CHAPTER I

폐기능 검사

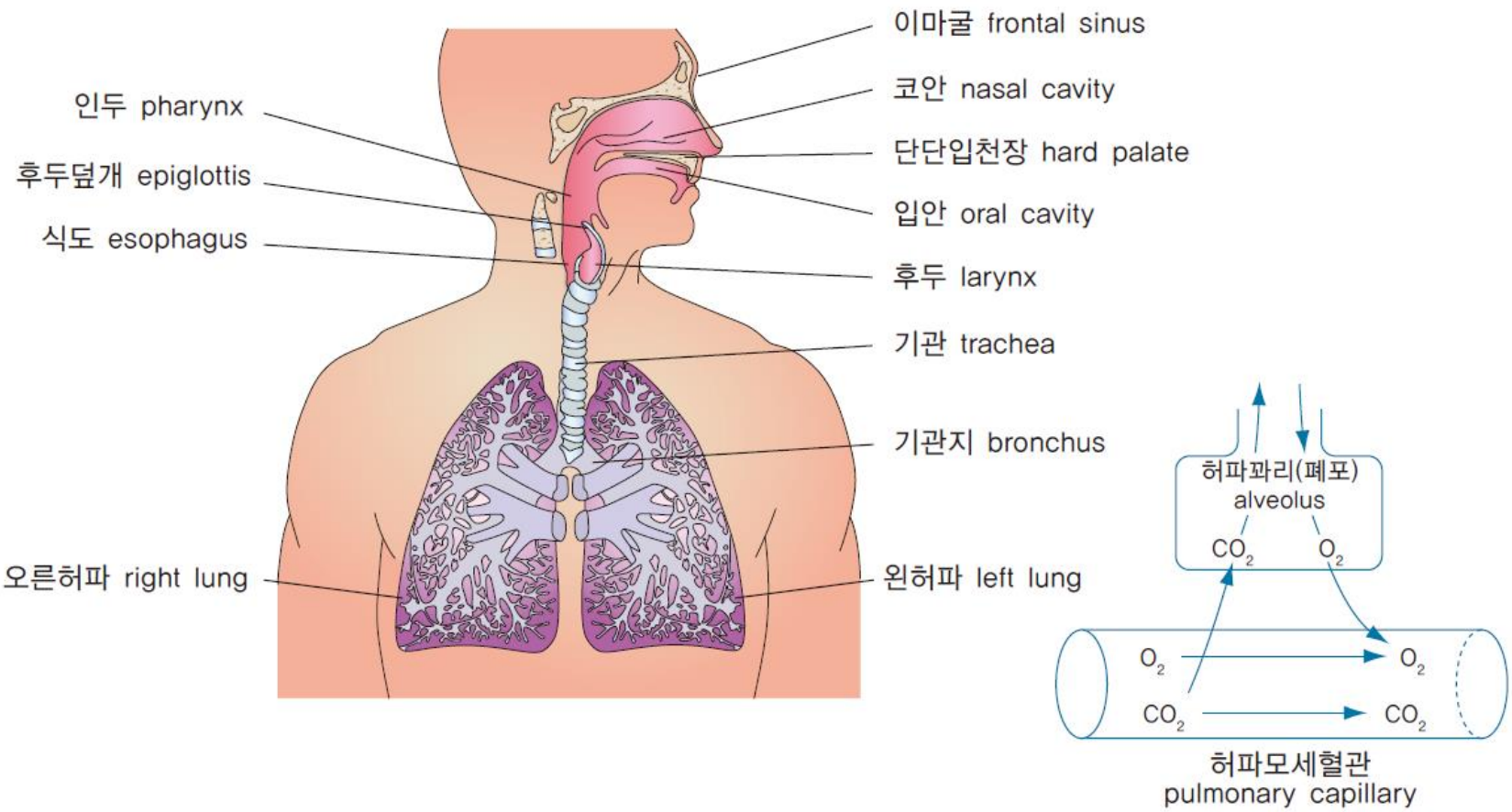
Pulmonary Funtion Test

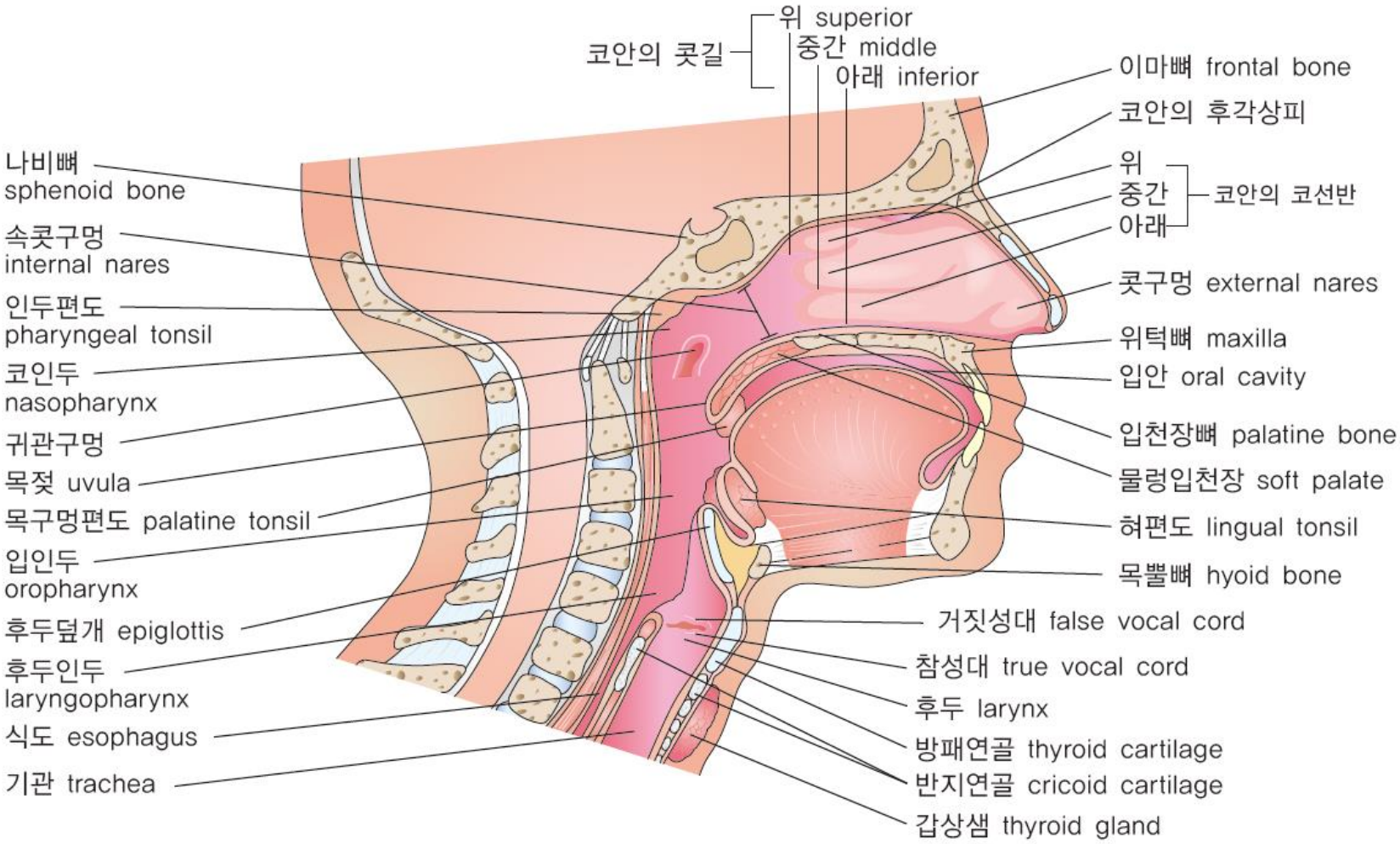
Section 01

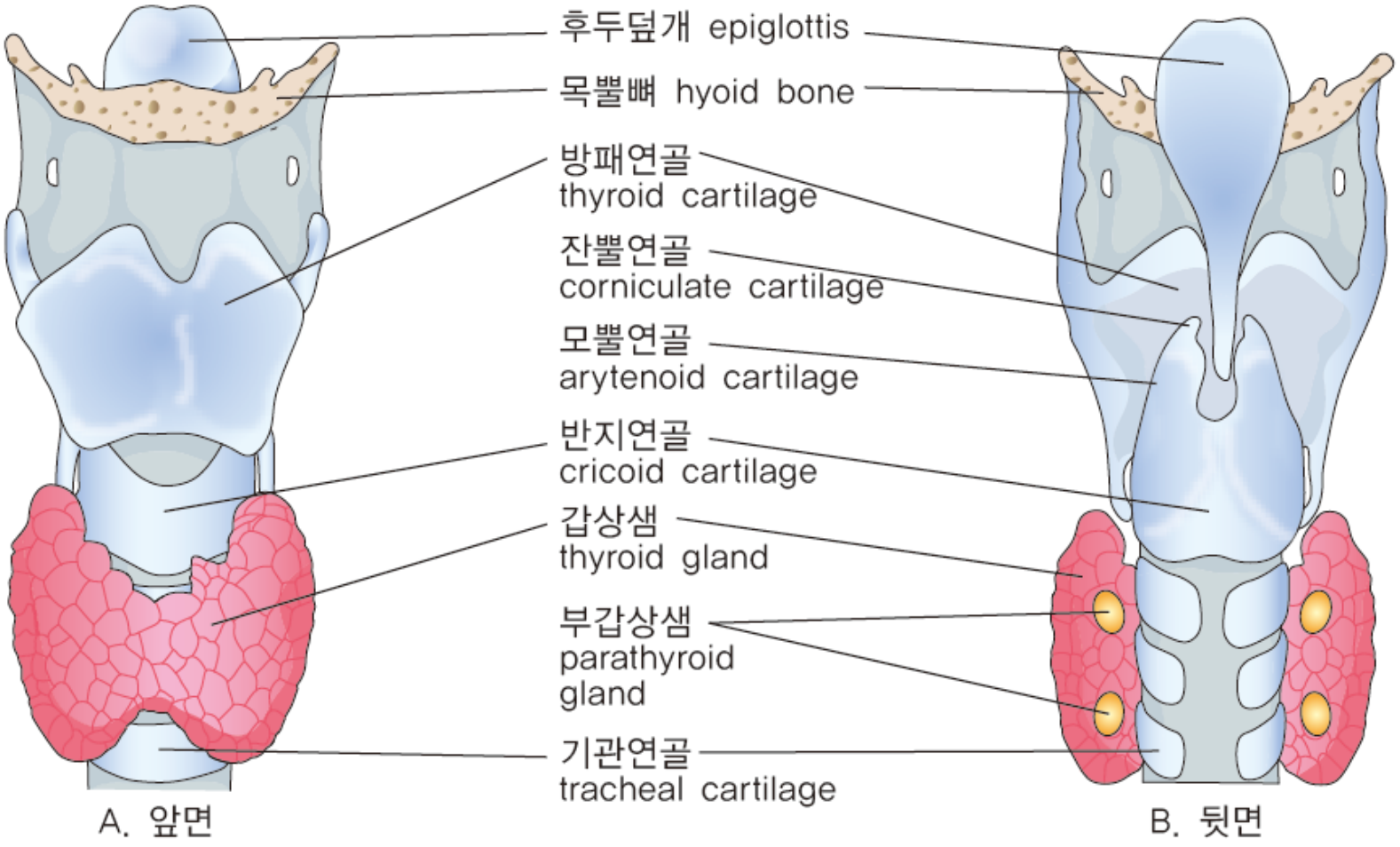
폐기능검사를 위한 해부생리

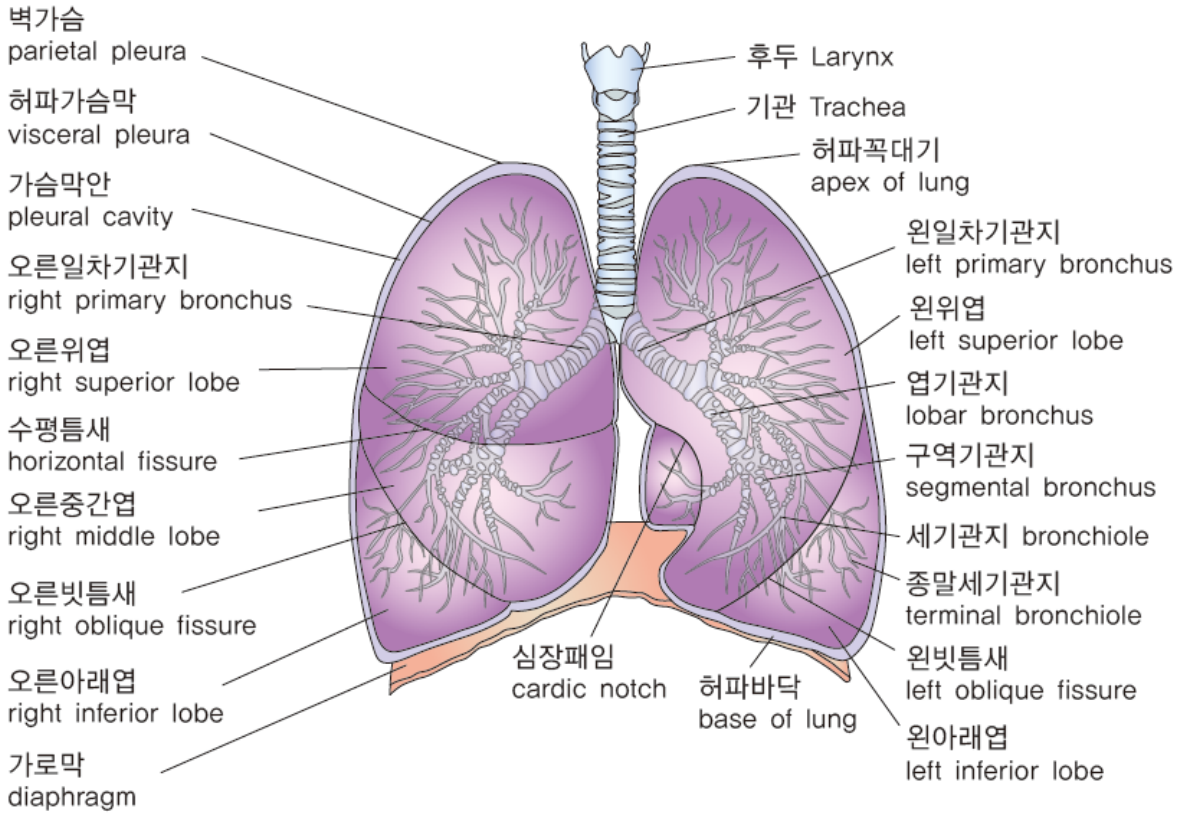
학습목표

1. 호흡기계의 구조를 설명할 수 있다(B).
2. 호흡기계의 생리를 설명할 수 있다(B).

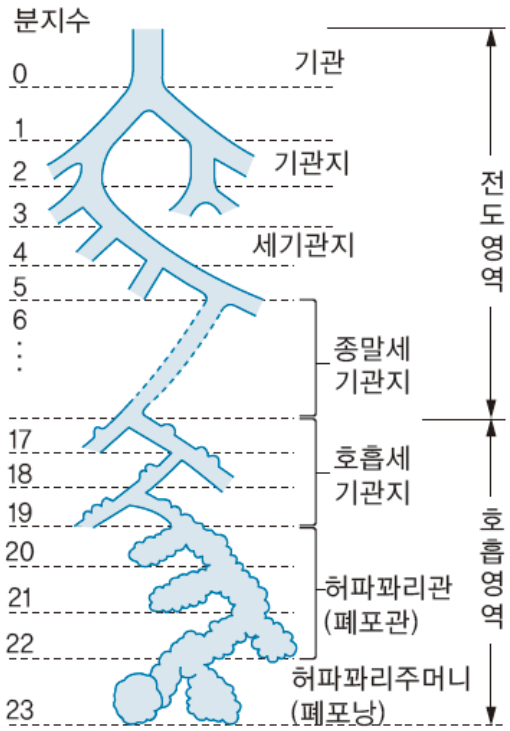

이마굴 frontal sinus
코안 nasal cavity
단단입천장 hard palate
입안 oral cavity
후두 larynx
기관 trachea
기관지 bronchus
왼허파 left lung
인두 pharynx
후두덮개 epiglottis
식도 esophagus
오른허파 right lung
허파꽈리(폐포)
alveolus
CO_2
O_2
O_2
O_2
CO_2
CO_2
허파모세혈관
pulmonary capillary


위 superior
코안의 콧길
중간 middle
아래 inferior
이마뼈 frontal bone
코안의 후각상피
위
중간
아래
코안의 코선반
나비뼈
sphenoid bone
속콧구멍
internal nares
콧구멍 external nares
인두편도
pharyngeal tonsil
위턱뼈 maxilla
코인두
nasopharynx
입안 oral cavity
입천장뼈 palatine bone
귀관구멍
물렁입천장 soft palate
목젖 uvula
목구멍편도 palatine tonsil
혀편도 lingual tonsil
입인두
oropharynx
목뿔뼈 hyoid bone
후두덮개 epiglottis
거짓성대 false vocal cord
후두인두
laryngopharynx
참성대 true vocal cord
후두 larynx
식도 esophagus
방패연골 thyroid cartilage
기관 trachea
반지연골 cricoid cartilage
갑상샘 thyroid gland

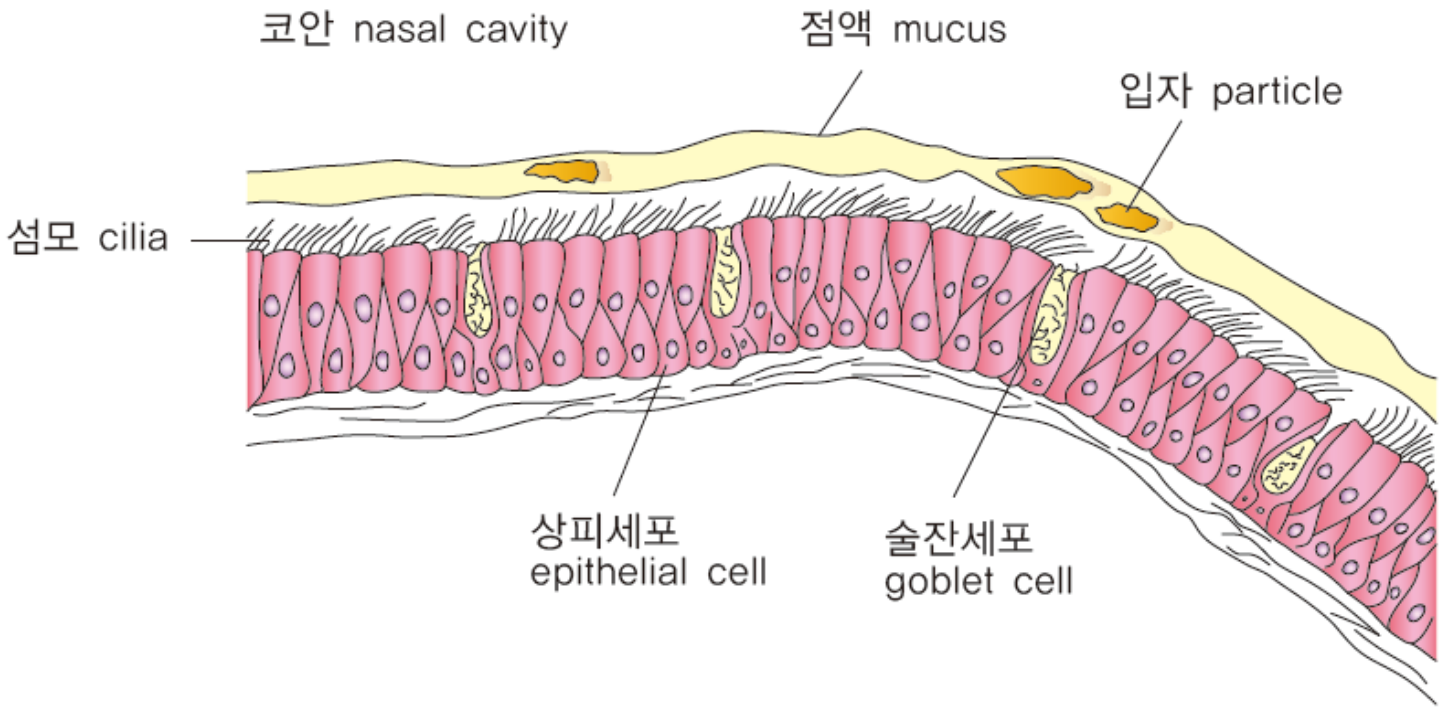

후두덮개 epiglottis
목뿔뼈 hyoid bone
방패연골
thyroid cartilage
잔뿔연골
corniculate cartilage
모뿔연골
arytenoid cartilage
반지연골
cricoid cartilage
갑상샘
thyroid gland
부갑상샘
parathyroid
gland
기관연골
tracheal cartilage
A. 앞면
B. 뒷면



A. 기관과 기관지



B. 기도의 분지


코안 nasal cavity
점액 mucus
입자 particle
섬모 cilia
상피세포
epithelial cell
술잔세포
goblet cell

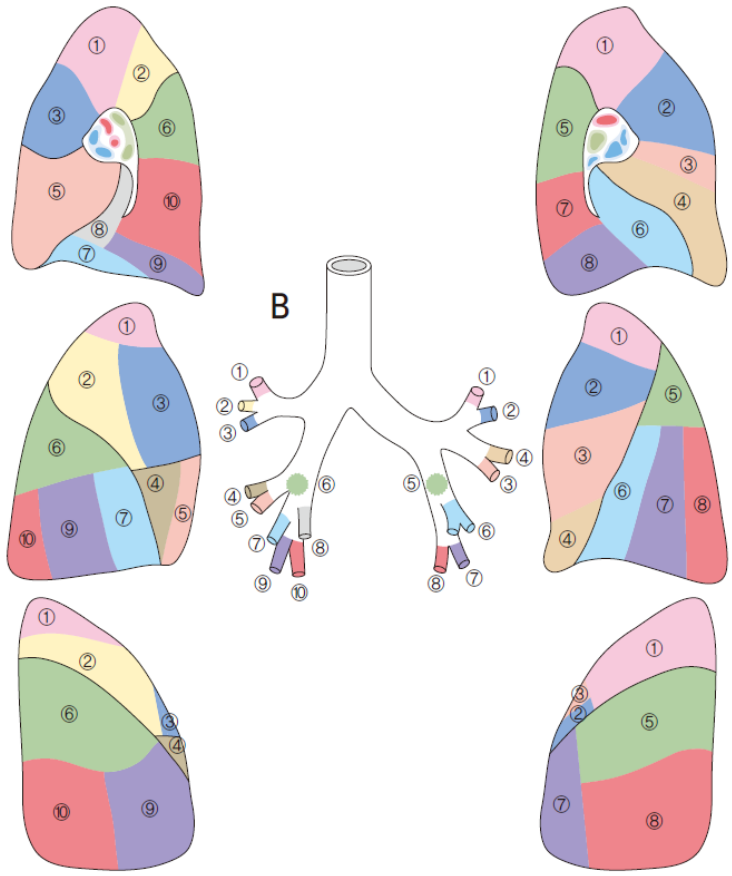
A

오른허파 (right lung)

위엽 superior lobe
① 꼭대기구역
apical segment
② 뒤구역
posterior segment
③ 앞구역
anterior segment

중간엽 middle lobe
④ 가쪽구역
lateral segment
⑤ 안쪽구역
medial segment

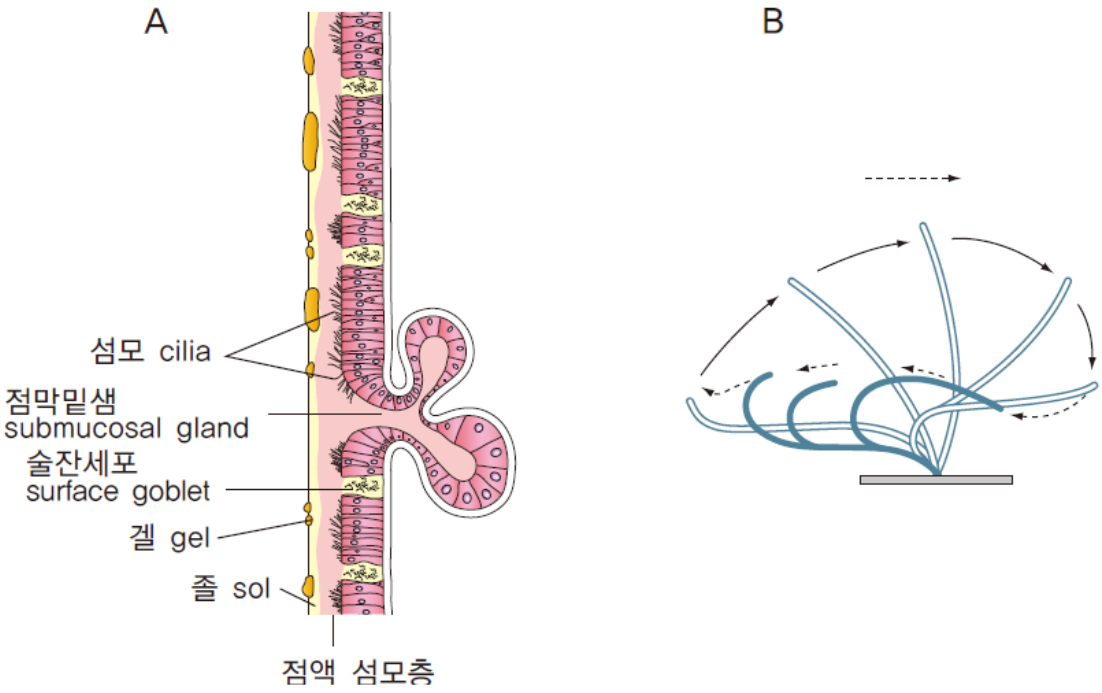
아래엽 inferior lobe
⑥ 위구역
superior segment
⑦ 앞바닥구역
anterior basal segment
⑧ 안쪽바닥구역
medial basal segment
⑨ 가쪽바닥구역
lateral basal segment
⑩ 뒤바닥구역
posterior basal segment

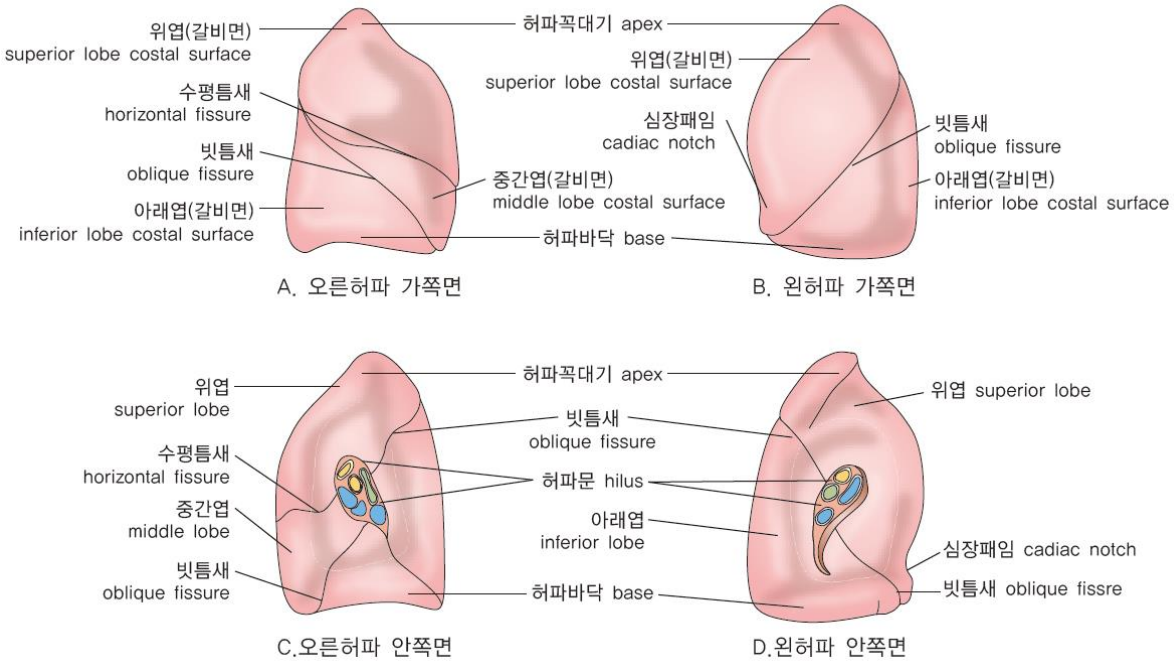


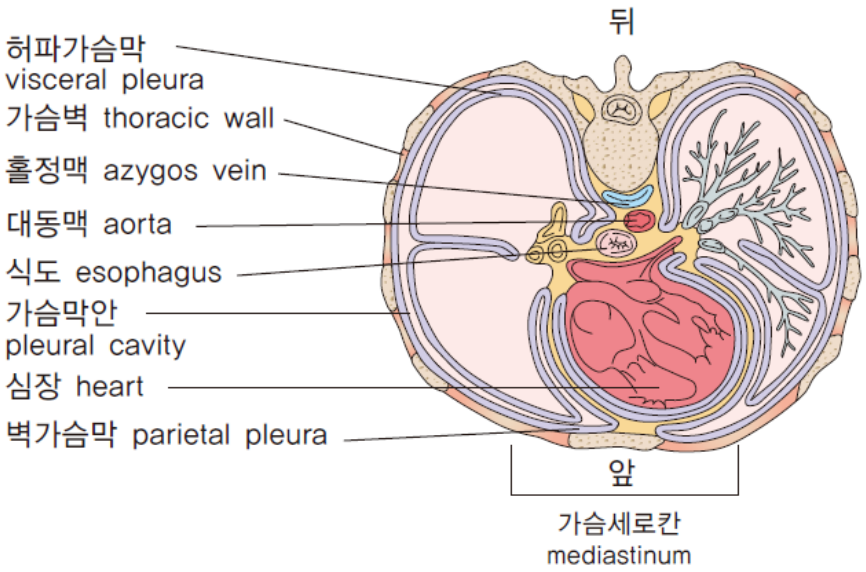
왼허파 (left lung)

위엽 superior lobe
① 꼭대기뒤구역
apicoposterior segment
② 앞구역
anterior segment
③ 위혀구역
superior lingular segment
④ 아래혀구역
inferior lingular segment

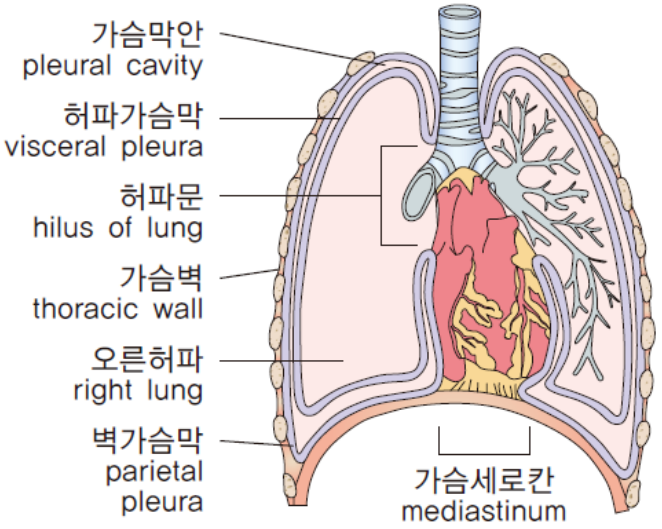
아래엽 inferior lobe
⑤ 위구역
superior segment
⑥ 앞안쪽바닥구역
anteromedial basal segment
⑦ 가쪽바닥구역
lateral basal segment
⑧ 뒤바닥구역
posterior basal segment


A
B
섬모 cilia
점막밑샘
submucosal gland
술잔세포
surface goblet
겔 gel
졸 sol
점액 섬모층

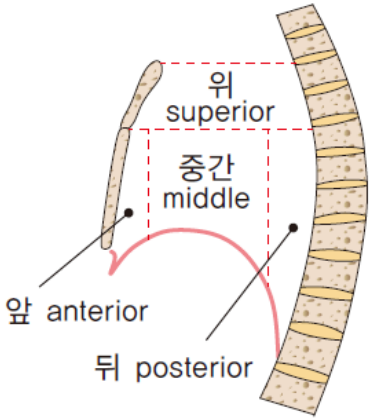

위엽(갈비면)
superior lobe costal surface
수평틈새
horizontal fissure
빗틈새
oblique fissure
아래엽(갈비면)
inferior lobe costal surface
허파꼭대기 apex
중간엽(갈비면)
middle lobe costal surface
허파바닥 base
A. 오른허파 가쪽면
허파꼭대기 apex
위엽(갈비면)
superior lobe costal surface
심장패임
cadiac notch
빗틈새
oblique fissure
아래엽(갈비면)
inferior lobe costal surface
B. 왼허파 가쪽면
위엽
superior lobe
수평틈새
horizontal fissure
중간엽
middle lobe
빗틈새
oblique fissure
허파꼭대기 apex
빗틈새
oblique fissure
허파문 hilus
아래엽
inferior lobe
허파바닥 base
C.오른허파 안쪽면
위엽 superior lobe
심장패임 cadiac notch
빗틈새 oblique fissre
D.왼허파 안쪽면



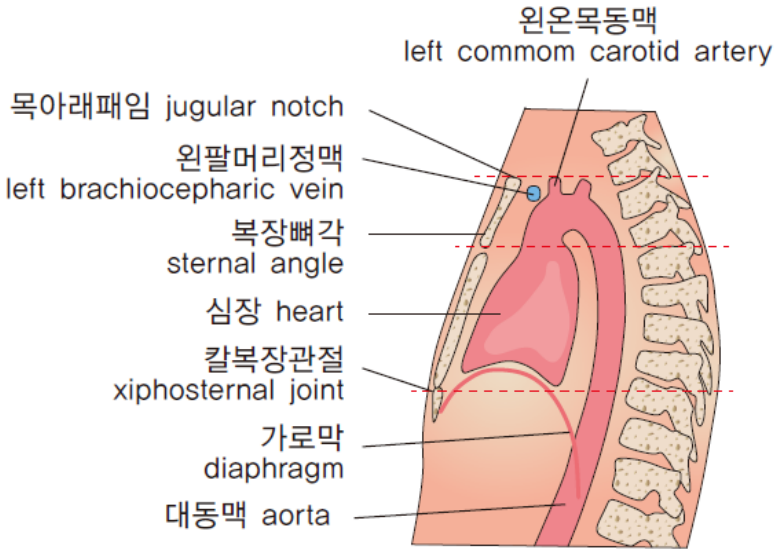
A. 절단면

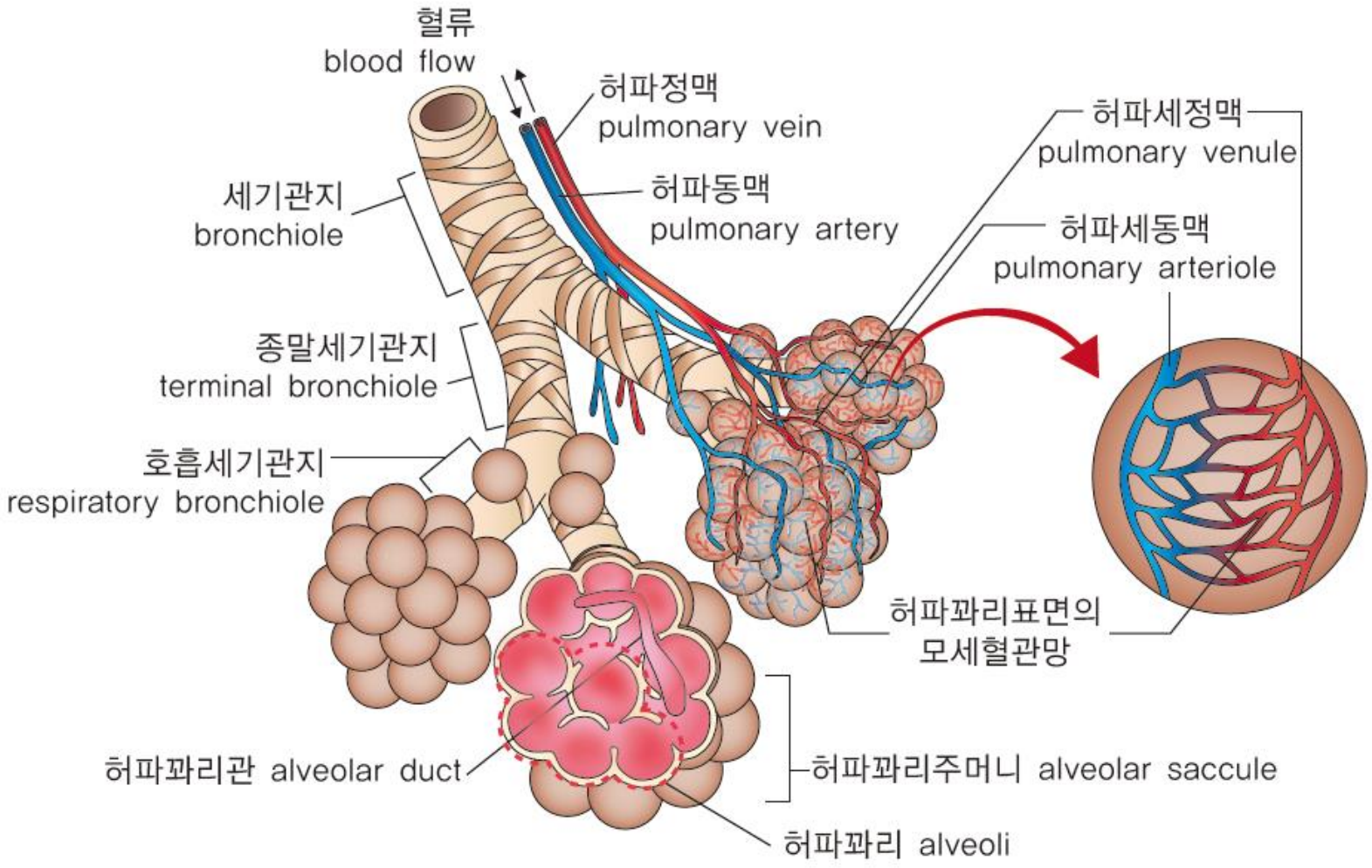


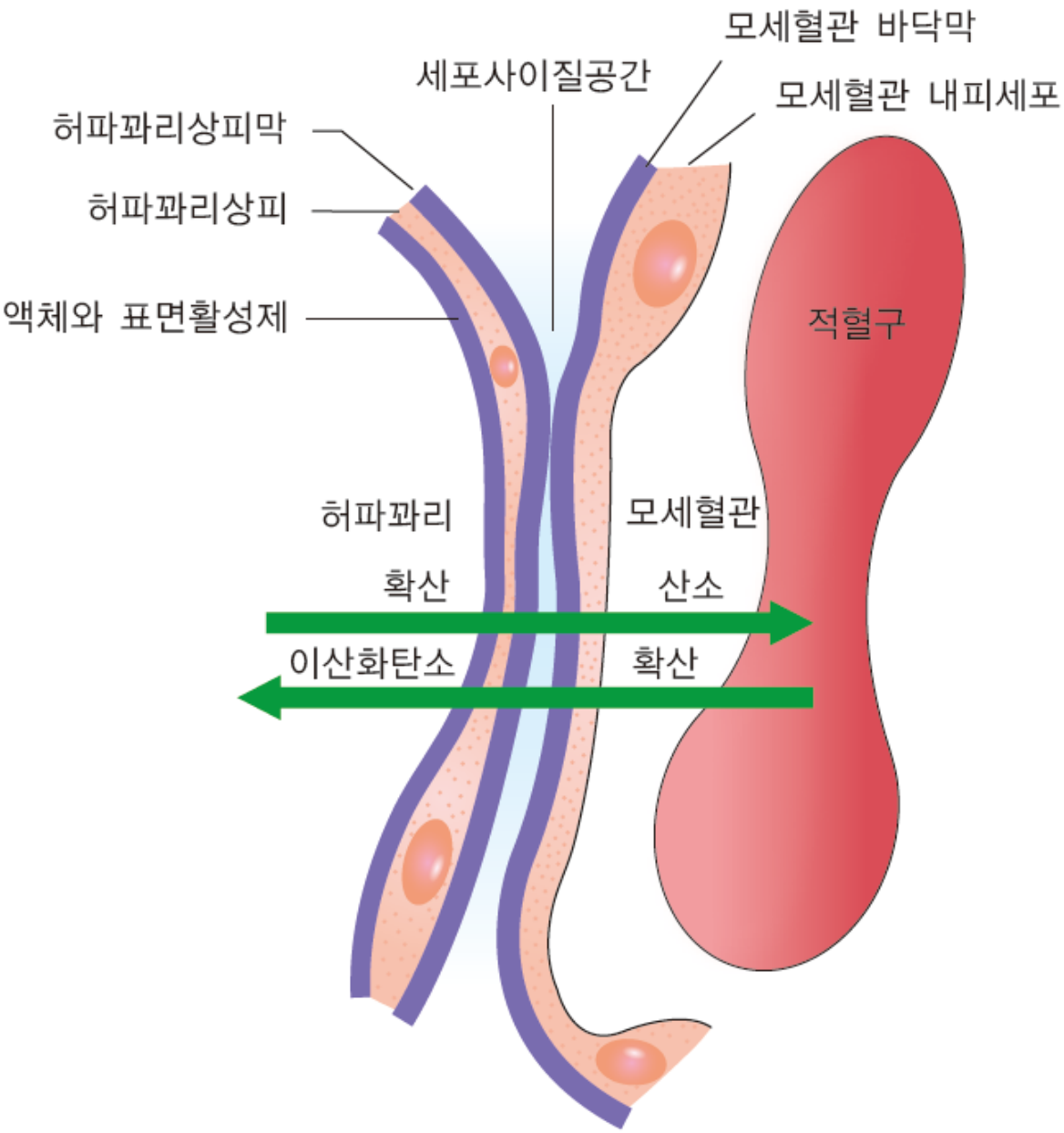
B. 앞면

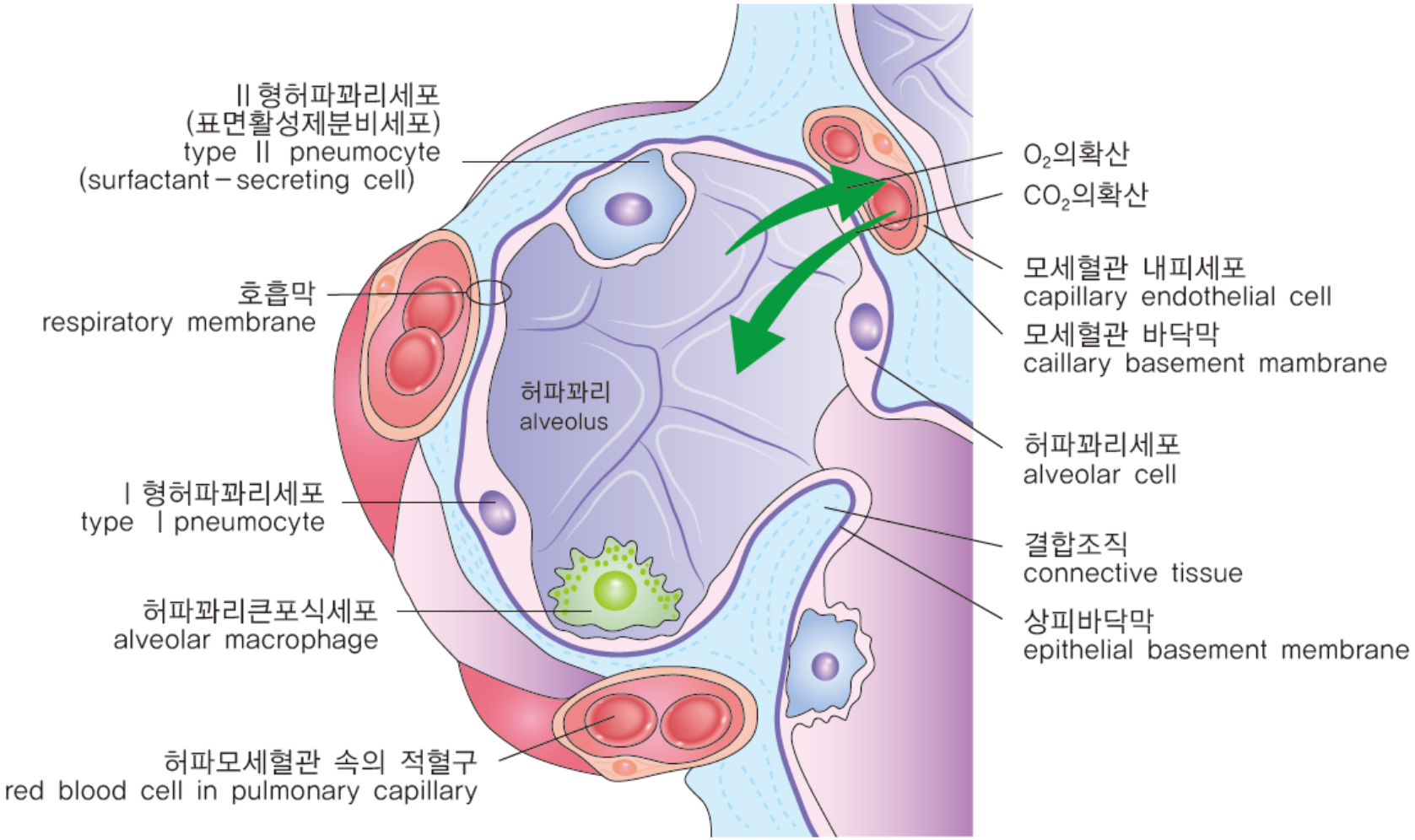


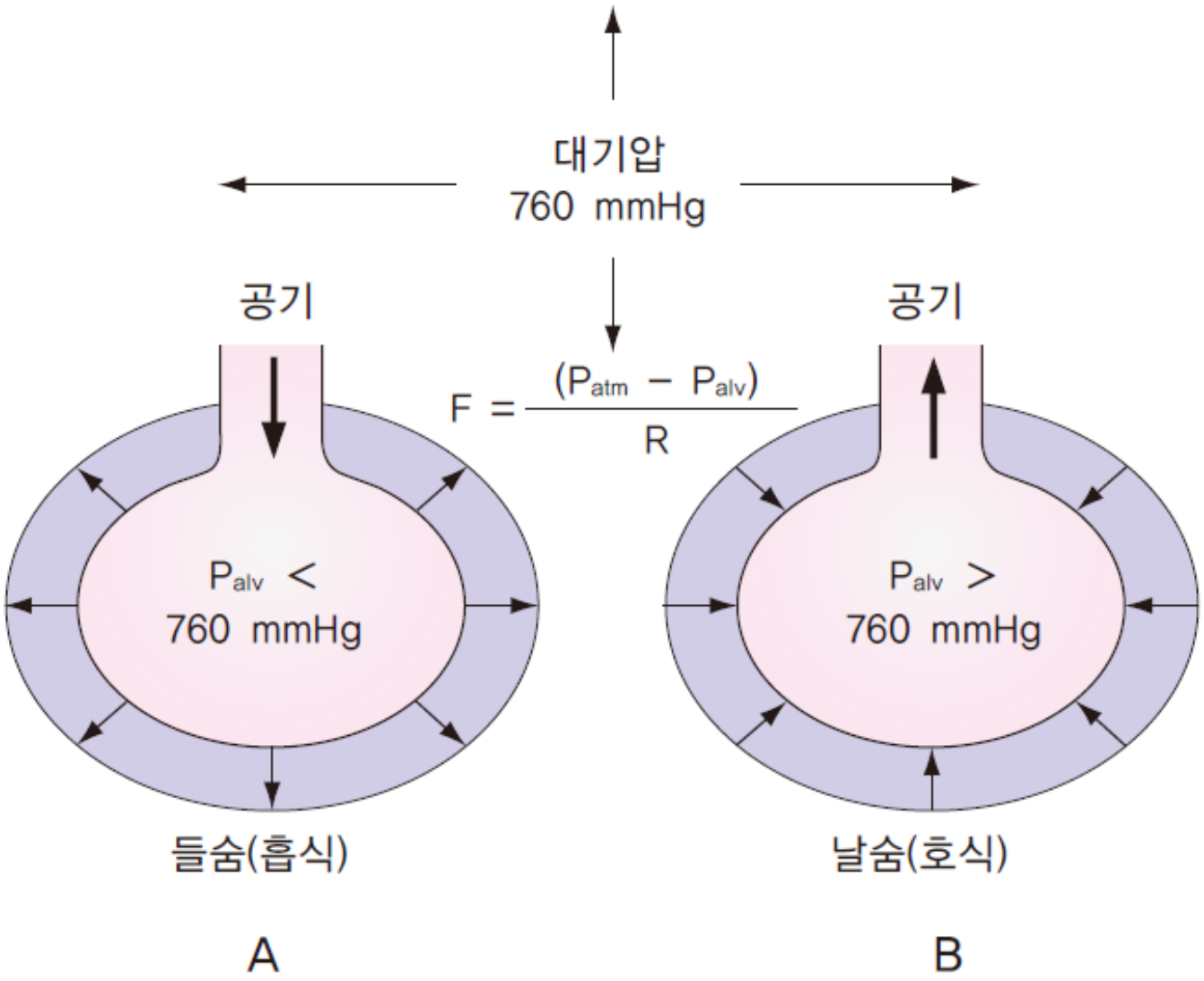
C. 세로칸




혈류
blood flow
허파정맥
pulmonary vein
허파세정맥
pulmonary venule
세기관지
bronchiole
허파동맥
pulmonary artery
허파세동맥
pulmonary arteriole
종말세기관지
terminal bronchiole
호흡세기관지
respiratory bronchiole
허파꽈리표면의
모세혈관망
허파꽈리관 alveolar duct
허파꽈리주머니 alveolar saccule
허파꽈리 alveoli


모세혈관 바닥막
세포사이질공간
모세혈관 내피세포
허파꽈리상피막
허파꽈리상피
액체와 표면활성제
적혈구
허파꽈리
모세혈관
확산
산소
이산화탄소
확산


II 형허파꽈리세포
(표면활성제분비세포)
type II pneumocyte
(surfactant-secreting cell)
호흡막
respiratory membrane
허파꽈리
alveolus
I 형허파꽈리세포
type I pneumocyte
허파꽈리큰포식세포
alveolar macrophage
허파모세혈관 속의 적혈구
red blood cell in pulmonary capillary
O_2의확산
CO_2의확산
모세혈관 내피세포
capillary endothelial cell
모세혈관 바닥막
caillary basement mambrane
허파꽈리세포
alveolar cell
결합조직
connective tissue
상피바닥막
epithelial basement membrane


대기압
760 mmHg
공기
공기
$F = \frac{(P_{atm} - P_{alv})}{R}$
P_{alv} <
760 mmHg
P_{alv} >
760 mmHg
들숨(흡식)
날숨(호식)
A
B

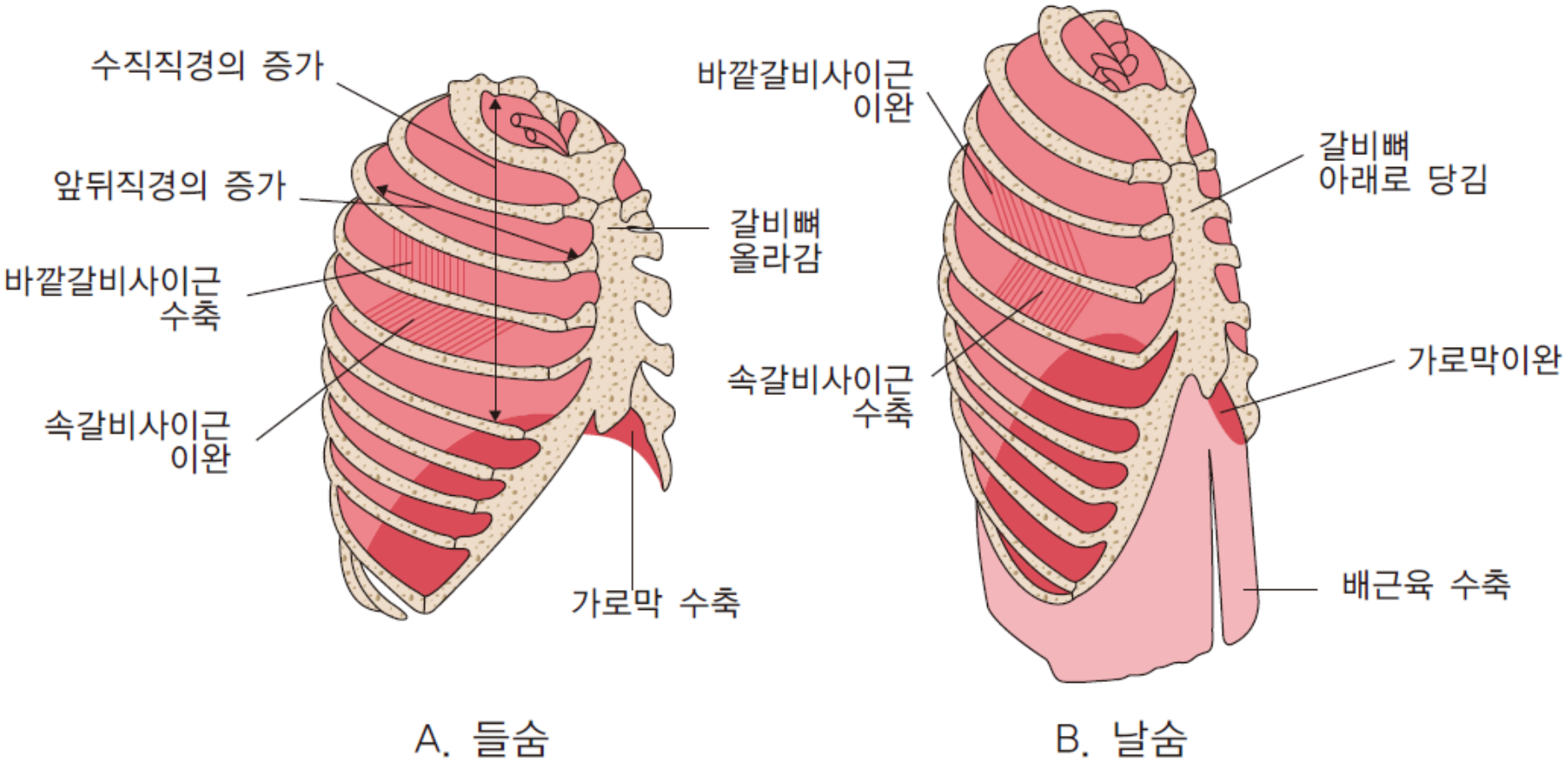
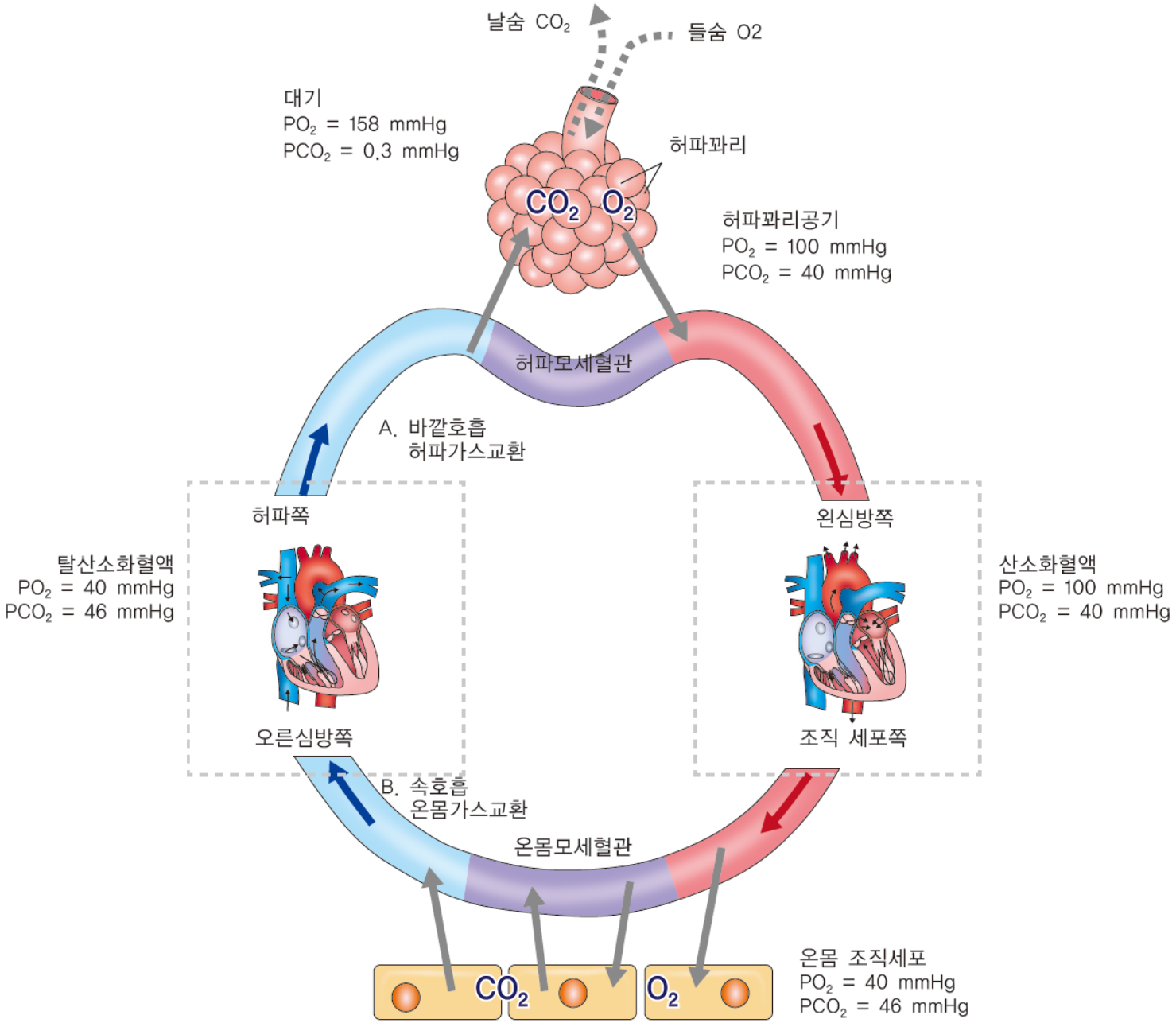
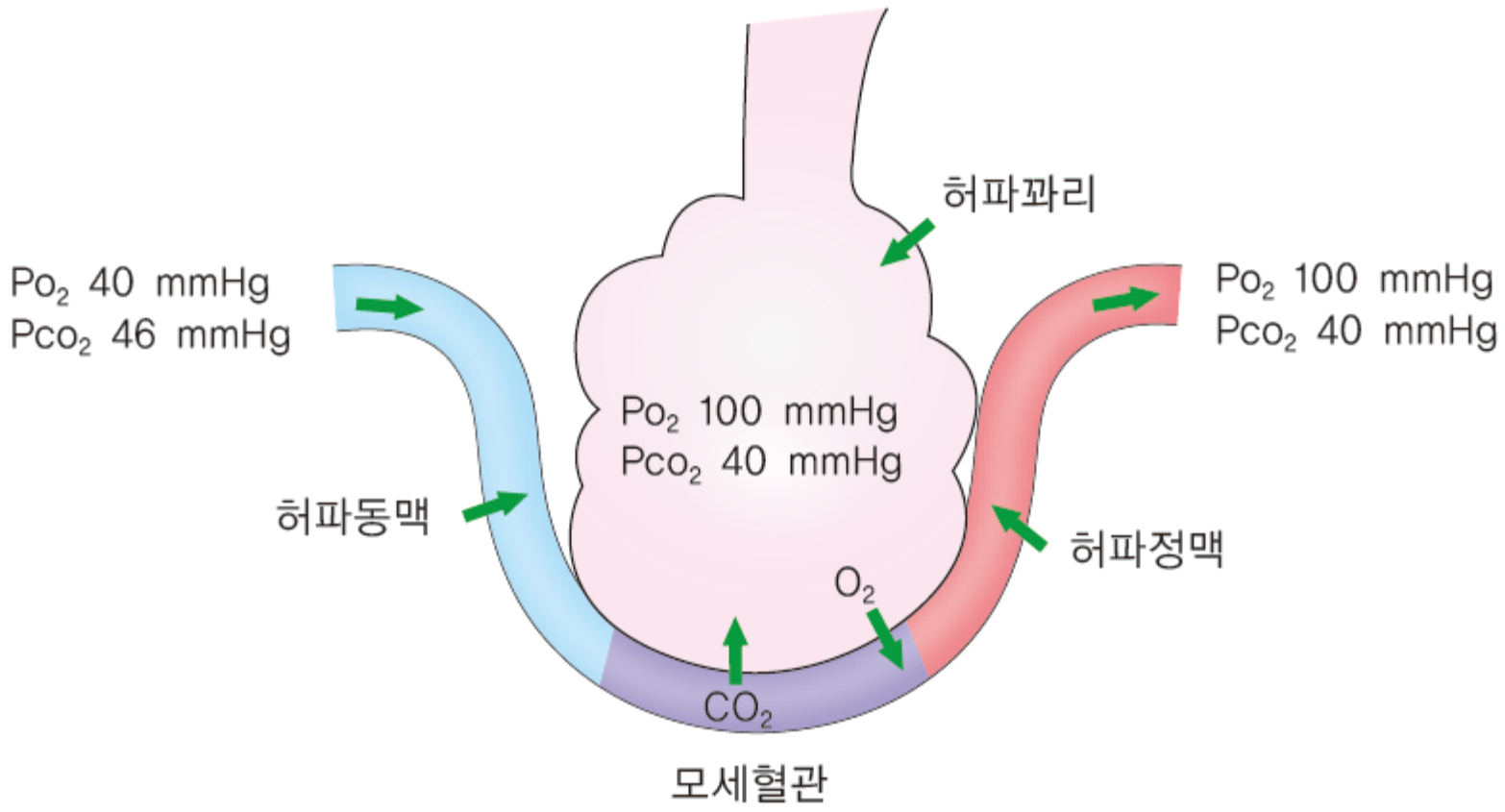
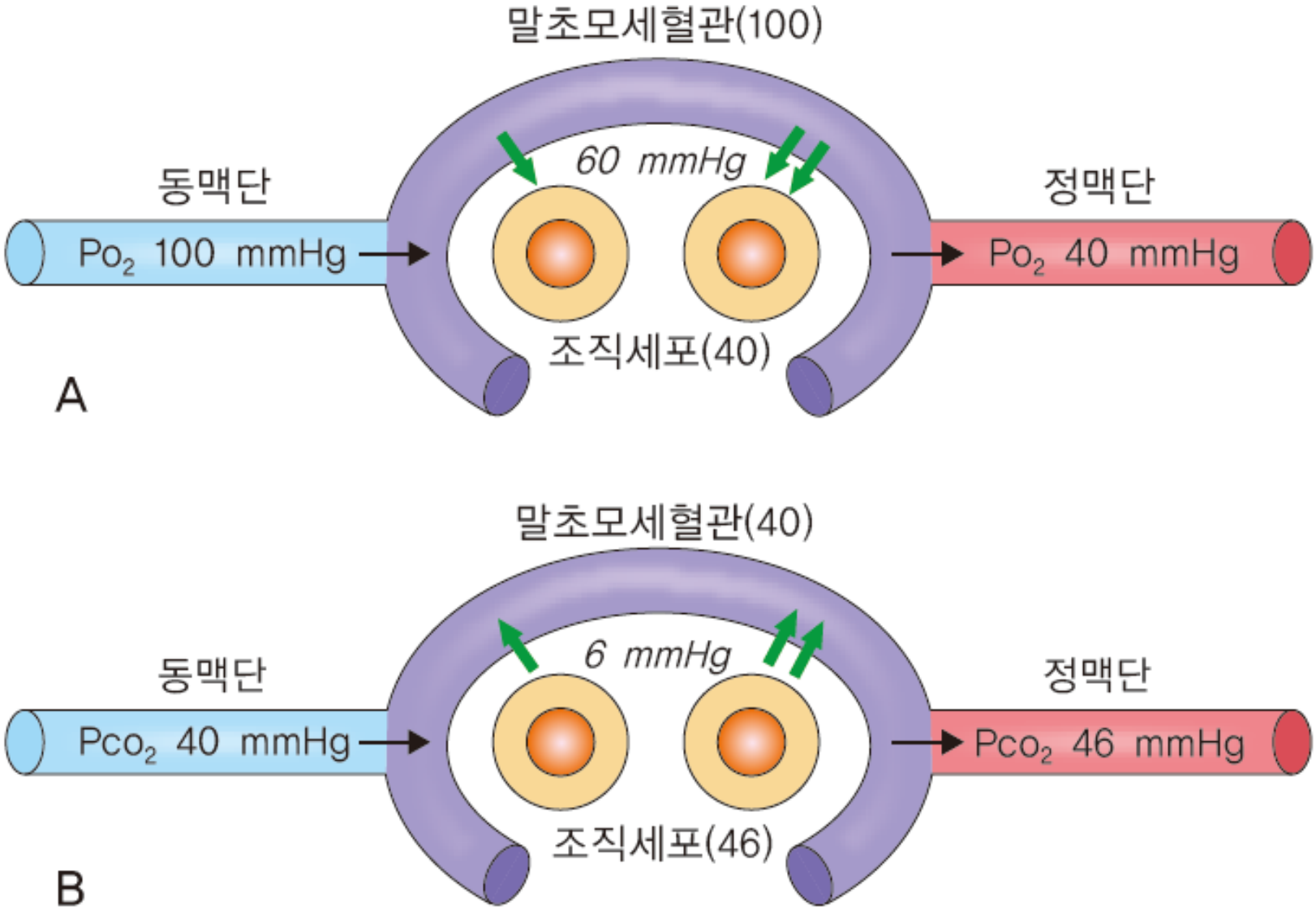

수직직경의 증가
앞뒤직경의 증가
바깥갈비사이근
수축
속갈비사이근
이완
갈비뼈
올라감
가로막 수축
A. 들숨
바깥갈비사이근
이완
갈비뼈
아래로 당김
속갈비사이근
수축
가로막이완
배근육 수축
B. 날숨

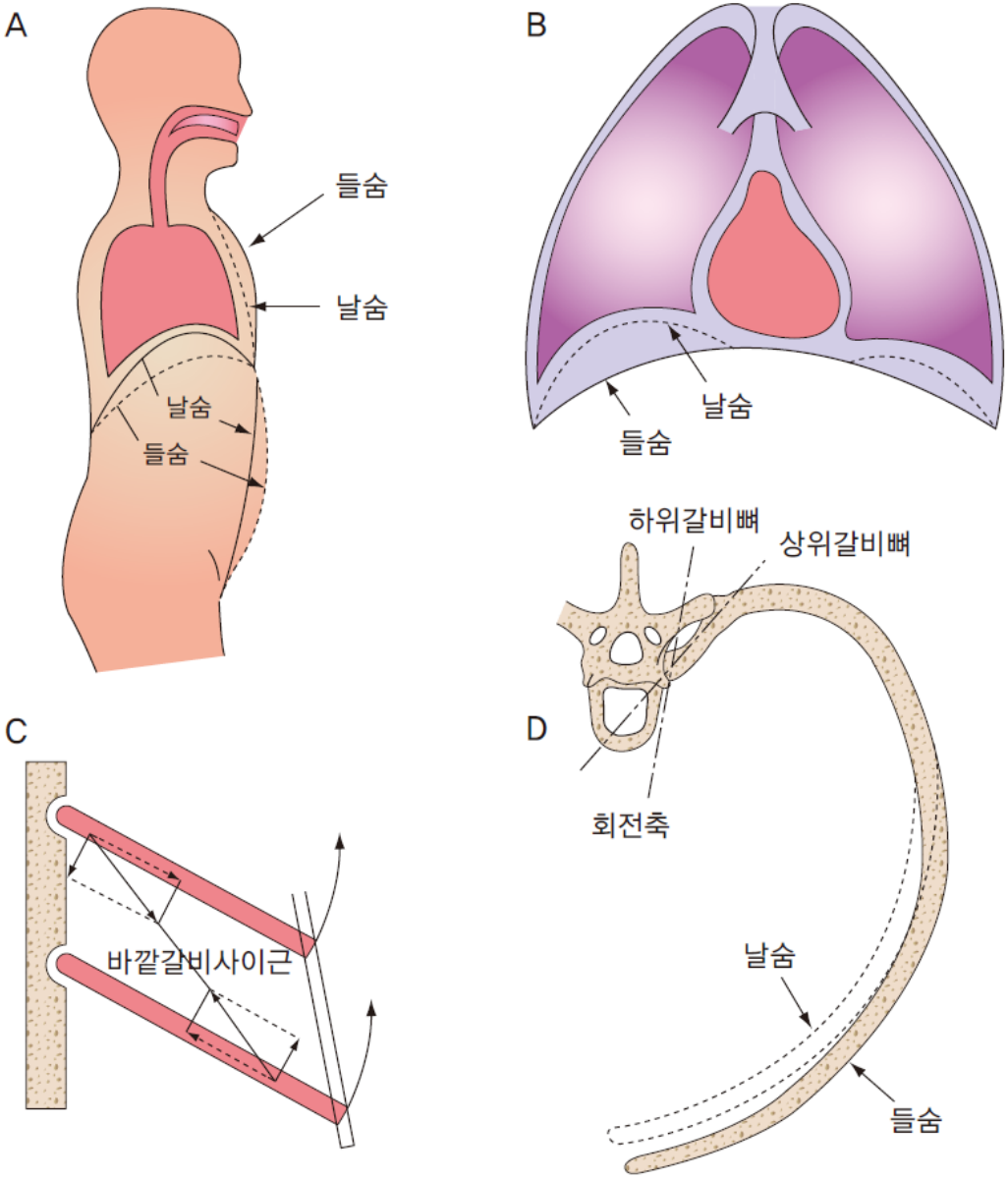
표 1-1. 안정 상태의 가스 분압(mmHg)

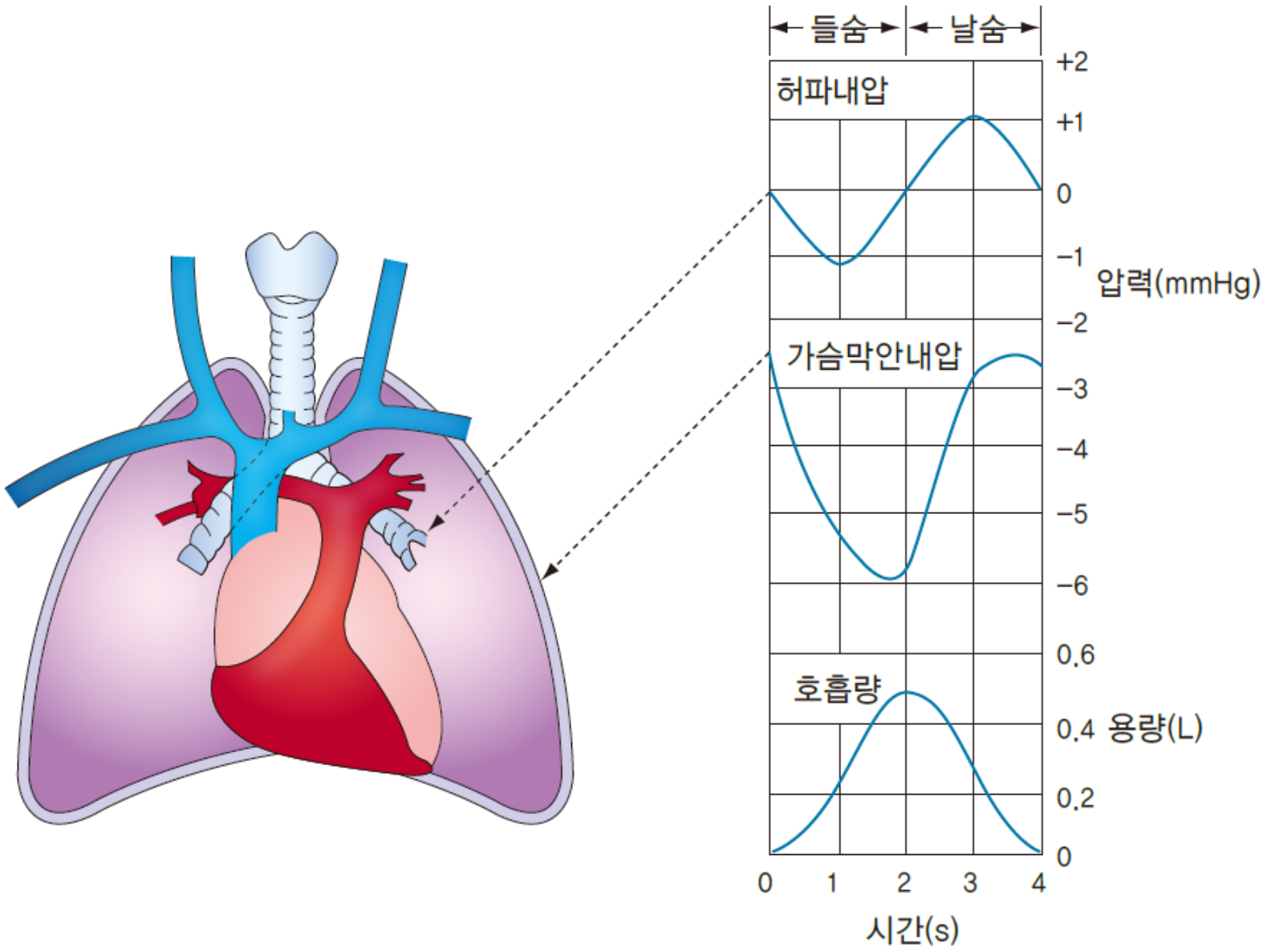
	산소	탄산가스	질소	수증기	합계
들숨공기	158	0.3	596	5.7	760
날숨공기	116	32	565	47	760
허파꽈리공기	100	40	573	47	760
동맥혈	100	40	573	47	760
정맥혈	40	46	573	47	706
조직	40	46	573	47	706

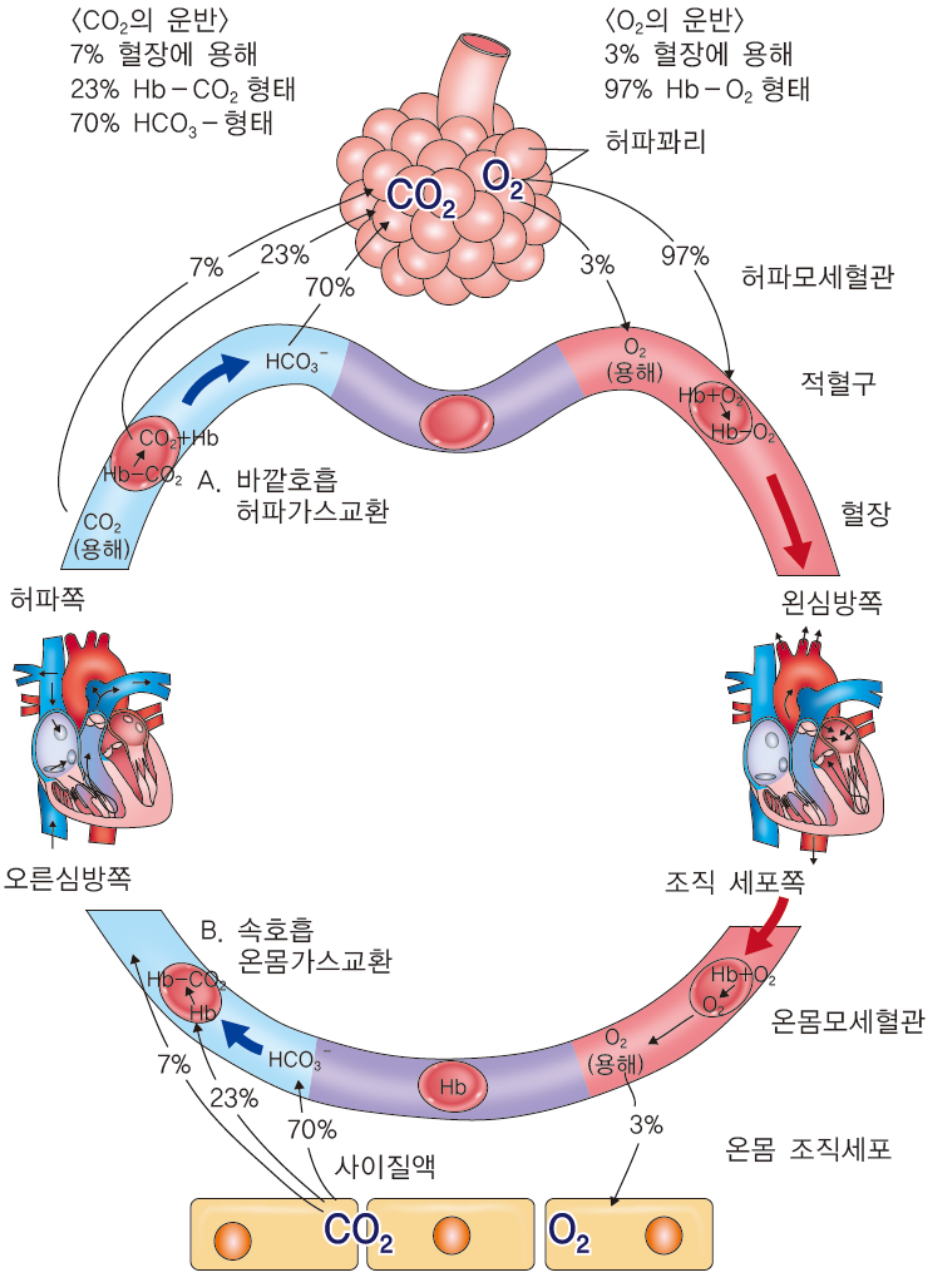

날숨 CO_2
들숨 O2
대기
PO_2 = 158 mmHg
PCO_2 = 0.3 mmHg
허파꽈리
CO_2 O_2
허파꽈리공기
PO_2 = 100 mmHg
PCO_2 = 40 mmHg
허파모세혈관
A. 바깥호흡
허파가스교환
허파쪽
왼심방쪽
탈산소화혈액
PO_2 = 40 mmHg
PCO_2 = 46 mmHg
산소화혈액
PO_2 = 100 mmHg
PCO_2 = 40 mmHg
오른심방쪽
조직 세포쪽
B. 속호흡
온몸가스교환
온몸모세혈관
CO_2
O_2
온몸 조직세포
PO_2 = 40 mmHg
PCO_2 = 46 mmHg

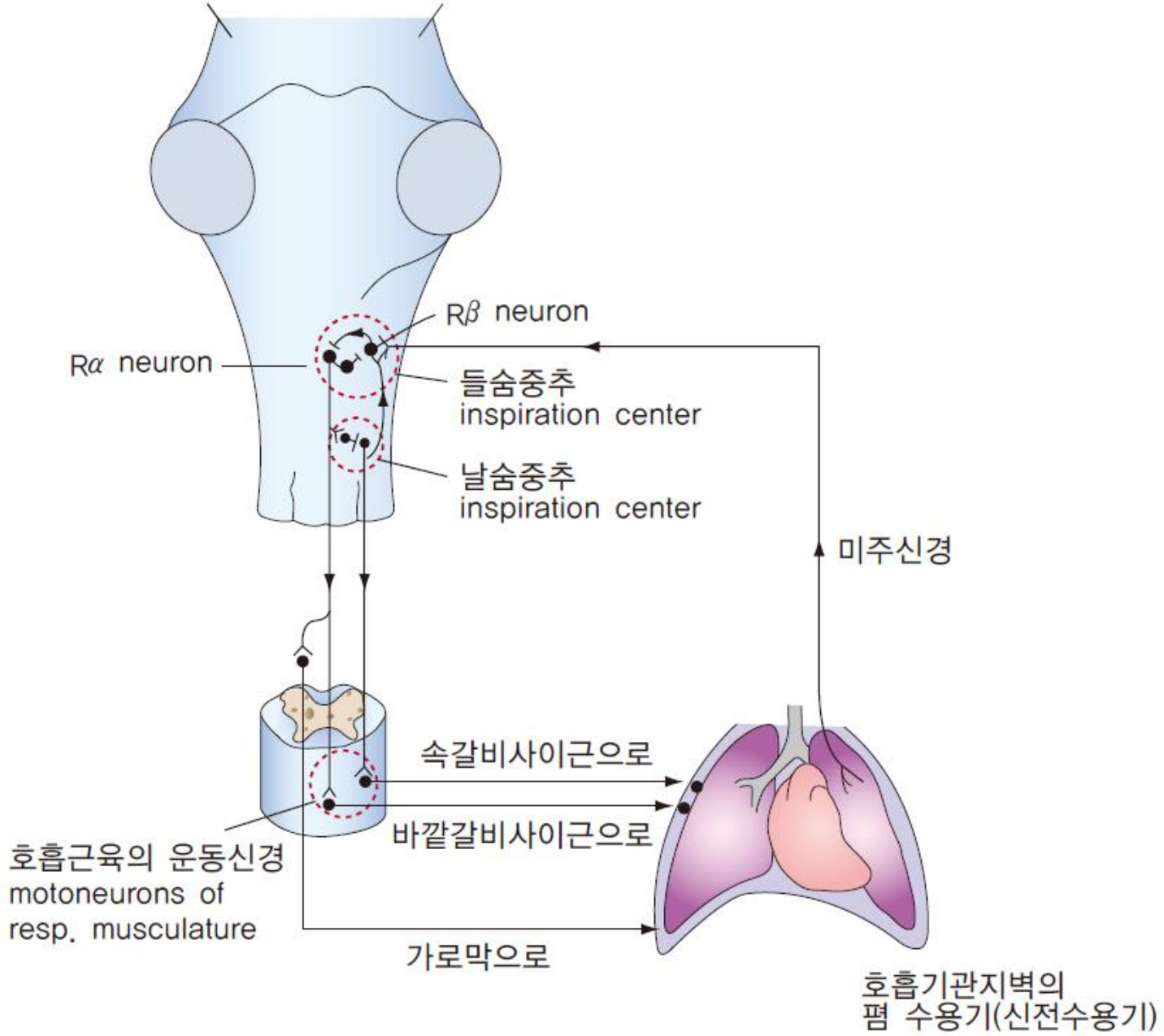

허파꽈리
Po_2 40 mmHg
Pco_2 46 mmHg
Po_2 100 mmHg
Pco_2 40 mmHg
Po_2 100 mmHg
Pco_2 40 mmHg
허파동맥
허파정맥
O_2
CO_2
모세혈관

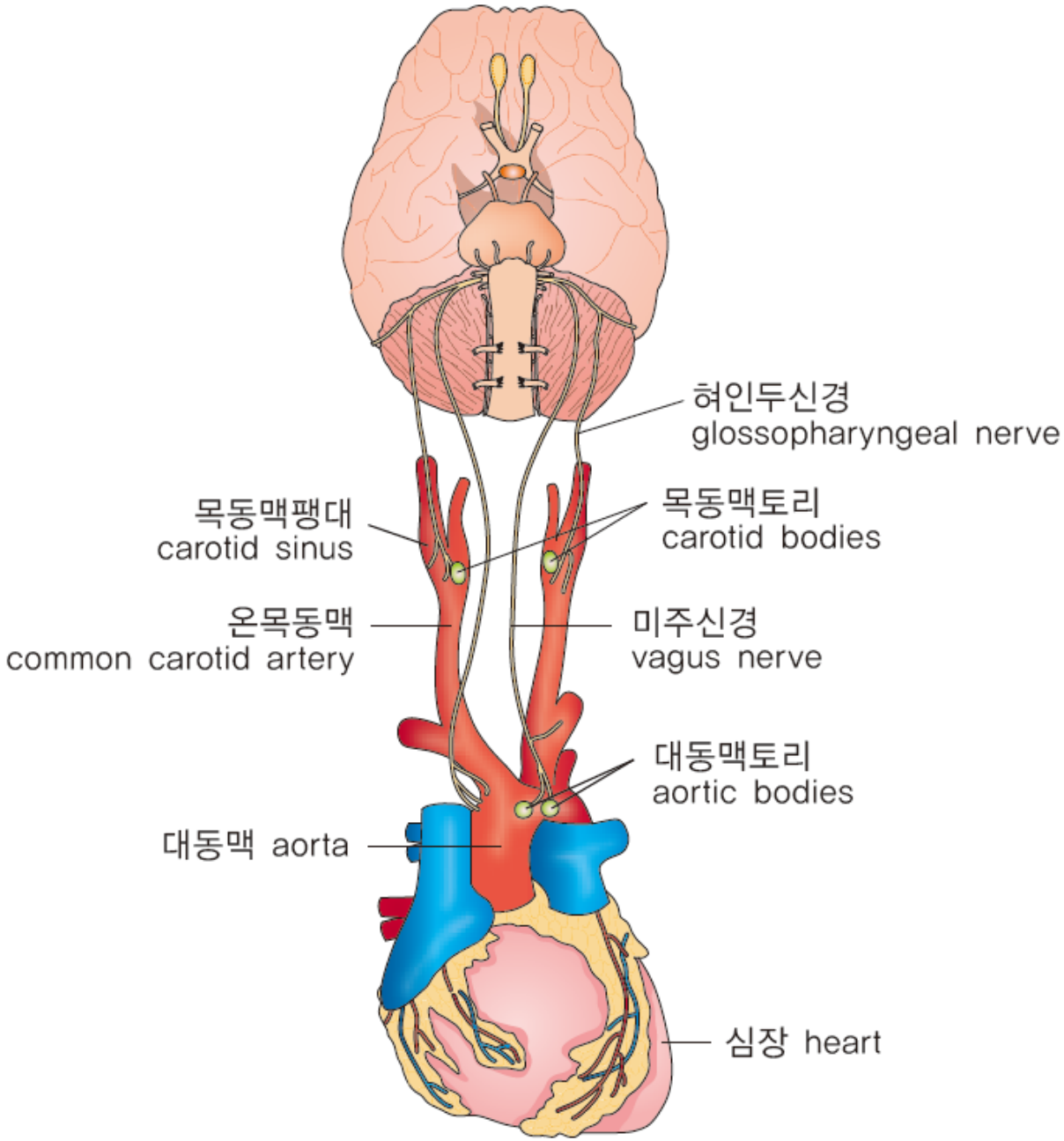

말초모세혈관(100)
60 mmHg
동맥단
Po2 100 mmHg
정맥단
Po2 40 mmHg
조직세포(40)
A
말초모세혈관(40)
6 mmHg
동맥단
Pco2 40 mmHg
정맥단
Pco2 46 mmHg
조직세포(46)
B


A
들숨
날숨
날숨
들숨
B
날숨
들숨
C
바깥갈비사이근
D
하위갈비뼈
상위갈비뼈
회전축
날숨
들숨


들숨
날숨
허파내압
가슴막안내압
호흡량
+2
+1
0
−1
−2
−3
−4
−5
−6
압력(mmHg)
0.6
0.4
0.2
0
용량(L)
0
1
2
3
4
시간(s)


〈CO_2의 운반〉
7% 혈장에 용해
23% Hb－CO_2 형태
70% HCO_3－형태
〈O_2의 운반〉
3% 혈장에 용해
97% Hb－O_2 형태
허파꽈리
CO_2
O_2
7%
23%
70%
3%
97%
허파모세혈관
HCO_3^-
O_2 (용해)
적혈구
$Hb+O_2$
$Hb-O_2$
CO_2+Hb
$Hb-CO_2$
A. 바깥호흡
허파가스교환
CO_2 (용해)
혈장
허파쪽
왼심방쪽
오른심방쪽
조직 세포쪽
B. 속호흡
온몸가스교환
$Hb-CO_2$
Hb
$Hb+O_2$
O_2
온몸모세혈관
O_2 (용해)
Hb
HCO_3^-
7%
23%
70%
3%
사이질액
온몸 조직세포
CO_2
O_2


Rβ neuron
Rα neuron
들숨중추
inspiration center
날숨중추
inspiration center
미주신경
속갈비사이근으로
바깥갈비사이근으로
호흡근육의 운동신경
motoneurons of
resp. musculature
가로막으로
호흡기관지벽의
폄 수용기(신전수용기)


혀인두신경
glossopharyngeal nerve
목동맥팽대
carotid sinus
목동맥토리
carotid bodies
온목동맥
common carotid artery
미주신경
vagus nerve
대동맥토리
aortic bodies
대동맥 aorta
심장 heart

Section 02

폐기능검사를 위한 기본 개념

학습목표

1. 폐기능검사의 임상적 의의를 설명할 수 있다(A).
2. 폐기능검사에 영향을 미치는 요인을 설명할 수 있다(A).
3. 폐기능검사의 종류를 설명할 수 있다(A).
4. 기체표시법을 설명할 수 있다(A).
5. 폐기능검사의 대상이 되는 질환을 설명할 수 있다(A).

표 2-1. 폐기능검사의 적합성과 재현성에 미치는 요인

외적 기술적 요인	내적 생물학적 요인
• 검사기의 성능 용적(volume) 측정의 적합성 유량(flow) 측정의 적합성 소프트웨어의 종류 • 예측치 공식 • 검사의 방법 부적절한 설명 부적절한 검사 방법 검사횟수 검사자세 • 검사자의 지식 설명하는 방법 예를 보이는 방법 독려 방법 • 검사의 환경 온도 습도 기압	• 피검자 자체의 차이점 검사의 자세 하루 중의 검사시간 노력의 정도 생체리듬, 호르몬 등의 변화 비협조 • 피검자 간의 차이점 체격(신장, 체중) 성 연령 인종 건강상태 거주지역(고도, 대기오염 등) 직업 및 환경 사회경제적 상태

표 2-2. 폐기능검사의 종류

환기 기능 검사	폐기량 측정	• 폐활량(VC) • 날숨예비량(ERV) • 잔기량(RV) • 총폐용량(TLC)	• 들숨예비량(IRV) • 들숨용량(IC) • 기능적 잔기용량(FRC)
	노력성 날숨곡선 측정	• 노력성 폐활량(FVC) • 1초율(FEV_1/FVC %) • 공기흡입지수(ATI)	• 시간폐활량(FEVt) • 최대날숨중간유량(MMF) • 유량용적곡선($\dot{V}75$, $\dot{V}25$, $\dot{V}peak$)
	환기량 측정	• 일회호흡량(TV)	• 최대 환기량(MVV)
	환기역학 검사	• 폐탄성(Compliance)	• 기도저항(Raw)
허파꽈리 기능 검사	기체상 검사	• 폐내가스분포 • CO_2 배출량 • 폐확산능(D_L) • 허파꽈리 공기의 O_2, CO_2 분압(P_{AO_2}, P_{ACO_2})	• O_2 섭취량(율) • 폐쇄용적(CV)
	액체상 검사	• 동맥혈의 O_2, CO_2 함량 및 분압(Pao_2, $Paco_2$) • 동맥혈 pH	• 동맥혈 O_2 포화도

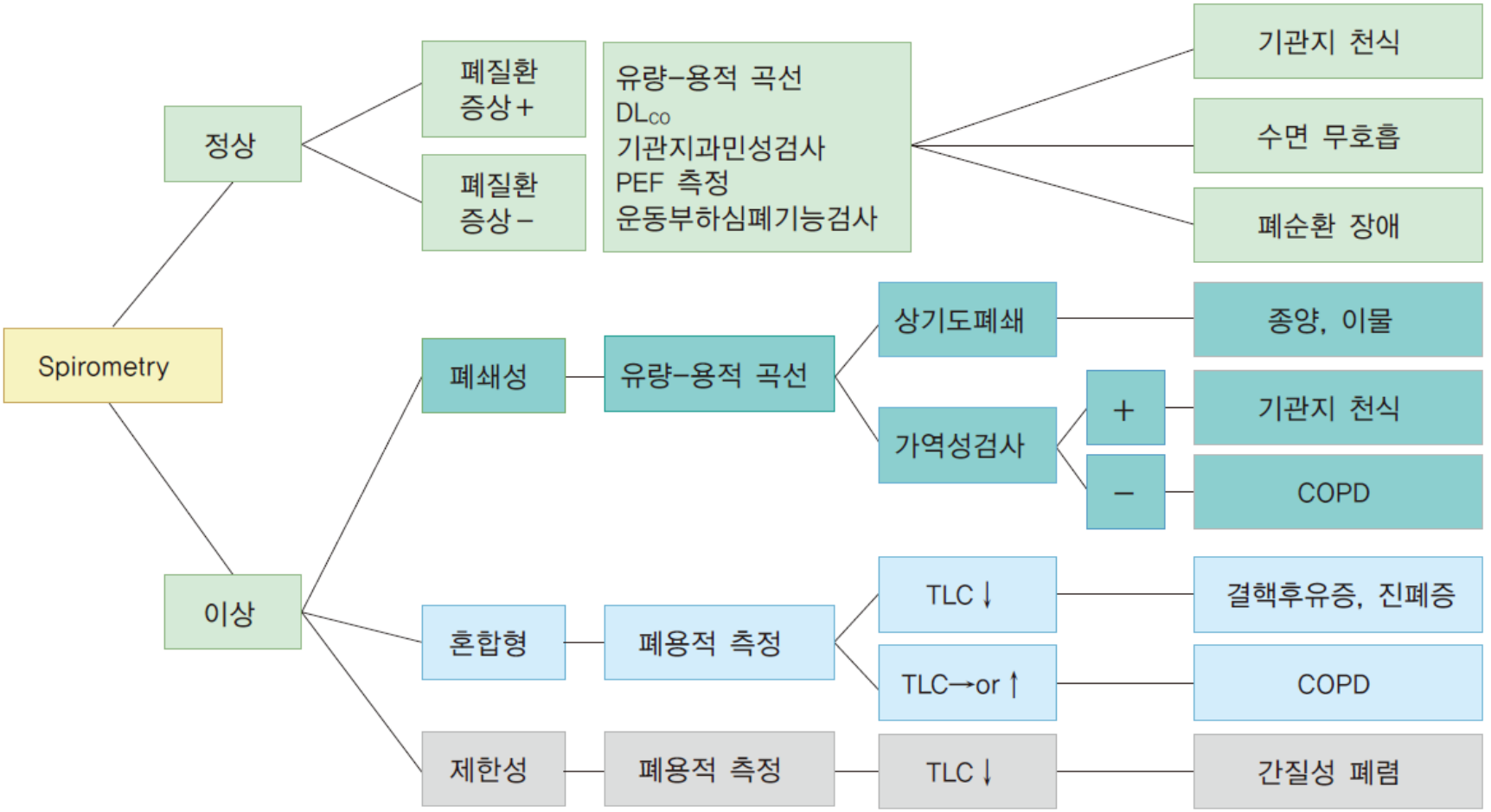
표 2-3. 폐기능검사에 사용되는 약호

1차 기호			2차 기호			
기호	내용		기호		내용	
V	폐용량	volume	기체상	I	들숨	Inspiratory
$\dot{V}$	폐유량	gas flow per unit time		E	날숨	Expiratory
P	압력 · 분압	pressure		A	허파꽈리기(폐포기)	Alveolar
C	함량 · 농도	content, concentration		T	1회 환기	Tidal
C	폐탄성	compliance		D	사강기	Dead space
F	가스농도	fractional concentration		B	대기	Barometric
S	포화도	saturation		L	허파	Lung
$\dot{Q}$	혈류량	blood flow per unit time	액체상	b	혈액	blood
D	확산계수	diffusion coefficient		a	동맥혈	arterial
R	가스 교환율	respiratory (gas) exchange ratio		c	모세관혈액	capillary
R	저항	resistance		v	정맥혈	venous
G	전도능	conductance			혼합정맥혈	mixed venous
f	호흡수	respiratory frequency		w	물	water

* 일차 또는 이차기호 위의 (dot) 표시는 단위시간(1분)당 이동량 또는 이동속도를 의미하며 "–"(bar) 표시는 평균 또는 혼합을 의미한다. 일반적으로 1차 기호는 알파벳의 큰 대문자, 2차 기호 중에서 기체는 작은 대문자, 액체는 소문자를 사용한다.

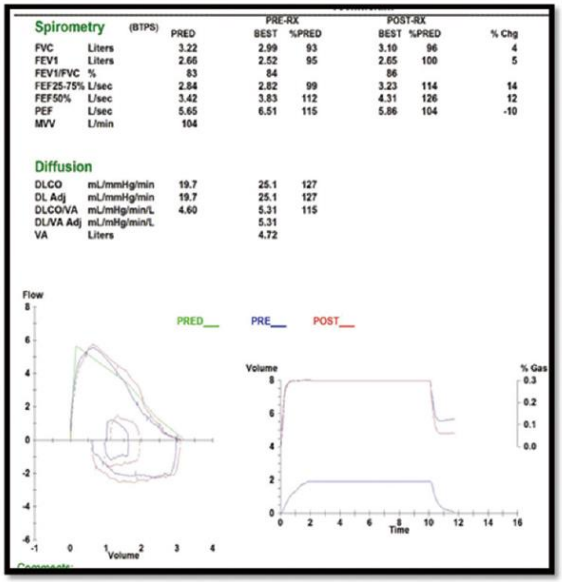
표 2-4. 기체표시법

계수	온도	기압	수증기	측정
ATPS	실온	측정 시 기압 : 대기압	포화상태	검사실 혹은 실험실 내 가스량
BTPS	37℃	측정 시 기압 : 대기압	37℃ 포화상태: 47 mmHg	허파 내에 있는 가스량 (폐활량, 1초율)
STPD	0℃	1기압 : 760 mmHg	건조상태	체외의 가스량 (O_2 소비량, CO_2 배출량)


Spirometry
정상
이상
폐질환 증상+
폐질환 증상−
유량-용적 곡선
DL_{CO}
기관지과민성검사
PEF 측정
운동부하심폐기능검사
기관지 천식
수면 무호흡
폐순환 장애
폐쇄성
유량-용적 곡선
상기도폐쇄
종양, 이물
가역성검사
+
기관지 천식
−
COPD
혼합형
폐용적 측정
TLC ↓
결핵후유증, 진폐증
TLC→or ↑
COPD
제한성
폐용적 측정
TLC ↓
간질성 폐렴

PFT 소견(정상)

X-ray 소견(정상)



Spirometry (BTPS)

		PRED	PRE-RX BEST	PRE-RX %PRED	POST-RX BEST	POST-RX %PRED	% Chg
FVC	Liters	3.22	2.99	93	3.10	96	4
FEV1	Liters	2.66	2.52	95	2.65	100	5
FEV1/FVC	%	83	84		86		
FEF25-75%	L/sec	2.84	2.82	99	3.23	114	14
FEF50%	L/sec	3.42	3.83	112	4.31	126	12
PEF	L/sec	5.65	6.51	115	5.86	104	-10
MVV	L/min	104					

Diffusion

DLCO	mL/mmHg/min	19.7	25.1	127
DL Adj	mL/mmHg/min	19.7	25.1	127
DLCO/VA	mL/mHg/min/L	4.60	5.31	115
DL/VA Adj	mL/mHg/min/L		5.31	
VA	Liters		4.72	



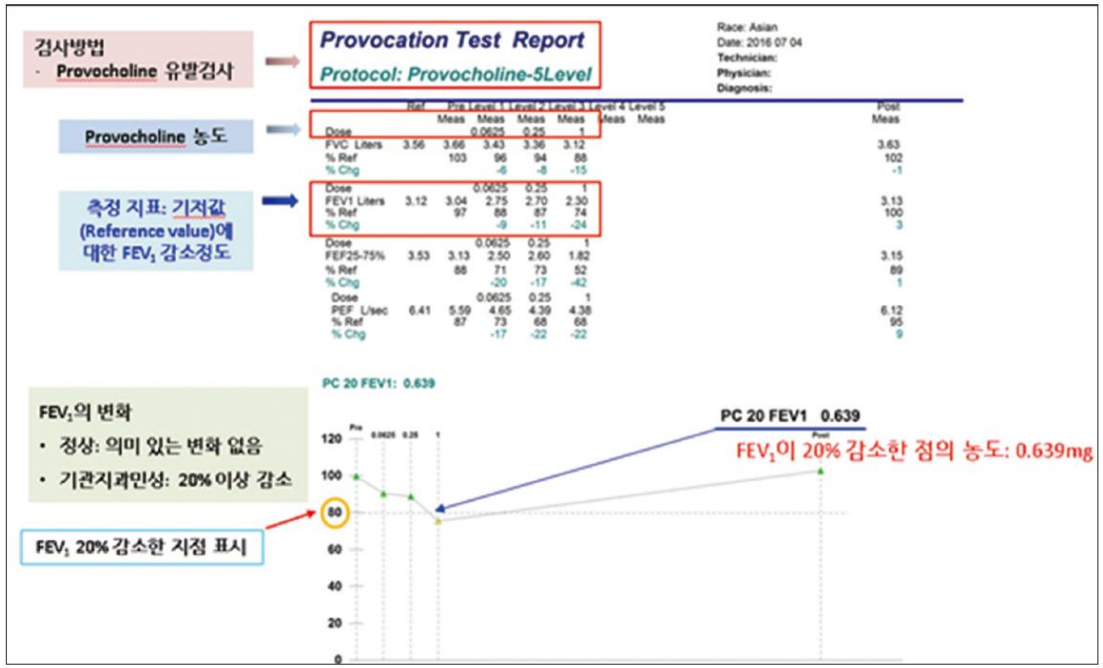
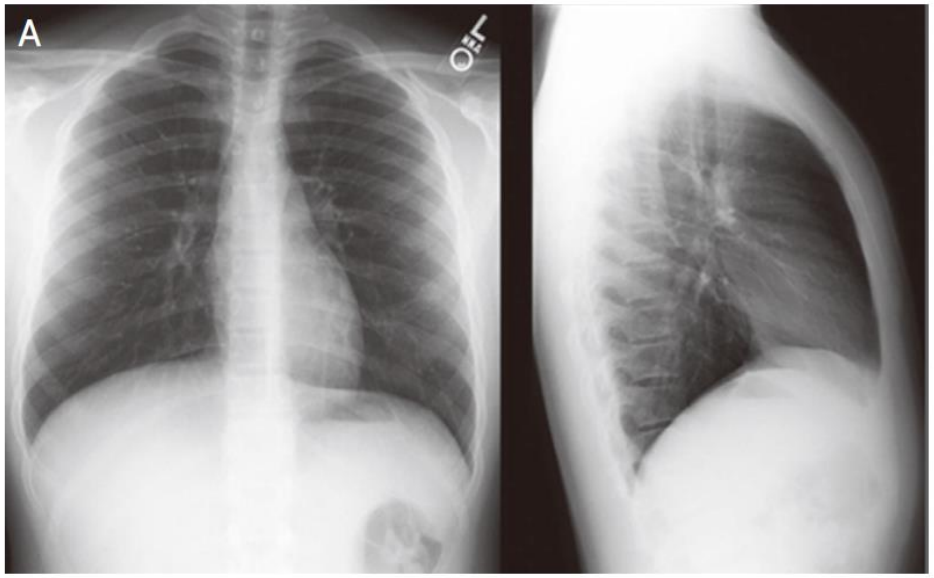
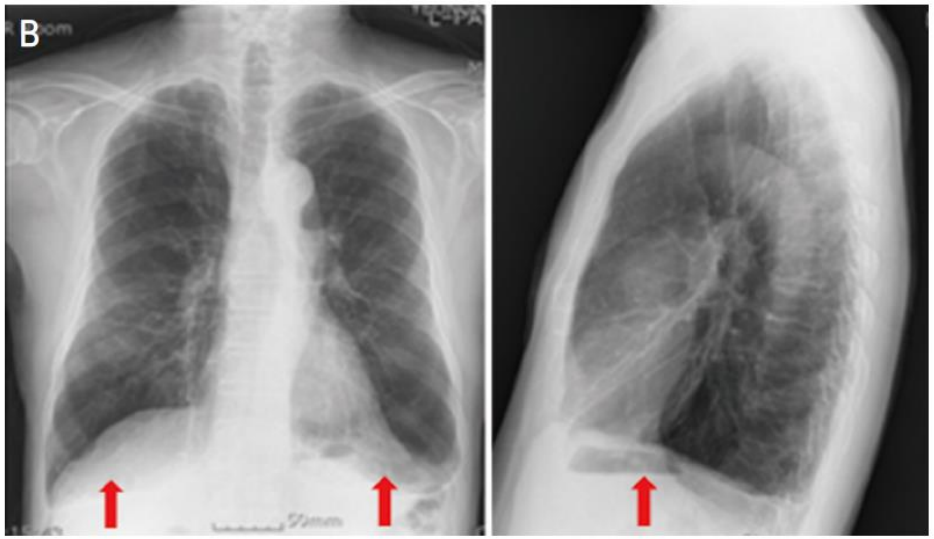


표 2-5. 기류제한의 중증도 분류

GOLD stage	1초량(FEV_1)
GOLD 1 : Mild	$FEV_1 = 80\%$
GOLD 2 : Moderate	$50\% = FEV_1 < 80\%$
GOLD 3 : Severe	$30\% = FEV_1 < 50\%$
GOLD 4 : Very severe	$FEV_1 < 30\%$



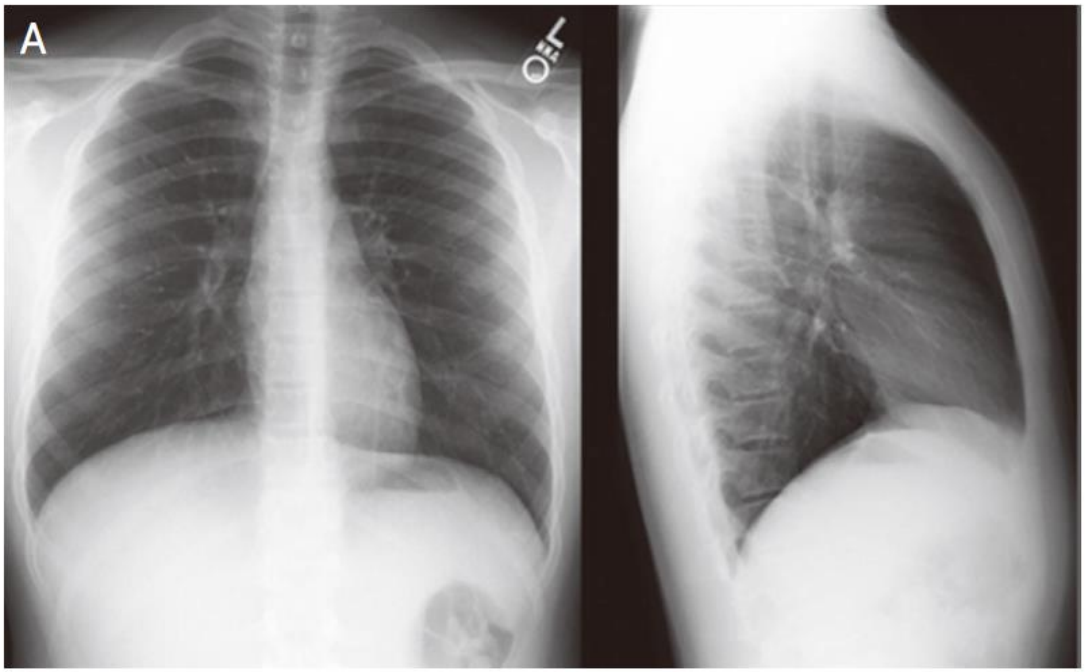


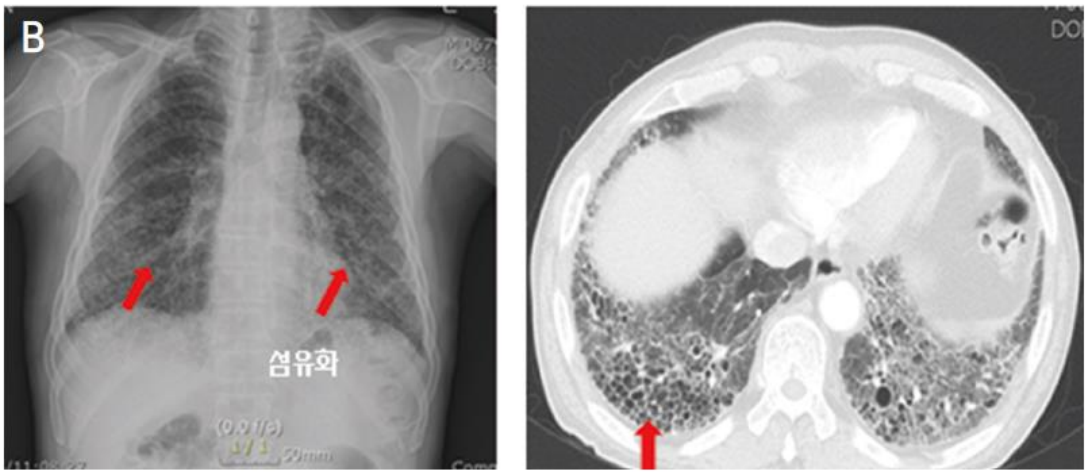
허리꽈리안이 공기에 의해 과팽창되어 허리꽈리벽이 파괴된 상태로 부분적으로 기포를 형성하기도 한다. 또한 정상보다 허파가 길게 늘어나 있음을 보인다.

가로막이 과팽창으로 배쪽으로 하강하는 모양을 보인다.

표 2-6. 천식의 발생과 발현에 영향을 미치는 인자

숙주인자	환경인자
유전적 인자 아토피 관련 유전자/기도과민증 관련 유전자 비만 성별	알레르겐 실내 : 집먼지진드기, 동물털(개, 고양이, 쥐), 바퀴벌레, 곰팡이, 이스트 실외 : 꽃가루, 곰팡이, 이스트 감염(주로 바이러스성) 직업성 감작물질 흡연 간접 흡연/직접 흡연 실외/실내 대기오염 음식





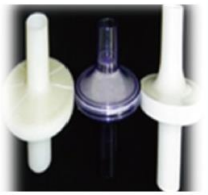
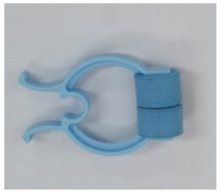
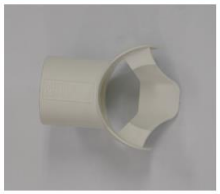
3~10 mm의 벌집 모양의 낭성 공간(cystic air space)들이 군집한 것으로 대개 가슴막아래에 경계가 분명한 벽의 구조로 되었다.

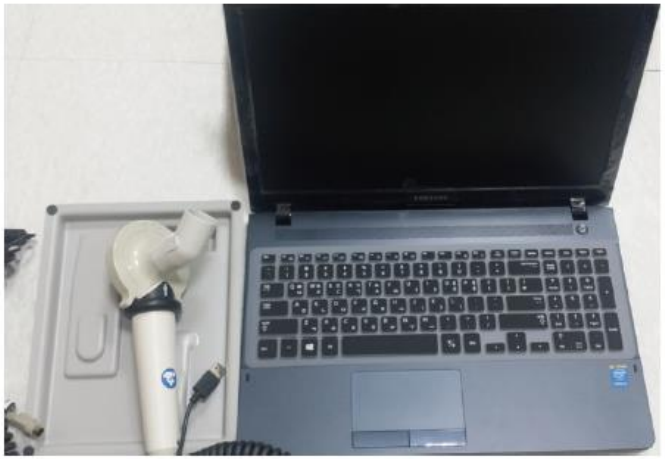
Section 03

폐활량계

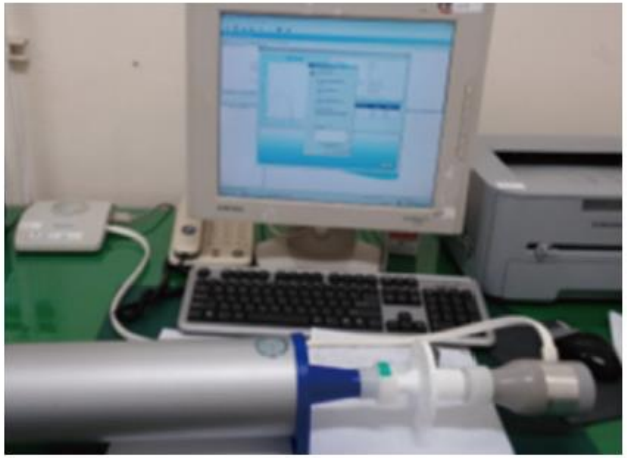
학습목표

1. 폐활량계와 부속장비를 설명할 수 있다(A).
2. 폐활량계의 종류 및 특징을 설명할 수 있다(B).
3. 폐활량계의 보정방법을 설명할 수 있다(A).

			
기압계 (온도, 습도 포함)	신장계	체중계	보정용 실린지(3 L)
			
마우스피스(1회용)	마우스피스(1회용)	마우스피스(1회용)	마우스피스(1회용)
			
코마개	코마개	코마개	장비세척제
			
측정센서	측정센서	개구기	개구기
			
응급구급장비 (isoket, 이동용 산소통, 기관지확장제 등)	응급의료품	의료폐기물 처리용기	




CARDIO TOUCH

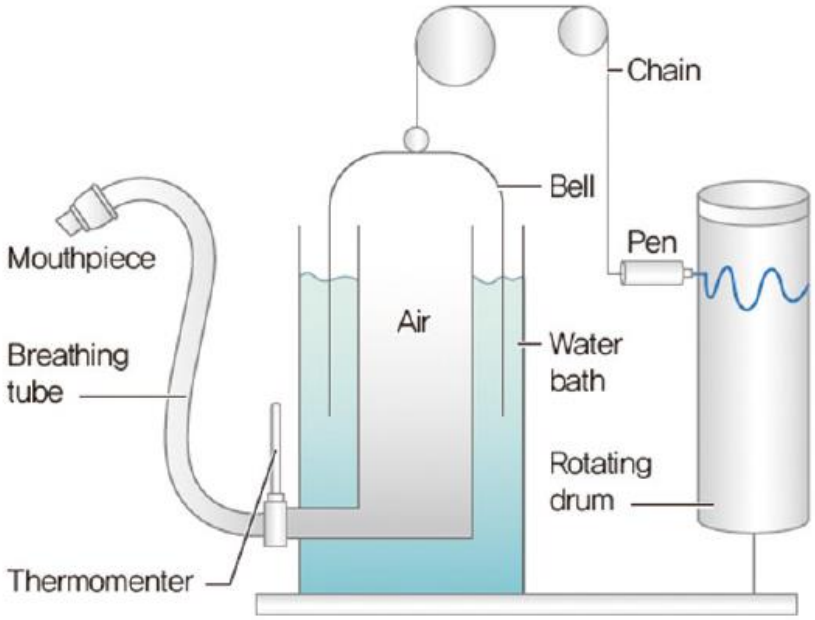




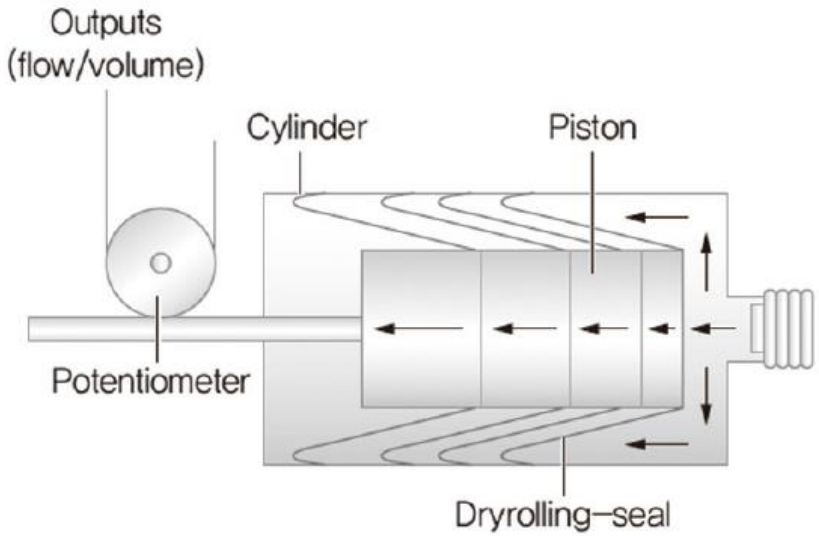





CareFusion
의료용
산 소
충전기한
2020.1

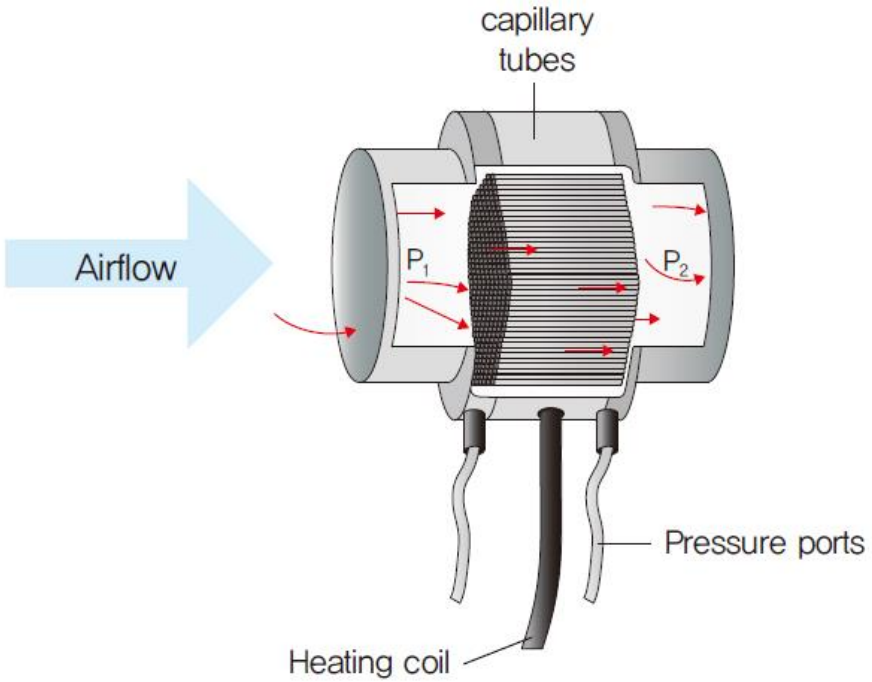

Chain
Bell
Pen
Mouthpiece
Air
Breathing tube
Water bath
Rotating drum
Thermomenter

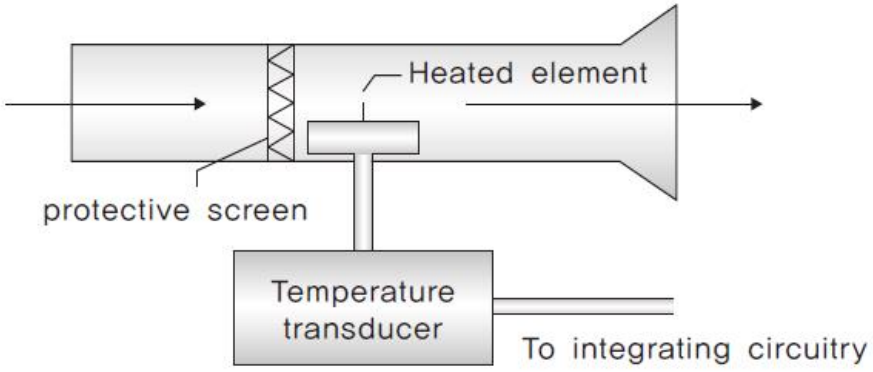

CHEST

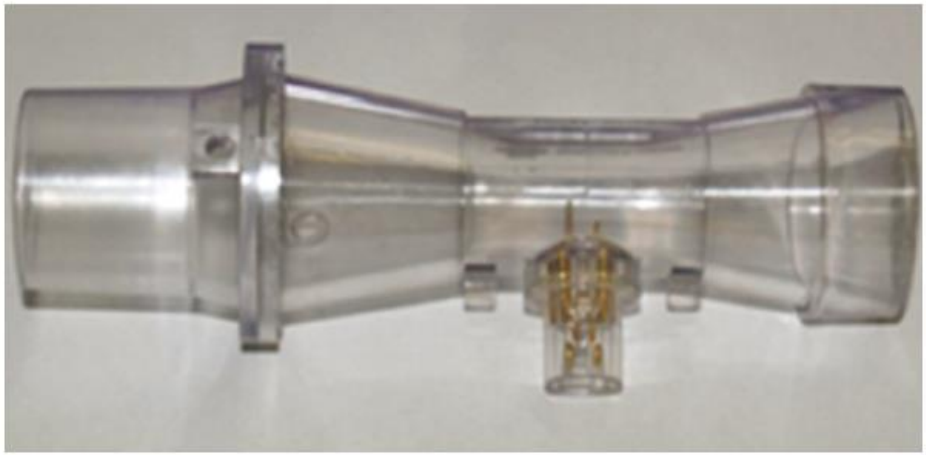

Outputs
(flow/volume)
Cylinder
Piston
Potentiometer
Dryrolling-seal

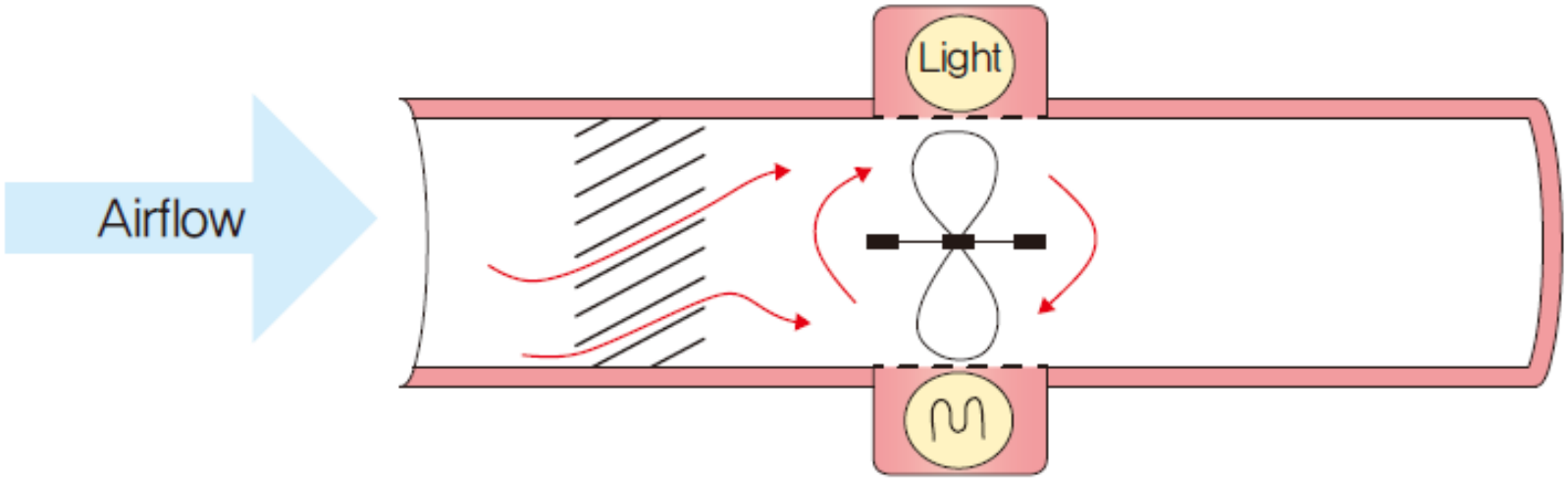




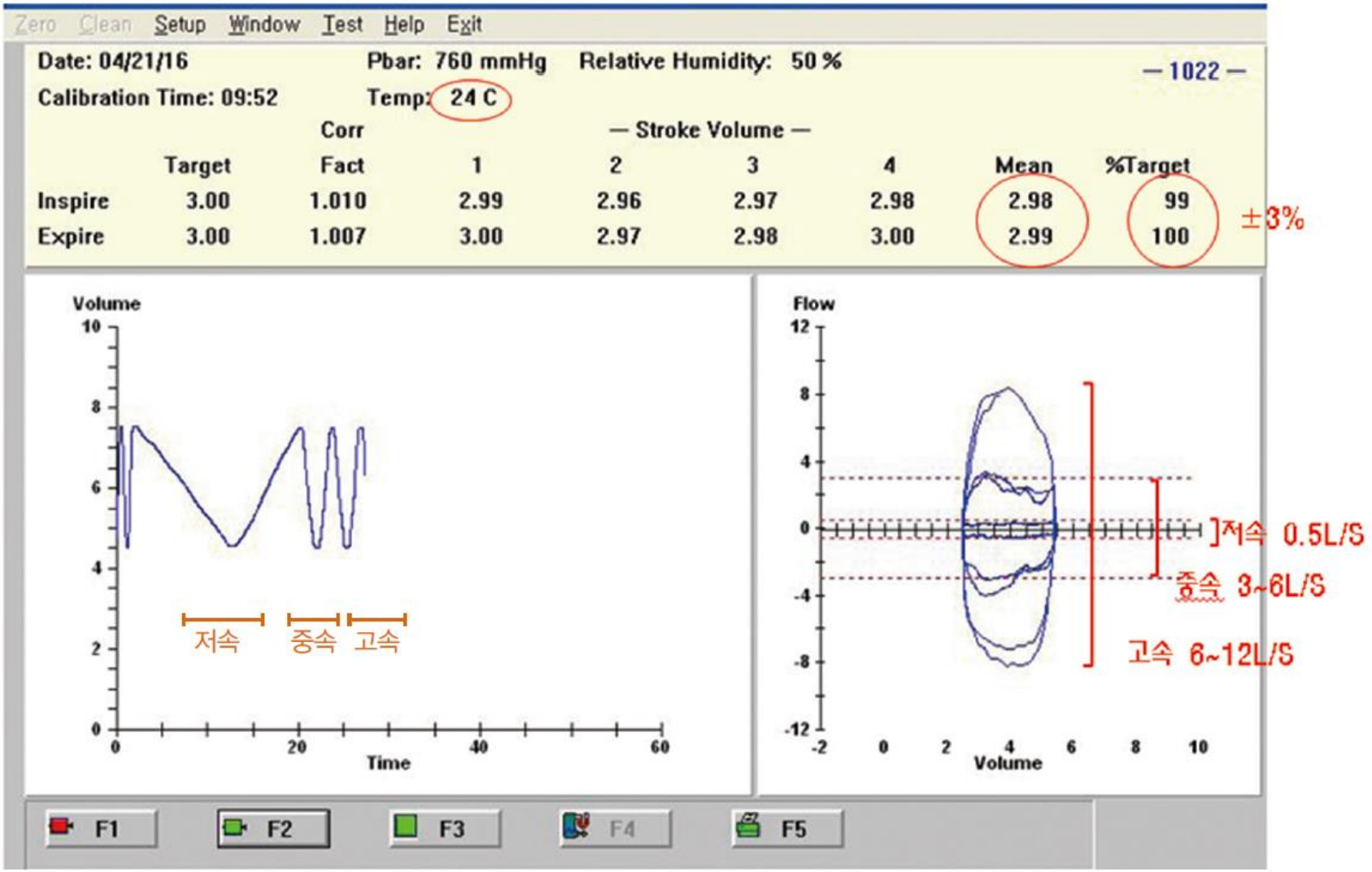

capillary
tubes
Airflow
P1
P2
Pressure ports
Heating coil


Heated element
protective screen
Temperature transducer
To integrating circuitry




Airflow
Light




Zero Clean Setup Window Test Help Exit
Date: 04/21/16
Pbar: 760 mmHg
Relative Humidity: 50 %
— 1022 —
Calibration Time: 09:52
Temp: 24 C
Corr
— Stroke Volume —
Target Fact 1 2 3 4 Mean %Target
Inspire 3.00 1.010 2.99 2.96 2.97 2.98 2.98 99
Expire 3.00 1.007 3.00 2.97 2.98 3.00 2.99 100
±3%
Volume
Time
저속
중속
고속
Flow
Volume
]저속 0.5L/S
중속 3~6L/S
고속 6~12L/S
F1
F2
F3
F4
F5

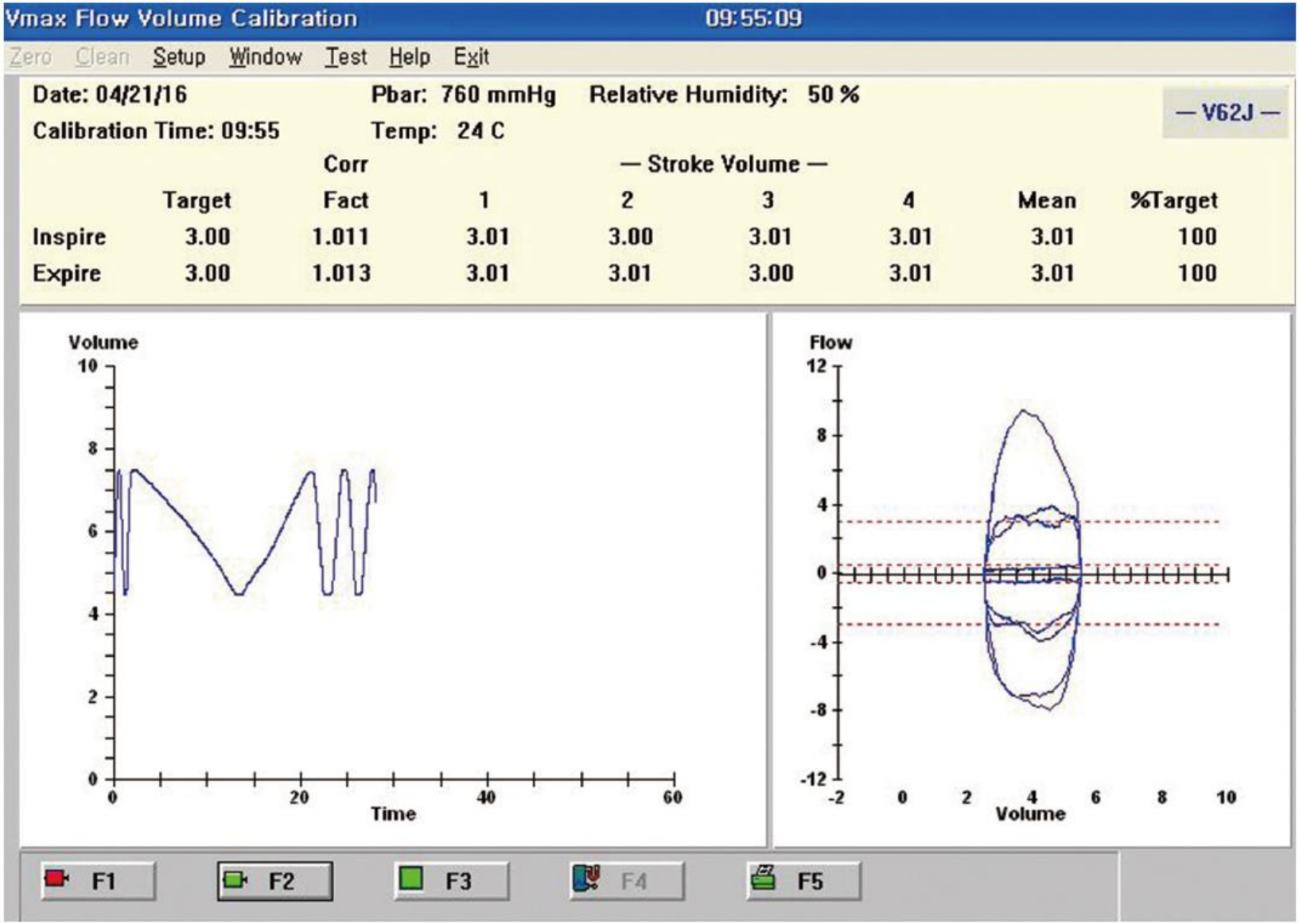
One or more of the Verify Strokes Exceed the ± 3% Accuracy Standards

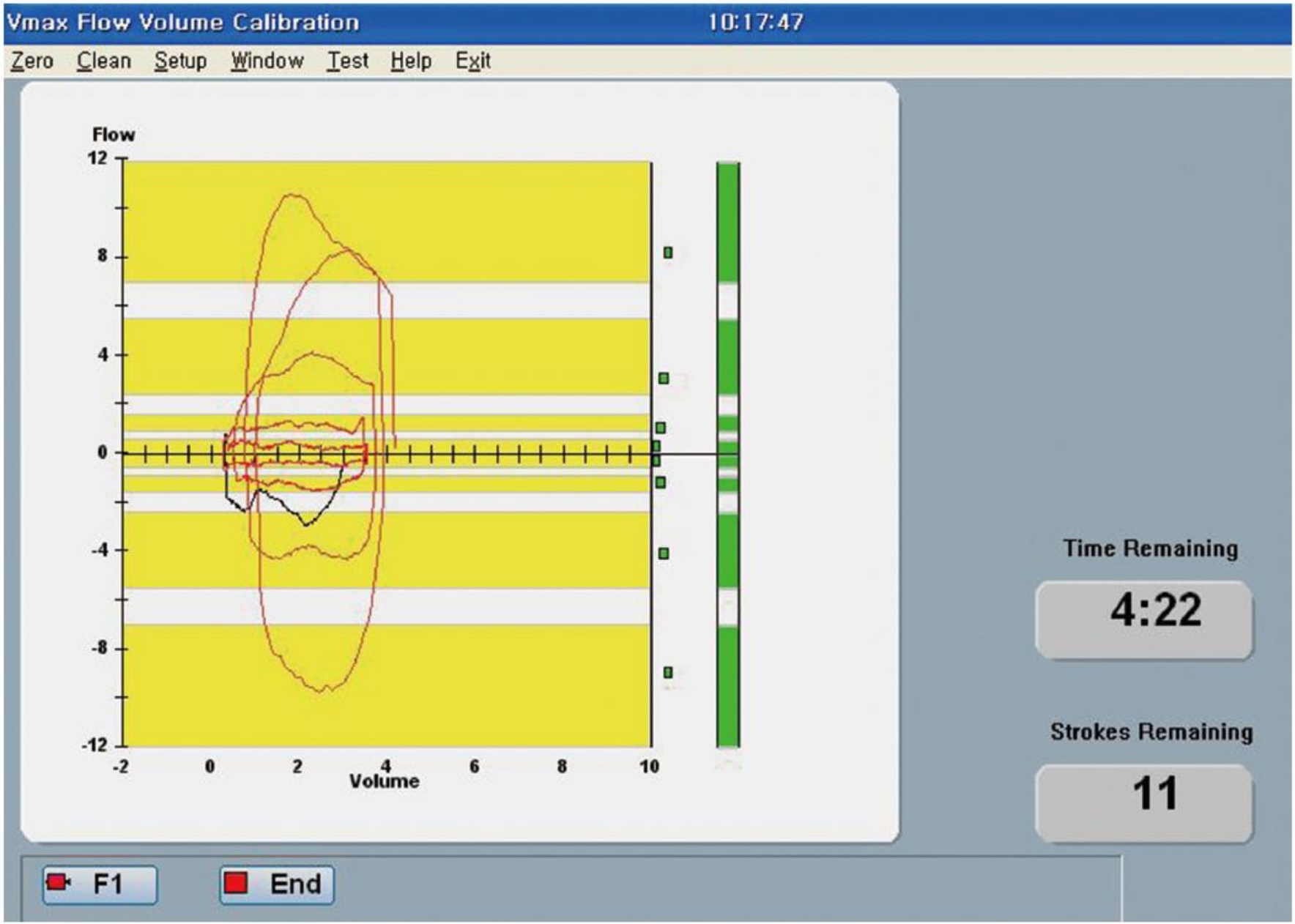
4번째 시행에서 보정기준범위 벗어남 ±3%

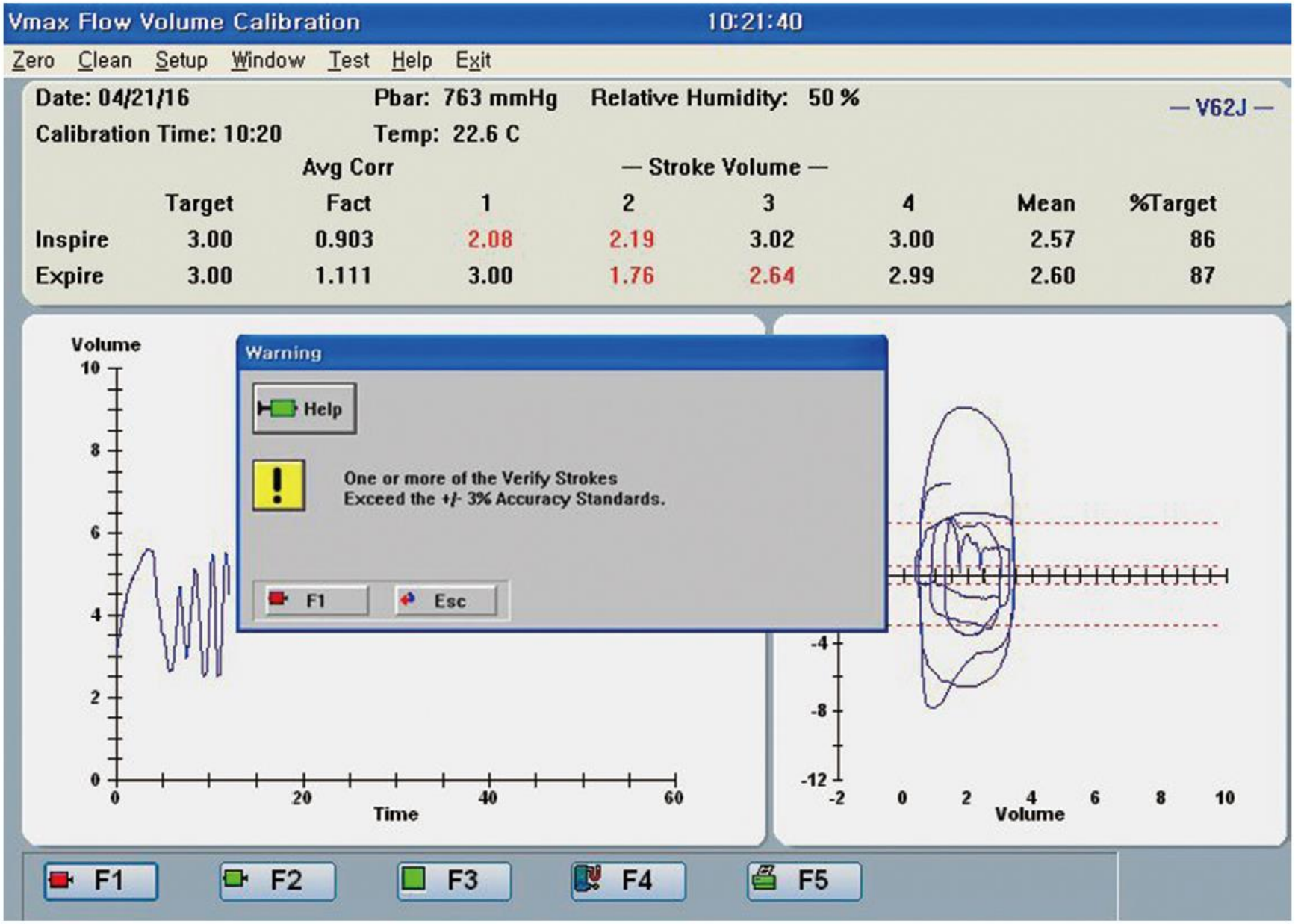
Out-of-range stroke volume

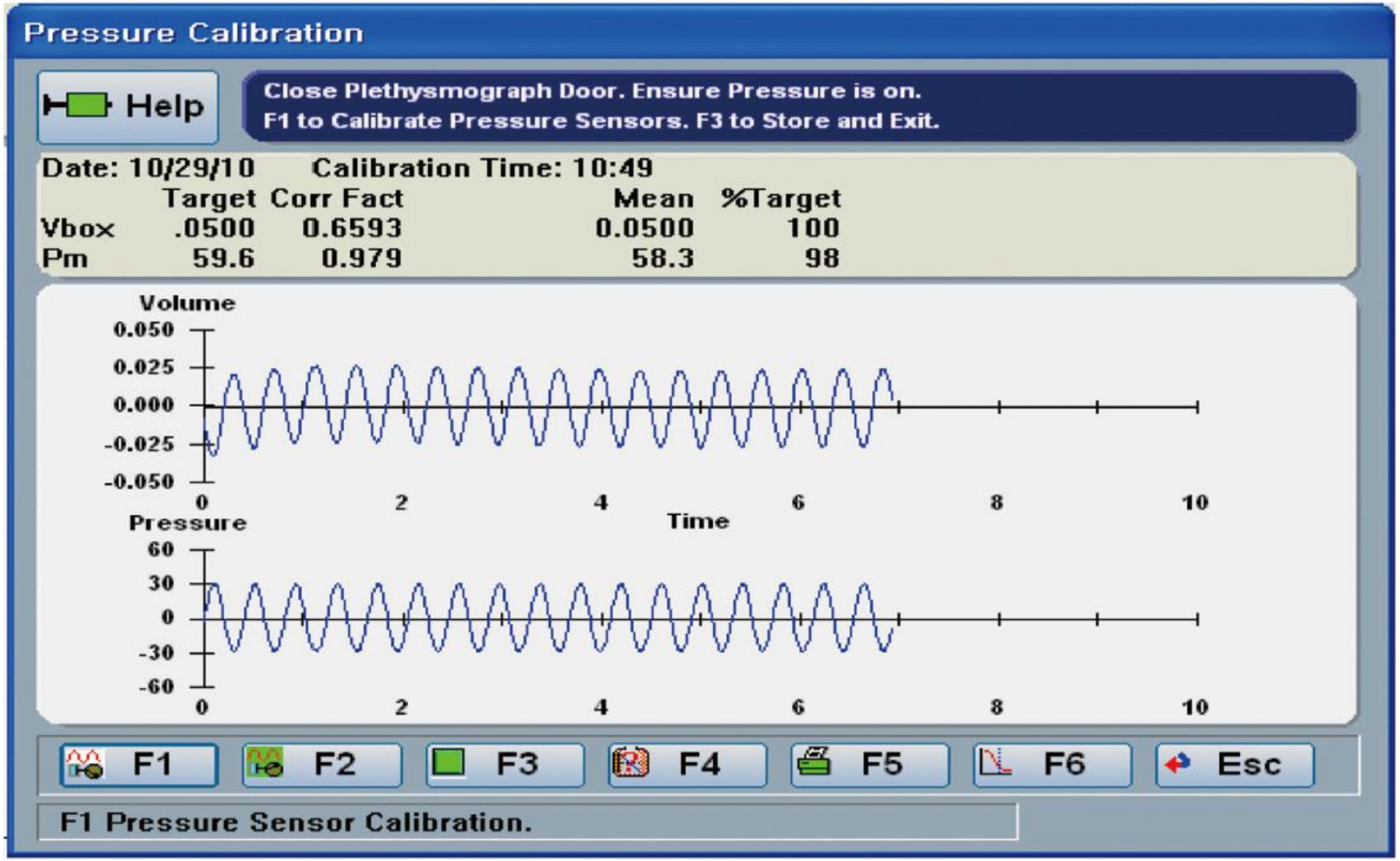
Calibration Date: 07/11/94
Calibration Time: 14:49:33

		Corr	— Stroke Volume —					
	Target	Fact	1	2	3	4	Mean	%Target
Inspire	3.00	0.989	2.97	3.06	2.98	2.90	2.98	99
Expire	3.00	0.981	3.05	2.96	2.96	2.96	2.98	99

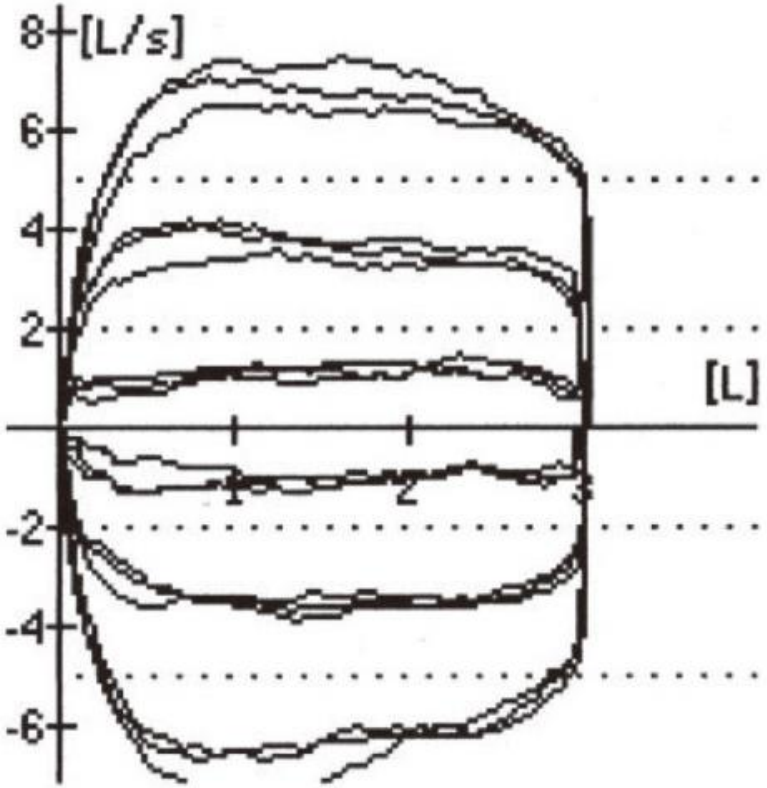

Vmax Flow Volume Calibration
09:55:09
Zero Clean Setup Window Test Help Exit
Date: 04/21/16
Pbar: 760 mmHg
Relative Humidity: 50 %
Calibration Time: 09:55
Temp: 24 C
— V62J —
Corr
— Stroke Volume —
Target
Fact
1
2
3
4
Mean
%Target
Inspire 3.00 1.011 3.01 3.00 3.01 3.01 3.01 100
Expire 3.00 1.013 3.01 3.01 3.00 3.01 3.01 100
Volume
10
8
6
4
2
0
0
20
40
60
Time
Flow
12
8
4
0
-4
-8
-12
-2
0
2
4
6
8
10
Volume
F1
F2
F3
F4
F5


Vmax Flow Volume Calibration
10:17:47
Zero
Clean
Setup
Window
Test
Help
Exit
Flow
12
8
4
0
-4
-8
-12
-2
0
2
4
6
8
10
Volume
Time Remaining
4:22
Strokes Remaining
11
F1
End


Vmax Flow Volume Calibration
10:21:40
Zero Clean Setup Window Test Help Exit
Date: 04/21/16
Pbar: 763 mmHg
Relative Humidity: 50 %
— V62J —
Calibration Time: 10:20
Temp: 22.6 C
Avg Corr
— Stroke Volume —
Target Fact 1 2 3 4 Mean %Target
Inspire 3.00 0.903 2.08 2.19 3.02 3.00 2.57 86
Expire 3.00 1.111 3.00 1.76 2.64 2.99 2.60 87
Volume
Time
Warning
Help
One or more of the Verify Strokes
Exceed the +/- 3% Accuracy Standards.
F1
Esc
Volume
F1
F2
F3
F4
F5


Pressure Calibration
Help
Close Plethysmograph Door. Ensure Pressure is on.
F1 to Calibrate Pressure Sensors. F3 to Store and Exit.
Date: 10/29/10 Calibration Time: 10:49
Target Corr Fact Mean %Target
Vbox .0500 0.6593 0.0500 100
Pm 59.6 0.979 58.3 98
Volume
0.050
0.025
0.000
-0.025
-0.050
0
2
4
6
8
10
Pressure
Time
60
30
0
-30
-60
0
2
4
6
8
10
F1
F2
F3
F4
F5
F6
Esc
F1 Pressure Sensor Calibration.

Linearity Calibration Check Re...



Stroke	IN(%)	OUT(%)	Okay	
1	-2.97	+1.33	✓	✓
2	-0.77	+1.13	✓	✓
3	-0.70	+1.27	✓	✓
4	-0.13	-0.23	✓	✓
5	-0.10	-0.33	✓	✓
6	-0.20	-0.37	✓	✓
7	+0.30	+1.10	✓	✓
8	+0.33	+0.73	✓	✓
9	+0.37	+1.30	✓	✓

End of Linearity Calibration Check.

Back

Cal Check

OK

Section 04

폐기능검사실

학습목표

1. 폐기능검사에 사용되는 용어를 설명할 수 있다(B).
2. 폐기능검사 전의 준비사항을 점검할 수 있다(A).

Name: , Date: 2012 01 26 Smoker: No How Long: 0 pack/yrs
Id: W Room: Pulmo Quit: No Stopped: yrs
Technician: Physician:
Gender: Female Height(cm): 162 Weight(kg): 56.0 Age: 23 Race: Asian

Spirometry (BTPS)

		PRED	PRE-RX BEST	PRE-RX %PRED	POST-RX BEST	POST-RX %PRED	% CHG
FVC	Liters	3.96	4.26	108			
FEV1	Liters	3.19	3.69	116			
FEV1/FVC	%	80	87				
FEF25-75%	L/sec	3.70	3.90	105			
PEF	L/sec	6.65	6.67	100			
MVV	L/min	120					
FET100%	Sec		4.84				

Lung Volumes (Plethysmograpy)

TLC	Liters	5.19
VC	Liters	3.96
IC	Liters	2.55
FRC PL	Liters	2.95
ERV	Liters	1.28
RV	Liters	1.51
RV/TLC	%	28

Diffusion

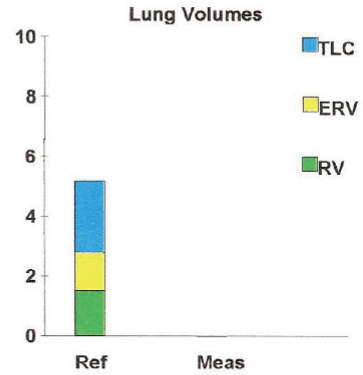
DLCO	mL/mmHg/min	22.4
VA	Liters	
DLCO/VA	mL/mHg/min/L	4.78

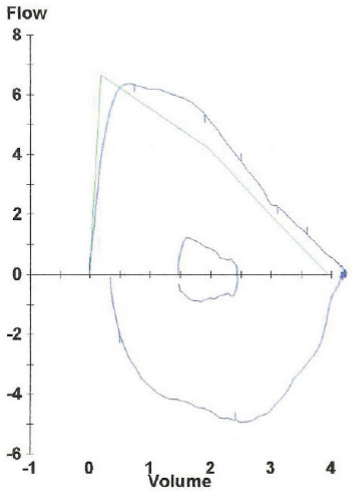
Airway Resistance

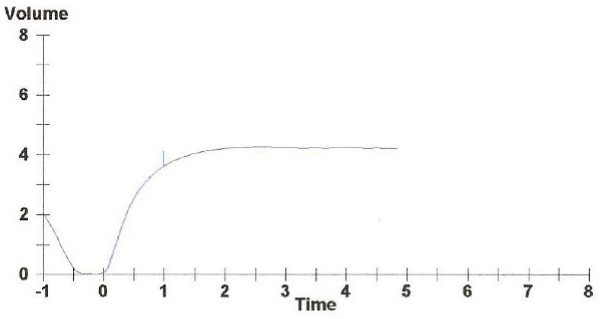
Raw	cmH2O/L/sec	1.29
sGaw	L/s/cmH2O/L	0.263

Max Pressure

PI max	cmH2O	92
PE max	cmH2O	158







Interpretation & Comments :

Name: , Date: 2012 01 16 Smoker: No How Long: 0 pack/yrs
Id: N Room: Pulmo Quit: No Stopped: yrs
Technician: Physician:
Gender: Male Height(cm): 177 Weight(kg): 68.0 Age: 65 Race: Asian

Spirometry (BTPS)

		PRED	PRE-RX BEST	PRE-RX %PRED	POST-RX BEST	POST-RX %PRED	% CHG
FVC	Liters	4.49	3.94	88	4.18	93	6
FEV1	Liters	3.10	1.93	62	1.98	64	2
FEV1/FVC	%	70	49		47		
FEF25-75%	L/sec	2.88	0.73	26	0.79	27	8
PEF	L/sec	8.44	4.01	48	4.58	54	14
MVV	L/min	134					
FET100%	Sec		9.66		7.84		-19

Lung Volumes (Plethysmograpy)

TLC	Liters	6.59
VC	Liters	4.49
IC	Liters	3.02
FRC PL	Liters	4.01
ERV	Liters	1.51
RV	Liters	2.46
RV/TLC	%	39

Diffusion

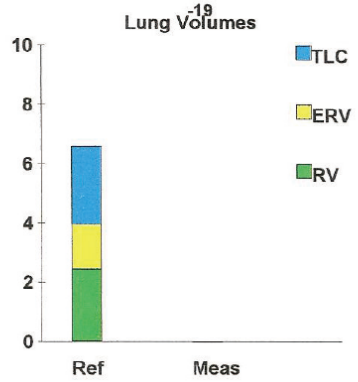
DLCO	mL/mmHg/min	19.8	22.3	112
VA	Liters	7.06	5.48	78
DLCO/VA	mL/mHg/min/L	3.70	4.07	110

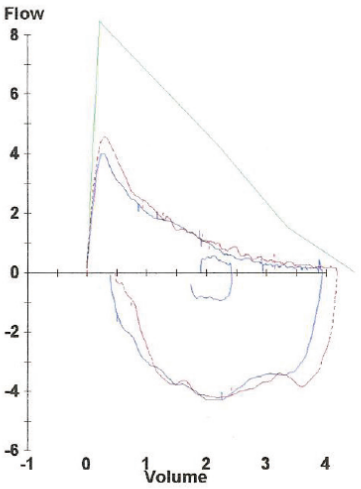
Airway Resistance

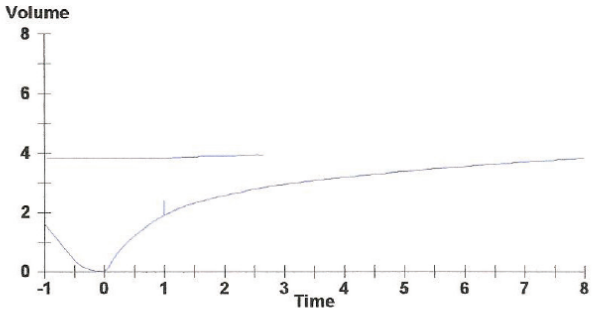
Raw	cmH2O/L/sec	1.09
sGaw	L/s/cmH2O/L	0.229

Max Pressure

PI max	cmH2O	107
PE max	cmH2O	201







Interpretation & Comments :

Name: ,
Id: F
Technician:
Gender: Female

Date: 2011 06 17
Room: Pulmo
Physician:
Height(cm): 152

Smoker: No
Quit: No
Weight(kg): 59.0

How Long: pack/yrs
Stopped: yrs
Age: 52

Race: Asian

Spirometry (BTPS)

		PRED	PRE-RX BEST	PRE-RX %PRED	POST-RX BEST	POST-RX %PRED	% CHG
FVC	Liters	2.80	1.55	55	1.52	54	-2
FEV1	Liters	2.11	1.43	68	1.43	68	0
FEV1/FVC	%	75	92		94		
FEF25-75%	L/sec	2.59	3.44	133	3.89	150	13
PEF	L/sec	5.43	5.76	106	6.09	112	6
MVV	L/min	98					
FET100%	Sec		7.01		7.15		2

Lung Volumes (Plethysmograpy)

TLC	Liters	4.15
VC	Liters	2.80
IC	Liters	1.82
FRC PL	Liters	2.36
ERV	Liters	0.91
RV	Liters	1.45
RV/TLC	%	35

Diffusion

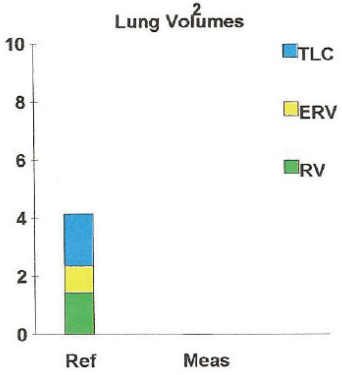
DLCO	mL/mmHg/min	18.4	8.7	47
VA	Liters		1.98	
DLCO/VA	mL/mHg/min/L	4.00	4.41	110

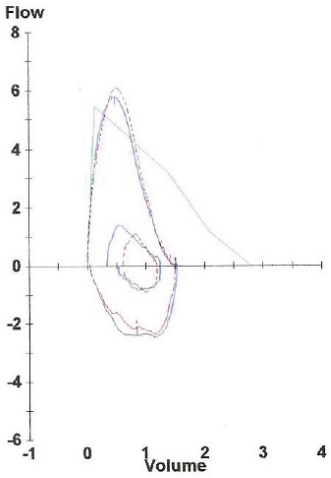
Airway Resistance

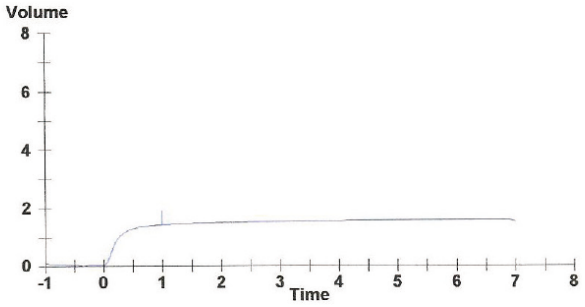
Raw	cmH2O/L/sec	1.65
sGaw	L/s/cmH2O/L	0.257

Max Pressure

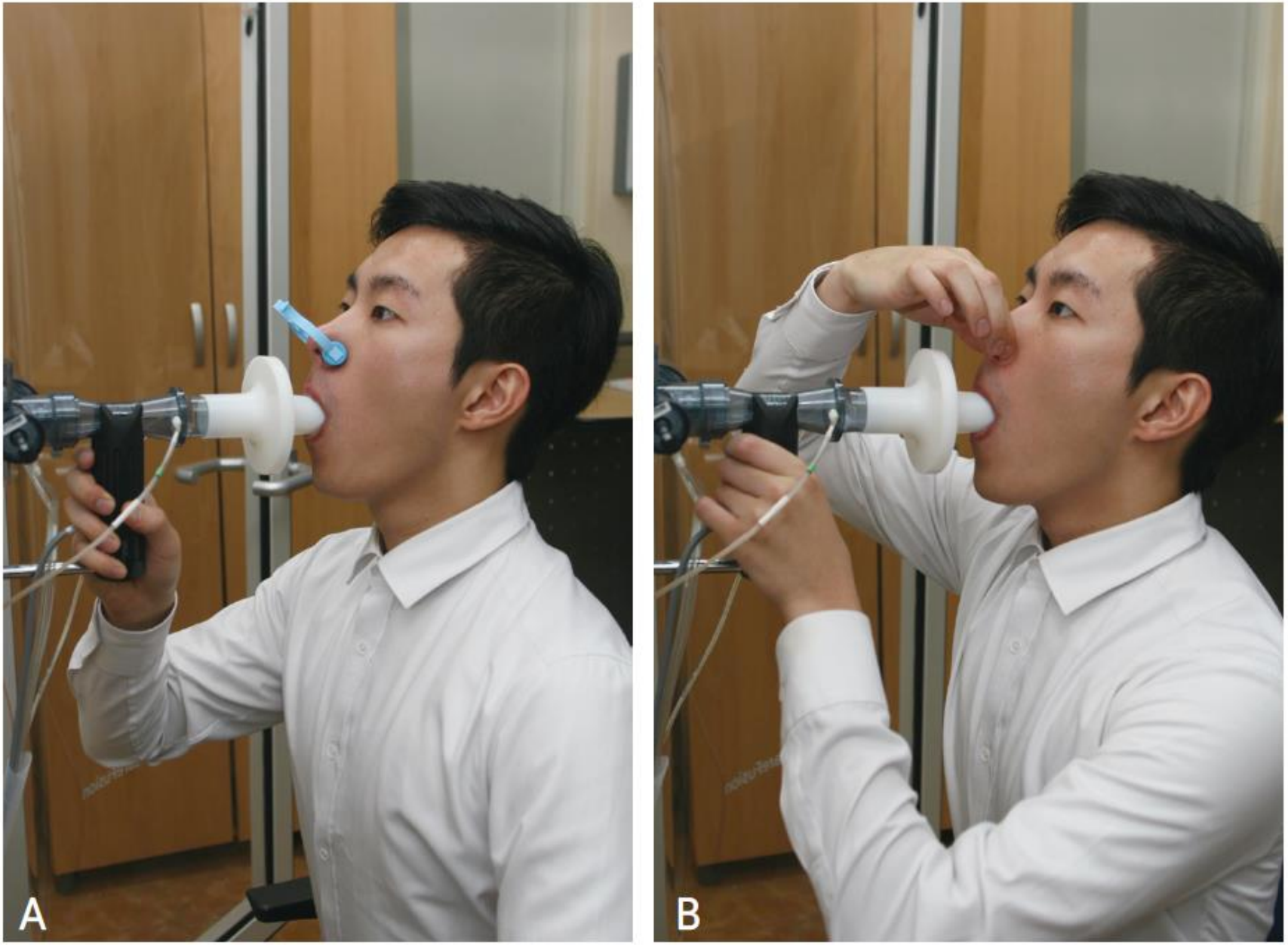
PI max	cmH2O	77
PE max	cmH2O	142







Interpretation & Comments :

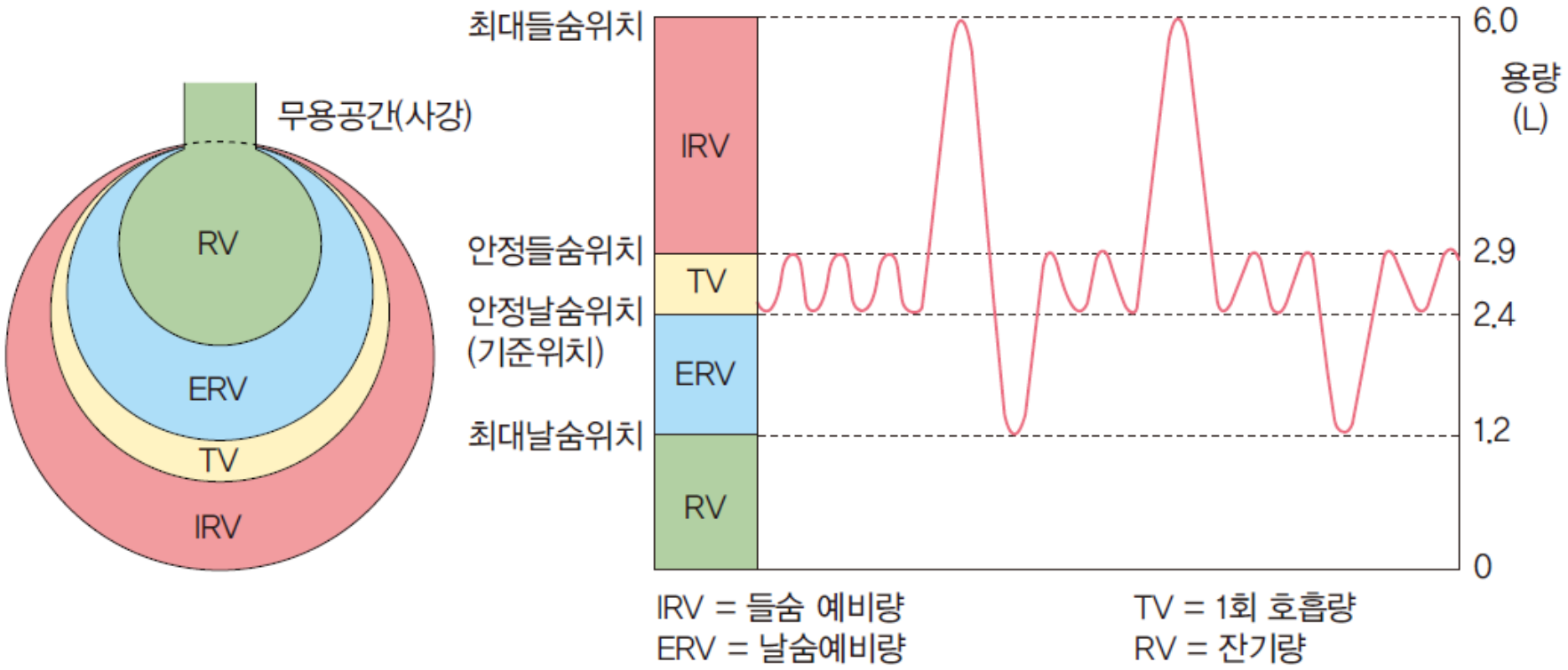

A
B

Section 05

폐활량 측정법

학습 목표

1. 폐활량검사를 수행할 수 있다(A).
2. 노력성 폐활량검사를 수행할 수 있다(A).
3. 최대 환기량 검사를 수행할 수 있다(A).
4. 폐기능검사 시에 발생하는 오류를 해결할 수 있다(A).

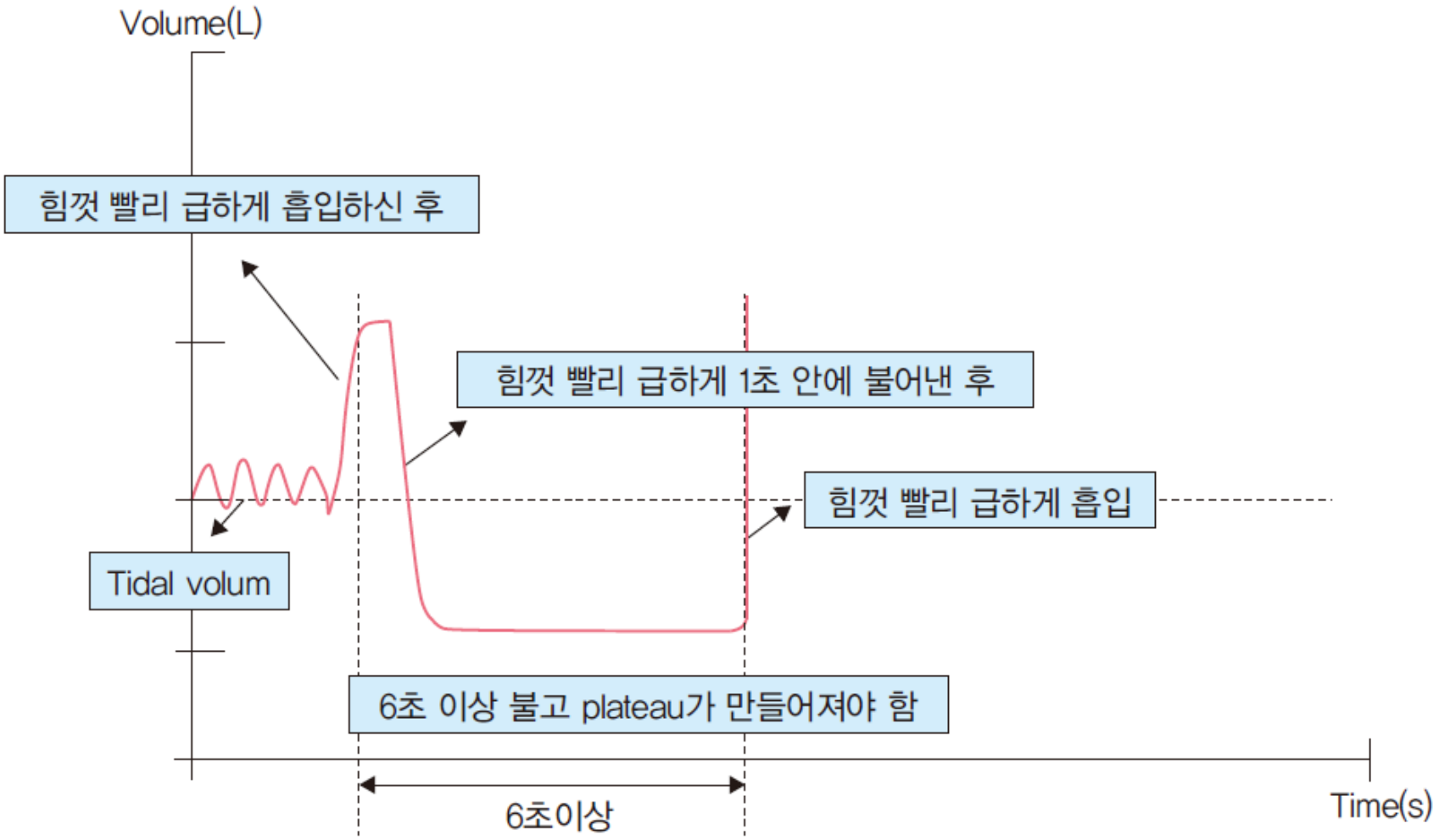

무용공간(사강)
RV
ERV
TV
IRV
최대들숨위치
안정들숨위치
안정날숨위치
(기준위치)
최대날숨위치
IRV
TV
ERV
RV
6.0
용량
(L)
2.9
2.4
1.2
0
IRV = 들숨 예비량
ERV = 날숨예비량
TV = 1회 호흡량
RV = 잔기량




SVC measurement
SpO2
Item
No.1
No.2
No.3
SVC
2.55
3.72
SVCer
XSVC
IC
1.54
2.00
TV
0.34
0.50
ERV
1.01
1.72
IRV
1.20
1.41
Select
Overlaid
FVC
4.25
Scale
Delete
START
STOP
PRINT
MENU





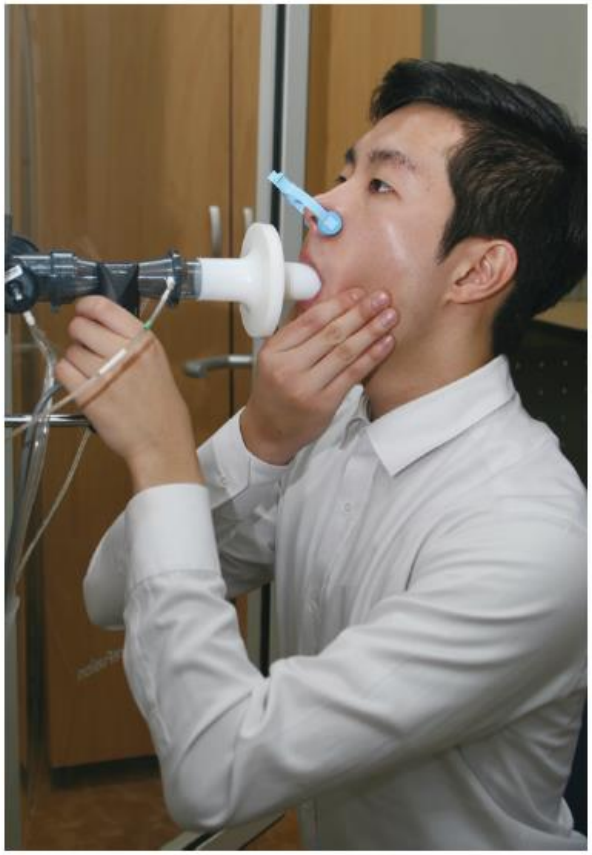

Volume(L)
힘껏 빨리 급하게 흡입하신 후
힘껏 빨리 급하게 1초 안에 불어낸 후
힘껏 빨리 급하게 흡입
Tidal volum
6초 이상 불고 plateau가 만들어져야 함
6초이상
Time(s)



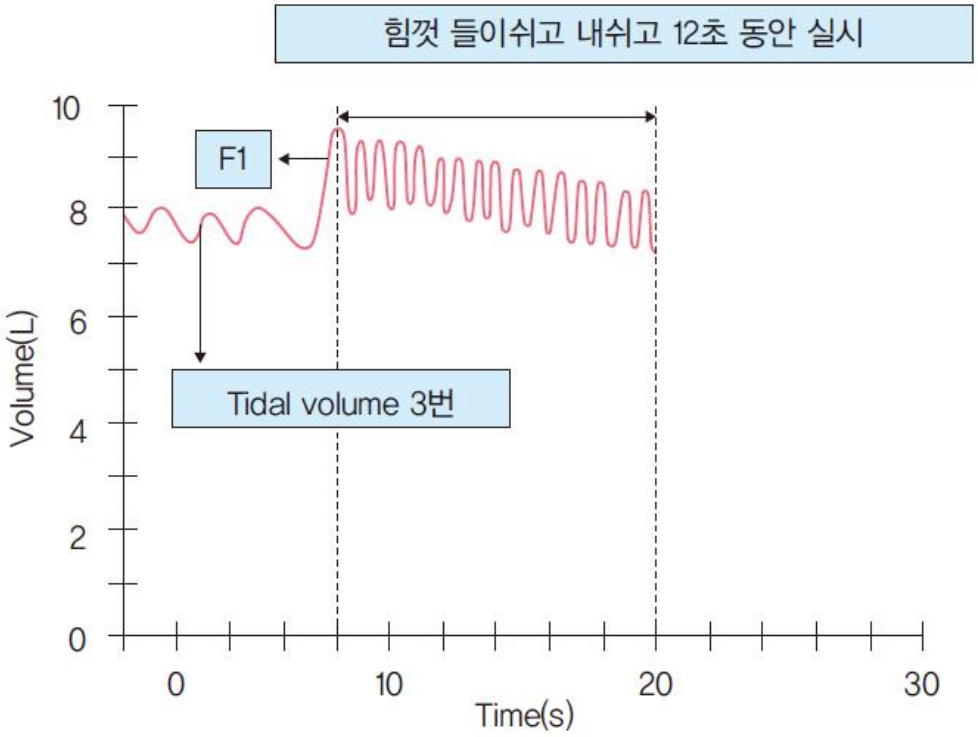
① 처음에는 편안히 숨쉬다가



② 깊게 힘껏 들이마시고



③ 힘껏 내쉬고 12초동안 반복한다.


힘껏 들이쉬고 내쉬고 12초 동안 실시
F1
Tidal volume 3번
Volume(L)
Time(s)
0
2
4
6
8
10
0
10
20
30





① 먼저 안정날숨위치까지 불어낸다.



② 흡입보조기를 입에 문다.



③ 최대들숨위치까지 들이마신다.



④ 5~10초 참는다.

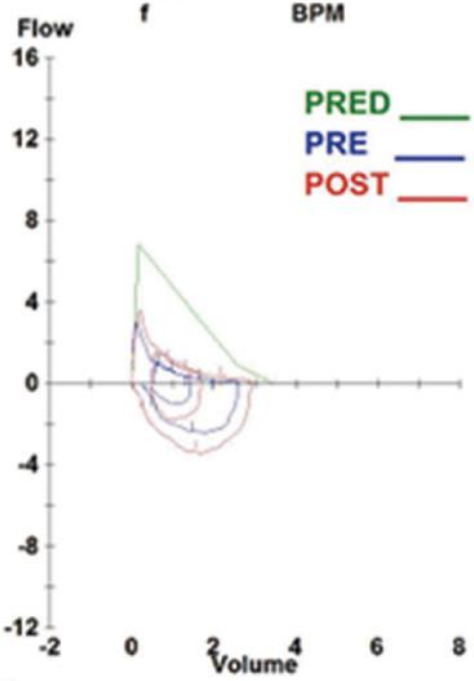


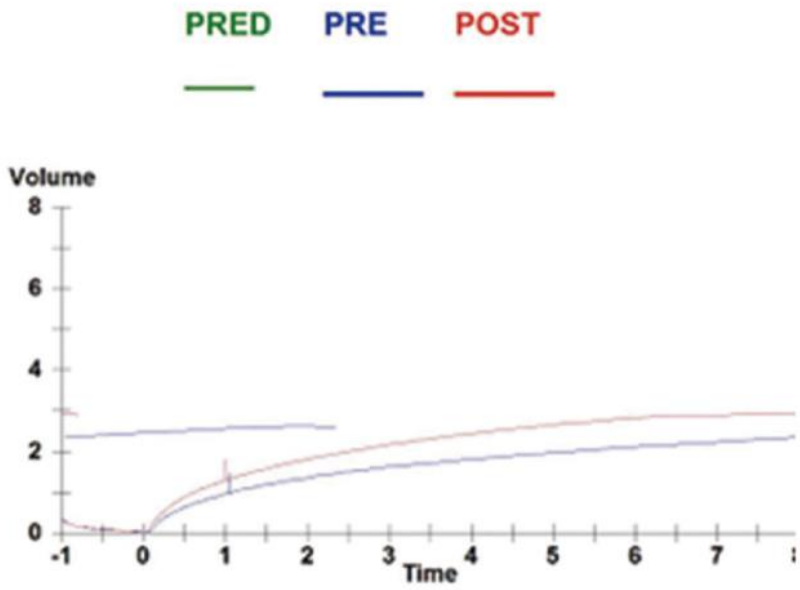
⑤ 최대날숨위치까지 천천히 내쉰다.

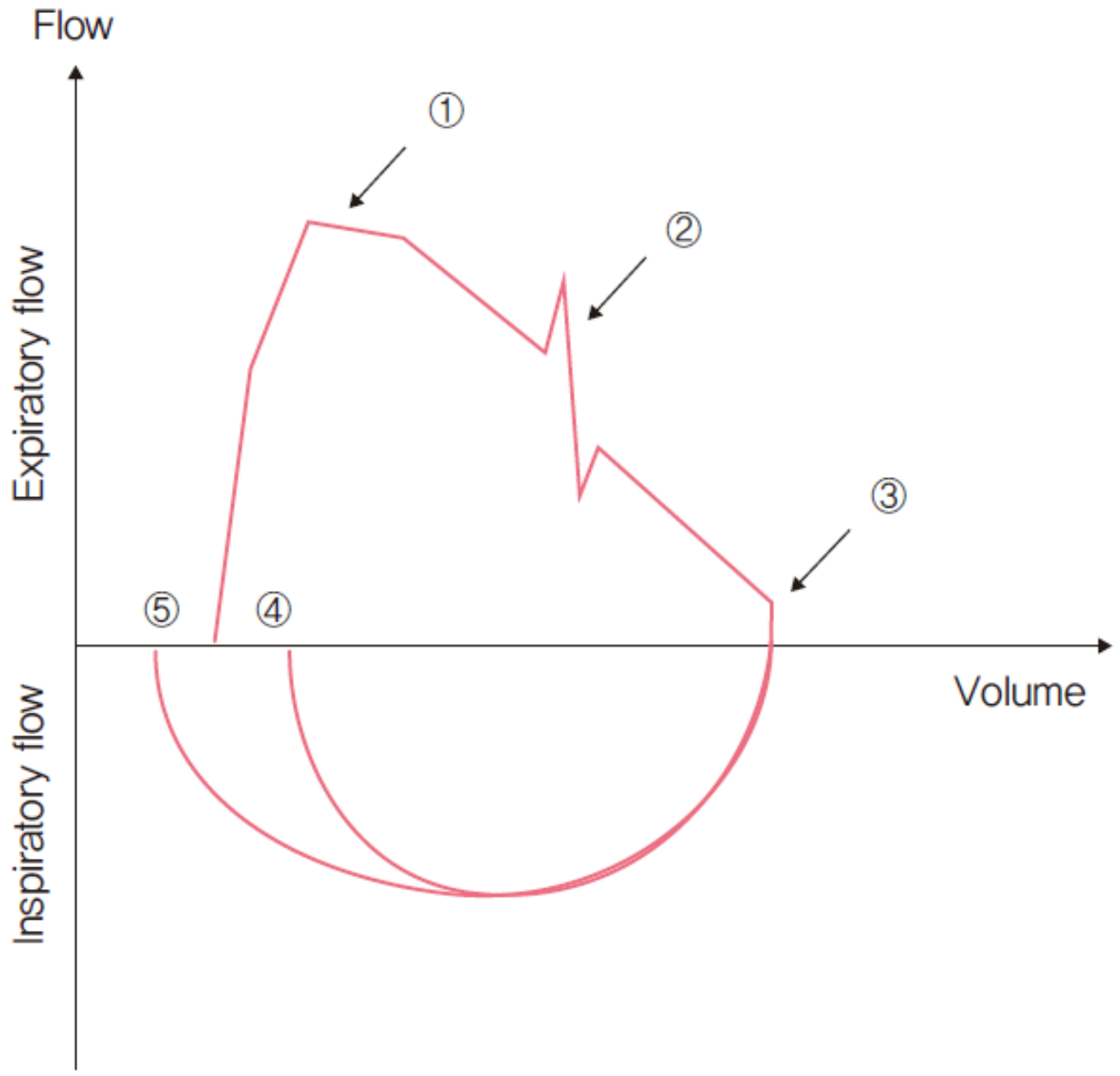
Spirometry

(BTPS)

		PRED	PRE-RX BEST	PRE-RX %PRED	POST-RX BEST	POST-RX %PRED	% CHG
FVC	Liters	3.46	2.61	75	2.92	84	12
FEV1	Liters	2.26	1.00	44	1.31	58	32
FEV1/FVC	%	79	38		45		
FEF25-75%	L/sec	2.12	0.29	14	0.53	25	81
IsoFEF25-75	L/sec	2.12	0.29	14	0.74	35	150
FEF75-85%	L/sec		0.13		0.27		103
PEF	L/sec	6.84	3.06	45	4.25	62	39
FET100%	Sec		11.31		8.20		-28
FIVC	Liters	3.46	2.33	67	2.87	83	23
FEV1	Liters	2.26	1.00	44	1.31	58	32
FIV1	Liters		1.89		2.49		32
FEF/FIF50		<1.00	0.13		0.18		39
Vol Extrap	Liters		0.01		0.01		62
FVL ECode			001010		000010		
MVV	L/min	102					
f	BPM						





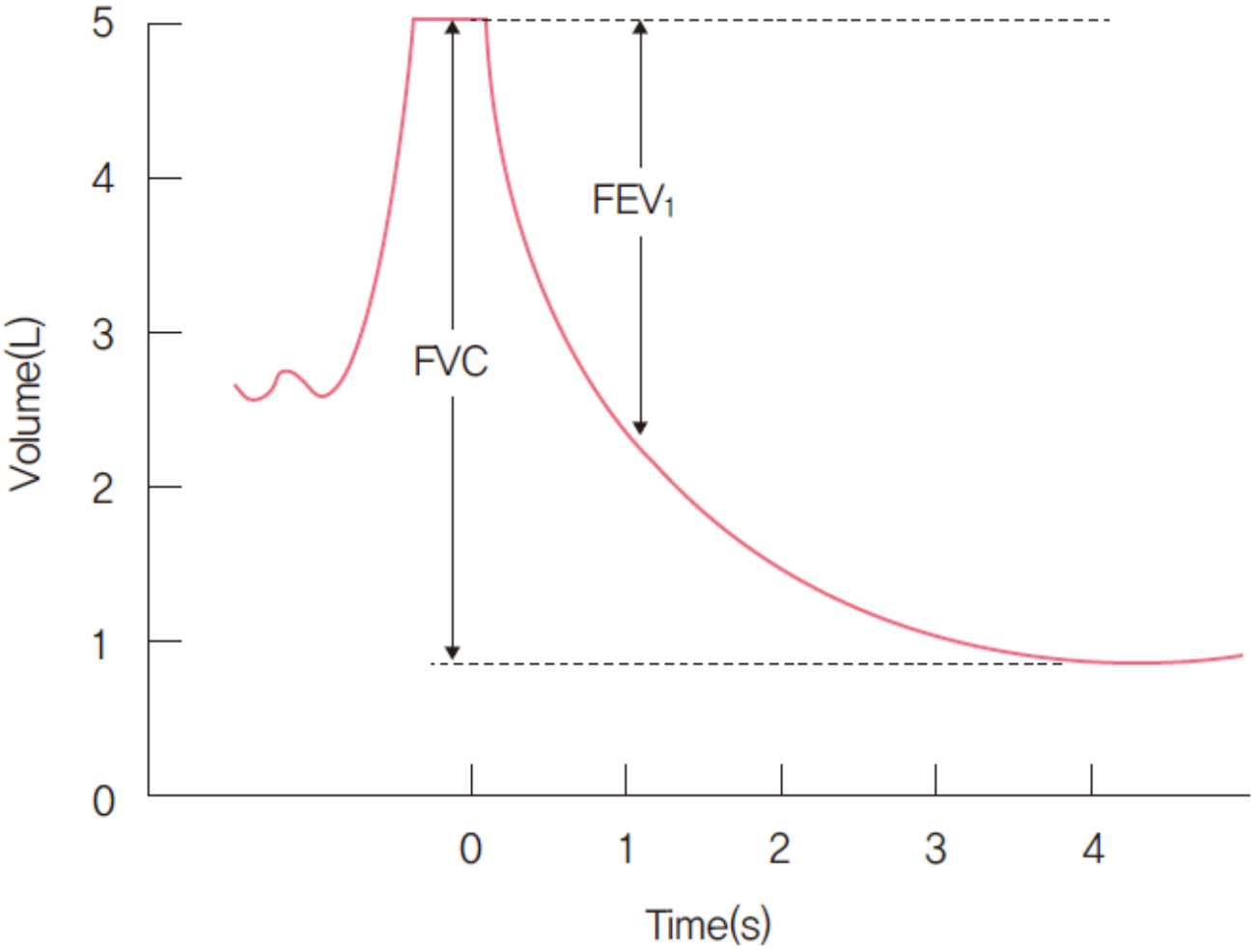

Flow
Expiratory flow
Inspiratory flow
Volume
①
②
③
④
⑤

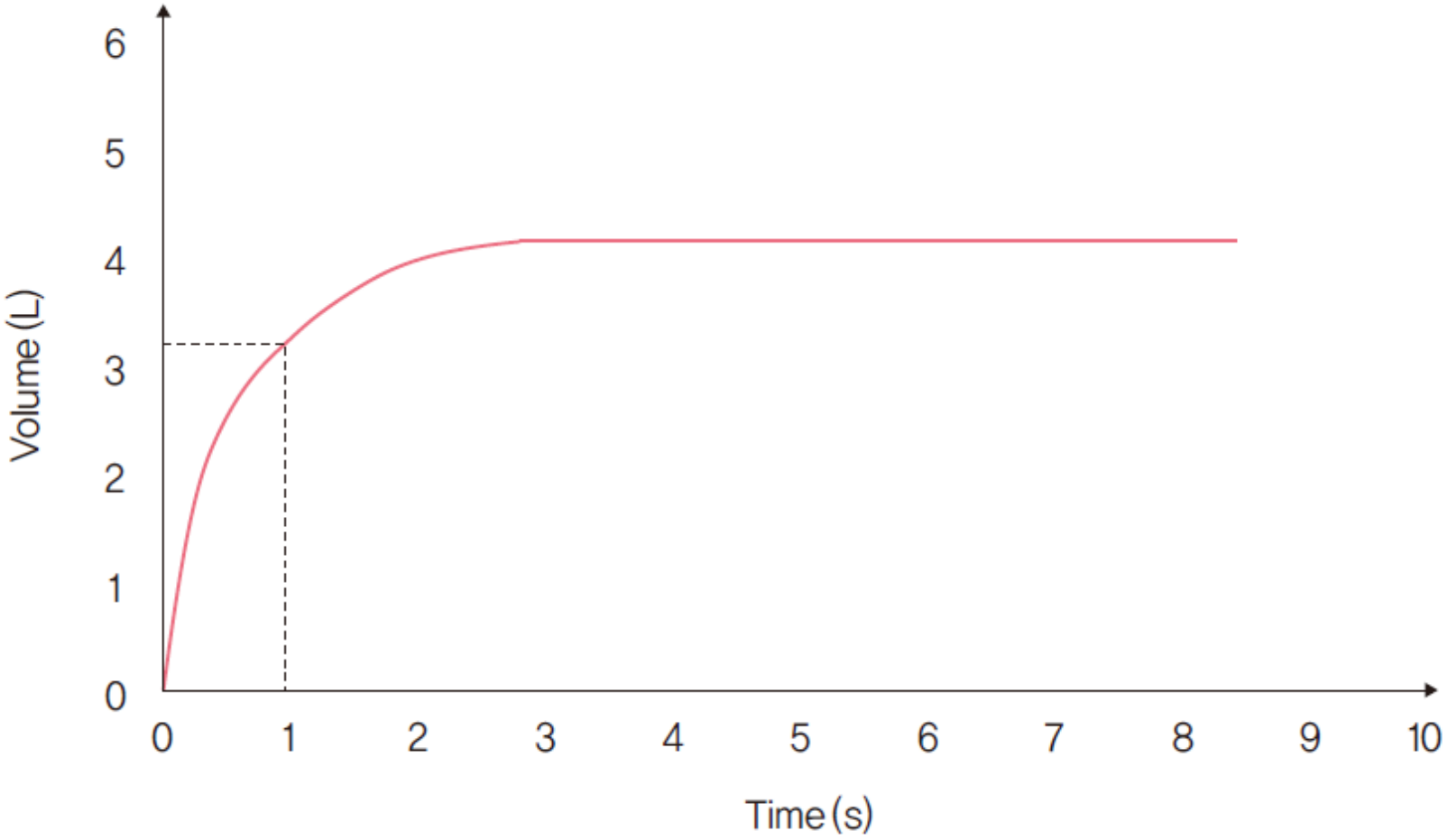
Section 06

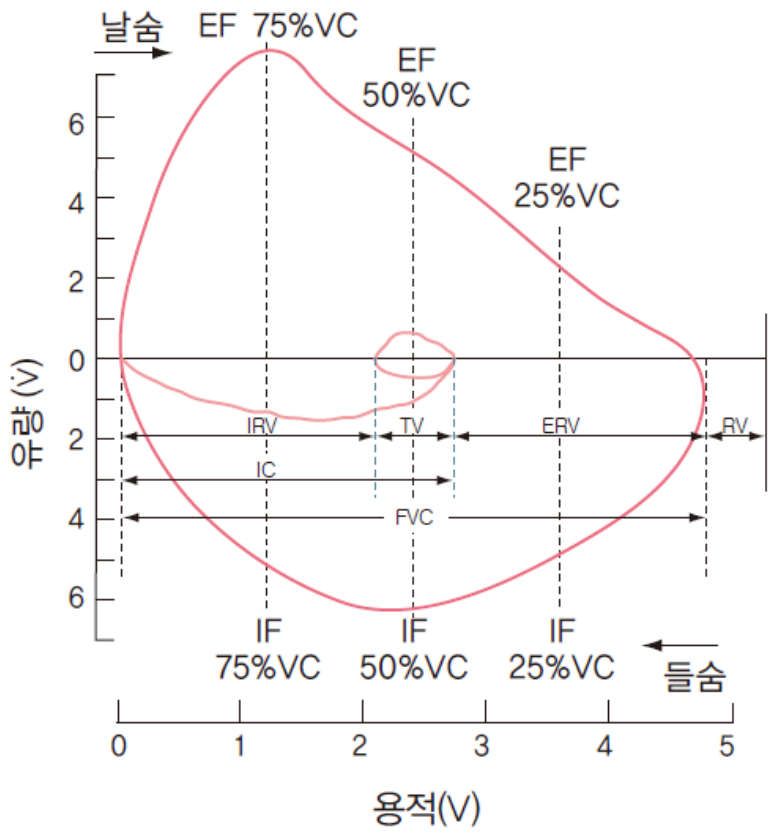
폐기능검사치의 평가 및 결과 해석

학습 목표

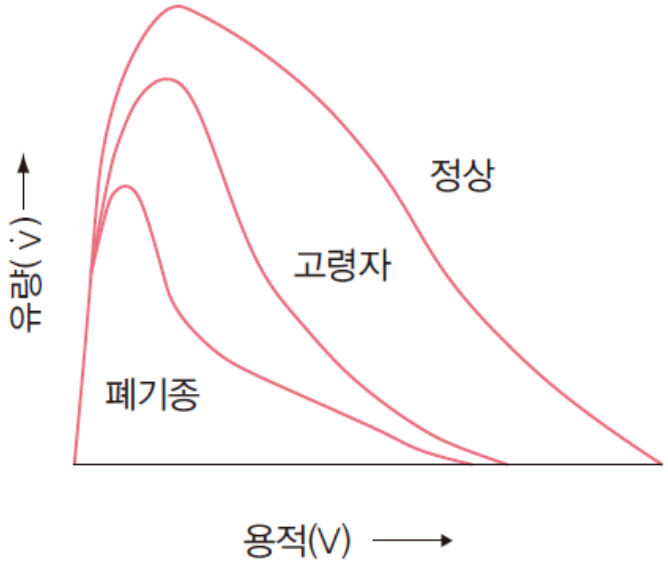
1. 폐활량 검사결과를 평가 및 해석할 수 있다(A).
2. 노력성 폐활량 검사결과를 평가 및 해석할 수 있다(A).
3. 최대 환기량 검사결과를 평가 및 해석할 수 있다(A).


5
4
3
2
1
0
Volume(L)
FVC
FEV1
0
1
2
3
4
Time(s)

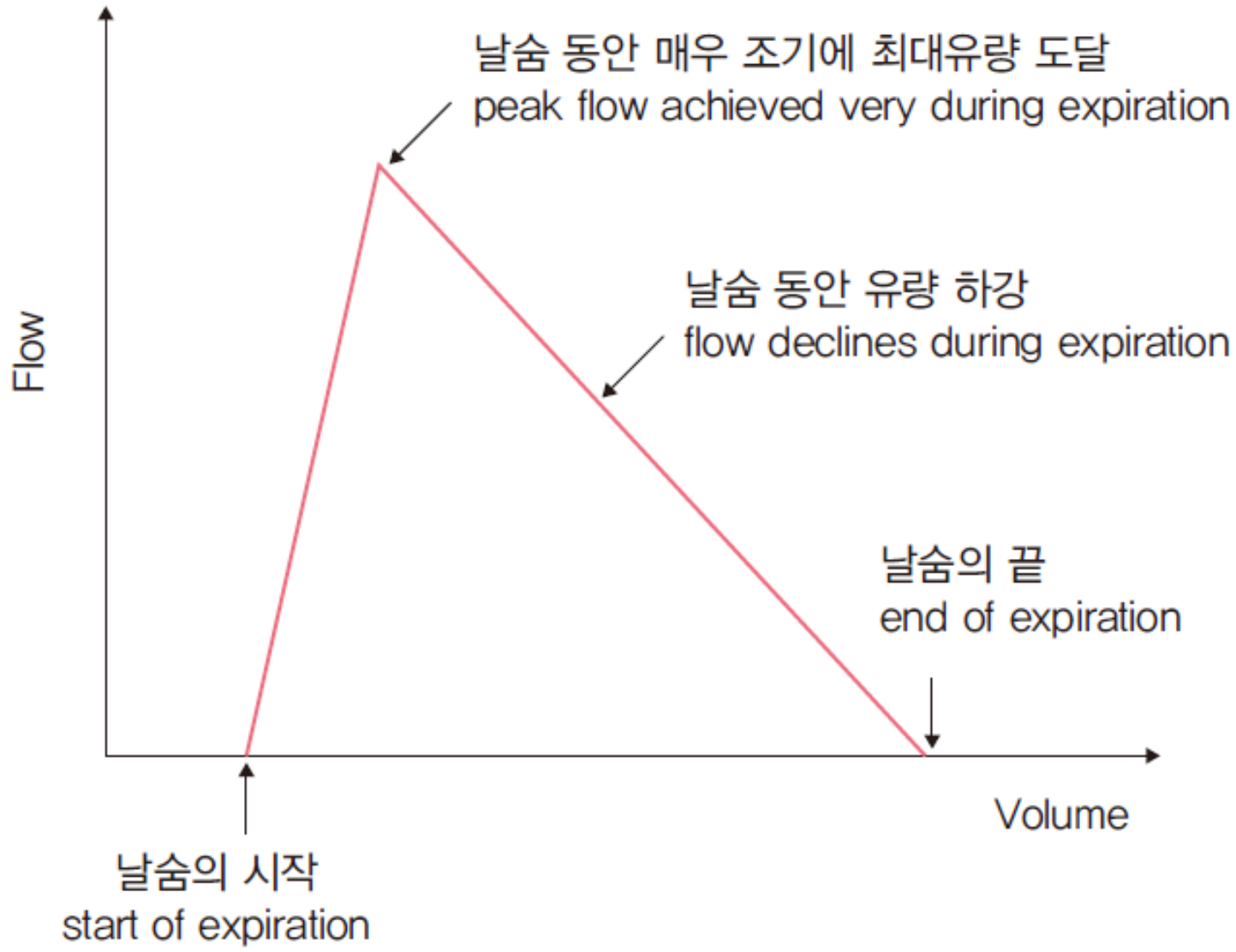

Volume (L)
0
1
2
3
4
5
6
0
1
2
3
4
5
6
7
8
9
10
Time (s)

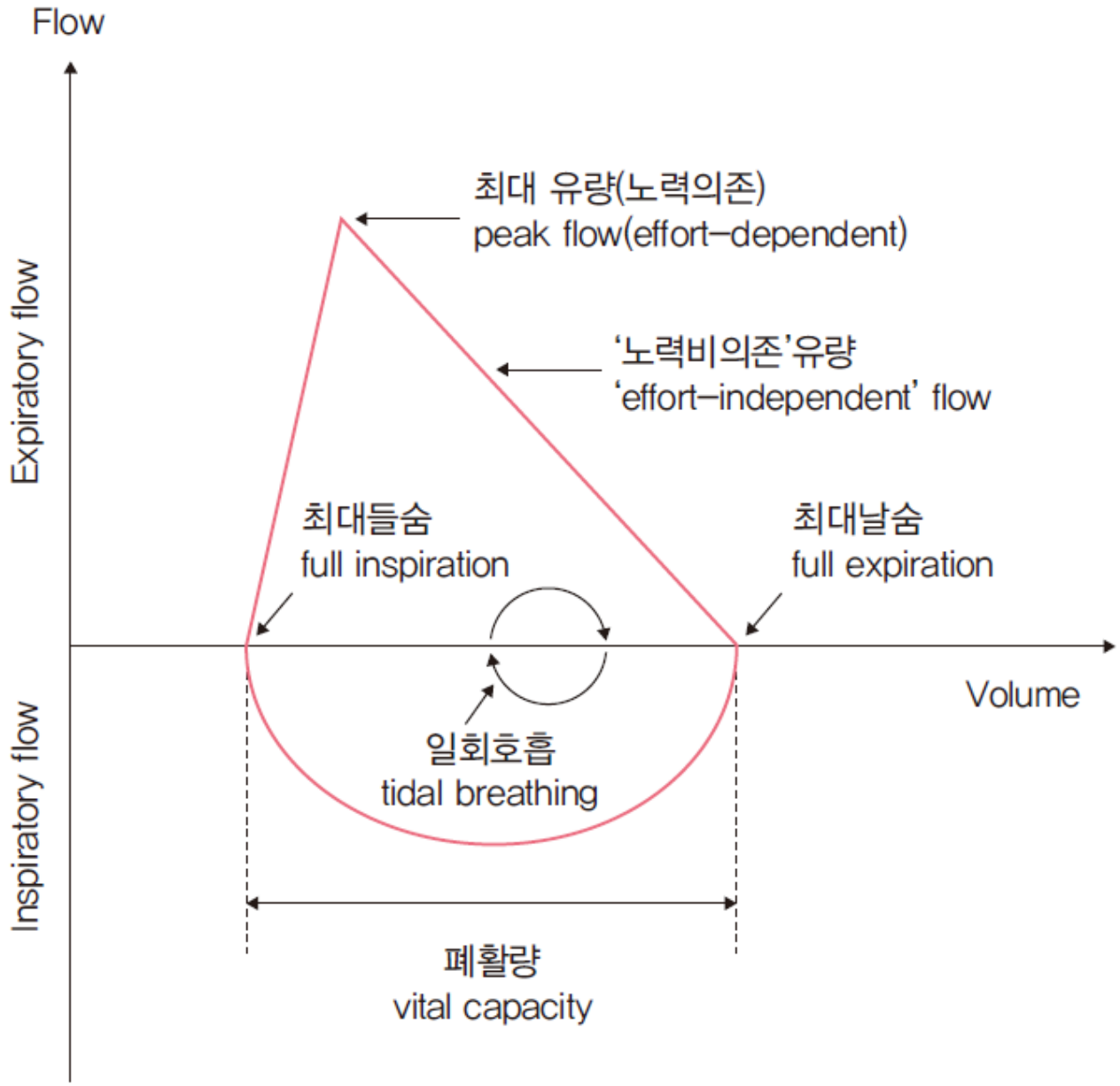

날숨
EF 75%VC
EF
50%VC
EF
25%VC
6
4
2
0
2
4
6
유량(V̇)
IRV
TV
ERV
RV
IC
FVC
IF
75%VC
IF
50%VC
IF
25%VC
들숨
0
1
2
3
4
5
용적(V)

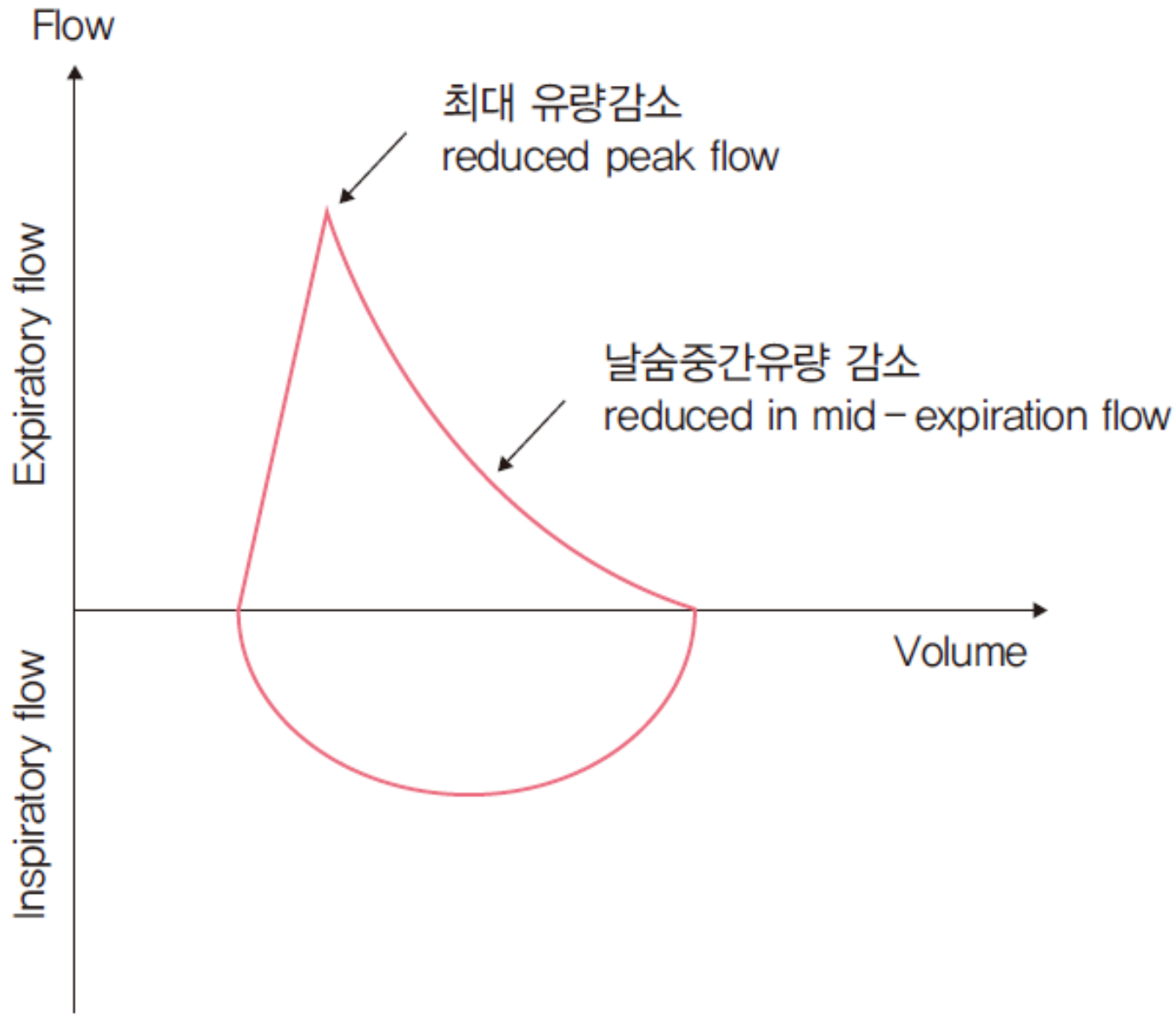
A

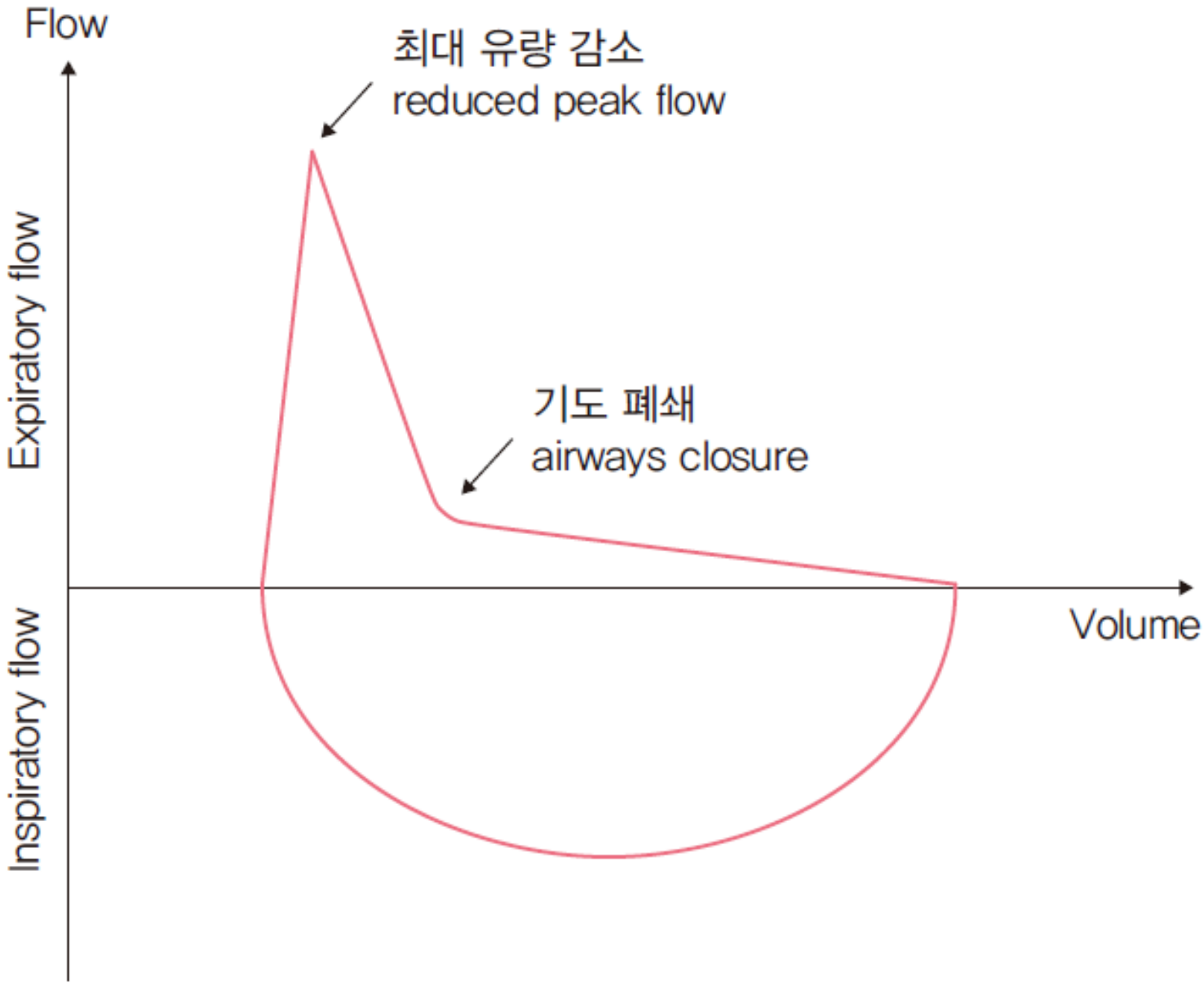

유량(V̇)
정상
고령자
폐기종
용적(V)

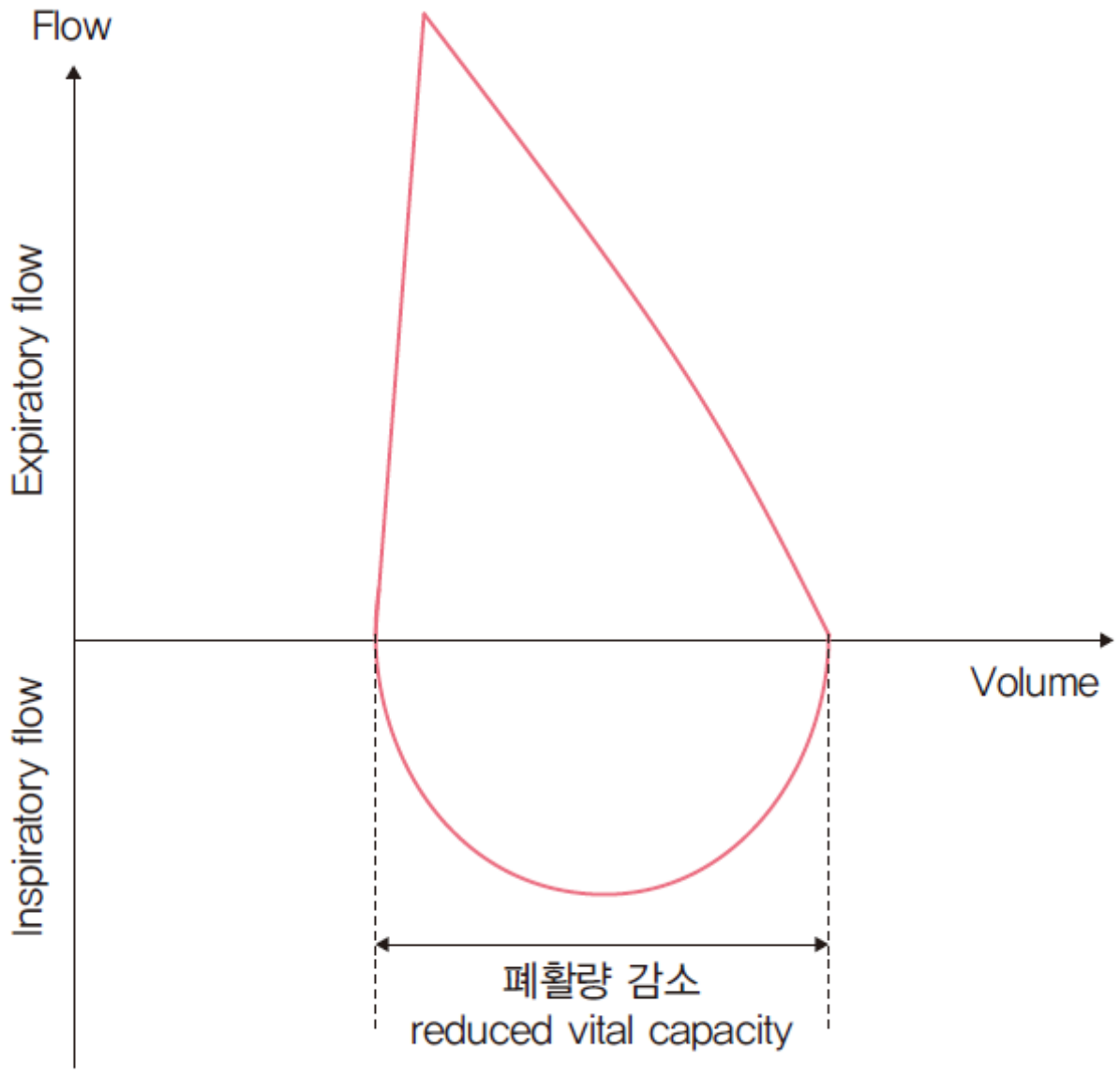
B


날숨 동안 매우 조기에 최대유량 도달
peak flow achieved very during expiration
날숨 동안 유량 하강
flow declines during expiration
날숨의 끝
end of expiration
Flow
Volume
날숨의 시작
start of expiration

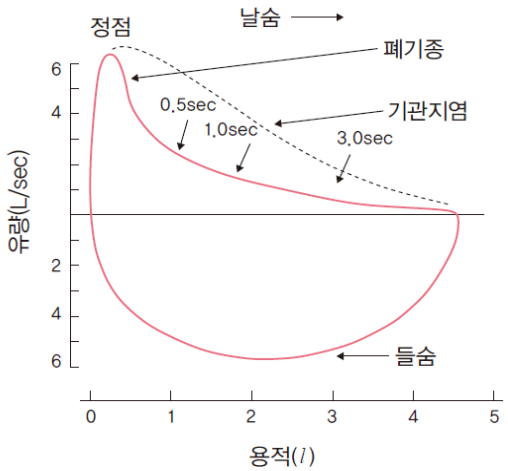

Flow
Expiratory flow
Inspiratory flow
최대 유량(노력의존)
peak flow(effort-dependent)
'노력비의존'유량
'effort-independent' flow
최대들숨
full inspiration
최대날숨
full expiration
Volume
일회호흡
tidal breathing
폐활량
vital capacity


Flow
최대 유량감소
reduced peak flow
날숨중간유량 감소
reduced in mid－expiration flow
Expiratory flow
Inspiratory flow
Volume

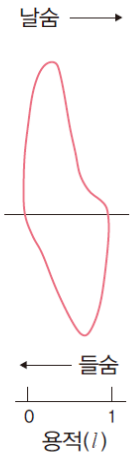

Flow
최대 유량 감소
reduced peak flow
Expiratory flow
기도 폐쇄
airways closure
Volume
Inspiratory flow

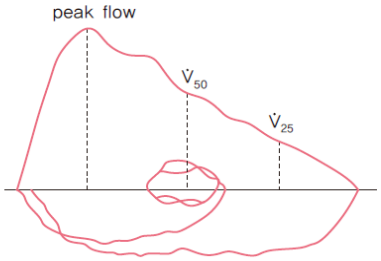

Flow
Expiratory flow
Inspiratory flow
Volume
폐활량 감소
reduced vital capacity

폐쇄성질환

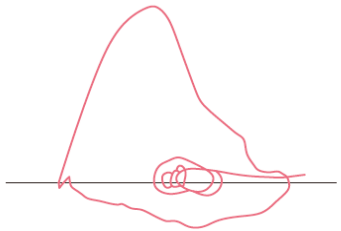


제한성질환

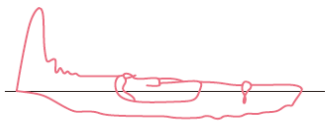




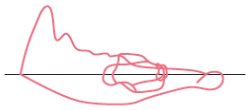
정상인의 flow－volume곡선
(23세, 여성, 비흡연자)



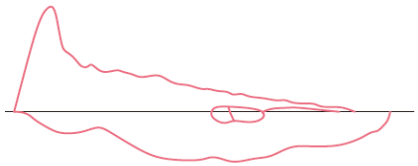
폐섬유증 flow－volume곡선
(65세, 여성, $\dot{V}_{50}$ 4.7 L/초,
$\dot{V}_{25}$ 1.2 L/초, $\dot{V}_{50}/\dot{V}_{25}$ 3.92)



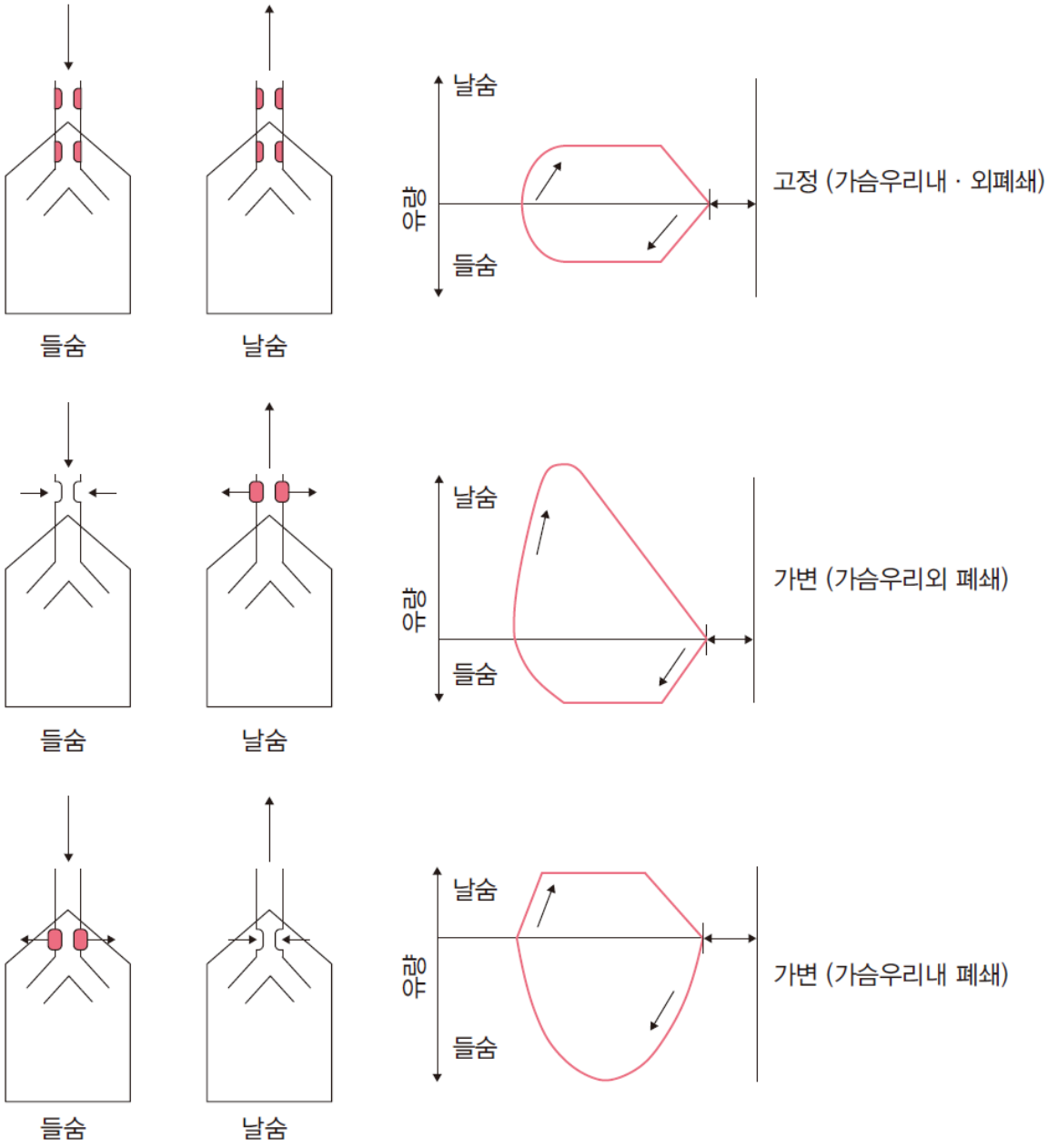
심한 폐기종
(60세, 남성, $\dot{V}_{50}$ 0.5 L/초,
V_{25} 0.3 L/초, $\dot{V}_{50}/\dot{V}_{25}$ 1.67)



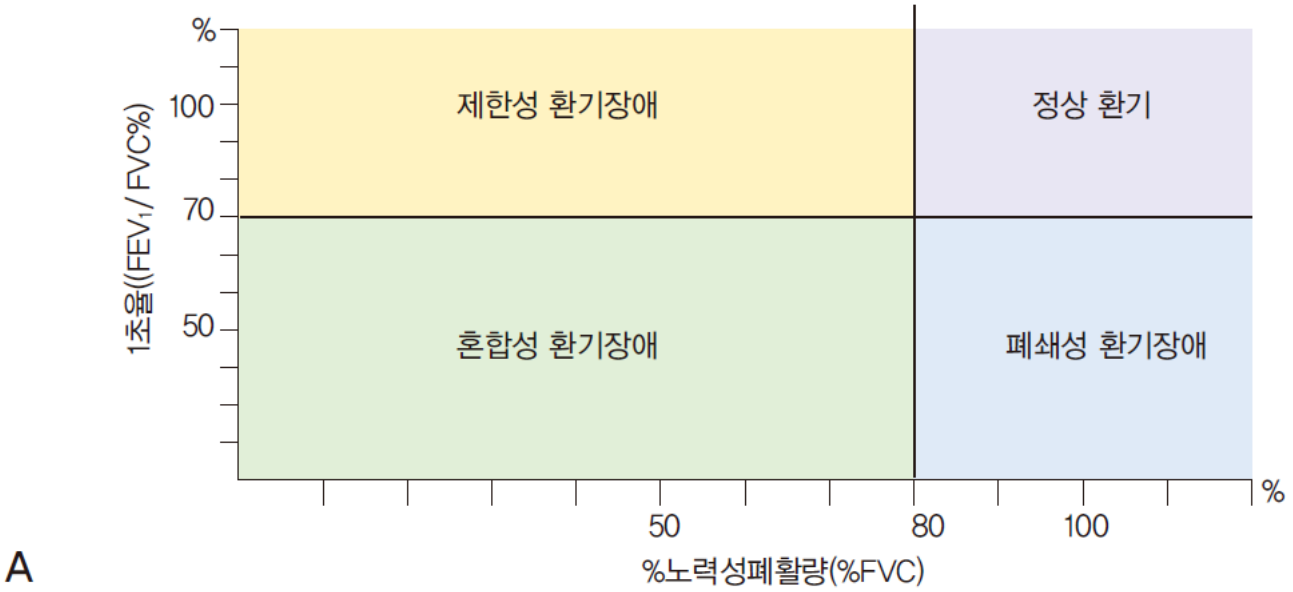
만성기관지염(경도)
(58세, 남성, $\dot{V}_{25}$ 0.9 l/초,
$\dot{V}_{25}$ 0.3 L/초, $\dot{V}_{50}/\dot{V}_{25}$ 3.0)



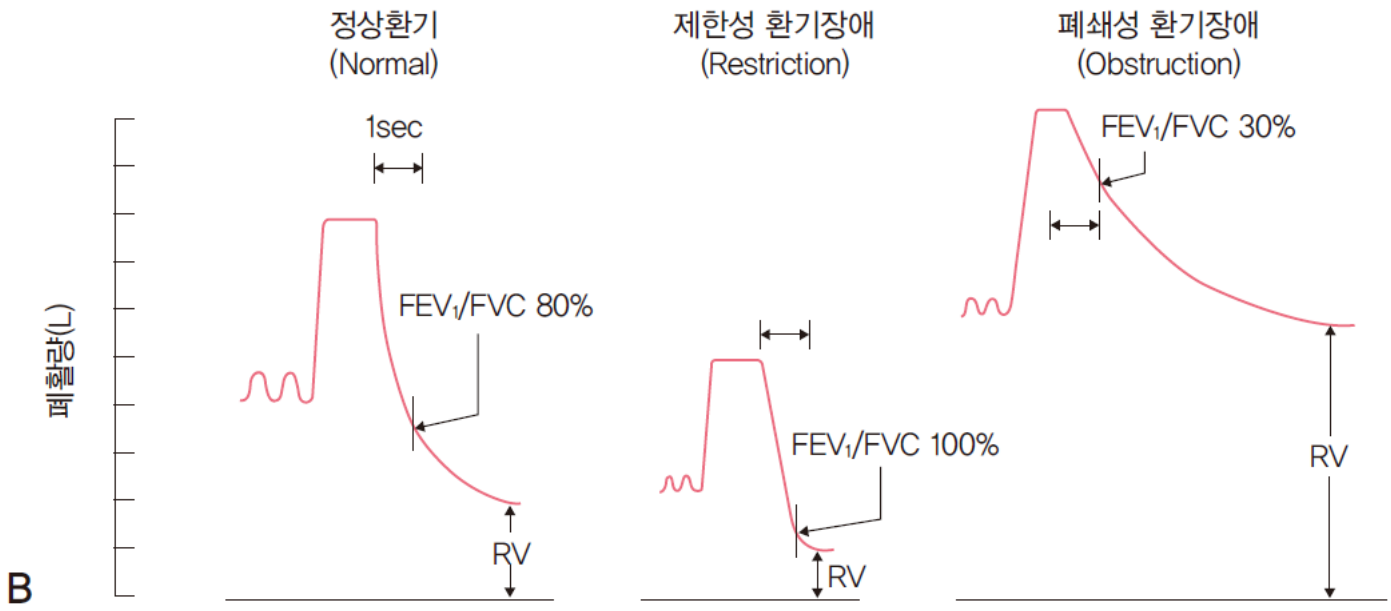
기관지천식(비발작시)
(25세, 남성, $\dot{V}_{25}$ 1.2 L/초,
$\dot{V}_{25}$ 0.5 L/초, $\dot{V}_{50}/\dot{V}_{25}$ 2.4)



Paw : 기도압　　Patm : 대기압　　Ppl : 흉강내압


%
100
70
50
1초율((FEV1/ FVC%)
제한성 환기장애
정상 환기
혼합성 환기장애
폐쇄성 환기장애
50
80
100
%
%노력성폐활량(%FVC)

A


정상환기
(Normal)
제한성 환기장애
(Restriction)
폐쇄성 환기장애
(Obstruction)
폐활량(L)
1sec
FEV1/FVC 80%
RV
FEV1/FVC 100%
RV
FEV1/FVC 30%
RV

B

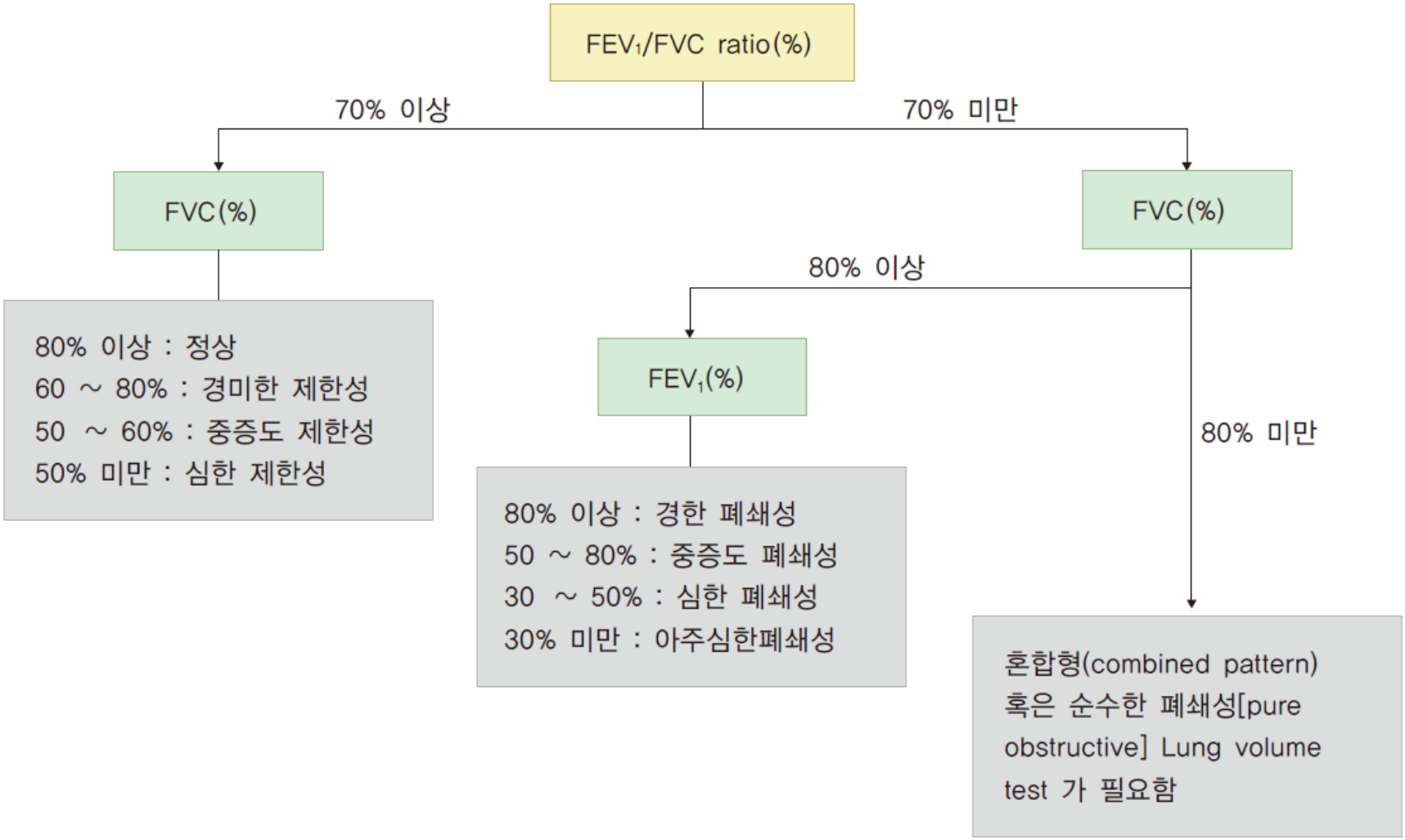

FEV1/FVC ratio(%)
70% 이상
70% 미만
FVC(%)
FVC(%)
80% 이상 : 정상
60 ~ 80% : 경미한 제한성
50 ~ 60% : 중증도 제한성
50% 미만 : 심한 제한성
80% 이상
FEV1(%)
80% 미만
80% 이상 : 경한 폐쇄성
50 ~ 80% : 중증도 폐쇄성
30 ~ 50% : 심한 폐쇄성
30% 미만 : 아주심한폐쇄성
혼합형(combined pattern) 혹은 순수한 폐쇄성[pure obstructive] Lung volume test 가 필요함

표 6-1. 폐기능 이상의 패턴

측정항목	제한성 환기장애	폐쇄성 환기장애	
		경증(mild)	중증(severe)
FVC	↓ ↓	Normal	↓
FEV_1	↓ ↓	↓	↓ ↓
FEV_1/FVC%	Normal	↓	↓ ↓
FEF_{25-75}%	↓ ↓	↓	↓ ↓
FRC	↓	Normal	↑
RV	↓	Normal	↑
TLC	↓	Normal	↑

Name: , Date: 2012 01 26 Smoker: No How Long: 0 pack/yrs
Id: W Room: Pulmo Quit: No Stopped: yrs
Technician: Physician:
Gender: Female Height(cm): 162 Weight(kg): 56.0 Age: 23 Race: Asian

Spirometry (BTPS)

		PRED	PRE-RX BEST	PRE-RX %PRED	POST-RX BEST	POST-RX %PRED	% CHG
FVC	Liters	3.96	4.26	108			
FEV1	Liters	3.19	3.69	116			
FEV1/FVC	%	80	87				
FEF25-75%	L/sec	3.70	3.90	105			
PEF	L/sec	6.65	6.67	100			
MVV	L/min	120					
FET100%	Sec		4.84				

Lung Volumes (Plethysmograpy)

TLC	Liters	5.19
VC	Liters	3.96
IC	Liters	2.55
FRC PL	Liters	2.95
ERV	Liters	1.28
RV	Liters	1.51
RV/TLC	%	28

Diffusion

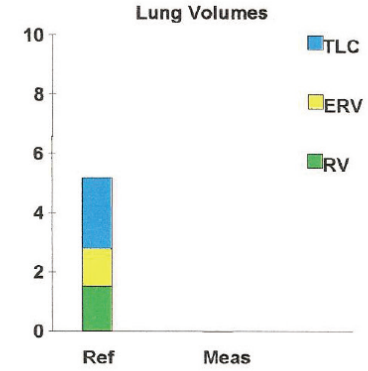
DLCO	mL/mmHg/min	22.4
VA	Liters	
DLCO/VA	mL/mHg/min/L	4.78

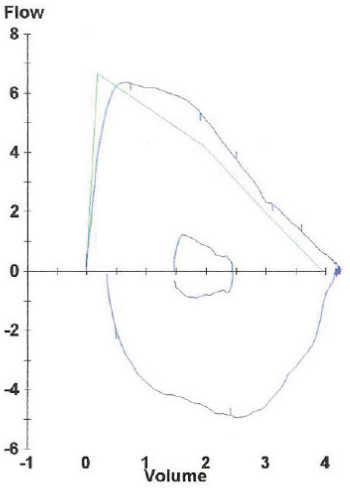
Airway Resistance

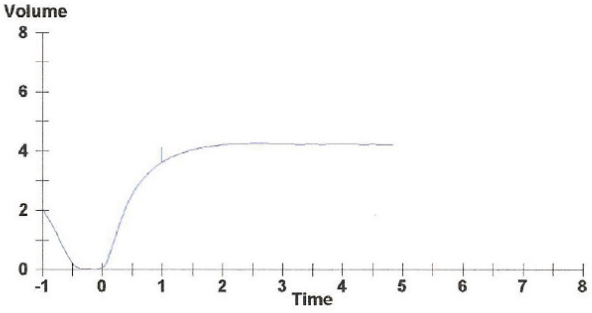
Raw	cmH2O/L/sec	1.29
sGaw	L/s/cmH2O/L	0.263

Max Pressure

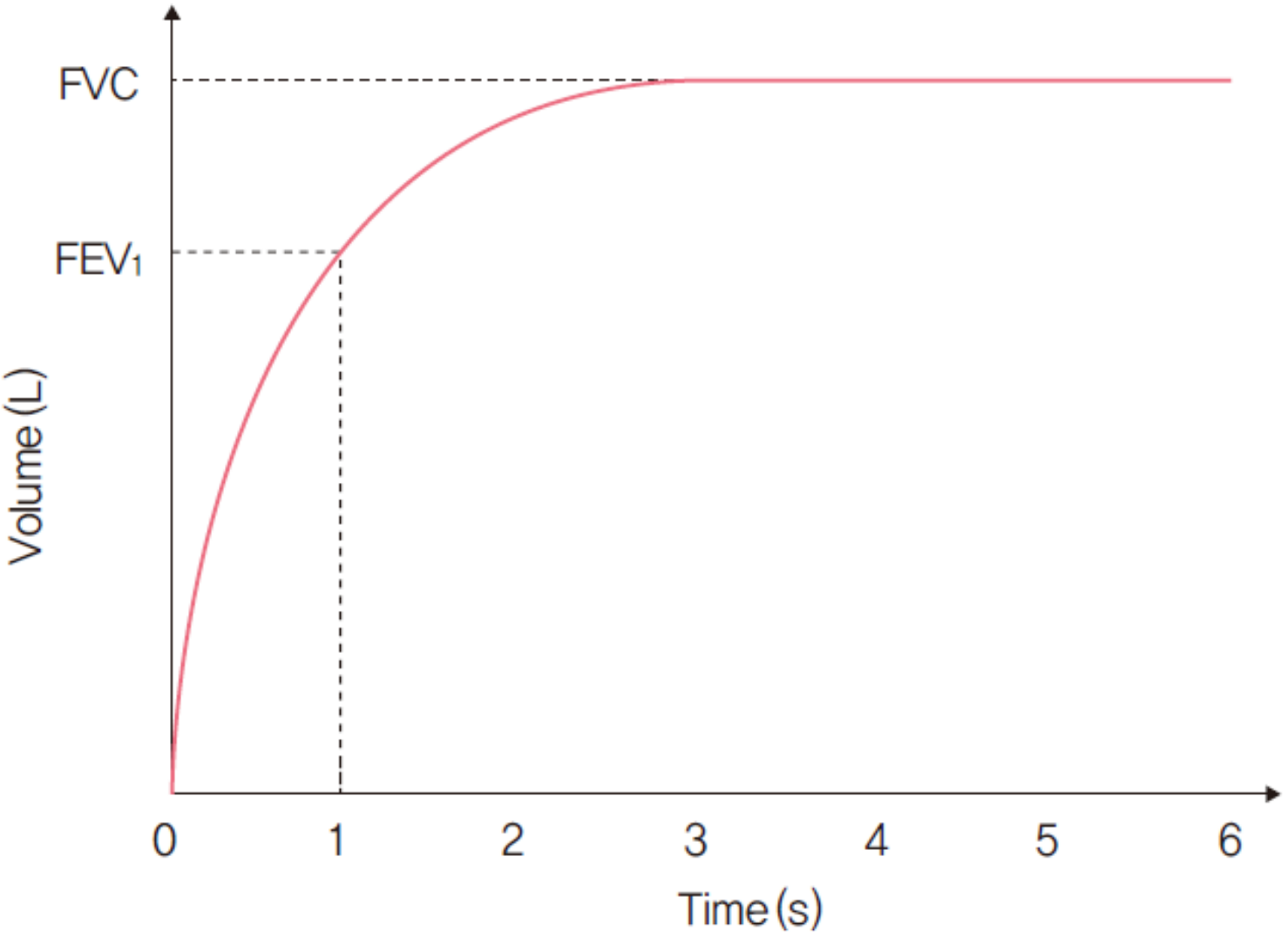
PI max	cmH2O	92
PE max	cmH2O	158







Interpretation & Comments :


FVC
FEV1
Volume (L)
0
1
2
3
4
5
6
Time (s)

Name: , Date: 2012 01 16 Smoker: No How Long: 0 pack/yrs
Id: N Room: Pulmo Quit: No Stopped: yrs
Technician: Physician:
Gender: Male Height(cm): 177 Weight(kg): 68.0 Age: 65 Race: Asian

Spirometry (BTPS)

		PRED	PRE-RX BEST	PRE-RX %PRED	POST-RX BEST	POST-RX %PRED	% CHG
FVC	Liters	4.49	3.94	88	4.18	93	6
FEV1	Liters	3.10	1.93	62	1.98	64	2
FEV1/FVC	%	70	49		47		
FEF25-75%	L/sec	2.88	0.73	26	0.79	27	8
PEF	L/sec	8.44	4.01	48	4.58	54	14
MVV	L/min	134					
FET100%	Sec		9.66		7.84		-19

Lung Volumes (Plethysmograpy)

TLC	Liters	6.59
VC	Liters	4.49
IC	Liters	3.02
FRC PL	Liters	4.01
ERV	Liters	1.51
RV	Liters	2.46
RV/TLC	%	39

Diffusion

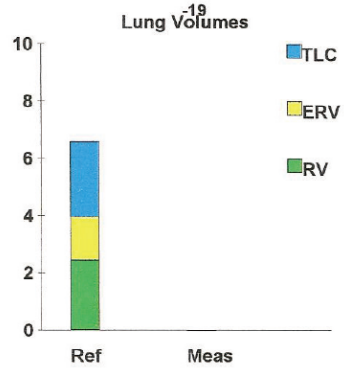
DLCO	mL/mmHg/min	19.8	22.3	112
VA	Liters	7.06	5.48	78
DLCO/VA	mL/mHg/min/L	3.70	4.07	110

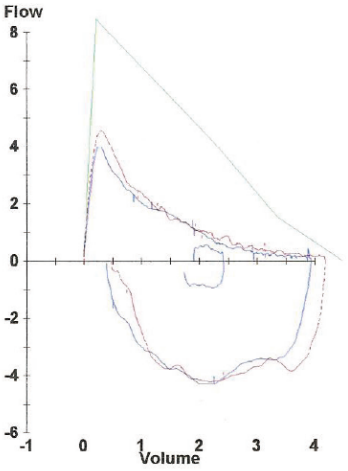
Airway Resistance

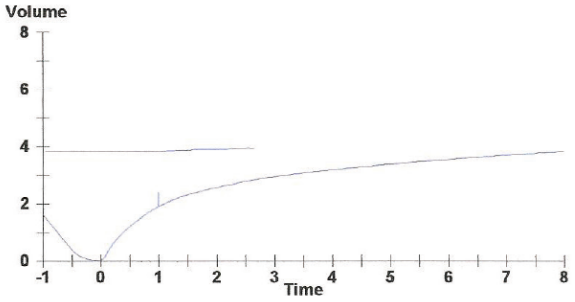
Raw	cmH2O/L/sec	1.09
sGaw	L/s/cmH2O/L	0.229

Max Pressure

PI max	cmH2O	107
PE max	cmH2O	201







Interpretation & Comments :

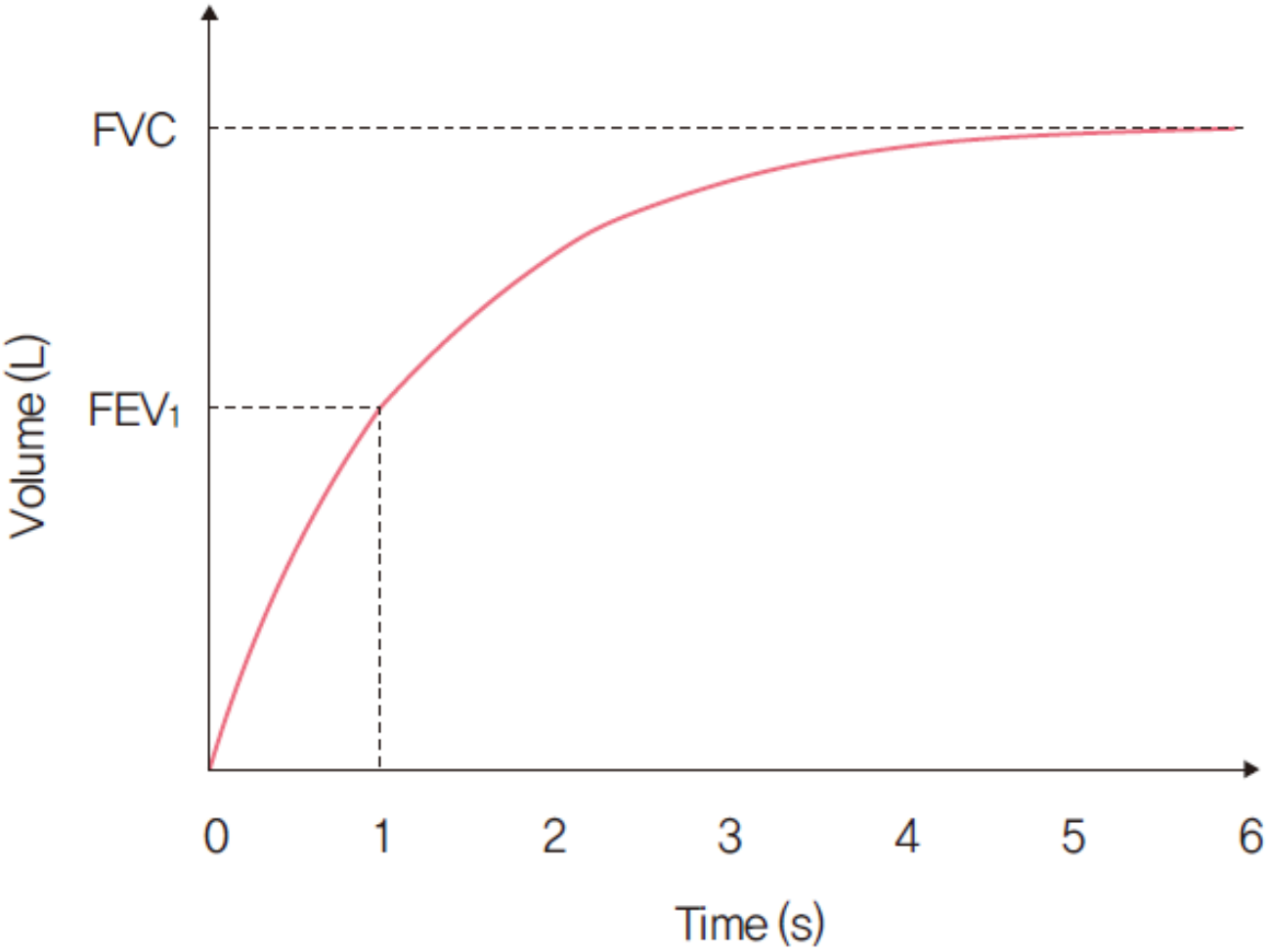

FVC
FEV1
Volume (L)
0
1
2
3
4
5
6
Time (s)

표 6-2. 폐쇄성 환기장애의 소견

	예측치	실측치	백분율(%)
FVC (L)	4.49	4.18	93
FEV_1 (L)	3.10	1.98	64
FEV_1/FVC%	70%	47%	
$FEF_{25\sim75}$% (L/sec)	2.88	0.79	27

Name: ,
Id: F
Technician:
Gender: Female

Date: 2011 06 17
Room: Pulmo
Physician:
Height(cm): 152

Smoker: No
Quit: No
Weight(kg): 59.0

How Long: pack/yrs
Stopped: yrs
Age: 52

Race: Asian

Spirometry (BTPS)

		PRED	PRE-RX BEST	PRE-RX %PRED	POST-RX BEST	POST-RX %PRED	% CHG
FVC	Liters	2.80	1.55	55	1.52	54	-2
FEV1	Liters	2.11	1.43	68	1.43	68	0
FEV1/FVC	%	75	92		94		
FEF25-75%	L/sec	2.59	3.44	133	3.89	150	13
PEF	L/sec	5.43	5.76	106	6.09	112	6
MVV	L/min	98					
FET100%	Sec		7.01		7.15		2

Lung Volumes (Plethysmograpy)

TLC	Liters	4.15
VC	Liters	2.80
IC	Liters	1.82
FRC PL	Liters	2.36
ERV	Liters	0.91
RV	Liters	1.45
RV/TLC	%	35

Diffusion

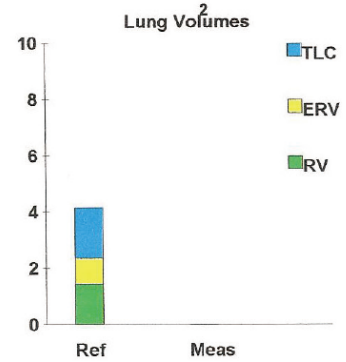
DLCO	mL/mmHg/min	18.4	8.7	47
VA	Liters		1.98	
DLCO/VA	mL/mHg/min/L	4.00	4.41	110

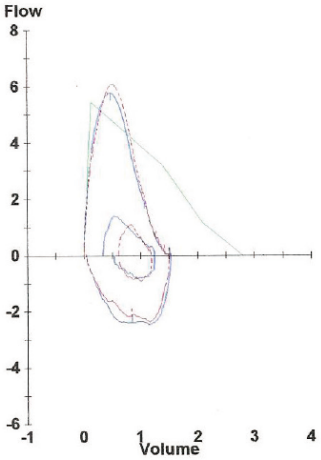
Airway Resistance

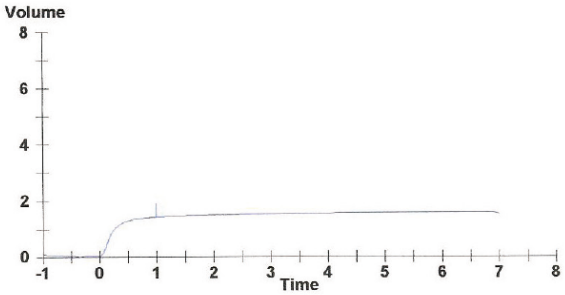
Raw	cmH2O/L/sec	1.65
sGaw	L/s/cmH2O/L	0.257

Max Pressure

PI max	cmH2O	77
PE max	cmH2O	142







Interpretation & Comments :

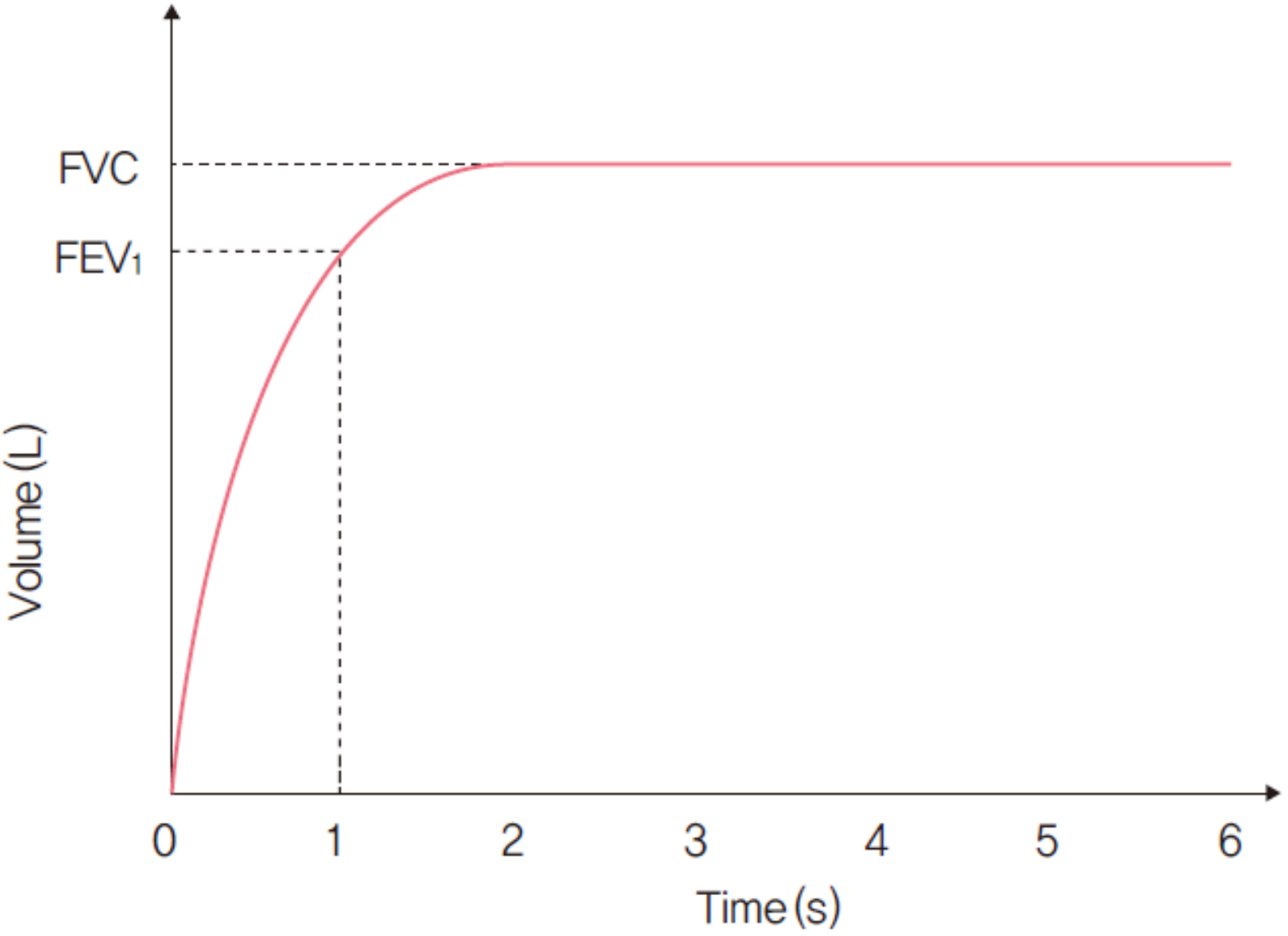

FVC
FEV1
Volume (L)
0
1
2
3
4
5
6
Time (s)

표 6-3. 제한성 환기장애의 소견

	예측치	실측치	백분율(%)
FVC (L)	2.80	1.52	54
FEV_1 (L)	2.11	1.43	68
FEV_1/FVC%	75%	94%	
$FEF_{25\sim75}$% (L/sec)	2.59	3.44	133

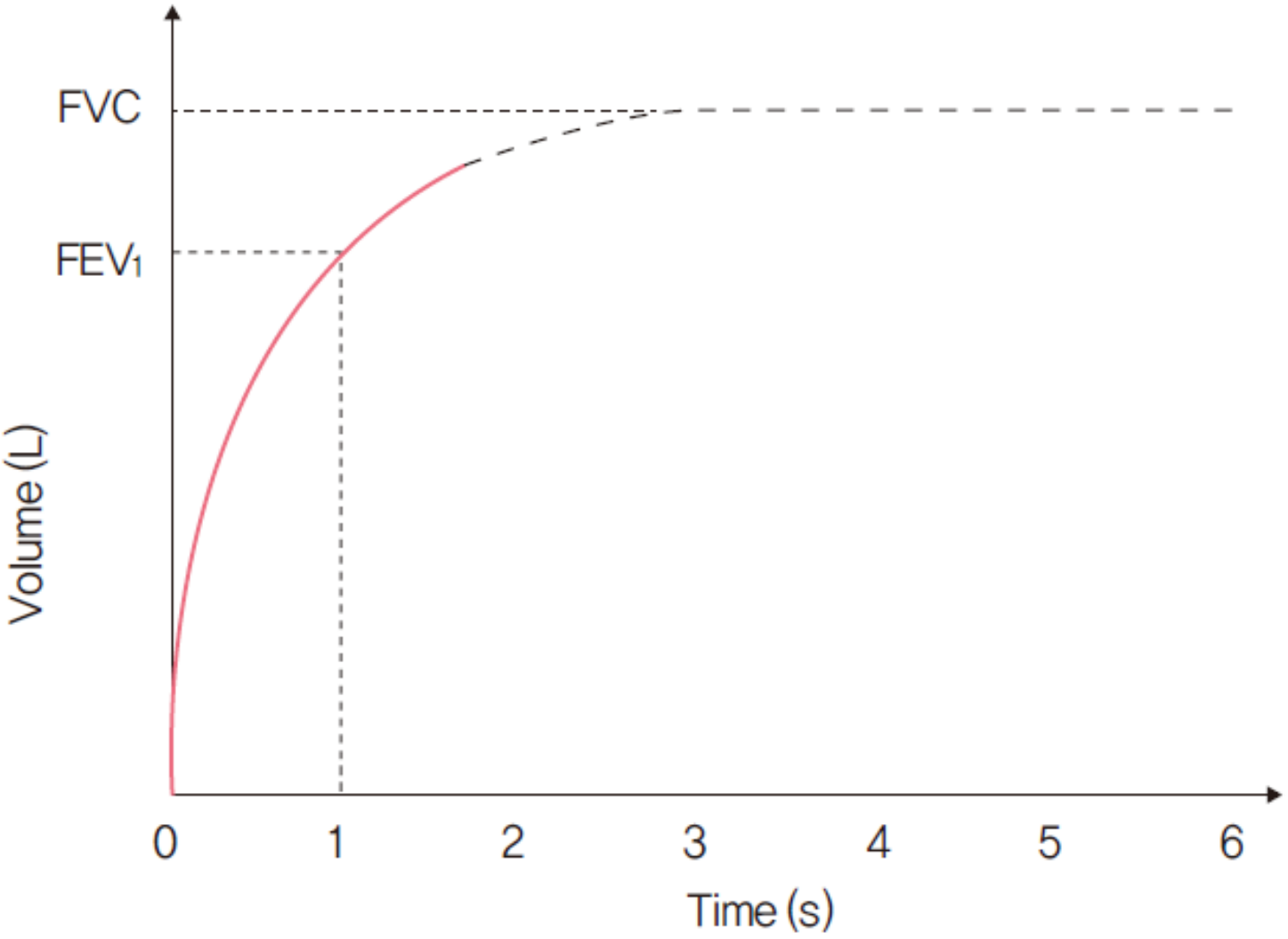
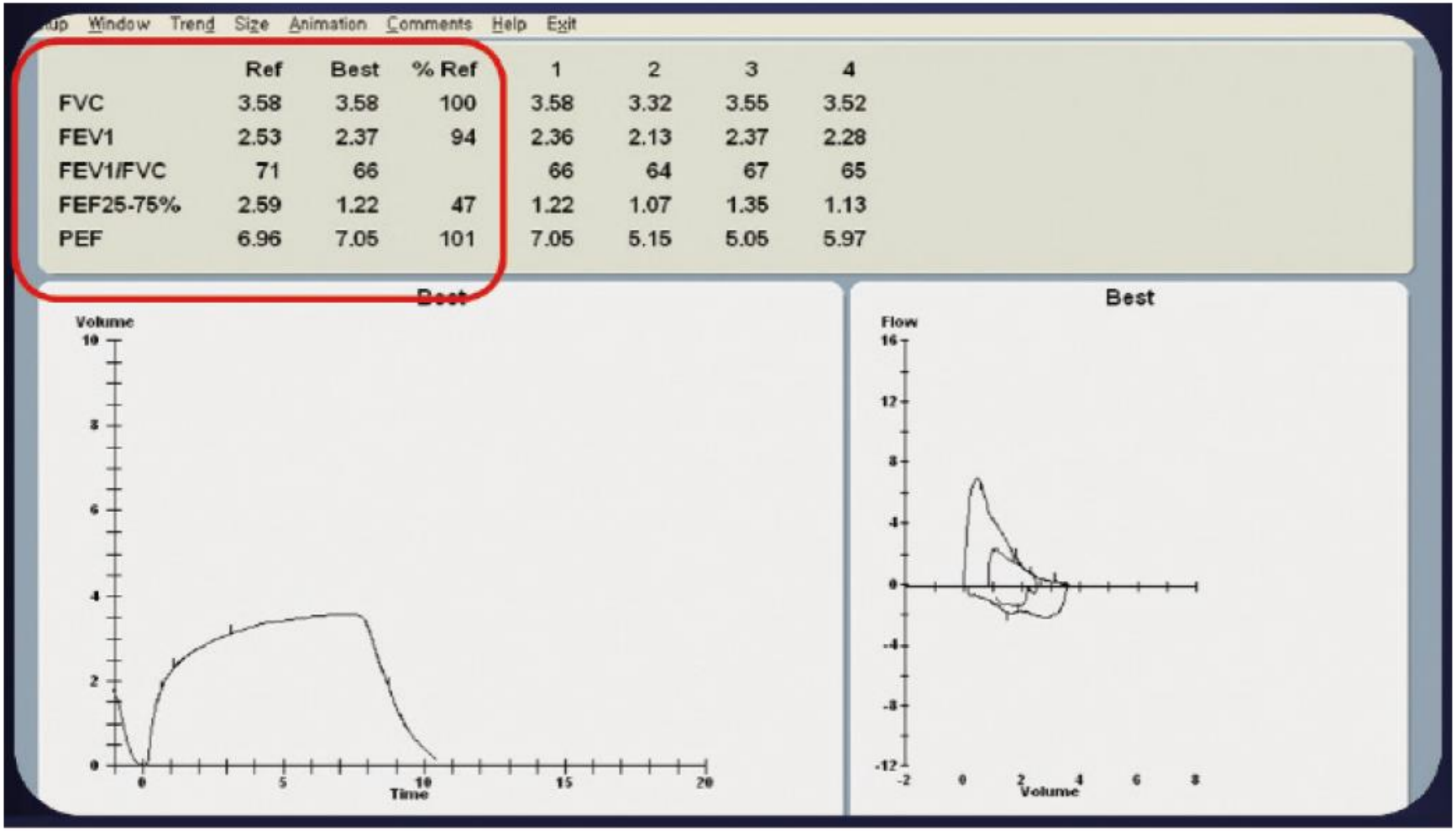

FVC
FEV1
Volume (L)
0
1
2
3
4
5
6
Time (s)

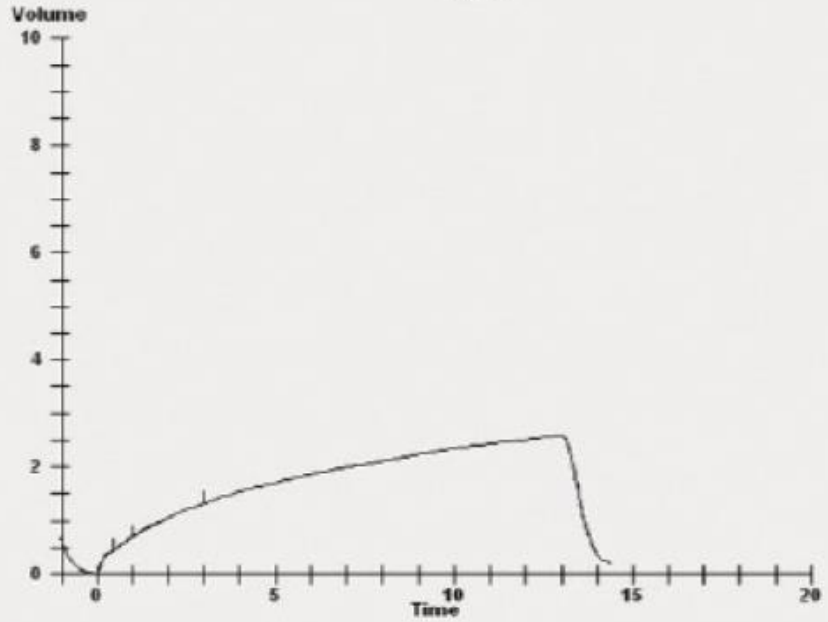
표 6-4. 환기기능 장애의 판정 기준

해석	%노력성 폐활량(%FVC)	1초율(FEV_1/FVC%)
정상	80% 이상	70% 이상
폐쇄성 환기기능 장애	80% 이상	70% 미만
제한성 환기기능 장애	80% 미만	70% 이상
혼합형 환기기능 장애	80% 미만	70% 미만

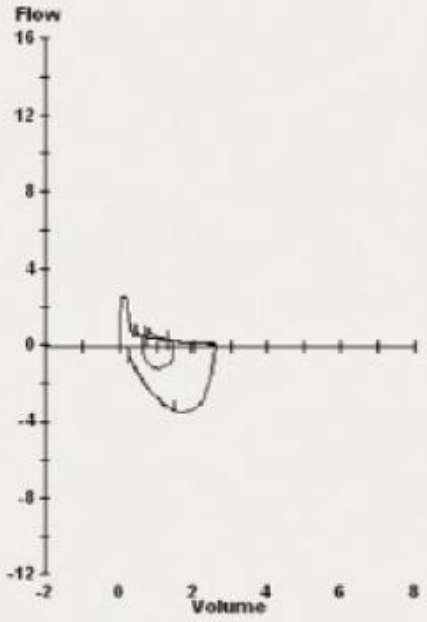

up Window Trend Size Animation Comments Help Exit
Ref Best % Ref 1 2 3 4
FVC 3.58 3.58 100 3.58 3.32 3.55 3.52
FEV1 2.53 2.37 94 2.36 2.13 2.37 2.28
FEV1/FVC 71 66 66 64 67 65
FEF25-75% 2.59 1.22 47 1.22 1.07 1.35 1.13
PEF 6.96 7.05 101 7.05 5.15 5.05 5.97
Best
Volume
Time
Best
Flow
Volume

	Ref	Best	% Ref	1	2	3
FVC	4.04	2.58	64	2.54	2.41	2.58
FEV1	2.79	0.73	26	0.73	0.69	0.70
FEV1/FVC	70	28		29	29	27
FEF25-75%	2.66	0.22	8	0.23	0.24	0.22
PEF	7.73	3.03	39	2.92	3.03	2.59

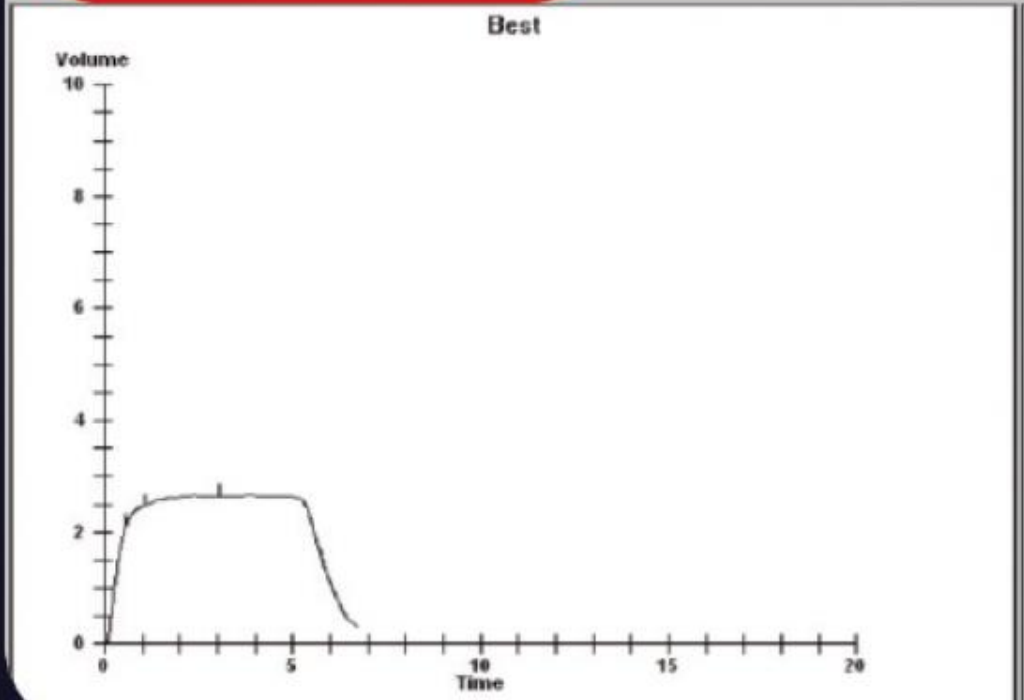
Best

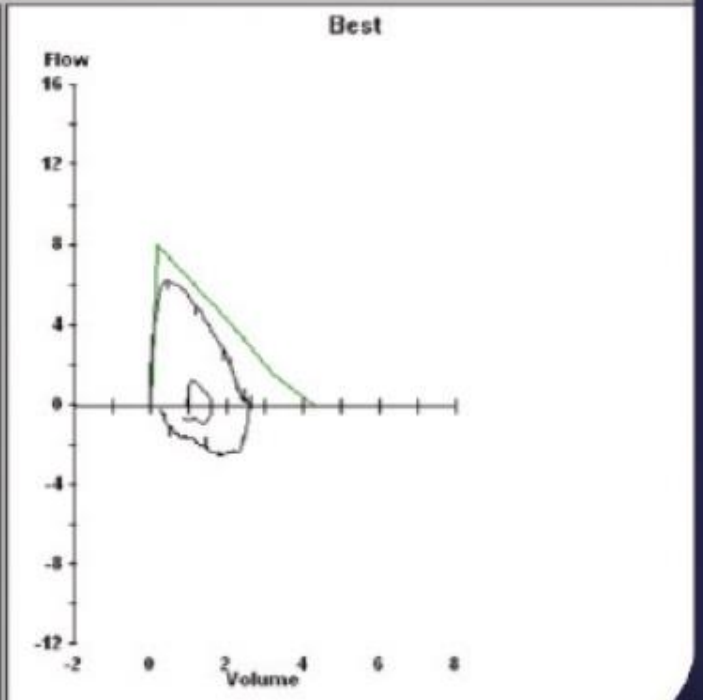


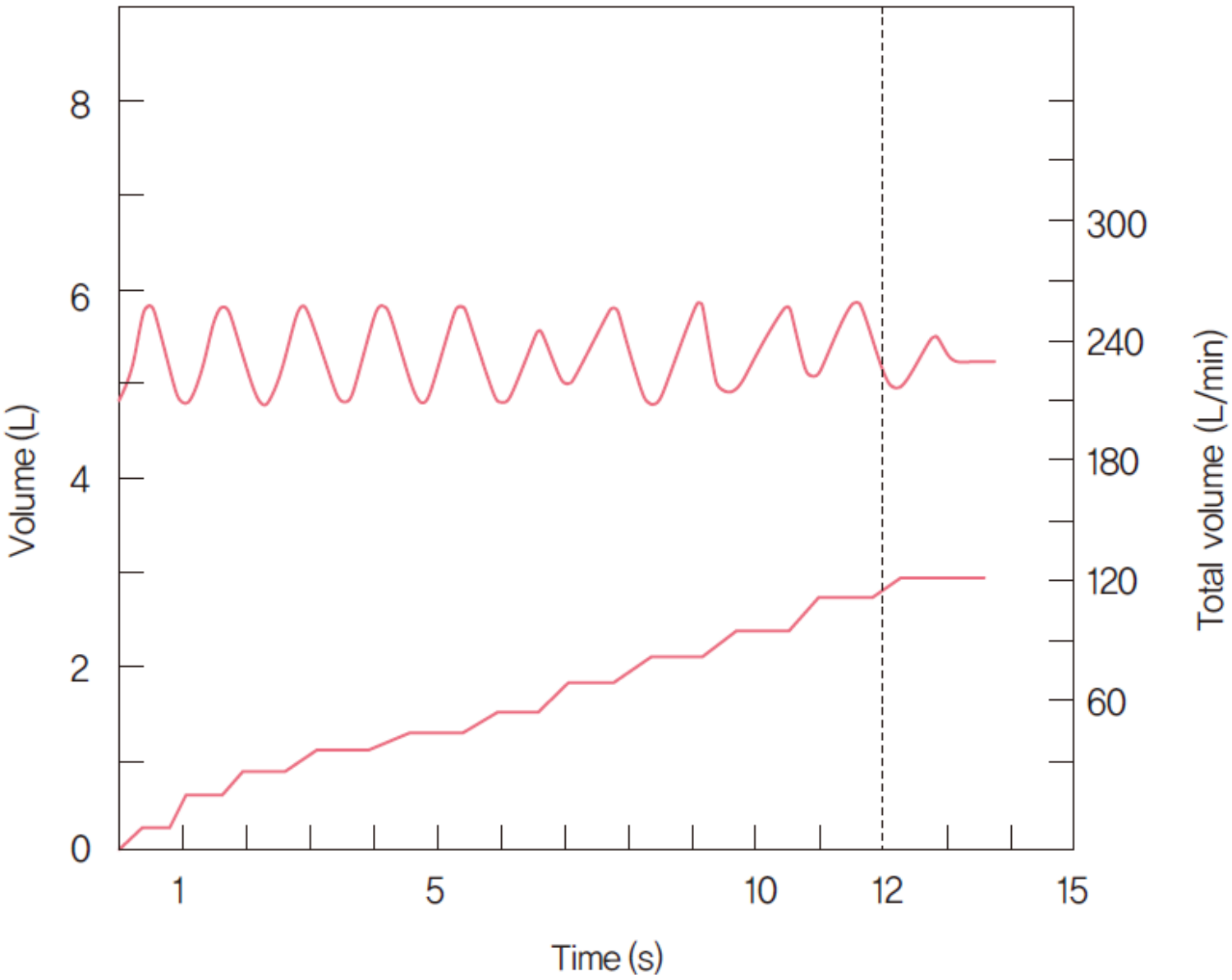
Best



	Ref	Best	% Ref	1	2	3
FVC	4.33	2.66	62	2.60	2.66	2.55
FEV1	3.18	2.48	78	2.36	2.48	2.31
FEV1/FVC	73	93		91	93	91
FEF25-75%	3.23	4.30	133	3.21	4.30	2.89
PEF	8.11	6.37	79	4.11	6.37	4.90

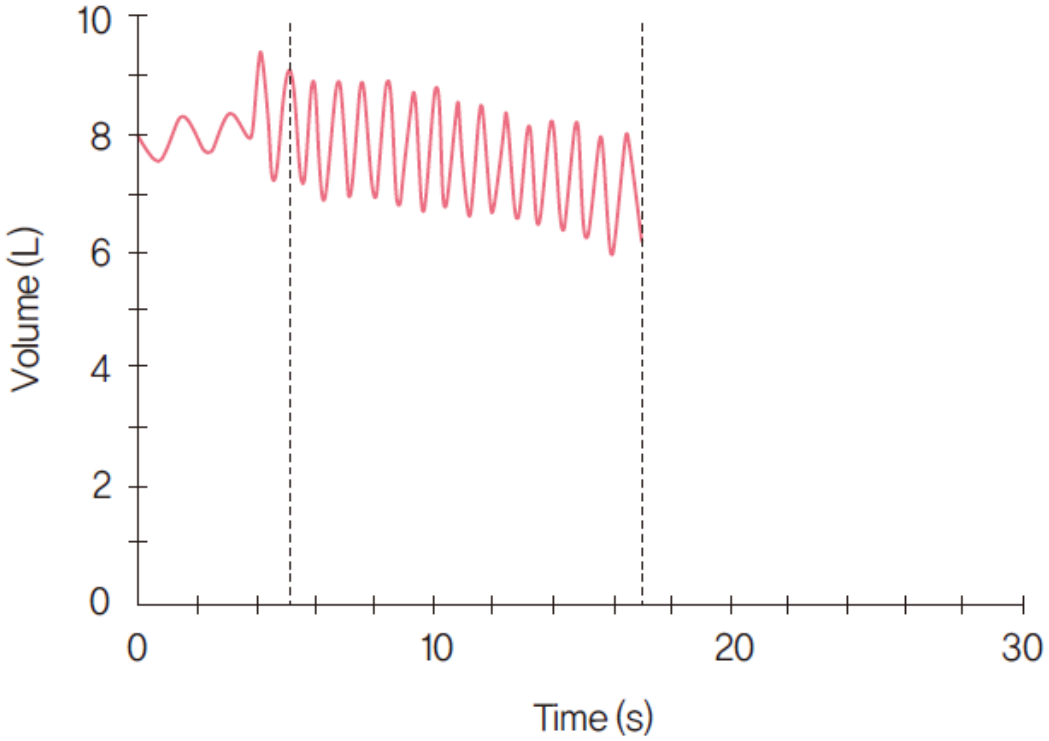


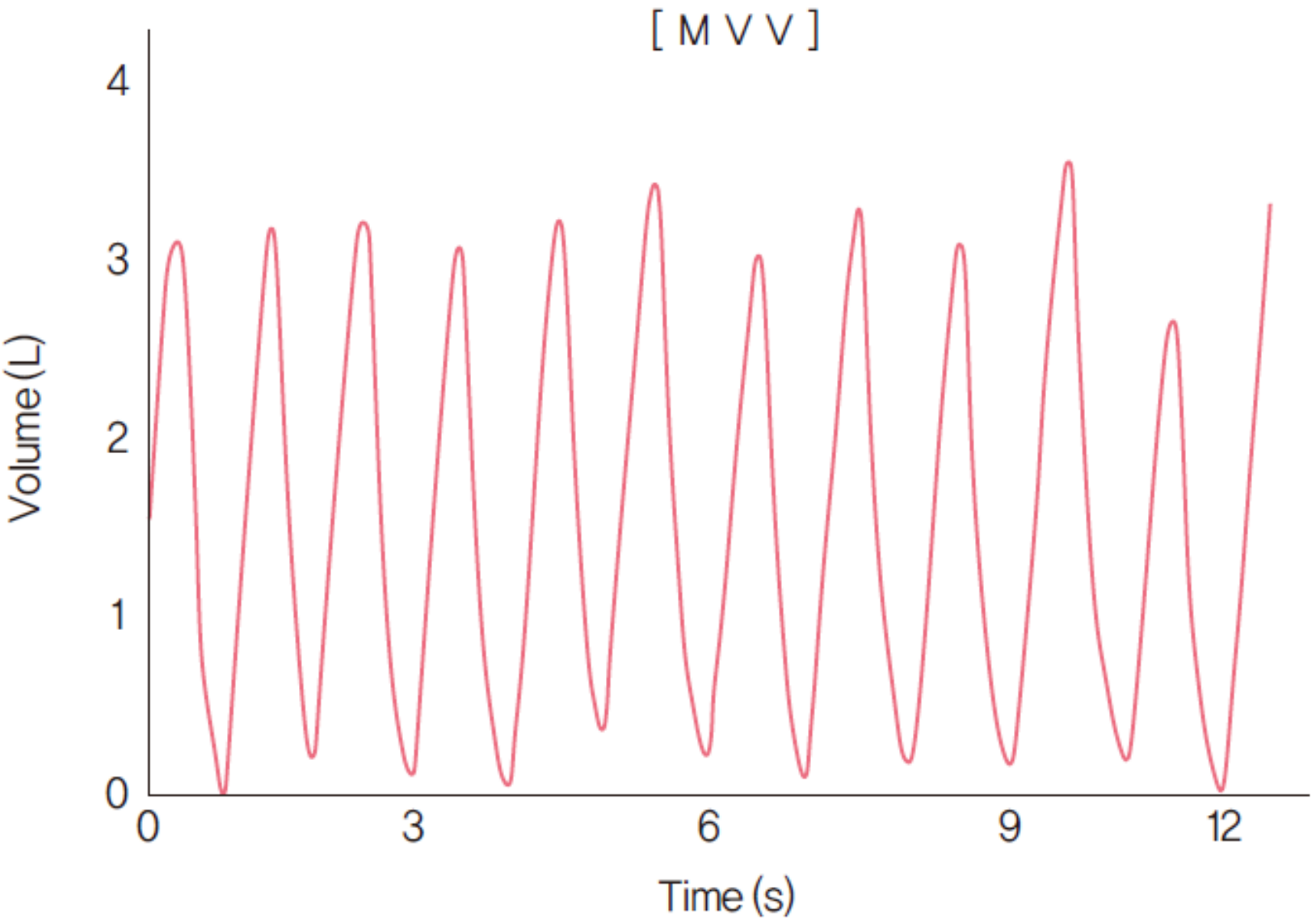



8
6
4
2
0
Volume (L)
300
240
180
120
60
Total volume (L/min)
1
5
10
12
15
Time (s)

MVV

	Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
MVV L/min	121	153	126			
f 8PM		75				




[M V V]
4
3
2
1
0
Volume (L)
0
3
6
9
12
Time (s)

Section 07

체적변동기록법 검사

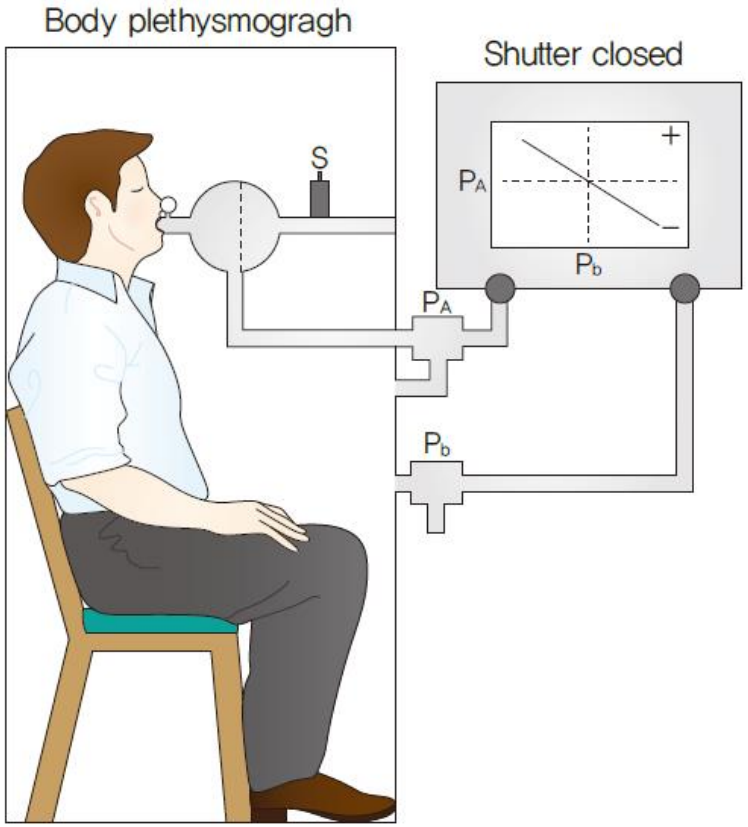
학습목표

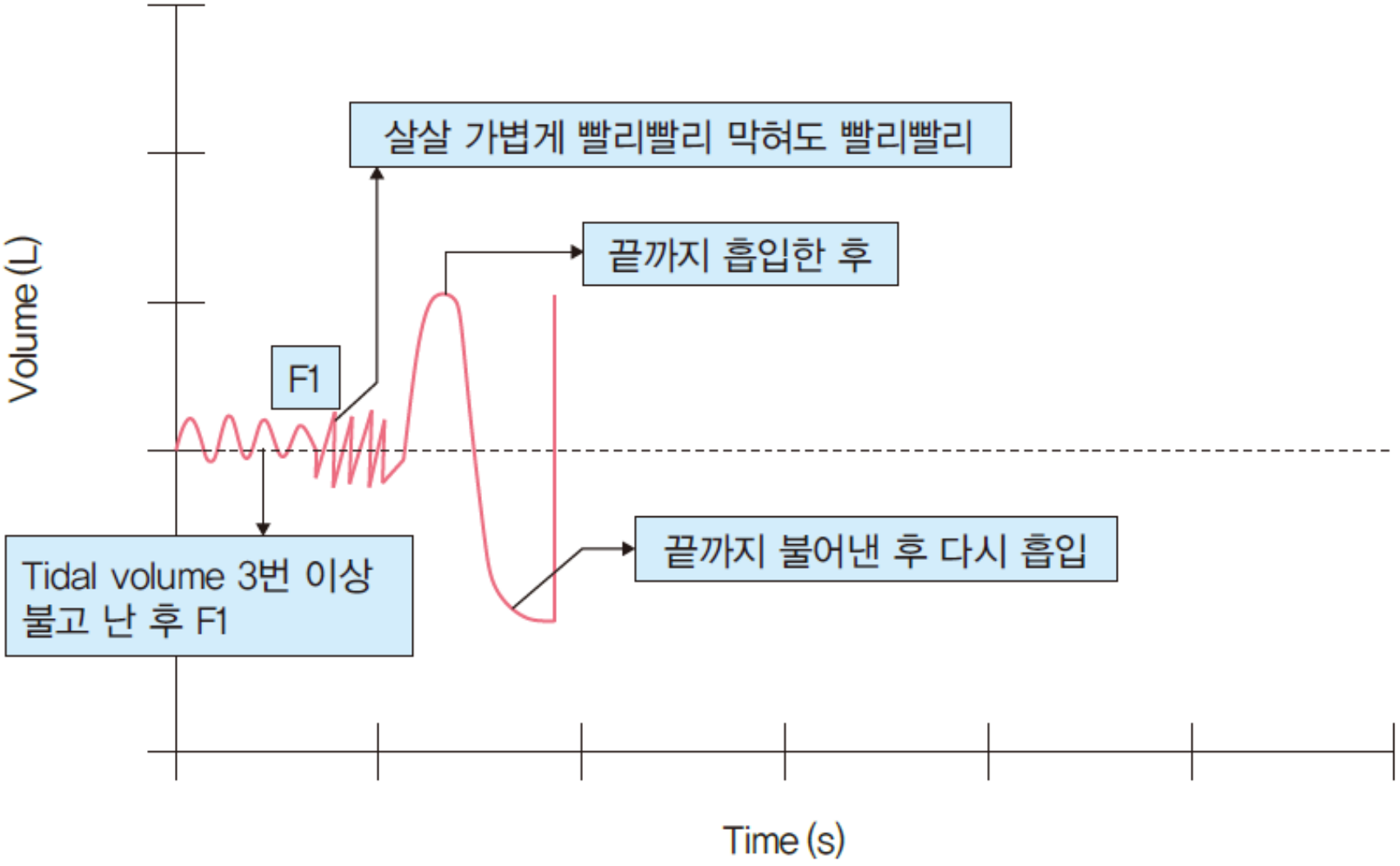
해석할 수 있다(A).

1. 폐쇄식 검사를 시행하고 검사결과를 평가 및 해

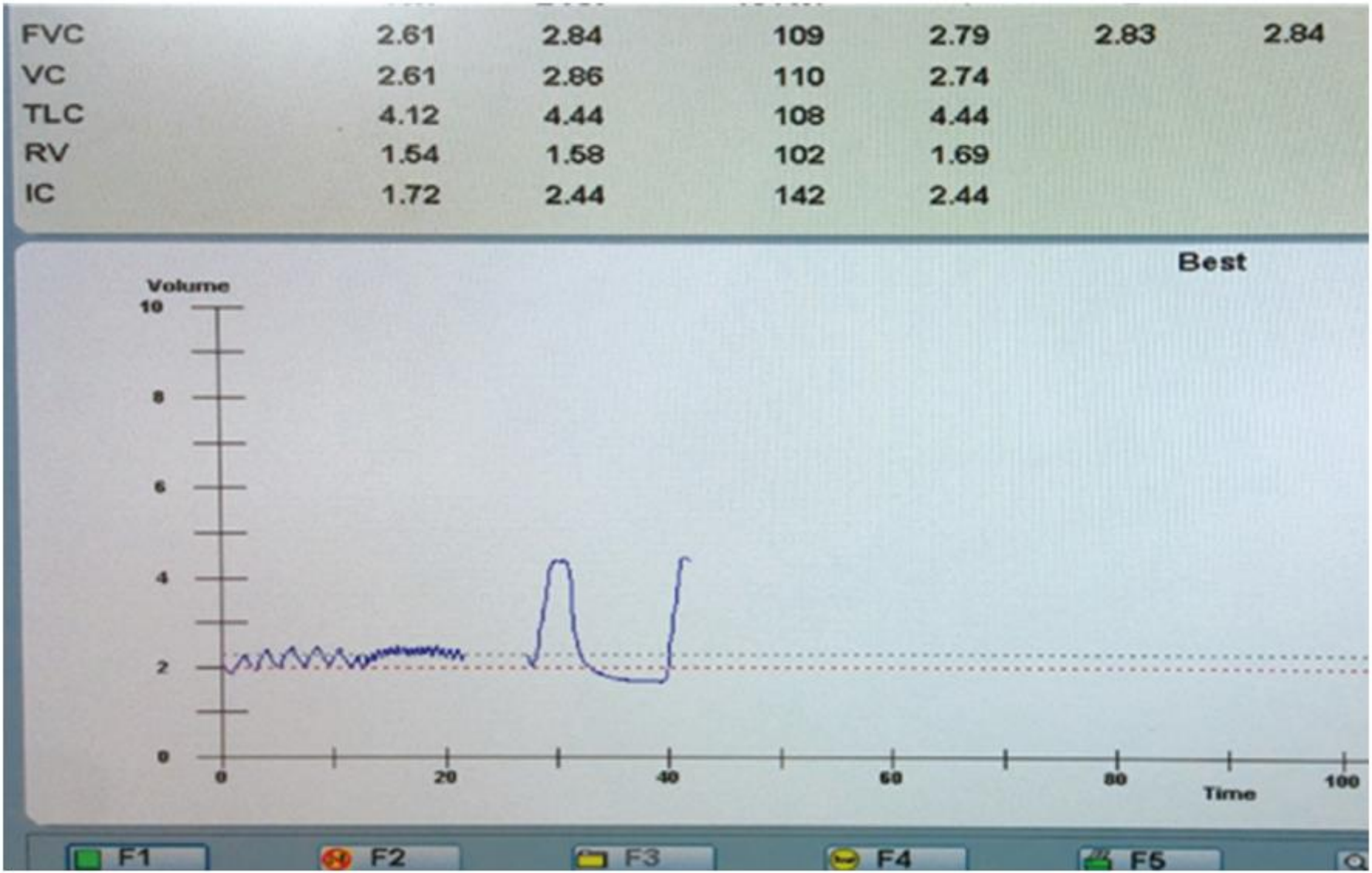
2. 기도저항 검사를 시행하고 검사결과를 평가 및 해




Body plethysmogragh
Shutter closed
S
P_A
+
−
P_b
P_A
P_b


살살 가볍게 빨리빨리 막혀도 빨리빨리
끝까지 흡입한 후
F1
Tidal volume 3번 이상
불고 난 후 F1
끝까지 불어낸 후 다시 흡입
Volume (L)
Time (s)

FVC	2.61	2.84	109	2.79	2.83	2.84
VC	2.61	2.86	110	2.74		
TLC	4.12	4.44	108	4.44		
RV	1.54	1.58	102	1.69		
IC	1.72	2.44	142	2.44		



$P_1V_1 = P_2V_2$

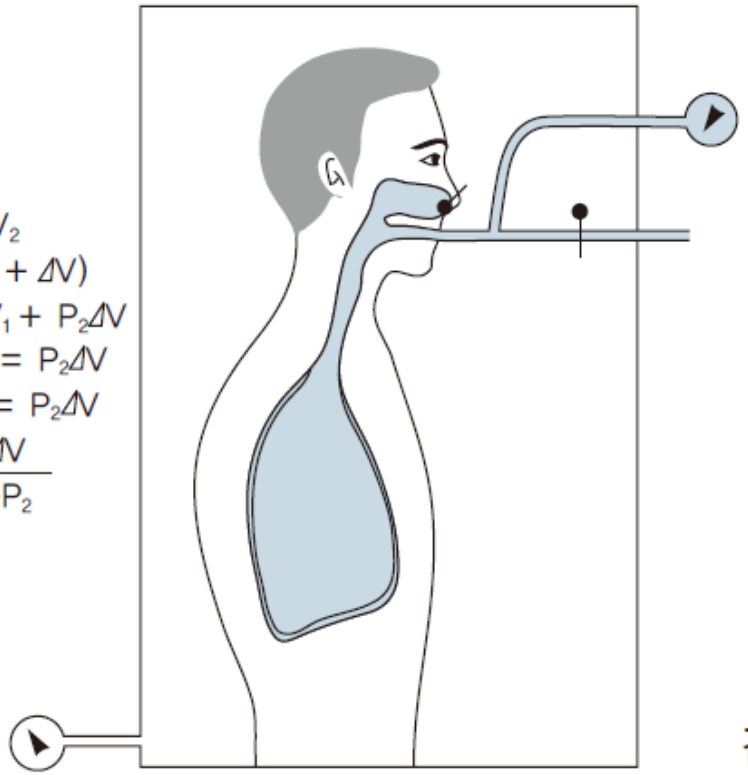
$P_1V_1 = P_2(V_1 + \Delta V)$

$P_1V_1 = P_2V_1 + P_2\Delta V$

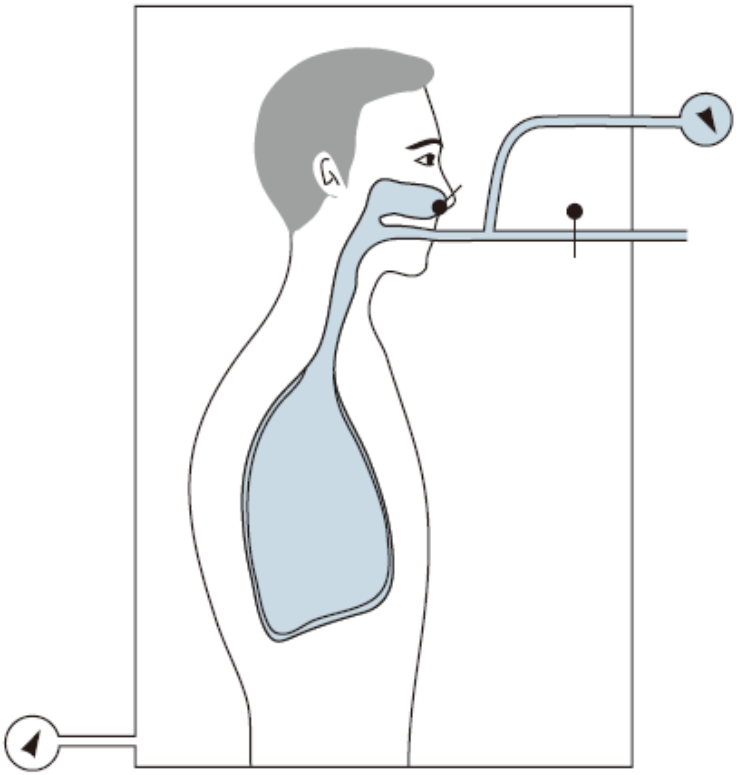
$P_1V_1 - P_2V_1 = P_2\Delta V$

$V_1(P_1 - P_2) = P_2\Delta V$

$$V_1 = \frac{P_2\Delta V}{P_1 - P_2}$$



검사 전



검사 후

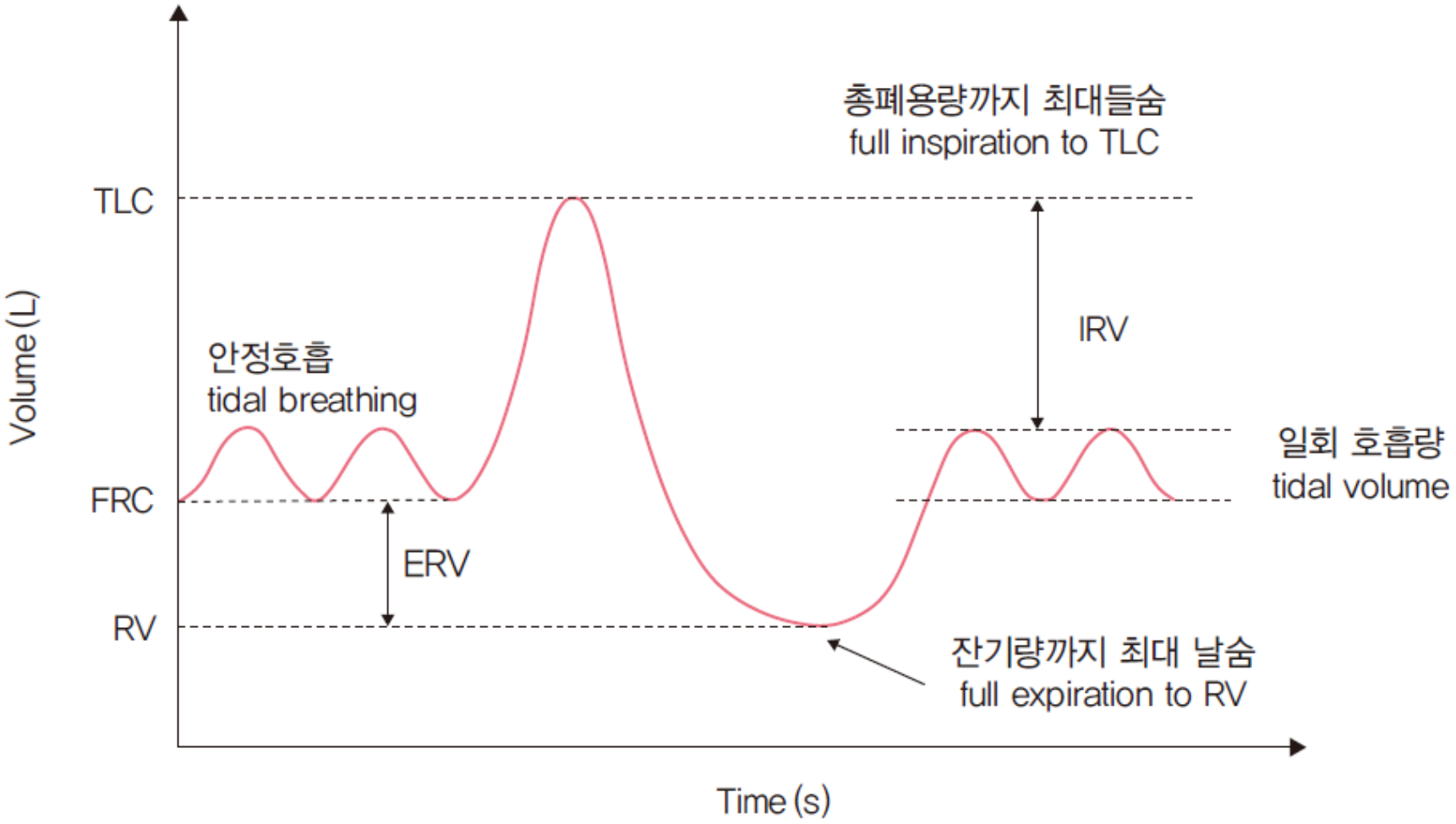
P_1 : 검사전 안정시 측정한 구강압

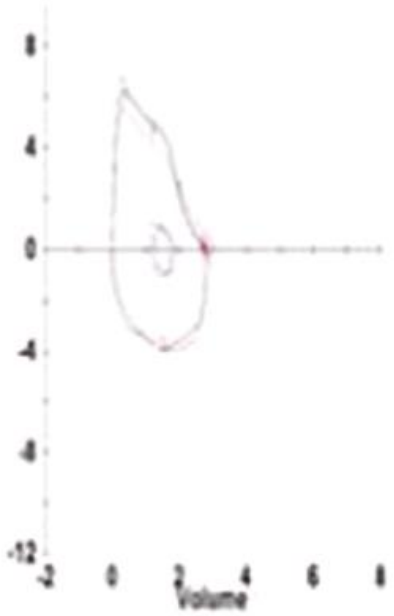
V_1 : 구하려는 폐용적

P_2 : 마우스피스를 막고 들숨시 측정한 구강압

V_2 : 마우스피스를 막고 들숨시의 폐용적

$\Delta V = V_2 - V_1$, 체적기록기 안의 압력변화에서 환산한 용적 변화


총폐용량까지 최대들숨
full inspiration to TLC
TLC
IRV
안정호흡
tidal breathing
일회 호흡량
tidal volume
FRC
ERV
RV
잔기량까지 최대 날숨
full expiration to RV
Volume (L)
Time (s)



Spirometry

		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	3.16	2.87	91	2.85	90	-1
FEV1	Liters	2.42	2.66	106	2.51	104	-2
FEV1/FVC	%	76	89		88		
FEF25-75%	L/sec	2.86	3.51	123	3.28	115	-7
PEF	L/sec	5.82	7.03	121	6.83	117	-3
FET100%	Sec		7.04		6.55		-7
FIVC	Liters	3.16	2.88	91	2.84	90	-1
FIF50%	L/sec		3.85		3.99		4
FVL ECode			000000		000000		
MVV	L/min	101					

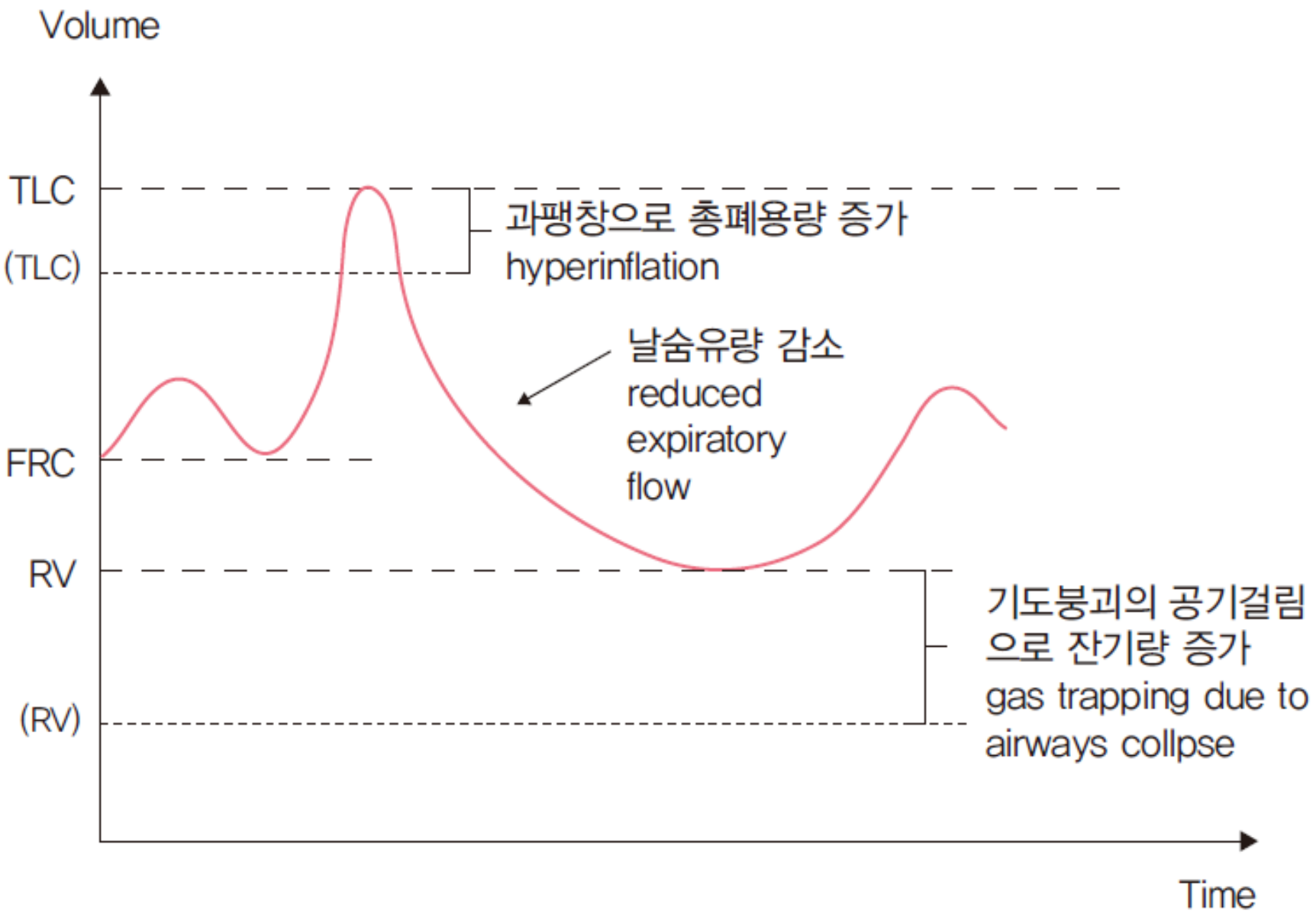


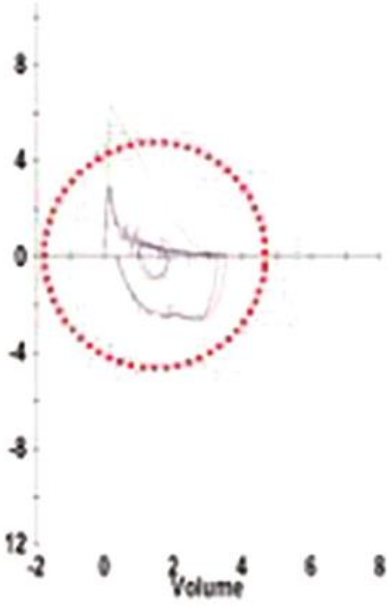
Lung Volumes

		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
VC	Liters	3.16	2.88	91	2.85	90	-1
TLC	Liters	4.63	4.23	91	4.46	96	5
RV	Liters	1.58	1.35	85	1.60	101	18
FRC PL	Liters	2.76	2.22	81	2.23	81	1
ERV	Liters	1.04	0.87	84	0.61	59	-30
IC	Liters	2.07	2.01	97	2.21	107	10
Raw	cmH2O/L/sec	1.39	1.70	122	1.87	135	10
Raw f	BPM		149		90		-40
Vtg (fRaw)	Liters		2.93		2.59		-12
Vtg	Liters		2.93		2.59		-12

Single Breath Lung Volumes

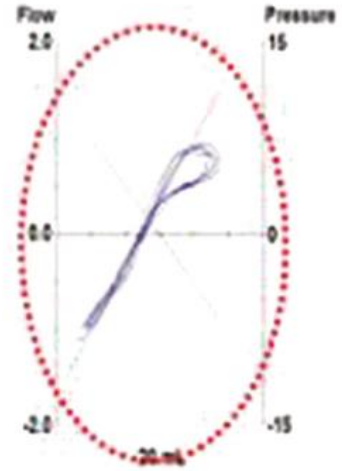
TLC Sb	Liters	4.63	3.92	85
RV Sb	Liters	1.58	1.45	92
RV/TLC Sb	%	34	37	


Volume
TLC
(TLC)
FRC
RV
(RV)
과팽창으로 총폐용량 증가
hyperinflation
날숨유량 감소
reduced
expiratory
flow
기도붕괴의 공기걸림
으로 잔기량 증가
gas trapping due to
airways collpse
Time



Spirometry

		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	3.19	3.28	103	3.52	110	7
FEV1	Liters	2.11	0.92	44	1.04	49	13
FEV1/FVC	%	69	28		29		
FEF25-75%	L/sec	2.06	0.26	13	0.28	14	6
PEF	L/sec	6.39	3.14	49	2.92	46	-7
FET100%	Sec		15.75		15.71		-0
FIVC	Liters	3.19	2.89	91	3.17	99	10
FIF50%	L/sec		2.45		2.38		-3
FVL ECode			000010		000010		
MVV	L/min	97					

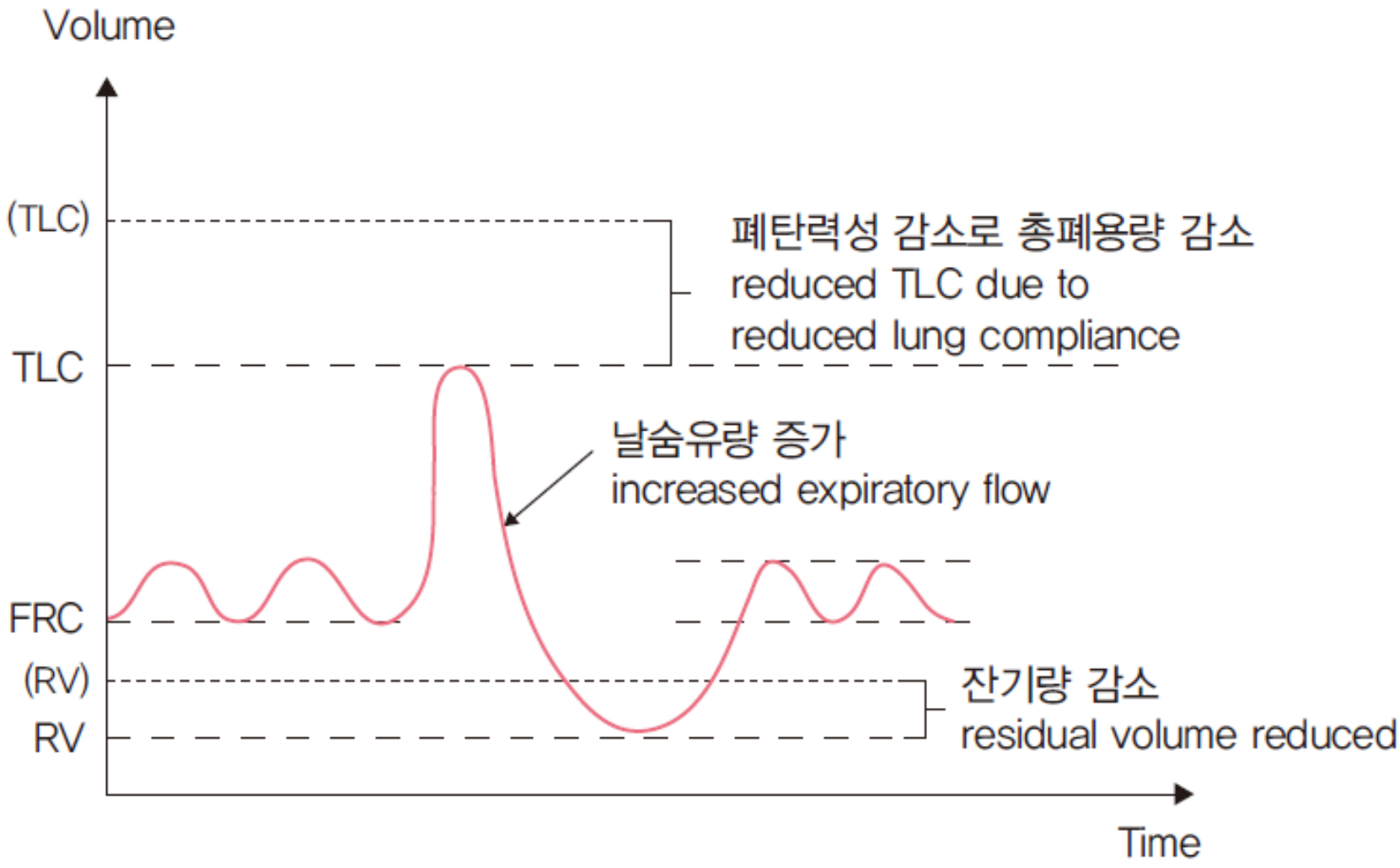


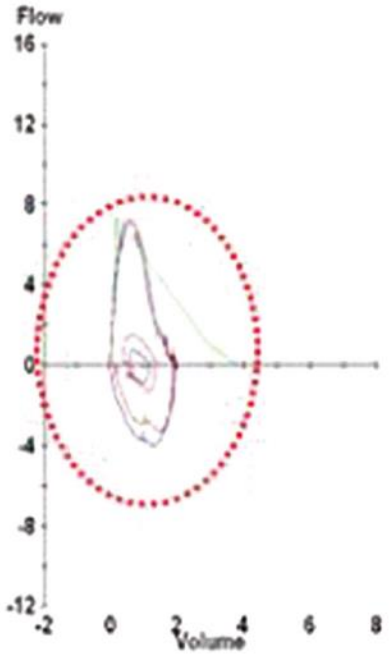
Lung Volumes

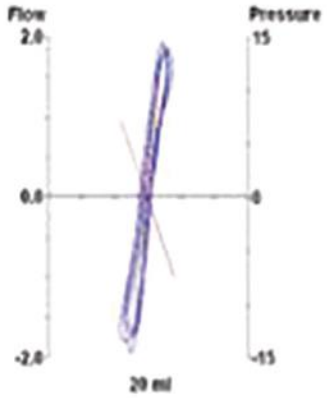
		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
VC	Liters	3.19	3.44	108	3.52	110	2
TLC	Liters	4.75	6.97	147	6.96	147	-0
RV	Liters	2.16	3.53	163	3.44	159	-2
FRC PL	Liters	3.18	4.97	156	5.02	158	1
ERV	Liters	1.10	1.44	131	1.46	133	1
IC	Liters	2.20	2.00	91	1.94	88	-3
Raw	cmH2O/L/sec	1.46	4.86	334	4.49	308	-8
Raw f	BPM		63		79		25
Vtg (Raw)	Liters		5.79		6.10		5
Vtg	Liters		5.79		6.10		5

Single Breath Lung Volumes

TLC Sb	Liters	4.75	5.03	106
RV Sb	Liters	2.16	2.96	137
RV/TLC Sb	%	43	59	


Volume
(TLC)
TLC
FRC
(RV)
RV
폐탄력성 감소로 총폐용량 감소
reduced TLC due to
reduced lung compliance
날숨유량 증가
increased expiratory flow
잔기량 감소
residual volume reduced
Time





Cough: No Persistent: No Productive (cc):

Smoker: No How Long(pk/yrs): Stopped(yrs):

Cigarettes: No Cigars: No

Technician: Temp: 21 PBar: 766

Spirometry

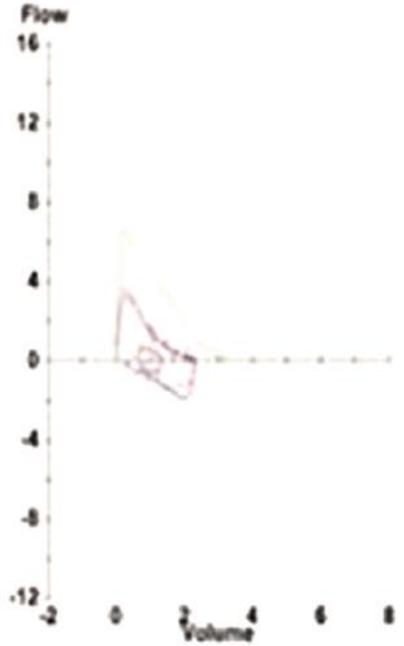
		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	3.83	1.94	51	1.95	51	0
FEV1	Liters	2.64	1.88	71	1.88	71	-0
FEV1/FVC	%	70	97		97		
FEF25-75%	L/sec	2.55	4.20	164	3.92	153	-7
PEF	L/sec	7.38	7.09	96	7.25	98	2
FET100%	Sec		6.79		4.05		-40
FIVC	Liters	3.83	1.95	51	1.82	48	-6
FIF50%	L/sec		3.80		2.90		-24
FVL ECode			000000		001011		
MVV	L/min	117					

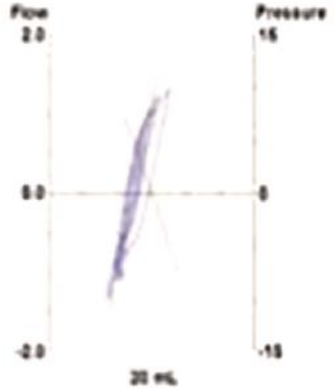
Lung Volumes

		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
VC	Liters	3.83	2.19	57	1.95	51	-11
TLC	Liters	5.58	3.36	60	[illegible]	58	-4
RV	Liters	2.23	1.17	52	1.29	58	11
FRC PL	Liters	3.62	2.51	69	2.71	75	8
ERV	Liters	1.29	1.18	91	1.40	108	19
IC	Liters	2.58	0.85	33	0.53	21	-38
Raw	cmH2O/L/sec	1.23	1.74	141	2.13	173	23
Raw f	BPM		114		127		11
Vtg (Raw)	Liters		2.42		2.52		4
Vtg	Liters		2.42		2.52		4

Single Breath Lung Volumes

TLC Sb	Liters	5.58	2.46	44
RV Sb	Liters	2.23	0.94	42
RV/TLC Sb	%	40	38	





Cough: No Persistent: No Productive (cc):
Smoker: No How Long(pk/yrs): Stopped(yrs):
Cigarettes: No Cigars: No
Technician: Temp: 15 PBar: 759

Spirometry

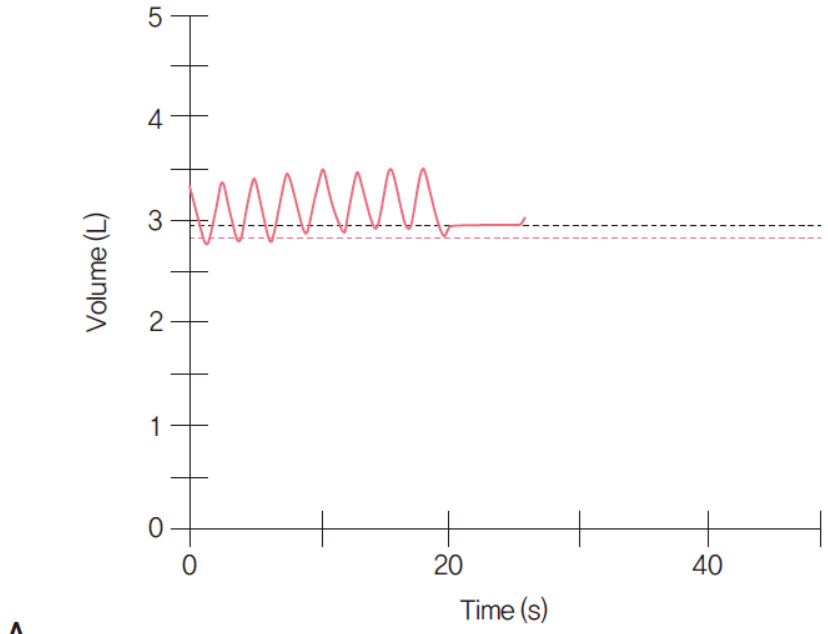
		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	3.30	2.30	70	2.36	71	3
FEV1	Liters	2.14	1.50	70	1.54	72	3
FEV1/FVC	%	68	65		65		
FEF25-75%	L/sec	2.01	0.89	44	0.91	45	2
PEF	L/sec	6.59	3.27	50	3.65	55	12
FET100%	Sec		8.56		7.30		-15
FIVC	Liters	3.30	2.04	62	1.74	53	-15
FIF50%	L/sec		0.99		1.53		55
FVL ECode			001000		001000		
MVV	L/min	98					

Lung Volumes

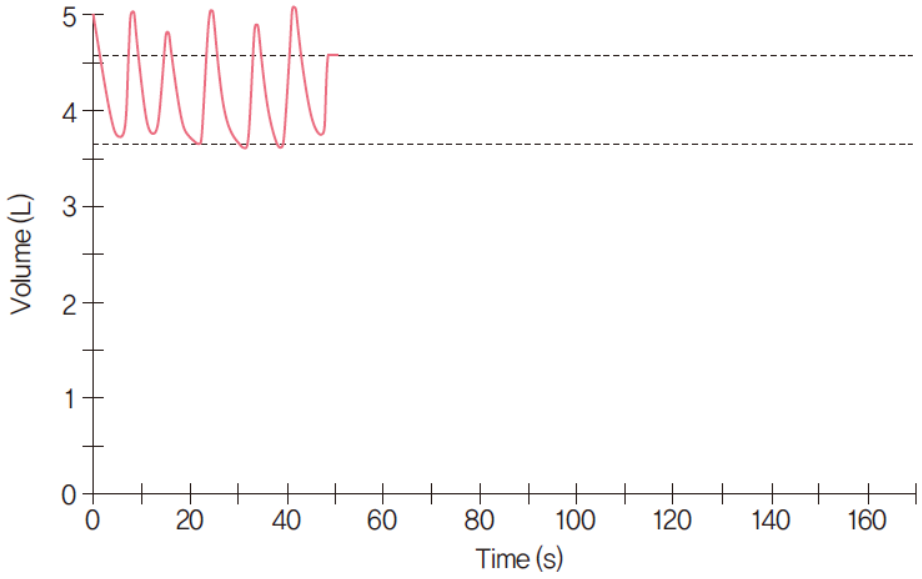
		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
VC	Liters	3.30	2.38	72	2.36	71	-1
TLC	Liters	5.00	3.60	72	3.56	71	-1
RV	Liters	2.28	1.22	53	1.20	52	-2
FRC Pl	Liters	3.13	2.15	69	2.13	68	-1
ERV	Liters	1.14	0.76	66	0.50	43	-35
IC	Liters	2.28	1.45	64	1.43	63	-2
Raw	cmH2O/L/sec	1.49	2.88	193	2.92	195	1
Raw f	BPM		108		113		5
Vtg (Raw)	Liters		2.63		2.68		2
Vtg	Liters		2.63		2.68		2

Single Breath Lung Volumes

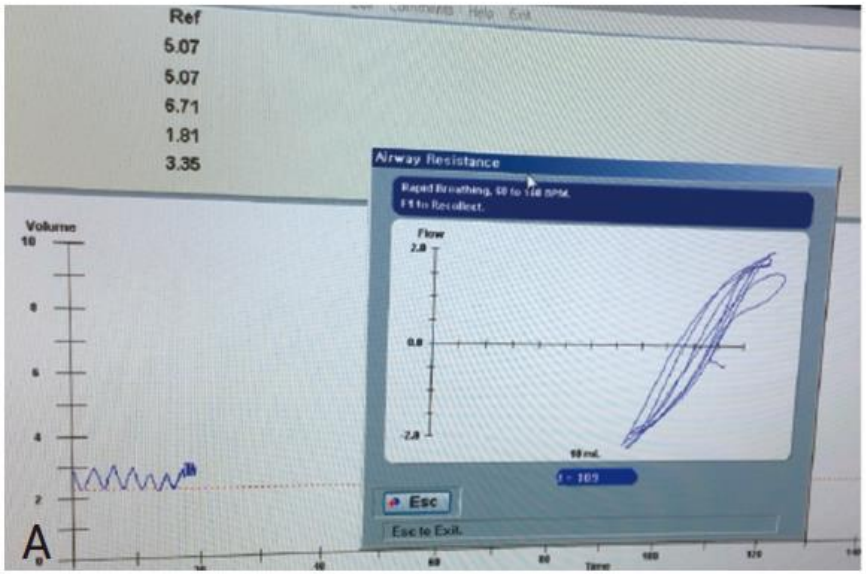
TLC Sb	Liters	5.00	2.54	51
RV Sb	Liters	2.28	1.00	44
RV/TLC Sb	%	44	39	

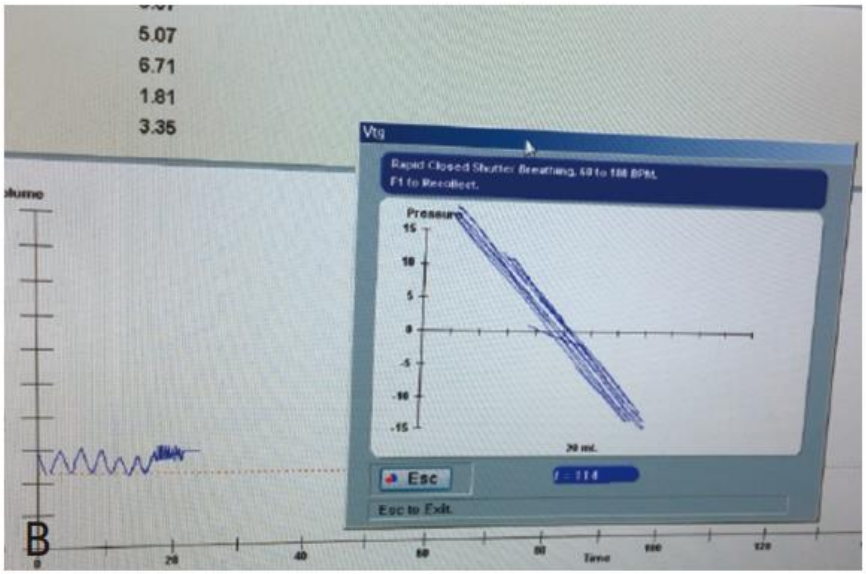

5
4
3
2
1
0
Volume (L)
0
20
40
Time (s)

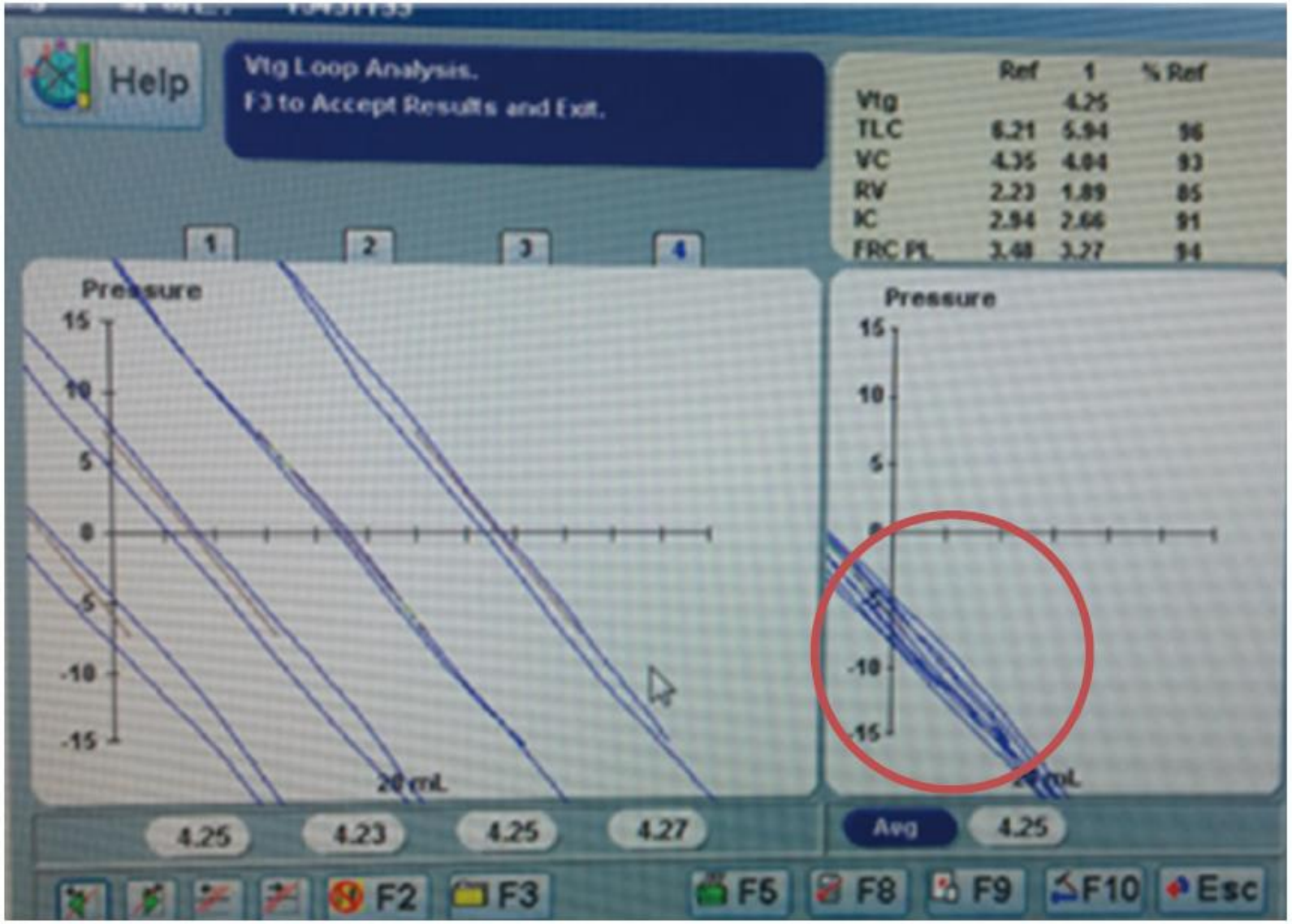
A

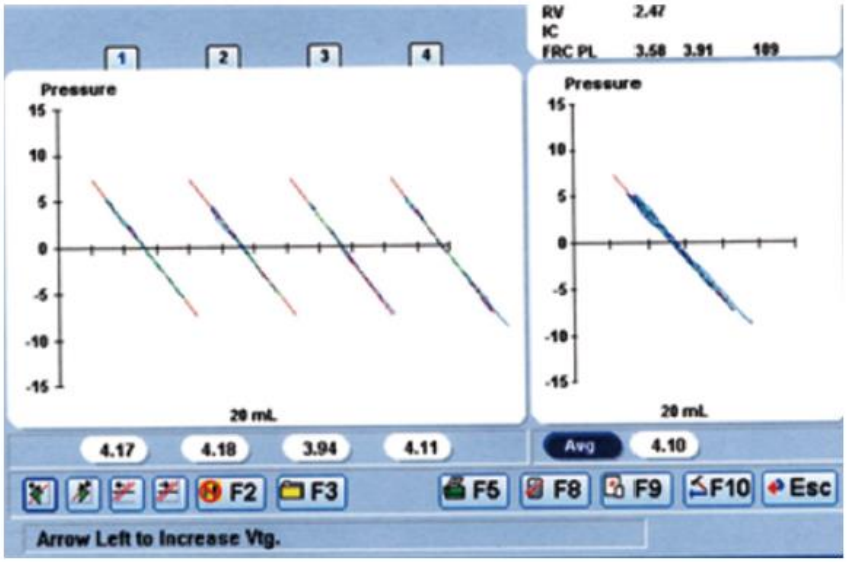

5
4
3
2
1
0
Volume (L)
0
20
40
60
80
100
120
140
160
Time (s)

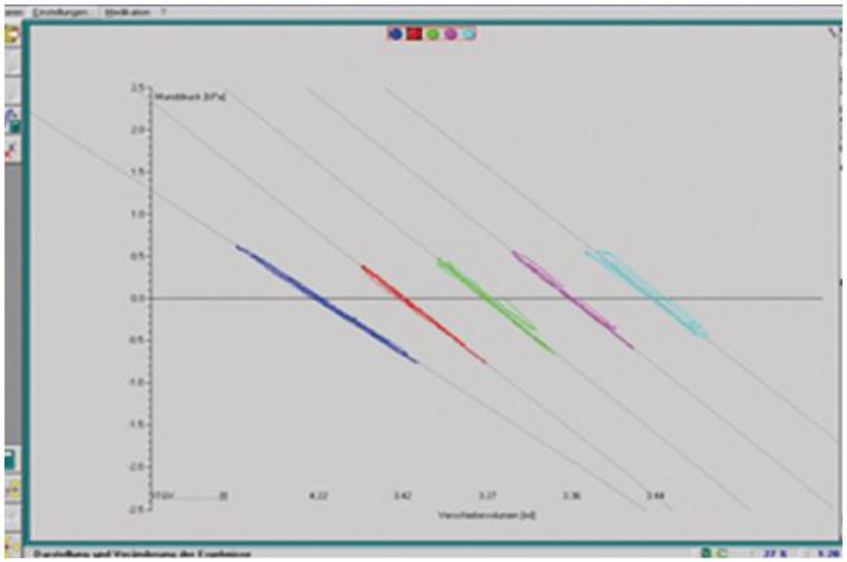
B

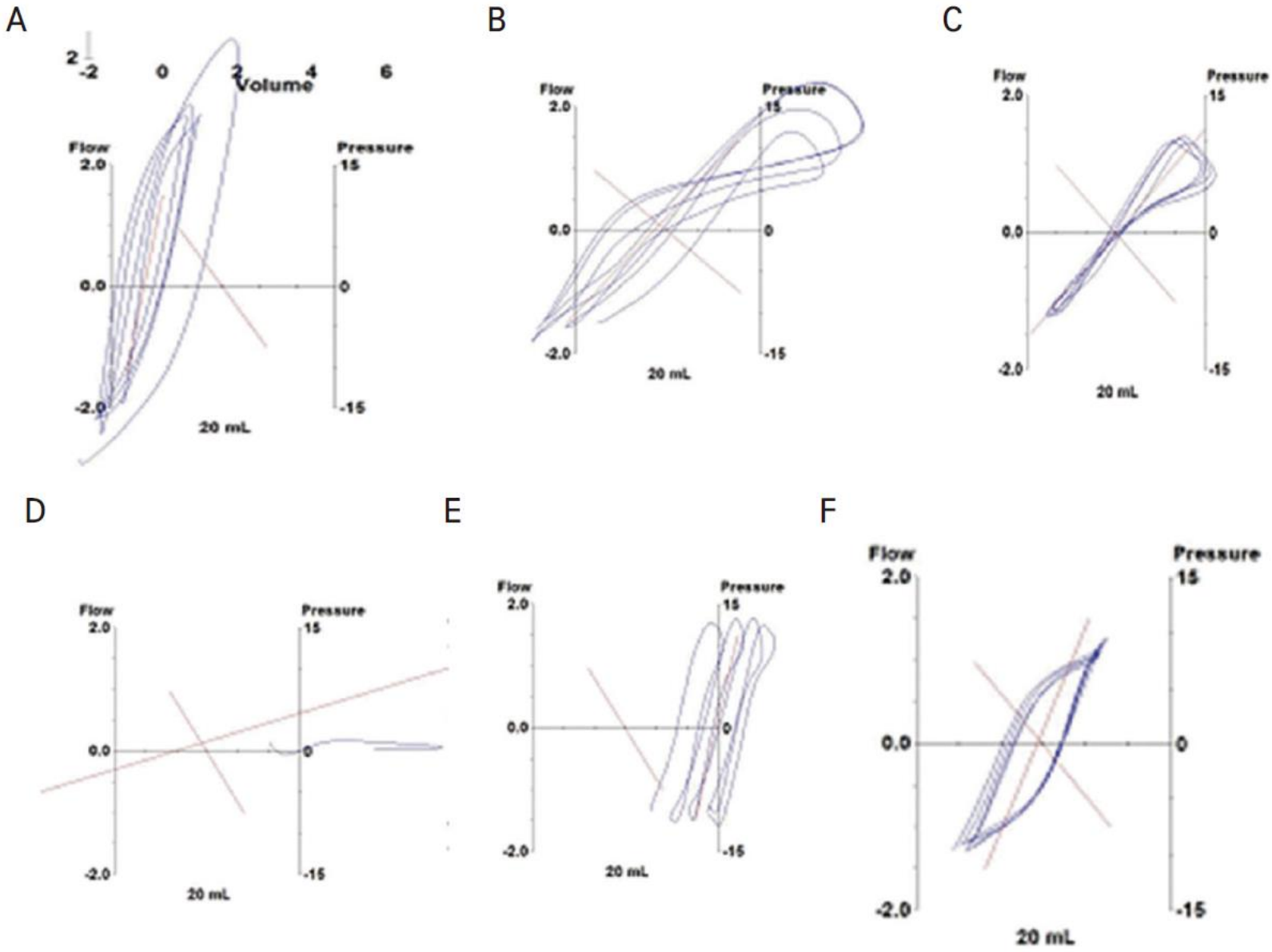

Ref
5.07
5.07
6.71
1.81
3.35
Airway Resistance
Flow
Volume
Esc
Esc to Exit.
A


5.07
6.71
1.81
3.35
Vtg
Pressure
Esc
Esc to Exit.
B


Help
Vtg Loop Analysis.
F3 to Accept Results and Exit.
Ref 1 % Ref
Vtg 4.25
TLC 6.21 5.94 96
VC 4.35 4.04 93
RV 2.23 1.89 85
IC 2.94 2.66 91
FRC Pl 3.48 3.27 94
1
2
3
4
Pressure
15
10
5
0
-5
-10
-15
20 mL
Pressure
15
10
5
-10
-15
4.25
4.23
4.25
4.27
Avg
4.25
F2
F3
F5
F8
F9
F10
Esc


RV 2.47
IC
FRC PL 3.58 3.91 109
1
2
3
4
Pressure
15
10
5
0
-5
-10
-15
20 mL
Pressure
15
10
5
0
-5
-10
-15
20 mL
4.17
4.18
3.94
4.11
Avg
4.10
F2
F3
F5
F8
F9
F10
Esc
Arrow Left to Increase Vtg.



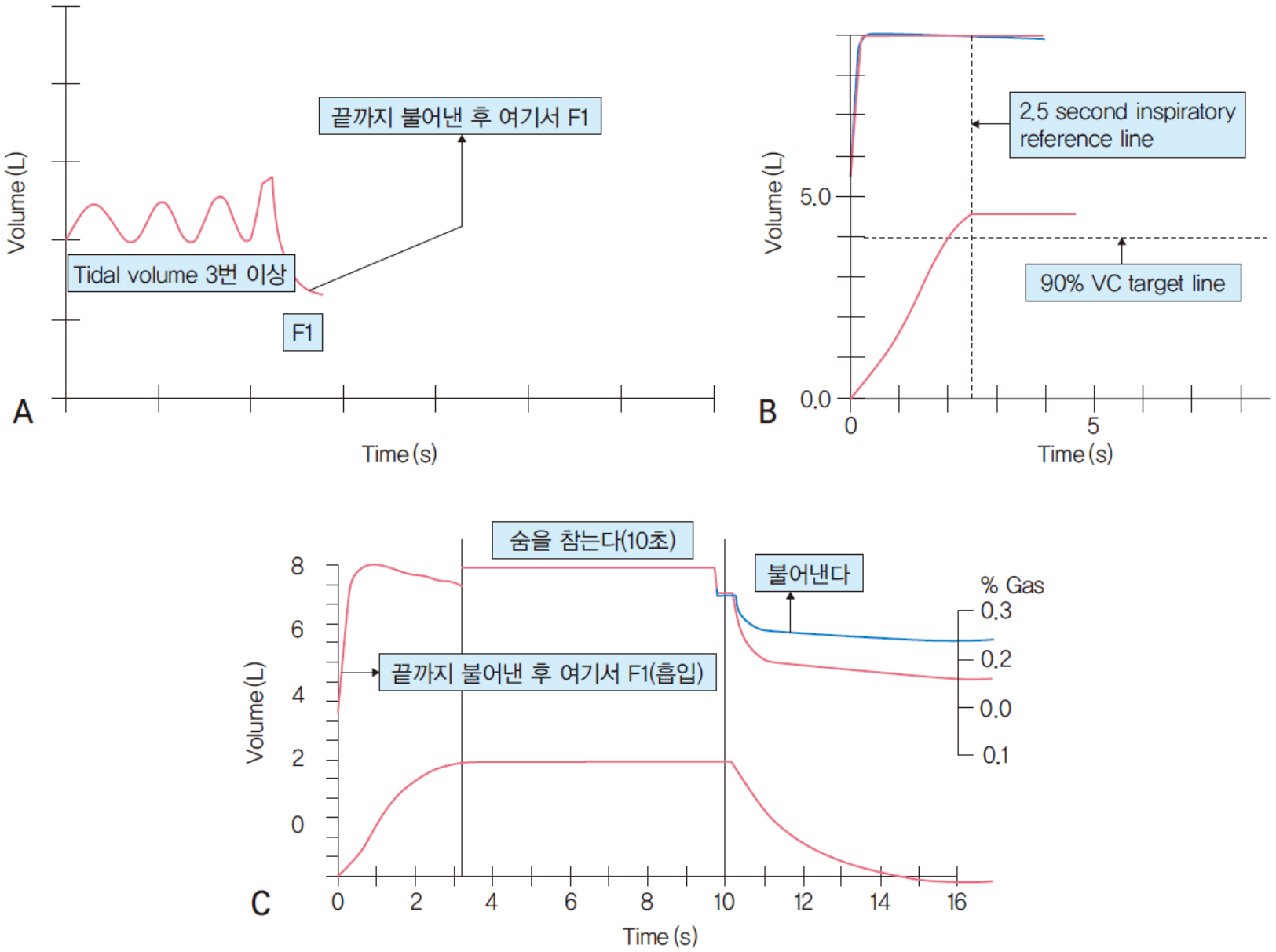

A
2
-2
0
2
4
6
Volume
Flow
2.0
0.0
-2.0
Pressure
15
0
-15
20 mL
B
Flow
2.0
0.0
-2.0
Pressure
15
0
-15
20 mL
C
Flow
2.0
0.0
-2.0
Pressure
15
0
-15
20 mL
D
Flow
2.0
0.0
-2.0
Pressure
15
0
-15
20 mL
E
Flow
2.0
0.0
-2.0
Pressure
15
0
-15
20 mL
F
Flow
2.0
0.0
-2.0
Pressure
15
0
-15
20 mL

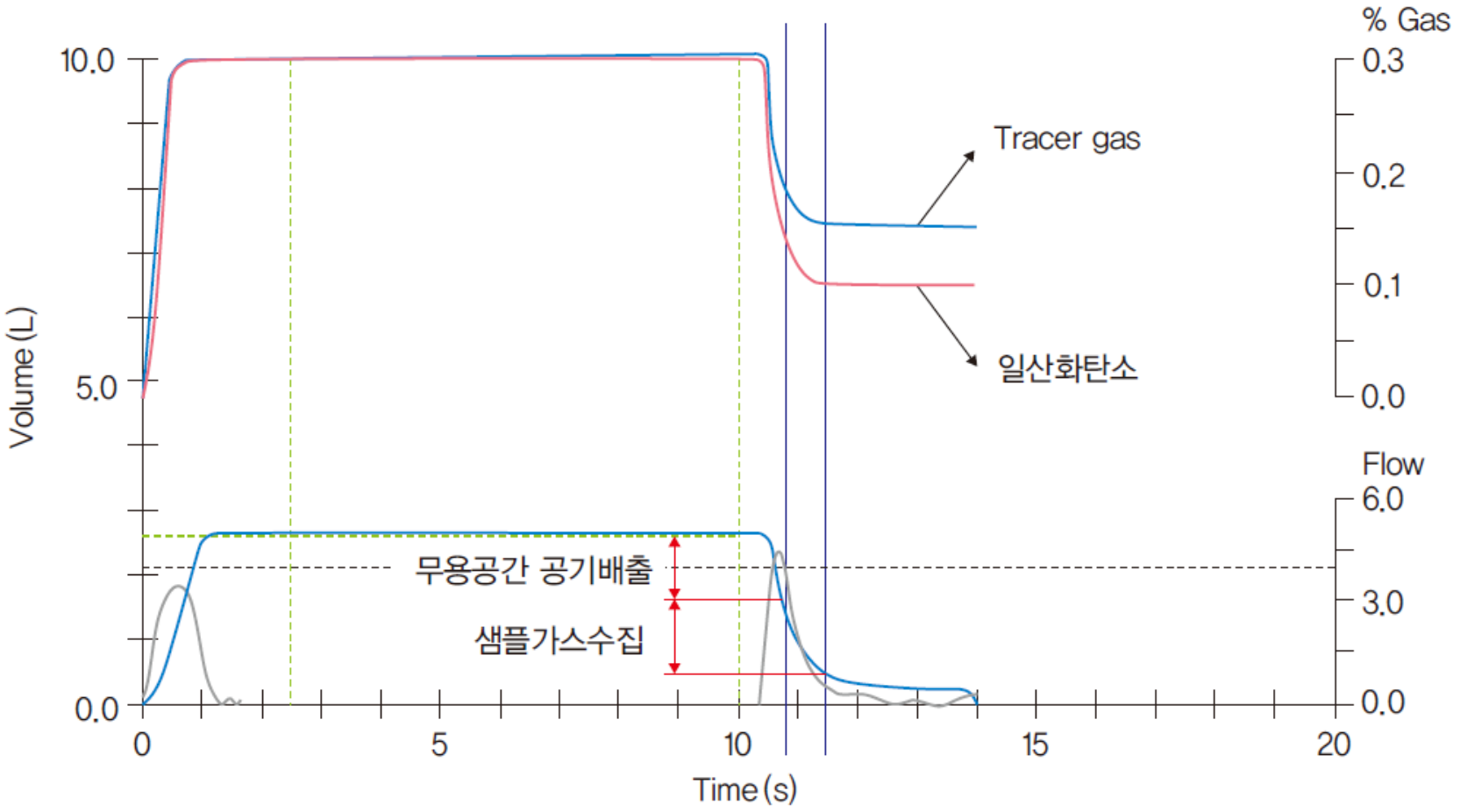
Section 08

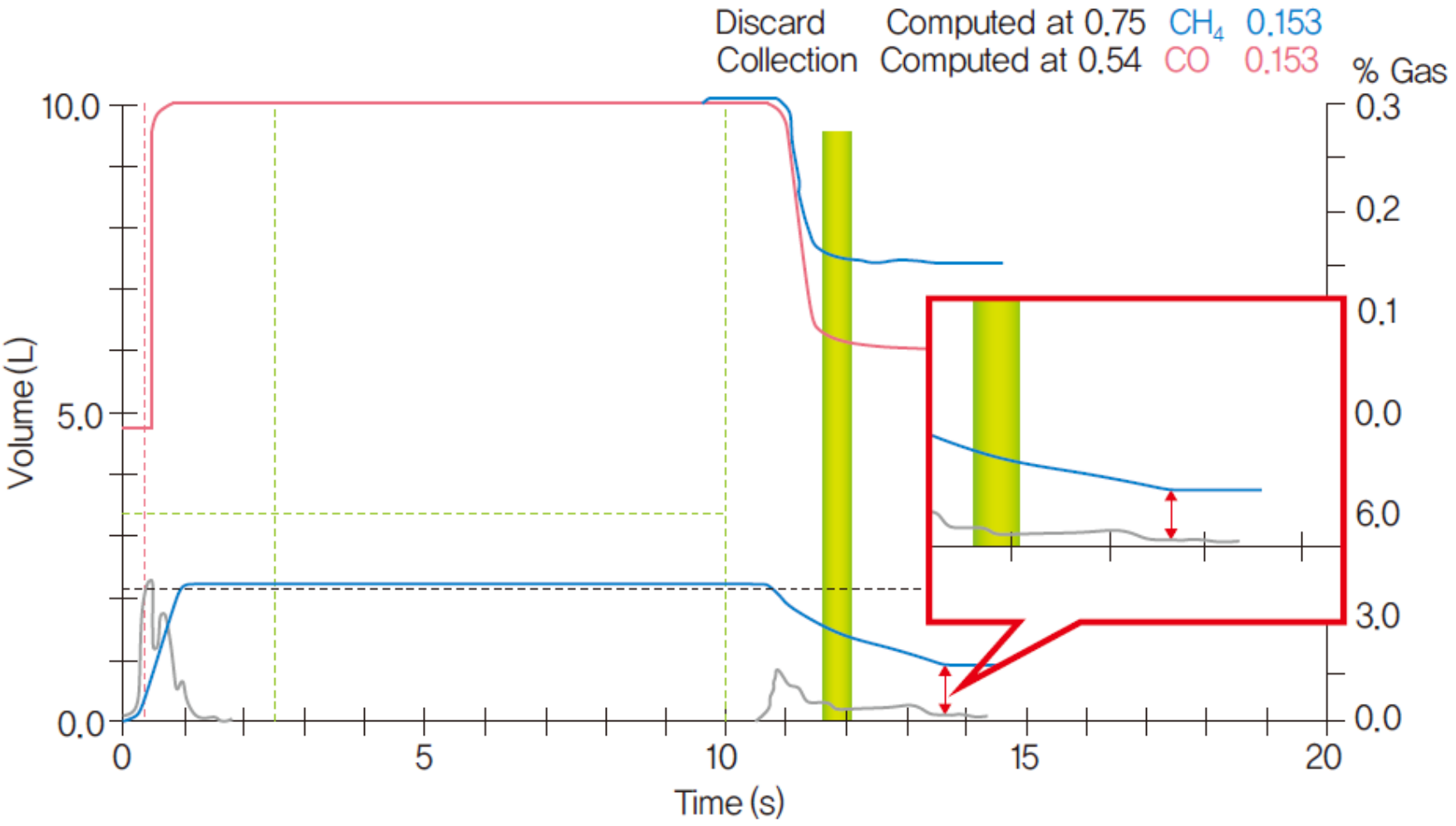
폐확산능 검사

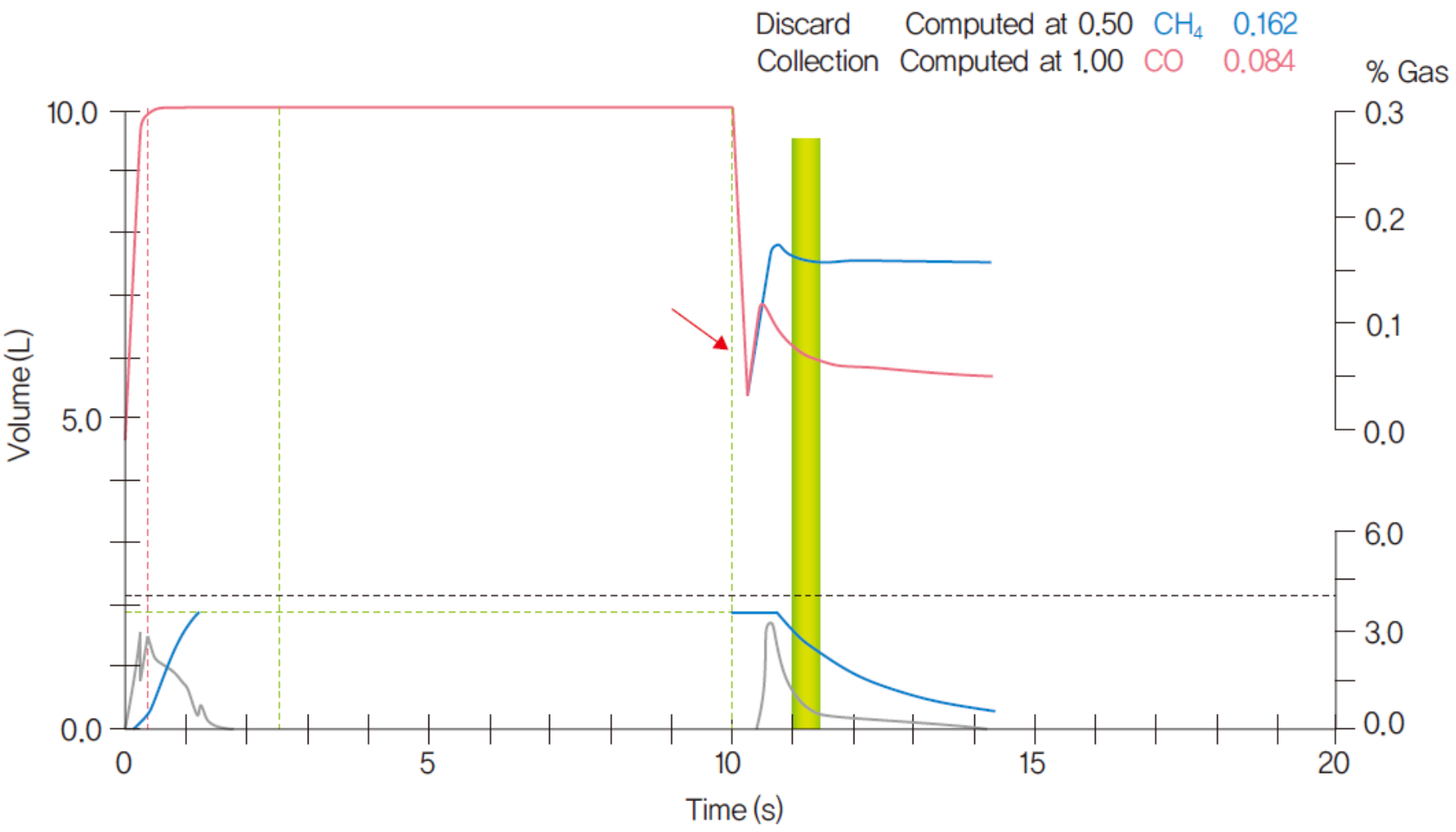
학습목표

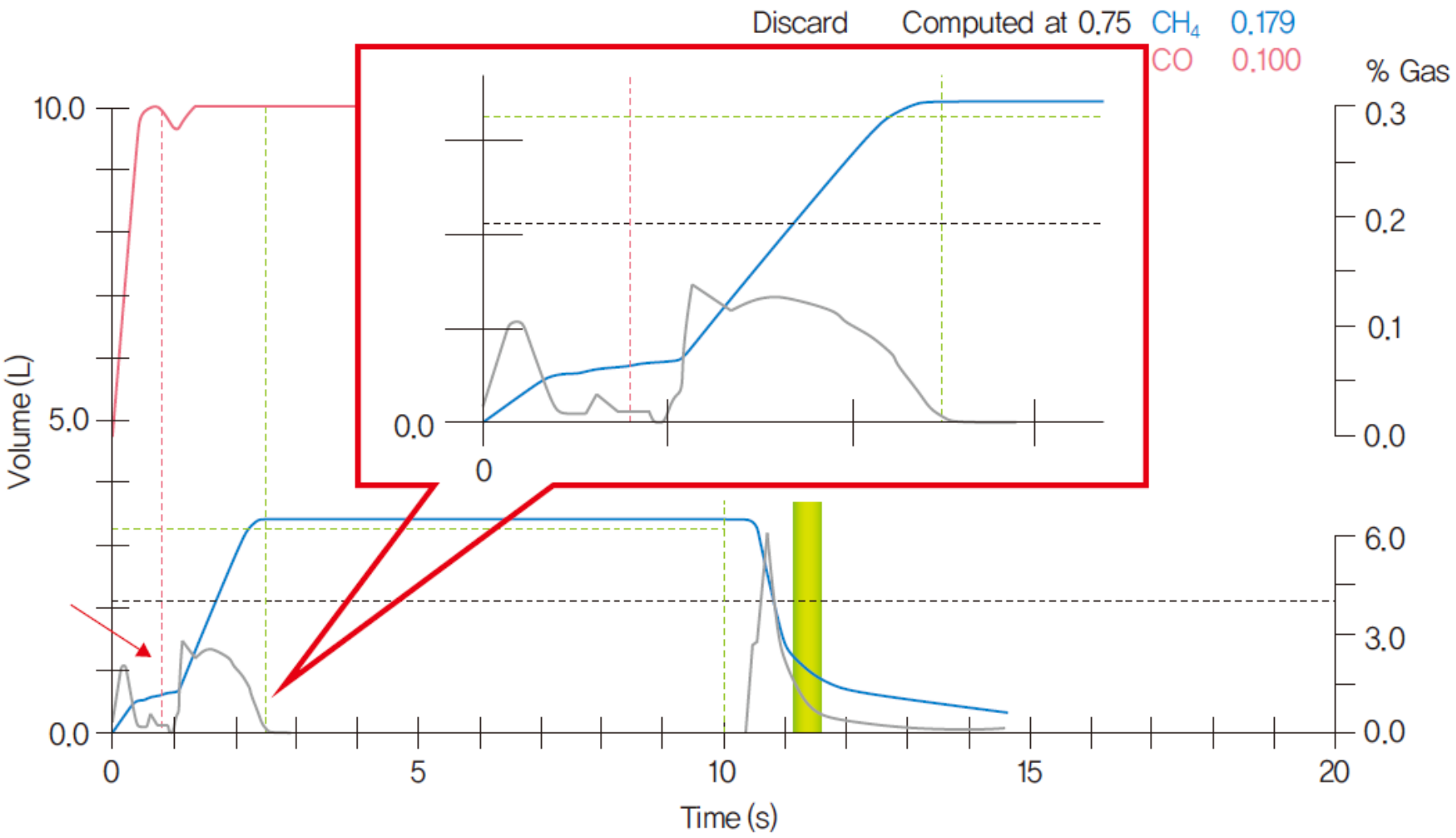
1. 폐확산능 검사를 시행하고 검사결과를 평가 및 해석할 수 있다(A).

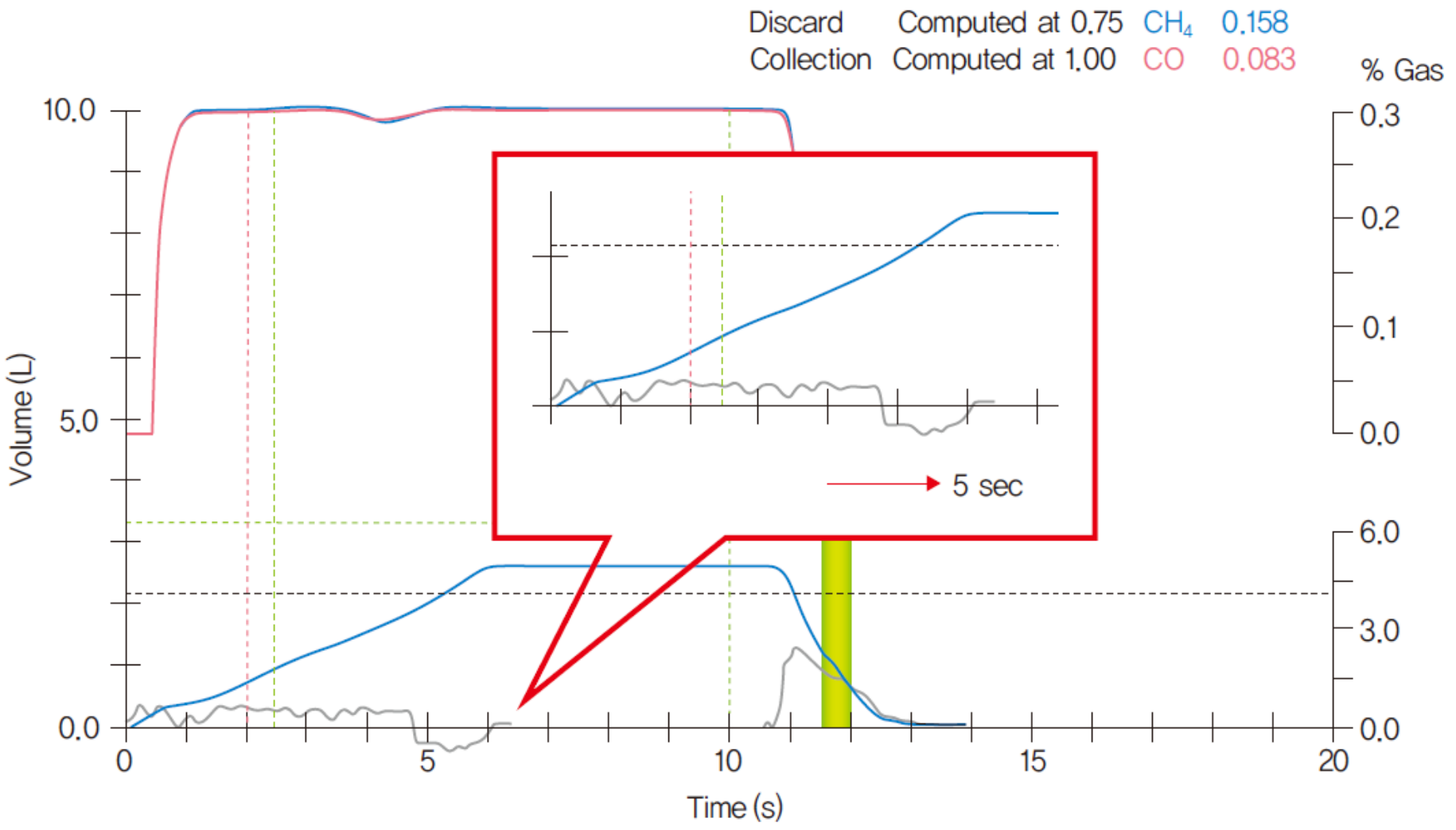

끝까지 불어낸 후 여기서 F1
Tidal volume 3번 이상
F1
Volume (L)
A
Time (s)
2.5 second inspiratory reference line
90% VC target line
5.0
0.0
0
5
B
숨을 참는다(10초)
불어낸다
% Gas
0.3
0.2
0.0
0.1
끝까지 불어낸 후 여기서 F1(흡입)
8
6
4
2
0
0
2
4
6
8
10
12
14
16
C


% Gas
0.3
0.2
0.1
0.0
Tracer gas
일산화탄소
Flow
6.0
3.0
0.0
10.0
5.0
0.0
Volume (L)
무용공간 공기배출
샘플가스수집
0
5
10
15
20
Time (s)


Discard
Collection
Computed at 0.75
Computed at 0.54
CH4 0.153
CO 0.153
% Gas
10.0
5.0
0.0
Volume (L)
0.3
0.2
0.1
0.0
6.0
3.0
0.0
0
5
10
15
20
Time (s)


Discard
Collection
Computed at 0.50
Computed at 1.00
CH_4 0.162
CO 0.084
% Gas
10.0
5.0
0.0
Volume (L)
0.3
0.2
0.1
0.0
6.0
3.0
0.0
0
5
10
15
20
Time (s)


Discard
Computed at 0.75
CH4 0.179
CO 0.100
% Gas
10.0
5.0
0.0
Volume (L)
0.3
0.2
0.1
0.0
6.0
3.0
0.0
0
5
10
15
20
Time (s)


Discard
Collection
Computed at 0.75
Computed at 1.00
CH_4 0.158
CO 0.083
% Gas
10.0
5.0
0.0
Volume (L)
0.3
0.2
0.1
0.0
6.0
3.0
0.0
5 sec
0
5
10
15
20
Time (s)

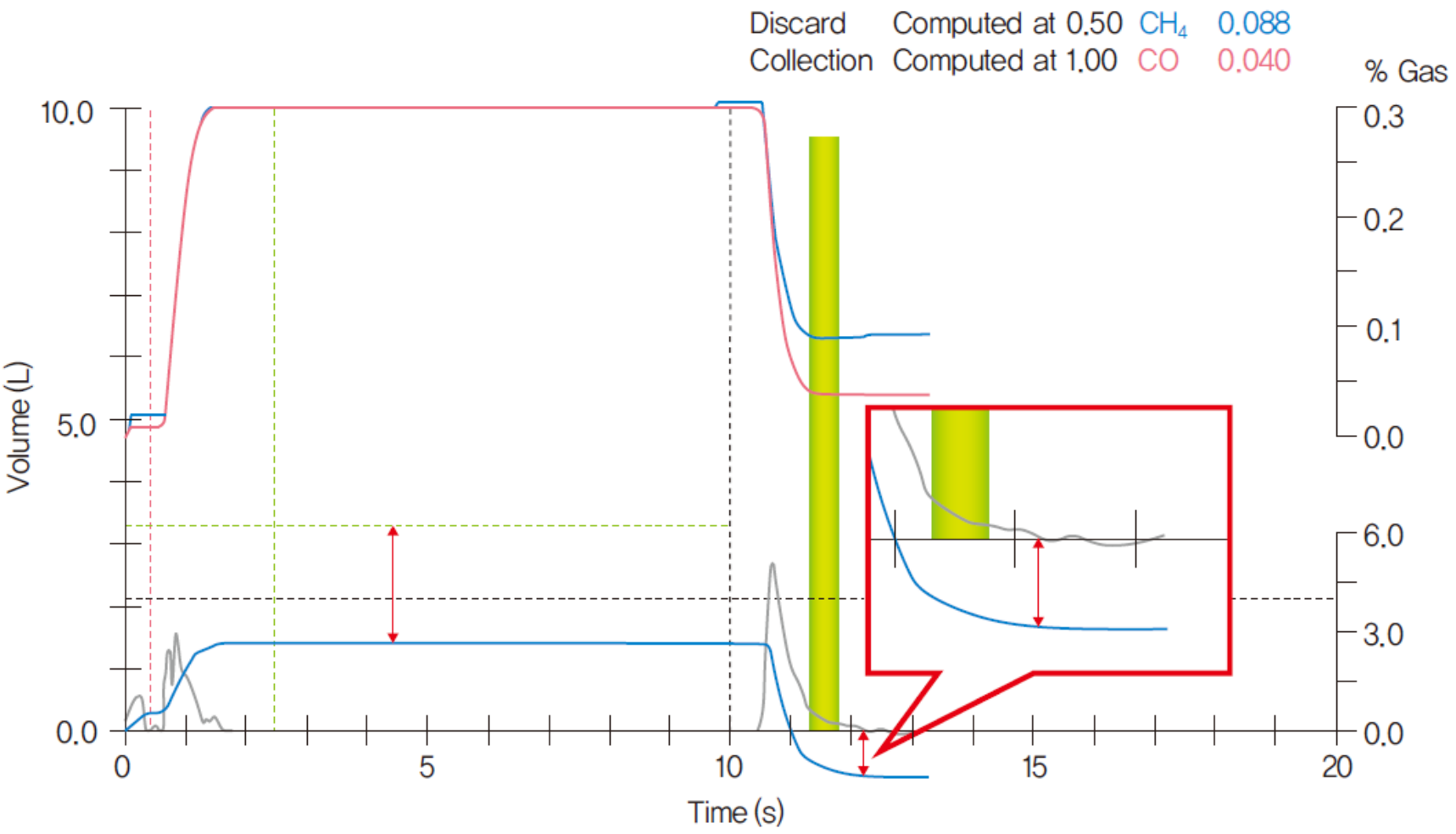

Discard Computed at 0.50 CH_4 0.088
Collection Computed at 1.00 CO 0.040
% Gas
10.0
5.0
0.0
Volume (L)
0.3
0.2
0.1
0.0
6.0
3.0
0.0
0
5
10
15
20
Time (s)

표 8-1. 폐확산능검사 중증도

중증도	폐확산능(% of predicted value)
정상	80% 이상
경증	61~79%
중등증	40~60%
중증	40% 미만

표 8-2. 폐기능검사에 따른 폐확산능값의 해석

폐확산능 값	감별진단
폐확산능 높음	천식, 적혈구증가증, 폐출혈
폐확산능 정상, 제한장애	척추후만증, 고도비만, 신경근육질환, 흉수
폐확산능 정상, 폐쇄장애	천식, 기관지확장증, 만성 기관지염
폐확산능 낮음, 제한장애	석면증, 베릴륨증, 과민성 폐렴, 특발폐섬유화증, 랑게르한스 세포 조직구증, 속립결핵, 사르코이드증, 규폐증(후기)
폐확산능 낮음, 폐쇄장애	낭성 섬유증, 폐기종, 규폐증(초기)
폐확산능 낮음, 정상기능	만성 폐색전증, 자가면역질환의 폐침범, 초기간질성 폐질환, 원발성 폐고혈압

표 8-3. 폐확산능(DL_{CO}) 검사에 영향을 줄 수 있는 인자들

1) 허파 팽창 감소(reduced V_A)로 인한 DL_{CO} 감소
   호흡근 약화나 가슴안 변형
2) 혈액양이나 Hb-CO 반응 감소를 유발하는 질환이나 상태로 인한 DL_{CO} 감소
   빈혈
   폐색전증
   발살바 조작(Valsalva maneuver)
   Hb 결합능 변화(예 : Hb-CO, FiO_2 증가)
3) 허파꽈리막 이상과 Hb-CO 반응 감소를 유발하는 질환들로 인한 DL_{CO} 감소
   폐기종
   간질성 폐질환(폐섬유증)
   폐혈관염
   폐고혈압
4) Hb-CO 반응, 혈액양 증가로 인한 DL_{CO} 증가
   적혈구증가증(polycythemia)
   폐출혈
   천식
5) 기타 DL_{CO} 증가 상태
   Hb 결합능 이상
   뮬러 조작(Muller maneuver)
   엎드린 자세(복와위)
   비만

Section 09

특수 폐기능검사

학습목표

1. 기관지 과민성 검사를 이해하고 수행할 수 있다(A).
2. 알레르기 검사를 이해하고 수행할 수 있다(A).
3. 운동부하 심폐기능검사를 이해하고 수행할 수 있다(B).

표 9-1. 기관지 과민성 검사의 적응증과 금기증

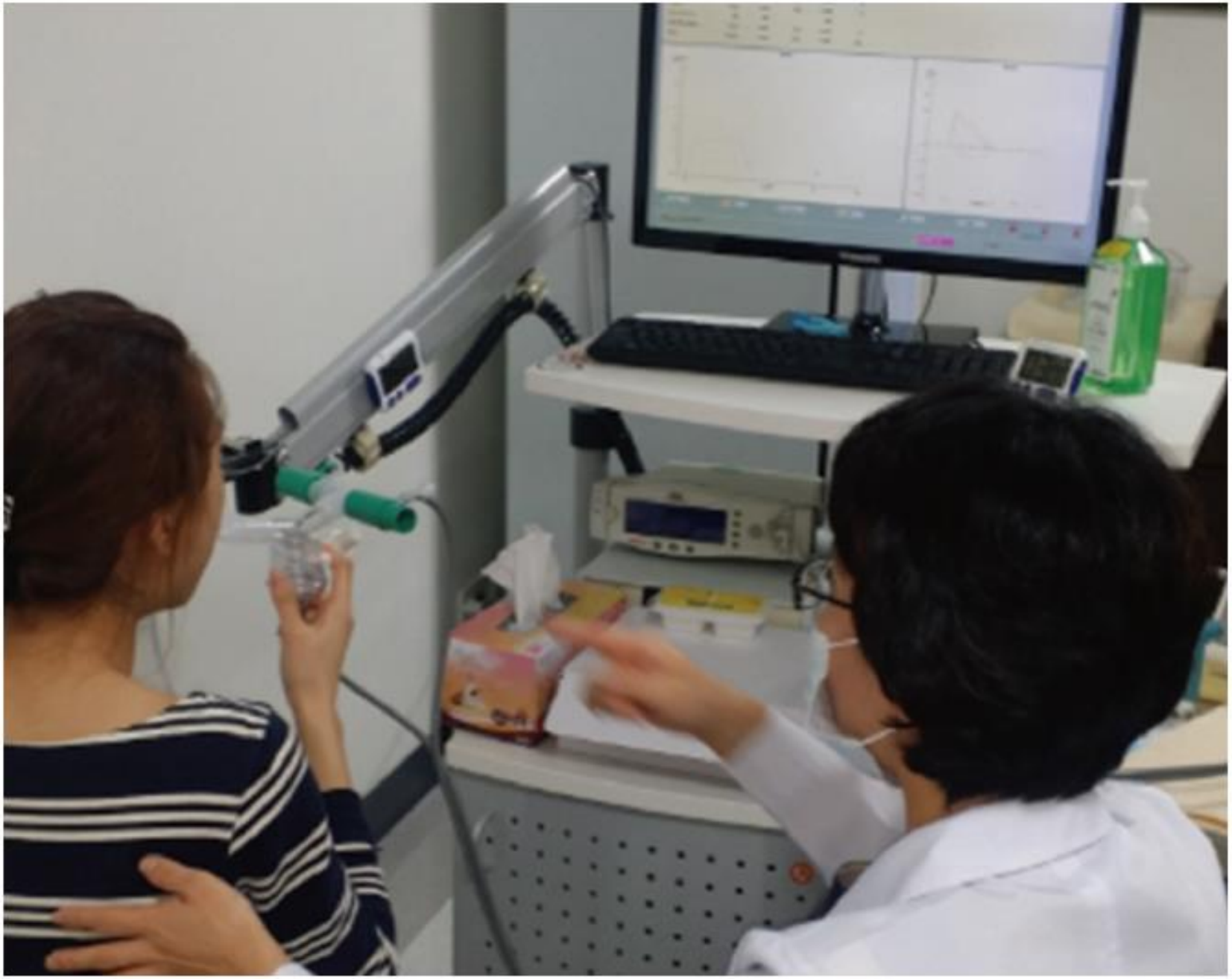
적응증
천식(기도과민성)의 진단
기도과민성의 중증도 평가
천식이 발생할 상대적 위험도 결정
천식 치료의 반응 평가
절대금기
중증 기류 제한(FEV_1 < 정상 예측치의 50%, 또는 < 1.0 L)
최근 3개월 동안 심근경색이나 뇌경색
진단된 동맥류
상대금기
중증도의 기류 제한(FEV_1 < 정상 예측치의 60%)
천식 급성 악화
최근 2주 이내의 상기도 감염
조절되지 않는 고혈압
임신이나 수유
약물 치료가 필요한 간질
인정할만한 수준의 폐화량 측정을 수행할 수 없을 경우

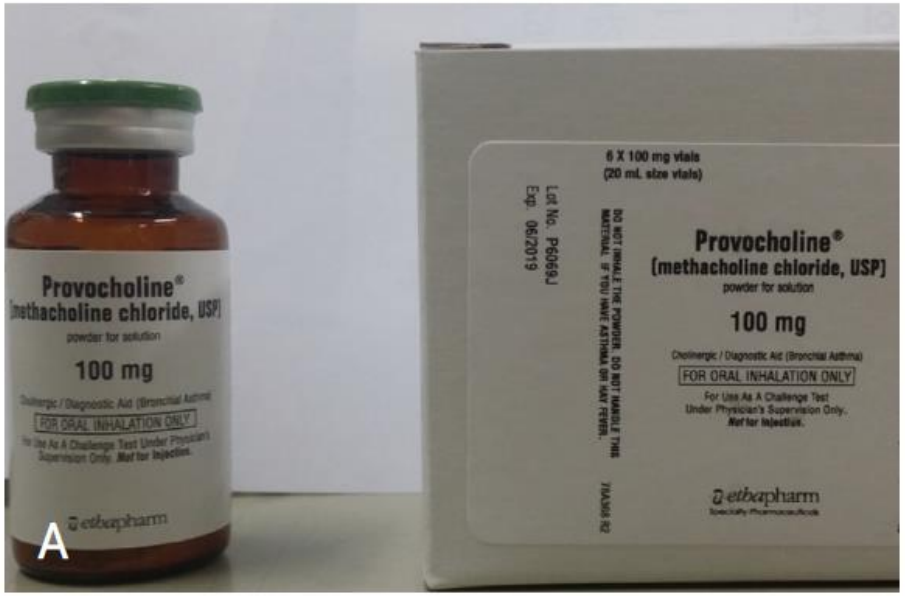
표 9-2. 기도 반응성을 감소시키는 인자들

인자	마지막 투약에서 검사까지 최소시간 간격
약물	
속효 흡입 베타2 항진제(isoproterenol, metaproterenol, albuterol, terbutaline)	8시간
속효 흡입 항콜린제(ipratropium)	24시간
지속 흡입 기관지 확장제(salmeterol, formoterol, tiotropium)	48시간(tiotropium인 경우 1주 이상)
경구 기관지 확장제	
중간 지속 테오필린	24시간
지속 테오필린	48시간
경구 베타2 항진제	12시간
지속 경구 베타2 항진제	24시간
Cromolyn sodium	8시간
Nedocromil	48시간
Hydroxyzine, cetirizine	3일
Leukotriene modifiers	24시간
스테로이드(경구 또는 흡입)	작용기간은 알 수 없음. 항염증 효과가 없어지기 위해서는 수주간 중단해야 함.
음식물	
커피, 차, 콜라, 초콜릿	검사당일

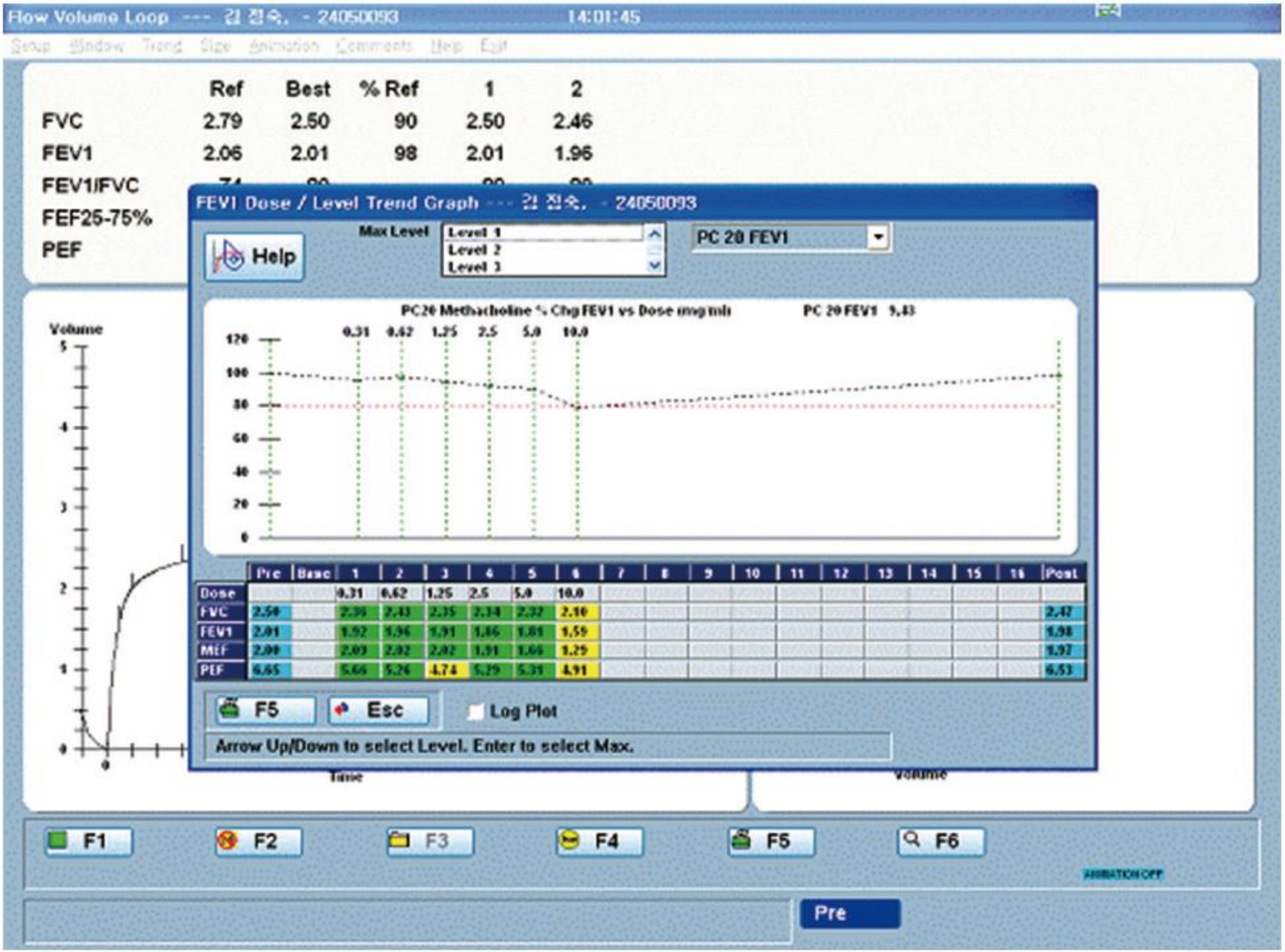
표 9-3. 기도 반응성을 증가시키는 인자들

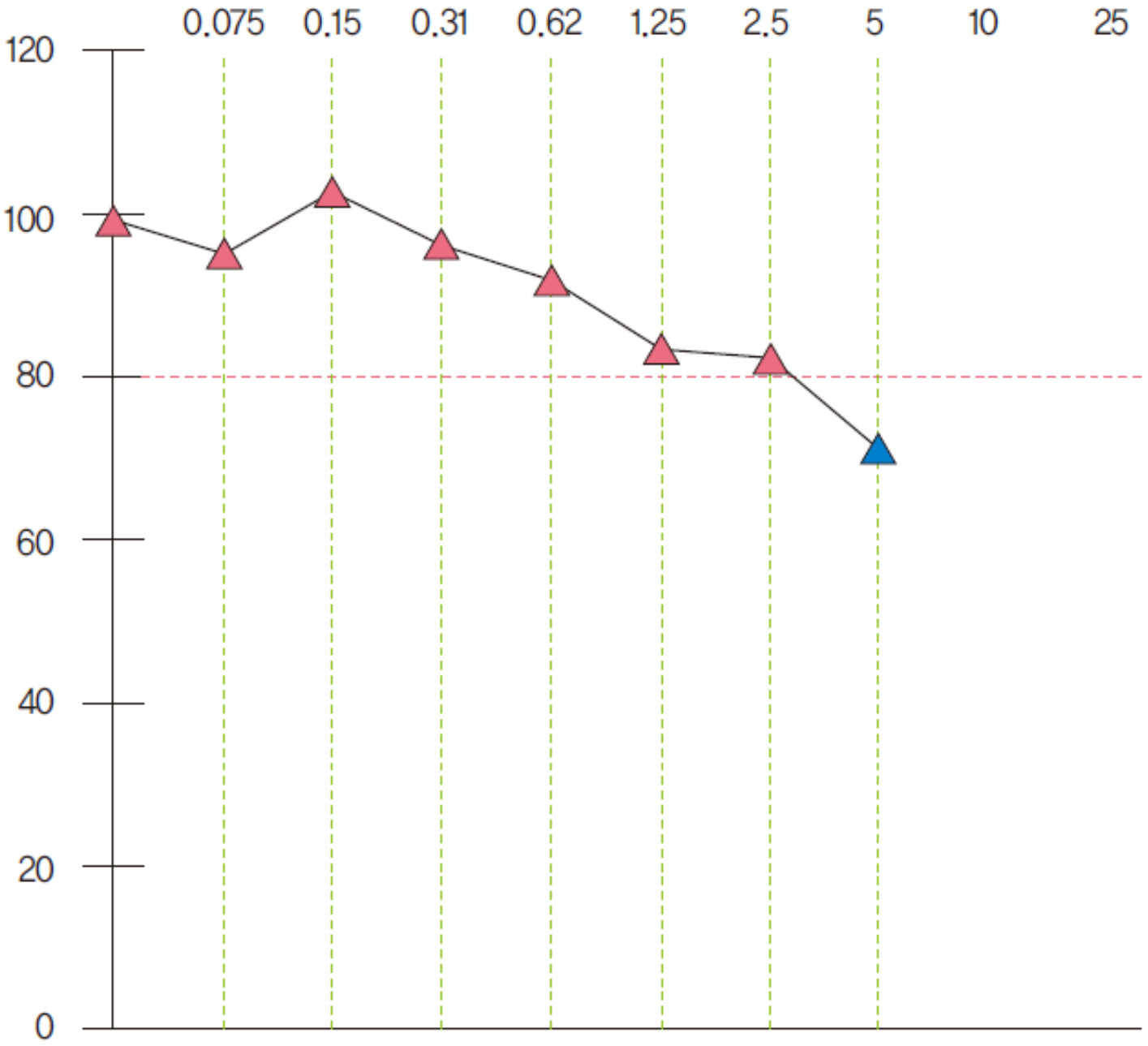
인자	작용시간
환경성 항원에 노출	1~3주
직업적 원인에 폭로	수개월
호흡기 감염	3~6주
대기 오염	1주
흡연	확실하지 않음
화학적 자극	수일에서 수개월




Provocholine®
(methacholine chloride, USP)
powder for solution
100 mg
FOR ORAL INHALATION ONLY
ethapharm
6 X 100 mg vials
(20 mL size vials)
Lot No. P6069J
Exp. 06/2019
Provocholine®
(methacholine chloride, USP)
powder for solution
100 mg
Cholinergic / Diagnostic Aid (Bronchial Asthma)
FOR ORAL INHALATION ONLY
For Use As A Challenge Test
Under Physician's Supervision Only.
Not for Injection.
ethapharm
A

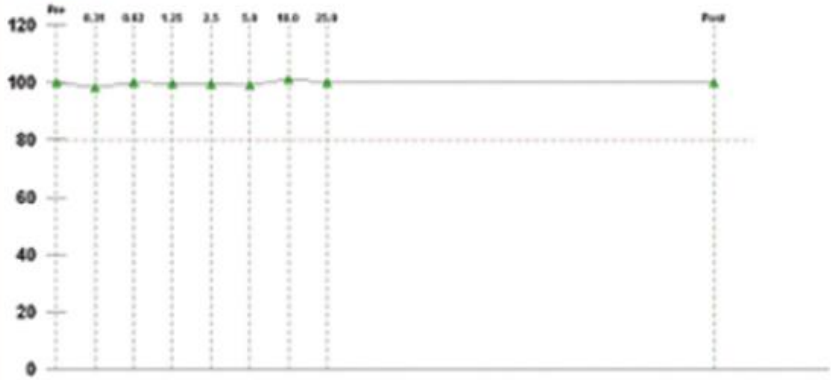

Salter AIRE Flow
B

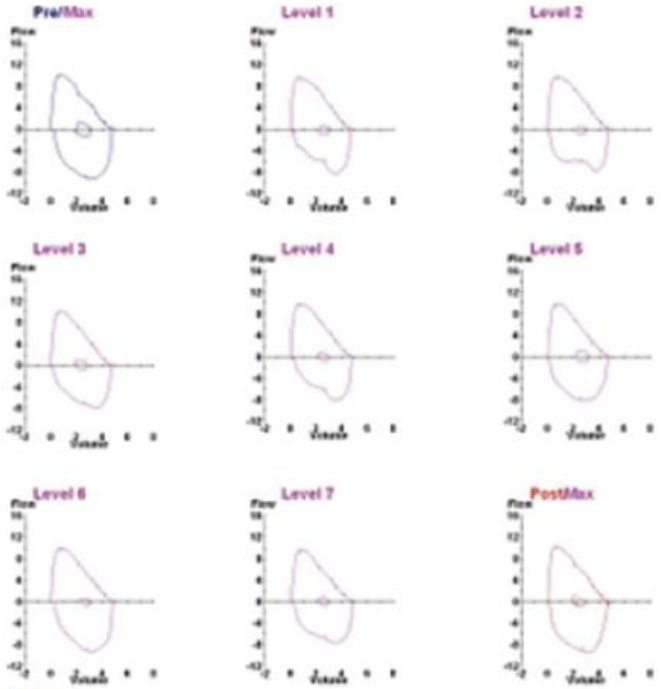

Flow Volume Loop --- 김정숙, - 24050093 14:01:45
Setup Window Trend Size Animation Comments Help Exit
Ref Best % Ref 1 2
FVC 2.79 2.50 90 2.50 2.46
FEV1 2.06 2.01 98 2.01 1.96
FEV1/FVC
FEF25-75%
PEF
FEV1 Dose / Level Trend Graph --- 김정숙, - 24050093
Help
Max Level
Level 1
Level 2
Level 3
PC 20 FEV1
PC20 Methacholine % Chg FEV1 vs Dose mg/ml
PC 20 FEV1 9.83
0.31 0.62 1.25 2.5 5.0 10.0
120
100
80
60
40
20
0
Pre Basc 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 Post
Dose 0.31 0.62 1.25 2.5 5.0 10.0
FVC 2.50 2.39 2.43 2.35 2.14 2.32 2.10 2.47
FEV1 2.01 1.92 1.96 1.91 1.86 1.81 1.59 1.98
MEF 2.00 2.03 2.02 2.02 1.91 1.66 1.25 1.97
PEF 6.65 5.66 5.26 4.74 5.29 5.31 4.91 6.53
F5
Esc
Log Plot
Arrow Up/Down to select Level. Enter to select Max.
Volume
5
4
3
2
1
0
Time
Volume
F1
F2
F3
F4
F5
F6
ANIMATION OFF
Pre


0.075
0.15
0.31
0.62
1.25
2.5
5
10
25
120
100
80
60
40
20
0

	Ref	Pre Meas	Level 1 Meas	Level 2 Meas	Level 3 Meas	Level 4 Meas	Level 5 Meas	Level 6 Meas	Level 7 Meas	Post Meas
Dose			0.31	0.62	1.25	2.5	5.0	10.0	25.0	
FVC Liters	5.05	4.77	4.68	4.75	4.73	4.77	4.70	4.82	4.82	4.78
% Ref		95	93	94	94	94	93	95	95	95
% Chg			-2	-0	-1	-0	-2	1	1	0
Dose			0.31	0.62	1.25	2.5	5.0	10.0	25.0	
FEV1 Liters	4.10	4.24	4.17	4.24	4.23	4.22	4.20	4.29	4.25	4.25
% Ref		103	102	103	103	103	102	105	104	103
% Chg			-2	0	-0	-1	-1	1	0	0
Dose			0.31	0.62	1.25	2.5	5.0	10.0	25.0	
FEF25-75%	4.54	5.33	5.30	5.42	5.39	5.22	5.19	5.24	5.08	5.36
% Ref		118	117	120	119	115	114	115	112	118
% Chg			-1	2	1	-2	-3	-2	-5	1
Dose			0.31	0.62	1.25	2.5	5.0	10.0	25.0	
PEF L/sec	9.36	10.10	9.57	9.66	10.01	9.81	9.85	9.97	9.63	10.32
% Ref		108	102	103	107	105	105	107	103	110
% Chg			-5	-4	-1	-3	-2	-1	-5	2

PC 20 FEV1: ---

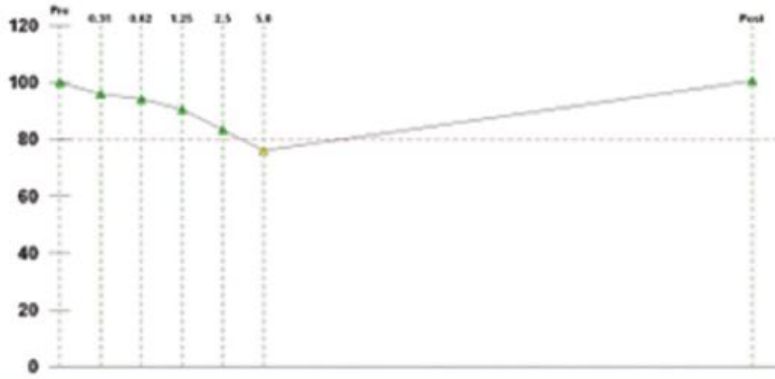


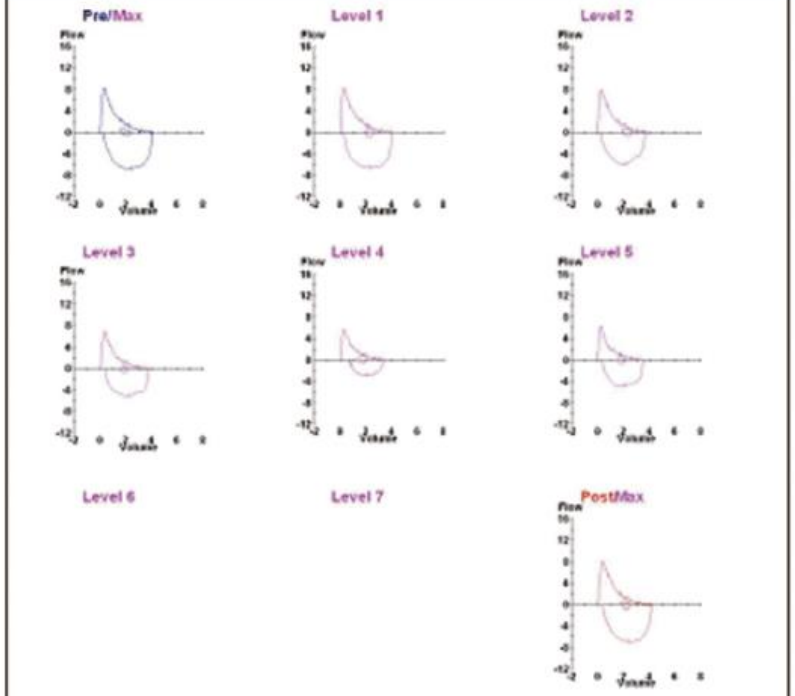


Comments:

	Ref	Pre Meas	Level 1 Meas	Level 2 Meas	Level 3 Meas	Level 4 Meas	Level 5 Meas	Level 6 Meas	Level 7 Meas	Post Meas
Dose			0.31	0.62	1.25	2.5	5.0			
FVC Liters	3.68	4.10	4.00	3.72	3.79	3.41	3.54			4.19
% Ref		111	109	101	103	93	96			114
% Chg			-2	-9	-7	-17	-14			2
Dose			0.31	0.62	1.25	2.5	5.0			
FEV1 Liters	2.54	2.36	2.26	2.23	2.13	1.97	1.80			2.37
% Ref		93	89	88	84	77	71			93
% Chg			-4	-6	-10	-17	-24			1
Dose			0.31	0.62	1.25	2.5	5.0			
FEF25-75%	2.51	0.92	0.84	0.99	0.78	0.81	0.61			0.84
% Ref		37	33	40	31	32	24			34
% Chg			-9	8	-15	-11	-34			-8
Dose			0.31	0.62	1.25	2.5	5.0			
PEF L/sec	7.14	8.25	8.35	7.99	6.84	6.88	6.34			8.08
% Ref		115	117	112	96	96	89			113
% Chg			1	-3	-17	-17	-23			-2

PC 20 FEV1: 3.42





검사방법
- Provocholine 유발검사

Provocholine 농도

측정 지표: 기저값 (Reference value)에 대한 FEV_1 감소정도

Provocation Test Report

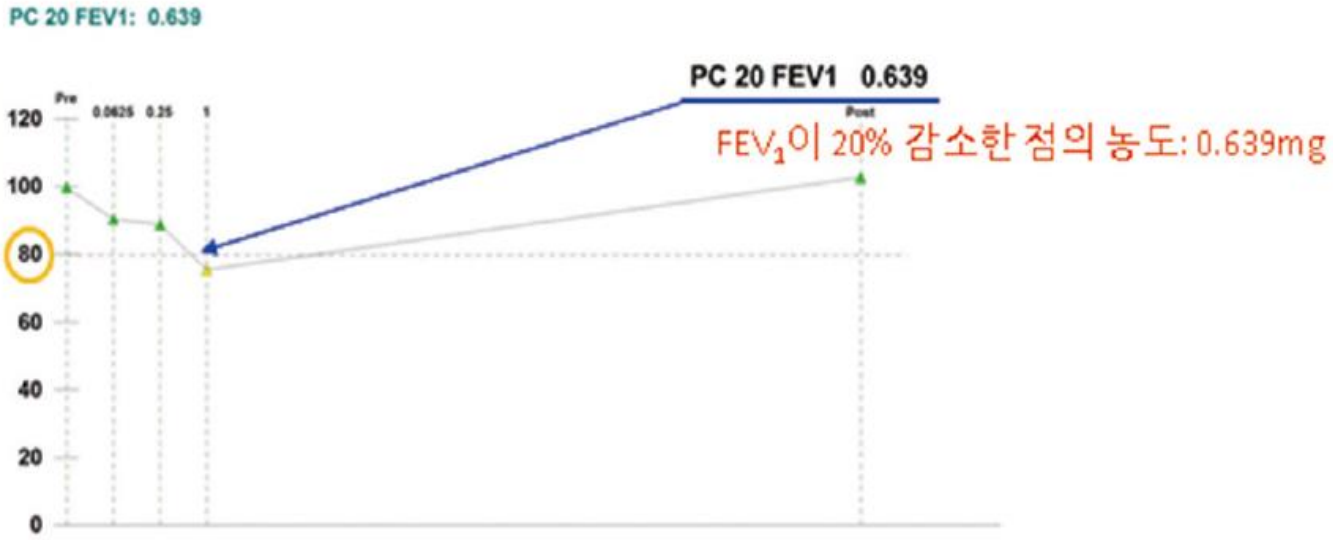
Protocol: Provocholine-5Level

Race: Asian
Date: 2016 07 04
Technician:
Physician:
Diagnosis:

	Ref	Pre	Level 1	Level 2	Level 3	Level 4	Level 5	Post
		Meas	Meas	Meas	Meas	Meas	Meas	Meas
Dose			0.0625	0.25	1			
FVC Liters	3.56	3.66	3.43	3.36	3.12			3.63
% Ref		103	96	94	88			102
% Chg			-6	-8	-15			-1
Dose			0.0625	0.25	1			
FEV1 Liters	3.12	3.04	2.75	2.70	2.30			3.13
% Ref		97	88	87	74			100
% Chg			-9	-11	-24			3
Dose			0.0625	0.25	1			
FEF25-75%	3.53	3.13	2.50	2.60	1.82			3.15
% Ref		88	71	73	52			89
% Chg			-20	-17	-42			1
Dose			0.0625	0.25	1			
PEF L/sec	6.41	5.59	4.65	4.39	4.38			6.12
% Ref		87	73	68	68			95
% Chg			-17	-22	-22			9

FEV_1의 변화
- 정상: 의미 있는 변화 없음
- 기관지과민성: 20% 이상 감소

FEV_1 20% 감소한 지점 표시

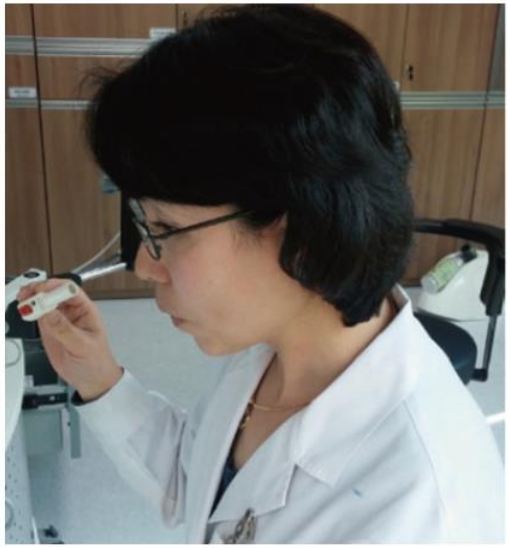


FEV_1이 20% 감소한 점의 농도: 0.639mg

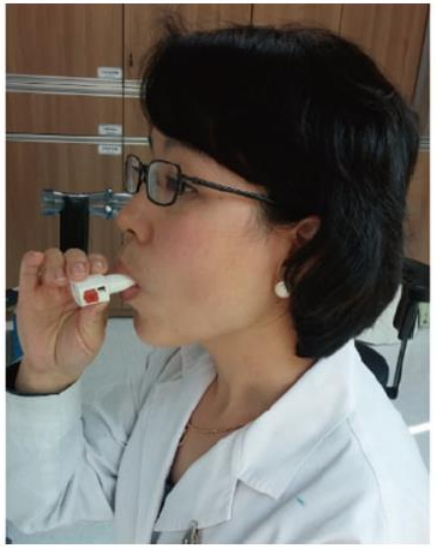
표 9-4. 만니톨 흡입 용량단계

단계	용량(mg)	캡슐의 수	누적 용량(mg)
1	0	1	0
2	5	1	5
3	10	1	15
4	20	1	15
5	40	1	75
6	80	2 × 40 mg	155
7	160	4 × 40 mg	315
8	160	4 × 40 mg	475
9	160	4 × 40 mg	635

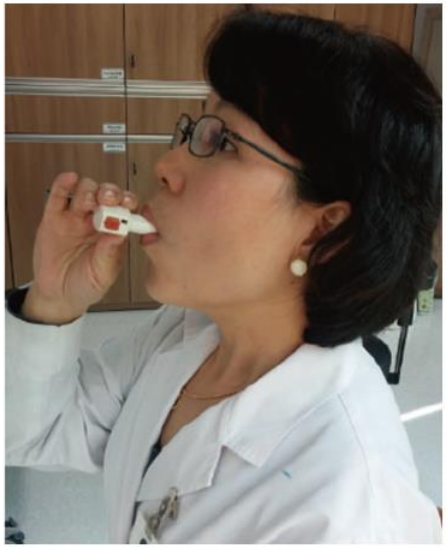




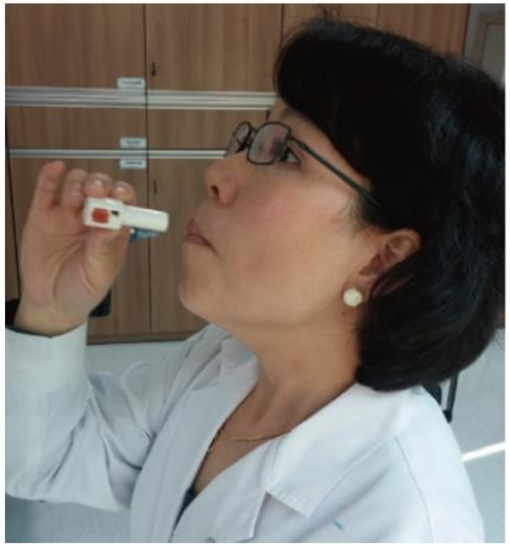
① 먼저 날숨 후



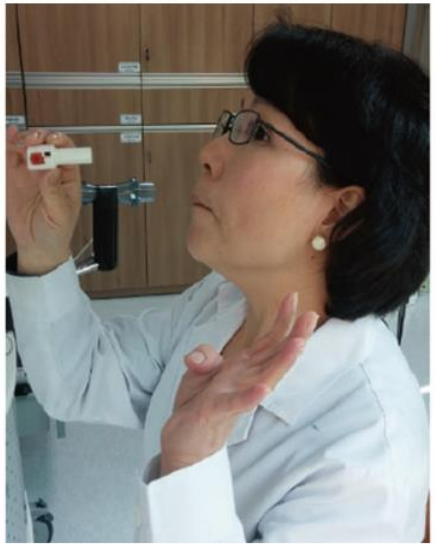
② 천천히 깊게 들이 마신다.



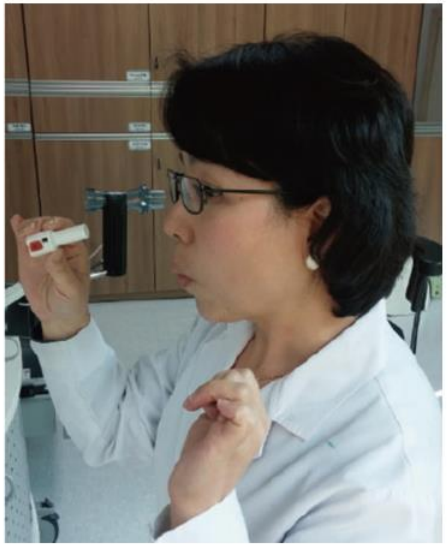
③ “빈 알약” 소리가 날때(또르륵 굴러가는 소리)까지 흡입한다.



④ 알약 안에 Power가 남아 있는지 확인한다.



⑤ 숨을 5초 참는다.



⑥ 날숨한다.

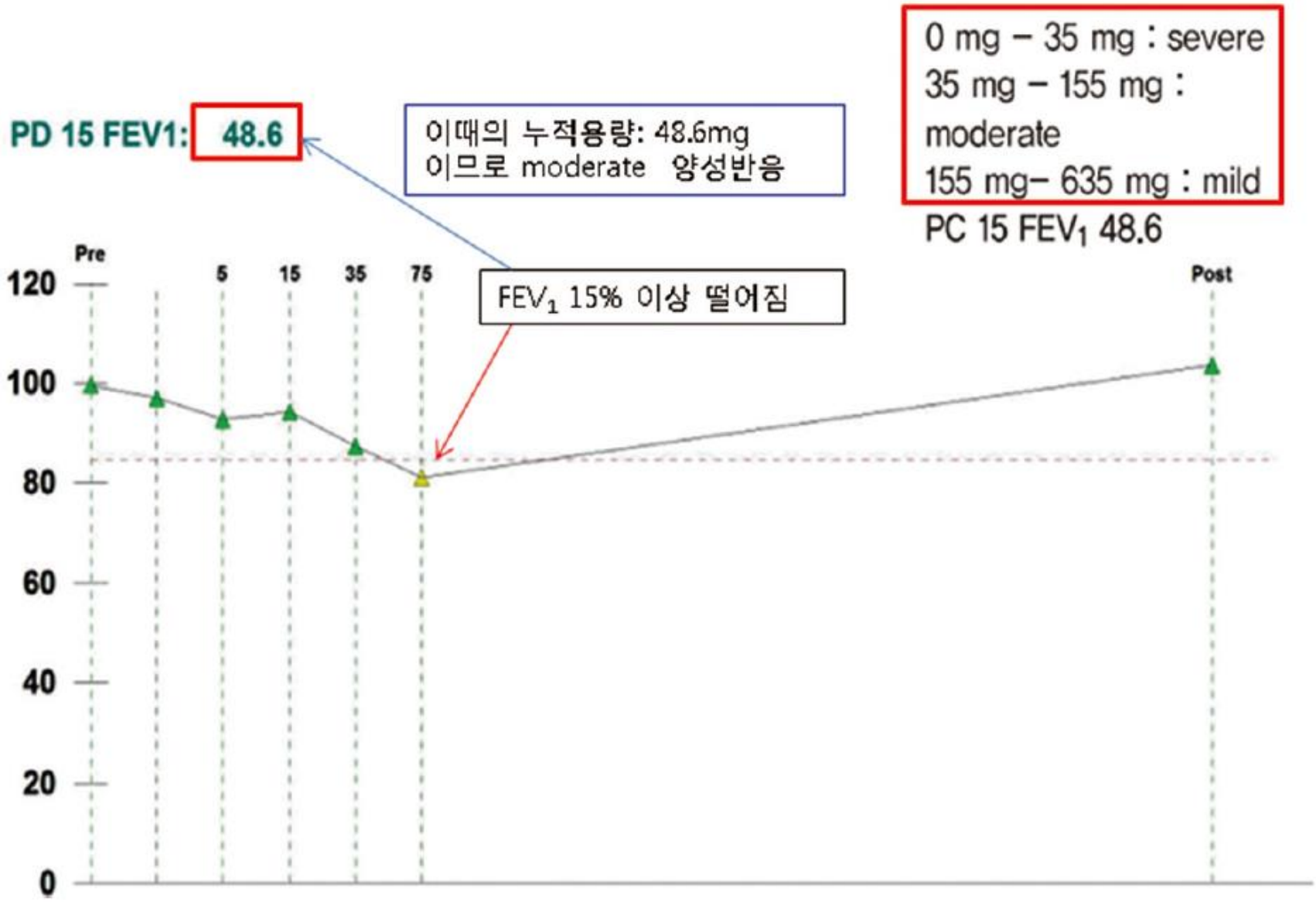
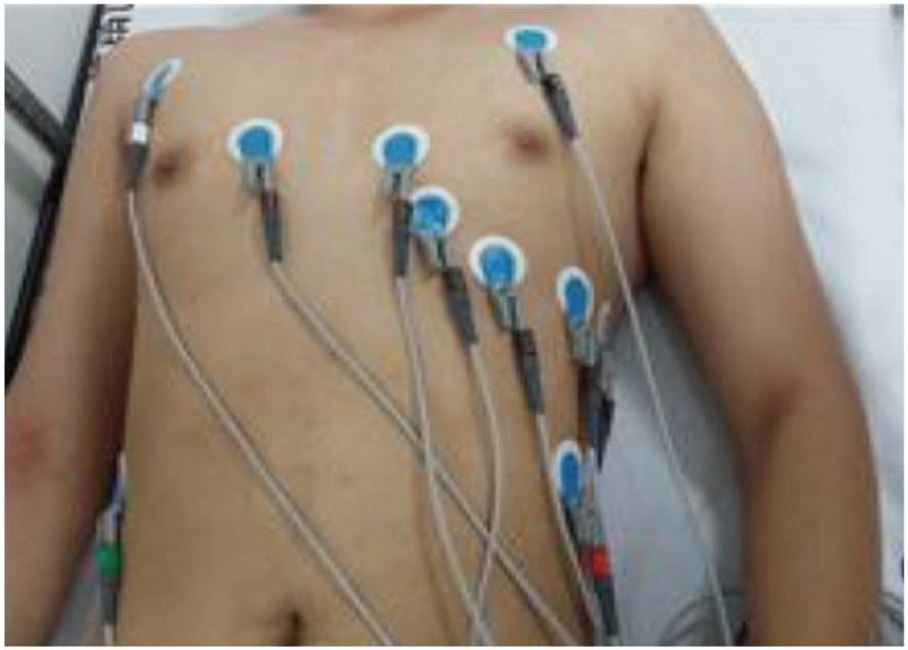

PD 15 FEV1: 48.6
이때의 누적용량: 48.6mg
이므로 moderate 양성반응
0 mg – 35 mg : severe
35 mg – 155 mg : moderate
155 mg– 635 mg : mild
PC 15 FEV1 48.6
FEV1 15% 이상 떨어짐
Pre
5
15
35
75
Post
120
100
80
60
40
20
0

표 9-5. 운동에 대한 금기사항

절대적 금기사항	상대적 금기사항
1. 급성 심근경색(3~5일) 2. 불안정협심증 3. 증상이나 혈역학적 이상이 있는 부정맥 4. 실신 5. 급성 심내막염 6. 급성 심근염이나 심내막염 7. 증상을 동반한 심한 대동맥협착증 8. 조절되지 않는 심부전 9. 급성 폐색전증이나 폐경색 10. 하지의 색전증 11. 박리성동맥류가 의심되는 경우 12. 조절되지 않은 천식 13. 폐부종 14. 안정 시 산소포화도가 85% 미만 15. 호흡부전 16. 운동으로 인해 악화되는 질환(감염증, 신부전, 갑상선중독증) 17. 협조되지 않을 정도의 정신장애	1. 좌주관상동맥(left main coronary)의 협착이나 그에 상응되는 상황 2. 중등도의 심장판막 협착 3. 심한 고혈압(수축기 혈압 > 200 mmHg, 이완기 혈압 > 120 mmHg) 4. 빈맥이나 서맥 5. 고도 방실차단(high-degree atrioventricular block) 6. 비후성 심근증 7. 유의한 폐동맥 고혈압 8. 진행되거나 합병증이 동반된 임신 9. 전해질 장애 10. 운동을 진행하기 곤란한 정형외과적 장애





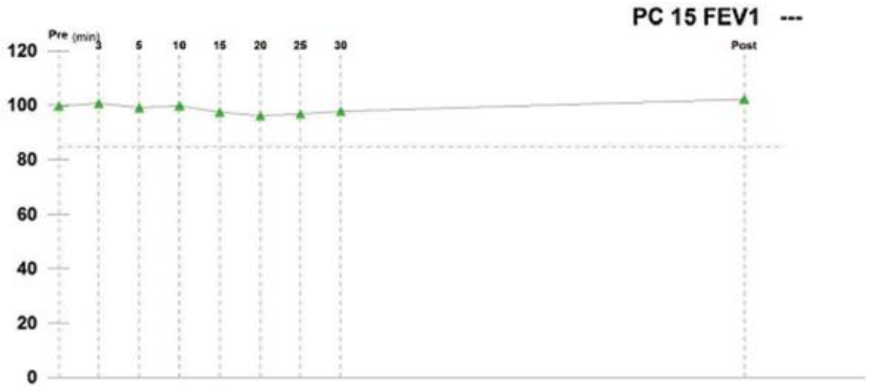


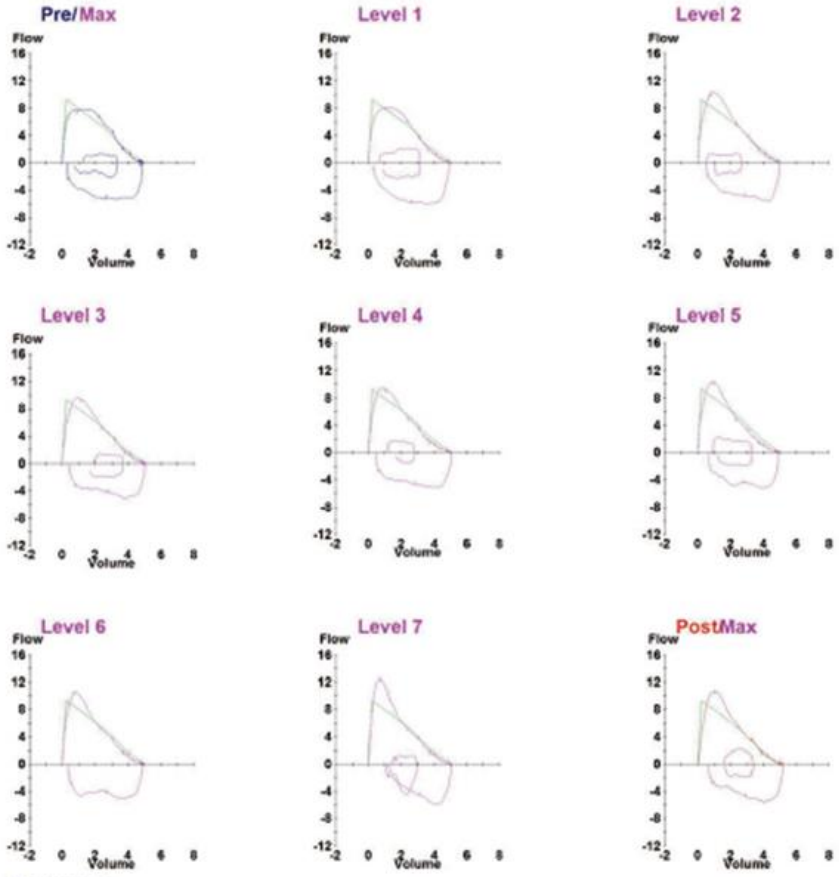
Exercise Provocation Test Report

Protocol: Exercise Provocation

Race: Asian
Date: 2016 12 15
Technician:
Physician:
Diagnosis:

	Ref	Pre	3 Min	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	Post
FVC Liters	5.01	4.93	4.95	5.02	5.09	5.07	4.95	4.93	5.09	5.23
% Ref		98	99	100	102	101	99	98	102	104
% Chg			0	2	3	3	0	0	3	6
FEV1 Liters	4.29	4.16	4.21	4.14	4.17	4.07	4.01	4.04	4.08	4.27
% Ref		97	98	96	97	95	94	94	95	99
% Chg			1	-1	0	-2	-4	-3	-2	2
FEF25-75%	4.39	4.76	4.72	4.31	4.20	3.96	4.01	3.98	3.71	4.32
% Ref		108	108	98	96	90	91	91	85	98
% Chg			-1	-9	-12	-17	-16	-16	-22	-9
PEF L/sec	9.23	8.51	9.89	10.30	10.98	10.46	10.29	10.59	12.44	10.65
% Ref		92	107	112	119	113	111	115	135	115
% Chg			16	21	29	23	21	24	46	25





Comments:

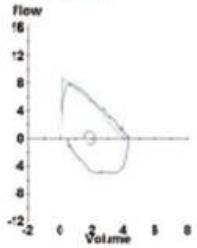
Exercise Provocation Test Report

Protocol: Exercise Provocation

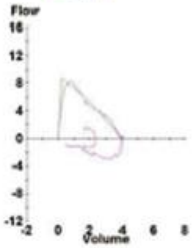
Race: Asian
Date: 2016 12 14
Technician:
Physician:
Diagnosis:

	Ref	Pre	3 Min	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	Post
FVC Liters	4.08	4.31	3.98	3.35						4.21
% Ref		106	97	82						103
% Chg			-8	-22						-2
FEV1 Liters	3.76	3.94	3.75	3.21						3.90
% Ref		105	100	85						104
% Chg			-5	-19						-1
FEF25-75%	4.14	4.58	4.54	4.38						4.58
% Ref		111	110	106						111
% Chg			-1	-4						-0
PEF L/sec	8.66	8.05	8.30	7.83						7.66
% Ref		93	96	90						88
% Chg			3	-3						-5

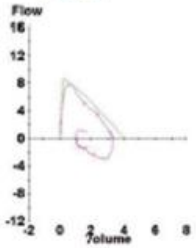
Pre/Max



Level 1



Level 2

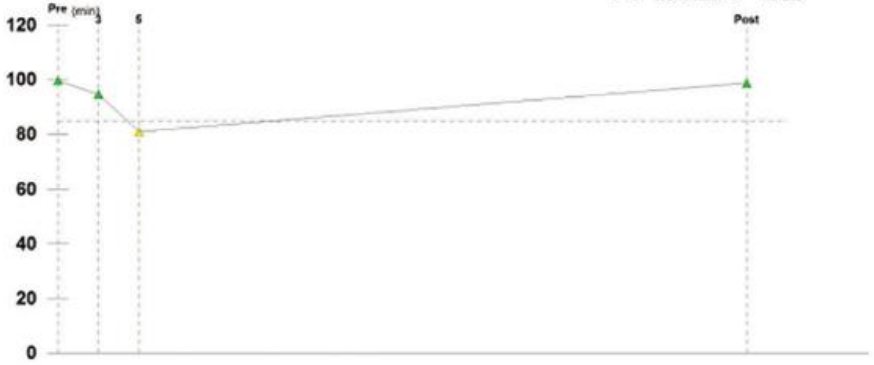


Level 3

Level 4

Level 5

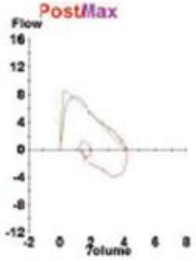
PC 15 FEV1 4.36



Level 6

Level 7

Post/Max



Comments:

검사방법: 운동유발검사
- 운동 종료 후 폐기능검사

운동종료 후 시간, 분

측정 지표: 기저값 (Reference value)에 대한 FEV_1 감소정도

FEV_1의 변화
- 정상: 의미 있는 변화 없음
- 운동과민성: 15% 이상감소

FEV_1 15% 감소한 지점 표시

Exercise Provocation Test Report

Protocol: Exercise Provocation

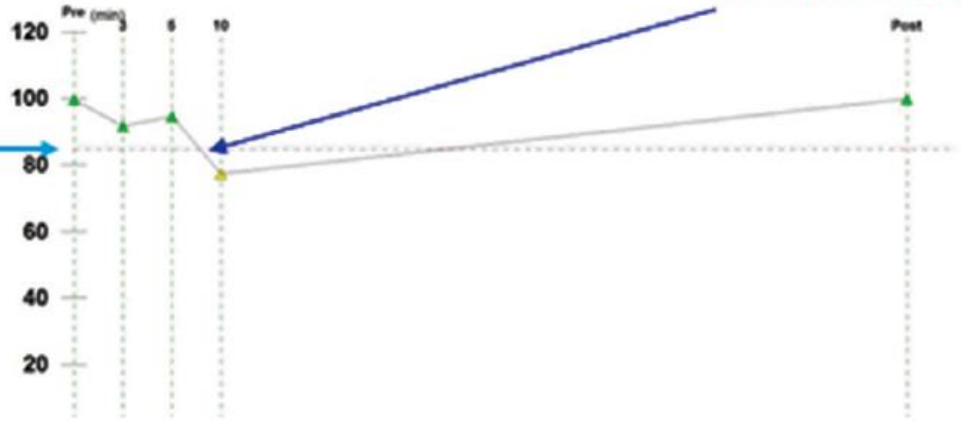
Race: Asian
Date: 2016 10 10
Technician:
Physician:
Diagnosis:

	Ref	Pre Meas	Level 1 Meas	Level 2 Meas	Level 3 Meas	Level 4 Meas	Level 5 Meas	Level 6 Meas	Level 7 Meas	Post Meas
Dose			3	5	10.0					
FVC Liters	3.84	3.80	3.36	3.50	3.03					3.77
% Ref		99	87	91	79					98
% Chg			-12	-8	-20					-1
Dose			3	5	10.0					
FEV1 Liters	3.54	3.12	2.87	2.96	2.43					3.13
% Ref		88	81	84	69					89
% Chg			-8	-5	-22					0
Dose			3	5	10.0					
FEF25-75%	3.92	2.90	2.94	2.92	2.14					3.02
% Ref		74	75	74	55					77
% Chg			1	0	-26					
Dose			3	5	10.0					
PEF L/sec	8.23	9.76	8.09	7.84	7.27					8.79
% Ref		118	98	95	88					107
% Chg			-17	-20	-26					-10

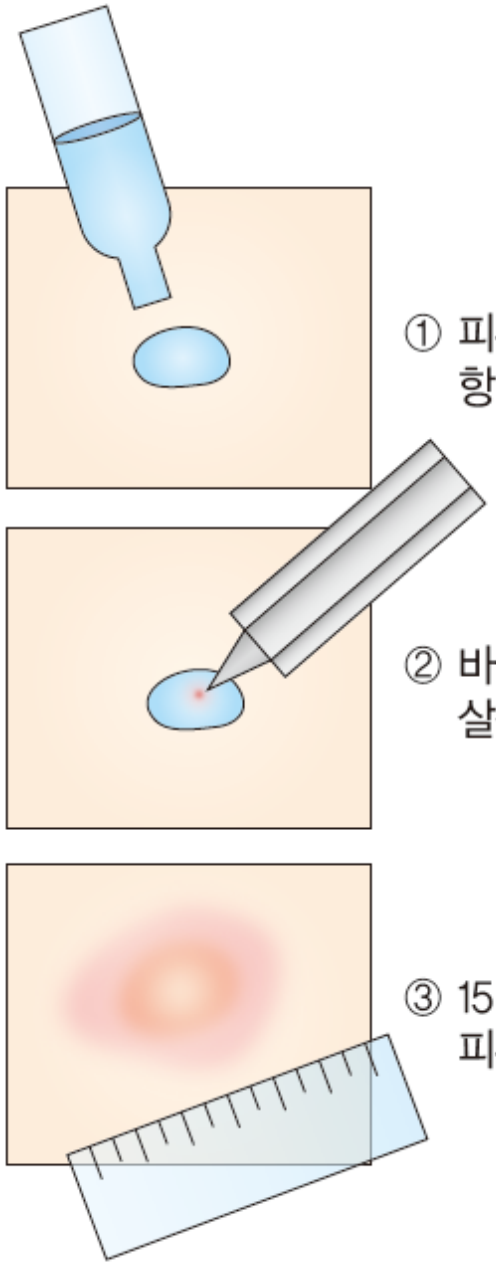
FEV_1이 22% 이므로 양성

PC 15 FEV1: 7.45

FEV_1이 15% 감소한 시점







① 피부에 다양한 종류의
항원액을 떨어뜨림

② 바늘로 피부를
살짝 찌름

③ 15 ~ 30분 후
피부 반응의 정도를 측정

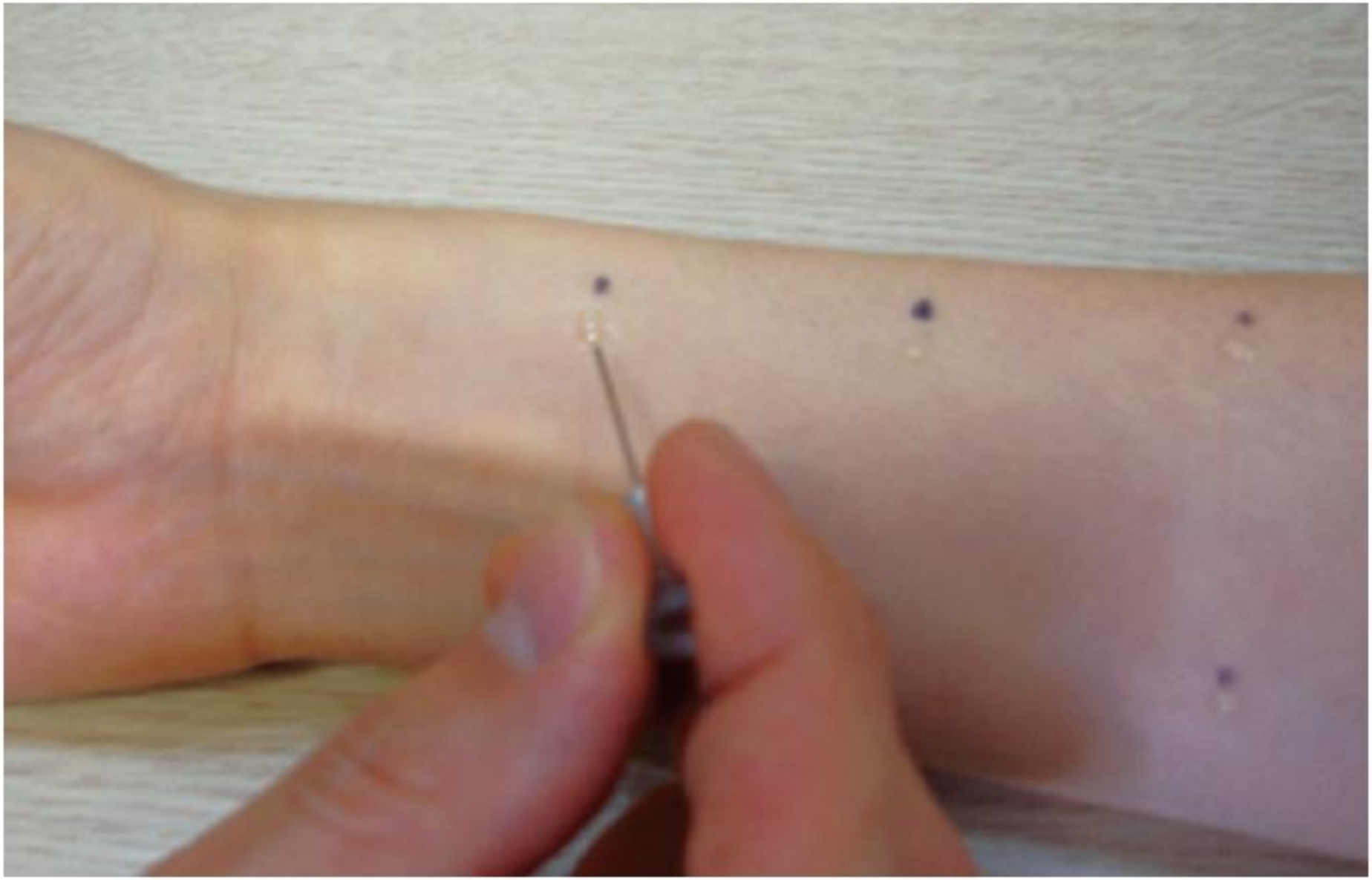








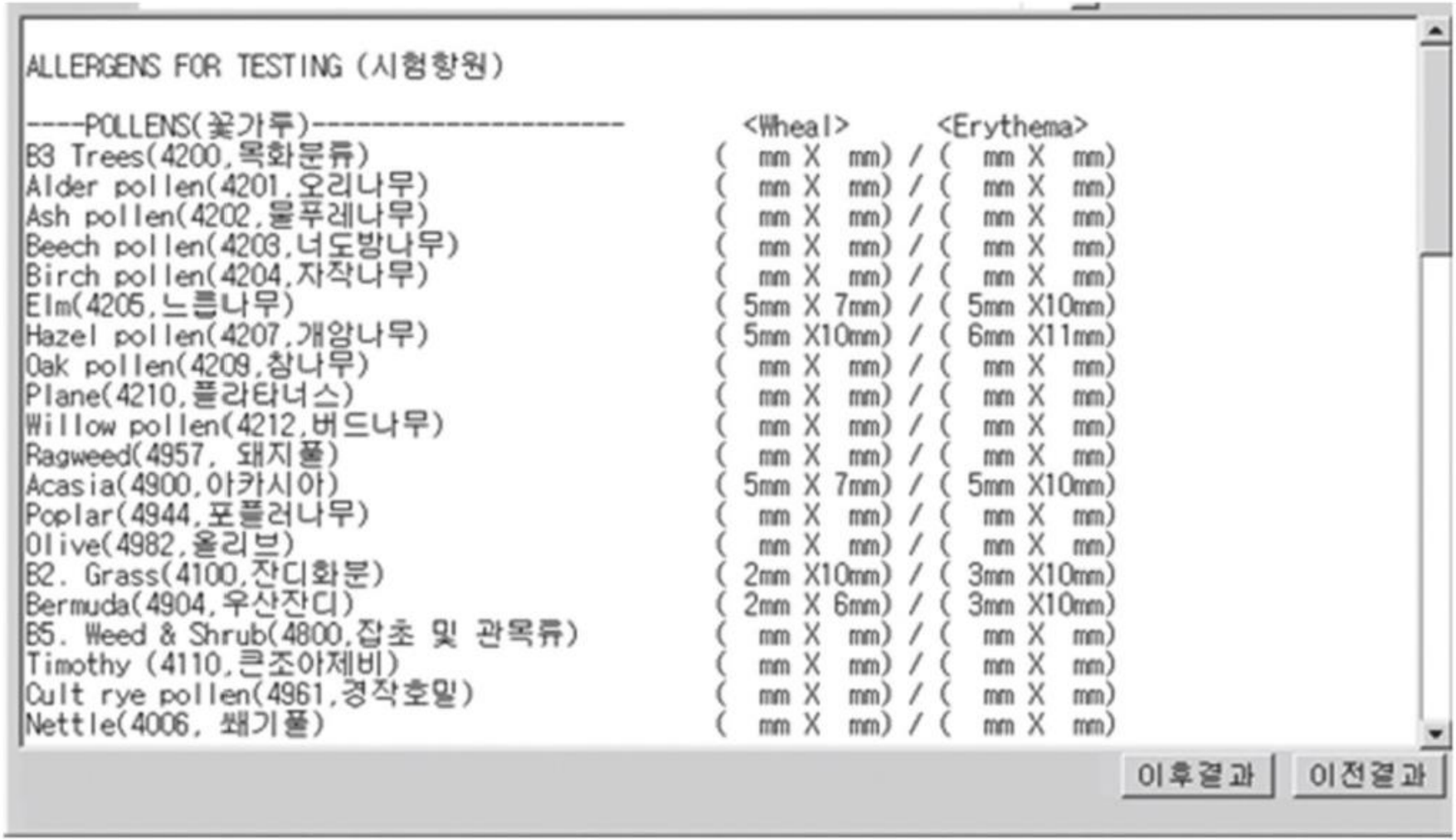


표 9-6. 피부단자시험 등급 판정 기준(A/H 비)

등급	팽진	발적
음성	0	0
1+	R* < 1	< 21 mm
2+	R < 1	= 21 mm
3+	1 = R < 2	= 21 mm
4+	2 = R < 3	= 21 mm
5+	3 = R < 4	= 21 mm
6+	R = 4	= 21 mm

* R : ratio of wheal of allergen and histamine (1 mg/mL)

알레르겐 피부반응 검사결과지



ALLERGENS FOR TESTING (시험항원)

----POLLENS(꽃가루)----------	<Wheal>	<Erythema>
B3 Trees(4200,목화분류)	(mm X mm) /	(mm X mm)
Alder pollen(4201,오리나무)	(mm X mm) /	(mm X mm)
Ash pollen(4202,물푸레나무)	(mm X mm) /	(mm X mm)
Beech pollen(4203,너도밤나무)	(mm X mm) /	(mm X mm)
Birch pollen(4204,자작나무)	(mm X mm) /	(mm X mm)
Elm(4205,느릅나무)	(5mm X 7mm) /	(5mm X10mm)
Hazel pollen(4207,개암나무)	(5mm X10mm) /	(6mm X11mm)
Oak pollen(4209,참나무)	(mm X mm) /	(mm X mm)
Plane(4210,플라타너스)	(mm X mm) /	(mm X mm)
Willow pollen(4212,버드나무)	(mm X mm) /	(mm X mm)
Ragweed(4957, 돼지풀)	(mm X mm) /	(mm X mm)
Acasia(4900,아카시아)	(5mm X 7mm) /	(5mm X10mm)
Poplar(4944,포플러나무)	(mm X mm) /	(mm X mm)
Olive(4982,올리브)	(mm X mm) /	(mm X mm)
B2. Grass(4100,잔디화분)	(2mm X10mm) /	(3mm X10mm)
Bermuda(4904,우산잔디)	(2mm X 6mm) /	(3mm X10mm)
B5. Weed & Shrub(4800,잡초 및 관목류)	(mm X mm) /	(mm X mm)
Timothy (4110,큰조아제비)	(mm X mm) /	(mm X mm)
Cult rye pollen(4961,경작호밀)	(mm X mm) /	(mm X mm)
Nettle(4006, 쐐기풀)	(mm X mm) /	(mm X mm)

이후결과 이전결과



팔뚝 위에 얼음이 올려져 있다.



5분 후 얼음을 제거하자 해당부위는 부어있고 주위는 붉게 발적이 되어 있다.(양성반응)









CardioPulmonary Exercise Test Results

Spirometry		Predicted	Measured	% Predicted
	FVC (L)	5.18	4.30	83
	FEV1 (L)	4.05	3.72	92
	MVV (L)	172	158	92

Resting Data HR (bpm): 90 SpO2: 99 SPB(mmHg): 120 DPB (mmHg): 80

Peak Cardiovascular Responses	Predicted	Measured	% Predicted
VO2 (ml/kg/min)	41.7	44.2	106
VO2 (l/min)	3.133	2.872	92
VCO2 (l/min)		3.714	
Work (Watts)	226	0	
Anaerobic Threshold (AT)(l/min)	>1.253	1.670	
AT (% Predicted Max VO2)	> 40%	53	
Heart Rate (bpm)	179	182	101
O2 Pulse (ml/beat)	16.2	15.8	97
Systolic Blood Pressure (Max)	185	180	97
Diastolic Blood Pressure (Max)	85-105	92	
Heart Rate Reserve (bpm)	<15	-3	
Peak Ventilatory Responses			
VE Max (l/min) BTPS	121.7	119.4	98
Tidal Volume (VT) (L)	2.239	2.260	101
Respiratory Rate (RR)	<50	50	
Breathing Reserve (%)	20-40	24	
Gas-Exchange Responses			
End Tidal CO2 (Peak PetCO2)		35.7	
End Tidal O2 (Peak PetO2)		118.7	
VE/VO2 @ AT		23	
VE/VCO2 @ AT		26	
VD/VT (Est) @ Rest	0.30	0.22	73
VD/VT (Est) Peak	0.18	0.11	59
Respiratory Quotient (RQ)(Peak)	1.1-1.3	1.29	
SpO2 (O2 Sat--Pulse Ox) @ Peak	97	94	

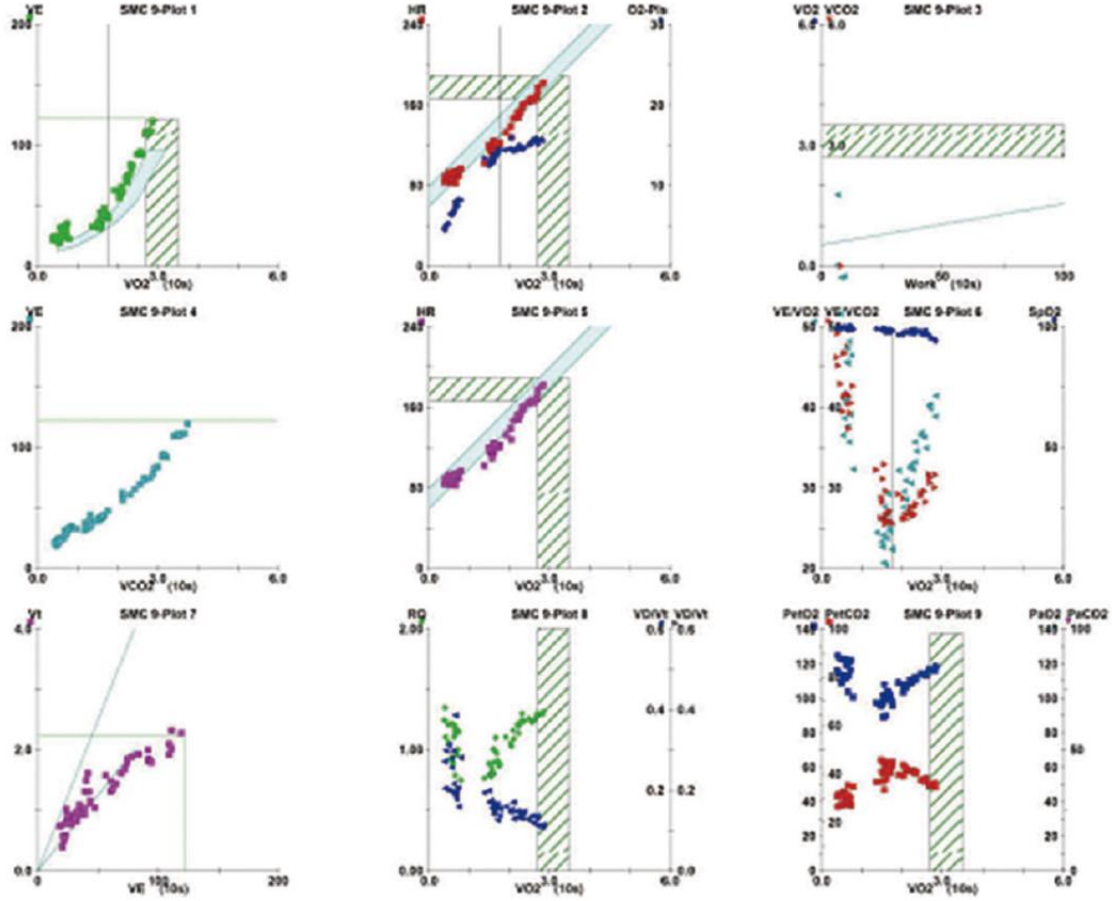
Calibration Results

Flow Cal: Pred Volume: 3.00 Expire Avg: 3.01 Inspire Avg: 3.00

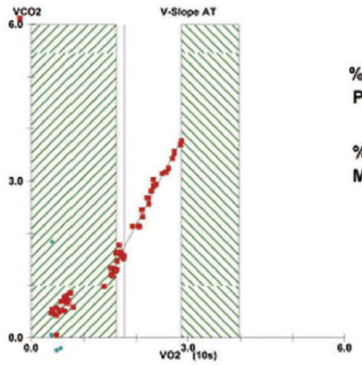
Gas Cal:	Cal1 O2	Cal 1 CO2	Cal 2 O2	Cal 2 CO2	Ambient O2	Ambient CO2
Predicted	16.00	4.00	26.00	0.00		
Measured	16.04	4.01	26.05	0.01	21.20	0.06
Transit (msec)	0.494	0.403				
Response (msec)	0.113	0.090				

Version: IVS-0101-27-2

Physician:

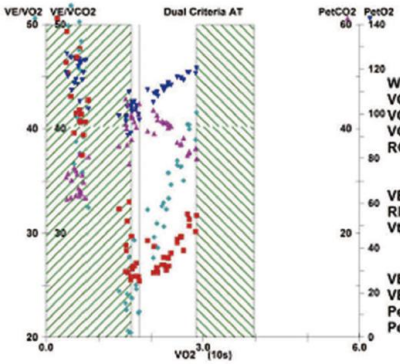


Measurement (peak)	Predicted	Measured	%Predicted	Plot #
VO2 (l/min)	3.133	2.872	92	1,3
Work Rate (Watts)	226	0		3
HR (bpm)	179	182	101	2
O2 Pulse (ml/beat)	16.2	15.8	97	5
Respiratory Quotient (RQ)	1.1-1.3	1.29		8
VE Max (l/min) BTPS	121.7	119.4	98	1,7
Breathing Reserve (%)	20-40	24		1,7
AT (l/min)	1.253	1.670		1,5,6,9
Slope Calculations			(Normal Range)	
VO2/Work (ml/min/watt)	10.3		8.7-11.9	3
HR/VO2kg (bpm/ml/kg)	3.8		3.0-4.0	2,5
VE/VO2 (L BTPS/L STPD)	27.5		23-26	1,6
VE/VCO2 (L BTPS/L STPD)	22.9		26-29	2



AT

		Expected Range
% Actual Peak VO2	58	40-60%
% Predicted Max VO2	53	40-60%



MEASUREMENT		VALUE @ AT
METABOLIC		
Work	Watts	0
VO2/kg	mL/kg/min	25.7
VO2	L/min	1.670
VCO2	L/min	1.483
RQ		0.89
VENTILATORY		
VE(BTPS)	L/min	38.7
RR	BPM	32
Vt	Liters	1.193
GAS-EXCHANGE		
VEO2		23
VECO2		26
PetO2	mmHg	98.6
PetCO2	mmHg	44.4
CARDIOVASCULAR		
HR	BPM	123
HR %Max	%	69
O2 Pulse	mL/Beat	13.6



운동 부하 검사 이유:
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운동 부하 검사 요약

모드 이름	단계 이름	시간 단계 내	속도 (km/h)	등급 (%)	심박수 (bpm)	혈압 (mmHg)	코멘트
예비검사	앙와위	02:53	0.80	0.00	92	120/80	
	서기	00:11	0.80	0.00	92		
운동	단계 1	03:00	2.70	10.00	122	140/80	
	단계 2	03:00	4.00	12.00	169		
	단계 3	01:02	5.40	14.00	187	180/110	
회복		03:03	2.40	0.00	139	166/110	

환자는 BRUCE 에 따라서for 7:02 분 동안 운동하였고, 작업 부하 수준 최대 METS: 10.00 에 도달하였습니다. 휴식시의 심장 박동 수는 95 bpm 에서 최대 심장 박동 수 187 bpm 으로 상승하였습니다. 이 수치는 해당 연령에 대해 예상되는 최대 심장 박동 수의 100 % 에 해당 합니다. 휴식기 혈압은 120/80 mmHg 에서, 최대 혈압 180/110 mmHg 으로 상승했습니다. 운동 검사는 숨도차고 다리도 아프고 으로 인해 중단 되었습니다..

<table>
<tr><td>병록번호</td><td>000000</td><td>성 명</td><td>김 ○○</td><td>성별/나이</td><td>33/남자</td></tr>
<tr><td>검 사 일</td><td>2014. 9. 2</td><td>키(cm)</td><td>176</td><td>몸무게</td><td>65</td></tr>
<tr><td>운동방법</td><td>답차(Treadmill)</td><td>검사방법</td><td>Bruce 방식</td><td>운동시간(분)</td><td>7</td></tr>
<tr><td>운동종료</td><td colspan="5">목표 심박수 도달</td></tr>
<tr><td rowspan="3">검사소견</td><td rowspan="2">안정 시
폐기능
검사</td><td colspan="4">• 노력성 폐활량(L, 예측값에 대한 비) : 4.30, 83%
• 1초간 노력성 호기량((L, 예측값에 대한 비) : 3.72, 92%
• 최대자발성 호흡량(L/min, 예측값에 대한 비) : 158, 92%</td></tr>
<tr><td colspan="4">정상</td></tr>
<tr><td>운동
부하
심폐
기능
검사</td><td colspan="4">• 최대산소섭취량(mL/kg/min, 예측값에 대한 비) : 44.2, 106%
(mL/min, 예측값에 대한 비) : 2,872, 92%
(Mets) : 10.0
• 무산소역치(L/min, 최대산소섭취량에 대한 비) : 1,670, 53%
• 맥박산소(mL/beat, 예측값에 대한 비) : 15.8, 97%
• 예비심박수(beat/min) : 16
• 분당환기량(L/min, 예측값에 대한 비) : 119.4, 98%
• 호흡예비능(%) : 24
• 산소에 대한 환기당량(무산소역치에서) : 23
• 이산화탄소에 대한 환기당량(무산소역치에서) : 26
• 일회호흡량에 대한 사강 비(VD/VT, 안정 시) : 0.22
• 일회호흡량에 대한 사강 비(VD/VT, 최대운동 시) : 0.11</td></tr>
<tr><td colspan="5">최대산소섭취량은 안정 시 산소섭취량에 비하여 약 10배로 정상이며, 무산소역치(anaerobic threshold)는 최대산소섭취량의 53%로 정상입니다. 최대 운동 시 혈압의 변화, 심박동수의 변화, 혈액 내 산소포화도, 그리고 맥박산소 역시 정상입니다. 운동 전 및 최대운동 시 심전도의 이상소견은 없으며, 예비심박동수 역시 정상입니다. 즉 최대운동 시 심혈관계의 반응은 정상입니다.
최대운동 시 분당 환기량 및 일회 환기량, 호흡수, 그리고 환기예비비는 정상이며, 최대운동 시 폐의 가스 교환기능 역시 정상소견입니다.</td></tr>
<tr><td>결론</td><td colspan="5">운동에 대한 심혈관계 및 폐의 환기반응, 그리고 폐포 및 모세혈관의 가스 교환 작용은 모두 정상임</td></tr>
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