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Association Between Sarcopenia and Functional Independence After Acute Fragility Hip Fracture at 6 Months

Science Metadilogkul, MD [1], Naputt Virasathienpornkul, MD [1], Pariyut Chiarapattanakom, MD [1], Nuttavut Chavalparit, MD [1], Piyabuth Kittithamvongs, MD [1], Piyatida Yousuk, BNS [2]

[1] *Orthopaedics, Lerdsin General Hospital, Department of Orthopaedic Surgery, College of Medicine, Rangsit University, Bangkok, Thailand*
[2] *Orthopaedic Nursing, Lerdsin Hospital, Department of Medical Services, Bangkok, Thailand*

Purpose: The primary goal of hip fracture treatment is to allow ambulatory life as early as possible to avoid any subsequent complication after fracture. The European Working Group on Sarcopenia in Older People (EWGSOP) defined sarcopenia as the presence of both low muscle strength and low muscle quantity. Our purpose in this study was to identify the association between sarcopenia and functional independence after acute fragility hip fracture.
Methods: Patients 50 years old or more without neurologic diseases who encountered fragility hip fracture for the first time were included. Sarcopenia was assessed using EWGSOP revised 2018 criteria. Functional independence was assessed using the Barthel Index (BI) at 6 months after injury. Data were analyzed using multiple linear regression.
Results: A total of 240 patients were included; overall, 84 patients with and 156 without sarcopenia. Multiple linear regression analysis showed significant difference in BI at 6 months among those with and without sarcopenia ($p<0.001$). Specifically, the lower limb related components of BI were decreased four points in patients with sarcopenia, which is a more statistically significant result when compared to the overall BI score.
Conclusions: In this study, patients with sarcopenia were associated with functional independence impairment. Lower limb-related components of the BI must be specifically assessed in patients with hip fracture. Moreover, rehabilitation programs should be tailored to the specific needs of the patient.

Keywords: sarcopenia, hip fracture, prevalence, outcome

Hip fracture is common among older adults. Apart from healing the injury, returning the patient back to functional independence is the ultimate goal. With increase in age, muscle mass and quality change significantly. After about 50 years of age, muscle mass decreases at an annual rate of 1–2%. The decline in muscle strength is even higher, amounting to 1.5% per year between ages 50 and 60 years and 3% per year thereafter[1,2]. In 2018, the European Working Group on Sarcopenia in Older People (EWGSOP) redefined sarcopenia as presence of both low muscle strength and low muscle quantity or quality (Fig.1). Muscle strength

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Correspondence to: Science Metadilogkul, MD
Orthopaedics, Lerdsin General Hospital, Department of Orthopaedic Surgery, College of Medicine, Rangsit University, Bangkok, Thailand
E-mail: sciorthop@gmail.com

is measured using grip strength or chair stand test. Conversely, muscle quantity, the appendicular skeletal muscle mass (ASMM), is measured using Dual-energy X-ray absorptiometry (DXA)[3]. Recent studies found that sarcopenia was present at a rate of up to 58% in patients with hip fracture and associated with falls and fractures, affecting the functional outcome and mortality in geriatric populations[4,5].

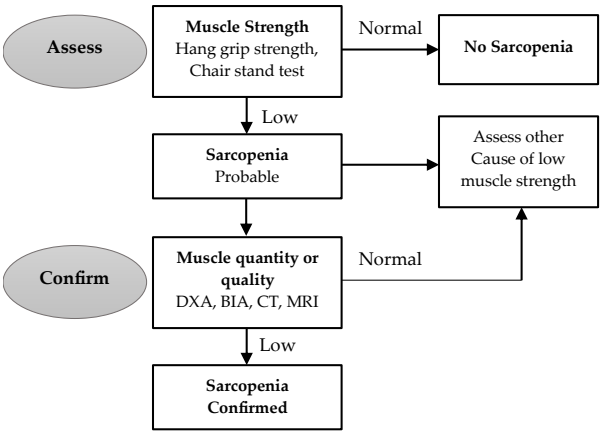

Fig. 1 Diagnosis of sarcopenia.
(From: Sarcopenia: revised European consensus on definition and diagnosis 2018. Age and Ageing. 2019)

The return of the patient to the community requires adequate functional independency, which is generally assessed using the Barthel Index (BI)[6-8]. The BI comprises 10 components, of which 6 are related to the activities that use more lower limb functions. Those are bed or chair transfer, toilet use, mobility on level surface, dressing, climbing stairs, and bathing. We wondered whether the lower extremity-related components of Bathel Index (BI) would provide a clearer picture of the patients' functional independency. Therefore, BI components were divided into two groups; those with lower extremity-related Barthel Index (LER-BI) and those with non-lower extremity related Barthel Index (non-LER-BI).

We aimed to identify the association between sarcopenia and the lower extremity-related functional independency of patients after acute fragility hip fracture.

METHODS

Patients aged 50 years or older with a diagnosis of acute fragility hip fracture, admitted in our hospital between April 2019 and January 2021, were included. The patients who had motor impairment from neurologic diseases, previous history of hip fractures, and incomplete data were excluded.

Data from medical records including sex, age, body mass index (BMI), ASMM by DXA, and handgrip strength during hospitalization for the treatment of hip fracture were collected.

Sarcopenia is defined as low muscle strength along with low muscle quantity. The muscle strength was measured using handgrip strength with Exacta Hydraulic Hand Dynamometer and performed with the Southampton protocol[9]. According to the revised EWGSOP 2018 criteria, handgrip strengths of <27 kg in male patients or <16 kg in female patients were used as cut-off points for low muscle strength. The ASMM measured using DXA was used as the indicator for the loss of muscle quantity. The ASMM results of <7.0 kg/m^2 in male patients or <5.5 kg/m^2 in female patients were used as cut-off points for low muscle quantity. We classified patients into two groups, non-sarcopenia and sarcopenia. According to EWGSOP 2018, patients who had both low muscle strength and low muscle quantity to the aforementioned level were classified as having sarcopenia[3].

Functional independence was assessed using BI at 6 months after injury. The Thai-version of BI, which yields good validity and reliability, was used[10]. Subgroup analysis of LER-BI and non-LER-BI were recorded.

Baseline characteristics were described as mean with standard deviation and frequency. Multiple linear regression analysis was used to identify the primary outcome with statistical significance at p-value <0.05. The independent variables were sarcopenia, sex, age, and BMI. The dependent variable was BI. STATA, version 16, was used for statistical analysis.

RESULTS

There were 375 consecutive patients treated in the hospital, of which 135 were excluded. Of the 245 patients included (Fig. 2), 76 male and 164 female and 156 (65%) did not have sarcopenia while 84 (35%) had sarcopenia. The mean age was 75.6 (50-93) years old. Overall, 10 (42.1%) patients had close intertrochanteric fracture and 139 (57.9%) had close femoral neck fracture.

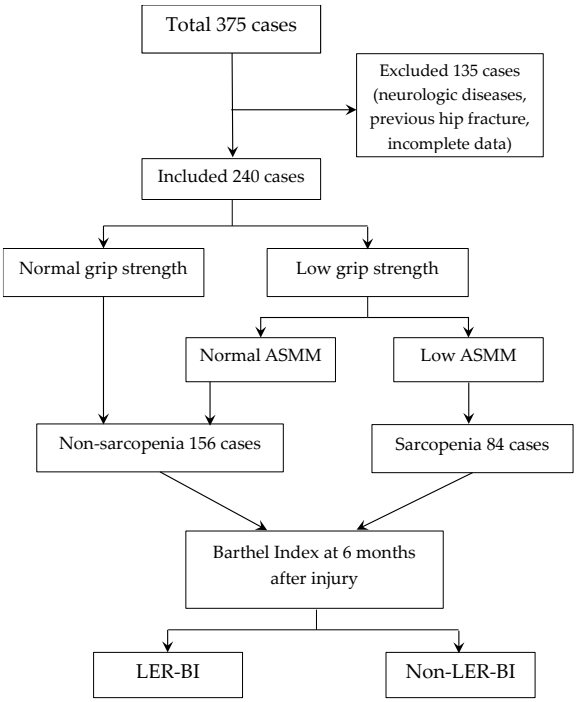

Fig. 2 Study flow chart.

Table 1 Demographic characteristics of the study population (N=240).

	Women	Men
n	164	76
Age	79.6 ± 16.8	71.5 ± 15.4
Body weight, kg	54.9 ± 11.9	68.6 ± 11.4
Height, m	1.53 ± 0.08	1.67 ± 0.07
Body mass index, kg/m²	23.5 ± 4.7	25.2 ± 3.4
Body fat, %	33.3 ± 9.3	21.1 ± 8.8
Fat free body mass, kg	35.3 ± 5.3	39.3 ± 7.5
Appendicular skeletal muscle, kg		
Total	17.6 ± 2.6	27.3 ± 3.9
Leg	13.8 ± 1.9	20.6 ± 2.8
Arm	3.8 ± 1.0	6.7 ± 1.5
Appendicular skeletal muscle mass (ASMM), kg/m²	5.4 ± 1.1	7.5 ± 1.7
Hand grip strength, kg	16.7 ± 3.6	28.9 ± 4.5

Univariate analysis showed a statistically significant difference between the mean BI of patients without sarcopenia (mean ± SD = 17.70 ± 1.62) and that of those with sarcopenia (mean ± SD = 13.34 ± 2.01), (p<0.001) (Fig.3). Furthermore, the difference between the LER-BI of those without sarcopenia (mean ± SD = 10.94 ± 1.42) and that of those with sarcopenia (mean ± SD = 7.02 ± 1.62), (p<0.001) was significantly different. There was also a statistically significant difference between the mean non-LER-BI of those without sarcopenia (mean ± SD = 6.76 ± 0.51) and that of those with sarcopenia (mean ± SD = 6.32 ± 0.80), (p<0.001) (Fig.4).

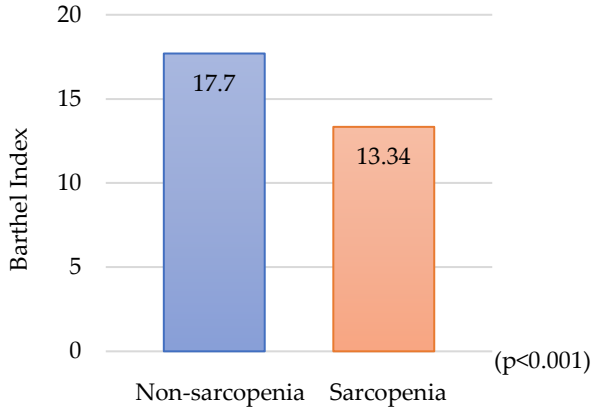

Fig. 3 Difference in mean BI between groups.

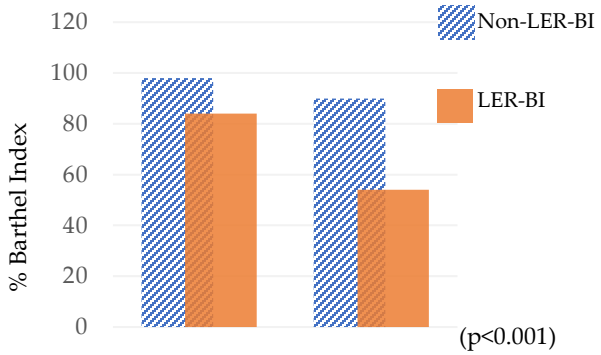

Fig. 4 Difference in non-LER-BI and LER-BI between groups.

Multiple linear regression analysis showed a significant association between BI at 6 months after injury and sarcopenia, sex, age, and BMI. Compared to those without sarcopenia, the BI was four points lower in those with sarcopenia

(p<0.001). The BI was also found to be decreased by one point in the female group (p=0.027). Details of the outcomes are shown in table 2.

Subgroup analysis, focusing on the lower limb related activities, showed that the BI was significantly lower in those with sarcopenia compared to those without, 13.3 vs 17.7 (p<0.001)(Fig.3). Compared to the non-sarcopenia group, the mean LER-BI was four points lower (p<0.001) (Table 3) and the mean non-LER-BI was 0.4 points lower (p=0.002) in those with sarcopenia compared to those without (Table 4).

Table 2 Multiple linear regression analysis: Barthel Index assessed at 6 months after injury.

Variables	Coefficient	p-Value	95% CI
Sarcopenia	-4.08	<0.001	-4.74 -3.42
Sex			
Female	-0.81	0.027	-15.2 -0.09
Age	-0.05	0.004	-0.08 -0.01
Body mass index	0.11	0.007	0.03 0.18

Statistically significant at p<0.05

Table 3 Subgroup analysis: Lower Extremity related Barthel Index (LER-BI) at 6 months after injury.

Variables	Coefficient	p-Value	95% CI
Sarcopenia	-3.68	<0.001	-4.24 -3.12
Sex			
Female	-0.62	0.045	-1.23 -0.02
Age	-0.04	0.009	-0.06 -0.01
Body mass index	0.10	0.004	0.03 0.16

Statistically significant at p<0.05

Table 4 Subgroup analysis: Non-Lower Extremity related Barthel Index (non-LER-BI) at 6 months after injury.

Variables	Coefficient	p-Value	95% CI
Sarcopenia	-0.40	0.002	-0.65 -0.15
Sex			
Female	-0.19	0.175	-0.46 0.08
Age	-0.01	0.084	-0.02 0.001
Body mass index	0.01	0.491	-0.02 0.04

Statistically significant at p<0.05

DISCUSSION

Several factors affect the recovery of patients with acute hip fracture. Sarcopenia indicates the muscle strength and muscle quantity and is now generally accepted as one of the major predictors of functional outcomes in older people. Therefore, assessing sarcopenia in every patient with hip fracture is crucial for the assessment of the correct prognosis and maximization of the recovery program of a patient at risk. This study showed a deficiency of the functional independence among patients with hip fracture related to the existence and degree of the sarcopenia.

The difference in the mean of BI among those with and without sarcopenia was more pronounced when the lower extremity related components of the BI was considered. However, the total BI score itself was not as significant or meaningful as the breakdown into individual items since these indicate where the deficiencies were.

Assessment of LER-BI seemed precise and time-effective in the evaluation of the patient post-fracture. A rehabilitation program tailored specifically to the deficiencies of the patient with hip fracture would be more useful and applicable. A scheme to follow patients' progression in the rehabilitation program can be planned. This strategy can lead to a more positive post-fracture functional outcome.

A limitation of this study was that it was a single-center study with one protocol for post-fracture rehabilitation for all hip fracture patients that might not be generalizable to the overall population of patients with hip fractures. To define sarcopenia using grip strength as the muscle strength measuring tool might not directly measure the affected part. However, the chair stand test, which is the other option to assess muscle strength could not be used due to the hip fracture. We used EWGSOP 2018 criteria instead of Asian working group for sarcopenia, AWGS 2019 due to the late launch of AWGS after our research was conducted. However, the cut-off values of these two criteria for the hand grip and the ASMM are quite similar, that is <27 kg in men and <16 kg in women for EWGSOP 2018 and <28 kg in men and <18 kg in women for AWGS 2019. ASMM cut-off values are <7.0 kg/m^2 in men and <5.5 kg/m^2 in women for EWSGOP 2018 and <7.0 kg/m^2 in men <5.4 kg/m^2 in women for AWGS 2019.

CONCLUSIONS

Sarcopenia was associated with the impairment of the patient's functional independence after acute hip fracture. When assessing a patient with hip fracture, there should be a focus on the lower limb related components of the BI. A rehabilitation program can be tailored to the specific impaired site and needs of the patient.

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