CT-Guided Transthoracic Needle Aspiration Biopsy of Subsolid Lung Lesions

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ABSTRACT

Purpose: To assess the diagnostic performance of computed tomography (CT)–guided transthoracic needle aspiration biopsy (TNAB) in the evaluation of persistent subsolid lung lesions.

Materials and Methods: A retrospective review of all CT-guided TNABs performed at a single institution from January 2002 to November 2012 was conducted to identify patients with persistent subsolid lung lesions. The diagnostic performance of CT-guided TNAB was assessed through comparison of cytologic diagnoses with core needle biopsy, surgical resection, or imaging and clinical follow-up. The cytologic, histologic, and imaging features of each lesion were characterized, and CT-guided TNAB complications were recorded.

Results: In 32 patients, a diagnosis of benign or malignant disease was identified through evaluation of pathologic or follow-up data. There were 18 men and 14 women, with a mean age of 67.1 years ± 9.6 (range, 52–86 y). The mean lesion diameter was 21 mm ± 11 (range, 8–62 mm). A final diagnosis of malignancy was made in 28 cases (87.5%); four benign lesions were also diagnosed. The overall sensitivity of CT-guided TNAB in the evaluation of these lesions was 89.2%, and the specificity and positive predictive value were 100%. Two pneumothoraces (6.3%) were identified.

Conclusions: Among patients with subsolid lung lesions, CT-guided TNAB is safe and shows high sensitivity. The high specificity and positive predictive value of the procedure allow for definitive treatment decisions to be made for most patients.

ABBREVIATIONS

GG = ground-glass, TNAB = transthoracic needle aspiration biopsy

Although there has been considerable interest in thin-section computed tomography (CT) characterization of subsolid lung nodules (defined as spherical lesions < 3 cm in diameter with a component that is less than soft tissue density) over the past 10 years (1), particularly in light of increasing detection rates on multidetector CT performed for lung cancer screening (2) or in the evaluation of chest disease, accurate diagnosis of these lesions remains difficult. This difficulty is due to the overlap in appearance on thin-section CT of preinvasive conditions, such as atypical adenomatous hyperplasia and adenocarcinoma in situ, with invasive adenocarcinoma as well as with inflammatory processes that may have a nodular subsolid appearance during the course of resolution (3,4). Although there is increasing recognition that a significant percentage of stable, subsolid lesions represent preinvasive or invasive adenocarcinoma (2,3), the accurate preoperative diagnosis of subsolid malignant lesions is important, particularly because some lesions are not readily amenable to thoracoscopic biopsy, and a substantial percentage of patients with subsolid malignant lesions are poor candidates for surgical resection because of comorbidities. There is scant information on the role of minimally invasive techniques such as CT-guided transthoracic needle aspiration biopsy (TNAB) cytology in the pathologic characterization of these lesions. The purpose of this study

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was to assess the diagnostic performance of CT-guided TNAB in the diagnosis of persistent subsolid lung lesions.

MATERIALS AND METHODS

This study, which was compliant with the Health Insurance Portability and Accountability Act, was approved by our institutional review board with a waiver for informed patient consent. A retrospective search of all CT-guided biopsy procedures performed at our institution from January 2002 to November 2012 was conducted using *Current Procedure Terminology* codes. Results were filtered by the key word "nodule" to yield a preliminary list, and from this list potentially relevant cases were identified via manual search of the associated procedure report for the terms "subsolid" and "ground-glass" (GG). When identified, all such cases were transferred into a database, and any associated chest CT images obtained before biopsy were analyzed on thin-section series to determine the presence or absence of persistent, solitary subsolid lesions. All cases featuring lesions not meeting criteria as "subsolid" were excluded from analysis. For the purposes of this investigation, lesion "persistence" was defined as repeated CT demonstration of the lesion under evaluation for at least 3 months after initial detection.

All identified subsolid nodules were characterized as to lobe within the lung, maximum lesion diameter in any plane, and estimated percent density (pure GG, > 50% GG component [predominant GG], or < 50% GG component [predominant solid]). Also recorded for each case was the presence or absence of biopsy-associated complications, in particular, pneumothoraces requiring in-hospital observation or treatment and bleeding requiring hospital admission.

All patients underwent CT-guided TNAB with or without concomitant core needle biopsy. The CT-guided TNAB procedure was performed by two board-certified thoracic radiologists with 24 years and 8 years of experience with CT-guided TNAB as well as cardiothoracic radiology fellows and a physician's assistant under direct supervision. All biopsies were performed under conscious sedation using CT fluoroscopy with a step-and-shoot mode controlled by the radiologist performing the biopsy. The patient was placed in a recumbent position on the CT table, with a needle approach chosen that used the shortest vertical pathway to the lesion to be sampled. A coaxial needle (Cook, Inc, Bloomington, Indiana) placement technique was used with a combination of an ultra-thin-walled needle placed via a single pleural puncture during patient breath hold in normal end expiration (ie, at functional residual capacity), with the outer needle placed to the edge of the lesion, followed by at least three aspiration biopsy specimens obtained during patient breath hold using a 22-gauge Chiba needle (INRAD Inc, Kentwood, Michigan). A rotatory and to-and-fro motion with aspiration using an attached 10- to 12-mL syringe was used to obtain specimens, which were transferred onto glass slides for fixation while the remaining aspirate was rinsed into CytoLyt (Hologic, Marlborough, Massachusetts) solution to enable cell block formation for immunocytologic or molecular studies. Rapid on-site assessments and preliminary diagnoses were rendered by departmental cytopathologists or fellows. All CT-guided TNAB specimens were subsequently reviewed for this study by a board-certified cytopathologist. In a few patients for whom a cytologic diagnosis was not evident by on-site rapid staining using toluidine blue and light microscopic examination, one to three core biopsy specimens were attempted using a 20-gauge Temno automated cutting biopsy needle (CareFusion, San Diego, California), with the specimens placed into formalin for histologic analysis.

Core biopsy and surgical resection specimens were signed out routinely by surgical pathologists and reviewed for this study by a board-certified surgical pathologist with fellowship training in pulmonary pathology. Review of both cytologic and surgical specimens was conducted with reviewers blinded to the original diagnoses. Standard morphologic criteria were used to evaluate both the cytologic and the histologic specimens. Histologic diagnoses based on core biopsy and surgical resection specimens were made according to the terminology recommended by the International Association for the Study of Lung Cancer (5). Cytologic diagnoses included "positive for malignancy" (eg, adenocarcinoma), "suspicious for malignancy," "atypical," and "negative for malignancy." In accordance with cytopathology convention, both "positive for malignancy" and "suspicious for malignancy" were considered positive CT-guided TNAB results, whereas "atypical" and "negative for malignancy" were considered negative CT-guided TNAB results. In instances in which evidence of malignancy was not identified on cytology, a general diagnosis of "negative for malignancy" was provided, unless additional features suggestive of a specific diagnosis were identified (eg, fungal hyphae).

When a tissue diagnosis was unavailable, repeat chest CT studies were reviewed in conjunction with clinical follow-up to determine the final diagnosis as malignant or benign. Imaging findings used to characterize a lesion as malignant include progressive lesion growth, development of metastatic disease, and increase in lesion density. Imaging features used to characterize a lesion as benign include progressive decrease in size over time, lesion stability over a minimum of 3 years of follow-up, and complete lesion resolution.

The rates of true-positive, true-negative, false-positive, and false-negative diagnoses were determined by comparing the CT-guided TNAB diagnosis with the final diagnosis as determined by either histology (core biopsy or surgical specimens) or radiologic or clinical follow-up.