Flow-volume loops: clinical correlation

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Flow volume loops are an essential part of spirometry testing. Their appearance can give information that can be helpful in the differential diagnosis of a patient's clinical condition. We present two clinical scenarios in which careful evaluation of the flow-volume loop gives an insight into the cause of the disease process.

Key Words: Flow volume loop, Pulmonary function test, Spirometry.

Case Report 1

A 51 year-old man was referred due to increasing shortness of breath. He described his symptoms as "asthma like" with exertional dyspnea, wheezes and frequent cough. He denied any systemic illnesses. He denied cough, hoarseness or stridor, hemoptysis or chest pain. He never smoked nor was he exposed to neither dust nor fumes at work. He worked as a salesman and had visited the Dominican Republic several times as part of his job. His symptoms had progressed gradually, for which he was evaluated by his primary physician who prescribed inhaled bronchodilators and steroids. No improvement was noted and chest film did not reveal any parenchymal lesion.

Pulmonary function test, sputum for AFB, and cytology were ordered. Flow-volume loop showed a flattening of the inspiratory and expiratory phase compatible with a fixed extrathoracic obstruction.

A bronchoscopy was performed. Whitish verrucous lesions were seen with decreased abduction of the vocal cords. No endobronchial lesions or masses were visualized in the rest of the tracheobronchial tree.

Sputum smears, as well as brushings from cord lesions were positive for numerous acid fast bacilli. A diagnosis of laryngeal tuberculosis was established and the patient was treated with four antituberculous drugs for 6 months. The symptoms -cough and hoarseness- resolved with antituberculous treatment.

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Pulmonary function tests were repeated after treatment was completed (Table 1).

Comparing with the initial test, a repeated flow-volume loop showed normalization of the curve.

Table 1. Pulmonary function tests (Case 1)

	Previous	Actual	%Change	% Pred
FVC	4.04L	4.57L	+13%	106
FEV1	2.48L	3.61L	+45%	103
FEV1/FVC	61.37%	78.8%	+28%	
PEFR	2.95L/s	8.21L/s	+178%	97

Case Report 2

A 75 year-old man with history of arterial hypertension, diabetes mellitus, and congestive heart failure was consulted to our service due to hoarseness and shortness of breath. Five months prior to this evaluation he was admitted due to a complicated myocardial infarction with decompensated heart failure that required intubation and mechanical ventilation for two weeks.

Upon examination, he was in mild distress, had inspiratory and expiratory stridor, with a pulse oximetry showing an oxygen saturation of 92% at room air. There was no jugular venous distension and no crackles or S3 gallop.

The patient was given inhaled bronchodilators with improvement. Pulmonary function test were done (Table 2).

Pulmonary function test showed mild hyperinflation, and severe air trapping. The findings were compatible with obstruction to airflow.

Flow-volume loop showed a limited flow during both inspiration and expiration with flattening of both inspiratory and expiratory components, suggesting a fixed airway obstruction.

With these findings, a tracheal stenosis due to prolonged intubation was suspected, and ENT was consulted.

An indirect laryngoscopy was done, showing severe subglottic stenosis 1.5 cm below the vocal cords.

Table 2. Pulmonary function tests (Case 2)

	Actual	Pred	% Pred
Spirometry			
FVC (L)	2.42	2.02	120
FEV1 (L)	1.47	1.57	94
FEV1/FVC	61	74	
FEF Max (L/sec)	2.56	5.64	45
Lung Volumes			
SVC (L)	2.20	2.88	77
IC (L)	1.84	2.25	82
ERV (L)	0.37	0.63	58
RV (L)	3.61	1.82	198
TLC (L)	5.81	4.70	124
RV/TLC (%)	62	37	

An uneventful tracheostomy was performed and the patient was discharged home two days later. He was recently seen at our clinics being in good health.

Discussion

These two cases althought due to different etiologies, illustrate how flow-volume loops findings can give insight into the clinical entities that may affect a patient.

Flow-volume loops have been used for the detection of respiratory disorders of both the lung (intrathoracic) and the upper airway or extra-thoracic airway (trachea to mouth) (1-2).

The flow-volume loop is generated by continuously recording flow and volume with an electronic spirometer during a forced inspiratory and expiratory vital capacity maneuver. The shape of the loop reflects the status of the lung volumes and airways throughout the respiratory cycle. The loop is especially helpful in detecting laryngeal and tracheal lesions. It can distinguished between fixed obstruction (e.g. tracheal stenosis) and variable obstruction (e.g. tracheomalacia, vocal cord paralysis) of the upper airway. (3-5)

With an extrathoracic obstruction, such as vocal cord paralysis or vocal cord tumors, airflow is more selectively limited during inspiration than expiration (Figure 1). When a single vocal cord is paralyzed, it moves passively in accordance with pressure gradients across the glottis. During a forced inspiration, it is drawn inward, resulting in a plateau of decreased inspiratory flow. The mid-inspiratory flow rate is markedly reduced from normal, whereas expiratory flow is minimally affected.

With an intrathoracic obstruction, such as a tracheal tumor above the carina, airway dynamics selectively potentiate airway compression during the expiratory phase. (Figure 1) During a forced inspiration; negative pleural pressure holds the “floppy” trachea open. With forced expiration, the loss of structural support results in narrowing of the trachea and a plateau of diminished flow (a brief period of maintained flow) is seen before airway compression occurs.

In the two cases presented, the flow-volume loop further added to a widened differential diagnosis as the culprit of the patient’s symptoms. These findings, together with a good clinical history, may help the clinician find the true answer to a patient’s disease process, and, hence, an appropriate treatment.

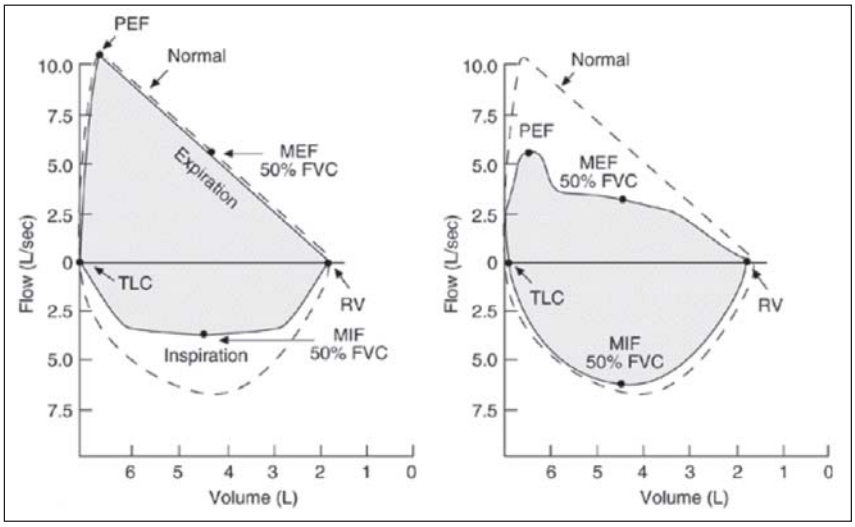

Figure 1. Airflow during inspiration and expiration

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