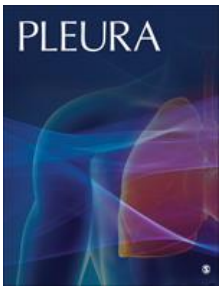

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Case Report

A Diagnostic Ultrasound-Guided Pleural Biopsy After Non-Diagnostic Chest Computed Tomography Guided Procedure for Stage IV Lung Cancer

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Abstract:
We report a case of a 70 year-old man with left upper lobe cavitary mass and pleural nodules in which an ultrasound (US) guided pleural biopsy approach yielded a definitive diagnosis of stage IV squamous cell carcinoma after a non-diagnostic computed tomography (CT) guided biopsy. The advantages of US as compared to CT are: (1) portable machines, allowing inpatient and outpatient procedures with local anesthesia only; (2) lack of ionizing radiation exposure; (3) availability at bedside reducing need for dedicated ancillary support; and (4) significant reduction of cost.

Keywords: Pleural biopsy; Ultrasound; Lung cancer

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Abstract:
We report a case of a 70 year-old man with left upper lobe cavitary mass and pleural nodules in which an ultrasound (US) guided pleural biopsy approach yielded a definitive diagnosis of stage IV squamous cell carcinoma after a non-diagnostic computed tomography (CT) guided biopsy. The advantages of US as compared to CT are: (1) portable machines, allowing inpatient and outpatient procedures with local anesthesia only; (2) lack of ionizing radiation exposure; (3) availability at bedside reducing need for dedicated ancillary support; and (4) significant reduction of cost.

Background:
Video-assisted thoracic surgery and medical thoracoscopy are gold standards for diagnosis of malignant pleural disease with a diagnostic yield above 90% (1). Both are invasive procedures which are associated with increased cost, resource utilization, require general anesthesia or conscious sedation. Thoracoscopy is contraindicated in high risk cardiac patients, high continuous oxygen need, or severe pulmonary hypertension (2). Image-guided closed biopsies, using CT or US, are minimally invasive alternatives with high diagnostic yields. US-guided biopsy offers additional advantages compared to the CT approach (1). Pulmonologists should reconsider US-guided transthoracic biopsy as a comparable approach in some cases.

Case Presentation:
A 70 year-old man with an extensive smoking history, very severe chronic obstructive lung disease on continuous home oxygen therapy developed new onset non-pleuritic chest pain. A chest x-ray and computed tomography (CT) showed a cavitated left upper lobe lung (LUL) mass measuring 3.7x2.6 cm (figure 1) without pathologic enlarged mediastinal lymphadenopathy. A position emission tomography-computed tomography showed hypermetabolic activity in (figure 2): (1) LUL mass (SUVmax 17.4); (2) medial aspect of the left diaphragm (SUVmax 3.3); and (3) pleural-based focus in the left lower hemithorax (SUVmax 5.7).

The patient underwent a CT-guided thoracentesis and pleural nodule biopsy, both negative for malignancy. Three weeks later, we were consulted to perform a bronchoscopy. We performed a pleural ultrasound (US) using a generic, portable ultrasound and phase array 5-1Mhz probe in an upright sitting position. A pleural based nodule and a small anechoic pleural effusion were identified. Color Doppler showed an absence of a pleural based arteriovenous malformation. Using a "free-hand" technique, a Biopince needle (18Gx11 cm; by Argon Medical Devices) was passed four times at the same angle of the US probe (Figures 3). A thoracentesis was performed afterwards and the pleural fluid analysis (Table 1) showed a lymphocytic exudate, negative for malignancy. The core biopsy showed non-small cell lung carcinoma, p40 positive and TTF-1 negative, consistent with stage IV squamous cell carcinoma.

Table 1: Pleural Fluid Analysis

pH	7.37
Protein (mg/dL)	2.4
Pf/S Protein ratio	0.52
LDH (IU/L)	876
Pf/S LDH ratio	4.1
Glucose (mg/dL)	89
Total Cell count (cells/mm^3)	1680
Lymphocytes	52%
Neutrophils	43%
Monocytes	3%
Basophils	2%

Discussion
Image-guided closed biopsies are minimally invasive, fast, and associated with lower cost (1). The disadvantages of CT-guided biopsies are the exposure to ionizing radiation, time allocation in a radiology department, increased cost, and resource allocation with ancillary staff. US machines are portable, allowing inpatient and outpatient procedures with local

Figure 1. 1A. Postero-anterior chest x-ray showing the cavitary lung mass in the left upper lobe (white arrow). 1B. CT showing cavitated lung mass in the left upper lobe (3.7x2.6cm) without enlarged mediastinal or hilar lymphadenopathy.

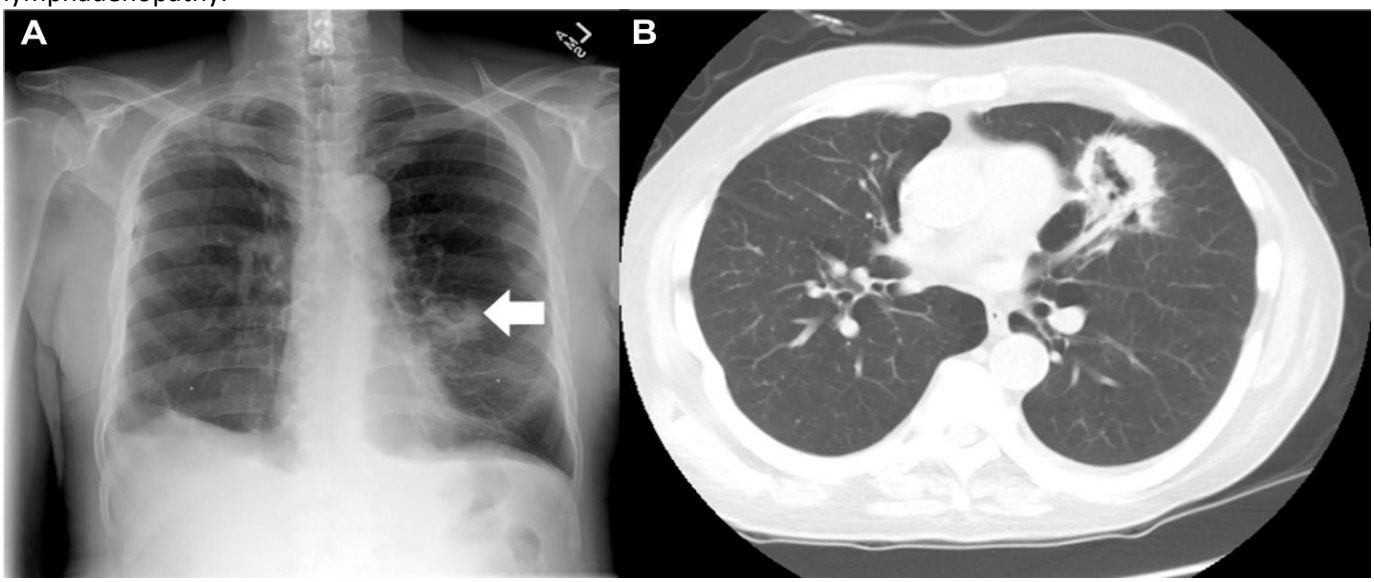
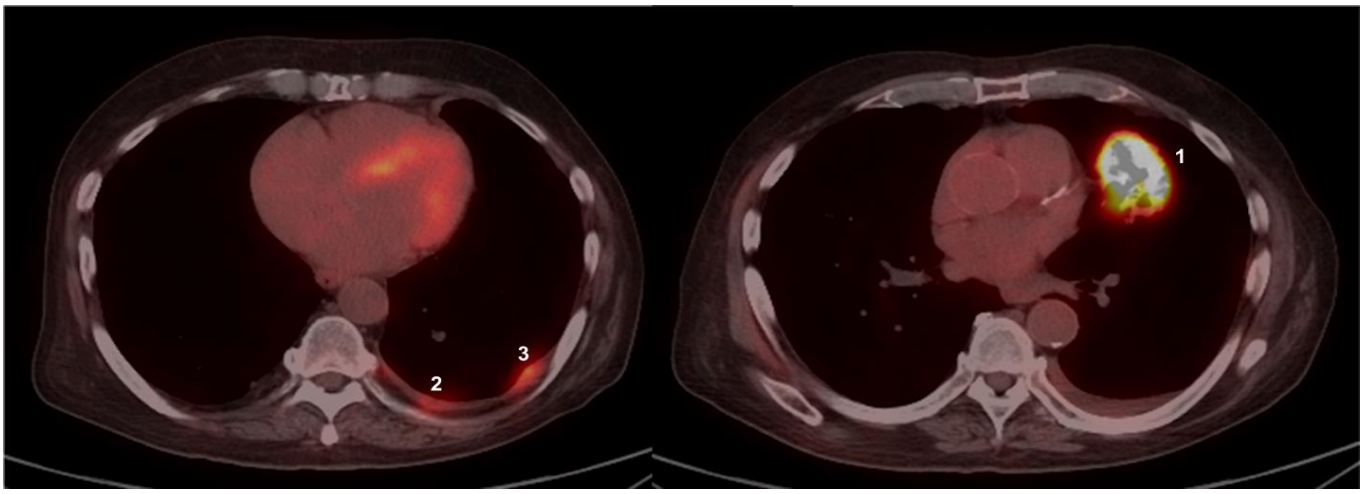


Figure 2. Positron emission tomography-computed tomography. There were 3 areas with hypermetabolic activity: (1) Lung mass in the left upper lobe; (2) lung nodule; (3) lung nodule.



anesthesia only. Furthermore, US is superior to CT at quantifying pleural fluid volume, identifying complexity in the pleural space, pleural thickening, pleural nodules and tumors (1). Both can help guide the needle insertion while preventing inadvertent lung and sub-diaphragmatic organ puncture (3). The procedure can be done using a "free hand" technique or biopsy needles mounted on the ultrasound probe. The latter ensures the needle moves in the same US plane (4).

Several core biopsy needles are available, which operate using 3 mechanical principles. The Surecut needle obtains the specimen by a quick forward movement of the needle and the specimen is maintained within the needle by the application of negative pressure. The yield for this needle system is inferior to other designs (5). The Tru-Cut needle obtains a smaller specimen than the Surecut needle but secures it in a biopsy chamber. The BioPince needle system combines the advantages of the Surecut and the Tru-cut needles. It obtains a large biopsy specimen while maintaining the biopsy secured with a special fixation wire (5). The Tru-Cut needle obtains a smaller specimen

than the Surecut needle but secures it in a biopsy chamber. The BioPince needle system combines the advantages of the Surecut and the Tru-cut needles. It obtains a large biopsy specimen while maintaining the biopsy secured with a special fixation wire (5). Similar to Tru-Cut needles, the depth of the puncture can be pre-set when biopsies are performed. The 18-gauge BioPince needle has shown to have an excellent diagnostic yield and low risk of complications (6).

The diagnostic yield of an image guided biopsy depends on the operator's experience, the use of a systematic approach and a careful pre-procedural scanning phase. First, proper US gain is needed because pleural based nodules and masses are relative hypoechoic and may not be seen otherwise. Second, once the lesion is identified, we recommend carefully measuring the distances to ensure adequate sample of the lesion and avoid lung or sub-diaphragmatic organ puncture. Third, add a few millimeters of depth of the cutting needle to ensure the needle slightly enters the pleural space. This will ensure the parietal pleura is sampled since tissue deformation will occur with firing of the needle pushing the lesion away. In our case, the distance from the top of the rib to the lesion was 19 mm and the BioPince needle was set at 23 mm. Finally, the use color Doppler to identify vascular anomalies and aberrant intercostal vessels prior to needle insertion.

The yield of pleural and peripheral lung nodule biopsy guided through either CT and US are similar with rates of 70-94% (7-9). US-guided biopsy can be an alternative in cases where thoracoscopy failed (10). In a retrospective cohort of 50 cases of US-guided pleural biopsies performed by pulmonologists, the diagnostic yield was 94% and 26% were performed after a non-diagnostic thoracoscopy (10). Furthermore, US compared to CT-guided biopsy reduced procedure time by 42% (295 vs 588 seconds) and pneumothorax rate (5.8% vs 14.7%) (9). Mutational analysis should be able to be performed from an US or CT-guided approach, but there is a lack of evidence to support that.

Conclusion:

Multiple studies reported that US-guided biopsy has a similar diagnostic yield to CT-guided approach in addition to some advantages: absence of radiation exposure, shorter length of procedure, and lower rate of pneumothorax. Therefore, we suggest to consider US-guided transthoracic biopsy for pleural-based lesions as the first line in selected patients.

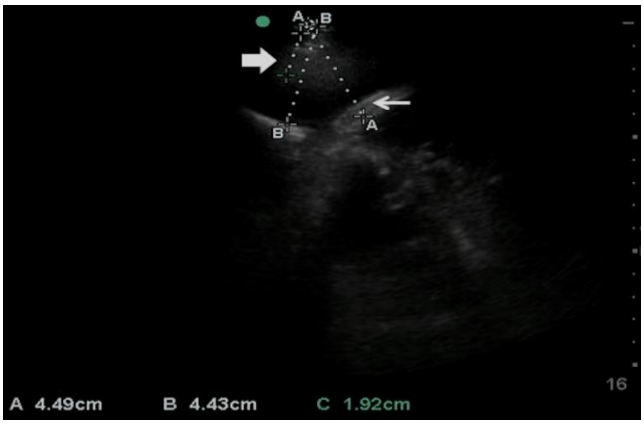


Figure 3. Lung ultrasound. Diaphragm (narrow white arrow), pleural nodule (thick white arrow). Distance measurements are represented by the dotted lines: (A) skin to diaphragm, (B) skin to lung, (C) size of lung nodule.

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