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Original Article

Relationship between Low Muscle Strength, and Protein Intake: A Preliminary Study of Elderly Patients with Hip Fracture

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Background: The purpose of the present study was to assess the daily protein uptake and its relationship with sarcopenia, as defined by the Asian Working Group for Sarcopenia (AWGS), among elderly patients with hip fractures. **Methods:** Forty-seven elderly patients with hip fractures were enrolled in this retrospective observational study. The main outcome measures included protein uptake, muscle mass, and grip strength for sarcopenia in elderly patients. Sarcopenia was diagnosed according to AWGS. Whole-body densitometry was used to measure skeletal muscle mass, and muscle strength was evaluated using handgrip testing. **Results:** Of 47 patients with hip fractures (12 men and 35 women), 37 (79%) patients exhibited insufficient protein intake (range, 0.01-0.588 g/kg/day), and 10 (21%) patients exhibited excessive protein intake (range, 1.215-2.121 g/kg/day). The mean daily protein intake was 56.5 g (range, 7.2–136.0 g). Prevalence of low muscle strength (handgrip strength <18 kg in women and <26 kg in men) was detected in 13 (37%) women and 8 (67%) men (P=0.076). Sarcopenia (lower muscle mass and lower muscle strength) was detected in 9 (26%) women and 6 (50%) men (P=0.119). Although lower protein intake was marginally associated with sarcopenia (P=0.189), it was significantly associated with lower grip strength (P=0.042). **Conclusions:** The present study demonstrated that insufficient protein intake in elderly patients with hip fractures was common, and lower protein intake was significantly associated with lower muscle strength.

Key Words: Aged · Dietary proteins · Hip fractures · Malnutrition · Sarcopenia

INTRODUCTION

Sarcopenia is a disease that has been assigned its code in the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM). The assigned code (M62.84) has been used since October 1, 2016.[1] Moreover, an increasing number of studies are investigating sarcopenia. In 2014, The Asian Working Group for Sarcopenia (AWGS) published a consensus statement on the diagnosis of sarcopenia, which was further revised in 2019 to improve diagnostic accuracy.[2,3]

Several epidemiological studies have recently reported a higher prevalence of sarcopenia among individuals who sustained hip fractures.[4-7] Hip fracture is

considered a typical condition among individuals with sarcopenia and results in high mortality and morbidity, and socioeconomic burden.[8] The development of sarcopenia is associated with several factors, including age, physical inactivity, malnutrition, and increased catabolism involving diseases, injuries, mitochondrial dysfunction, sex hormones, oxidation products, and inflammation.[9,10] Among these factors, malnutrition is especially important in patients with hip fractures. Inadequate dietary protein intake is often associated with malnutrition.[11-13]

As such, adequate-protein intake may be an important factor in preventing sarcopenia among elderly individuals. However, to our knowledge, protein intake has not been extensively studied in elderly patients with hip fractures.

The purpose of the present study was to assess daily protein uptake and its relationship with sarcopenia as defined by AWGS-among in elderly patients with hip fractures.

METHODS

The protocol for this retrospective observational study was approved by the Institutional Review Board of the authors' hospital, and all patients provided informed consent to participate. Between June 2021 and August 2021, all patients who sustained a hip fracture were ≥65 years of age, and referred to the authors' hospital were eligible for this study. During the study period, 125 patients with hip fractures ≥65 years of age visited the institution.

Of these, 12 (9.6%) were excluded because dual energy X-ray absorptiometry (DXA) was not performed perioperatively, 35 (28%) refused examination, and 31 (24.8%) were excluded due to mental illness. Ultimately, therefore, 47 patients who sustained hip fractures were included in this study (Fig. 1).

Body composition was assessed using whole-body DXA (DPX-NT; GE Lunar, Madison, WI, USA). Bone mineral content, fat mass, and lean soft tissue mass were measured separately for each part of the body, including the arms and legs. The lean soft tissue masses of the arms and legs were nearly equal to skeletal muscle mass. Because absolute muscle mass is correlated with height, the skeletal muscle mass index (SMI) was calculated using the following equation: SMI=lean mass (kg)/height^2 (m^2). Arm SMI was defined as (arm lean mass [kg]/height^2 [m^2]), while leg SMI was defined as (leg lean mass[kg]/height^2 [m^2]). Appendicular SMI was defined as the sum of arm and leg SMI. To eliminate the effects of metal implant for fixation, the measured value of the lower extremity with implants was excluded and the measured value of the unaffected lower extremity was doubled for calculating appendicular lean mass.

Muscle strength was assessed according to handgrip strength. Participants held a digital hand dynamometer (Digital grip strength dynamometer, T.K.K 5401; Takei Scientific Instruments Co., Ltd., Tokyo, Japan) in the dominant hand with the arm fully extended at an angle of 30° with respect to the trunk and the palm of the hand perpendicular to the shoulder line.

Sarcopenia was defined according to the AWGS criteria for low muscle strength (handgrip strength <18 kg in females and <26 kg in males) and low muscle mass (SMI <5.4 kg/m^2 in females and <7.0 kg/m^2 in males).[2]

A dietician conducted face-to-face interviews to administer the Food Frequency Questionnaire (FFQ) used in the Korea National Health and Nutrition Examination Survey

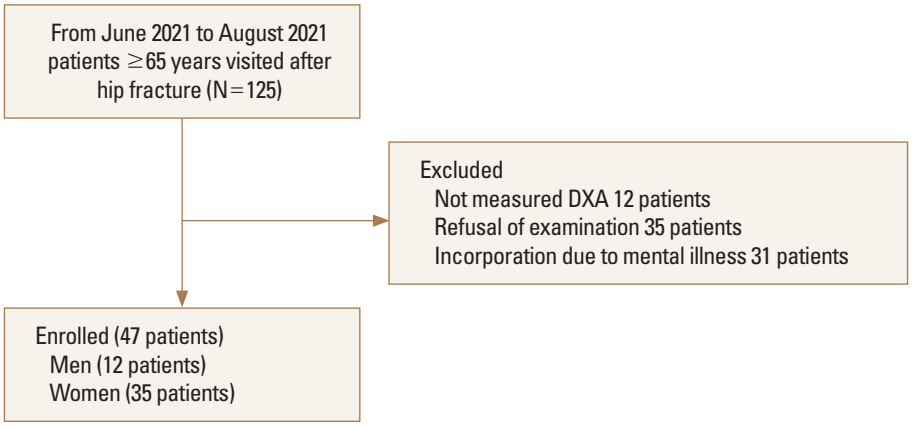

Fig. 1. Flow diagram illustrating patient inclusion/exclusion. DXA, dual energy X-ray absorptiometry.

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(KNHANES). The FFQ was used to assess the average dietary intake over the previous year. Nutritional intake reported in the FFQ was analyzed using the CAN-Pro 5.0 (Korean Nutrition Society, Seoul, Korea). The minimum dietary requirement for elderly individuals was defined as at least 1.2 g protein/kg body weight/day.[14]

Statistical analysis

The χ^2 test was used for categorical variables and the *t*-test for numerical variables. All reported *P* values are 2-sided, and differences with *P* values of less than 0.05 were considered to be statistically significant. Statistical analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA) for Windows (Microsoft Corp., Redmond, WA, USA).

Table 1. Patient characteristics

Characteristic	Total	Men	Women	*P*-value
Patients	47 (100)	12 (25.5)	35 (74.5)	
Age (yr)	76.0±6.6	76.5±76.4	74.8±7.3	0.467
Height (cm)	156.9±8.8	167.9±5.1	153.1±6.1	<0.001
Weight (kg)	55.7±9.2	62.2±8.6	53.4±8.3	0.003
Body mass index (kg/m^2)	22.6±3.5	22.1±3.1	22.8±3.6	0.524
ASA Grade				0.646
2	30	23	7	
3	17	12	5	
Type of fracture				0.278
Femoral neck	22 (46.8)	4 (18.1)	18 (81.8)	
Intertrochanteric	25 (53.2)	8 (32.0)	17 (68.0)	
Daily protein intake (g)	56.5±27	53.8±23.4	64.5±35.5	0.237
Grip strength (kg)	20.6±7.5	22.7±7.9	19.9±7.4	0.292
Sarcopenia	15 (31.9)	6 (50.0)	9 (25.7)	0.119

The data is presented as N (%) or mean±standard deviation, unless otherwise indicated.
ASA, American Society of Anesthesiologists.

RESULTS

The mean daily protein intake of 47 patients with hip fractures was 56.5 g/day (range, 7.2–136.0 g/day) and 37 (79%) patients exhibited insufficient protein intake (range, 0.01-0.588 g/kg/day) and 10 (21%) patients exhibited excessive protein intake (range, 1.215-2.121 g/kg/day). Baseline demographic information and patient characteristics are summarized in Table 1.

According to sex differences described in the AWGS guideline, lower muscle mass (SMI <5.4 kg/m^2 in women and <7.0 kg/m^2 in men) was exhibited by 21 (60%) women and 8 (67%) men (P=0.774). Low muscle strength (hand grip strength <18 kg in women, <26 kg in men) was evident in 13 (37%) women and 9 (75%) men (P=0.042). Based on the guideline definition, sarcopenia (i.e., lower muscle mass and muscle strength) was detected in 9 (26%) women and 6 (50%) men (P=0.119) (Table 2).

Although lower protein intake was marginally associated with sarcopenia (P=0.119), it was significantly associated with lower grip strength (P=0.041) (Table 3).

Table 2. Relationship between sex and lower protein intake, muscle mass, muscle strength, and prevalence of sarcopenia among elderly patients who sustained hip fracture

Gender	Variable	Normal group	Abnormal group	*P*-value
Men/Women	Daily protein intake	3 (25.0)/8 (22.9)	9 (75.0)/27 (77.1)	0.880
	Muscle mass (kg/m^2)	4 (33.3)/14 (40.0)	8 (66.7)/21 (60.0)	0.774
	Muscle strength (kg)	3 (25.0)/22 (62.9)	9 (75.0)/13 (37.1)	0.042
	Prevalence of sarcopenia	6 (50.0)/26 (74.3)	6 (50.0)/9 (25.7)	0.119

The data is presented as N (%) unless otherwise indicated. Low protein intake: <1.2 g/kg/day; muscle mass, skeletal muscle mass index (SMI) <5.4 kg/m^2 in women and SMI <7.0 kg/m^2 in men; muscle strength, hand grip strength: <18 kg in women and <26 kg in men.

Table 3. Relationship between protein intake and muscle mass, muscle strength, and prevalence of sarcopenia in elderly patients with hip fracture

Protein intake	Variable	Normal group	Abnormal group	*P*-value
Normal/Abnormal	Muscle mass (kg/m^2)	4 (36.4)/7 (63.6)	14 (38.9)/22 (61.1)	1.000
	Muscle strength (kg)	9 (81.8)/2 (18.2)	16 (44.4)/20 (55.6)	0.041
	Prevalence of sarcopenia	9 (81.8)/2 (18.2)	23 (63.9)/13 (36.1)	0.119

The data is presented as N (%) unless otherwise indicated. Low protein intake: <1.2 g/kg/day; muscle mass, skeletal muscle mass index (SMI) <5.4 kg/m^2 in females and SMI <7.0 kg/m^2 in males; muscle strength, hand grip strength: <18 kg in women and <26 kg in men.

DISCUSSION

Malnutrition in elderly patients with hip fracture is an important risk factor for sarcopenia and is related to inadequate protein intake. This preliminary study aimed to estimate daily protein intake and assess its relationship with sarcopenia among elderly individuals who sustained hip fractures. Seventy-nine percent of patients exhibited insufficient protein intake (range, 0.01-0.588 g/kg/day), and lower protein intake was significantly associated with lower grip strength ($P=0.042$).

Insufficient protein intake among the elderly is a concern and is associated with disease, including sarcopenia. A meta-analysis investigating protein intake among an elderly population, including 50,284 older adults in 10 studies, reported that high protein intake was negatively associated with frailty status in older adults (odds ratio, 0.67; 95% confidence interval, 0.56-0.82; $P=0.0001$).[15] Among 946 participants (mean age, 75 years) in the Framingham osteoporosis study, the mean protein intake was 68 g/day and the risk for hip fracture in the population with increased protein intake was lower.[16] Optimal protein intake among the elderly is 0.8 g protein/kg body weight/day for adults, regardless of age. However, optimal protein intake in elderly patients with chronic illness remains controversial, with an intake of 1.0 to 2.0 g protein/kg/day considered a reasonable target for elderly individuals wishing to optimize protein intake for health and function.[17-19] In the present study, the mean daily protein intake of elderly patients with hip fractures was 56.5 g/day, and 79% were considered to have insufficient protein intake by definition (minimum dietary requirement of at least 1.2 g protein/kg body weight/day).

The relationship between sarcopenia and nutritional status among the elderly population has been assessed and reported in many studies. A systematic review of 33 studies reported that sarcopenia in adults ≥60 years of age was correlated with poor nutritional status.[20] Yoo et al. [11] assessed 327 elderly patients with hip fracture and reported that hypoproteinemia among elderly women with hip fracture was associated with a 2.1 times greater risk for sarcopenia than those without sarcopenia. However, the relationship between sarcopenia and protein intake among elderly patients with hip fractures has not been studied. In this study, lower protein intake in elderly individuals who sustained hip fractures was significantly associated with lower grip strength ($P=0.042$). The relationship between sarcopenia and insufficient protein intake was only marginally significant ($P=0.182$).

This study, however, had several limitations, the first of which were its retrospective, cross-sectional design, and small sample size. As such, selection bias may be inevitable. Second, optimal protein intake among elderly patients remains controversial ranging from 1.0 to 2.0 g/kg/day.[17-19] In this study, optimal protein intake among elderly patients was defined as a dietary requirement of at least 1.2 g protein/kg body weight/day.[14] Therefore, the prevalence of insufficient protein intake is difficult to compare with other studies. However, to our knowledge, no study has assessed protein intake in patients with hip fractures. Finally, the relationship between sarcopenia and insufficient protein intake was marginal significant. However, as the number of participants increases, concrete results can be obtained.

In conclusion, results of the present study demonstrated that insufficient protein intake among elderly patients who sustained hip fractures was common, and lower protein intake was significantly associated with lower grip strength in those with sarcopenia.

DECLARATIONS

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Ethics approval and consent to participate

This study was approved by the Institutional Review Board for human research at each hospital, and all patients provided written informed consent prior to enrollment.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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