considered in the context of prior reports with equivocal findings and added to the growing body of literature highlighting the complex nature and management of pGGNs.

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See Article page 451.

Commentary: Is size everything in the management of ground-glass opacities?

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The benefits of lung cancer screening have been demonstrated by the National Lung Screening and Netherlands Leuven Screening Onderzoek trials,^{1,2} and clinicians will encounter increasing number of patients with ground-glass opacities (GGOs). A significant proportion of persistent GGOs may turn out to be adenocarcinomas, and up to 22.7% of the resected GGOs are invasive adenocarcinomas on histology.³

In this issue of the *Journal*, the Fu and colleagues⁴ from China reviewed 432 cases of resected adenocarcinoma cases that presented as pure GGO on computed tomography (CT) and reported that CT density could not separate invasive from preinvasive histology. The size of the GGO, specifically at 1.05-cm cutoff, was the only factor that correlated with invasive adenocarcinoma, which resonates with the TNM 8th edition in which size increments at 1 cm translate into survival differences for T1 tumors.⁵

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CENTRAL MESSAGE

The size of GGOs can separate preinvasive from invasive adenocarcinoma. Changes over time of GGOs and individual patient factors are important factors in the decision for and timing of resection.

The Fudan article adds to the literature in that (1) this is the largest series of pure GGO adenocarcinomas; (2) they excluded atypical adenomatous hyperplasia (AAH) cases and grouped adenocarcinoma in situ with minimally invasive adenocarcinoma together as the preinvasive group to compare with the invasive adenocarcinomas; and (3) they focused on CT density as one of the parameters to differentiate preinvasive from invasive groups.

The findings of the Fudan group differed from previous publications regarding CT density, likely because they excluded AAH in the preinvasive category. Kitami and colleagues⁶ found that for the association with AAH, a combination of GGO size and CT density can achieve 90%

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specificity and 100% sensitivity, with a 100% negative predictive value.⁶ Because the pathological diagnosis of the GGO is not known until after resection, CT density remains a helpful parameter to guide the clinical decision.

Fu and colleagues⁴ only analyzed CT parameters at one time point before resection, and changes in nodule characteristics in the preoperative period were not reported. The decision to offer invasive procedures in patients with pure GGO is rarely based on a single set of CT images. The current guidelines recommend resection for pure GGOs that grow or show the development of solid portions or for pure GGOs more than 10 mm with confirmed persistence.^{7,8}

Developments in radiomics may take the management of GGO beyond changes in diameter or density of the nodule. A study using deep learning algorithm based on the National Lung Screening Trial data included individuals with at least 2 CT scans up to 2 years apart. The deep learning algorithm was shown to be superior to Lung-RADS at identifying individuals at high risk of cancer diagnosis and at higher risk of lung cancer-specific mortality and reaffirms that temporal changes provide important information to spatial changes.⁹

There is no clear consensus on the timing of surgery for GGO. Important considerations include whether the GGO is solitary or multiple and whether there is a history of cancer. Lee and colleagues¹⁰ reported that for GGOs less than 6 mm, the median rate of progression was 3 mm over 8.6 years. In addition to progression of the GGO, the decision to offer surgery needs to take into account the associated comorbidities and the life expectancy of each individual patient.^{11,12}

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