Ratio Of Low Frequency Energy To High Frequency Energy Of Lung Sounds In Patients With COPD

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**Purpose**
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.

**Materials and Methods**
A 16-channel lung sound analyzer was used to collect 20 seconds samples of sound during deeper than normal breathing.

**Results**

<table>
<thead>
<tr>
<th></th>
<th>Normals</th>
<th>IPF</th>
<th>CHF</th>
<th>Asthma</th>
<th>PN</th>
<th>COPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean R4 left</td>
<td>0.3±0.4</td>
<td>0.4±0.6</td>
<td>0.5±0.5</td>
<td>0.5±0.7</td>
<td>0.6±0.7</td>
<td>0.9±0.8</td>
</tr>
<tr>
<td>Mean R4 right</td>
<td>0.4±0.4</td>
<td>0.4±0.5</td>
<td>0.5±0.5</td>
<td>0.6±0.5</td>
<td>0.6±0.7</td>
<td>0.9±0.8</td>
</tr>
</tbody>
</table>

- Notice that R4 was significantly greater in COPD as compared to normals (p<0.05).

**Frequency Distribution of R4**

Age matched COPD (n=128) and Normals (n=128)

**Discussion**
- The mechanism of the increased R4 in COPD is unknown.
- A possible explanation is that it may be due to the relatively increased size of the air spaces in the lung of COPD patients as we have noted a similar increase in low frequency peaks in patients with pneumothorax and pneumonectomy as well in a patient with a giant bulla.

**Conclusions**
- Acoustic energy at low frequency is increased in patients with COPD as compared to normals.
- This finding combined with other observations such as decreased amplitude and prolonged expiratory phase is useful in identifying the presence of COPD by a bedside technique that requires little patient cooperation.

**Normal**

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

**COPD**

COPD:
- Note the high power peaks at frequency 0 to 80 Hz (arrows)

**Pneumothorax**

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

**Bulla**

Bulla:
- A bulla in the left lung is associated with increased energy at frequency 0 to 80 Hz and decreased vesicular breath sounds.

**Materials and Methods**

- Typical power spectral density of sound recorded at lung bases during deeper than normal breathing in a normal subject and in a patient with COPD.

- To quantify the energy of lung sounds at low frequency, the ratio of sound energy from 20 Hz to 80 Hz 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.

Patients: COPD (n=103), Normals (n=379), Pneumonia (PN, n=118), Congestive heart failure (CHF, n=92), Bronchial asthma (n=62), Interstitial pulmonary fibrosis (IPF, n=39)