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MULTIMODAL CLINICAL-IMAGING DATASET FOR RISK STRATIFICATION OF SOLITARY PULMONARY LESIONS USING ARTIFICIAL INTELLIGENCE

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Introduction. Modern medical imaging techniques generate substantial volumes of clinical, morphological, and quantitative information on solitary pulmonary lesions. However, patients' clinical characteristics, multislice computed tomography (MSCT) findings, and metabolic parameters obtained by positron emission tomography/computed tomography (PET/CT) are often assessed separately. This approach may limit the potential for comprehensive risk stratification. Integration of multimodal data using artificial intelligence (AI) and machine-learning methods represents a promising approach for improving the objectivity of malignancy risk assessment and supporting clinical decision-making.

Objective. To establish a structured multimodal clinical-imaging dataset of patients with solitary pulmonary lesions and develop an analytical approach using artificial intelligence technologies for risk stratification and differential diagnosis.

Materials and Methods. The study included 85 patients with solitary pulmonary lesions. The comparison group consisted of 53 patients, including 32 men (60.4%) and 21 women (39.6%). The main group consisted of 32 patients: 21 men (65.6%) and 11 women (34.4%). The mean age was 52±0.5 years in the comparison group and 53±0.3 years in the main group.

All patients underwent chest multislice computed tomography (MSCT). In the comparison group, the size of the solitary lesion was 1.0–1.5 cm in 21 patients (39.6%), 1.5–3.0 cm in 12 patients (22.6%), and greater than 3.0 cm in 20 patients (37.7%). Lesions were located in the right lung in 27 patients (50.9%) and in the left lung in 26 patients (49.1%).

In the main group, lesions were located in the right lung in 18 patients (56.3%) and in the left lung in 14 patients (43.8%). All patients were evaluated by an oncologist, thoracic surgeon, and pulmonologist.

In the comparison group, video-assisted thoracoscopic biopsy was performed in 33 patients, while open multisegmental lung resection was performed in 11 patients. Nine patients refused surgical treatment and were managed with dynamic follow-up.

Morphological verification was obtained in 44 of 53 patients (83.0%) in the comparison group. Among the morphologically verified cases, non-small cell lung cancer (NSCLC) was diagnosed in 37 patients (84.1%), carcinoma in 4 patients (9.1%), and fibro-inflammatory changes in 3 patients (6.8%). Thus, a malignant process was histologically confirmed in 41 of 44 morphologically verified patients (93.2%), corresponding to 77.4% of the entire comparison group. In 9 patients (17.0%), morphological verification was unavailable because of refusal of surgical treatment followed by dynamic observation.

In the main group, clinical data and MSCT findings were analyzed using AI. According to the AI-based classification, a probable malignant pulmonary neoplasm was identified in 21 patients (65.6%), probable tuberculoma or hamartoma in 4 patients (12.5%), and a nonspecific inflammatory process in 7 patients (21.9%).

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VTS/VATS intervention was performed in 21 patients of the main group, followed by AI-based analysis of the intraoperative findings and morphological examination of the resected or biopsy material.

Results. In the overall cohort of 85 patients, 53 (62.4%) comprised the comparison group and 32 (37.6%) comprised the main group. In the comparison group, morphological verification was obtained in 44 patients (83.0%). Malignant neoplasms were identified in 41 of these patients (93.2%), including 37 cases of NSCLC and 4 cases of carcinoma. Fibro-inflammatory changes were identified in 3 patients (6.8%).

In the main group, AI classified 21 of 32 lesions (65.6%) as probably malignant, 4 (12.5%) as probable tuberculoma or hamartoma, and 7 (21.9%) as a nonspecific inflammatory process.

In the subgroup of 21 patients who underwent VTS/VATS intervention, AI-based classifications were compared with subsequent morphological findings.

In 15 cases (71.4%), AI classified the intraoperative findings as consistent with a malignant process. Subsequent histopathological examination confirmed malignant carcinoma in all 15 cases, corresponding to 100% concordance within this category.

In 2 cases (9.5%), AI interpreted the intraoperative findings as an inflammatory process. Morphological examination revealed NSCLC in one case and fibro-inflammatory changes in the other. Thus, correct classification in this category was observed in 1 of 2 cases.

In 3 cases (14.3%), AI classified the intraoperative findings as probable tuberculoma or hamartoma. Morphological examination confirmed the presumed diagnosis in all three cases: tuberculoma in 2 cases and hamartoma in 1 case.

In 1 case (4.8%), AI classified the lesion as a nonspecific inflammatory process; however, subsequent morphological examination revealed carcinoma.

Thus, among the 21 cases in which AI classification could be compared with the morphological diagnosis, correct classification was observed in 19 cases (90.5%), while discrepancies occurred in 2 cases (9.5%). Both discrepancies were associated with malignant processes being incorrectly classified by AI as inflammatory changes.

Among the 15 cases classified by AI as malignant, all 15 were morphologically confirmed. Similarly, all 3 cases classified as tuberculoma/hamartoma demonstrated morphological concordance. These findings indicate a high level of concordance between AI classification and morphological findings in the analyzed surgical subgroup; however, further validation in a larger cohort is required.

Discussion. The established clinical-imaging dataset enables the integration of demographic and clinical characteristics with morphological features of solitary pulmonary lesions identified by MSCT and AI-based analytical results. The preliminary findings indicate the potential utility of AI for classifying lesions according to the probable nature of the pathological process.

Of particular interest is the further integration of MSCT features with quantitative metabolic characteristics obtained by PET/CT and clinical parameters into a unified multimodal model. Such an approach may provide more objective risk stratification and improve the diagnostic value of the preoperative assessment.

At the same time, the identification of two malignant processes that were incorrectly classified by AI as inflammatory changes demonstrates that the algorithm cannot be considered an independent diagnostic tool. Improving the reliability of the model will require expansion of the study population, an increased number of morphologically verified cases, and standardization of the input feature set.

Conclusion. The established multimodal clinical-imaging dataset of 85 patients provides a foundation for developing an AI-based risk-stratification model for solitary pulmonary lesions. In the

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subgroup of 21 patients, concordance between AI results and morphological verification was 90.5%. The highest concordance was observed in the classification of malignant lesions and tuberculoma/hamartoma. The identified discrepancies highlight the need for further refinement of the algorithm.

A promising direction is the integration of clinical data, quantitative morphological MSCT features, and metabolic PET/CT parameters into a unified model, followed by assessment of diagnostic performance using standardized metrics. AI should be regarded as an additional clinical decision-support tool and not as a substitute for morphological verification.

Keywords: artificial intelligence; machine learning; solitary pulmonary lesion; solitary lung nodule; MSCT; PET/CT; multimodal analysis; radiomics; risk stratification; morphological verification; thoracic surgery.

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