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Pleural Ultrasound for Detection of Postbronchoscopy Pneumothorax in Lung Transplant Recipients

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Pleural ultrasound is a well-established modality for ruling out pneumothorax,[1,2] including postbronchoscopy pneumothorax.[3–5] Currently, some bronchoscopists use pleural ultrasound to assess for postbronchoscopy pneumothorax in lung transplant recipients, but the accuracy of this approach has not been well studied. One study demonstrated a pleural ultrasound examination 2 hours postbronchoscopy can rule out pneumothorax in lung transplant recipients; however, waiting 2 hours postbronchoscopy limits the practicality of implementing this study's approach.[6] To determine whether an *immediate* postbronchoscopy pleural ultrasound examination can accurately rule out pneumothorax in lung transplant recipients in a clinical practice setting, we reviewed pleural ultrasound examinations of lung transplant recipients postbronchoscopy at our institution.

METHODS

A retrospective observational study of adult lung transplant recipients who underwent a bronchoscopy with multiple transbronchial biopsies that included an immediate prebronchoscopy and postbronchoscopy pleural ultrasound examination was conducted. Inclusion criteria included age above 18 years; history of lung transplantation; performance of a fiberoptic bronchoscopy for routine surveillance or clinical indications; and sampling of 8 to 10 peripheral transbronchial biopsies from the right upper, middle, and lower lobes. Exclusion criteria included lack of available prebronchoscopy and postbronchoscopy pleural ultrasound images; preexisting pneumothorax; and lack of an available postbronchoscopy chest x-ray (CXR). The University of Texas Health—San Antonio's Investigational Review Board approved this study (HSC20160258H).

Pleural ultrasound images were acquired by 2 academic interventional pulmonologists proficient in point-of-care ultrasound using a high-frequency linear-array transducer on a single portable ultrasound machine (Sonosite Edge; L-38 10-5 MHz transducer; Bothell, WA). Using a vascular preset, longitudinal views of the pleura were acquired along the right mid-clavicular line from the clavicle to the diaphragm. Both B-mode and M-mode ultrasound video clips and still images, respectively, were acquired immediately prebronchoscopy and postbronchoscopy (< 10 min) with the subject in a supine position on the bronchoscopy table.

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Images were interpreted independently by 3 blinded ultrasound expert reviewers, and disagreements were adjudicated by 2 study investigators. Pleural sliding was categorized as present, absent, or indeterminate. A pneumothorax was defined by an acute loss of pleural sliding from prebronchoscopy to postbronchoscopy on B-mode or M-mode images or detection of a lung point. Presence of pleural sliding, comet-tails, or lung pulse ruled out pneumothorax. All subjects underwent a postbronchoscopy 1-view anterior-posterior CXR, followed by either 1-view or 2-view CXRs during their first follow-up visit. Pneumothoraces were categorized as small (< 15%) versus large (≥ 15%) on CXR using a formula described by Collins et al.[7]

RESULTS

A total of 206 bronchoscopies with transbronchial biopsies performed on adult lung transplant recipients were reviewed. Ten subjects were excluded for preexisting pneumothoraces, lack of available ultrasound images, or nonperformance of transbronchial biopsies. Data were analyzed from 196 subjects.

The mean age of the subjects was 54 years, and 51% were male. Most bronchoscopies were for surveillance (73%), and 53% of subjects were > 90 days postlung transplantation.

The incidence of postbronchoscopy pneumothorax was 5.6% (n = 11). Of the 11 pneumothoraces, 3 (27%) were diagnosed immediately (< 10 min) postbronchoscopy by ultrasound, 4 (36%) were diagnosed early (10 min to 3 h) by CXR, and 4 (36%) were delayed diagnoses (≥ 3 h) (Fig. 1).

Most postbronchoscopy pneumothoraces (55%) were managed expectantly. Tube thoracostomy was required in 2 of 3 subjects with an immediate pneumothorax (< 10 min) detected by pleural ultrasound and 3 of 4 subjects with a delayed pneumothorax (≥ 3 h) detected by CXR.

DISCUSSION

Our study is the largest retrospective review of postbronchoscopy pneumothorax in lung transplant recipients in the United States and the first to report findings of an *immediate* postbronchoscopy pleural ultrasound examination to rule out pneumothorax. An immediate postbronchoscopy pleural ultrasound examination detected 3 pneumothoraces but may have missed

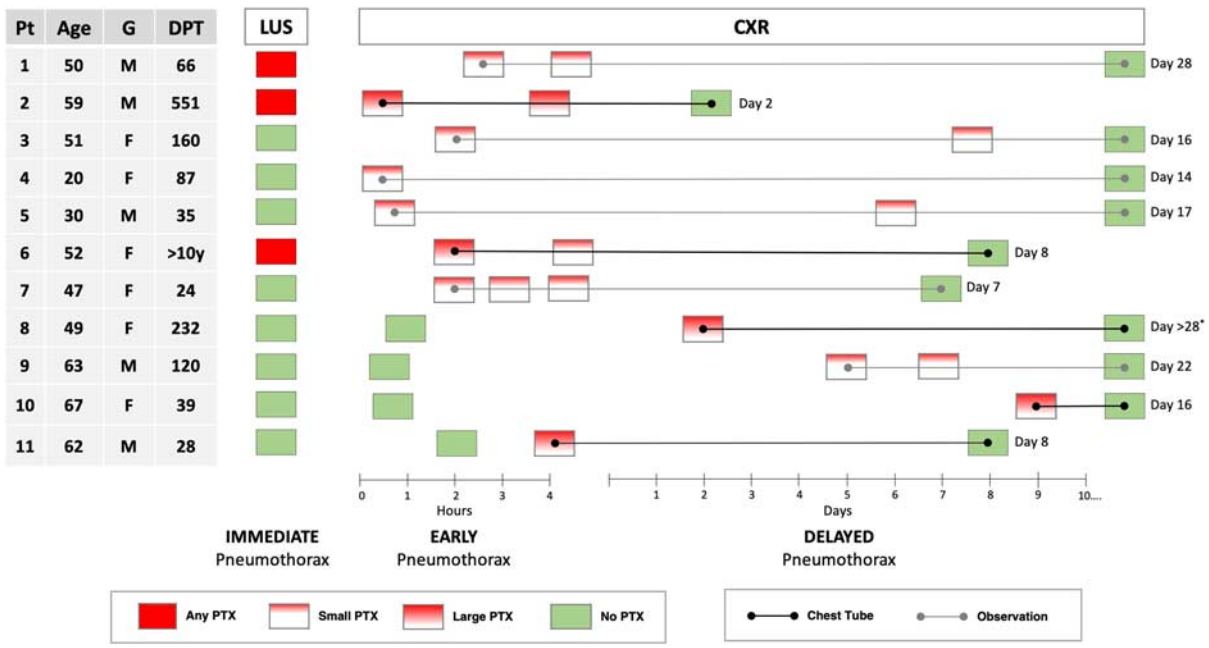

FIGURE 1. LUS and CXR for detection of immediate, early, and delayed PTXs postbronchoscopy in lung transplant recipients. An immediate postbronchoscopy LUS examination detected 3 early PTXs (< 10 min), and 2 of these were large and required tube thoracostomy. CXR detected 4 early PTXs (10 min to 3 h) that were small, and none required tube thoracostomy. Delayed PTXs (≥ 3 h) were seen in 4 subjects, and 3 required tube thoracostomy. Day of resolution of the PTX is noted to the right of each line. Large PTX was defined by size > 15% using Collins formula.[7] *Heimlich valve placed and resolved after > 4 weeks on CXR. CXR indicates chest x-ray; DPT, days postlung transplant; F, female; G, gender; LUS, lung ultrasound; M, male; Pt, patient; PTX, pneumothorax.

4 small pneumothoraces that were detected by CXR within 3 hours postbronchoscopy. Most delayed pneumothoraces were detected a few days postbronchoscopy and were large in size requiring tube thoracostomy.

Few studies have reported the incidence of postbronchoscopy pneumothorax among lung transplant recipients undergoing transbronchial biopsies. Our study found an incidence of 5.6%, while another study reported an incidence of 9.6% in this population.[6]

Pleural ultrasound has demonstrated higher sensitivity and similar specificity compared with CXR for diagnosis of pneumothorax in general,[2] but few studies have assessed the accuracy of pleural ultrasound to detect postbronchoscopy pneumothorax.[3,4,6] Compared with one study that included lung transplant recipients, our study had a lower sensitivity of pleural ultrasound for detecting immediate or early pneumothoraces (43% vs. 75%). This difference may be explained by the delay between the pleural ultrasound examination and CXR in our study which allowed pleural air to accumulate in patients with slow air leaks. Whether serial pleural ultrasound examinations can detect small postprocedure pneumothoraces should be evaluated in future studies.

Approximately one third of pneumothoraces were delayed (>3 h), and neither the immediate pleural ultrasound examination nor initial postbronchoscopy CXR detected these pneumothoraces. Most important, 3 of the 4 subjects with delayed pneumothoraces required tube thoracostomy for several days.

Delayed pneumothoraces can have potentially life-threatening consequences. The right and left pleura are anatomically contiguous after lung transplantation, and a unilateral pneumothorax can rapidly expand bilaterally causing hemodynamic compromise. In addition, patients that use noninvasive positive pressure ventilation can develop a tension pneumothorax requiring emergent decompression. Lung transplant patients often travel long distances to transplant centers, and delayed pneumothoraces manifesting a few days postbronchoscopy can be challenging to promptly diagnose and manage. The literature on delayed pneumothorax after transbronchial biopsy is limited to case reports and warrants further investigation.[8–10]

Our study has limitations. As a retrospective study, pleural ultrasound and CXR were not performed simultaneously at prespecified times postbronchoscopy; however, our findings represent the real-world experience of an active lung transplant center. Further, the pleural ultrasound examination was limited to scanning the right lung where biopsies were performed. Perhaps a more extensive pleural ultrasound examination could have detected additional small pneumothoraces that may have been missed.

In conclusion, an immediate postbronchoscopy pleural ultrasound examination can detect large pneumothoraces in lung transplant recipients. However, relatively slow air leaks leading to delayed pneumothoraces may be missed by an immediately postbronchoscopy pleural ultrasound examination. Delayed pneumothoraces are an important consideration in lung transplant recipients, and performing a pleural ultrasound examination just before discharging the patient may be the safest approach.

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