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Original article

Relationship between sarcopenia and pain catastrophizing in patients with lumbar spinal stenosis: A cross-sectional study

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ABSTRACT

Objectives: The purpose of this study is to clarify the psychological factors related to sarcopenia in patients with lumbar spinal stenosis (LSS).
Methods: This cross-sectional study included 72 patients with LSS (38 males and 34 females; mean age, 70.4 ± 6.9 years). Demographic data, lower extremity pain, back pain, Japanese Orthopaedic Association score, Pain Catastrophizing Scale (PCS) score, Hospital Anxiety and Depression Scale (HADS) score, Fear-Avoidance Beliefs Questionnaire score, walking velocity, grip strength, walking distance, and appendicular muscle mass were assessed. Muscle mass was measured using bioelectrical impedance analysis. Patients were grouped based on sarcopenia status according to skeletal muscle mass index.
Results: The prevalence of sarcopenia was 13.9% (10 of 72 patients). Sarcopenia was significantly more common in females. The incidence of dyslipidemia and cardiovascular disease were significantly higher in the sarcopenia group. The sarcopenia group had lower body weight, body mass index, grip strength, and walking distance than the control group. The sarcopenia group had higher PCS scores and HADS-anxiety scores. Multivariate analysis identified body weight, dyslipidemia, walking distance, and PCS score as significantly related to sarcopenia.
Conclusions: Pain catastrophizing might be the most relevant psychological factor in sarcopenia. Evaluation of both physical function and pain catastrophizing is needed when investigating sarcopenia in LSS.

1. Introduction

Sarcopenia is defined by the European Working Group on Sarcopenia in Older People as a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength. It is associated with a higher risk of adverse outcomes such as physical disability, poor quality of life (QoL), and death [1]. It is classified into primary sarcopenia, which is caused by aging alone, and secondary sarcopenia, which is caused by physical inactivity, nutrition, or disease [1]. Sarcopenia is considered to be an important social problem because it is associated with decreased physical function [1] and an increased risk of falls [2] and mortality [3]. The prevalence of sarcopenia in elderly Japanese individuals has been reported to be approximately 20% [2].

The relationship between sarcopenia and psychological factors has recently drawn attention [4]. Many reports related to sarcopenia focus on elderly and middle-aged people. Sarcopenia is associated with musculoskeletal disease, including chronic low back pain [5], osteoporosis [6], and lumbar spinal stenosis (LSS) [7]. LSS is mainly caused by degenerative changes in the lumbar spine that result in low back pain, lower extremity pain, and decreased physical function [8]. Intermittent claudication due to LSS is associated with decreased QoL [9]. An estimated 5.8 million people in Japan are affected by LSS [10]. Few studies have focused on the relationship between LSS and sarcopenia. Originally, sarcopenia was diagnosed based on muscle strength, walking speed, and skeletal muscle mass index (SMI) [1], but in reports on the relationship between LSS and sarcopenia, it has been based on SMI alone because of functional impairment due to LSS [7,11–13]. One report suggested that the prevalence of sarcopenia with LSS is 33% [7], whereas another report suggested it to be 26.5% [11]. The prevalence of sarcopenia is significantly associated with Roland-Morris Disability Questionnaire scores [11]. Sakai et al. [12] suggested in 2018 that patients with LSS

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who have sarcopenia before surgery have less postoperative relief of back pain. LSS is known to be associated with worsening mental health and a higher prevalence of depression than in the general population [14]. Furthermore, LSS is associated with severe pain catastrophizing, which is associated with disability [15]. These psychological factors result in decreased physical activity [16], suggesting the possibility that both physical and neurological factors affect muscle mass decline. Therefore, sarcopenia is an important factor that might affect postoperative outcomes in patients with LSS and some psychological factors might be involved in muscle mass decline. Although psychological factors in LSS are more severe than in the general population, there are no reports on specific psychological factors related to sarcopenia in patients with LSS before surgery. If there is an association between sarcopenia and psychological factors in patients with LSS, assessment and intervention to treat the psychological factors during rehabilitation may lead to maintenance of physical activity and prevention of muscle mass decline. Therefore, this cross-sectional study aims to evaluate the association between psychological factors and sarcopenia in patients with LSS.

2. Methods

2.1. Participants

This study is based on a cross-sectional design. Between October 2015 and April 2018, there were 151 patients aged 55 years or older [7] with both clinically and radiologically defined LSS with indications for surgical treatment. Exclusion criteria included (1) severe medical problems (e.g., stroke, tumor, infection, or cardiovascular disease): that the researchers determined to preclude participation in this study, (2) dementia, (3) traumatic spinal disorder, (4) previous spinal surgery, (5) pacemaker, (6) implant (arthroplasty in the lower extremities), and (7) nonambulatory status. After application of the exclusion criteria, 72 patients (38 males and 34 females) were included in the analysis (Fig. 1). All participants provided written informed consent. The study was approved by the ethics committees of the Faculty of Medicine, Tottori University (No. 1508B013). This study was registered in the University Hospital Medical Information Network Clinical Trials Registry (Study ID, UMIN000019467).

2.2. Assessment categories

Between hospital admission and surgery, demographic data were collected. In addition, participants completed a questionnaire and functional testing.

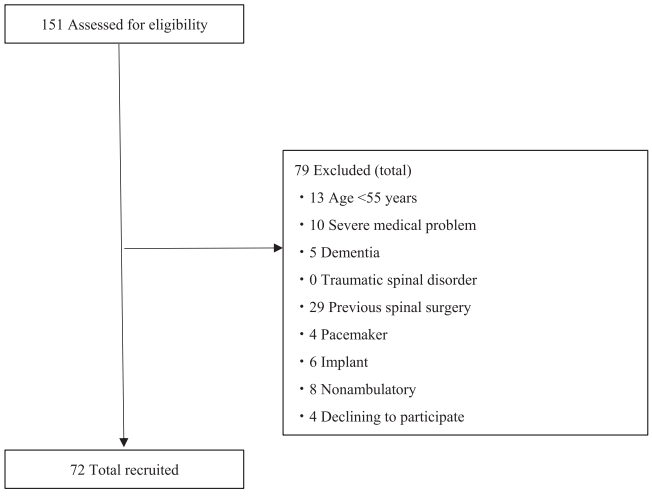

Fig. 1. Participants recruitment.

2.3. Assessment of muscle mass and classification into groups

Muscle mass was measured with bioelectrical impedance analysis (BIA) using an MC-780A body composition analyzer (Tanita, Tokyo, Japan). The BIA method requires participants to step onto a platform that looks similar to a bathroom scale and grasp handgrip electrodes with both hands for approximately 30 seconds while standing. The electrodes emit current through both feet and hands. The current is detected in the heels of both feet and the palms of both hands. This device applies electric current through the body at frequencies of 5, 50, and 250 kHz. Whole-body impedance was measured using the ipsilateral foot-hand electrical pathway. The recommended BIA measurement conditions were explained to the participants, who were instructed to arrive with (1) an empty stomach, (2) an empty bladder, and (3) no exercising before the measurement. Appendicular skeletal muscle mass (AMM) was derived as the sum of the muscle mass of the arms and the legs. SMI was calculated by dividing AMM by body height in meters squared (kg/m^2). In this study, participants were classified as having sarcopenia based on SMI, similar to most previous studies about sarcopenia and LSS [7,11–13]. The participants were all Japanese. They were divided into 2 groups using Asian Working Group for Sarcopenia (AWGS) SMI cutoff values [17]. Males with SMI <7.0 kg/m^2 and females with SMI <5.7 kg/m^2 were considered to have sarcopenia. Participants without sarcopenia constituted the control group.

2.4. Outcome variables

2.4.1. Demographic data

Characteristics such as age, sex, body height, body weight, body mass index (BMI), smoking habit, symptom duration, history of fragility fracture, and comorbidities such as hypertension, hyperlipidemia, diabetes, cardiovascular disease, and kidney disease were collected from medical records.

2.4.2. Questionnaire

The participants were asked to rate their pain on a numerical rating scale (NRS) in which 0 indicates no pain and 10 indicates the worst imaginable pain. The severity of lumbar dysfunction was evaluated based on the assessment of treatment for low back pain according to the Japanese Orthopaedic Association criteria (JOA score) [18]. The highest possible JOA score is 29 points. Pain catastrophizing was assessed using the Pain Catastrophizing Scale (PCS). The PCS consists of 13 items that describe an individual's specific beliefs about their pain and evaluates catastrophic thinking about pain [19]. Participants responded to each item using a Likert-type scale from 0 ("not at all") to 4 ("all the time"). Scores from all 13 items were summed to obtain a final score (range, 0 to 52). The scale provides an overall score and subscale scores for rumination, magnification, and helplessness. The reliability and validity of the Japanese version have been validated [20]. Higher PCS scores indicate greater pain catastrophizing. Anxiety and depression were measured using the 14-item Hospital Anxiety and Depression Scale (HADS) [21]. There are 7 items each for anxiety and depression. Items are scored from 0 to 3, with higher scores indicating greater anxiety (HADS-anxiety) or depression (HADS-depression). Subscale scores range from 0 to 21. Fear-avoidance beliefs were measured using the Fear-Avoidance Beliefs Questionnaire (FABQ) [22]. This 16-item questionnaire was scored according to a 7-point Likert scale, where 0 indicates completely disagree, 3 indicates unsure, and 6 indicates completely agree. The FABQ comprises 2 subscales regarding the potential influence of fear-avoidance beliefs on

physical activity (FABQ-PA) and work-related activity, respectively. The reliability and validity of the Japanese version of this scale have been verified [23]. Only the FABQ-PA was administered because many participants were retirees.

2.4.3. Functional measurements

Participants were asked to walk 14 m at their normal speed. Measurements were taken only during the middle 10 m (i.e., between meters 2 and 12). The first and last 2 m were used to eliminate periods of acceleration and deceleration. The time required to walk 10 m at normal speed was used to calculate walking speed. Participants were allowed to use aids while walking, such as canes or walkers. Handgrip strength was measured using a T.K.K. 5401 dynamometer (Takei, Niigata, Japan). Each participant was asked to squeeze the dynamometer twice with each hand. The highest score for both hands combined was recorded as the representative value. Walking distance was measured to assess intermittent claudication. Participants walked on a flat pathway for 90 m without a cane or walker. Each participant continued to walk until he or she was unable to walk any longer because of pain or numbness in the lower extremities. The maximum distance for the walking test was set as 500 m based on the gait subscale of the JOA score.

2.5. Statistical analysis

The sarcopenia and control groups were compared based on the aforementioned variables. Normality was evaluated using the Shapiro-Wilk test. Differences in demographic data, pain-related factors, psychological factors, and functional performance between the 2 groups were examined using the Pearson χ^2 test for categorical variables, nonpaired t-test for normally distributed variables, and Mann-Whitney U test for nonnormally distributed variables. Multivariate logistic regression with stepwise selection was used to estimate the adjusted odds ratio for associations with sarcopenia. The dependent variable was the presence or absence of sarcopenia. Age, fragility fracture, and significant variables in the univariate analysis were selected as independent variables to be included in the multivariate model. If multicollinearity occurred, only one variable was selected. Model fit was tested using the Hosmer-Lemeshow test and R^2 values. A P-value greater than 0.05 on the Hosmer-Lemeshow test indicated that the model was well calibrated. All data were analyzed using IBM SPSS Statistics ver. 24.0 (IBM Co., Armonk, NY, USA); P-values less than 0.05 were considered statistically significant.

3. Results

The characteristics of the sarcopenia and control groups are summarized in Table 1. The prevalence of sarcopenia was 13.9% (10 of 72 patients). Sarcopenia was significantly more common in females ($P = 0.025$). The incidence of dyslipidemia ($P = 0.034$) and cardiovascular disease ($P = 0.032$) was significantly higher in the sarcopenia group. The sarcopenia group had lower body weight and BMI than the control group ($P < 0.01$, respectively). The sarcopenia group had less handgrip strength ($P = 0.015$), lower SMI ($P < 0.01$), and shorter walking distance ($P = 0.017$) compared with the control group (Table 1). NRS and JOA scores were similar between the 2 groups (Table 2). The sarcopenia group had higher PCS scores compared with the control group ($P = 0.012$) (Table 2), with significantly higher rumination ($P = 0.012$), magnification ($P = 0.005$) and helplessness ($P = 0.005$) subscale scores. The sarcopenia group had higher HADS-anxiety scores compared with the control group ($P = 0.034$). Based on multivariate logistic regression analysis adjusting for age, fragility fracture, and significant variables in the univariate analysis, the following variables were significantly associated with sarcopenia in patients with LSS: body weight, dyslipidemia, walking distance, and PCS scores (Table 3). Body weight and BMI could be multicollinear, so only body weight was included in the model. The Hosmer-Lemeshow test indicated good model fit ($P = 0.865$ and $R^2 = 0.732$).

4. Discussion

This cross-sectional study investigated the association between psychological factors and sarcopenia in patients with LSS. The participants were divided into 2 groups using AWGS cutoff values and various variables were compared. The sarcopenia group had significantly more severe pain catastrophizing and anxiety. In addition, multivariate logistic regression identified body weight, dyslipidemia, walking distance, and PCS scores as significantly associated with sarcopenia.

The prevalence of sarcopenia in this study was 13.9%. A study of 174 patients with LSS aged 65 years or older (mean age, 73.0 ± 6.2 years) reported that the prevalence of sarcopenia was 24% before surgery [12]. Another study of 91 patients with lumbar spinal disease aged 65 years or older (mean age, 73.8 ± 0.7 years) reported that the prevalence of sarcopenia was 39% before surgery [13]. Since sarcopenia is affected by age [6,12], the prevalence of sarcopenia might have been lower in this study because the subjects

Table 1
Characteristics of the sarcopenia and control groups.

Characteristic	All (n = 72)	Sarcopenia (n = 10)	Control (n = 62)	P-value
Age, yr	70.4 ± 6.9	73.4 ± 5.8	69.9 ± 7.0	0.140
Sex, male:female	38:34	2:8	36:26	0.025
Height, cm	158.1 ± 8.4	156.2 ± 6.4	158.4 ± 8.7	0.442
Weight, kg	62.6 ± 11.1	52.7 ± 5.3	64.2 ± 11.0	<0.01
BMI, kg/m^2	24.9 ± 3.0	21.6 ± 1.4	25.5 ± 2.8	<0.01
Symptom duration, mo	10.0 (6.0–40.0)	19.0 (7.0–73.8)	10.0 (5.0–38.5)	0.329
Fragility fracture, %	1.4	0.0	1.6	0.686
Hypertension, %	52.8	50.0	53.2	0.850
Dyslipidemia, %	23.6	50.0	19.4	0.034
Diabetes, %	13.9	0.0	16.1	0.171
Cardiovascular disease, %	5.6	20.0	3.2	0.032
Kidney disease, %	4.2	0.0	4.8	0.477
Habitual smoking, %	11.1	10.0	11.3	0.904
Walking velocity, m/s	1.0 (0.8–1.2)	0.9 (0.6–1.1)	1.0 (0.8–1.2)	0.198
Grip strength, kg	29.7 ± 8.9	23.4 ± 8.1	30.7 ± 8.6	0.015
Walking distance, m	200 (80–500)	82.5 (13.5–182.5)	300 (80–500)	0.017
SMI, kg/m^2	7.2 (6.1–8.1)	5.6 (5.4–5.9)	7.5 (6.3–8.3)	<0.01

Values are presented as mean ± standard deviation or median (interquartile range) unless otherwise indicated.
BMI, body mass index; SMI, skeletal muscle mass index.

Table 2
Pain-related factors, disability scores, and psychological factors in the sarcopenia and control groups.

Variable	All (n = 72)	Sarcopenia (n = 10)	Control (n = 62)	P-value
NRS for leg pain	5.0 (3.0–7.0)	8.0 (5.3–8.0)	6.0 (3.0–7.0)	0.085
NRS for back pain	5.0 (3.0–7.0)	6.0 (3.8–8.0)	5.0 (3.0–7.0)	0.302
JOA score	15.7 ± 4.1	13.9 ± 3.3	16.0 ± 4.2	0.145
PCS subscores				
Rumination	17.0 (13.3–19.0)	19.5 (17.3–20.0)	16.0 (12.0–19.0)	0.012
Magnification	6.0 (4.0–8.8)	10.0 (6.0–11.0)	6.0 (4.0–8.0)	0.005
Helplessness	10.5 (6.0–15.0)	15.0 (11.8–17.8)	9.0 (6.0–13.0)	0.005
Overall PCS score	33.0 (25.3–41.8)	44.5 (33.0–47.8)	32.0 (23.8–38.3)	0.003
HADS				
Anxiety	5.0 (3.0–7.0)	8.5 (4.5–11.0)	5.0 (3.0–7.0)	0.034
Depression	5.5 (3.0–8.0)	8.0 (3.8–8.3)	5.0 (3.0–8.3)	0.214
FABQ-PA	16.0 (12.0–20.0)	18.0 (15.8–20.3)	16.0 (12.0–19.5)	0.246

Values are presented as median (interquartile range).
NRS, numerical rating scale; JOA, Japanese Orthopaedic Association; PCS, Pain Catastrophizing Scale; HADS, Hospital Anxiety and Depression Scale; FABQ-PA, Fear-Avoidance Beliefs Questionnaire on physical activity.

Table 3
Multivariate logistic regression analysis of the association between PCS and sarcopenia.

Variable	OR	95% CI	P-value
Weight	0.72	0.55–0.94	0.017
Dyslipidemia	17.90	1.08–297.49	0.044
Walking distance	0.99	0.98–1.00	0.030
Overall PCS score	1.26	1.04–1.53	0.019

Independent variables: age, fragility fracture, sex, weight, dyslipidemia, cardiovascular disease, grip strength, walking distance, overall PCS score, HADS-anxiety.
OR, odds ratio; CI, confidence interval; PCS, Pain Catastrophizing Scale; HADS, Hospital Anxiety and Depression Scale.

were younger (mean age, 70.4 ± 6.9 years) than those in previous studies. A study of 2400 Japanese women with osteoporosis aged 40 years or older (mean age, 66.3 ± 9.2 years) reported that the prevalence of sarcopenia was 20.4% [24]. Osteoporosis and sarcopenia have many shared causal factors, such as vitamin D deficiency and age-related decreases in levels of sex and anabolic hormones [25]. Accordingly, our study had a higher mean age compared with another study [24], but a lower prevalence of sarcopenia.

Previous study has reported that female gender is associated with low muscle mass among patients with LSS [26]. The result of this study was similar to that of previous study. Previous studies have reported that low body weight and BMI are associated with sarcopenia in community-dwelling elderly Japanese individuals [27] and patients with LSS [12]. Multivariate analysis in this study also identified body weight as a factor associated with sarcopenia. Previous studies have reported that dyslipidemia [28] and cardiovascular disease [1,29] are associated with sarcopenia or sarcopenic obesity. Grip strength was also significantly lower in the sarcopenia group. In previous studies of community-dwelling elderly individuals, it has been reported that grip strength is related to muscle mass in the extremities [30]. The results of this study were similar to those of previous studies, supporting the presence of an association between sarcopenia and grip strength. In this study, continuous walking distance was significantly shorter in the sarcopenia group than in the control group. In patients with LSS, intermittent claudication leads to decreased continuous walking distance. Reductions in continuous walking distance have been reported to be associated with decreases in physical activity during daily life [30]. Therefore, continuous walking distance is considered to reflect physical activity. In patients with LSS, intermittent claudication might reduce continuous walking distance, and as a result impaired physical activity in daily life decreased muscle mass. As expected, sex, body weight, BMI, dyslipidemia, cardiovascular disease, grip strength, and walking distance were also associated with sarcopenia in patients with LSS.

The overall PCS scores and all subscores indicated more severe disease in the sarcopenia group. Currently, there are no reports on the relationship between PCS and sarcopenia or low muscle mass. However, previous studies have reported that PCS is associated with pain intensity, Oswestry Disability Index scores, and physical activity levels [15,16]. In a population-based study, patients with sarcopenia were less physically active than individuals without sarcopenia [31]. In addition, PCS is related to slower walking speed and shorter continuous walking distance [32]. Pain catastrophizing in the sarcopenia group might become more severe because of an increased tendency to interpret pain excessively when continuous walking distance decreases. Pain catastrophizing and shorter continuous walking distance reduce physical activity in daily life, which may result in decreased muscle mass. Previous studies have reported a relationship between anxiety and low muscle mass [33] or low muscle function [34]. The results of this study were similar to those of previous studies, supporting the presence of an association between sarcopenia and anxiety. Previous studies in the general population have reported a relationship between depression and sarcopenia [4]. However, our study showed no association between sarcopenia and HADS-depression. The psychological factor most strongly related to sarcopenia in our study was pain catastrophizing. No studies have examined the relationship between sarcopenia and psychological factors in LSS. Therefore, this study may be the first study to investigate the relationship between sarcopenia and psychological factors. Our results suggest that pain catastrophizing is a specific psychological factor associated with sarcopenia in LSS. It has been suggested that pain catastrophizing after lumbar fusion and low back pain can be lessened with cognitive behavioral rehabilitation [35,36]. Currently, interventions based on nutrition or exercise (e.g., strength training) are considered effective in preventing and treating sarcopenia [37,38]. Thus, in addition to these interventions, programs that include cognitive behavioral rehabilitation may lead to decreased sarcopenia in patients with LSS.

One of limitations of this study is a small sample size, which might impair generalizability. However, primary results indicated good model calibration. The causal relationship between sarcopenia and related factors could not be evaluated because the study was cross-sectional in design. It cannot be deduced that the onset of LSS preceded sarcopenia. Future prospective studies with larger sample sizes are needed to determine whether pain catastrophizing causes sarcopenia in LSS. Although our discussion describes the relationship between physical activity levels and sarcopenia, this study did not measure the actual amount of physical activity. We evaluated intermittent claudication using a walking distance test only. Therefore, it is necessary to add a

questionnaire specifically evaluating intermittent claudication in future studies.

5. Conclusions

The prevalence of sarcopenia in patients with LSS was 13.9%. Pain catastrophizing and anxiety were more severe in the sarcopenia group. Multivariate analysis identified body weight, dyslipidemia, walking distance, and overall PCS score as significantly related to sarcopenia. These findings suggest that pain catastrophizing is the most relevant psychological factor related to sarcopenia. Our results demonstrate the need to evaluate not only physical function but also pain catastrophizing when investigating sarcopenia in LSS.

Authors contributions

All authors have read the manuscript and have approved this submission. Study design: TW, ST and HH. Study conduct: TW and ST. Data collection: TW. Data analysis: TW. Data interpretation: TW and ST. Drafting manuscript: TW. Revising manuscript content: TW, ST, MO, HN and HH. Approving final version of manuscript: TW, ST, MO, HN and HH. TW takes responsibility for the integrity of the data analysis.

Conflicts of interest

The authors declare no conflict of interest.

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