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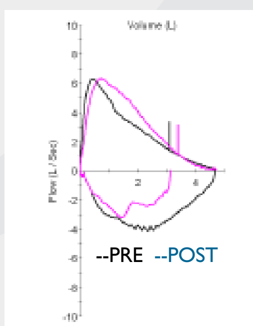
Elite Series Body Plethysmograph

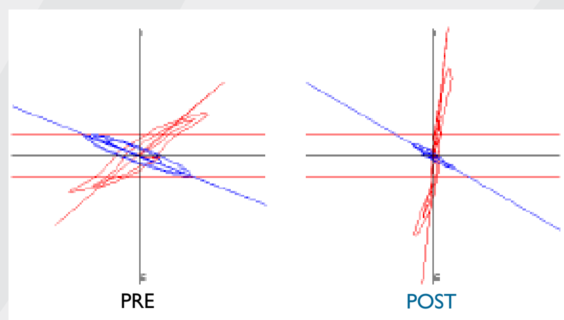
Case Studies - Adolescent Asthma

While the use of flow-volume loops to determine reversibility of airways disease is standard practice in some labs, flow-volume loops alone may not be sufficient to effectively diagnose many patients. Airways resistance measurements using a plethysmograph are the most sensitive method to detect airways disease.

A 16 year old Caucasian male presented at his physician's office complaining of shortness of breath and dyspnea on exertion. Present medication was Ventolin inhaler PRN which was prescribed by another physician at his last office visit 10 years ago. The patient demonstrated moderate diffuse bronchospasm and mild diaphragmatic tenderness. Pulmonary function studies were performed with the results below:

	Pre-Bronchodilator			Post-Bronchodilator		
	Actual	Pred	%Pred	Actual	%Pred	%Change
FVC	4.69	5.54	85%	4.73	85	1
FEV_1	3.13	4.79	65%	3.40	71	9
FEF Max	6.27	9.46	66%	6.32	67	1
FEF 25-75%	2.08	5.27	40%	2.54	48	22
R_{aw}	7.17	1.51	474%	0.96	63	-87%
G_{aw}	0.14	0.66	21%	1.04	158	643%
sG_{aw}	0.02	0.19	11%	0.25	131	1150%





As seen above, the patient's plethysmography measurements of airways resistance (R_{aw}), conductance (G_{aw}) and specific conductance (sG_{aw}) were substantially below normal for his age group. The post-bronchodilator FEV_1 increased by only 9%, which could be considered a non-significant change. However, R_{aw}, G_{aw} and sG_{aw} all had a dramatic improvement following bronchodilator therapy.

Based on the results of this test, the physician was able to make a diagnosis of reversible airways obstruction and prescribe an appropriate regimen including inhaled bronchodilators and anti-inflammatory medication. A follow-up visit 3 months later revealed normal pre-bronchodilator measurements of FEV_1 (100% of predicted), R_{aw} (85% of predicted) and sG_{aw} (186% of predicted).

Acknowledgement:
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Case Studies - Bronchial Provocation In Dyspnea

The patient who seeks medical consultation because of shortness of breath, difficulty breathing, fatigue and other symptoms is usually subjected to a series of questions, a physical examination, chest x-ray, spirometry, etc. These studies when taken individually usually do not provide the answer but collectively shed light on the problem. When taking a clinical history from a patient complaining of dyspnea, we attempt to quantitate the symptoms in terms of onset, magnitude and methods of reducing the severity of the symptoms.

In the case of the patient with suspected reactive airways disease, it is frequently necessary to challenge the airway to determine the degree of reactivity. In such cases a methacholine challenge is often ordered. The symptoms of chest tightness and breathlessness, produced by the reactive airways disease and produced during testing in patients with the disease, are in part due to the hyperinflation that accompanies the bronchospasm. A positive test by traditional pulmonary function testing is regarded as a 20% change from baseline measurement of the FEV_1. In some situations, there may be no change in the FEV_1 as demonstrated in the following study.

A 19 year old female (height 5'6", weight 125 lbs) presents with symptoms of cough and breathlessness which at times is not related to specific events or activities. The following pulmonary function tests were obtained:

	SPIROMETRY		METHACHOLINE			PLETHYSMOGRAPHY VALUES			
	Acutal	%Pred	Dose (mg/ml)	% Change		Pre BRP	Post BRP	% Change	Post Bronch.
FVC	3.73	91%	0.025	0.2%	TGV	2.94	3.54	20%	2.77
FEV_1	2.92	81%	1.400	0%	RV	1.51	2.50	65%	1.56
FEV_1/FVC	88%		14.00	0.6%	sR_{aw}	7.01	9.54	36%	6.17
FEF25-75	2.59	60%	189.00	0%	sG_{aw}	0.14	0.10	-30%	0.016

The above testing reveals a significant increase in thoracic gas volume. residual volume and total capacity with methacholine challenge. Airways resistance increased and conductance decreased similarly and all values returned to baseline with the inhalation of bronchodilator therapy while the FEV_1 from spirometry did not show any signs of reduction when challenged. The patient was started on bronchodilator therapy which resulted in improvement in symptoms.

Pulmonary function tests are commonly thought to consist of spirometry which includes vital capacity, timed lung volumes and peak flows. Plethysmographic measurement of airways resistance and conductance is a more sensitive tool to determine the presence of airway disease. It can differentiate between central and peripheral disease. It can also differentiate between bronchospastic disease and emphysema as a cause of hyperinflation. Finally, R_{aw} and G_{aw} are a more sensitive test of the responsiveness of airways to inhaled bronchodilators.

Acknowledgement:
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Case Studies - Reactive Airway Disease

Pulmonary function tests (PFT) are a useful diagnostic tool to the physician. They are particularly valuable in determining obscure causes of dyspnea such as reactive airway disease (RAD) when a patient's symptoms are inconclusive (cough, wheezing or dyspnea on exertion). PFTs done in patients with RAD may be completely normal or reveal only mild abnormality, depending on the severity of the case. A definitive diagnosis is often difficult to make solely on the baseline PFT. Therefore, a bronchial provocation test is often ordered to confirm the diagnosis of RAD.

Performance of the bronchial provocation test involves administration of the bronchoreactive agent methacholine. Patients with RAD demonstrate bronchoconstriction with this agent. In recent months, we have been assessing the effect of this agent by measuring airway resistance (R_{aw}) and specific conductance (sG_{aw}) in the body plethysmograph, in addition to the traditional spirometric variables (FVC, FEV_1, FEV_1/FVC). The present case highlights the usefulness of bronchial provocation testing using plethysmography as opposed to spirometry alone to diagnose RAD.

The patient is a non-smoking 44 year old female with no history of allergy or pulmonary problems prior to a January 1993 on the job exposure to alkaline paint fumes. She became dizzy, short of breath, and complained of non-productive cough and chest pain. She was taken to the emergency room, where she was treated and released approximately six hours post admission. The patient experienced continuing dyspnea and cough over the next six months. A pulmonary function study was ordered to establish the etiology of her symptoms. Pulmonary function tests done in July 1993 revealed mild obstructive pulmonary disease with no significant improvement after bronchodilator administration (using current ATS/ERS criteria) as seen in Table 1.

Table 1

	Actual	% Pred	Post BD	% Change
FVC	3.74	120%	3.89	4%
FEV_1	2.86	105%	3.09	8%
FEF25-75	2.33	76%	3.00	29%
PEF	6.00	99%	5.72	-5%

In the last two years the patient has been treated with bronchodilator inhalers, Azmacort and prednisone for her continuing exertional dyspnea, chronic cough and wheezing. There has been no significant improvement with this regimen. She has been unable to work since the inhalation injury and was sent to a pulmonary specialist for further evaluation of her symptoms.

Pulmonary function studies were ordered to determine if there had been deterioration of the lung function since the previous study. Results of this study were essentially the same, revealing mild obstructive pulmonary disease with no significant improvement after bronchodilator (Table 2). A bronchial provocation study was then ordered to further investigate the underlying cause for her symptoms.

Table 2

	Actual	% Pred	Post BD	% Change
FVC	3.60	114%	3.55	-1%
FEV_1	2.66	101%	2.86	7%
FEF25-75	2.06	66%	2.77	34%
PEF	6.02	106%	6.42	7%

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Spirometry results from the bronchial provocation test were considered non-reactive. The FEV_1 at maximum dose (125 dose units) dropped 15%. However, airways resistance results were markedly positive (Table 3). R_{aw} at maximum dose increased 203% and specific conductance decreased 76%. This strongly indicated reactive airway disease.

Table 3

	BD	After Max Dose	% Change	Post BD
FVC	3.38	3.14	-7	3.18
FEV_1	2.55	2.18	-15	2.39
R_{aw}	1.26	3.82	203	-
sG_{aw}	0.21	0.05	-76	-

DISCUSSION: The usefulness of body plethysmography has been known for its role in the diagnosis of emphysema with air trapping. More recently, however, body plethysmography has been increasingly used in bronchial provocation testing. By using plethysmography as well as spirometry in the testing process, a positive test result may be detected based on an increased R_{aw} of 35-40% and a decreased sG_{aw} of 35-40% before a decrease of 20% is noted in the FEV_1 as seen in this case. In using both testing methods, a positive test result may be detected on the basis of the plethysmography values where spirometry alone would not indicate reactive airways.

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