Dynamic Spirometry

By

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Objectives

At the end of this session, students should be able to:

1. Perform a dynamic spirometry test on a fellow student.
2. Describe the two graphs recorded by dynamic spirometry, namely: flow-volume loop (FVL) and the volume-time curve (forced expiratory curve "FEV_1" curve forced expiratory curve (FEV1 curve).
3. Analyze the components of each graph; FVL and FEV1 and describe their normal appearance.

5. Calculate the forced expiratory volume in the first second (FEV1) and forced vital capacity (FVC) and the FEV1/FVC ratio from the FEV1 curve.

6. Calculate the FVC, peak expiratory flow rate (PEFR), peak inspiratory flow rate (PIFR) and maximal expiratory flow rate at 50% of the forced vital capacity (MEF50).

7. Analyze the components of each graph in both obstructive and restrictive lung diseases

8. Differentiate between both obstructive and restrictive lung diseases

Dynamic Spirometry

Spirometry

- It is the most basic and frequently performed test of pulmonary (lung) function.
- It is concerned with the measurement of flow and volume of air entering and leaving the lungs.

Dynamic?

- Performed at forcible and max effort against **time**
- Measures the **rate** at which the lung changes volume during forced breathing.

Forced vital capacity

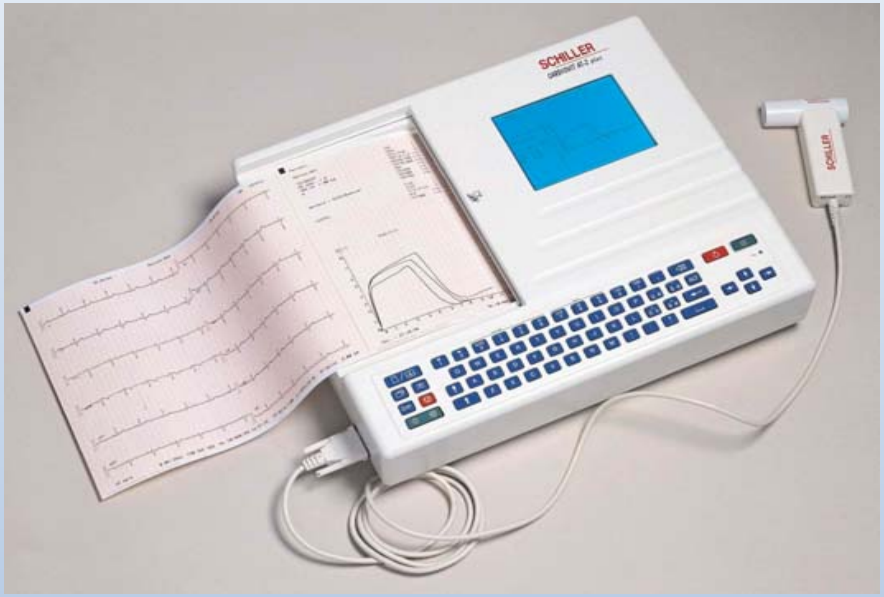
The max volume of air that can be forcibly and rapidly exhaled following a max inspiration.

Equipment

1. Dynamic spirometer

2. Nose clip.

3. Disposable mouth piece.

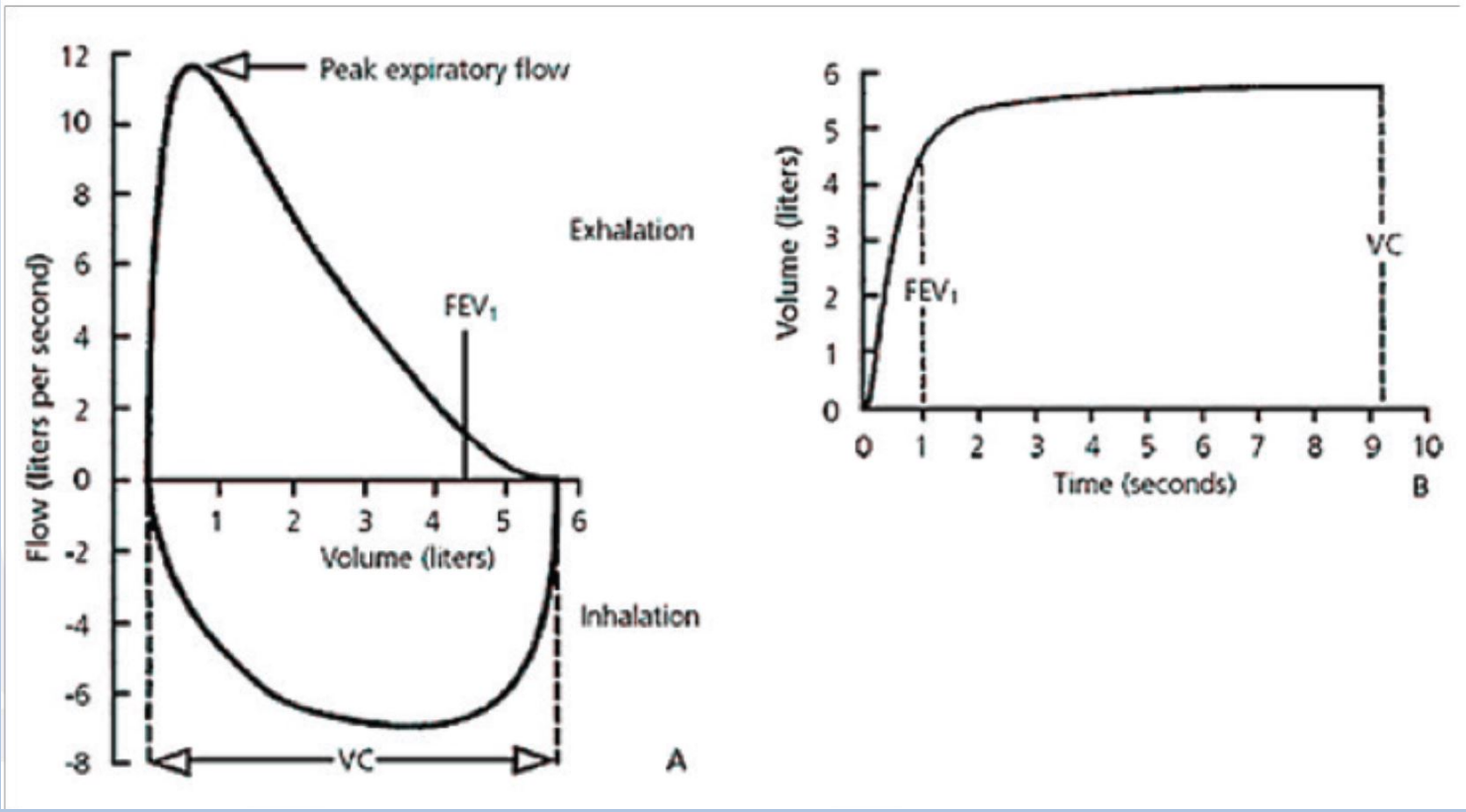


Dynamic Spirometer

Procedure

1. Insert a new disposable mouthpiece into the flow sensor (SP-250).
2. Hold the sensor in an upright position.
3. Insert the mouthpiece in the oral cavity (mouth) and seal the lips tightly around the mouthpiece.
4. Place the nose clip on the subject's nose to avoid air escaping through nostrils.
5. While subject is standing, allow him/her to breathe normally through mouthpiece, approximately 3 normal breaths to record TV.
6. Then ask the subject to inhale as deep as possible and then follow it with a fast and forceful exhalation. The exhalation should be as fast and forceful as possible.
7. Two types of graphs may be recorded.

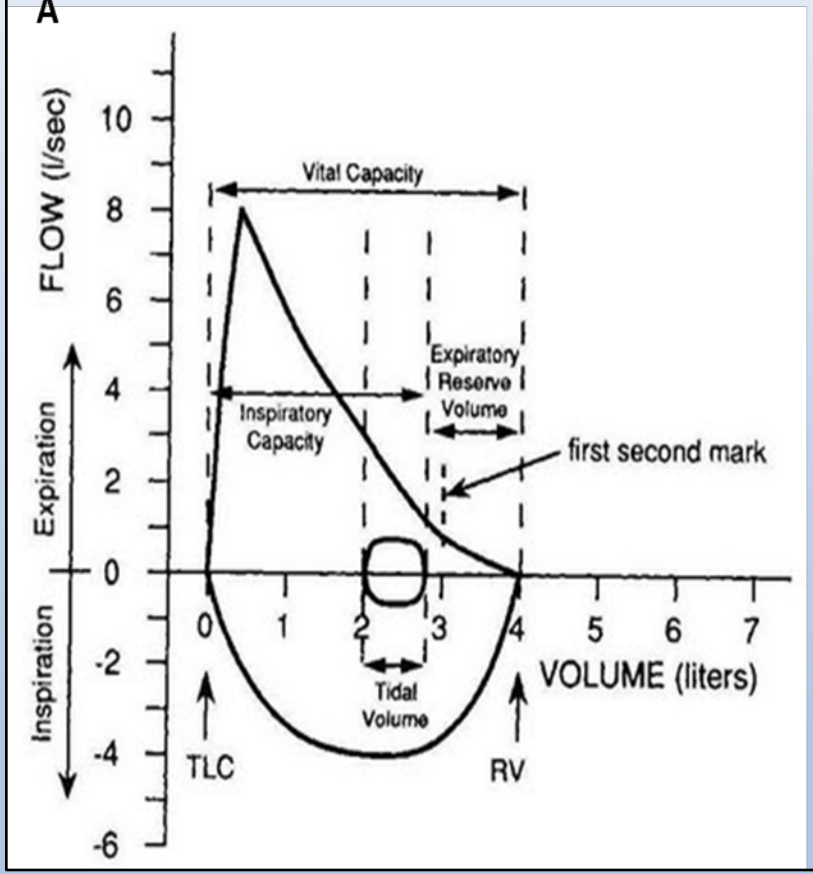
Two types of curves can be obtained



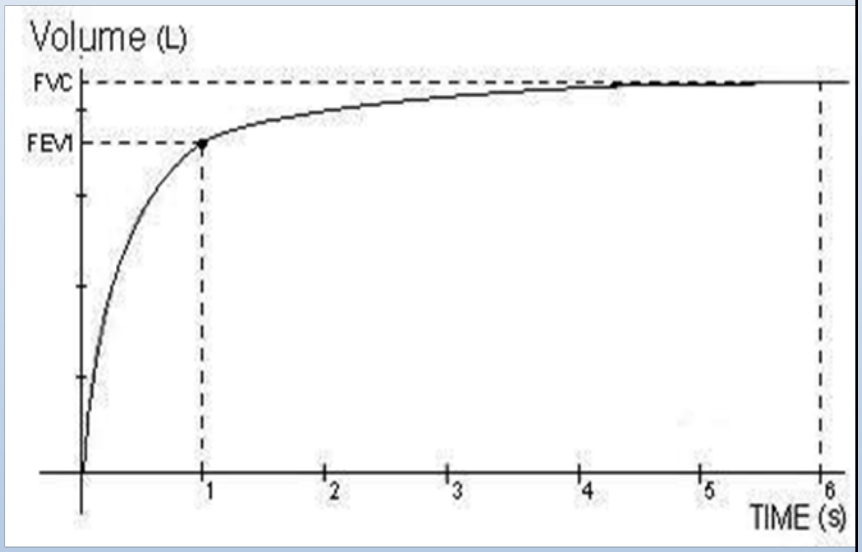
A Flow Volume curve

B Forced expiratory volume curve (FEV)

A


FLOW (l/sec)
10
8
6
4
2
0
-2
-4
-6
Expiration
Inspiration
Vital Capacity
Inspiratory Capacity
Expiratory Reserve Volume
first second mark
Tidal Volume
TLC
RV
0
1
2
3
4
5
6
7
VOLUME (liters)

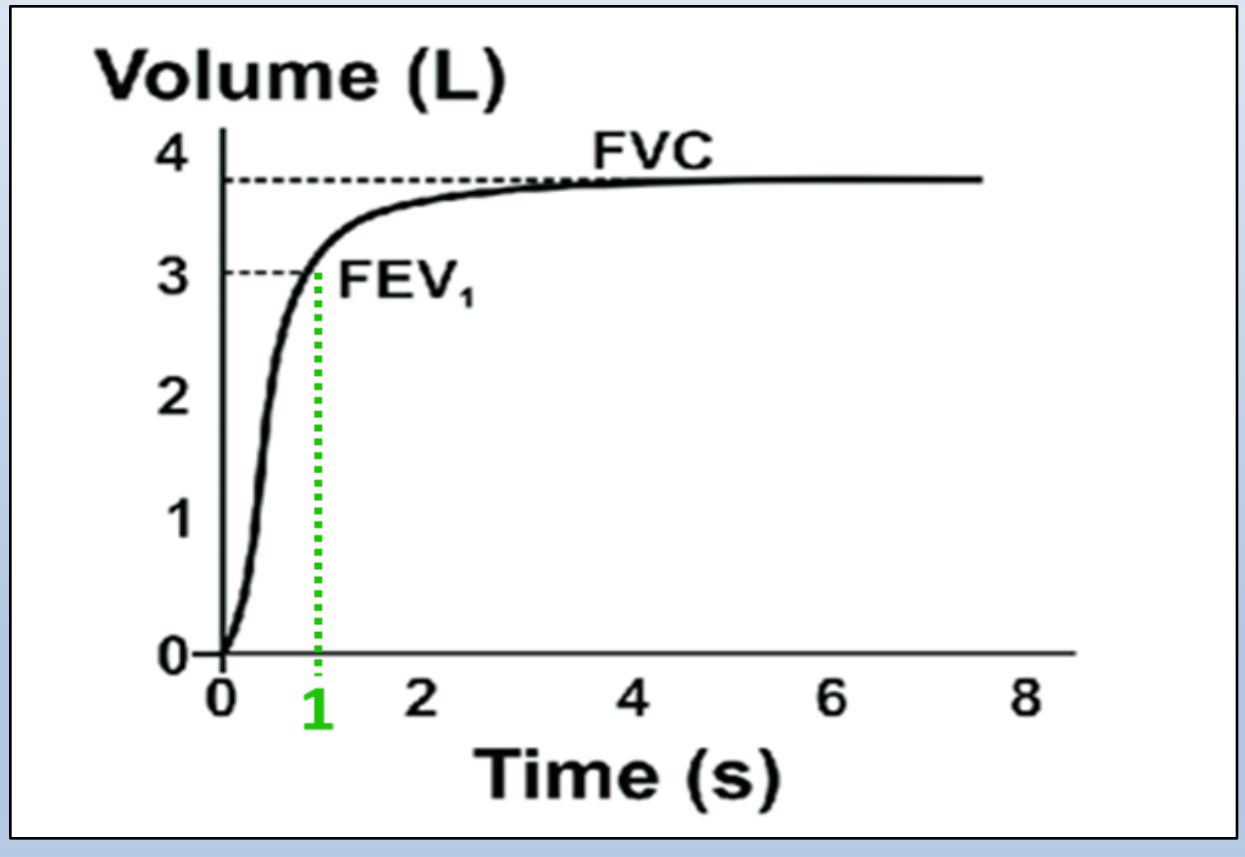
B


Volume (L)
FVC
FEV1
1
2
3
4
5
6
TIME (s)

Forced Expiratory Curve

- The subject takes a maximal inspiration and then exhales as rapidly, as forcibly,& as maximally as possible.
- A plot of volume against time.

A normal volume-time graph (FEV_1 curve).



FEV1

Volume of air expelled in the 1st sec of forced expiration starting from full inspiration

Plateau: FVC

FEV1 % or ratio

(FEV1/FVC) * 100

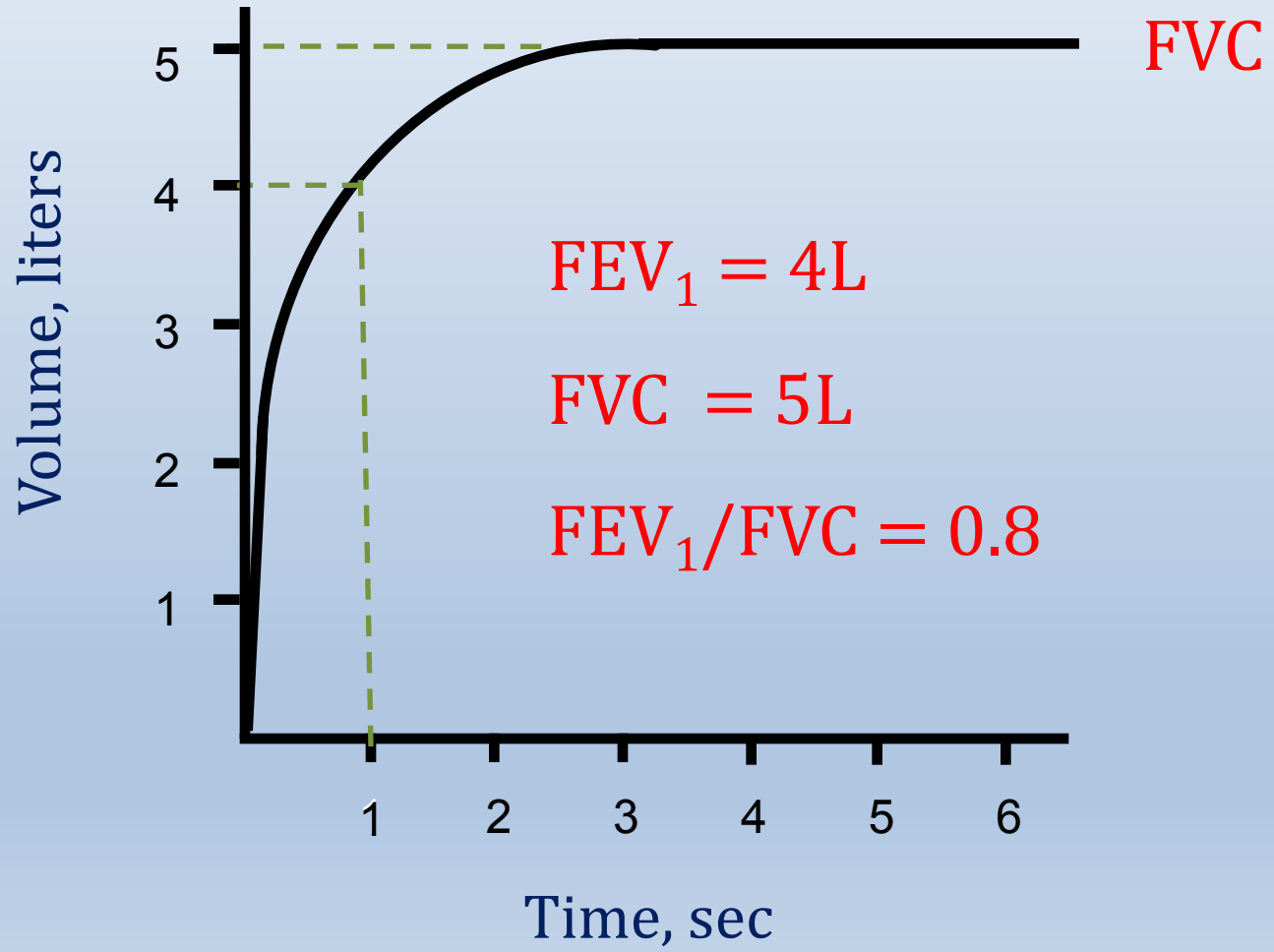
Fraction of the VC expired during the 1st sec of a forced expiration (NL 70%-80%)

- FEV1 is a useful measure of how quickly the lungs can be emptied.
- The ratio is a useful index of airflow limitation.

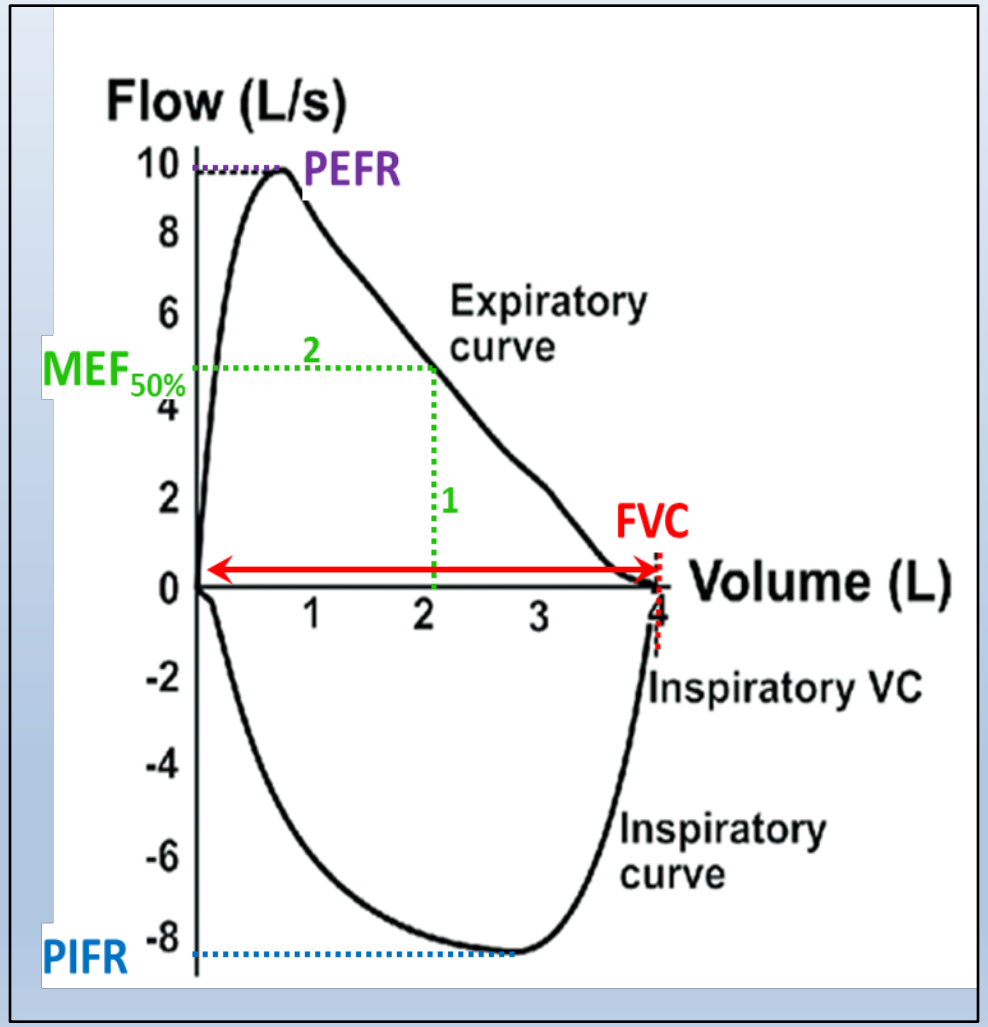
Normal FEV1 values (% predicted).

Parameter	Normal value (ATS/ERS)
FEV_1	≥ 70% (% predicted FEV1)
FVC	≥ 70% (% predicted FVC)
FEV_1/FVC ratio	≥ 70% (0.7)

ATS=American Thoracic Society,
ERS=European Respiratory Society

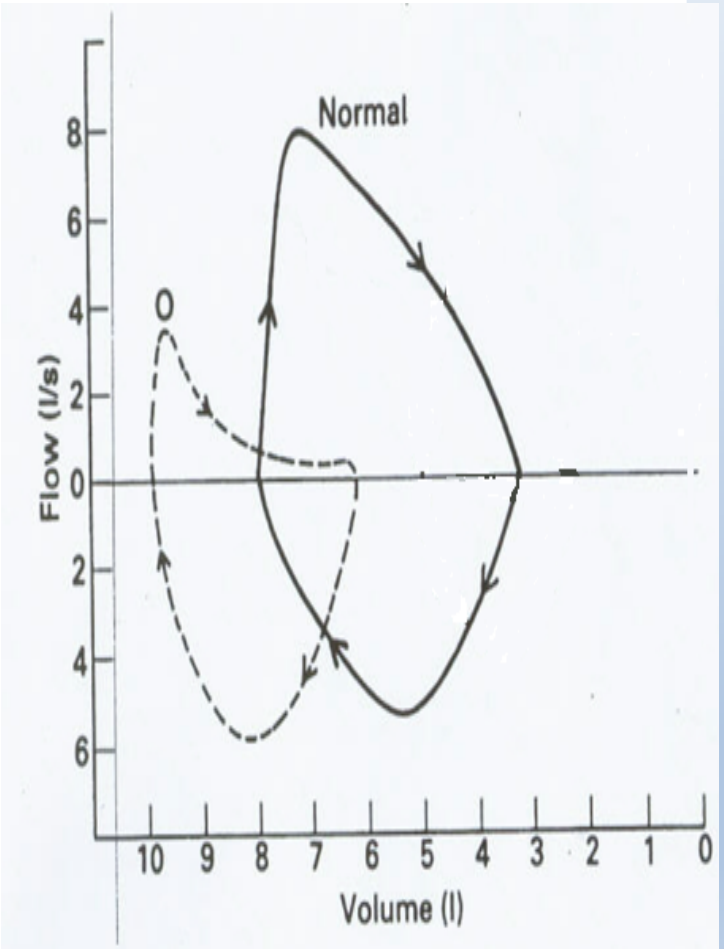

FVC
5
4
3
2
1
Volume, liters
$FEV_1 = 4L$
$FVC = 5L$
$FEV_1/FVC = 0.8$
1
2
3
4
5
6
Time, sec

A normal flow-volume loop.



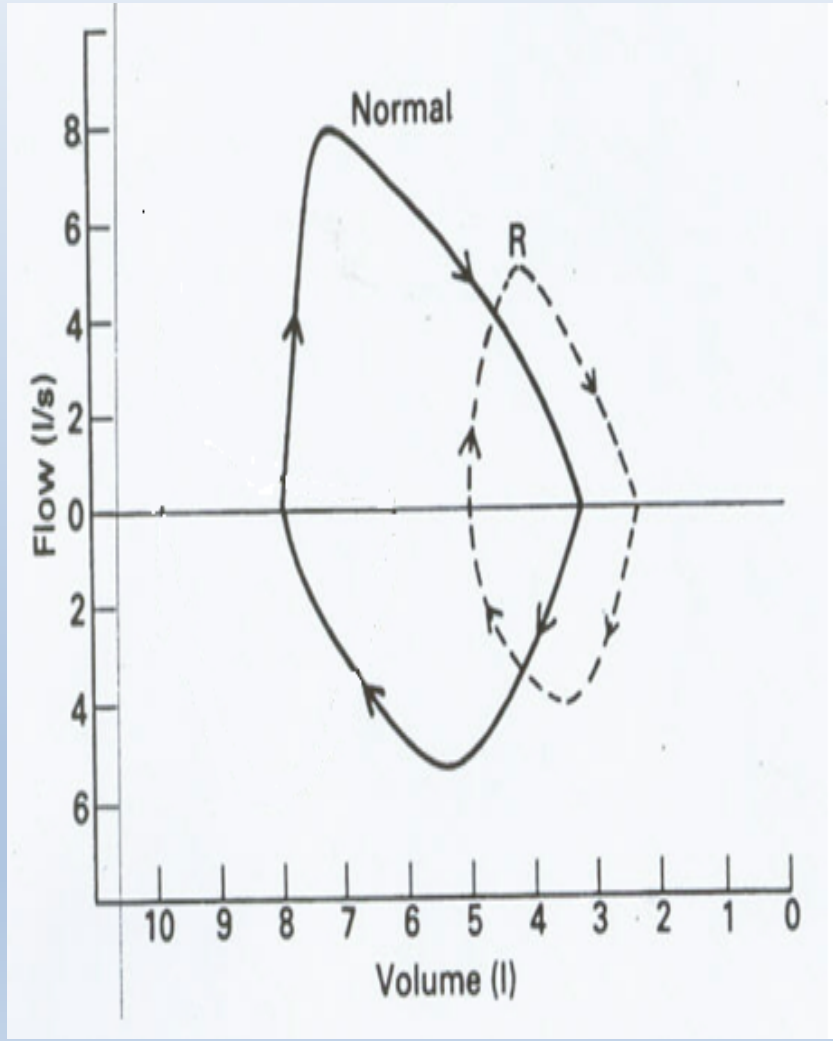
Obstructive pulmonary diseases

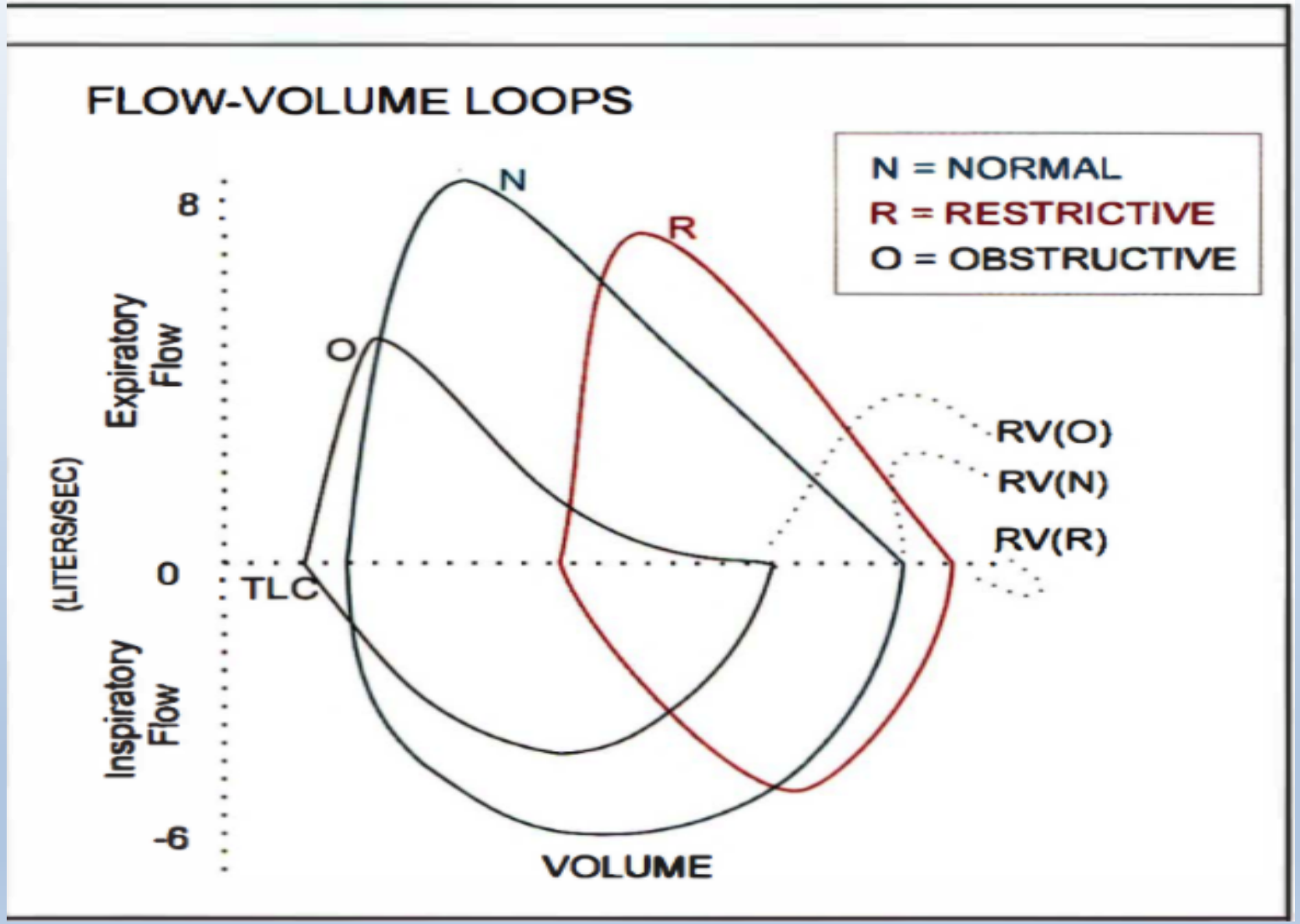
- MEF50↓
- Effort independent part of curve: concave (Curvilinear)
- PEFR normal or ↓ in severe cases
- Inspiratory loop Normal



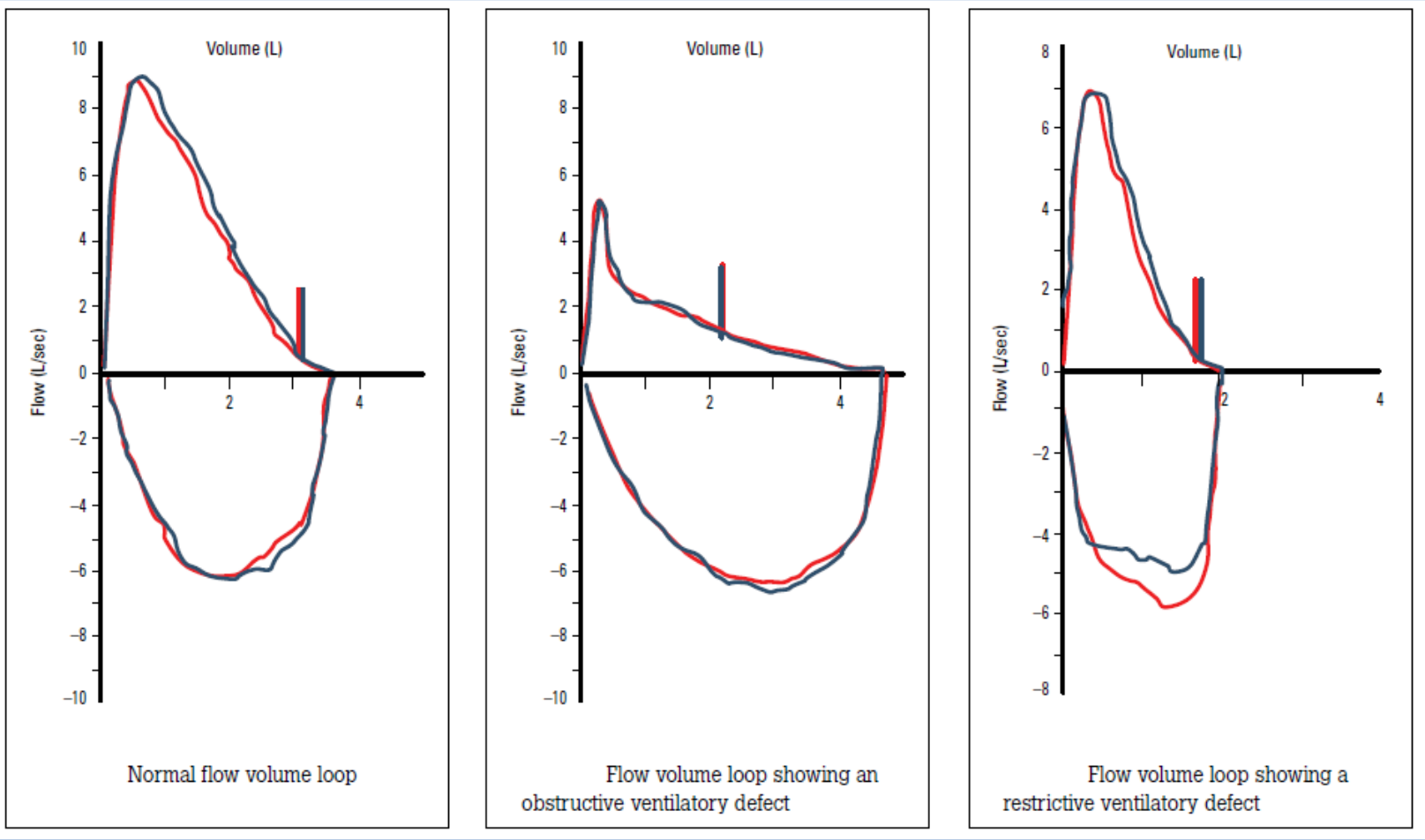
Restrictive pulmonary disease

- Miniature loop (elliptical)
- All flow parameters ↓

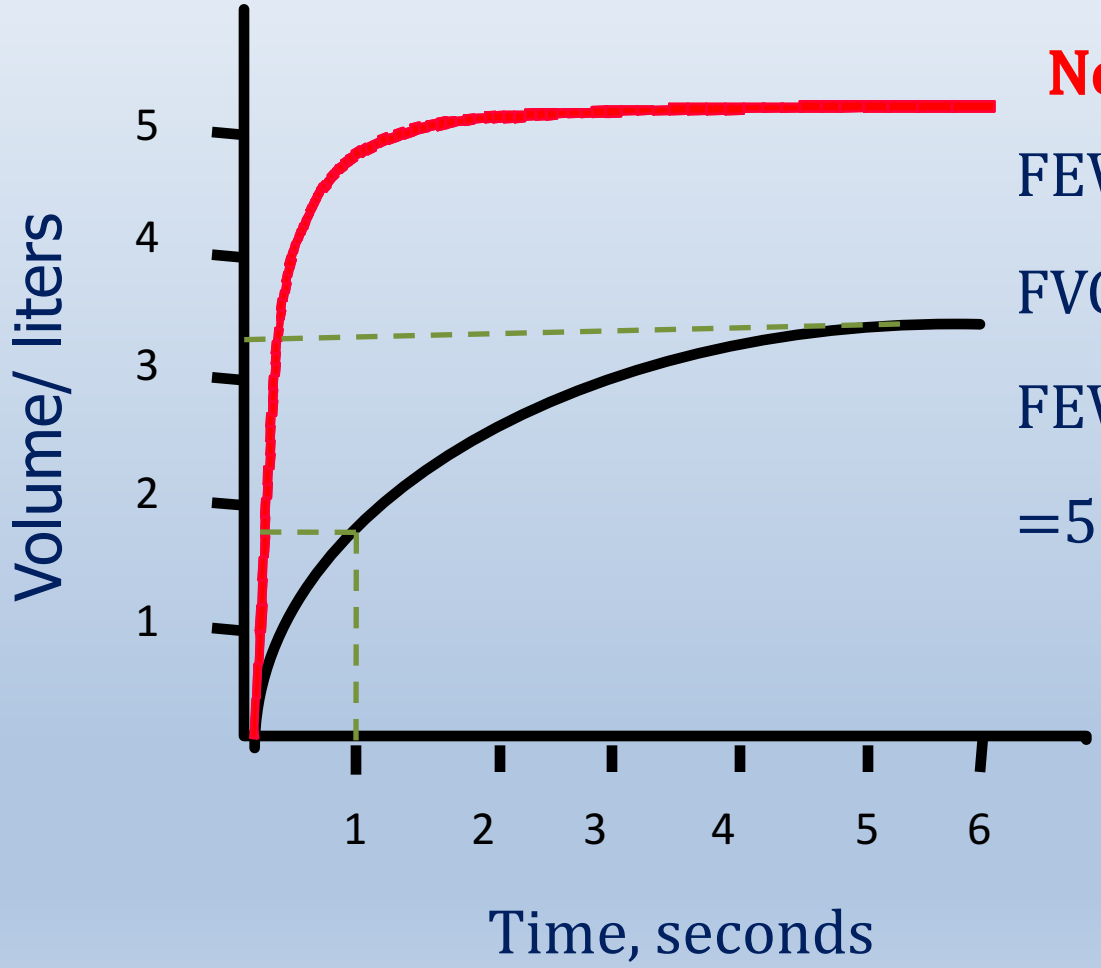



FLOW-VOLUME LOOPS
N = NORMAL
R = RESTRICTIVE
O = OBSTRUCTIVE
8
0
-6
(LITERS/SEC)
Expiratory Flow
Inspiratory Flow
N
R
O
TLC
RV(O)
RV(N)
RV(R)
VOLUME

Differences between Obstructive and Restrictive Airway Diseases



Obstructive Disease



Normal

$FEV_1 = 1.8L$

$FVC = 3.2L$

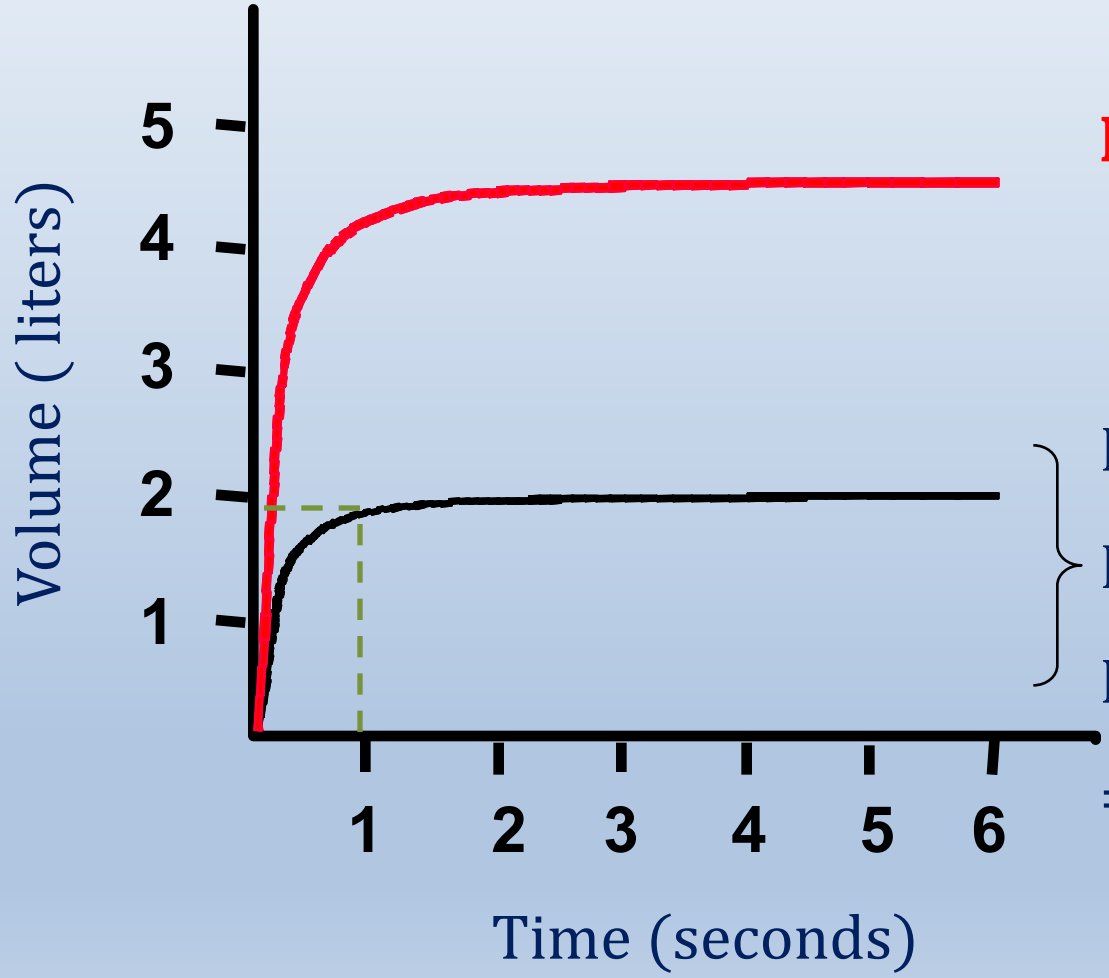
$FEV_1/FVC = 0.56$

$=56\%$

Prolonged Expiration

Obstructive

Restrictive Disease



Normal

$FEV_1 = 1.9L$

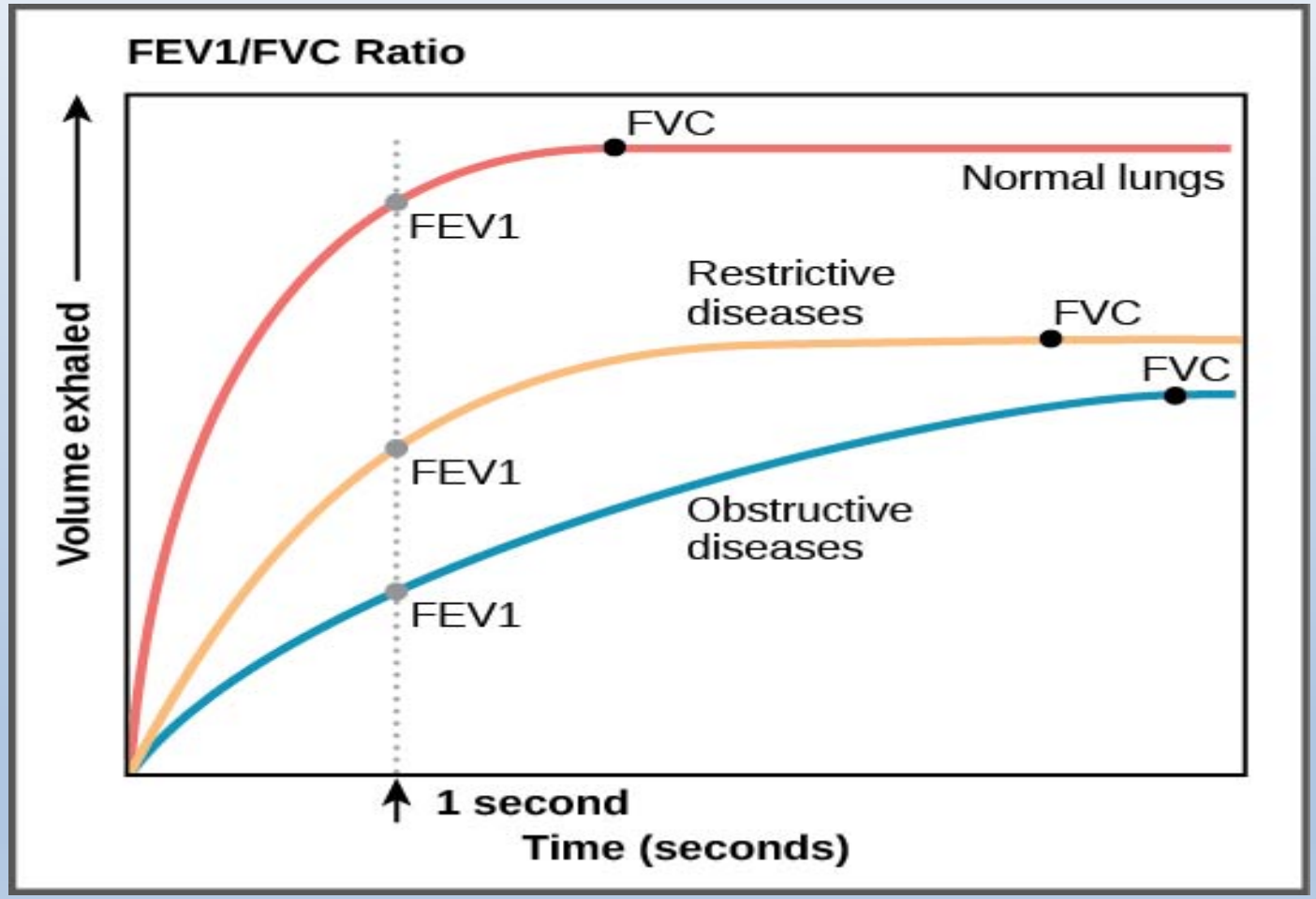
$FVC = 2.0L$

$FEV_1/FVC = 0.95$

$= 95\%$

Restrictive

- The normal and restrictive expire fully in 2 sec.
- The obstructive needs more than 2 sec, the curve rises slowly to reach its highest point.
- It may need more than 6 sec.
- It can or not get rid of all VC depending on the severity of the disease.


FEV1/FVC Ratio
Volume exhaled
FVC
Normal lungs
FEV1
Restrictive
diseases
FVC
FVC
FEV1
Obstructive
diseases
FEV1
1 second
Time (seconds)

Differences between Obstructive and Restrictive Airway Diseases

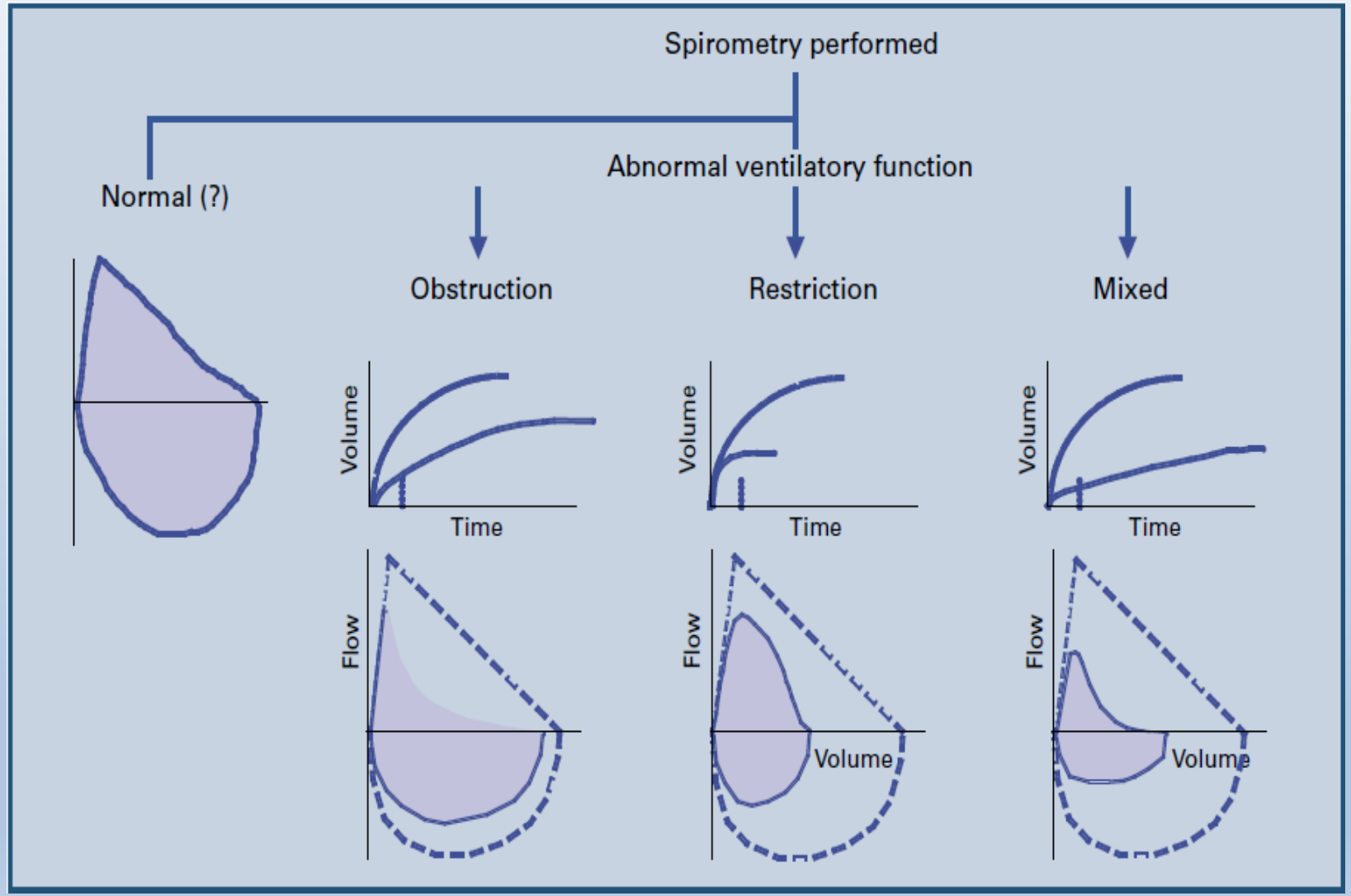
	Obstructive pattern	Restrictive pattern	Mixed pattern
FEV_1	↓↓↓	Normal or ↓	↓↓
FVC	Normal or ↓	↓↓↓	↓↓
FEV_1/FVC (FEV_1 %)	< 0.7 (70%)	Normal or > 0.7 (70%)	variable

Dynamic Spirometry was done on 3 patients, the results were the following:

A. FEV1= 4L , FVC=5L
FEV1/FVC=80%

B. FEV1=1.2L , FVC=3L
FEV1/FVC=40%

C. FEV1= 2.7 L, FVC=3L
FEV1/FVC= 90%


Spirometry performed
Normal (?)
Abnormal ventilatory function
Obstruction
Restriction
Mixed
Volume
Time
Flow
Volume

THANK YOU