

IN VIVO CHARACTERIZATION OF ULTRASONIC BACKSCATTERING FROM NORMAL AND ABNORMAL LUNGS

Farhad Jafari

The primary goal of this project has been to characterize the lung tissue in its in vivo ultrasonic backscattering properties in normal human subjects, and study the changes in the lung echo characteristics under various pathological conditions. Such a characterization procedure is used to estimate the potential of ultrasound for providing useful diagnostic information about the superficial region of the lung.

The results of this study may be divided into three categories: (1) This work has resulted in the ultrasonic characterization of lung tissue, in vivo, and has investigated the various statistical features of the lung echo properties in normal human subjects. The echo properties of the lungs are characterized with respect to the mean echo amplitude relative to a perfect reflector and the mean autocorrelation of normalized echo signals. (2) A theoretical model is developed to simulate the ultrasonic backscattering properties of the lung under normal and various simulated abnormal conditions. This model has been tested on various phantoms simulating the strong acoustic interactions of the lung. When applied to the lung this model has shown excellent agreement to experimental data gathered on a population of normal human subjects. By varying a few of the model parameters, the effect of changes in the lung structural parameters on the detected ultrasonic echoes is investigated. It is found that alveoli size changes of about 50 percent and concentration changes of 40 percent may produce spectral changes exceeding the variability exhibited by normal lungs. (3) Ultrasonic echoes from the lungs of 4 groups of patients were studied. The groups included patients with edema, emphysema, pneumothorax, and patients undergoing radiation therapy for treatment of lung cancer. Significant deviations from normal lung echo characteristics is observed in more than 80 percent of the patients studied. These deviations are intercompared and some qualitative associations between the echo characteristics on each patient group and their pulmonary pathology is made. It is concluded that the technique may provide a potential tool in detecting pulmonary abnormalities. More controlled patient studies, however, are indicated as necessary to determine the sensitivity of the ultrasound technique.