Research Article

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Biochemical markers as predictors of hip fractures in elderly individuals with sarcopenia

Sarkopenili yaşlı bireylerde kalça kırıklarının öngörülmesinde biyokimyasal belirteçler

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Abstract

Purpose: Sarcopenia causes numerous senior hip fractures. The aim of the study is to investigate the effect of fracture type on hip function, clinical morbidity, and sarcopenia. Postoperative risk variables and prognosis were studied for surgically treated sarcopenic hip fractures.

Materials and methods: Skelatal Mass Index (SMI), Total Psoas Area Index (TPAI), and serum dickkopf-related protein-1 (DKK-1) and sclerostin (SOST) were compared. In this single-center study, patients with proximal femur fractures treated at a tertiary trauma hospital between January 1, 2020, and March 1, 2021 were analyzed. Prospective 26-patient sarcopenic pertrochanteric/femoral neck fracture study. Our study included 52 patients (mean age 76.80±9.96 years, 27 males, 25 women). Preoperative lumbar and pelvic CT scans, TPAI, DKK-1, and SOST biochemical markers, postoperative DEXA, and SMI were included. Clinical follow-up assessed walking speed, Harris Hip Score (HHS), and Oxford Hip Score (OHS).

Results: SMI was 5.65±0.98 kg/m² in group 1 and 4.88±0.79 in group 2 (p=0.003). The mean TPAI was 488.58±39.87 mm²/m² for group 1 and 455.92±44.3 for group 2 (p=0.007). Total DKK1 mean: 776.4286±577.50 pg/mL. The mean SOST was 1787.80±1262.01 pg/mL. SOST and DKK1 correlate (r=0.27, p=0.054). Group 1 had a mean OHS value of 29.81±4.23 post-op, while Group 2 had 28.85±3.76 (p=0.391). Group 1 had a mean HHS value of 63.27±10.88, while Group 2 had 64.15±7.34. The difference between groups in HHS was not significant (p=0.733). A link exists between OHS and HHS (r=0.79, p<0.001). Gait speed test showed not significant group differences.

Conclusion: Femoral neck fracture patients with equal muscle mass may have better functional results, while those with less are at danger. Hip fractures in sarcopenia may elevate DKK1 and SOST.

Keywords: Sarcopenia, hip fractures, sclerostin, dickkopf-1 protein, fractures.

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Öz

Amaç: Sarkopeni, yaşlılarda çok sayıda kalça kırığına neden olmaktadır. Bir çalışmada kırık tipinin kalça fonksiyonu, klinik morbidite ve sarkopeni üzerindeki etkisi incelenmiştir. Cerrahi olarak tedavi edilen sarkopenik kalça kırıklarında postoperatif risk değişkenleri ve prognoz değerlendirilmiştir.

Gereç ve yöntem: İskelet Kitle indexi (SMI), total psoas alan indexi (TPAI) ve serum dickkopf-ilişkili protein-1 (DKK-1) ile sklerostin (SOST) düzeyleri karşılaştırılmıştır. Tek merkezli bu çalışmada, 1 Ocak 2020 ile 1 Mart 2021 tarihleri arasında üçüncü basamak bir travma hastanesinde proksimal femur kırığı hastaları incelenmiştir. Prospektif olarak yürütülen çalışmada 26'sı sarkopenik pertrokanterik kırık, 26'sı femur boyun kırığı olmak üzere toplam 52 hasta yer almıştır (yaş ortalaması 76,80±9,96 yıl; 27 erkek, 25 kadın). Preoperatif lomber ve pelvik BT taramaları, TPAI, DKK-1 ve SOST biyokimyasal belirteçleri, postoperatif DEXA ve SMI değerleri değerlendirilmiştir. Klinik takipte yürüme hızı, harris kalça skoru (HHS) ve oksford kalça skoru (OHS) skorları ölçülmüştür.

Bulgular: SMI, grup 1'de 5,65±0,98 kg/m², grup 2'de 4,88±0,79 kg/m² bulunmuştur (p=0,003). Ortalama TPAI, grup 1'de 488,58±39,87 mm²/m², grup 2'de 455,92±44,3 mm²/m²'dir (p=0,007). Toplam DKK-1 ortalaması 776,4286±577,50 pg/mL, ortalama SOST ise 1787,80±1262,01 pg/mL'dir. SOST ile DKK-1 arasında korelasyon saptanmıştır (r=0,27, p=0,054). Postoperatif ortalama OHS, grup 1'de 29,81±4,23, grup 2'de 28,85±3,76'dır (p=0,391). Ortalama HHS, grup 1'de 63,27±10,88, grup 2'de 64,15±7,34'tür (p=0,733). OHS ile HHS arasında anlamlı ilişki bulunmuştur (r=0,79, p<0,001). Yürüme hızı testinde gruplar arasında anlamlı fark saptanmamıştır.

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Sonuç: Kas kütlesi eşit olan femur boyun kırıklı hastalarda fonksiyonel sonuçlar daha iyi olabilirken, kas kütlesi düşük olanlar daha fazla risk altındadır. Sarkopenide görülen kalça kırıkları DKK-1 ve SOST düzeylerini yükseltebilir.

Anahtar kelimeler: Sarkopeni, kalça kırıkları, sklerostin, dickkopf- 1 protein, kırıklar.

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Introduction

The prevalence of hip fractures is rising constantly due to the global increase in average age. Hip fractures in the elderly are considered crucial due to their association with elevated mortality rates, diminished quality of life, and significant economical burden [1-3]. Age, gender, bone density loss, and multiple medical conditions are recognized as important risk factors associated with fractures of the hip. Sarcopenia, marked by functional deficits, physical insufficiency, and increased fall risk, has recently become significant in the assessment of the older population [4-8]. Sarcopenia is a disorder marked by decreased muscular function and an ongoing decrease in skeletal muscle mass [9]. The simultaneous occurrence of sarcopenia and osteoporosis is common among the elderly, increasing the likelihood of frailty [10, 11].

Serum levels of DKK1, which inhibit the Wnt-beta-catenin signaling pathway influencing bone formation and resorption, increase when bone production is reduced. It suppresses the Wnt signaling pathway, obstructs the differentiation of osteoprogenitor cells, and impedes bone production at the injury site. Inhibition of DKK1 has been observed to expedite the healing process and enhance bone growth at the fracture site. SOST, produced by osteocytes, diminishes bone growth by inhibiting the Wnt signaling pathway in osteoblasts [12, 13]. There appears to be a limited body of evidence investigating sarcopenic hip fractures. Nevertheless, no studies have examined the impact of fracture type on morbidity, functional outcomes, and biochemical markers such as DKK1 and SOST, which serve as indicators of bone production and degradation in osteoporotic hip fractures.

The hypothesis of our study posits that in sarcopenic hip fractures, the patient's sarcopenia and biochemical markers may influence postoperative morbidity, functional results, and fracture type. This study aimed to demonstrate the impact of fracture type on patient morbidity and hip function, the influence of sarcopenia on clinical outcomes, and to correlate postoperative risk factors with prognosis by measuring serum levels of DKK1 and SOST, while examining the relationship of these data with other known systemic diseases, SMI, and TPAI in surgically treated sarcopenic hip fractures. In this context, guiding data will be assessed among other factors about prognosis and clinical considerations.

Materials and methods

Study population

Ethical approval for this study was obtained from the Clinical Research Ethics Committee of SBÜ Ankara Training and Research Hospital in 2020, reference no. E-93471371-514.10-44 under number 446, comprised 26 patients with pertrochanteric femur fractures and 26 patients with femoral neck fractures, all classified as sarcopenic according to the European Working Group on Sarcopenia in the Geriatric Population (EWGSOP) 2 criteria, from a total of 98 patients over the age of 65 treated at the tertiary trauma center between January 1, 2020, and March 1, 2021. The patients' data were evaluated prospectively. The exclusion criteria included polytrauma, metastatic fractures, patients failing to meet sarcopenia criteria, immobile patients, non-compliant patients, and those unable to undergo surgery due to comorbidities, resulting in the elimination of 46 patients from the study.

The EWGSOP2 method is used for case identification, sarcopenia diagnosis, and severity assessment. These assessments included included the SARC-F and the assessment of strength of the muscles, amount of muscle, and physical condition. Muscle strength (assessed by chair stand test), muscle quantity

and quality (measured through appendicular skeletal muscle mass with DEXA), and physical performance (rated by walking speed) were assessed. The SARC-F survey comprises five subjects, each pertaining to a specific functional domain: capability, walking support, chair raise, climbing staircases, and falling. A score between 0 and 2 is allocated, and a cumulative total of ≥4 points out of a possible 12 indicates a case requiring further investigation [5].

The procedure for assessing muscle strength was as follows: Handgrip strength can be assessed via a hand dynamometer. The thresholds for low grip strength were determined by gender: <27 kg for males and <16 kg for females [5]. The chair stand test necessitated that participants rise from a seated position five times as swiftly as feasible without pausing, with arms crossed over the chest. Time, quantified in seconds, was employed for the present investigations. The strength barrier was set at over 15 seconds for five repetitions for both sexes.

The quantity of skeletal muscle was assessed using whole-body DEXA by dual-energy x-ray absorptiometry, with the measurement defined as appendicular skeletal muscle mass (ASM). The patients had complete body DEXA scans with dual energy x-ray absorptiometry (GDR 2012; Hologic Inc., USA) in the postperative first week. The appendicular skeletal muscle mass (ASM) was measured. SMI calculations were performed via ASM/height².ASM: Low muscle mass was defined as less than 20 kg for men and less than 15 kg for women [14]. The ASM Index (ASMI, calculated as ASM/height squared) indicates low muscle mass as <7.0 kg/m² for men and <5.5 kg/m² for women [15, 16].

Subsequent to these assessments, the people were categorized in accordance with the EWGSOP2 methodology [7, 8]: 1. Probability of sarcopenia was indicated by a SARC-F score of ≥4 points and diminished strength of the muscles, defined as grasping power <27 kg for men and <16 kg for women, or the chair stands time >15 seconds. 2. They received a diagnosis of confirmed sarcopenia based on the assessment of low muscle mass (ASM <20 kg for men and <14 kg for women; or ASMI <7.0 kg/m² for men and <5.5 kg/m² for women) [5]. Additionally, they exhibited severe sarcopenia, indicated by impaired Physical efficiency (gait velocity <0.8 m/s; SPPB ≤8 points; or TUG ≥20 s).

Individuals with SMI <7.0 kg/m^2 for males and <5.5 kg/m^2 for females, together with a walking speed of ≤0.8 m/sec, were incorporated into the study to reinforce the diagnosis of sarcopenia.

The t-score for the lumbar vertebrae was derived by comparing DEXA results with the bone mass of a healthy young adult.

Preoperative CT scans were conducted using a computed tomography system (Revolution Evo 2019; GE Healthcare Inc., Japan). Bilateral psoas muscle area measurements were conducted at the lumbar 3 vertebrae level utilizing the image archiving and communication system (PACS) (Akgun PACS Viewer). TPA values were acquired. The TPA value was divided by the square of the neck to calculate the TPAI.

Radiologic measurements were conducted by two observers on two occasions, separated by two-week intervals. Intraclass correlation coefficients (ICC) were computed to assess intraobserver and interobserver reliability for all measurements. The intraobserver ICCs for each observer were 0.95 and 0.93, while the inter-rater ICC was 0.92. Given that the results indicated outstanding measurement reliability per Winer's criteria, the mean values from two distinct measures conducted by a single investigator were utilized in the analysis [17].

ASA ratings, the Itaki fall risk assessment scale, and comorbidities were documented in all patients with pertrochanteric femur fractures and femoral neck fractures who were assessed prospectively. All patients included in the study were operated within the first 3 days following trauma. Serum concentrations of DKK1 and sclerostin were assessed within the initial 24 hours post-admission, and postoperative biochemical markers were analyzed. Serum DKK-1 was quantified utilizing the Elabscience® ELISA kit employing the Sandwich Enzyme-Linked Immunosorbent Assay (ELISA) technique, Catalog no: E-EL-H0057, while serum SOST was assessed using the Elabscience® ELISA kit with the Sandwich ELISA method, Catalog no: E-EL-H1544.

Harris hip scores (HHS), Oxford hip scores (OHS), and ambulation velocity were assessed at the third month postoperatively.

A priori power analysis was conducted using G*Power version 3.1, with an assumed medium effect size (Cohen's d=0.8), α=0.05, and power (1-β)=0.80. The primary outcome measure for the calculation was the difference in mean SMI values between the pertrochanteric and femoral neck fracture groups. Based on these assumptions, a minimum of 26 patients per group was required.

Statistical analysis

Data analysis was conducted using the IBM SPSS Statistics 23 (Evaluation version) software package. The normality of distributions was assessed using the Shapiro–Wilk test, and the homogeneity of variances was evaluated with the Levene test. Descriptive statistics are reported as mean ± standard deviation for normally distributed data, median (min-max) for non-normally distributed variables, and number of cases and percentage for categorical variables. The distinction between the groups regarding means was examined using the independent sample t test, while the difference in median values was assessed by the Mann Whitney U test. For correlation analyses, Pearson's correlation coefficient was applied to normally distributed variables, while Spearman's rank correlation coefficient was used for non-normally distributed variables. Correlation coefficients were reported with their 95% confidence intervals. Scatter plots were generated using dot density (hexbin) visualization to better illustrate the distribution of data points. Categorical variables were assessed using the Pearson Chi-Square test or Fisher's exact test. Results were deemed statistically significant for $p<0.05$.

Results

Among the 52 participants in the study, 26 patients had pertrochanteric femur fractures (Group 1) and 26 patients had femoral neck fractures (Group 2). A difference of no statistical significance was observed in the gender percentages among the groups compared. No statistically noteworthy distinction was observed in the mean age across the study groups (Table 1).

A statistically significant difference was seen when comparing the mean TPAI (mm^2/m^2) among the groups. It was statistically significantly reduced in group 2. Furthermore, when comparing the mean values of TPAI (mm^2/m^2) among the groups by gender, group 2 exhibited a statistically significant reduction (Table 1).

Our investigation revealed a statistically significant difference in the mean SMI (kg/m^2) among the groups. It is statistically considerably reduced in group 2. Furthermore, when comparing the mean value of SMI (kg/m^2) between the groups by gender, it was shown to be statistically substantially lower in group 2 (Table 1).

There is a strong correlation between SMI and TPAI and the relationship between the values is statistically significant (r=0.75, 95% CI:0.61-0.85, $p<0.001$). As SMI increases, TPA trends to increase (Figure 1). Especially at the disturbtion graphic of SMI and TPAI show us nearly same overlapping in groups (Figure 2). A post-hoc power analysis confirmed that the observed effect sizes for the primary structural outcomes were robust (Cohen's d=0.869 for SMI and 0.774 for TPAI). These values validate the statistical adequacy of our final total sample size (n=52) for reliably evaluating these specific parameters.

There's no statistically noteworthy differences was observed when comparing the mean values of DKK1 across the groups. Mean total DKK1 776.4286±577.50 pg/ml. No statistically significant difference was observed in the comparison of mean SOST values between the groups. The overall mean SOST level was 1787.80±1262.01 pg/mL. seen in the comparison of SOST means among the groups. The whole mean SOST was 1787.80±1262.01 pg/mL. The relationship between DKK1 and SOST values is very close to the significance limit, but not statistically significant. There exists a mildly beneficial relationship among the values (r=0.27, $p=0.054$), meaning that as SOST increases, DKK-1 also tends to increase slightly (Figure 3).

Table 1. Demographic and baseline characteristics of participants grouped by fracture type (n=52)

Parameter	Group 1	Group 2	*p*-value	Effect size
Number of Patients	26 (14 males, 12 females)	26 (13 males, 13 females)	*p*=1.000 (χ^2=0.000)	N/A
Age (years)	76.08±9.81	77.54±11.58	0.626 (t=−0.487)	Hedges g=-0.11 (95% CI -0.66-0.43)
TPAI (mm²/m²)	488.58±39.87	455.92±44.3	0.007* (t=2.790)	Hedges g=0.76 (95% CI 0.21-1.34)
SMI (kg/m²)	5.65±0.98	4.88±0.79	0.009* (t=3.134)	Hedges g=0.86 (95% CI 0.30-1.44)
DKK1 (pg/mL)	759.39±596.24	793.46±569.42	0.680 (t=−0.211)	Hedges g=-0.06 (95% CI -0.60-0.49)
SOST (pg/mL)	1640.54±607.76	1935.04±1683.6	0.745 (t=−0.839)	Hedges g=-0.23 (95% CI -0.78-0.31)
TPAI (mm²/m²) - Males	511.57±26.33	444.08±48.58	0.005* (t=4.534)	Hedges g=1.69 (95% CI 0.86-2.63)
SMI (kg/m²) - Males	6.23±0.97	4.70±1.04	0.003* (t=3.955)	Hedges g=1.48 (95% CI 0.67-2.38)
HHS	63.27±10.88	64.15±7.34	0.733 (t=−0.344)	Hedges g=-0.09 (95% CI -0.64-0.45)
OHS	29.81±4.23	28.85±3.76	0.391 (t=0.866)	Hedges g=0.24 (95% CI -0.31-0.79)
Gait speed (m/s)	0.68±0.13	0.70±0.10	0.634 (t=−0.479)	Hedges g=-0.131 (95% CI: -0.675, 0.413)
Itaki Score (Median)	13 (8-16)	14 (9-16)	0.194 (U=268.0)	N/A
No. of Significant Differences	No significant difference (gender, ASA score, lomber T-score, comorbidity, albumin levels, Neutrophil-Lymphocyte Ratio)			

TPAI (mm²/m²)= Total Psoas Area Index, SMI (kg/m²)= Skeletal Muscle Mass Index, DKK1 (pg/mL)= Dickkopf-Related Protein-1
SOST (pg/mL)= Sclerostin, HHS= Harris Hip Score, OHS = Oxford Hip Score, Group 1= Patients with Pertrochanteric Femur Fractures
Group 2= Patients with Femoral Neck Fractures, The *p*-values indicate the significance level of comparisons between the two groups
"*" indicate the the significance values of comparisons between the two groups, "-" indicates that the value is not applicable for that specific parameter in the context presented. Statistical significance is noted for the TPAI, SMI, TPAI–Males and SMI- Males comparisons, while no significance was found for age, HHS, OHS, Itaki score DKK1, and SOST levels

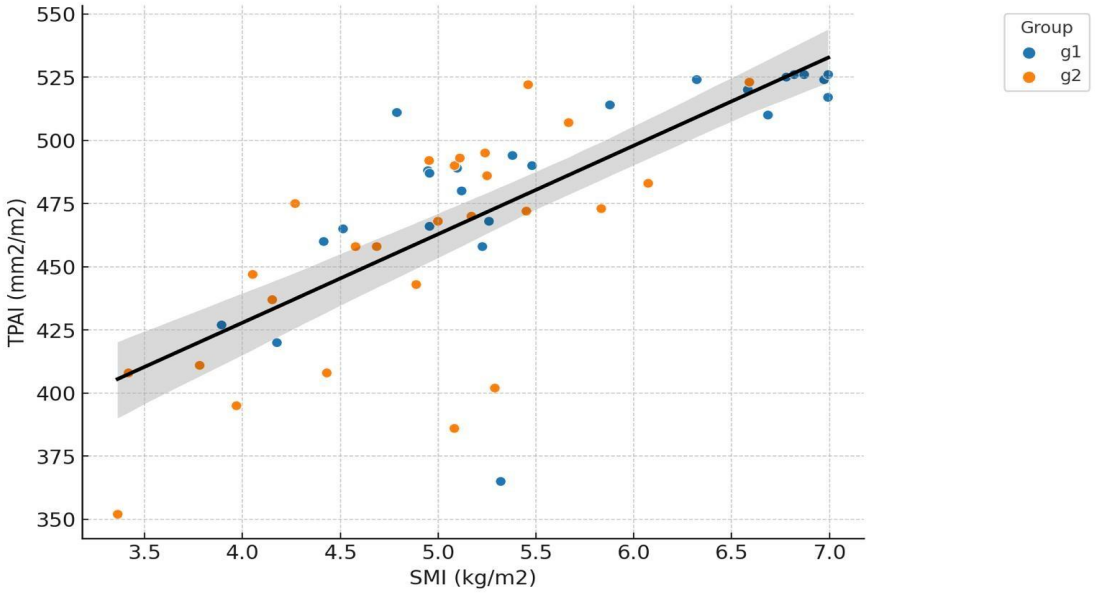

Figure 1. Scatter plot showing the relationship between skeletal muscle mass index (SMI, kg/m²) and total psoas area index (TPAI, mm²/m²) among patients with pertrochanteric femur fractures (Group 1, n=26) and femoral neck fractures (Group 2, n=26)

Correlation was evaluated using Pearson's correlation coefficient (r=0.75, 95% CI: 0.61-0.85, p<0.001)

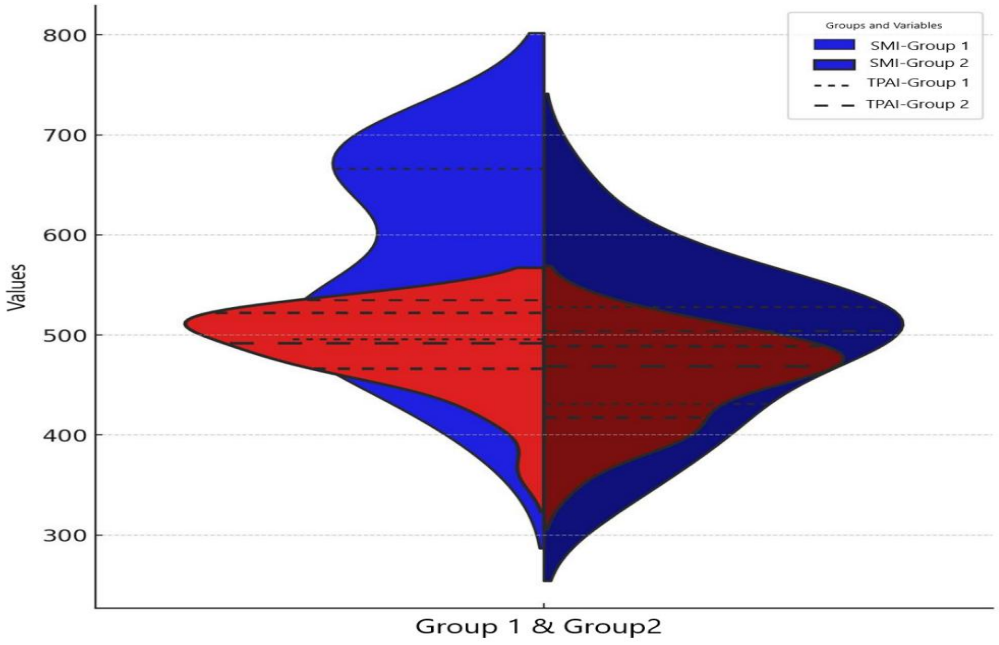

Figure 2. Violin plots comparing the distribution of skeletal muscle mass index (SMI, kg/m²) and total psoas area index (TPAI, mm²/m²) between pertrochanteric (Group 1, n=26) and femoral neck fracture patients (Group 2, n=26)

Group comparisons were made using the Independent t-test. White dots indicate median values, thick bars show interquartile ranges, and the violin outlines display the overall data distribution

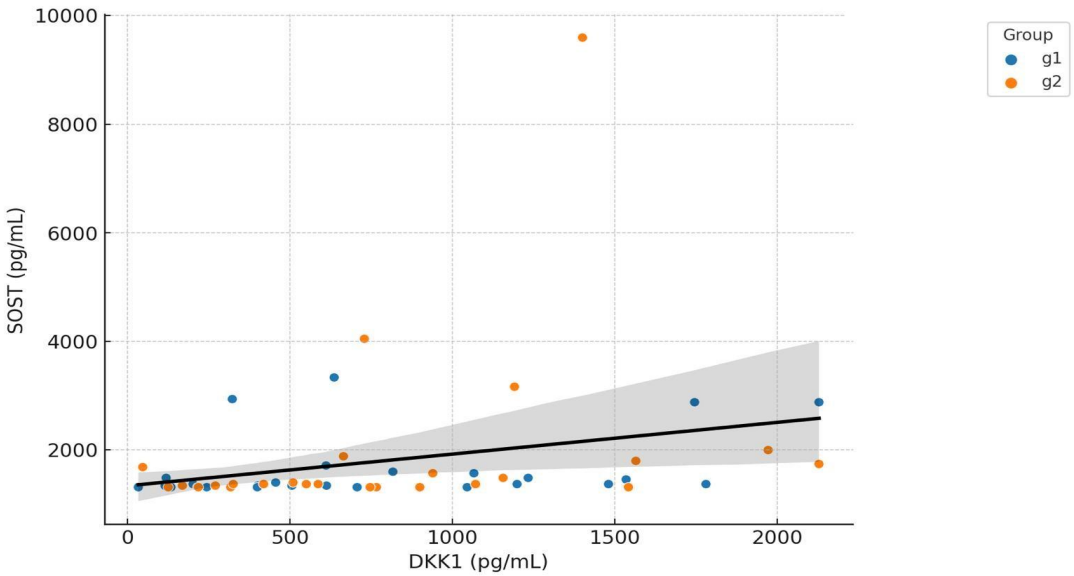

Figure 3. Scatter plot demonstrating the relationship between serum Dickkopf-related protein-1 (DKK-1, pg/mL) and sclerostin (SOST, pg/mL) levels in patients with sarcopenic hip fractures (n=52)

Correlation was analyzed using Spearman's rank correlation (r=0.27, 95%, CI:-0.02 to 0.53, p=0.054). Dot density was illustrated using hexbin visualization

A strong linear relationship was observed between OHS and HHS (r=0.79) (p<0.001), which was statistically significant. In other words, as OHS increases, HHS also increases significantly (Figure 4).

Group 1 had a mean gait speed value of 0.68±0.13, while Group 2 had 0.70±0.10 (p=0.634). No statistically significant difference was seen in the comparison of gait speeds

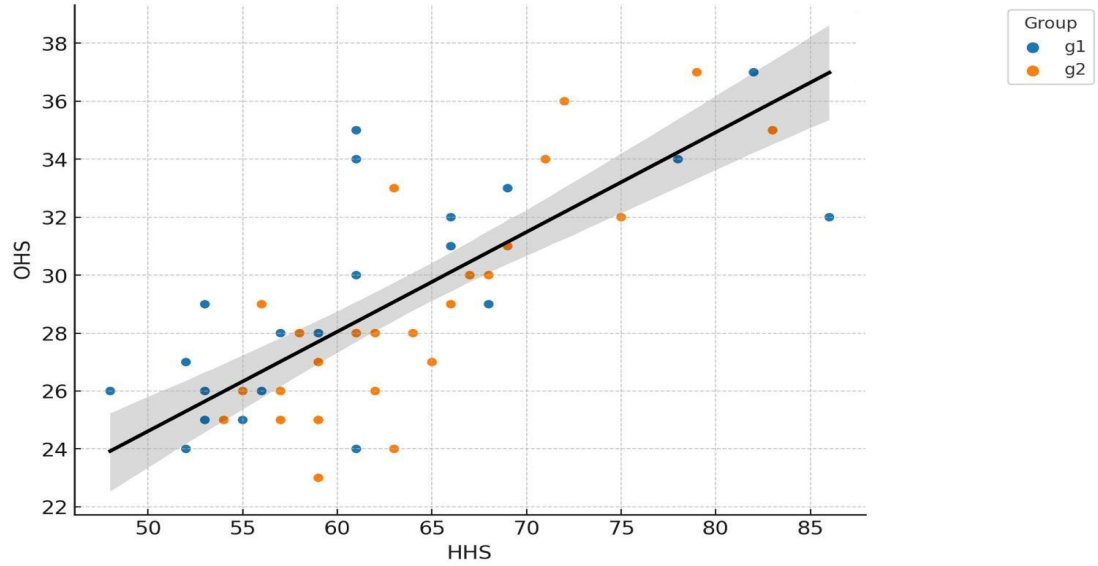

Figure 4. Scatter plot showing the correlation between Oxford Hip Score (OHS, points) and Harris Hip Score (HHS, points) among sarcopenic hip fracture patients (n=52)

Correlation was evaluated using Pearson's correlation coefficient (r=0.79, p<0.001)

No notable variations were detected among the groups regarding age, gender, ASA score, gait speed, HHS, OHS, fall risk, mobility, DKK1, and SOST levels (Table 1).

Discussion

Bone markers, specifically DKK-1 and SOST, were elevated in sarcopenic hip fracture patients relative to the general population, suggesting that these markers may serve as risk indicators for hip fractures in sarcopenic individuals. The average DKK1 level in our study was determined to be 776.4286±577.50 pg/ml. In the research conducted by Lin et al. [18], the DKK1 level was determined to be 11.740 pg/mL. The research by Dovjak et al. [19], revealed that the average DKK1 level in hip fracture patients was 3.114 pg/mL, which was lower than the levels seen in our study. The average SOST value in our investigation was determined to be 1787.80±1262.01 pg/mL. The study by Medeiros et al. [20], indicated that SOST levels rose as SMI declined. In our investigation, a comparable association was noted between poor SMI and SOST levels; however, no significant variation in SOST levels was seen among fracture types. In the research conducted by Bruzzese et al. [21], the SOST level was recorded at 300±120 pg/mL. SOST levels in hip fracture patients were measured at 7.855 pg/mL, which was significantly elevated compared to the control group [22]. Despite the absence of a specified reference range for the biochemical markers, the values recorded were markedly elevated compared to the SOST and DKK1 levels in healthy persons; nevertheless, no distinction was noted between the groups based on fracture type.

The skeletal muscle mass index assessed by DEXA, utilized for diagnosing sarcopenia in our investigation, was substantially greater in the pertrochanteric fracture group compared to the femoral neck fracture group within the same age cohort. Moreover, this value was markedly elevated in male patients within the pertrochanteric fracture cohort relative to their counterparts in the femoral neck fracture cohort. The average value for all patients in our study was determined to be 5.27±0.97 kg/m². Upon examination of group 1 and group 2, the findings were 5.65±0.98 kg/m² and 4.88±0.79 kg/m², respectively. In a study by Shin et al. [23], involving 135 hip fracture patients, the SMI value for sarcopenic patients was determined to be 5.4±0.8 kg/m². The mean SMI of all patients was consistent with the literature. Upon dividing them into groups, the outcomes of group 1 were analogous, however a discernible disparity in the SMI value was seen in group 2. The SMI value in the literature was determined to be 5.3±0.8 kg/m² [24]. It demonstrates an association with the average SMI value in our research. In the research by Yoo et al. [3], the SMI value was determined to be 5.32±2.02 kg/m² in the hip fracture cohort, which aligns with the mean SMI value observed in our study. The research indicates that the mean SMI of patients with hip fractures is 5.8±1.0 kg/m² [25]. Our investigation revealed that the mean SMI values were elevated compared to the mean SMI of all patients. The study by Iida et al. [26], observed a SMI rate of 4.87±0.64 kg/m² in patients with sarcopenia, noting that femoral neck fractures were prevalent among the sarcopenic patient cohort. This corresponds with the average SMI of patients in group 2 in our study

The total psoas area index, determined by assessing bilateral psoas muscle area at the L3 vertebral level via computed tomography for sarcopenia diagnosis, revealed a significant excess in patients with pertrochanteric fractures compared to those with femoral neck fractures. The femoral neck fracture cohort exhibits a diminished psoas muscle ratio in individuals who have sarcopenia and hip fractures of comparable age. The mean TPAI in group 1 was 488.58±39.87 mm²/m², but in group 2 it was 455.92±44.3 mm²/m². In the literature, TPAI was reported as 4.81±1.59 cm²/m² in sarcopenic patients. The TPAI values of Group 1 were associated with the findings of Xu et al. [27], while the TPAI values of Group 2 were determined to be low. In the research by Dodson et al. [28], the mean TPAI in individuals with liver cancer was determined to be 515 mm²/m². Both groups exhibited reduced mean TPAI values relative to the research conducted by Dodson et al. [28]. Sarcopenia is characterized by the deterioration of muscular function and a gradual reduction in muscle mass. A notable disparity was observed between the groups for SMI and TPAI, favoring the pertrochanteric fracture cohort.

SMI and TPAI are correlated with skeletal muscle mass. We examined whether variations in muscle mass result in functional disparities

in hip fractures based on fracture type. This involved measuring serum levels of DKK1 and SOST, analyzing the relationship of these data with other known systemic diseases of the patients, fracture type, SMI, TPAI, and functional outcomes. We also assessed whether postoperative risk factors correlate with prognosis and whether sarcopenia influences biochemical parameters. Furthermore, the identification of biomarkers capable of assessing the unique functions of bone tissue and understanding the link between bone and other organs is a priority in diagnosis, therapy, and monitoring.

The limitations of our study include the low patient sample size, but the power analysis was above 80%, the absence of a control group, the exclusive inclusion of patients with severe sarcopenia, and factors that hindered patient access due to the pandemic during the study period. A comprehensive study is required that examines all sarcopenia groups, includes a control group, and incorporates a larger patient population under optimal settings with regular follow-ups.

In conclusion, our study revealed that elevated levels of DKK1 and SOST may serve as indicators of sarcopenic hip fractures, and there was a statistically significant reduction in SMI and TPAI values among patients with femoral neck fractures. The femoral neck fracture group exhibited reduced muscle mass, and there was no significant disparity in functional outcomes between the two groups. Based on these findings, we propose that maintaining adequate muscle mass may be protective against femoral neck fractures, whereas patients with reduced muscle mass are at higher risk for this fracture type.

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