A Doctoral Dissertation

The combination of low bone density and muscle mass correlates with physical function in severe knee osteoarthritis

Department of Medicine

GRADUATE SCHOOL
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(Supervised by professor Jinseok Kim)

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ABSTRACT

The combination of low bone density and muscle mass correlates with physical function in severe knee osteoarthritis

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Supervised by Professor Jinseok Kim

Purpose: To investigate the prevalence of osteoporosis and low muscle mass, concomitantly or isolated, and its association with physical function, pain and quality of life in patients with severe knee osteoarthritis (OA).

Methods: The cross-sectional study assessed 578 patients (77 males and 501 females) diagnosed with severe knee OA. Patients were divided into four groups according to the different body-composition profiles; Control, Osteoporosis, Low muscle mass, Osteoporosis and Low muscle mass group. All participants underwent performance-based physical function tests including a stair climbing test (SCT), a 6-minute walk test (6MWT), a timed up and go test (TUG), and instrumental gait analysis to examine spatio-temporal parameters. Self-reported physical function and pain were measured using the Western Ontario McMaster Universities Osteoarthritis Index (WOMAC) and Visual Analog Scale (VAS), and self-reported quality of life was measured using the EuroQOL five dimensions (EQ-5D) questionnaire.

Results: Of 578 patients, 46.4% (n=268) was included in the control group, 25.6% (n=147) in the osteoporosis group, 18.3% (n=106) in the low muscle mass group, and 9.7% (n=56) in the osteoporosis and low muscle mass group. Analysis of variance (ANOVA) that the osteoporosis and low muscle mass group exhibited significantly higher scores that the other three groups in the SCT-ascent, SCT-descent, and TUG, and lower scores in the 6MWT, gait speed and cadence, than the other groups ($p<0.05$). After adjusting for age, sex, and body mass index (BMI), multiple linear regression analysis identified SCT-descent ($\beta=0.140$, $p=0.001$, $R^2=0.126$), SCT-descent ($\beta=0.182$, $p<0.001$, $R^2=0.124$), gait speed ($\beta=-0.116$, $p=0.005$, $R^2=0.079$), and cadence ($\beta=-0.093$, $p=0.026$, $R^2=0.031$) are significantly associated with the combination of osteoporosis and low muscle mass.

Conclusion: The combination of low bone density and muscle mass correlates with physical function in severe knee osteoarthritis

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LIST OF ABBREVIATIONS

OA, Osteoarthritis

SCT, Stair climbing test

6MWT, 6-minute walk test

TUG, Timed up and go test

WOMAC, Western Ontario McMaster Universities Osteoarthritis Index

VAS, Visual Analog Scale

EQ-5D, EuroQOL five dimensions

ANOVA, Analysis of variance

BMI, Body mass index

BMD, Bone mineral density

QOL, Quality of life

TKA, Total knee arthroplasty

K-L, Kellgren-Lawrence

BIA, Bioelectrical impedance analysis

FNIH, Foundation for National Institutes of Health

ASM, Appendicular skeletal muscle mass

ASM_{BMI}, ASM to BMI ratio

AWGS, Asian Working Group for Sarcopenia

EWGSOP, European Working Group on Sarcopenia in Older People

IWGS, International Working Group on Sarcopenia

I. INTRODUCTION

Osteoporosis and sarcopenia are chronic conditions that are common in frail older patients (Edwards et al., 2015; Peterson et al., 2016; Vlietstra et al., 2019). Osteoporosis are identified by a loss of bone mineral density (BMD) (Dempster, 2011; Dobbs et al., 1999), and sarcopenia refers to the reduction of muscle mass and strength accompanied by impaired muscle function (Fielding et al., 2011). The combination of these two diseases, which exacerbates negative health outcomes, is known as the "hazardous duet"; this phenomenon increases the risk of falls and damage to bones (Crepaldi et al., 2005). In addition, these diseases are significantly associated with physical disabilities and dependency (Curtis et al., 2015; Hirschfeld et al., 2017). Yu. et al. showed that the fracture risk in men with osteosarcopenia increases 3.5-fold; indeed, the risk is significantly higher than for those with osteoporosis or sarcopenia alone (Yu et al., 2014). Yoo et al. reported that 1-year mortality rates for hip fracture patients with osteosarcopenia were higher than for those without (Yoo et al., 2017). The global population is aging rapidly and living longer; therefore, the burden of both osteoporosis and sarcopenia is expected to increase.

Knee osteoarthritis (OA), a very common disease, causes joint pain and swelling of joint, reduced quality of life (QOL) and functional disability (Peat et al., 2001). In an aging population, the impact of OA is likely to increase, particularly as it commonly coexists with other comorbidities. Kadam et al. showed that the presence of comorbidities in OA patients increases the likelihood of physical disability; indeed, the combined effect of comorbidities is higher than that of OA alone or of each individual condition (Kadam et al., 2007). A meta-analysis of data from 17 studies revealed that more comorbidities contributes to worse pain and physical function in knee and/or hip OA patients (Calders et al., 2018).

Therefore, we hypothesized that a synergistic effect between low bone density and muscle mass were related to worse physical function, pain and QOL in severe knee OA patients. Although there are several studies evaluating sarcopenia/low muscle mass and osteopenia/osteoporosis, but few studies have examined patients with severe knee OA.

Therefore, the purpose of this study is to investigate the prevalence of severe knee OA patients with low bone density and muscle mass, concomitantly or isolated. Secondarily, we evaluated the association between different body-composition types (combined osteoporosis and low muscle mass, only osteoporosis, only low muscle mass, none of these conditions) and various physical function, pain and QOL in severe knee OA patients.

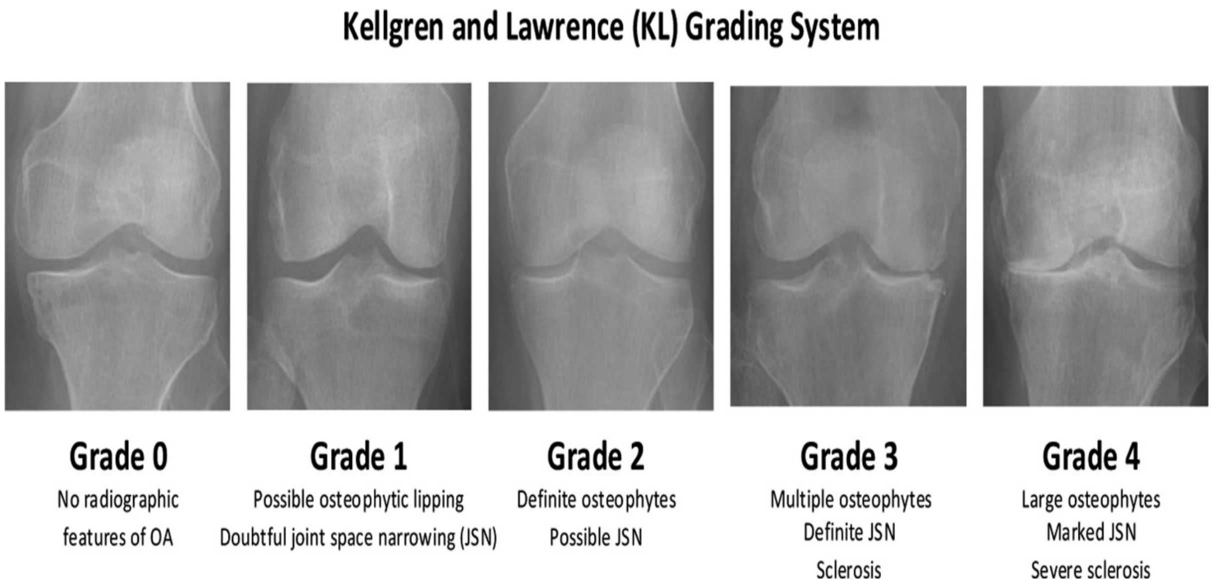
II. METHODS

Study participants

This cross-sectional study used data collected previously. Data from 578 patients (77 males and 501 females) diagnosed with severe knee OA and scheduled to perform primary total knee arthroplasty (TKA) at the Department of Orthopedic Surgery in OO National University Hospital between October 2013 and June 2019 were assessed. All participants had radiographic criteria of severe knee OA as evidenced by Kellgren-Lawrence (K-L) grade 3 and grade 4. The K-L grading system, accepted by WHO in 1961, is the most commonly used knee OA severity grading system (Kellgren et al., 1957). K-L system classified knee OA severity into 5 grades from grade 0 to grade 4. The sample and criterion of each grade are shown in Fig. 1 (Chen et al., 2019).

Patients with a history of orthopedic or neurological disease that may cause a gait impairment deficit (e.g., unstable cardio-respiratory disease or hemiplegia of stroke) were excluded. The study protocol was approved by the institutional review board of OO National University Hospital. The requirement for informed consent was waived due to the retrospective nature of the study.

Figure 1. The K-L grading system to assess the severity of knee OA.



Body composition assessments

Osteoporosis is defined as a BMD of more than 2.5 standard deviations (SD) below the healthy young population according to the World Health Organization criteria (Glaser et al., 1997).

Appendicular skeletal muscle mass is obtained by the sum of arms and legs muscle mass on bioelectrical impedance analysis (BIA) (Fig. 2). The diagnosis of low muscle mass was made based on the values established by the Foundation for National Institutes of Health (FNIH) (Studenski et al., 2014). It was calculated with appendicular skeletal muscle mass (Kg) divided by body mass index (BMI) (cut-off reference values were <0.512 for women and <0.789 for men).

On the basis of the osteoporosis and low muscle mass cutoffs, the participants were classified into four groups: Control, Osteoporosis, Low muscle mass, Osteoporosis and Low muscle mass group.

Figure 2. The figure shows the measurement of appendicular skeletal muscle mass using bioelectrical impedance analysis (BIA)

Outcome measurements

All patients completed the following assessments before surgery: performance-based physical function tests, including a stair climbing test (SCT), a 6-minute walk test (6MWT), a timed up and go test (TUG), and instrumental gait analysis of spatio-temporal parameters. Self-reported physical function and pain were measured using the Western Ontario McMaster Universities Osteoarthritis Index (WOMAC) and a Visual Analog Scale (VAS). And, self-reported QOL was measured using the EuroQOL five dimensions (EQ-5D) questionnaire.

Assessment of performance-based physical function

SCT

The SCT measures the time required to ascend and descend a flight of stairs (12 steps, each 17 cm high and 25 cm wide). Patients had to ascend and descend the stairs as quickly as possible, starting on the word "go." There was a 5-minute interval between each trial and the shortest time was recorded (Almeida et al., 2010). The higher the score in the SCT, the worse the performance (i.e., means that it takes longer to climb or descend the stairs).

6-MWT

The 6MWT assesses functional walking capacity and gait endurance in adults. Patients walked as far as possible for 6 minutes along a 50 m hallway. The distance traveled was recorded (Enright et al., 2003). The higher the score, the better the performance.

TUG

The TUG test evaluates dynamic balance. Each patient sat with their back against a chair (seat height, 44 cm; depth, 45 cm; width, 49 cm; arm rest height, 64 cm) placed at the end of a 3 m track. While being timed, patients stood up on the word "go," walked at a comfortable speed to the 3 m mark, turned around, walked back, and sat down again in the chair without physical assistance (Lynch, 2010). The higher the score in the TUG means, the worse the performance (i.e., the patient takes longer to get up and go).

Gait analysis

The spatio-temporal variables of gait were measured using a validated wireless inertial sensing device (G-Walk, BTS Bioengineering S.p.A., Milan, Italy) (Fig. 3). Each patient wore a semi-elastic back belt device around the waist, which measures acceleration along three anatomical axes (anteroposterior, mediolateral, and vertical). Patients were instructed to stand and remain standing for a few seconds and then to walk barefoot for 8 m as naturally as possible and at a comfortable speed. Gait data were collected and transmitted to a personal computer via Bluetooth. Data were processed using the BTS G-Walk system, a specialized software that measures gait variables (speed, cadence, stride length, the duration of the gait cycle, stance phase, swing phase, and double and single support phases) (Bugané et al., 2012).

Figure 3. The figure shows spatiotemporal gait analysis using a validated 24 wireless inertial sensing device (G-Walk®, BTS Bioengineering S.p.A., Milan, Italy)

Assessment of self-reported physical function, QOL and pain

WOMAC

The multidimensional WOMAC questionnaire includes questions about pain, stiffness, and physical function. The questionnaire has five pain, two stiffness, and 17 physical function variables. Each variable is scored on the Likert scale (0: none, 1: slight, 2: moderate, 3: very, and 4: extremely), which is used widely in rheumatology clinical trials. Higher scores indicate a greater degree of pain, stiffness, and difficulty in performing each of the 17 activities over the preceding 48 h. The sum of the scores for pain, stiffness, and physical function determine the WOMAC pain (range, 0–20), WOMAC stiffness (range, 0–8), and WOMAC function (range, 0–68) subscores (Bellamy et al., 1988).

VAS

Patients were asked to evaluate their level of knee pain on a VAS. Scores are based on self-reported measures of symptoms that are recorded with a single handwritten mark placed at one point along the length of a 10-cm line that stretches between two extremes (from no pain to worst pain) (Delgado et al., 2018).

EQ-5D questionnaires

The EQ-5D index is used widely to measure general health status. It is an evaluated self-reported QOL with five dimensions: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression. Each question assesses each dimension on three severity levels (no problem, some or moderate problems, or extreme problems). The scores are transformed using utility weights derived from the general Korean population (ranging from -1 to 1). Higher scores indicate better overall health status (Kim et al., 2005).

Statistical analysis

All statistical data analyses were performed using SPSS 20.0 (SPSS V 20.0K, SPSS Inc., Chicago, Illinois, USA). Analysis of variance (ANOVA) test with post-hoc comparison using the Bonferroni test was used to test for differences in performance-based physical function, self-reported physical function, pain and QOL among the four groups. A stepwise multiple linear regression analysis by adjusting for age, sex, BMI was used to evaluate the association of the combination of osteoporosis and low muscle mass with performance-based physical function, self-reported physical function, pain and QOL. P-values < 0.05 were considered statistically significant.

III. RESULTS

Table 1 shows the baseline demographic and disease-related characteristics of the patients. Of the 578 participants enrolled in the study, 86.7% were women, and the mean age was 71.47 ± 5.72 years old. The prevalence of hypertension, diabetes, degenerative spine disease, osteoporosis and sarcopenia by FNIH criteria was 382 (65.1%), 105 (18.2%), 89 (15.4%), 204 (35.3%) and 162 (28.0%) respectively.

Table 1. Demographic characteristics of the subjects (N=578)

	Total	**Male**	**Female**	
Number	578	77(13.3)	501(86.7)	
Age (years)	71.47±5.72	72.32±5.83	71.34±5.70	0.160
BMI (kg/m^2)	26.63±3.47	26.28±3.21	26.68±3.51	0.340
ASM_{BMI} (m^2)	0.60±0.13	0.80±0.14	0.57±0.10	<0.001
K-L grade				0.420
Grade 3	122(21.1)	15(19.5)	107(21.4)	
Grade 4	456(78.9)	62(80.5)	394(78.6)	
Comorbidities				
Hypertension	382(65.1)	58(75.3)	324(64.7)	0.040
Diabetes mellitus	105(18.2)	12(15.6)	93(18.6)	0.330
Degenerative spine disease	89(15.4)	8(10.4)	81(16.2)	0.130
Osteoporosis	204(35.3)	13(16.9)	191(38.1)	<0.001
Sarcopenia[a]	162(28.0)	39(50.6)	123(24.6)	<0.001

Values represent mean ± standard deviation or number (%) of cases.

Sarcopenia[a]: Sarcopenia by FNIH (Foundation for the National Institutes of Health) Criteria

Abbreviation: BMI, Body Mass Index; ASM, appendicular skeletal muscle mass; ASM_{BMI}, ASM to BMI ratio; K-L, Kellgren-Lawrence

Comparison of performance-based physical function, self-reported physical function, QOL, and pain according to the presence or absence of osteoporosis and low muscle mass

Table 2 compares demographics, performance-based physical function, self-reported physical function, pain and QOL according to the presence or absence of osteoporosis and low muscle mass. Of 578 participants, 46.4% (n=268) was included in the control group, 25.6% (n=147) in the osteoporosis group, 18.3% (n=106) in the low muscle mass group, and 9.7% (n=56) in the osteoporosis and low muscle mass group.

As ANOVA with post-hoc comparison, the time of SCT-ascent, SCT-descent in the osteoporosis and low muscle mass group were significant more than the time in the other three groups. And, 6MWT, gait speed and cadence were remarkably lower in the osteoporosis and low muscle mass group than in control group. Also, the time of TUG in the osteoporosis and low muscle mass group were significantly more than that of the control group.

Table 2. Comparison of physical function, pain and quality of life according to four groups (N=578).

Variables	Control	Osteoporosis	Low muscle mass	Osteoporosis and Low muscle mass	
Number	268(46.4)	148(25.6)	106(18.3)	56(9.7)	
Age (years)	70.83±5.56 [a]	71.64±5.31	71.80±6.05	73.45±6.46 [a]	0.014
BMI (kg/m2)	26.33±3.32 [de]	25.39±3.00 [adf]	28.59±3.58 [ef]	27.61±3.40 [a]	<0.001
SCT-ascent (sec)	13.04±5.32 [a]	13.67±5.04 [b]	13.80±5.31 [c]	16.81±6.71 [abc]	<0.001
SCT-descent (sec)	15.41±6.03 [a]	16.40±5.54 [b]	16.50±5.88 [c]	20.69±8.57 [abc]	<0.001
6MWT (m)	326.63±107.54 [a]	308.77±107.98	299.24±108.30	276.79±94.58 [a]	0.005
TUG (sec)	11.52±3.26 [a]	12.40±5.51	11.96±3.24	13.67±5.96 [a]	0.004
Gait analysis					
Gait speed(m/sec)	0.93±0.18 [ae]	0.89±0.18	0.87±0.15 [e]	0.82±0.15 [a]	<0.001
Cadence(steps/min)	105.56±14.65 [a]	103.12±15.95	104.74±12.99	99.03±17.60 [a]	0.030
WOMAC-pain	9.22±3.12	9.84±3.13	9.10±2.76	9.57±3.20	0.170
WOMAC-stiffness	2.87±1.44	2.89±1.17	2.68±1.20	2.70±1.41	0.490
WOMAC-function	28.54±8.94	28.70±8.69	30.09±8.66	31.80±9.92	0.050
VAS	6.93±1.72	7.06±1.56	6.77±1.81	6.98±1.50	0.600
EQ-5D	0.59±0.16	0.58±0.16	0.58±0.16	0.53±0.19	0.080

Values represent mean ± standard deviation or number (%) of cases

Abbreviation: BMI, Body Mass Index; SCT, Stair Climbing Test; 6MWT, 6-minute walk test; TUG, Timed up and go; WOMAC, Western Ontario McMaster Universities Osteoarthritis Index; VAS, Visual analog scale; EQ-5D, EuroQOL five dimensions

[a] *Significant difference between Control group and Low muscle mass and osteoporosis group ($p<0.05$)*

[b] *Significant difference between Osteoporosis group and Low muscle mass and osteoporosis group ($p<0.05$)*

[c] *Significant difference between Low muscle mass group and Low muscle mass and osteoporosis group ($p<0.05$)*

[d] *Significant difference between Control group and Osteoporosis group ($p<0.05$)*

[e] *Significant difference between Control group and Low muscle mass group ($p<0.05$)*

[f] *Significant difference between Osteoporosis group and Low muscle mass group ($p<0.05$)*

Association of the combination of osteoporosis and low muscle mass with physical functions by multiple linear regression analyses

Table 3 presents the factors associated with physical function including the combination of osteoporosis and low muscle mass. After adjusting for age, sex, and BMI, multiple linear regression analysis identified the combination of osteoporosis and low muscle mass significantly correlated with SCT-ascent (β=0.140, p=0.001, R^2=0.126), SCT-descent (β=0.182, p<0.001, R^2=0.124), gait speed (β=-0.116, p=0.005, R^2=0.079), and cadence (β=-0.093, p=0.026, R^2=0.031).

Table 3. Association of the combination of osteoporosis and low muscle mass with physical functions by multiple linear regression analyses

Outcome/Independent predictor	Standardized β	p-value	Adjusted R^2
SCT-ascent (sec)			0.126
Age	0.292	<0.001	
BMI	0.087	0.037	
Sex	0.148	<0.001	
Osteoporosis and low muscle mass	0.140	0.001	
SCT-descent (sec)			0.124
Age	0.248	<0.001	
BMI	0.085	0.04	
Sex	0.164	<0.001	
Osteoporosis and low muscle mass	0.182	<0.001	
gait speed (m/sec)			0.079
Age	-0.213	<0.001	
Sex	-0.151	<0.001	
Osteoporosis and low muscle mass	-0.116	0.005	
Cadence (steps/min)			0.031
Age	-0.149	<0.001	
Osteoporosis and low muscle mass	-0.093	0.026	

Values represent mean ± standard deviation or number (%) of cases.

Abbreviation: SCT, Stair Climbing Test; BMI, Body Mass Index

IV. DISCUSSION

Here, we present strong evidence that the combination of osteoporosis and low muscle mass significantly correlated with physical function in patients with severe knee OA. To the best of our knowledge, this is the first epidemiological study to assess the prevalence of osteoporosis and low muscle mass in patients with severe knee OA.

The prevalence of combination of osteoporosis and low muscle mass in this study was 9.7% (56/578), but 35.3% (204/578) in patients with osteoporosis and 28.0% (162/578) in patients with sarcopenia by FNIH criteria. Osteosarcopenia is a recently recognized disease entity, so its prevalence is broad and unclear; to date, no study has examined the prevalence of osteosarcopenia in patient with OA. In studies of Japanese (Kobayashi et al., 2019) and Chinese (Wang et al., 2015) community-indwelling elderly, prevalence rates of osteosarcopenia were 8.4% and 12.7%, similar to our study. While, the prevalence of osteosarcopenia in the elderly was reported at 38% in Huo et al.'s study (Huo et al., 2015) and 27.9% in Drey et al.'s study (Drey et al, 2016), which is higher than that of our study. This is possibly that patient demographics (age, sex, and diseases) and the definition of osteoporosis/sarcopenia were different between studies, making direct comparison between studies difficult. In some studies, low bone density was defined including osteopenia as well as osteoporosis. Or, other studies defined sarcopenia by the other validated diagnostic criteria, such as the Asian Working Group for Sarcopenia (AWGS) or the European Working Group on Sarcopenia in Older People (EWGSOP) or the International Working Group on Sarcopenia (IWGS) (Drey et al., 2016; Huo et al., 2015; Wang et al., 2015). Although, there is no definite consensus, it is meaningful to confirm the prevalence of osteoporosis and low muscle mass in patients with severe knee OA.

The coexistence of osteoporosis and low muscle mass, present serious problems for patients. Previous reports have focused on fractures and mortality (Huo et al., 2015; Yoo et al., 2017) in patients with osteosarcopenia, but few have examined physical function and QOL. Here, we showed that performance in the SCT-descent, SCT-ascent, gait speed, and cadence results are associated significantly with the combination of osteoporosis and low muscle mass in severe knee OA. These tests measure functional status, a decline in which is a common problem for patients with severe knee OA; these parameters are not captured by self-reported measures (Bennell et al, 2011). Previous studies show the validity of the SCT-descent, SCT-ascent, TUG, gait speed, and 6MWT for demonstrating impairment of physical performance in severe knee OA (Almeida et al., 2010; Ateef et al., 2016; Mehta et al., 2019). The results suggest that, when compared to age-matched people, patients with severe knee OA have reduced physical function in important areas of daily activity, such as maintaining gait speed and balance during mobility. In particular, the majority of falls occur on stairs in a domestic setting (Whiteside, 2001), and these falls may result in major injuries or even death. Valtonen et al. (Valtonen et al, 2015) reported that knee flexor and extensor muscle strength were related with stair ascension times in the knee OA. Therefore, stair-climbing is one of the important functional activities of daily living for maintaining mobility and independence in patients with OA. Also, Dunlop et al. revealed that high levels of physical activity are closely related to greater functional performance objectively measured by gait speed in knee OA cohort (Dunlop et al., 2011). Marcum et al. found that gait speed correlates with deterioration of function in elderly with advanced knee OA (Marcum et al., 2014). In view of these findings, our study highlighted the impact of low bone mass and muscle mass on mobility and balance which are important parameters of functional status in severe knee OA patients. And, a preventive approach to managing osteosarcopenia might be warranted in those with severe knee OA and scheduled to perform primary TKA.

The correlation of low bone density and muscle mass with impaired physical function, has been observed in previous studies (Frisoli Jr et al., 2020; Kobayashi et al., 2019; Wang et al., 2015). Kobayashi et al. (Kobayashi et al., 2019) showed that osteosarcopenia was associated with muscle weakness in community-dwelling elderly people in Japan. Frisoli et al. (Frisoli Jr et al., 2020) demonstrated the association of osteoporosis and low muscle mass with impaired mobility, muscle weakness, and frailty status in Brazilian older community-dwelling outpatient adults. The results of the present study were in line with previous studies and verified in detail.

Kerr et al. (Kerr et al., 2017) suggest that osteoporosis, especially with a fracture, can have a major impact on physical activity and function. The effects of osteoporosis accumulate over time through a cycle of disability: fracture result in long-term decline in physical function, including immobilization, loss of muscle mass and physical capacity, which in turn increases the risk of further fracture and the likelihood of further physical limitations. Low bone density and muscle mass have common biological pathways and risk factors, which correlate with metabolic, cellular, vascular, and inflammatory factors (Arazi et al., 2018; Curtis et al., 2015).

Changes in bone and muscle activate a vicious cycle, leading to accelerated weakness or eventually to physical disability (Wang et al., 2015). Many older adults, especially those at risk (such as severe knee OA patients), are also time to osteoporosis and sarcopenia, and the risks and complications of these two diseases increase. This has the potential to contribute to clinically significant functional limitations than OA alone, and should be considered when developing guidelines for OA management and treatment. Our results provide insight into factors related to progression of osteosarcopenia and will help to develop various preoperative rehabilitation strategies.

This study has several limitations. First, it was a cross-sectional retrospective study and as such does not allow us to establish a cause and effect relationship; longitudinal research is needed to further explore these relationships between the presence of osteoporosis and low muscle mass and physical functions. Second, the results may not be generalizable all knee OA patients because we only analyzed data from patients scheduled to perform unilateral TKA.

V. CONCLUSION

In severe knee OA patients, the combination of osteoporosis and low muscle mass presents a higher association with impaired physical function compared to the only osteoporosis, only low muscle mass, or none of these conditions. We also suggest that the measurement of osteoporosis and appendicular skeletal muscle mass may be helpful in the identification of physical function in patient of severe knee OA with frailty. And, more studies should be performed to better understand the epidemiology and effects of low bone density and muscle mass.

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VII. ABSTRACT IN KOREAN

중증 퇴행성 슬관절염 환자에서 낮은 골밀도와 근육량이 신체 기능에 미치는 영향

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목적: 본 연구는 중증 퇴행성 슬관절염 환자에서 낮은 골밀도와 근육량의 유병률을 조사하고, 환자의 신체적 기능, 통증, 삶의 질과의 연관성을 알아보고자 하였다.

방법: 본 연구는 후향적 단면 연구로, 총 578명(남자 77명, 여자 501명, 평균 나이 71.4세)의 중증 퇴행성 슬관절염 환자들이 연구에 모집 되었다. 환자들은 신체구성비에 따라 대조군, 골다공증 그룹, 저 근육량 그룹, 골다공증 및 저 근육량 그룹으로 분류하였다. 수행 기반 기능 평가 지표로는 계단오르기 검사(stair climbing test), 6분 걷기 검사(6-minute walk test), 일어서서 걷기 검사(timed up and go test), 보행 분석(instrumental gait analysis), 자가 설문 기반 기능 및 통증, 삶의 질 평가 지표로는 WOMAC 지수(Western Ontario McMaster Universities Osteoarthritis Index), 시각통증척도(Visual Analog Scale), 삶의 질 지수(EuroQOL five dimensions) 설문지를 통해 측정하였다.

결과: 총 578명의 환자들 중, 대조군은 46.4 % (n = 268), 골다공증 그룹은 25.6 % (n = 147),

저 근육량 그룹은 18.3 % (n = 106), 골다공증 및 저 근육량 그룹은 9.7 % (n = 56) 에서 관찰되었다. 분산분석에서 네 그룹은 수행 기반 기능 평가에서 유의한 차이를 보였으며, 연령, 성별, 체질량 지수를 보정한 다중 선형 회귀 분석에서 골다공증과 저 근육량의 조합은 계단 상승 시간과 하강 시간, 보행 속도 및 걸음 수와 유의하게 연관성을 보였다.

결론: 중증 퇴행성 슬관절염 환자에서 낮은 골밀도와 근육량이 같이 있는 경우, 환자의 신체 기능과 유의한 연관성을 가진다.

VIII. APPENDICES

<Appendix 1>

WOMAC Survey Form Name: ______________________________

Instructions: In Sections A, B, and C, questions will be asked about your hip or knee pain. Please mark each response with an X. If you are unsure about how to answer a question, please give the best answer you can.

A. Think about the pain you felt in your hip/knee during the last 48 hours.

Question: How much pain do you have?

	None	Mild	Moderate	Severe	Extreme
1. Walking on a flat surface	☐	☐	☐	☐	☐
2. Going up and down stairs	☐	☐	☐	☐	☐
3. At night while in bed, pain disturbs your sleep	☐	☐	☐	☐	☐
4. Sitting or lying	☐	☐	☐	☐	☐
5. Standing upright	☐	☐	☐	☐	☐

B. Think about the stiffness (not pain) you have in your hip/knee during the last 48 hours. Stiffness is a sensation of decreased ease in moving your joint.

	None	Mild	Moderate	Severe	Extreme
6. How severe is your stiffness after first awakening in the morning?	☐	☐	☐	☐	☐
7. How severe is your stiffness after sitting, lying, or resting in the day?	☐	☐	☐	☐	☐

C. Think about the difficulty you had in doing the following daily physical activities due to your hip/knee during the last 48 hours. By this we mean your ability to move around and look after yourself.

Question: What degree of difficulty do you have?

	None	Mild	Moderate	Severe	Extreme
8. Descending stairs	☐	☐	☐	☐	☐
9. Ascending stairs	☐	☐	☐	☐	☐
10. Rising from sitting	☐	☐	☐	☐	☐
11. Standing	☐	☐	☐	☐	☐
12. Bending to the floor	☐	☐	☐	☐	☐
13. Walking on flat surfaces	☐	☐	☐	☐	☐
14. Getting in and out of a car, or on or off a bus	☐	☐	☐	☐	☐
15. Going shopping	☐	☐	☐	☐	☐
16. Putting on your socks or stockings	☐	☐	☐	☐	☐
17. Rising from the bed	☐	☐	☐	☐	☐
18. Taking off your socks or stockings	☐	☐	☐	☐	☐
19. Lying in bed	☐	☐	☐	☐	☐
20. Getting in or out of the bath	☐	☐	☐	☐	☐
21. Sitting	☐	☐	☐	☐	☐
22. Getting on or off the toilet	☐	☐	☐	☐	☐
23. Performance heavy domestic duties	☐	☐	☐	☐	☐
24. Performing light domestic duties	☐	☐	☐	☐	☐

<Appendix 2>

본인의 건강 상태 변화(EQ5D)

아래의 각 문항에서, 오늘 귀하의 건강 상태를 가장 잘 설명해주는 하나의 항목에 표시해 주십시오.

1)운동 능력
①나는 걷는데 지장이 없다
②나는 걷는데 다소 지장이 있다
③나는 종일 누워있어야 한다

2)자기관리
①나는 목욕을 하거나 옷을 입는데 지장이 없다
②나는 혼자 목욕을 하거나 옷을 입는데 다소 지장이 있다
③나는 혼자 목욕을 하거나 옷을 입을 수가 없다

3)일상 활동(예 : 일, 공부, 가사일, 가족 또는 여가 활동)
①나는 일상 활동을 하는데 지장이 없다
②나는 일상 활동을 하는데 다소 지장이 있다
③나는 일상 활동을 할 수가 없다

4)통증/불편
①나는 통증이나 불편감이 없다
②나는 다소 통증이나 불편감이 있다
③나는 매우 심한 통증이나 불편감이 있다

5)불안/우울
①나는 불안하거나 우울하지 않다
②나는 다소 불안하거나 우울하다
③나는 매우 심하게 불안하거나 우울하다