Complications of CT Scan-Guided Lung Biopsy

Lesion Size and Depth Matter

Percutaneous transthoracic biopsies are commonly performed for the diagnosis of thoracic lesions. Early reports of needle biopsies of the lung were published in the late 1800s. In 1883, Leyden biopsied the consolidated right lower lobe of a moribund 48-year-old man. The specimen was stained, and bacteria and WBCs were identified. Pneumonia was diagnosed, unfortunately, the patient died 1 day later. Menetrier described a 51-year-old man who presented on May 25, 1885, with a productive cough, fever, and physical examination findings positive at the left base. On July 14, 150 mL pus was extracted via a needle, and the organism was identified as *Streptococcus pyogenes*. The patient died on October 19 of that year. Autopsy showed an organized left pleural empyema with no malignancy. Since then, needle biopsy has gained wide acceptance for diagnosing malignant and benign lung lesions. The common modalities employed in the guidance of percutaneous lung biopsy are fluoroscopy and CT scanning. Since the advent of CT scanning, fluoroscopic guidance has been utilized less often, and CT scanning and CT scan-fluoroscopic guidance dominate the current literature. Ultrasound guidance can be used for the biopsy of subpleural lesions. However, the use of ultrasound as an imaging modality for guiding lung biopsies has not been widely adopted.

Technologic advances in both needle design and imaging equipment have broadened the range of lesions that are accessible to needle biopsy. Lung biopsies can be performed by fine-needle aspiration (FNA), providing a specimen for cytologic examination, or using an automated core biopsy needle, providing a specimen for histologic examination. FNA was introduced by Nordenstrom in 1965. Numerous reports have advocated the use of FNA, since it is a reasonably simple and safe technique with an accuracy of about 95% for malignant lesions, despite a lower yield for benign lesions. Early reports cited cytology to be less reliable than histology in determining the cell type of malignant lesions. This disadvantage can be obviated by the presence of a cytopathologist during the biopsy, which has been shown to increase the diagnostic accuracy of FNA. However, at many centers, well-trained cytopathologists are not available to immediately interpret FNA specimens. To avoid this problem, several series have advocated the use of automated cutting needles to obtain core tissue for histologic evaluation. Complication rates for automated cutting needle biopsies are comparable to, or slightly higher than those for FNA.

The most common complications of percutaneous transthoracic lung biopsy are pneumothorax and bleeding. Pneumothorax has a broad frequency range of 8 to 64%. Bleeding occurs less often (range, 2 to 10%) but is more frequently fatal. Many reports have evaluated the relationship between specific variables and the complications of percutaneous lung biopsy. Complications are evaluated according to variables related to the patient, the lesion, and the biopsy procedure.

In this issue of CHEST (see page 748), Yeow et al analyzed the risk factors for pneumothorax and bleeding for 660 consecutive CT scan-guided percutaneous coaxial cutting needle biopsies. They consistently performed coaxial cutting needle biopsies because an on-site cytopathologist was not available. The diagnostic accuracy of these biopsies has been previously reported. Multiple variables related to the patient, the lesion, the biopsy needle, and the radiologist were assessed using univariate and multivariate analysis to determine the influence of each specific variable on the rate of pneumothorax and bleeding. The analyzed variables included the presence of emphysema, chest wall thickness, lesion size and depth, lesion necrosis or cavitation, needle size, number of specimens obtained, needle-pleural angle, and the experience of the radiologist performing the biopsies.

The results of multivariate analysis showed that patients with lesions ≤2 cm had a higher incidence of pneumothorax than did those with larger lesions. In fact, the risk of pneumothorax was 11 times greater for patients with lesions ≤2 cm compared with patients with lesions >4 cm. Smaller lesion size has been reported previously to correlate with an increased risk of pneumothorax. This may be due to the difficulty in maneuvering the needle into the target lesion, thus extending the time required to biopsy smaller lesions.

The pleura-to-lesion distance was the second factor influencing the risk of pneumothorax. Haramati
and Austin\textsuperscript{11} reported a negligible risk of pneumothorax for lesions abutting the pleura and not requiring the traversal of the aerated lung. Interestingly, Yeow et al demonstrated a sevenfold increase in the rate of pneumothorax for the biopsy of subpleural lesions that were \(\leq 2\) cm from the pleural surface compared with lesions abutting the pleural surface. Patients with subpleural lesions also had a fourfold increase in the rate of pneumothorax compared with those with lesions that were \(> 2\) cm from the pleural surface. In contrast, other authors who have analyzed the pleura-to-lesion distance,\textsuperscript{13,15–18} have described an increasing rate of pneumothorax with greater lesion depth.

Subpleural lesions are technically more difficult to biopsy,\textsuperscript{19–21} and the associated increase in the pneumothorax rate is likely due to small needle-pleural angles, multiple punctures, and a longer biopsy time. Furthermore, insufficient anchoring, which is accentuated in cutting biopsies by the heavier hub, may result in the tearing of the pleura and the laceration of the adjacent parenchyma. Based on the present study by Yeow et al and on data from previous studies,\textsuperscript{19–21} it would be reasonable to take a longer needle path for subpleural nodules in order to reduce the risk of pneumothorax.

Yeow et al demonstrated a significant correlation between operator experience and the risk of developing a pneumothorax. This is in contrast to the conclusions of Cox et al,\textsuperscript{13} who reported an identical risk of pneumothorax when FNA was performed by operators with various levels of expertise. Although the complication rates for automated cutting needle biopsies and FNA are comparable, differences in the learning curve between the two biopsy techniques has not, to our knowledge, been studied and may explain the difference in the results.

Negative findings in a large series are an important component of the results. Yeow et al showed no increase in the risk of pneumothorax for factors that intuitively, and in other series, have been suggested to increase the risk of pneumothorax. Emphysema, cavitation of the lesion, needle size, number of specimens, and postbiopsy patient positioning all showed no association with an increased risk of pneumothorax. Earlier studies\textsuperscript{14–16,22,23} reported a higher risk of pneumothorax in patients with obstructive pulmonary disease. However, others,\textsuperscript{17,24} in agreement with Yeow et al, have found no correlation among emphysema, abnormal pulmonary function test results, and pneumothorax.

Bleeding is the second most common complication of percutaneous lung biopsy. Yeow et al reported a sixfold increase in bleeding complications for patients with lesions \(\leq 2\) cm in size compared with those having lesions \(> 4\) cm in size. This increased risk has been attributed to the sampling of the adjacent aerated lung along with the decreased ability of the adjacent aerated lung to provide tamponade. Laurent et al\textsuperscript{25} reported comparable rates of pneumothorax and bleeding for nodules \(< 2\) cm and \(> 2\) cm. However, a varied length of needle throw may have confounded their results. In that series, the needle throw was adjusted on a case-by-case basis, depending on the size and position of the lesion. In contrast, Yeow et al consistently used a needle throw of 1.3 cm.

The depth of the lesion also correlated with the risk of bleeding. Lesions that were \(> 2\) cm from the pleural surface had a 10-fold increased risk of bleeding compared with those that abutted the pleural surface. This is intuitive and has been previously observed.\textsuperscript{19} Pulmonary vessels are more crowded and are larger centrally. Therefore, during the biopsy of a peripheral lesion, the radiologist is less likely to traverse a pulmonary vessel, and if a vessel is traversed, it is likely to be a smaller one.

Surprising to us, the presence of a pleural effusion correlated with a decreased risk of bleeding. To our knowledge, no previous study has described this correlation. Although the lesions associated with a pleural effusion were generally larger and closer to the pleural surface than those without effusions, this finding was an independent risk factor for bleeding in the multivariate analysis. The possible reasons for a decreased risk of bleeding in those with effusions may include diminution in the negative intrapleural pressure and tamponade by the effusion. Furthermore, the presence of a pleural effusion may hinder the detection of bleeding.

In conclusion, the study by Yeow et al in this issue of \textit{CHEST} describes a large consecutive series of patients who underwent transthoracic cutting needle biopsies of the lung. Although most of the results are in line with those of previous publications, the size of the series, and the meticulous statistical evaluation of the risk factors for pneumothorax and bleeding make this a definitive study.

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References


Which Exercise Test Should Be Used for Patients With Symptomatic COPD?

Over the past decade, our understanding of exercise pathophysiology in patients with chronic airflow obstruction has expanded rapidly. Several articles, including one in this issue of CHEST by Turner et al (see page 765), have explored the responses to various testing protocols. I will argue that the 6-min walk test (6MWT) is the best one to use at a single point in time to assess a patient with symptomatic airflow limitation. It is also a good test to repeat to document declining exercise tolerance, and an adequate test to document improvement in function. Treadmill testing at constant workload is more sensitive for the latter purpose.1 Treadmill testing is also better if more advanced monitoring such as continuous electrocardiography or expired gas analysis is required during exercise. Cycle ergometry is less desirable since it has been shown to have important respiratory differences when compared with walking in this group, and is less closely related to the patient’s usual activities.2

Why should exercise testing be done in patients with COPD? The main reason is that it allows objective assessment of the effect of the disease on the patient’s ability to function. Such information may be helpful in deciding how aggressively to treat underlying airflow obstruction as well as in determining the need for supplemental oxygen, pulmonary rehabilitation, and surgical therapy (lung volume reduction and transplantation). Also, functional capability is an independent predictor of various outcomes in this group. Both mortality3,4 and postoperative complications5,6 are inversely related to this important variable. Unfortunately, spirometric parameters are poorly predictive of exercise ability,7 such that one patient may be in a wheelchair and another living independently with the same reduction in FEV1. Functional capability is often deter-