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Integrated Computed Tomography and Biomarker Evaluation of Myosteatosis Associated with Sarcopenia in Palliative Oncogynecological Patients

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Abstract **Background:** Myosteatosis and sarcopenia are important manifestations of cancer-associated muscle deterioration, particularly in palliative oncology patients, and are associated with poor clinical outcomes. **Objective:** To evaluate the diagnostic value of computed tomography in detecting myosteatosis associated with sarcopenia in palliative patients with oncogynecological malignancies. **Materials and Methods:** A prospective single-center study included 65 patients with advanced oncogynecological malignancies receiving palliative care. CT-based body composition assessment was performed at the L3 vertebral level with evaluation of skeletal muscle index (SMI), skeletal muscle density (SMD), and intermuscular adipose tissue (IMAT). Laboratory markers included albumin, CRP, and IL-6. **Results:** Sarcopenia was identified in 63.1% of patients, myosteatosis in 55.4%, and the combined phenotype in 47.7%. Patients with myosteatosis had significantly lower SMI (34.2 ± 4.1 vs 41.8 ± 3.7 cm²/m²), lower SMD (27.4 ± 6.2 vs 39.1 ± 5.4 HU), higher IMAT (14.8 ± 3.6 vs 7.1 ± 2.2 cm²), lower albumin, and higher CRP and IL-6 levels ($p < 0.05$). **Conclusion:** CT assessment at the L3 level is an effective method for diagnosing myosteatosis in palliative oncogynecological patients. Myosteatosis is associated with systemic inflammation, nutritional deficiency, and severe muscle deterioration, making it a clinically relevant prognostic biomarker.

Keywords Myosteatosis, Sarcopenia, Computed tomography, Oncogynecology, Palliative care

1. Introduction

Modern clinical oncology is increasingly focused not only on the morphological characteristics of the tumor process but also on the objective assessment of the patient's functional and metabolic status, which significantly determines treatment effectiveness and disease prognosis. One of the most significant manifestations of tumor-associated metabolic disorders is sarcopenia, characterized by a progressive decline in skeletal muscle mass, strength, and functional capacity. In oncological practice, sarcopenia is regarded as an independent predictor of increased systemic therapy toxicity, postoperative complications, impaired quality of life, and reduced overall survival [8,11].

According to current concepts, myosteatosis is considered not merely a morphological alteration of muscle tissue, but also an independent biological marker of systemic metabolic dysfunction, chronic inflammation, and cancer cachexia [3,6]. International studies report that the prevalence of myosteatosis among oncology patients ranges from 25% to 78%, depending on tumor type, patient age, disease stage, and diagnostic criteria applied [1,2,3]. The presence of myosteatosis has been associated with a significantly increased risk of postoperative complications, systemic chemotherapy toxicity, infectious complications, prolonged hospitalization, and decreased overall survival [2,11].

Recent studies suggest that qualitative muscle deterioration may have greater prognostic significance than isolated muscle mass reduction. Daly et al. demonstrated that reduced skeletal muscle radiodensity measured by computed tomography is an independent predictor of adverse outcomes in cancer patients, even in cases with relatively preserved skeletal muscle volume [4]. Similar findings were reported by Xiao et al., who showed that myosteatosis is closely associated with the severity of systemic inflammatory response and functional impairment in oncology patients [5].

The pathogenesis of myosteatosis in cancer patients is multifactorial. Chronic tumor intoxication, hypercatabolism, protein metabolism disturbances, mitochondrial dysfunction, insulin resistance, and persistent inflammation contribute to the progressive replacement of muscle tissue with lipid

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components [6,9]. Pro-inflammatory cytokines, particularly interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and C-reactive protein (CRP), play a crucial role by activating proteolytic pathways and disrupting myogenesis [6]. Chronic inflammation is considered one of the central mechanisms underlying the development of the sarcopenic phenotype in malignant diseases [6].

This issue is of particular clinical relevance in gynecologic oncology. Patients with cervical cancer, ovarian cancer, endometrial cancer, and other malignancies of the female reproductive system represent a high-risk group for metabolic disturbances due to the combined effects of tumor burden, surgical treatment, polychemotherapy, radiotherapy, chronic pain, nutritional deficiency, and forced physical inactivity [6,9]. According to Rutten et al., sarcopenia is detected in 20–54% of patients with ovarian cancer and significantly worsens treatment outcomes [7]. Similar observations indicate the adverse impact of muscle degradation on the clinical course of endometrial and cervical cancers [7,11].

Despite growing interest in sarcopenia in oncology, the diagnostic approach to myosteatosis in gynecologic oncology remains insufficiently standardized. Most clinical studies primarily focus on the quantitative assessment of muscle mass, whereas qualitative structural alterations in skeletal muscle remain considerably less investigated. Computed tomography is currently considered one of the most objective methods for body composition assessment, as it enables simultaneous evaluation of skeletal muscle area and radiological muscle density, reflecting the degree of fatty infiltration [4,5,10].

Aim of the study

To evaluate the diagnostic value of computed tomography -based assessment of myosteatosis associated with sarcopenia in palliative patients with oncogynecological malignancies and to determine its relationship with inflammatory and nutritional-metabolic parameters.

2. Materials and Methods

A single-center prospective clinical study was conducted at the oncology palliative care department.

The study included 65 patients with morphologically confirmed advanced oncogynecological malignant neoplasms.

Functional status was assessed using **the Eastern Cooperative Oncology Group (ECOG) performance scale**.

Inclusion criteria:

- age >18 years;
- confirmed stage III–IV oncogynecological malignancy;
- palliative stage of treatment;
- availability of abdominal computed tomography (CT) imaging;
- ECOG performance status 1–3;
- written informed consent.

Exclusion criteria:

- significant CT imaging artifacts;
- neuromuscular disorders;
- decompensated multiple organ failure;
- acute infectious conditions.

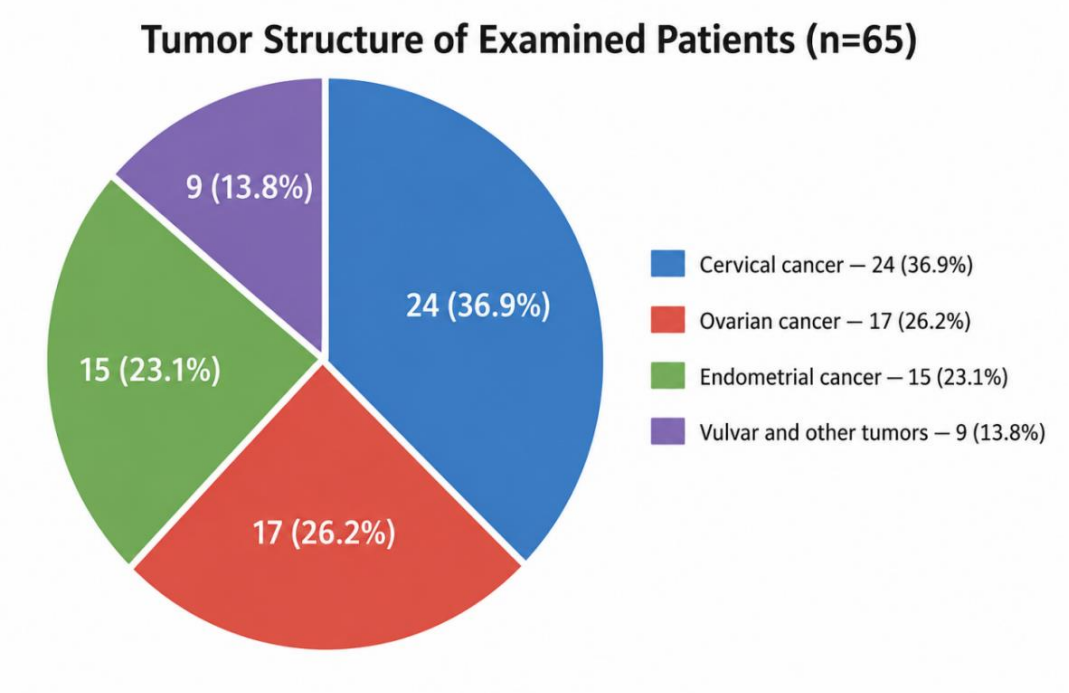

Figure 1. Distribution of examined patients according to tumor localization (n = 65)

Computed Tomography Assessment Methodology

Computed tomography (CT)-based body composition assessment was performed at the level of the **third lumbar vertebra (L3)**, which is recognized as the most representative anatomical landmark for evaluating total skeletal muscle composition, as this level strongly correlates with whole-body skeletal muscle mass.

The following parameters were assessed on axial CT images:

1. Skeletal Muscle Area (SMA)

The evaluated muscle groups included:

- m. psoas major
- m. erector spinae
- m. quadratus lumborum
- m. transversus abdominis
- m. obliquus internus
- m. obliquus externus
- m. rectus abdominis

Muscle area was measured in cm^2.

2. Skeletal Muscle Index (SMI)

SMI was calculated using the formula:

SMI=SMA (cm2) : height2 (m2)

The diagnostic threshold for sarcopenia in women was defined as: SMI < 38.5 cm^2/m^2

3. Skeletal Muscle Density (SMD)

Muscle radiodensity was measured in Hounsfield Units (HU).

The attenuation range for skeletal muscle tissue was defined as:

$$-29 \text{ to } +150 \text{ HU}$$

Reduced muscle density was interpreted as evidence of fatty infiltration.

Diagnostic criteria for myosteatosis:

- <30 HU in obese patients
- <35 HU in non-obese patients

4. Intermuscular Adipose Tissue (IMAT)

IMAT was defined as adipose tissue located between muscle fascia planes.

The attenuation range for adipose tissue was:

$$\mathbf{-190 \text{ to } -30 \text{ HU}}$$

Increased IMAT was interpreted as a marker of progressive myosteatosis.

5. Myosteatosis Index

An integrated myosteatosis index was additionally calculated:

$$\text{Myosteatosis Index} = \text{IMAT} : \text{SMA}$$

Functional and Laboratory Assessment

Additional parameters included:

- ECOG performance status
- body mass index (BMI)
- serum albumin level
- C-reactive protein (CRP)
- interleukin-6 (IL-6)
- homeostatic model assessment of insulin resistance (HOMA-IR)
- triglyceride/high-density lipoprotein ratio (TG/HDL ratio)

3. Results

Sarcopenia was diagnosed in **41 patients (63.1%)**.

Myosteatosis was identified in **36 patients (55.4%)**.

The combined phenotype of sarcopenia and myosteatosis was observed in **31 patients (47.7%)**.

Table 1. In patients with myosteatosis, the following findings were observed

Parameter	Myosteatosis	Without Myosteatosis
SMI (cm^2/m^2)	34.2 ±4.1	41.8 ±3.7
SMD (HU)	27.4 ±6.2	39.1 ±5.4
IMAT (cm^2)	14.8 ±3.6	7.1 ±2.2
Albumin (g/L)	29.3 ±4.1	36.7 ±3.8
CRP (mg/L)	24.8 ±8.3	11.2 ±4.6
IL-6 (pg/mL)	19.4 ±5.7	8.5 ±3.1

4. Discussion

The obtained results demonstrate a high prevalence of skeletal muscle composition abnormalities among palliative patients with oncogynecological malignancies. Sarcopenia was diagnosed in 63.1% of the examined patients, myosteatosis in 55.4%, while the combined phenotype was identified in nearly half of the cohort (47.7%). These findings indicate that skeletal muscle alterations in patients with advanced oncogynecological malignancies are characterized not only by quantitative muscle loss but also by pronounced qualitative structural deterioration.

The high prevalence of sarcopenia in this patient population is expected, as malignant disease progression is accompanied by severe hypercatabolism, systemic inflammatory response, reduced physical activity, nutritional deficiency, and cancer-associated cachexia. However, particular clinical interest is associated with myosteatosis, which reflects pathological fatty infiltration of skeletal muscle and is currently recognized as an independent adverse prognostic factor in oncology patients.

Comparative analysis of computed tomography parameters revealed a statistically significant reduction in the skeletal muscle index (SMI) in patients with myosteatosis compared with those without evidence of fatty muscle degeneration (34.2 ± 4.1 vs 41.8 ± 3.7 cm^2/m^2; $p < 0.05$). This finding confirms the close pathophysiological relationship between quantitative muscle depletion and qualitative structural muscle deterioration. Reduced SMI in patients with myosteatosis suggests more severe muscle wasting and profound metabolic decompensation.

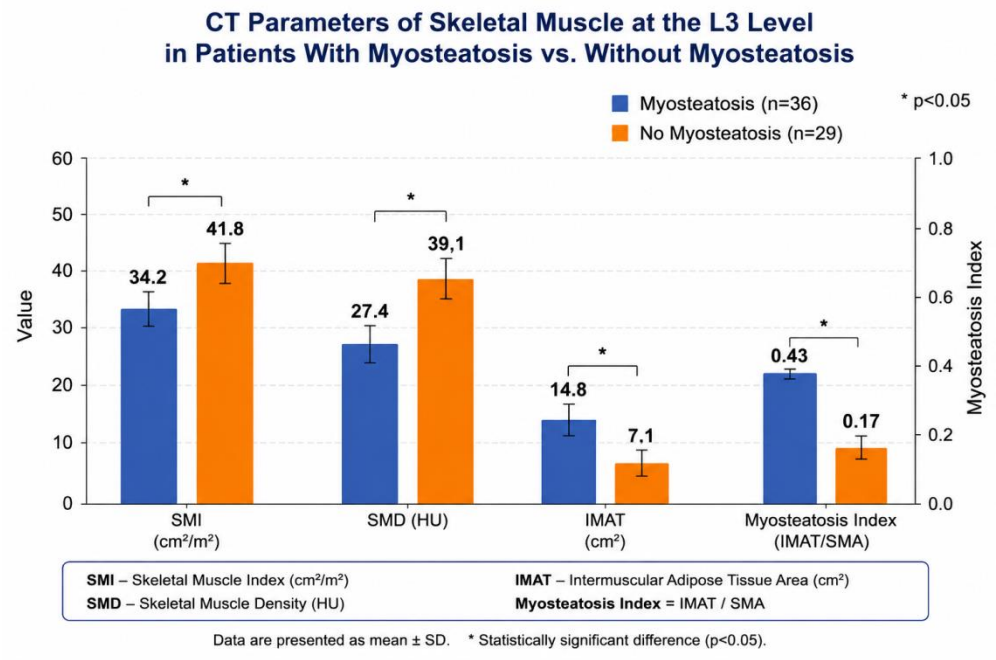

Figure 2. Comparative CT assessment of skeletal muscle parameters at the L3 vertebral level in patients with and without myosteatosis

The most indicative marker of qualitative muscle impairment was the reduction in skeletal muscle radiodensity (SMD). In patients with myosteatosis, the mean SMD was 27.4 ± 6.2 HU, whereas in patients without myosteatosis it reached 39.1 ± 5.4 HU ($p < 0.05$). Reduced muscle density reflects intramuscular lipid accumulation and serves as an objective CT-based marker of myosteatosis. These alterations indicate significant disruption of muscle architecture, diminished contractile capacity, and progressive functional impairment of the muscular system.

Additional confirmation of severe fatty degeneration was provided by the increased volume of intermuscular adipose tissue (IMAT), which was more than twofold higher in patients with myosteatosis compared with the control group (14.8 ± 3.6 vs 7.1 ± 2.2; $p < 0.05$). Increased IMAT reflects not only localized fat redistribution but also systemic metabolic disturbances associated with chronic inflammation, insulin resistance, and impaired lipid metabolism.

Particular attention should be paid to the identified association between myosteatosis and markers of nutritional deficiency. Significantly lower serum albumin levels were observed in patients with myosteatosis compared with those without this condition (29.3 ± 4.1 g/L vs 36.7 ± 3.8 g/L; $p < 0.05$), indicating pronounced protein-energy deficiency. Hypoalbuminemia in this patient population reflects not only insufficient nutritional substrate intake but also enhanced catabolic activity, which is characteristic of cancer cachexia.

A significant elevation of inflammatory markers was also observed. The level of C-reactive protein (CRP) in patients with myosteatosis was more than twofold higher than in the comparison group (24.8 ± 8.3 vs 11.2 ± 4.6 mg/L; $p < 0.05$), while interleukin-6 (IL-6) concentrations were also substantially increased (19.4 ± 5.7 vs 8.5 ± 3.1 pg/mL; $p < 0.05$). These findings confirm the central role of chronic systemic inflammation in the pathogenesis of myosteatosis. IL-6 is considered one of the key mediators of tumor-induced catabolism, contributing to enhanced proteolysis, lipotoxicity, and suppression of muscle regeneration processes.

Thus, the obtained findings suggest that myosteatosis should not be regarded merely as an isolated radiological phenomenon, but rather as a complex clinical and metabolic syndrome reflecting profound disturbances in protein-energy metabolism, chronic systemic inflammation, and progressive deterioration of patients' functional status.

The practical significance of this study lies in the fact that CT-based body composition assessment at the **L3 vertebral level** allows not only the diagnosis of sarcopenia but also the detection of hidden qualitative alterations in skeletal muscle tissue with important prognostic implications. This is particularly relevant in palliative patients, where early identification of myosteatosis may provide a basis for timely nutritional support, anti-inflammatory correction, and individualized palliative treatment strategies.

Overall, the results confirm that the combination of sarcopenia and myosteatosis represents one of the most unfavorable phenotypes of cancer cachexia in oncogynecological patients and should be mandatorily incorporated into comprehensive clinical assessment algorithms.

5. Conclusions

Myosteatosis is a highly prevalent and clinically significant component of skeletal muscle deterioration in palliative patients with oncogynecological malignancies. In the present study, sarcopenia was identified in 63.1% of patients, myosteatosis in 55.4%, and the combined phenotype in 47.7%, indicating a substantial burden of cancer-associated muscle pathology.

Computed tomography assessment at the L3 vertebral level demonstrated high diagnostic utility for detecting both quantitative and qualitative skeletal muscle abnormalities. Patients with myosteatosis showed significantly lower skeletal muscle index and muscle density, along with markedly increased intermuscular adipose tissue, confirming profound structural muscle degeneration.

The association of myosteatosis with hypoalbuminemia, elevated CRP, and increased IL-6 levels indicates that this condition reflects not only radiological muscle alteration but also severe systemic inflammation, metabolic dysregulation, and protein-energy deficiency.

Therefore, myosteatosis should be regarded as an important imaging biomarker of adverse clinical status in palliative oncogynecological patients. Integration of CT-based body composition assessment into routine palliative oncology practice may improve risk stratification, facilitate early nutritional and anti-inflammatory interventions, and support personalized supportive care strategies.

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