Virtual Special Edition: Pulmonary Nodules

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In this Virtual Special Edition, we are pleased to curate six recently published papers from Clinical Radiology on a common topic in everyday radiology practice, pulmonary nodules. The papers are wide-ranging and cover current topics including detection of pulmonary nodules and analysis of nodule composition using the emerging technologies of radiomics and artificial intelligence, as well as newer techniques of ultra low dose computerised tomography (CT) scanning for nodule detection.

The question of which ground-glass nodules represent the highest risk of malignancy is always a challenging clinical question. Kitazawa et al.(1) undertook a retrospective analysis of semiautomated volumetric data from 96 known lung malignancies which presented as ground-glass nodules and demonstrated the mean 3D CT attenuation value could distinguish pre-invasive lesions and minimally invasive adenocarcinoma from invasive adenocarcinoma. Univariate analysis revealed four tumour invasiveness-associated predictors: maximum diameter, SUV max, mean 2D CT attenuation value, and mean 3D CT attenuation value. Multivariate analysis revealed that the maximum diameter, SUV max, and mean 3D CT attenuation value were significant predictors of pathological invasiveness.

Clinical evaluations of artificial intelligence systems targeting pulmonary nodules are awaited with interest. Martins Janrnalo et al.(2) evaluated a deep learning computer-aided detection software system to evaluate pulmonary nodules on CT scans using as a reference standard the opinion of three radiologists. While the size of their dataset was relatively modest (145 chest CT examinations), the study found a
sensitivity of 88% and a false-positive rate of 1.04 false positives/scan. The negative predictive value of 95% indicated their CAD system performed very well, but the rates were thought sufficient by the authors enough to replace the radiologist, even for the specific task of nodule detection. Also, the overestimation of nodule size was a feature noted using the CAD system. It should be noted however that the reference standard was extremely high in this study (consensus opinion of three radiologists) and does not represent usual practice in most countries with a single reporter for these examinations. Their CAD system may have fared better compared with a single radiologist.

Radiomics is a technique that extracts a large number of characteristics from radiographic images using data-characterisation algorithms. These features, termed radiomic features, have the potential to uncover lesion characteristics that may not be detected by the trained eye of the radiologist.

Addressing the topic of the invasiveness of pulmonary adenocarcinomas, Weng (3) created a nomogram model to predict the histological subtypes of invasive adenocarcinomas and minimally invasive adenocarcinomas that manifest as ground-glass nodules (GGN) on CT scans. The study incorporated 119 patients with pathologically confirmed part-solid GGNs. Radiomic features were extracted from the unenhanced CT images. The CT morphology of the lesion shape and diameter of the solid component was confirmed to be significant for building the CT features model. A nomogram that integrated both lesion shape and radiomic signature was constructed. The authors conclude that a radiomic signature, such as the one they
have produced, could provide an important reference for differentiating invasive versus minimally invasive adenocarcinomas.

Feng et al.(4) also evaluated the preoperative differentiation between the minimally invasive adenocarcinoma (MIA) and invasive adenocarcinoma (IAC) in their study in a cohort of 100 patients with sub-solid pulmonary nodules who had pathologically confirmed malignancy using radiomics nomogram. Radiomic features were extracted from CT images. A radiomics signature was constructed by the least absolute shrinkage and selection operator (LASSO) algorithm. Solid presence, lesion size, shape regularity, and margins of pulmonary nodules were assessed to construct a subjective finding model. Their radiomics signature, which consisted of 11 radiomics features, showed a good discrimination accuracy. The authors conclude that their proposed radiomics nomogram has the potential to preoperatively differentiate MIA and IAC in patients with sub-solid pulmonary nodules.

Clearly, a number of radiomic models perform well and show promise in discriminating between invasive and minimally invasive adenocarcinoma, it will be for radiologists to decide and assess which is most transferable to clinical practice.

Miller et al.(5) address the question of newer CT techniques with reduced doses to assess the question of pulmonary nodule detection. The authors evaluated 99 individuals undergoing surveillance of solid pulmonary nodules and undertook both low-dose (LD) and ultra-low-dose (ULD) CT scans. Image pairs of the two types of CT scans were read blinded, in random order, and independently by two experienced thoracic radiologists, and the results were compared. There was a very good inter-rater agreement with regard to nodules ≥4mm for both the LD-CT and
ULD-CT with a sensitivity of 98.5% and specificity of 100% for ULD-CT. The effective dose of radiation was significantly different between the two scans, 1.67 mSv for the LD-CT and 0.13 mSv for the ULD-CT. The authors conclude ULD-CT delivering radiation equivalent to plain radiography, allows detection of lung nodules with high sensitivity.

In our final article, Ye(6) et al. evaluated the accuracy of a specific type of ultra-low dose CT, ULDCT with ASiR-V using a noise index (SmartmA) for pulmonary nodule detection, and Lung CT Screening Reporting and Data System (Lung-RADS) classifications compared with LDCT. They also performed simultaneous conventional thoracic LDCT followed by ULD CT on 210 patients. The types and diameters of all nodules were recorded.

LDCT revealed 362 nodules, and the overall sensitivity on ULDCT was 90.1%. The sensitivity for solid nodules (SNs) of ≥1 mm diameter was 96.6% and 100% (26/26) for SNs of ≥6 mm diameter. The test sensitivity was similarly high for the detection of GGN. The authors concluded ULDCT with ASiR-V using SmartmA is suitable for lung-cancer screening in people with a BMI ≤35 kg/m² as it has a low radiation dose of 0.16 mSv, high sensitivity for nodule detection, and good performance of Lung-RADS classifications.

References


