Evaluation of Sarcopenia by Psoas Muscle Measurements in Osteoporotic Patients with Vertebral Compression Fracture

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ABSTRACT

Objective: To examine the effect of sarcopenia on osteoporotic vertebral compression fracture with psoas muscle measurements.

Study Design: Cross-sectional study.

Place and Duration of the Study: Department of Radiology, Sivas Cumhuriyet University, Sivas, Turkiye, from January 2020 to March 2023.

Methodology: Measurements evaluating psoas muscle area (PMA), psoas muscle index (PMI), and psoas muscle density (PMD) were made at L2 vertebral corpus level for the diagnosis of sarcopenia from muscle mass with computed tomography (CT). The association between sarcopenia and osteoporotic compression fracture was examined with significance at $p < 0.05$.

Results: Osteoporotic patients with 37 compression fractures and 37 without compression fractures were examined. PMA and PMI were statistically significantly lower in the study group ($p < 0.01$). PMD was also found to be statistically significantly lower in the study group ($p < 0.05$). Diagnostic performance (DP) was good for the discrimination of patients and control groups for psoas area (AUC = 0.88; 95% confidence interval (CI) 0.807 - 0.956 and PMI (AUC = 0.83; 95% CI 0.734 – 0.917. It was poor for psoas density (AUC = 0.66, 95% CI 0.531 – 0.782).

Conclusion: Sarcopenia is an important risk factor for osteoporotic compression fracture. Psoas measurements show a significant association with osteoporosis and vertebral fracture and can be easily determined on CT scan.

Key Words: *Sarcopenia, Osteoporotic compression fracture, Psoas muscle.*

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INTRODUCTION

Osteoporosis (OP) is a progressive metabolic bone disease that is frequently encountered in the geriatric population and is characterised by decreased bone mineral density, leading to an increase in bone fractures.[1] Sarcopenia is a skeletal muscle disease that can cause general loss of muscle function, frailty, falls, and death with decreased muscle mass and function.[2] It is stated that these two diseases of advanced age may be related to each other and some common factors play a role in both.[3]

The geriatric population is increasing in many countries. Due to this increase, OP is becoming a major health problem. In Turkiye, similar to many countries in the world, osteosarcopenia has become a critical health problem among the elderly population. For this reason, it is important to have quantitative measurements in making the diagnosis.[4]

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Vertebral compression fractures caused by osteoporosis are also increasing. Thus, it causes problems such as embolism, decubitus ulcers, infective conditions, and being bedridden for a long time. As a result of these problems, the quality of life of the cases is seriously affected. Sometimes, it can even cause mortality due to these reasons. In this patient group, new compression fractures can be seen in imaging studies as a result of increased lumbar complaints.[5]

The estimated prevalence of sarcopenia in the elderly is between 4.1% and 11.55%.[6] Sarcopenia, similar to OP, leads to various morbidities in the geriatric population. It is thought that sarcopenia is associated with OP. Bone and muscle are interconnected, both anatomically and chemically, and metabolically. For this reason, the term osteosarcopenia is frequently used.[7] These two pathologies often occur simultaneously, and the risk of osteoporotic fractures increases in geriatric population.[8]Hida *et al.*, in their study, found a high prevalence of sarcopenia in patients with osteoporotic vertebral fractures.[9] Measurement of the psoas muscle by computed tomography (CT) is a very simple and consistent method and has been used to predict morbidity in certain situations (cirrhosis, colorectal surgery).[10]

The aim of this study was to investigate the association between psoas muscle measurements and OP compression fracture and sarcopenia, and evaluation with quantitative measurements.

METHODOLOGY

Thoracic and lumbar vertebrae CT images taken between January 2020 and March 2023, in Sivas Cumhuriyet University Hospital, Turkiye, were retrospectively scanned from the database. The study group included 37 patients over 65 years of age with thoracic or lumbar osteoporotic compression fractures, with a lumbar total T-score of -2.5 and below in Dual-energy x-ray absorptiometry (DEXA). Exclusion criteria were malignancies, trauma, demyelinating diseases, and presence of lumbar or thoracic fixation material. Thirty-seven patients over 65 years of age who had a lumbar total T-score of -2.5 and below in DEXA, who had thoracic and lumbar spine CT for any reason, and who had no thoracic or lumbar fractures were randomly included in the control group.

First, sagittal images were analysed for osteoporotic compression fracture. Psoas muscle examination was performed in the study group with compression fracture and in the control group without compression fracture. Psoas muscle measurements were performed independently and manually using a previously published technique by taking a single axial section from the L2 vertebral corpus.[11,12] Psoas muscle boundaries were determined using the specific Hounsfield unit (HU) threshold for skeletal muscle between -29 and +150.

The psoas muscle area (PMA) was measured separately for the right and left sides using picture archiving communication systems (PACS) (Figure 1). Three consecutive measurements were made for both the right and left psoas muscles, and subsequently averaged. The mean PMA was determined by averaging the values on both sides. To normalise the measurements, the mean PMA was divided by the body mass index (BMI) to obtain the psoas muscle index (PMI).[13] In addition, the psoas muscle density (PMD) was measured by calculating the density of both psoas muscles from the same section over the HU and taking the average.[14]

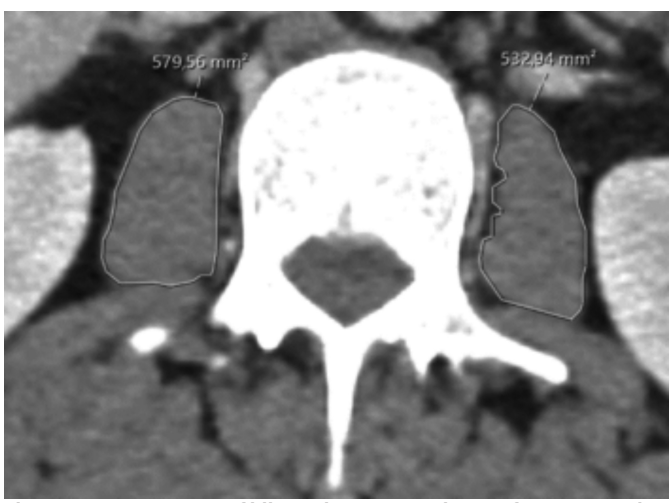

Figure 1: Measurement of bilateral psoas muscle area from L2 vertebra level.

SPSS 22.0 was used for statistical analysis. The normality of the variables was analysed by visual (histogram and probability plots) and analytical methods (Kolmogorov–Smirnov/ Shapiro– Wilk tests). Descriptive statistics of the data were given as mean ± standard deviation. Categorical data were summarised with frequencies and percentages (%). For quantitative data suitable for normal distribution, analyses were made using t-tests in independent groups according to the number of groups. Chi-square analysis was used to evaluate qualitative data.

In the evaluation of some quantitative data, the diagnostic performance (DP) was calculated by analysing the receiver operating characteristics (ROC). Type 1 error level was taken as $p < 0.05$.

RESULTS

There were 26 (70%) women and 11 (30%) men in the study group. The control group consisted of 21 (57%) women and 16 (43%) men. There was no significant age difference between the groups in terms of gender and age ($p > 0.01$). When PMA and PMI were analysed in the study and control groups, a significant difference was found ($p < 0.01$). PMA and PMI these measurements were smaller in the case group. There was a significant difference between the groups in terms of PMD ($p = 0.035$). The PMD was lower in the study group than in the control group (Table I).

Table I: Characteristics of the patients and control group with vertebral fracture.

	Fracture (+)	Control	p-value
Gender			
Female	26 (70%)	21 (57%)	0.22[a]
Male	11(30%)	16 (43%)	
Age (year)	71.54 ± 5.62	73.35 ± 6.45	0.20[b]
BMI (kg/m^2)	30.15 ± 5.70	30.67 ± 4.85	0.67[b]
Psoas area (cm^2)	4.51 ± 1.04	2.93 ± 0.83	**0.0001*[b]**
PMI (cm^2/kg/m^2)	0.15 ± 0.05	0.09 ± 0.03	**0.0001*[b]**
Psoas density (HU)	44.37 ± 11.90	38.46 ± 11.68	**0.035*[b]**

*BMI; Body mass index, PMI; Psoas muscle index. p <0.05 * Statistically significant. [a] Chi-square analysis was used. [b] Independent samples t-test was used.*

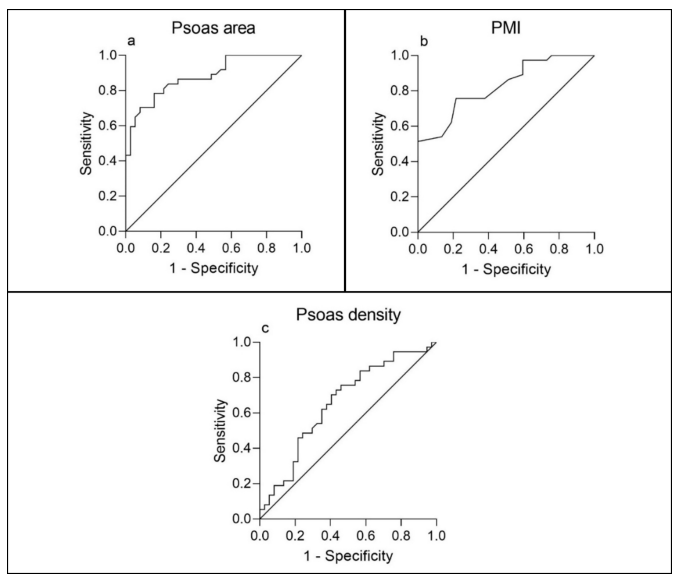

Figure 2: ROC curve analyses of values of psoas area and PMI reveal good diagnostic performance for the differentiation of fracture (+) and control cases (a, b), and poor discrimination with psoas density (c).

DP as defined with area under the receiver operating characteristic curve (AUC) using values of psoas density, psoas area, and PMI were calculated in fracture (+) and control cases.

DP was good for discrimination fracture (+) and control cases for psoas area (AUC=0.88; 95% confidence interval (CI) 0.807 - 0.956 and PMI (AUC=0.83; 95% CI 0.734 - 0.917. It was poor for psoas density (AUC=0.66, 95% CI 0.531 to 0.782). Therefore, sensitivity and specificity for the psoas area at a cut-off value of 3.7 were 0.86 and 0.70, and for PMI were 0.76 and 0.78 at a cut-off value of 0.11. At a cut-off value of 45.7 for the psoas density, sensitivity was 0.76 but specificity was only 0.46 (Figure 2).

DISCUSSION

Recent studies have shown that bone signalling pathways involved in neuronal regulation and muscle biology, and myokines that affect bone have a role in the possible muscle-bone relationship.[15] A study also found a synergistic effect between OP and sarcopenia. The coexistence of OP and sarcopenia leads to decreased mobility, falls, and fractures in elderly individuals.[7] As a result of fractures, prolonged bed rest is recommended. As a result, serious complications such as stroke, deep vein thrombosis, and pneumonia may develop. Considering the relationship between sarcopenia and compression fracture, necessary preventive measures should be taken to prevent such morbidities in the geriatric population. The clinical approach algorithm mentioned in a review published by Kutsal *et al.* can be a guide in this regard.[4]

This study found a significant relationship between sarcopenia and osteoporotic vertebral compression fractures. The psoas muscle area was found to be smaller in patients with osteoporotic compression fractures than in those without osteoporotic compression fractures. In the study conducted by Hida *et al*., sarcopenia has been reported to be a risk factor for OP fractures in geriatric women.[9] In addition, in a prospective study on the cohort of men in the geriatric age group; sarcopenia is an independent risk factor for compression fractures and this risk increases with OP.[16] Both studies showed that sarcopenia increases the risk of OP compression fracture.

The quantitative values obtained in this study may contribute to the evaluation of sarcopenia in patients with OP. Choosing a cut-off value of 3.7 was considered a highly sensitive split point for PMA. Similarly, choosing a cut-off of 1.1 was considered a very sensitive split point for PMA. At a cut-off value of 45.7 for psoas intensity sensitivity, the specificity rate was good and the sensitivity was poor. In a recent study similar to this study, the muscle area of the group with osteoporotic compression fracture was found to be smaller than the group without compression fracture ($p < 0.001$).[17] The mentioned study was conducted with magnetic resonance imaging. This study was conducted with CT and muscle density was evaluated as well as muscle area. It also makes diagnosis easier by finding quantitative values.

This study also confirms that sarcopenia is a factor that increases the risk of fracture, similar to OP and other clinical risk factors. It is predicted that the reason for the high risk of fracture is the combination of OP and sarcopenia.

For the diagnosis of sarcopenia, it is important to meet the criteria for decreased muscle strength, mass, and physical performance. One of the limitations of this study was that the decrease in muscle mass and quality was evaluated for the diagnosis of sarcopenia, but physical performance was not evaluated. It is thought that the difference between the two groups will be even greater in the presence of all criteria for sarcopenia. New studies with a larger sample group, including prospective, clinical, and radiological evaluation, will reveal the relationship between sarcopenia and compression fractures more clearly and will help prevent possible morbidities.

CONCLUSION

PMA, PMI, and PMD values were found to be lower in patients with OP compression fracture than in those without OP compression fracture. Measuring these values may enable early diagnosis in patients with OP before compression fracture develops. Thus, an important cause of mortality and morbidity can be prevented.

ETHICAL APPROVAL:
The study was approved by the Ethics Committee of the Sivas Cumhuriyet University, Faculty of Medicine with decision number 2023-03/13, dated 22 March 2023.

PATIENTS' CONSENT:
Due to the retrospective nature of the study, explicit consent of patients was not required.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
IA: Substantial contribution to the conception, designing of the work, acquisition, analysis, interpretation, and drafting of the manuscript.
EG: Conception designing of the work, designing, and interpretation of the work.
Both authors approved the final version of the manuscript to be published.

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