

ASSOCIATION BETWEEN QUANTITATIVE PARAMETERS AND RADIOMIC FEATURES OF ORBITAL ADIPOSE TISSUE IN PATIENTS WITH NON-SMALL CELL LUNG CANCER

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Growing interest has focused on the use of adipose tissue radiomics as a potential source of non-invasive biomarkers of systemic metabolic and immunological processes. However, it remains unclear whether the radiomic characteristics of orbital adipose tissue merely reflect its quantitative properties or provide additional information regarding its intrinsic structural organization. The objective of this study was to evaluate the relationship between quantitative parameters and radiomic features of orbital adipose tissue in patients with non-small cell lung cancer. The study included 86 patients with non-small cell lung cancer treated with immunotherapy. Orbital adipose tissue was segmented on pretreatment head CT images, and its total volume and CT attenuation were measured. Six radiomic features were subsequently extracted using the PyRadiomics platform. Associations were assessed using Spearman's rank correlation analysis and the Mann–Whitney U test. No statistically significant correlations were found between total orbital adipose tissue volume and any of the investigated radiomic features (all $P > 0.05$). CT attenuation demonstrated only weak negative correlations with Variance ($p = -0.24$, $P = 0.027$) and Entropy ($p = -0.21$, $P = 0.049$). Weak to moderate correlations were observed among most radiomic features, whereas the strongest association was identified between Kurtosis and Skewness ($p = 0.81$, $P < 0.001$). Radiomic features demonstrated only isolated weak associations with markers of systemic inflammation and showed no significant correlations with body mass index. In conclusion, radiomic features of orbital adipose tissue are largely independent of its conventional quantitative parameters, nutritional status, and systemic inflammatory markers.

Key words: non-small cell lung cancer, orbital adipose tissue, radiomics, computed tomography, biomarkers.

Connection of the publication with planned research work.

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Introduction.

Radiomics has emerged as one of the most promising fields in modern medical imaging, enabling the extraction of quantitative features from computed tomography (CT) images that reflect the spatial organization and heterogeneity of tissues. Unlike conventional visual image assessment, radiomic features can indirectly characterize the biological properties of tissues and provide complementary information to clinical, morphological, and molecular data [1].

This approach has found its widest application in oncology. In patients with non-small cell lung cancer (NSCLC), radiomic models have been used to predict tumor molecular characteristics, response to immunotherapy, and clinical outcomes. Despite the widespread use of programmed death-ligand 1 (PD-L1) expression and other biomarkers, their predictive performance remains limited, highlighting the need for novel non-invasive predictive biomarkers. Integrating radiomic features with clinical and laboratory variables has been shown to improve predictive accuracy compared with the use of individual biomarkers alone [2, 3].

In recent years, research has gradually shifted from the analysis of the tumor itself toward the evaluation of host tissues that may reflect systemic metabolic and immunological processes. This concept is consistent with the emerging paradigm of host-related biomarkers, according to which the response to anticancer therapy is

determined not only by tumor biology but also by the biological characteristics of the host [4, 5].

Within this context, adipose tissue has attracted considerable interest. It is now recognized as a metabolically and immunologically active organ that plays a key role in regulating inflammation, energy metabolism, and cancer-associated cachexia. Structural alterations in adipose tissue may reflect systemic disturbances even before overt morphological changes become apparent [6, 7].

The potential of this approach has been demonstrated in studies showing that radiomic features of epicardial and perivascular adipose tissue can predict heart failure, atrial fibrillation, and other cardiovascular events. These findings suggest that radiomic analysis captures structural characteristics of adipose tissue that are not reflected by its volume or CT attenuation [8, 9].

Orbital adipose tissue represents an anatomically distinct fat depot that is readily visualized on CT and exhibits high metabolic activity. Although its role has been extensively investigated in thyroid eye disease, the potential of orbital adipose tissue as a source of systemic radiomic biomarkers in oncology has received little attention [10, 11].

It remains unclear whether the radiomic characteristics of orbital adipose tissue merely reflect its quantitative properties and the associated changes in nutritional status and systemic inflammation, or whether they provide additional information on the tissue's intrinsic structural organization. Addressing this question is essential for establishing the clinical value of orbital adipose tissue as a novel source of non-invasive imaging biomarkers.

The aim of the study.

To determine whether the radiomic features of orbital adipose tissue capture additional structural characteristics independent of its volume, CT attenuation, nutritional status, and systemic inflammatory markers.

Object and research methods.

Study Design and Patient Population. This retrospective single-center study included 86 patients with histologically confirmed stage IV NSCLC who received immune checkpoint inhibitor (ICI) therapy at the Sumy Regional Clinical Oncology Center. Eligible patients were aged ≥ 18 years and had pretreatment head CT scans suitable for orbital adipose tissue analysis, along with complete clinical, laboratory, and histopathological data, including programmed death-ligand 1 (PD-L1) expression status. Patients were excluded if CT image quality was inadequate, orbital adipose tissue segmentation could not be reliably performed, or clinical data were incomplete.

Clinical data were retrospectively extracted from medical records. The following variables were collected for each patient: age, sex, body mass index (BMI), line of systemic therapy, type of ICI administered, PD-L1 expression status, and laboratory parameters required for calculating the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and systemic immune-inflammation index (SII). All clinical, laboratory, and imaging data corresponded to the baseline evaluation performed before the initiation of immunotherapy.

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Bioethics Committee of the Educational and Research Medical Institute of Sumy State University (Protocol No. 5/04, April 20, 2026). Owing to the retrospective nature of the study, the requirement for informed consent was waived.

Computed Tomography and Radiomic Analysis of Orbital Adipose Tissue. Pretreatment head CT scans obtained as part of the routine clinical assessment before initiation of immune checkpoint inhibitor therapy were used for radiomic analysis. All CT examinations were exported in DICOM format and analyzed using 3D Slicer software (version 5.8.1).

After image import, bilateral orbital adipose tissue was semi-automatically segmented for each patient using the Segment Editor module. The region of interest (ROI) was defined within the bony orbital walls and included only the retrobulbar adipose tissue. The globe, optic nerve, extraocular muscles, lacrimal gland, neurovascular structures, and all other orbital soft tissues were excluded from the segmentation. ROI boundaries were visually inspected and manually adjusted when necessary on consecutive axial slices, with verification in the coronal and sagittal planes, to generate a three-dimensional segmentation mask of the orbital adipose tissue.

From the resulting segmentation masks, total orbital adipose tissue volume (cm^3) and mean CT attenuation (Hounsfield units, HU) were calculated. Radiomic feature extraction was subsequently performed using the PyRadiomics extension integrated into 3D Slicer. Six radiomic features of orbital adipose tissue were analyzed: Variance, Kurtosis, Skewness, Entropy, Joint Entropy, and Size Zone Non-Uniformity (SZNU). These features encompass both first-order intensity-based and texture characteristics of the region of interest and were selected a priori as the most clinically informative parameters for evaluating orbital adipose tissue.

For statistical analyses, quantitative variables (volume and CT attenuation) and radiomic features were treated as continuous variables. In addition, for descrip-

tive analyses and between-group comparisons, variables were dichotomized according to their median values as follows: total orbital adipose tissue volume, 9.8 cm^3 ; CT attenuation, -77 HU ; Variance, 563; Kurtosis, 3.85; Skewness, 0.94; Entropy, 2.01; Joint Entropy, 3.43; and SZNU, 52.14.

Statistical analyses were performed using Stata software (version 19.5; StataCorp LLC, College Station, TX, USA). Continuous variables were assessed for normality using the Shapiro–Wilk test. As most variables were not normally distributed, continuous data are presented as the median and interquartile range (IQR), whereas categorical variables are expressed as frequencies and percentages.

Associations between quantitative characteristics of orbital adipose tissue, radiomic features, and clinical and laboratory variables were evaluated using Spearman's rank correlation coefficient (ρ). Correlation matrices were visualized as heat maps illustrating the direction and strength of the observed associations.

Continuous radiomic features were compared between patient groups stratified according to the median values of orbital adipose tissue volume and CT attenuation using the Mann–Whitney U test.

A two-sided P value < 0.05 was considered statistically significant. The strength of Spearman's correlation coefficients was interpreted according to their absolute values as follows: $\rho < 0.30$, weak correlation; $0.30–0.49$, moderate correlation; and ≥ 0.50 , strong correlation.

Research results and their discussion.

Clinical Characteristics of the Study Cohort and Distribution of Quantitative and Radiomic Parameters of Orbital Adipose Tissue. A total of 86 patients with NSCLC receiving ICI therapy, either as monotherapy or in combination with chemotherapy, were included in the study. The clinical characteristics of the study cohort, together with the distribution of quantitative and radiomic parameters of orbital adipose tissue, are summarized in **table 1**.

The median age of the patients was 61 years (IQR, 56–67). Most patients were younger than 65 years (67.4%) and were male (81.4%). The majority received immunotherapy as first-line treatment (83.7%), with chemoimmunotherapy administered in 64.0% of cases. Pembrolizumab was the most frequently used immune checkpoint inhibitor (61.6%), whereas atezolizumab was administered to 38.4% of patients. PD-L1 expression ranged from 1% to 49% in most patients (77.9%), while high PD-L1 expression ($\geq 50\%$) was observed in 22.1%.

The distribution of quantitative orbital adipose tissue parameters was relatively balanced. An orbital adipose tissue volume $< 9.8 \text{ cm}^3$ was observed in 54.7% of patients, whereas a mean CT attenuation $< -77 \text{ HU}$ was identified in 46.5%. A similarly balanced distribution was observed for most radiomic features after dichotomization according to their predefined median cutoff values, enabling the formation of comparable groups for subsequent analyses of the relationships between quantitative and radiomic characteristics of orbital adipose tissue.

Correlation Analysis Between Quantitative and Radiomic Characteristics of Orbital Adipose Tissue. Following the characterization of the study cohort and the distribution of quantitative and radiomic parameters of orbital adipose tissue, the relationships among the in-

Table 1 – Clinical characteristics of the study cohort and distribution of quantitative and radiomic parameters of orbital adipose tissue

Clinicopathological Characteristics and Radiomic Parameters	Value
Age, years, n (%)	
median (IQR)	61 (56–67)
<65	58 (67.4)
≥65	28 (32.6)
Sex, n (%)	
Male	70 (81.4)
Female	16 (18.6)
Line of treatment, n (%)	
First	72 (83.7)
Second	14 (16.3)
Regimen, n (%)	
Chemo+immunotherapy	55 (64.0)
Immunotherapy	31 (36.0)
Type of ICIs, n (%)	
Atezolizumab	33 (38.4)
Pembrolizumab	53 (61.6)
PD-L1 expression, n (%)	
1–49 %	67 (77.9)
≥50 %	19 (22.1)
Total orbital adipose tissue volume, cm ³ , n (%)	
<9.8	47 (54.7)
≥9.8	39 (45.3)
CT attenuation of orbital adipose tissue, HU, n (%)	
<–77	40 (46.5)
≥–77	46 (53.5)
Variance, n (%)	
<563	49 (57.0)
≥563	37 (43.0)
Kurtosis, n (%)	
<3.85	56 (65.1)
≥3.85	30 (34.9)
Skewness, n (%)	
<0.94	52 (60.5)
≥0.94	34 (39.5)
Entropy, n (%)	
<2.01	60 (69.8)
≥2.01	26 (30.2)
Joint Entropy, n (%)	
<3.43	48 (55.8)
≥3.43	38 (44.2)
SZNU, n (%)	
<52.14	46 (53.5)
≥52.14	40 (46.5)

investigated variables were evaluated. Spearman correlation analysis was performed to assess associations between the quantitative characteristics of orbital adipose tissue (total volume and CT attenuation) and radiomic features, as well as among the radiomic features themselves. The resulting correlation matrix is presented as a heat map in **figure 1**.

No statistically significant correlations were observed between total orbital adipose tissue volume and any of the investigated radiomic features (all $P>0.05$). In contrast, orbital adipose tissue CT attenuation demonstrated weak negative correlations with Variance ($\rho = -0.24$, $P=0.027$) and Entropy ($\rho = -0.21$, $P=0.049$).

Among the radiomic features, the strongest positive correlation was identified between Kurtosis and Skewness ($\rho=0.81$, $P<0.001$). Moderate positive correlations were observed between Entropy and SZNU ($\rho=0.53$, $P<0.001$), Entropy and Joint Entropy ($\rho=0.49$, $P<0.001$), and Variance and Entropy ($\rho=0.42$, $P<0.001$). Weak positive correlations were found between SZNU and Kurtosis ($\rho=0.36$, $P<0.001$), SZNU and Skewness ($\rho=0.34$,

$P=0.002$), as well as between SZNU and Joint Entropy ($\rho=0.29$, $P=0.006$).

Comparative Analysis of Radiomic Features According to Quantitative Parameters of Orbital Adipose Tissue. To further investigate the relationship between conventional quantitative measures and radiomic characteristics of orbital adipose tissue, a comparative analysis of continuous radiomic feature values was performed according to categories of total orbital adipose tissue volume and CT attenuation. The results are presented in **table 2**.

No statistically significant differences were observed in any of the investigated radiomic features between patients with a total orbital adipose tissue volume <9.8 cm³ and those with a volume ≥ 9.8 cm³ (all $P>0.05$). Similarly, none of the radiomic features differed significantly between groups stratified according to orbital adipose tissue CT attenuation (<-77 HU vs. ≥ -77 HU). A trend toward higher Variance values was observed in patients with lower orbital adipose tissue CT attenuation. However, this difference did not reach statistical significance ($P=0.060$).

Associations Between Radiomic Features of Orbital Adipose Tissue and Markers of Nutritional Status and Systemic Inflammation. To investigate the relationship between radiomic features of orbital adipose tissue and markers of nutritional status and systemic inflammation, Spearman's rank correlation analysis was performed. The results are presented as a heat map in **figure 2**.

Among the nutritional status markers, no statistically significant correlations were observed between BMI and any of the investigated radiomic features of orbital adipose tissue (all $P>0.05$). In contrast, Variance demonstrated a weak positive correlation with the PLR ($\rho=0.264$, $P=0.014$). Kurtosis showed a weak negative correlation with the NLR ($\rho = -0.230$, $P=0.033$), while SZNU was also weakly negatively correlated with NLR ($\rho = -0.219$, $P=0.043$). A trend toward a negative correlation was observed between SZNU and the SII ($\rho = -0.209$, $P=0.054$), although this association did not reach statistical significance. No other radiomic features of orbital adipose tissue demonstrated statistically significant associations with markers of nutritional status or systemic inflammation (all $P>0.05$).

The principal finding of the present study is that quantitative and radiomic characteristics of orbital adipose tissue exhibit distinct patterns of association with clinical and laboratory variables. While orbital adipose tissue volume and CT attenuation were closely associated with BMI and selected markers of systemic inflammation, most radiomic features demonstrated only weak or moderate correlations with these parameters. These findings suggest that the two groups of imaging biomarkers do not reflect the same biological phenomenon. Conventional quantitative parameters primarily represent the overall nutritional and metabolic status of the patient, whereas radiomic features appear to capture additional information regarding the intrinsic structural organization of adipose tissue that is only partially related to systemic alterations.

The strong association between orbital adipose tissue volume and BMI is biologically plausible and consistent with current concepts of adipose tissue remodeling in obesity and cancer-associated cachexia. Adipose tissue is increasingly recognized as a dynamic metabolic

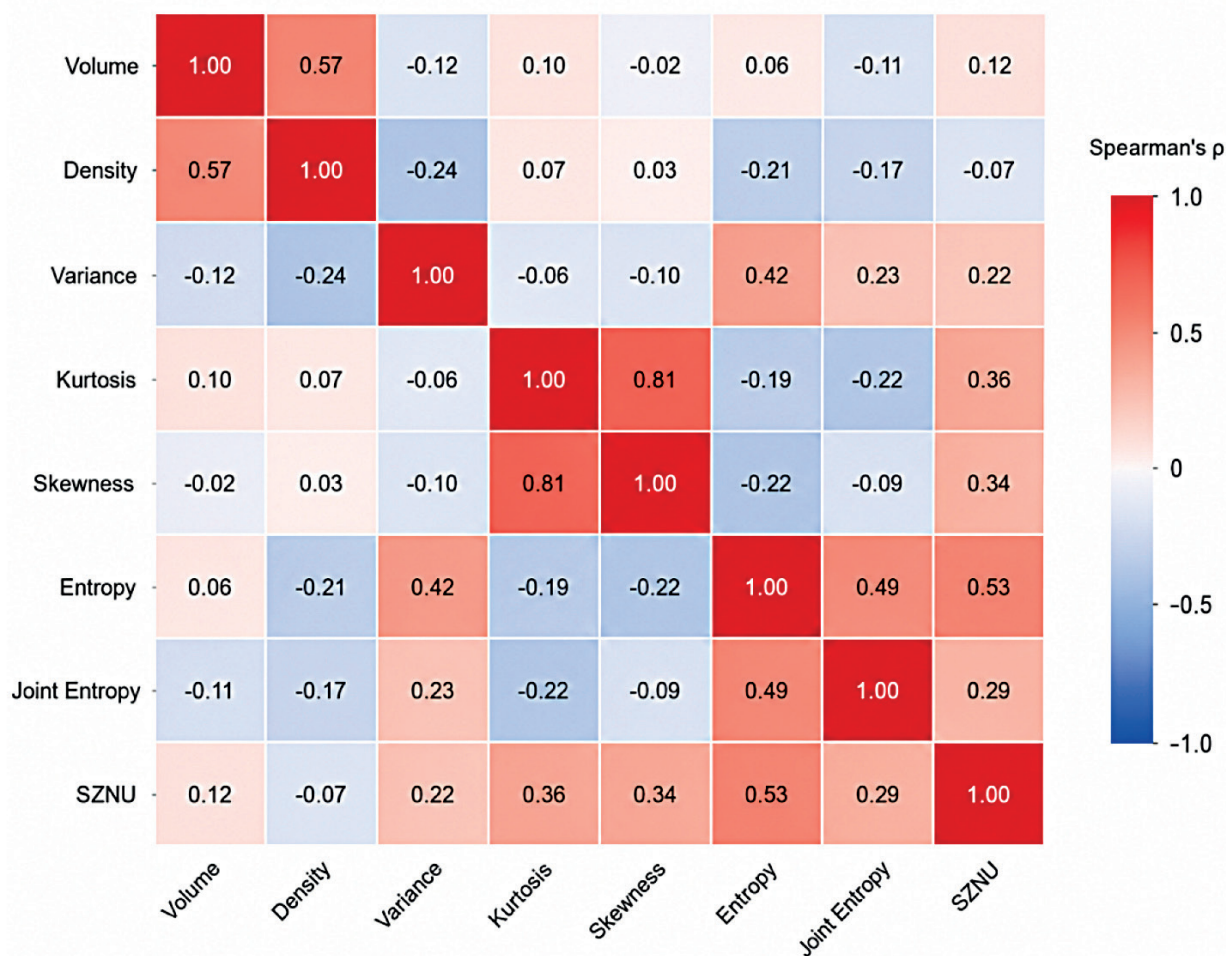


Figure 1 – Heat map of the correlation matrix between quantitative and radiomic characteristics of orbital adipose tissue in patients with non-small cell lung cancer.

Notes: Color intensity represents the strength and direction of Spearman's correlation coefficient (ρ), ranging from dark blue (negative correlation) to dark red (positive correlation), while white indicates the absence of or a very weak correlation.

organ that responds to alterations in energy balance, systemic inflammation, and tumor progression [6, 7]. During cancer progression, enhanced lipolysis, lipid metabolic reprogramming, and altered adipokine secretion contribute to the progressive loss of adipose tissue and the development of cachexia [12]. The observed relationship between orbital adipose tissue volume and BMI indicates that even this relatively small and anatomically distinct fat depot reflects global changes in nutritional status. Likewise, the association between CT attenuation and selected inflammatory markers is biologically plausible. Increased CT attenuation of adipose tissue may result from reduced lipid content, interstitial edema, fibrosis, or inflammatory cell infiltration, all of which are

characteristic features of chronic inflammation and catabolic states [13]. Taken together, these findings suggest that conventional quantitative parameters of orbital adipose tissue, particularly its volume and mean CT attenuation, primarily reflect systemic metabolic alterations rather than local structural characteristics.

In contrast, the radiomic features demonstrated a fundamentally different pattern. Despite several statistically significant associations, most radiomic features were independent of, or only weakly associated with, BMI, CT attenuation, and systemic inflammatory indices. Unlike conventional quantitative measures, texture-based radiomic features do not characterize tissue quantity or average physical properties. Instead, they

Table 2 – Comparison of continuous radiomic features of orbital adipose tissue between patient groups stratified by total orbital adipose tissue volume and CT attenuation

Radiomic parameter	Total orbital adipose tissue volume <9,8 cm ³	Total orbital adipose tissue volume ≥9,8 cm ³	p	CT attenuation of orbital adipose tissue <-77 HU	CT attenuation of orbital adipose tissue ≥-77 HU	p
Variance, median (IQR)	574 (454–778)	560 (465–654)	0.504	618 (457–799)	537 (465–654)	0.060
Kurtosis, median (IQR)	3.85 (3.66–4.84)	3.85 (3.66–4.84)	0.965	3.84 (3.66–4.84)	3.93 (3.66–4.84)	0.741
Skewness, median (IQR)	0.94 (0.92–1.01)	0.92 (0.89–1.01)	0.492	0.92 (0.91–1.01)	0.94 (0.92–1.01)	0.671
Entropy, median (IQR)	1.99 (1.87–2.56)	2.01 (1.90–2.55)	0.686	2.08 (1.89–2.67)	1.99 (1.88–2.15)	0.151
Joint Entropy, median (IQR)	3.48 (3.21–3.65)	3.38 (3.21–3.52)	0.421	3.43 (3.21–3.65)	3.43 (3.21–3.52)	0.702
SZNU, median (IQR)	51.97 (47.60–71.76)	59.19 (50.09–68.93)	0.652	52.06 (47.71–73.42)	56.87 (49.33–66.47)	0.556

Notes: data are presented as the median (IQR), where IQR denotes the interquartile range (25th–75th percentiles). Comparisons between two independent groups were performed using the Mann–Whitney U test.

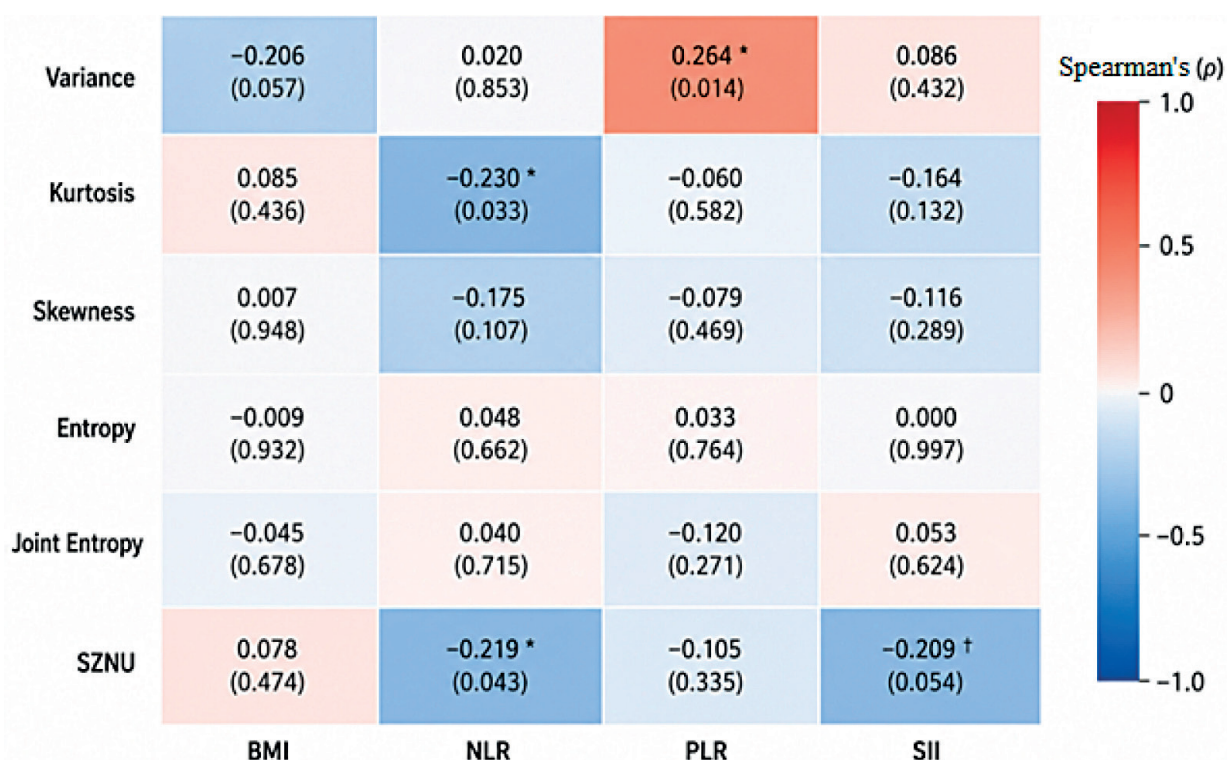


Figure 2 – Heat map showing the correlations between radiomic features of orbital adipose tissue and markers of nutritional status and systemic inflammation in patients with non-small cell lung cancer.

Notes: cells display Spearman's rank correlation coefficients (ρ), with the corresponding P values shown in parentheses. Color intensity reflects the strength and direction of the correlation, ranging from blue (negative correlation) to red (positive correlation), whereas white indicates weak or no correlation. Statistically significant correlations ($P < 0.05$) are marked with an asterisk (*), and trends toward statistical significance ($0.05 \leq P < 0.10$) are indicated by a dagger (†).

describe the spatial distribution of voxels, the degree of image heterogeneity, local intensity variation, and the intrinsic architectural organization of the tissue. Consequently, radiomic features may capture subtle microstructural alterations that remain undetectable using conventional quantitative imaging metrics [14, 15].

Similar approaches have increasingly been applied to the analysis of other adipose tissue depots. For example, radiomic phenotyping of epicardial and perivascular adipose tissue has demonstrated the ability to predict heart failure, atrial fibrillation, and other cardiovascular events independently of fat volume or established clinical risk factors [16, 17]. Furthermore, in patients with non-small cell lung cancer, the integration of body composition radiomics with machine learning algorithms has improved the prediction of immunotherapy outcomes [5]. Although the biological interpretation of individual radiomic features remains incompletely understood, our findings are consistent with the emerging concept that radiomic features provide complementary structural information that is not captured by conventional quantitative imaging parameters.

The choice of orbital adipose tissue as the subject of the present investigation is of particular interest. Unlike visceral or subcutaneous adipose tissue, orbital adipose tissue is confined to a well-defined anatomical compartment, can be readily delineated on computed tomography, and is less influenced by interindividual variability in body fat distribution. Experimental studies have further demonstrated its high metabolic activity and its involvement in the regulation of inflammatory processes and extracellular matrix remodeling [18]. In clinical practice, orbital adipose tissue has been investigated primarily in

the context of thyroid eye disease, whereas its potential as a source of systemic radiomic biomarkers has remained largely unexplored [19, 20]. Our findings suggest that orbital adipose tissue may serve not only as a convenient target for quantitative imaging assessment but also as a promising source of information on structural alterations that are not captured by conventional measures of tissue volume or CT attenuation.

The major strengths of this study include the comprehensive evaluation of both quantitative and radiomic characteristics of orbital adipose tissue and their simultaneous assessment in relation to markers of nutritional status and systemic inflammation. This approach enabled not only the identification of statistical associations but also provided insight into the distinct biological information conveyed by different categories of imaging biomarkers. Nevertheless, several limitations should be acknowledged. First, this was a retrospective study conducted at a single institution, which may limit the generalizability of the findings. Second, the observed radiomic characteristics could not be directly correlated with histopathological alterations of orbital adipose tissue, as histological validation was not available. Future studies involving independent external cohorts and integrating radiomic analyses with histopathological and molecular investigations are warranted to further elucidate the biological basis of the observed imaging phenotypes.

Conclusions.

Conventional quantitative characteristics of orbital adipose tissue, particularly tissue volume and CT attenuation, primarily reflect patients' nutritional status and selected manifestations of systemic inflammation, supporting their association with systemic metabolic alter-

ations in non-small cell lung cancer. In contrast, radiomic features demonstrated only weak to moderate associations with body mass index, inflammatory markers, and conventional quantitative parameters of adipose tissue, indicating their relative independence from these factors. These findings suggest that radiomic features of orbital adipose tissue capture additional aspects of its intrinsic structural organization that cannot be fully characterized by conventional quantitative imaging metrics. Collectively, our results support further investigation

of orbital adipose tissue as a potential source of novel non-invasive radiomic biomarkers in oncology.

Prospects for further research.

Future research should focus on external validation of these findings and on integrating orbital adipose tissue radiomics into multimodal predictive models incorporating clinical, laboratory, and molecular biomarkers. Such approaches may contribute to the development of non-invasive imaging biomarkers for precision oncology and improve risk stratification in patients with non-small cell lung cancer.

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ВЗАЄМОЗВ'ЯЗОК КІЛЬКІСНИХ ПОКАЗНИКІВ ТА РАДІОМІЧНИХ ХАРАКТЕРИСТИК ОРБІТАЛЬНОЇ ЖИРОВОЇ ТКАНИНИ У ХВОРИХ НА НЕДРІБНОКЛІТИННИЙ РАК ЛЕГЕНЬ

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Резюме. Радіомічний аналіз дозволяє отримувати з комп'ютерно-томографічних зображень кількісні характеристики, що відображають просторову організацію та неоднорідність тканин. Останніми роками зростає інтерес до використання радіомічних характеристик жирової тканини як потенційних неінвазивних біомаркерів системних метаболічних та імунологічних процесів. Проте залишається невідомим, чи відображають радіомічні характеристики орбітальної жирової тканини лише її кількісні параметри або характеризують додаткові особливості внутрішньої структури тканини.

Мета дослідження – оцінити взаємозв'язок між кількісними показниками та радіомічними характеристиками орбітальної жирової тканини у хворих на недрібноклітинний рак легень.

Проведено ретроспективне одноцентрове дослідження за участю 86 пацієнтів із гістологічно підтвердженим недрібноклітинним раком легень IV стадії, які отримували терапію інгібіторами контрольних точок імунної відповіді. На комп'ютерно-томографічних зображеннях голови виконували сегментацію орбітальної жирової тканини, визначали її загальний об'єм і радіологічну щільність, після чого за допомогою PyRadiomics

екстрагували шість радіомічних характеристик. Взаємозв'язки оцінювали за коефіцієнтом рангової кореляції Спірмена та U-критерієм Манна-Уїтні.

Не виявлено статистично значущих кореляцій між загальним об'ємом орбітальної жирової тканини та жодною з досліджуваних радіомічних характеристик (усі $p > 0,05$). Радіологічна щільність демонструвала лише слабкі негативні кореляції з дисперсією інтенсивності ($p = -0,24$; $p = 0,027$) та ентропією ($p = -0,21$; $p = 0,049$). Між більшістю радіомічних параметрів встановлено слабкі або помірні взаємозв'язки, тоді як найсильнішу кореляцію виявлено між ексцесом та асиметрією розподілу ($p = 0,81$; $p < 0,001$). Порівняльний аналіз не виявив статистично значущих відмінностей радіомічних характеристик між групами, сформованими за медіанними значеннями об'єму або радіологічної щільності орбітальної жирової тканини. Радіомічні характеристики також демонстрували лише поодинокі слабкі асоціації з показниками системного запалення та не корелювали з індексом маси тіла.

Таким чином, радіомічні характеристики орбітальної жирової тканини є відносно незалежними від її кількісних параметрів, нутритивного статусу та системного запалення, що свідчить про їхню здатність відображати додаткові особливості внутрішньої структурної організації тканини та обґрунтовує перспективність їх використання як нових неінвазивних біомаркерів в онкології.

Ключові слова: недрібноклітинний рак легень, орбітальна жирова тканина, радіоміка, комп'ютерна томографія, біомаркери.

ASSOCIATION BETWEEN QUANTITATIVE PARAMETERS AND RADIOMIC FEATURES OF ORBITAL ADIPOSE TISSUE IN PATIENTS WITH NON-SMALL CELL LUNG CANCER

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Abstract. Radiomic analysis enables the extraction of quantitative features from computed tomography (CT) images that reflect the spatial organization and heterogeneity of tissues. In recent years, growing interest has focused on the use of adipose tissue radiomics as a potential source of non-invasive biomarkers of systemic metabolic and immunological processes. However, it remains unclear whether the radiomic characteristics of orbital adipose tissue merely reflect its quantitative properties or provide additional information regarding its intrinsic structural organization.

The aim of this study was to evaluate the relationship between quantitative parameters and radiomic features of orbital adipose tissue in patients with non-small cell lung cancer.

This retrospective single-center study included 86 patients with histologically confirmed stage IV non-small cell lung cancer treated with immune checkpoint inhibitors. Orbital adipose tissue was segmented on pretreatment head CT images, and its total volume and CT attenuation were measured. Six radiomic features were subsequently extracted using the PyRadiomics platform. Associations were assessed using Spearman's rank correlation analysis and the Mann-Whitney U test.

No statistically significant correlations were found between total orbital adipose tissue volume and any of the investigated radiomic features (all $P > 0.05$). CT attenuation demonstrated only weak negative correlations with Variance ($p = -0.24$, $P = 0.027$) and Entropy ($p = -0.21$, $P = 0.049$). Weak to moderate correlations were observed among most radiomic features, whereas the strongest association was identified between Kurtosis and Skewness ($p = 0.81$, $P < 0.001$). Comparative analysis revealed no significant differences in radiomic features between patient groups stratified according to the median values of orbital adipose tissue volume or CT attenuation. Radiomic features also demonstrated only isolated weak associations with markers of systemic inflammation and showed no significant correlations with body mass index.

In conclusion, radiomic features of orbital adipose tissue are largely independent of its conventional quantitative parameters, nutritional status, and systemic inflammatory markers, suggesting that they capture additional aspects of the tissue's intrinsic structural organization. These findings support the potential of orbital adipose tissue as a novel source of non-invasive radiomic biomarkers in oncology.

Key words: non-small cell lung cancer, orbital adipose tissue, radiomics, computed tomography, biomarkers.

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A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article.

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