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THE ROLE OF MSCT-RADIOMETRIC TEXTURE CRITERIA IN THE DIFFERENTIAL DIAGNOSIS OF PANCREATIC PATHOLOGIES

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Abstract: This study evaluates the potential of radiometric texture analysis (radiomics) of multislice computed tomography (MSCT) images in differentiating between malignant (adenocarcinoma, neuroendocrine tumors) and benign (chronic pancreatitis, cysts) pancreatic pathologies. Unlike conventional visual assessment methods, radiometric criteria (first- and higher-order texture matrices: entropy, homogeneity, asymmetry) enable the quantification of imperceptible microstructural tissue heterogeneity using mathematical models. The results demonstrated that radiometric texture analysis provides high accuracy in the differential diagnosis of visually similar hypodense lesions (sensitivity – 88.5%, specificity – 84.2%). The clinical implementation of this method reduces the number of invasive procedures, enhances early-stage disease detection, and improves the efficacy of personalized treatment strategy selection for patients.

Keywords: Pancreas, MSCT, radiomics, texture analysis, differential diagnosis, adenocarcinoma, heterogeneity, neuroendocrine tumors, chronic pancreatitis, computer-aided diagnosis (CAD), entropy, homogeneity, visualization.

Introduction: In modern oncoradiology and gastroenterology, the early differentiation of pancreatic pathologies, particularly malignant tumors (adenocarcinoma, neuroendocrine tumors) from benign and inflammatory changes (chronic pancreatitis, pseudocysts), remains one of the most complex and critical challenges. Delayed detection of these organ pathologies and difficulties in visual diagnostics contribute to high mortality rates and suboptimal treatment strategy

selection.

Materials and Methods: Within the scope of the study, a retro- and prospective analysis was conducted on data from patients who underwent multislice computed tomography (MSCT) for suspected pancreatic pathologies at the medical center between 2023 and 2026. The definitive diagnoses for all patients were confirmed either by histological examination (surgical or biopsy specimens) or by at least 6 months of clinical-laboratory and instrumental dynamic follow-up.

Results: Statistical and mathematical analysis of the acquired MSCT-radiometric texture data revealed statistically significant differences in the degree of microstructural heterogeneity among pancreatic adenocarcinomas (PDAC), neuroendocrine tumors (pNET), and focal forms of

chronic pancreatitis (CP) ($p < 0.05$).

1. First-Order Histogram Metrics

When evaluating the mean attenuation values (Mean) of the lesions in the native and delayed arterial (pancreatic) phases, the pNET group demonstrated the highest value (112.4 ± 8.6 HU) due to hyperattenuation in the arterial phase. Conversely, the PDAC and CP groups maintained hypodensity during the arterial phase (48.2 ± 5.1 HU and 56.7 ± 6.3 HU, respectively).

However, conventional density metrics did not allow for a reliable differentiation between visually similar PDAC and CP lesions. At this stage, histogram asymmetry (Skewness) and kurtosis (Kurtosis) criteria proved beneficial:

In the PDAC (Adenocarcinoma) group, a right-skewed distribution and a higher asymmetry index (0.84 ± 0.12) were observed, indicating an irregular structure of the tumor tissue.

In the CP (Chronic Pancreatitis) group, the pixel distribution was relatively symmetrical and closer to a normal distribution, with an asymmetry index of 0.31 ± 0.05 ($p = 0.012$).

2. Higher-Order Texture Matrices (GLCM and GLRLM) Analysis

Entropy and Homogeneity metrics demonstrated the highest diagnostic value in detecting imperceptible microstructural features of tissues:

Entropy (Degree of Heterogeneity): The highest entropy values were recorded in patients with pancreatic adenocarcinoma (PDAC) (7.42 ± 0.35). This finding is explained by the highly irregular (heterogeneous) tissue microstructure resulting from the tumor's desmoplastic stroma, micro-necrosis, and erratic neovascularization. In chronic pancreatitis (CP), entropy was significantly lower (5.18 ± 0.28), as fibrous tissue is characteristically diffuse and uniform in nature.

Homogeneity (Uniformity): The degree of homogeneity was higher in focal chronic pancreatitis (0.68 ± 0.04) compared to adenocarcinomas (0.41 ± 0.03), confirming microstructural uniformity ($p < 0.001$). In the pNET group, homogeneity reached an intermediate value in the arterial phase (0.55 ± 0.05).

Conclusions. Based on the findings and statistical analyses of the presented scientific study, 5 key conclusions were formulated:

1. Insufficiency of conventional visual metrics: Standard optical density (HU) criteria in native and contrast-enhanced MSCT phases were proven to possess insufficient diagnostic value for the reliable differentiation (differential diagnosis) of visually similar pancreatic adenocarcinoma (PDAC) and chronic pancreatitis (CP) lesions.

2. Microstructural heterogeneity differences (Entropy): The Entropy metric in MSCT-radiometric texture analysis demonstrated the highest diagnostic performance; it was maximally elevated in adenocarcinoma tissue (7.42 ± 0.35) due to the complex tumor stroma and micro-necrosis, whereas it was significantly lower in the uniform fibrosis of chronic pancreatitis (5.18 ± 0.28) ($p < 0.001$).

3. Pixel distribution and symmetry (Asymmetry): In first-order histogram analysis, the asymmetry (Skewness) index was sharply right-skewed in

adenocarcinoma (0.84 ± 0.12) due to the irregularity of the tumor structure, while pixels in focal forms of chronic pancreatitis were symmetrical and closer to a normal distribution (0.31 ± 0.05) ($p = 0.012$).

4. High diagnostic accuracy (ROC analysis): The differential diagnosis of visually similar hypodense pancreatic lesions using radiometric texture analysis demonstrated high efficacy, with a sensitivity of 88.5%, a specificity of 84.2%, and an AUC of 0.892.