

SPECTRAL CHARACTERISTICS OF LUNG SOUNDS IN PATIENTS WITH CHRONIC OBSTRUCTIVE LUNG DISEASE

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OBJECTIVE

To determine if the frequency characteristics of lung sounds differed in non-wheezing patients with chronic obstructive lung disease (COPD) as compared to normal subjects.

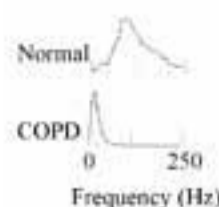
METHODS

A 16-channel lung sound analyzer (Stethographics Model STG1602) was used to collect 20 second samples of sound during deeper than normal breathing from 63 patients with COPD. Only patients, who did not have inspiratory wheezing and who did not have over 5 inspiratory crackles per breath, were included in this study. 63 aged-matched normals were also studied in a similar manner. We also examined a patient with a pneumothorax and a patient with a bulla that occupied 1/3 of the left lower hemithorax. To quantify the energy of lung sounds at low frequency, the ratio of sound energy from 20 Hz to 80Hz to that from 80 to 800 Hz was calculated (R4). The maximum value of the R4 ratio at 8 basilar sites was chosen for each subject.

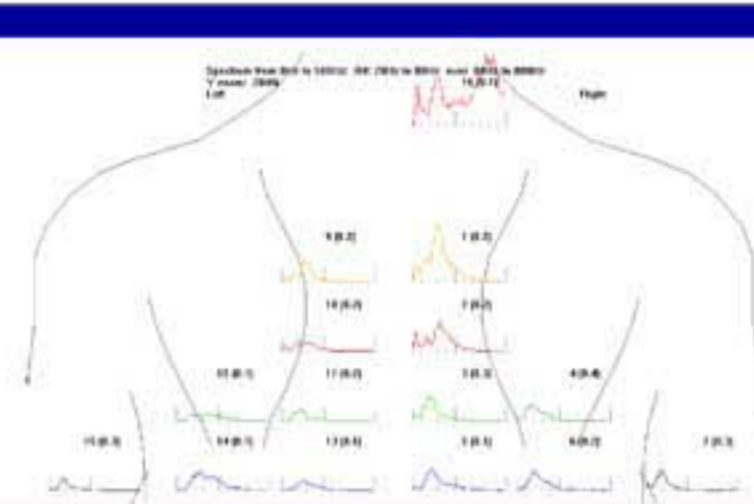


RESULTS

COPD patients had higher maximum R4 values than age matched normal subjects. COPD: $R4 = 3 \pm 3$ (range 0.3-13). Normals: $R4 = 0.8 \pm 0.8$ (range 0.1-5.5) ($p < 0.0001$). Figure 1 shows typical power spectral density of sound recorded at lung bases during deeper than normal breathing in normal subject and in patient with COPD.



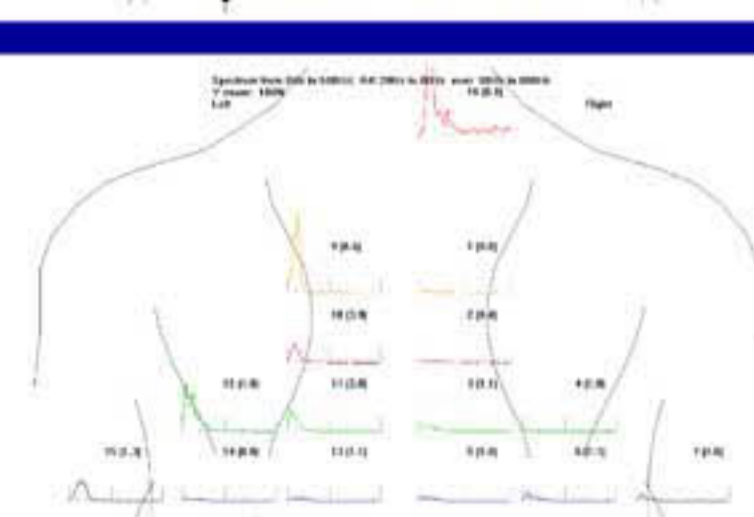
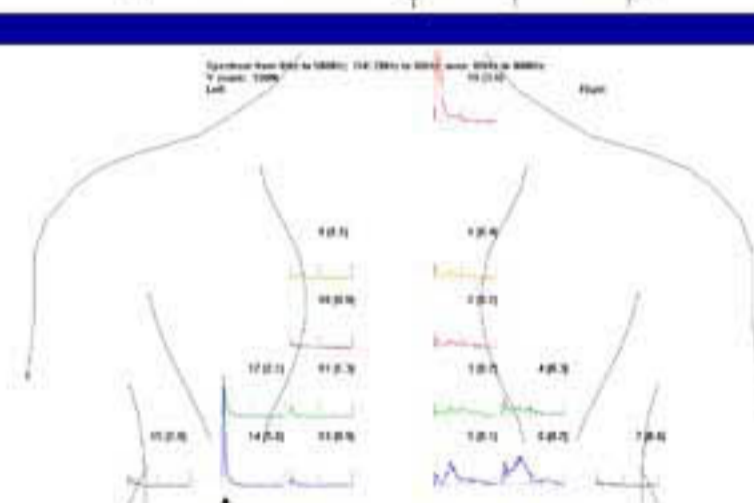
Normal.
Note the spectrum of normal inspiratory sound - most energy is concentrated between 80 and 200 Hz.



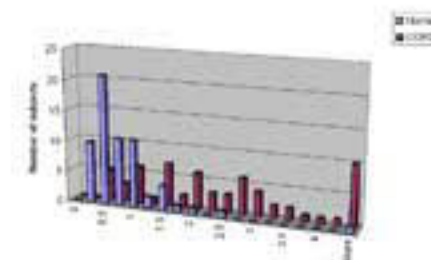
COPD.
Note high power peaks at frequency 0 to 80Hz in COPD patient (arrows).



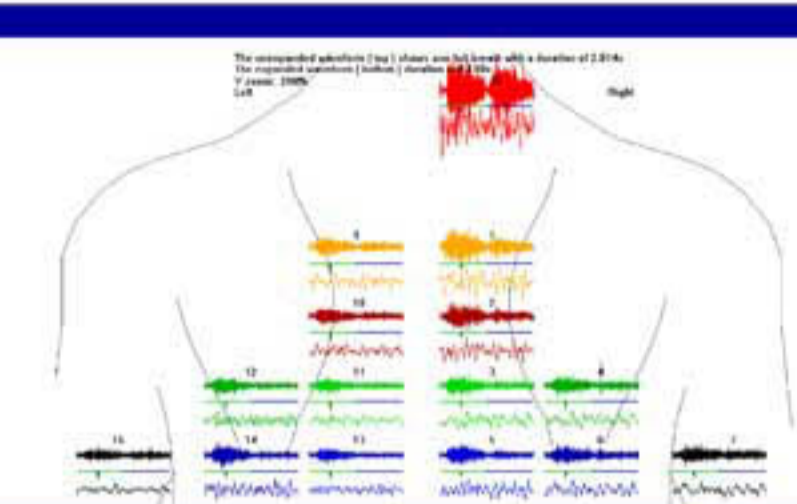
Pneumothorax.
Spontaneous collapse of left lung. Note the spectrum of normal inspiratory sound on the right - most energy is concentrated between 80 and 200 Hz. On the left note the presence very low frequency peak at 20Hz (arrow) and the absence of energy at higher frequency.



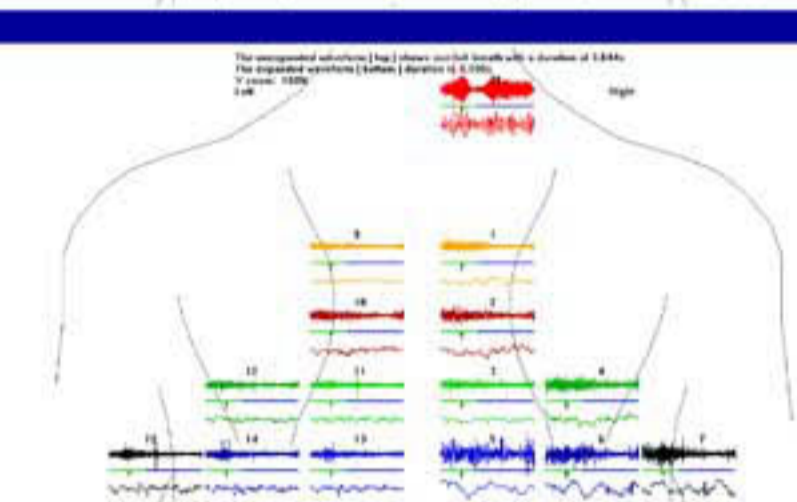
R4 FREQUENCY DISTRIBUTION



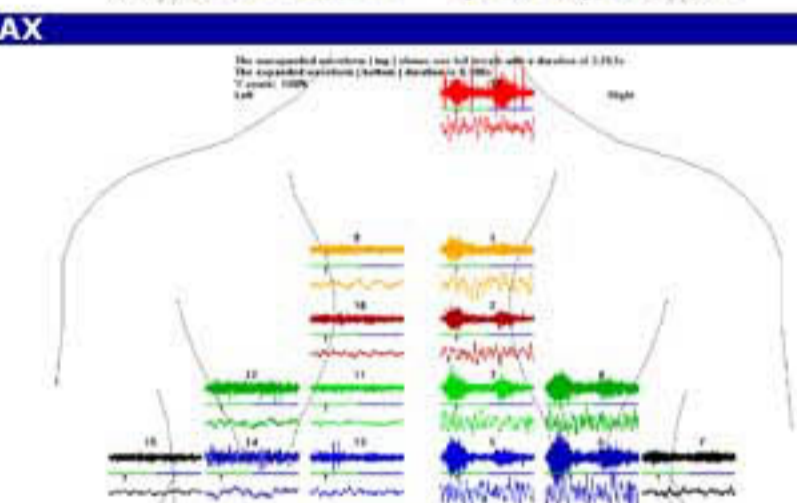
NORMAL



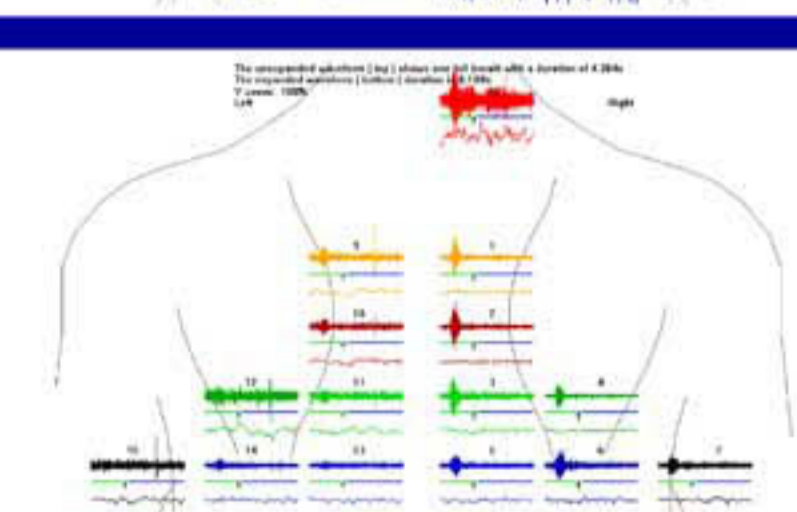
COPD



PNEUMOTHORAX



BULLA



CONCLUSION

The spectral content of inspiratory sounds of COPD patients showed higher energy at low frequency than did the sounds of age matched normals. The cause of this is unclear but may be due to decreased tissue density inhibiting the transmission of the higher frequencies. Some evidence that this is the case is presented by the fact that low frequency peaks were also noted over a 100% pneumothorax and over a large bulla. These preliminary results suggest that increased acoustic energy at low frequency might prove useful in noninvasive assessment of regional distribution of disease severity. The smallest volume of affected lung associated with this phenomena (i.e. the resolution of this technique) is not known at this time.