Assessment of interstitial lung disease using lung ultrasound surface wave elastography

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Background, Motivation and Objective

Interstitial lung disease (ILD) includes multiple serious lung disorders associated with lung fibrosis and stiffened lung parenchyma. High-resolution CT (HRCT) is the clinical standard for assessing lung fibrosis, but is expensive and with radiation. Ultrasonography is not widely used for lung assessment because ultrasound cannot image deep lung tissue. We developed a lung ultrasound surface wave elastography (LUSWE) technique for measuring superficial lung tissue stiffness. LUSWE is useful for assessing ILD because many ILDs have predominantly peripheral involvement.

Statement of Contribution/Methods

In LUSWE, a local, gentle, 0.1 second harmonic vibration is generated on the chest wall of a subject using a handheld vibrator. An ultrasound probe is positioned in the same intercostal space as the indenter of the vibrator to measure the generated surface wave propagation on the lung. The Verasonics ultrasound system with an ultrasound probe of L11-4 with a central frequency of 6.4 MHz is used. A human subject is examined in a sitting position. The lung testing is performed with full inspiration breath hold and through three intercostal spaces on both lungs. The surface wave speeds are measured at the three excitation frequencies of 100 Hz, 150 Hz, and 200 Hz.

Results/Discussion

We studied 30 healthy controls (stage F0), 16 early stage (F1), 54 moderate stage (F2), and 27 severe stage (F3) ILD patients. The surface wave speeds of patients' lungs were significantly higher than those of control subjects. LUSWE presented 92% sensitivity and 89% specificity for separating healthy subjects from ILD patients. The sensitivity is 88% and the specificity is 97% for separating healthy subjects from early stage ILD patients. LUSWE presented 50% sensitivity and 81% specificity for separating subjects F0-F2 and F3. LUSWE was used to measure the changes between the follow up measurements with the baseline measurements. It was found that the average global changes of wave speed correlated well with clinical changing scores for the lower lung locations. LUSWE is a safe and noninvasive technique for generating and measuring surface wave propagation on the lung. LUSWE may be useful for screening early stage ILD patients and monitoring disease progression.