar), body mass index (BMI), grasping power (GP), days from onset to admission and nutritional status. The patient's height was measured in the supine position, and the body weight was measured in the supine position with an electric lift scale. The nutritional status was evaluated based on the amount of the patient's daily nutritional intake and the following laboratory findings, which were collected at the time of admission: serum albumin (Alb), hemoglobin (Hb), total lymphocyte count (Ly), creatinine phosphokinase (CPK), total cholesterol (TC), and cholinesterase activity (ChE). In addition, the Mini-Mental State Examination (MMSE), which has a maximum score of 30, was used to assess the cognitive function.

We used the Functional Independence Measure (FIM) to evaluate various aspects of disability. This measure, which is used worldwide to evaluate the function of patients in

rehabilitation hospitals, has motor and cognitive scores and is subdivided into 18 subcategories (Table 1), each of which is scored on a scale of 1 (total assistance) to 7 (complete independence). The total FIM scores range from 18 to 126. The FIM has been found to show good reliability. We used the motor score of the FIM (mFIM) to evaluate the function of patients at the time of their discharge from the hospital.

The patients were divided into two groups based on the median mFIM score: the high mFIM group (mFIM score $\geq$ median mFIM); and the low mFIM group (mFIM score < median mFIM) at the time of discharge.

A multivariate logistic regression analysis, which included the baseline characteristics as dependent variables, was used to predict the outcome.

Statistical analysis

The statistical analyses were performed using the SPSS software program (version 22.0, SPSS, Chicago, IL, USA). The Mann–Whitney U-test or chi-squared test was used to analyze the significance of differences between the two groups. To investigate the variables that could be used to predict a good patient outcome, a multivariable logistic regression model, which was controlled for possible confounding covariates, was fitted by

the stepwise forward selection of variables. Variables that showed significant differences between the two groups were included in the regression model. Odds ratios (OR) and 95% confidence intervals (CI) were calculated for the clinical characteristics that were associated with the independent variables. P values of <0.05 were considered to indicate statistical significance. The descriptive statistics are shown as the mean $\pm$ SD.

Results

The clinical characteristics of the patients are shown in Table 2. Thirty-three patients had thoracic fractures and 36 had lumbar fractures. The median mFIM score at the time of discharge was 79. Thirty-six patients were classified into the high mFIM group and 33 patients were classified into the low mFIM group. The patients in the high mFIM group were significantly younger than those in the low mFIM group. The fracture location, hemoglobin level, total lymphocyte count and total cholesterol level did not differ to a statistically significant extent between the groups. The BMI, GP, the amount of the patient's nutritional intake, MMSE score, Alb, ChE and CPK values of the low mFIM group were significantly lower in comparison to the high mFIM group. The number of days from the onset to admission and the length of the hospital stay in the low mFIM group were significantly greater than in the high mFIM group. There were no patients with insufficient bone union at the time of discharge.

The results of the multivariate logistic regression analysis of the factors predicting a high mFIM value are shown in Table 3. The amount of the patient's nutritional intake and the MMSE score were found to be the only predictors of a high mFIM value. We found the mFIM score to be significantly correlated with the MMSE score (Figure 1-A) and

the patient’s nutritional intake (Figure 1-B).

Discussion

The density and quality of bone decline and the risk of fracture increases with age. Most women develop osteoporosis after menopause. Cummings et al. reported that after approximately 60 years of age, the incidence of vertebral fractures in women is approximately two- or three-fold higher than that in men[4]. The biggest risk factor for VCF is osteoporosis; patients with osteoporosis can easily suffer fracture from minor trauma, including falls. However, only a quarter of vertebral fractures result from falls; most are precipitated by routine everyday activities[5]. Age, a history of fracture, a history of osteoporosis, decreased height, and decreased physical activity have previously been reported to be risk factors for vertebral fracture[6].

The pain caused by the acute symptoms of VCF typically resolves over weeks or months. The patient is typically bedridden for a considerable period until the pain resolves. The adverse effects of VCFs on most activities of daily living are caused by long-term bed rest.

Kado et al. reported that women with VCF had an enhanced risk of death due to cardiovascular and pulmonary disease, which increased in line with the number of vertebral fractures[7]. Lukasiewicz et al. reported that patients with fractures in more than 1 region of

the spine had a high risk of adverse events[8]. Matsumoto et al. reported that in patients with VCF, old age (>75 years), female sex, 2 or more previous spine fractures, the presence of a middle column injury, and a lack of regular exercise before fracture were significantly associated with a reduced ability to perform ADLs[9]. In our study, the bivariate analysis showed that the BMI, the amount of the patient's nutritional intake, the GP, CPK, Alb, and ChE values, and the MMSE score were significantly decreased in the poor outcome group. These factors are associated with muscle volume, muscle strength, the nutritional status and the cognitive status. A loss of muscle volume and strength is referred to as "sarcopenia"[10]. Sarcopenia is one of the major inhibitors of recovery from various forms of disability[11-13]. Patients with VCF do not usually have dysphagia or gastrointestinal dysfunction. Thus, an adequate nutritional intake is very important for VCF patients. While the bivariate analysis showed that the values of some of the factors associated with the nutritional state were low in the low mFIM group at the time of admission, these items were not included as predictive values. Thus, a sufficient nutritional supply after hospitalization may lead to a good outcome in patients with VCF.

Muscle strength exercise is also necessary to prevent weakness, even while patients are bedridden. Previous studies have reported the benefits of muscle strength

exercise in the clinical management of patients with osteoporotic vertebral fractures[14-16]. We tried to start physical therapy as soon as possible to prevent disuse weakness.

In our study, low MMSE scores also restricted the recovery. Ruggiero et al. reported that cognitive dysfunction was a risk factor for mortality among hospitalized elderly patients with hip fracture[17]. Mathew et al. reported that patients with low cognitive FIM scores showed slow gait speeds at discharge[18]. Poor memory may prevent the cumulative effects of daily exercise.

The present study is associated with some limitations. First, the small sample size might have affected the results, which might limit the generalizability. Second, we were unable to assess the mFIM score at the time of admission. Because of the variance in the number of days from onset to admission, some patients had to rest on the bed for the stability of fracture lesion regardless of their ability. Thus, the score of mFIM at the time of admission did not truly reflect their ADL. We were therefore unable to evaluate the change in the mFIM score from admission to discharge. Third, this model has not yet been validated in another population. To validate the risk factors, their predictive abilities must be examined in a prospective study. Further follow-up studies are therefore needed to confirm these results.

Conclusion

The cognitive status and the nutritional intake were associated with the prognosis of elderly women with acute VCF. Sarcopenia was also associated with a poor outcome in patients with VCM. Appropriate nutrition and exercise are important for recovering from disability after VCF.

Disclosure Statement

The authors did not receive and will not receive benefits or funding from any commercial party related directly or indirectly to the subject of this article.

Figure Legend

Figure 1. (A) Correlation between the motor score of Functional Independence Measure (mFIM) and the Mini-Mental State Examination (MMSE) score. (B) Correlation between the mFIM score and the patient's nutritional intake.

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Table 1 Functional independence measure

Motor			Cognitive		
Self-care	Eating	1 - 7	Communication	Comprehension	1 - 7
	Grooming	1 - 7		Expression	1 - 7
	Bathing	1 - 7	Social Cognition	Social Interaction	1 - 7
	Dress-Upper body	1 - 7		Problem-Solving	1 - 7
	Dress-Lower body	1 - 7		Memory	1 - 7
	Toileting	1 - 7			
Sphincter Control	Bladder	1 - 7			
	Bowel	1 - 7			
Transfers	Bed/Chair	1 - 7			
	Toilet	1 - 7			
	Tub/Shower	1 - 7			
Locomotion	Walk/Chair	1 - 7			
	Stairs	1 - 7			
Total		13 - 91			5 - 35

Each item is scored on a 7 point ordinal scale, ranging from a score of 1 to a score of 7. The higher the score, the more independent the patient is in performing the task associated with that item.

1:Total assist; 2:Maximal assist; 3:Moderate assist; 4:Minimal assist; 5:Supervision; 6:Modified independence; 7:Complete independence

Table 2　Clinical characteristics of patients and comparisons among high FIM and low FIM group

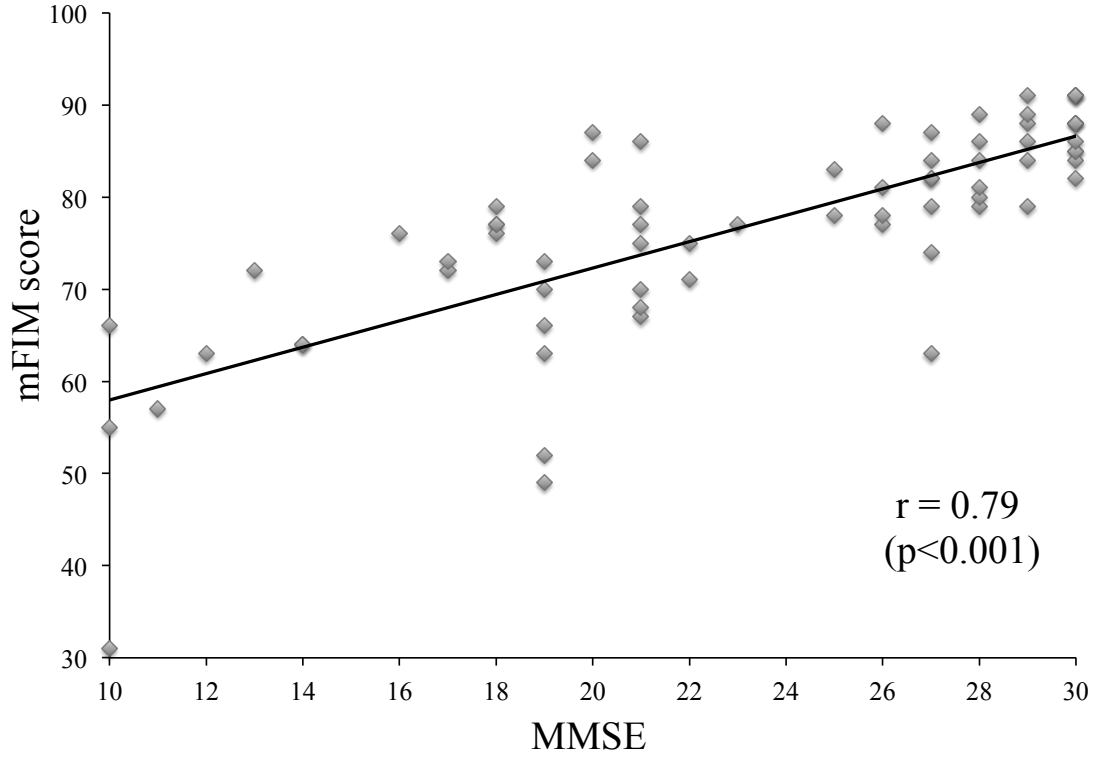
	Total (n=69)	High mFIM score group (n=36)	Low mFIM score group (n=33)	P-value
Age (y)	84.0±6.0	82.5±5.6	85.7±6.1	0.027
Lesion (T/L)	33/36	17/19	16/17	0.918
BMI	19.9±2.9	21.2±2.6	18.4±2.6	< 0.001
GP (kg)	18.2±3.7	19.9±3.2	16.2±3.1	< 0.001
Amount of nutritional intake (kcal/day)	1505±185	1602±166	1400±141	< 0.001
Total MMSE score	23.2±6.0	27.3±3.3	18.6±4.9	< 0.001
Days from onset to admission	17.2±5.0	14.5±4.2	20.0±4.1	< 0.001
Length of stay (day)	43.1±12.0	36.8±7.9	49.0±13.0	< 0.001
Laboratory findings				
Alb (g/dl)	3.5±0.4	3.7±0.4	3.2±0.4	< 0.001
Hb (g/dl)	11.4±1.6	11.7±1.8	11.0±1.4	0.072
Lym (number/dl)	1434.4±474.5	1536.1±460.4	1323.5±471.6	0.062
ChE (IU/l)	232.0±75.6	253.0±86.3	209.2±54.6	0.015
CPK (IU/l)	77.3±34.1	92.8±28.4	60.5±32.2	< 0.001
TC (mg/dl)	174.2±35.1	179.7±36.7	168.2±32.8	0.177

BMI: body mass index; GP: grip power; MMSE: mini mental state examination; Alb: serum albumin; Hb: hemoglobin; Ly: total lymphocyte count; CPK: creatinine phosphokinase; TC: total cholesterol; and ChE: cholinesterase activity

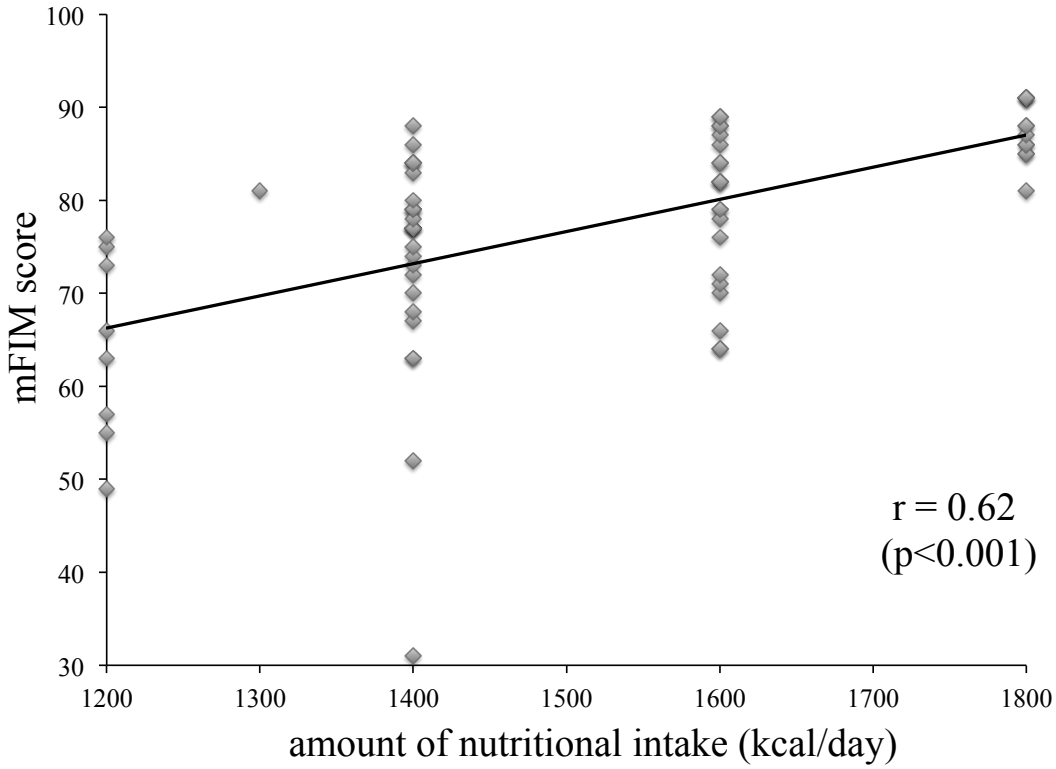
Table 3 Stepwise Logistic Models for predicting high mFIM

Predictors	OR	95% CI	P
Amount of nutritional intake	1.009	1.002-1.016	0.014
MMSE	1.524	1.238-1.877	< 0.001

A


100
90
80
70
60
50
40
30
mFIM score
10
12
14
16
18
20
22
24
26
28
30
MMSE
r = 0.79
(p<0.001)

B


100
90
80
70
60
50
40
30
mFIM score
1200
1300
1400
1500
1600
1700
1800
amount of nutritional intake (kcal/day)
r = 0.62
(p<0.001)