Editorial

Safer lung biopsy techniques: fewer patients with pneumothorax, fewer chest tube insertions

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Submitted Sep 28, 2015. Accepted for publication Oct 10, 2015.
doi: 10.3978/j.issn.2072-1439.2015.10.60
View this article at: http://dx.doi.org/10.3978/j.issn.2072-1439.2015.10.60

Percutaneous image guided lung biopsy

Image guided transthoracic lung biopsy is a widely accepted technique for the workup of lung lesions (1). Screening for lung cancer and the growing need for research biopsy samples will continue to increase the demand for image guided lung biopsy (2,3). Technical aspects of the procedure have evolved over the years and will continue to change. In the early days, lung biopsies were performed under fluoroscopic guidance. With the widespread use of cross sectional imaging and multidetector CTs, most centers in the US have shifted their practice to performing lung biopsies under CT guidance (4). Others have experimented with C-arm cone-beam computed tomography (CBCT) to combine advantages of real-time fluoroscopic guidance with accuracy of cross sectional imaging (5-7).

Pneumothorax

Pneumothorax is the most common complication of transthoracic lung biopsy (4). A patient with stable pneumothorax may be treated conservatively without chest tube insertion. If pneumothorax is large (greater than 30% of hemithorax), is rapidly expanding, or is causing symptoms, chest tube insertion is warranted. The reported rates of pneumothorax and chest tube placement vary greatly in the published literature. In some of the larger series, pneumothorax was encountered in 20-25% of patients, and chest tube was inserted in 0% to 17% of patients (4).

Risk factors for pneumothorax and drainage catheter insertion

A number of factors have been shown to be associated with higher risk of pneumothorax after lung biopsy. These include presence of emphysema, needle pleura angle, lesion size, lesion location, needle path, and patient position (8). In a study of 4,262 consecutive lung biopsies, the overall rate of pneumothorax and chest tube placement was 30.2% and 15%, respectively (4). The rate of pneumothorax and chest tube placement was lower with the use of a 19 gauge guide needle (24.5% and 13.1%, respectively) when compared to 18 gauge guide needle (35% and 16.7%, respectively). Several other factors were found to be associated with higher rates of pneumothorax and chest tube placement: older age, emphysema, greater number of pleural surfaces crossed, and a longer biopsy needle path length. There are several other issues to consider: operator experience, presence of a trainee, member of passes, pulmonary hemorrhage, proximity to Broncho vascular tree or diaphragm, and prior chest surgery.

Strategies to reduce the rate of pneumothorax and/or drainage catheter insertion

Lung biopsy should be planned carefully to select the shortest path to the lesion while avoiding multiple punctures of the pleural linings or traversing emphysematous lung parenchyma. Using smaller gauge guide needle helps reduce the rate of pneumothorax and chest tube insertion rate (4,8).

Other strategies include the use of blood patch (9,10), saline injection in the biopsy track (11), or the use of a collagen plug (12). If a pneumothorax is detected after lung biopsy, aspiration may preclude the need for insertion of a drainage catheter (13).

Moore *et al.* studied the impact of patient positioning after lung biopsy with the biopsy site in a dependent position, demonstrating a reduction in chest tube insertion rate (14), while another study showed no benefit (15). Those in favor of the technique hypothesize that placement of the puncture site in a dependent position reduces the size of alveoli surrounding the needle track, which results in development of airway closure, an increased resistance to collateral ventilation in the dependent lung, a reduction in the alveolar to pleural pressure gradient at the puncture site, and a dependent accumulation of hemorrhagic fluid around the needle track. In other words, placing the patient with the biopsy-site down causes the weight of the lung to maintain good visceral to parietal pleural apposition and minimizes air leak from the puncture (16). In a study of 201 patients, O'Neill *et al.* further reduced both pneumothorax and chest tube insertion rates by a "rapid needle-out, patient-rollover" technique (16). In their adaptation of patient positioning, they minimized the time required between removing the needle and placing the patient in a recumbent position with the biopsy site down.

The article in European Radiology by Kim *et al.* reviews the impact of rapid needle-out patient-rollover approach in 1,227 percutaneous lung biopsies (7). All patients underwent C-arm CBCT guided transthoracic lung biopsy with a coaxial technique using a 17 gauge guide needle. In 617 biopsies, patients remained on the fluoroscopy table after needle removal and underwent repeat CBCT imaging, and then rolled over to a stretcher with the biopsy site down position (estimated time 3-5 minutes). In the other 610 biopsies, patients rolled over to a biopsy site down position immediately after needle removal (elapsed time 24.6±9.2 seconds). CBCT imaging was repeated after positioning the patient with the biopsy site down to evaluate the presence or absence of pneumothorax. There was no significant difference in the overall pneumothorax rates between the two groups. However, pneumothorax rate requiring drainage catheter placement was significantly lower in rapid needle-out patient-rollover group (1.6%) when compared to the conventional group (4.2%) (P=0.010).

First of all, the investigators should be applauded for a very low rate of chest tube insertion after lung biopsy procedures even in the conventional group without the rapid needle-out patient-rollover technique. Comparing the two study groups, the rate of pneumothorax was similar; but for chest tube insertion, they have demonstrated a statistically significant advantage in favor of rapid needle-out patient rollover approach. In an earlier study, O'Neill *et al.* demonstrated a significant reduction both in the rate of pneumothorax development and chest tube insertion with the use of rapid needle-out patient-rollover technique (16). As Kim *et al.* have pointed out, the duration of time required for the rapid needle-out patient-rollover was substantially different between the two studies. O'Neill *et al.* accomplished this task in 10 seconds, while Kim *et al.* took 24.6 seconds on average. Another explanation may be related to the differences in duration of recumbent positioning with the biopsy site down. Kim *et al.* maintained patients in that position for 3 continuous hours. Whereas, O'Neill *et al.* ambulated patients in 1 hour to obtain an erect chest radiograph and then determined if the patient would go back to biopsy site down or upright sitting position. In an earlier study, Moore *et al.* highly recommended observation of patients in the erect seated position before discharge, because puncture-site-down positioning may sometimes mask unsealed sites of air leakage (14). Not having observed patient in an erect seated position, Kim *et al.* could have missed delayed small, asymptomatic pneumothorax in some patients.

In the discussion, Kim *et al.* compare their rate of pneumothorax in the conventional group (19.8%) to that reported by O'Neill *et al.* (37%) and attribute the difference to the use of a virtual guidance system. Although this may be a reasonable hypothesis, it is certainly not validated by the data presented in this study. Furthermore, there are many differences between the two studies, most notably with regard to the overall duration of patient positioning with the biopsy site down, ambulation for chest radiography, and positioning of the patient afterwards for the remainder of the observation period. Among other reported parameters, mean patient age is different between the two studies. Adequately detailed data are not provided to compare the presence and extent of emphysema, lesion depth, and other parameters. It is unlikely that these parameters are closely matched between the two studies just by chance. These points highlight the difficulties in making comparison between studies from different institutions without strict standardization and reporting guidelines.

Rapid needle-out patient-rollover technique is a simple and inexpensive method for reducing the rate of pneumothorax, drainage catheter insertion, or both after transthoracic lung biopsy. Despite its simplicity, it may not be applicable to all patients. Kim *et al.* excluded patients with hemoptysis who were placed in lateral decubitus position after lung biopsy (7). O'Neill *et al.* excluded up to 26% of patients from each group for various reasons including development of intraprocedural pneumothorax, hemoptysis requiring lateral decubitus positioning, and patient immobility (16). Rapid needle-out and patient-rollover may also be challenging in morbidly obese patients and those who are heavily sedated. Rapid patient-rollover onto a stretcher and immediate discharge form the procedure room precludes obtaining a final set of images to evaluate for complications (e.g., pneumothorax, parenchymal hemorrhage, hemothorax). Rapid patient-rollover on the CT or fluoroscopy table adds time to the procedure and requires repeat marking and sterile preparation should pneumothorax aspiration become necessary. Admittedly, these circumstances are exceptions rather than the rule and overall, rapid needle-out patient-rollover technique is an excellent strategy that is applicable to the majority of patients undergoing percutaneous lung biopsy. Radiologists who perform image guided lung biopsies should be familiar with the technique and its benefits. Moreover, it does not preclude other Preventive measures that are preferred by some radiologists. Application of blood patch and/or collagen plug can be performed immediately before rapid needle-out and patient-rollover maneuver.

Acknowledgements

None.

Footnote

Provenance: This is a Guest Editorial commissioned by the Guest-Editor Lihua Chen [Department of Radiology, Taihu Hospital (PLA 101 Hospital), Wuxi, Jiangsu, China].

Conflicts of Interest: The author has no conflicts of interest to declare.

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Cite this article as: Ahrar K. Safer lung biopsy techniques: fewer patients with pneumothorax, fewer chest tube insertions. J Thorac Dis 2015;7(10):1704-1707. doi: 10.3978/j.issn.2072-1439.2015.10.60