

Asynchrony of the Timing of Lung Sounds in Patients with Chronic Obstructive Lung Disease

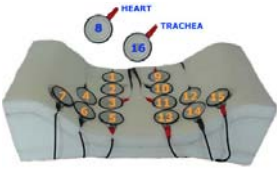
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Purpose

To determine if time based parameters of lung sounds differed in patients with chronic obstructive lung disease (COPD) as compared to normal subjects.

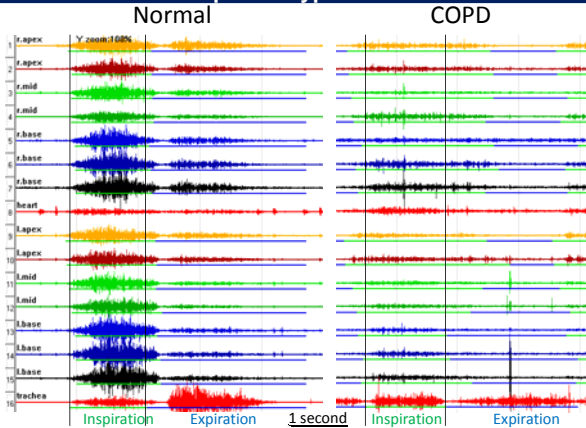
Materials and Methods

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



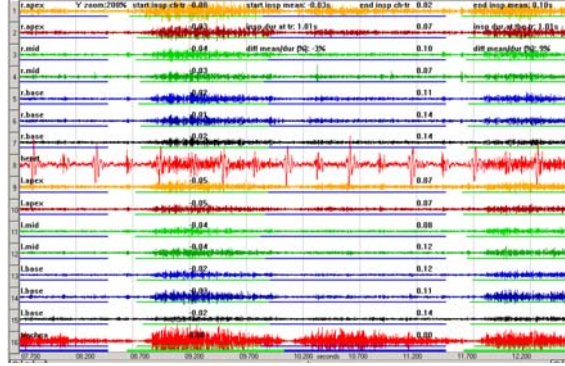
Patients: COPD (n=103), Normals (n=379), Pneumonia (PN, n=118), Congestive heart failure (CHF, n=92), Bronchial asthma (n=62), Interstitial pulmonary fibrosis (IPF, n=39)

Examples of typical results

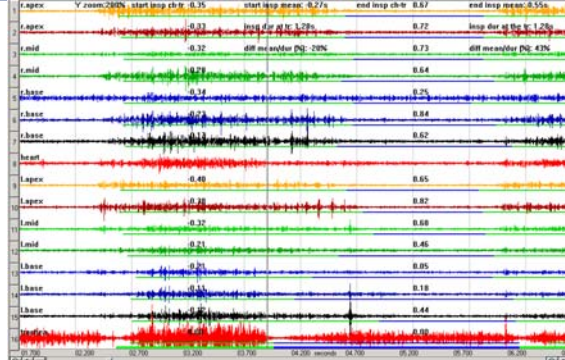


The figure above compares sounds obtained from a normal subject and a patient with COPD. Vertical lines mark the start and end of inspiratory sounds recorded at the trachea. Notice that in the normal subject the inspiratory sound starts and ends at almost the same time at all the chest sites as well as the trachea. In other words inspiratory sound is synchronous among chest sites as well as the trachea. In COPD patient inspiratory sounds at the chest sites tend to start earlier than the inspiratory sound at the trachea. In addition, inspiratory sounds at the chest sites tend to end later than the inspiratory sound at the trachea.

Normal – Asynchrony Definition



COPD – Asynchrony Definition

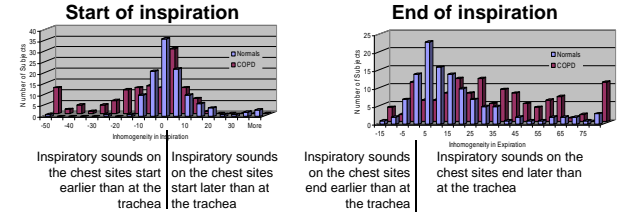


- To quantify the asynchrony phenomena the lung sounds were band pass filtered between 50Hz and 500Hz.
- A running average of the absolute value of the time amplitude signal for each microphone was calculated.
- The start of inspiration at every location including the trachea was defined as the time when the signal just exceeded 20% of its maximum level.
- The end of inspiration was defined as the time when the signal just dropped below 20% of its maximum value.
- The thin green line under each channel waveform indicates the duration of inspiration at that channel as automatically identified by the STG software.
- The time of the start of the inspiration at the trachea was subtracted from the time of the start of inspiration at each chest wall site. Similarly the time of the end of inspiration at the trachea was subtracted from the time of the end of inspiration at each chest wall site.
- The mean of 14 time differences for the start and end was expressed in percent of the duration of the inspiration at the trachea to calculate the start of inspiration asynchrony (SI) and the end of inspiration asynchrony (EI) respectively.
- A negative sign indicates that chest microphones detected inspiration before the tracheal microphone.

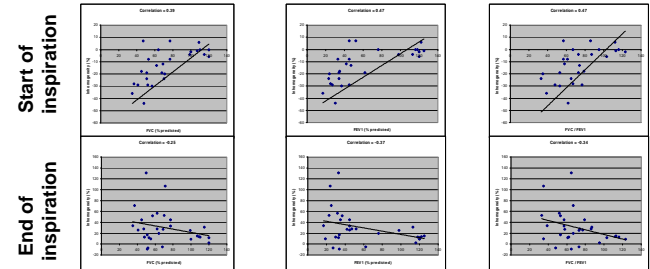
Results

	Normals	IPF	Asthma	CHF	PN	COPD
Start of inspiration	-1±9	0±6	-5±12	-6±18	-8±15	-16±21
End of inspiration	14±18	13±13	12±19	19±21	17±23	27±26

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



Correlation between asynchrony and PFT



Conclusions

- Inspiratory timing asynchrony was greater in COPD.
- This asynchrony moderately correlated with spirometric tests.
- The mechanism of the inter-channel asynchrony is unknown, but a possible explanation is regional variations in elasticity and airway resistance. In other words in a normal subject as the chest wall moves outward on inspiration the airways dilate relatively uniformly and the lung is uniformly expanded. In COPD, airway dilatation is less likely to be uniform and dilatation is more asynchronous secondary to regional variations in elasticity and resistance.
- The fact that acoustic energy appears over the chest wall before it appears at the trachea in COPD patients suggests that decreased elastic recoil is present in these patients.
- The fact that the start of the inspiratory sound varies from site to site suggests that elastic recoil also varies from site to site.
- The increase in the inter-channel asynchrony together with other features of COPD, such as decreased amplitude of sound and relatively prolonged expiratory phases can help provide evidence that COPD is present.
- This can be done using a simple test using that requires little patient cooperation.