Section 02

뇌파의 기본개념

학습목표

1. 뇌파의 정의를 설명할 수 있다(A).
2. 뇌파검사의 임상적 의의와 대상 질환을 이해할 수 있다(A).
3. 뇌파검사에 영향을 주는 인자를 이해할 수 있다(A).
4. 뇌파의 구성요소에 대하여 설명할 수 있다(A).

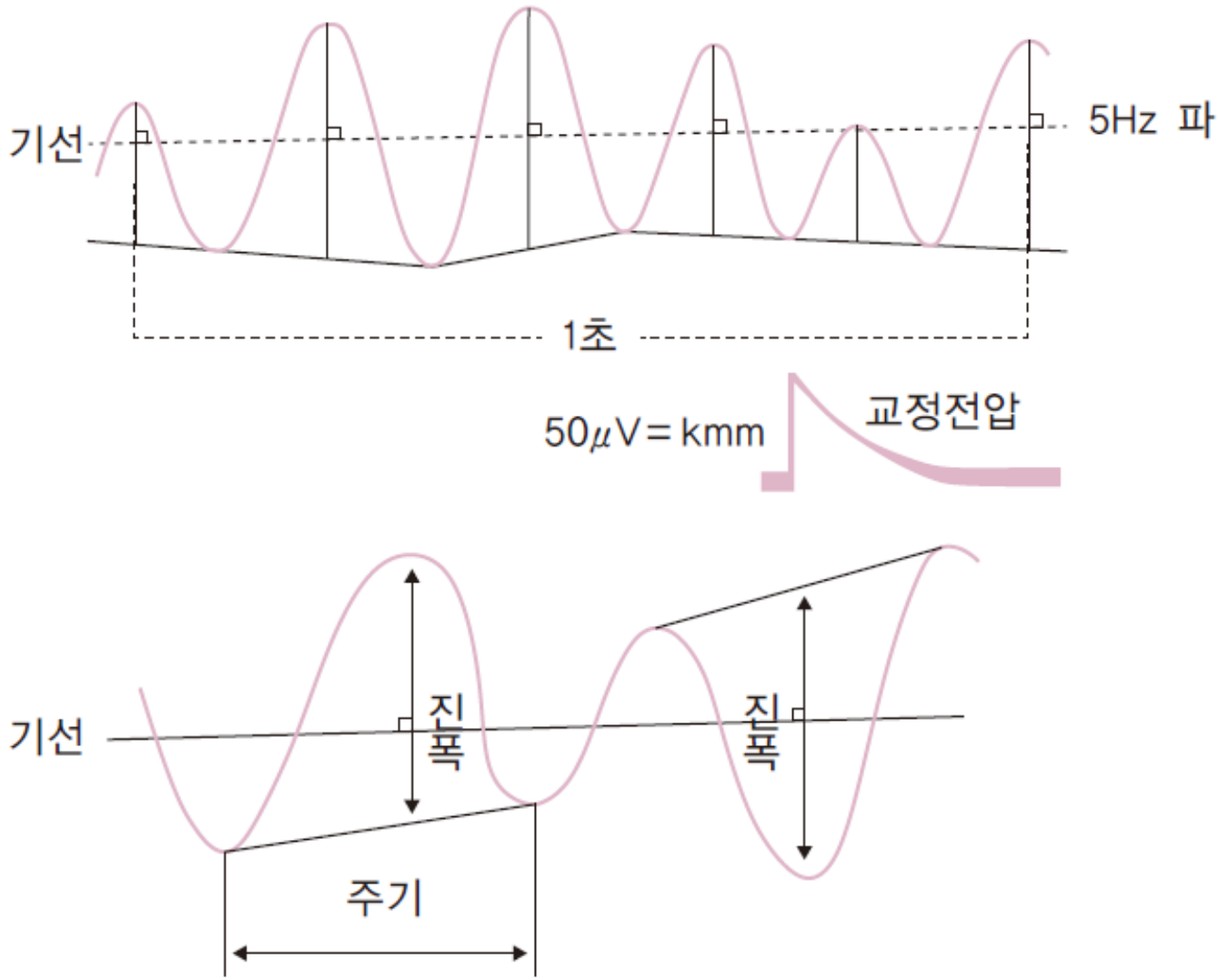
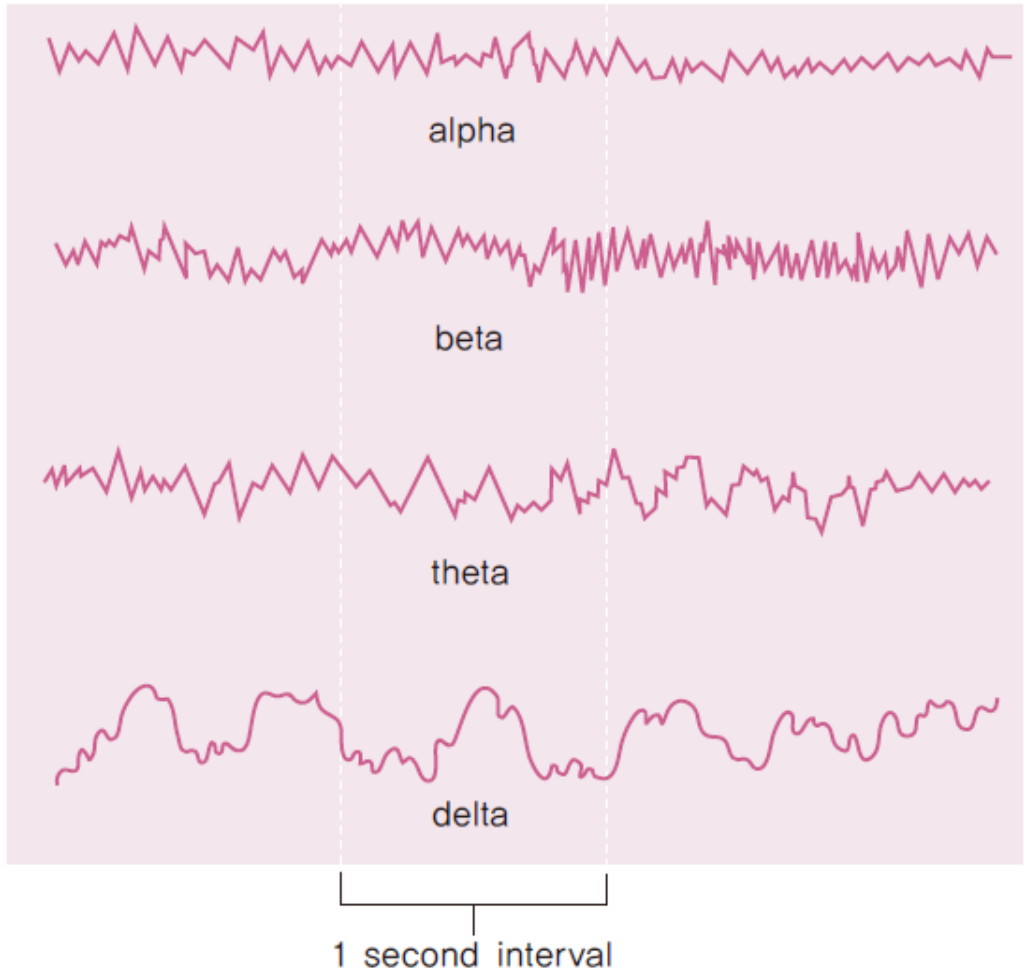

기선
5Hz 파
1초
50μV = kmm
교정전압
기선
진폭
진폭
주기

표 2-1. 뇌파의 주파수 영역

	Hz	구분
δ (delta)	0.5~3 Hz 이하	↑ 느린파(slow wave)
θ (theta)	4~7 Hz	
α (alpha)	8~13 Hz	기본파
β (beta)	14~30 Hz	↓ 빠른파(fast wave)


alpha
beta
theta
delta
1 second interval

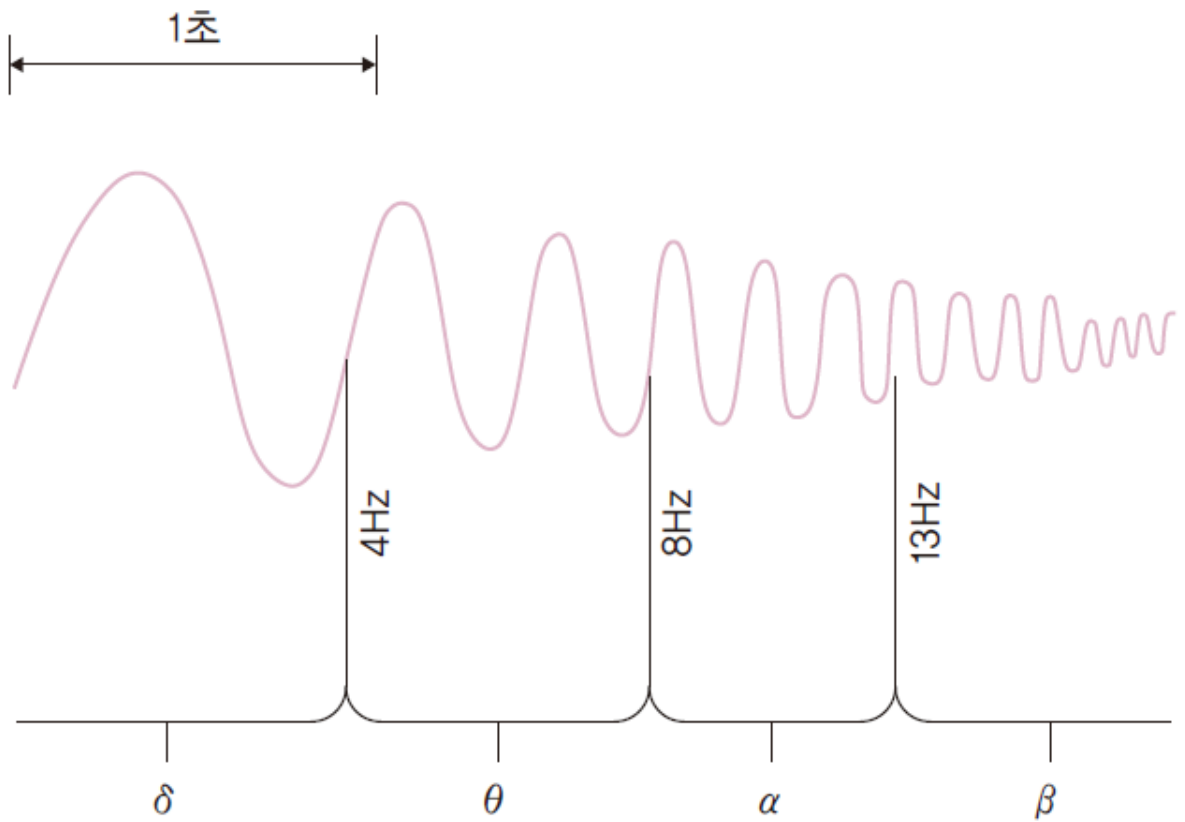
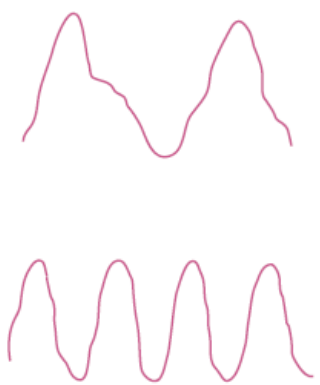
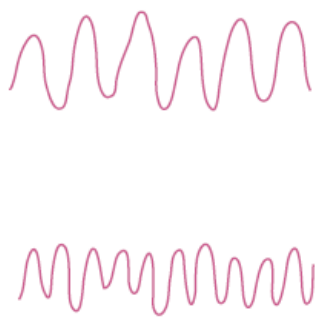
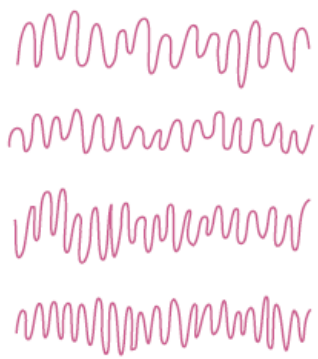
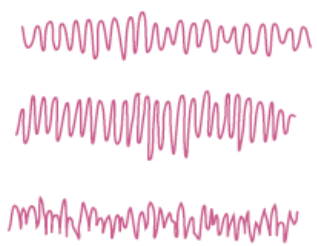
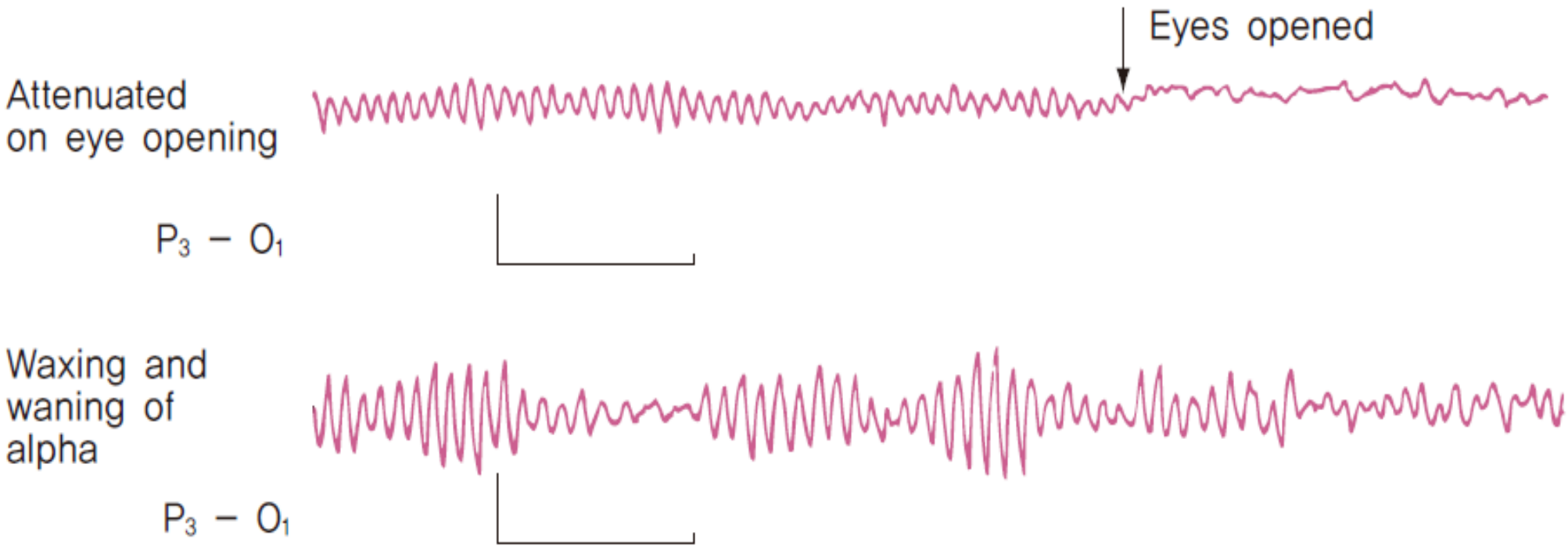
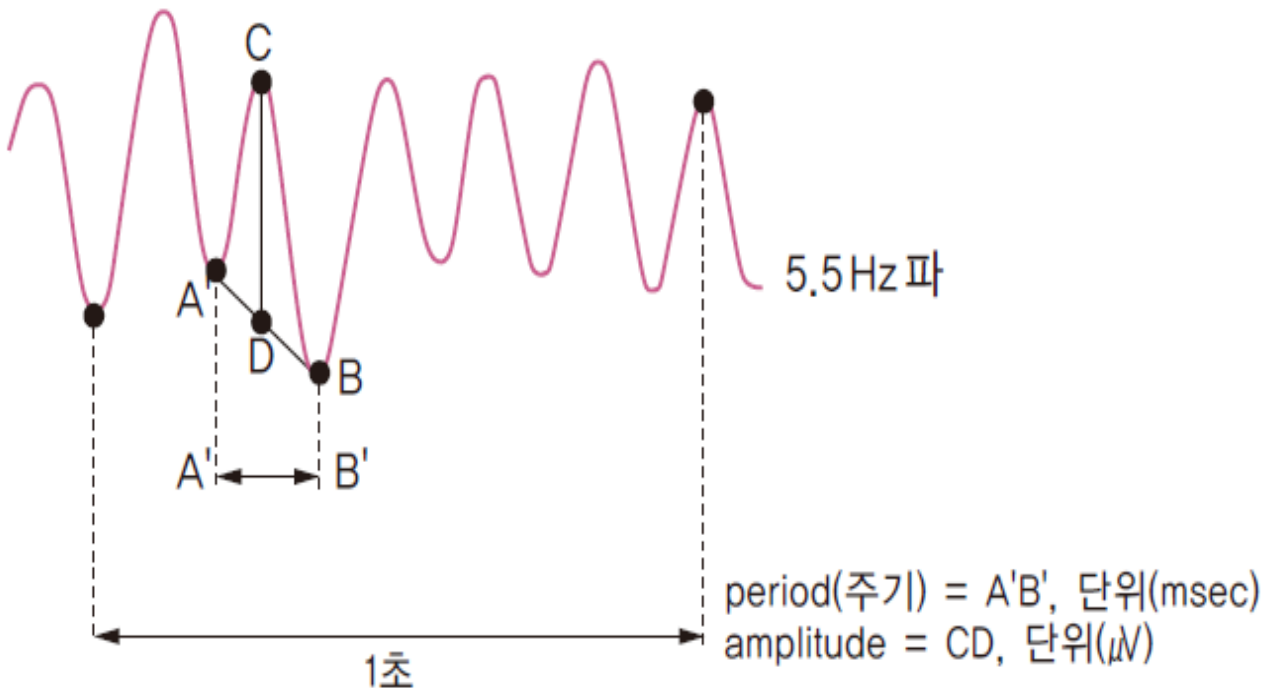
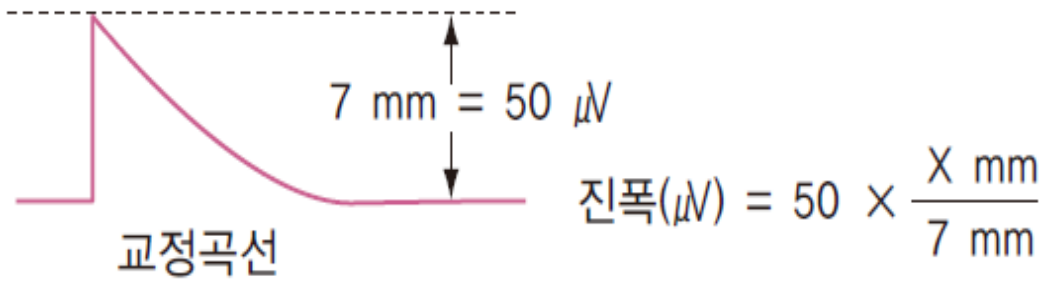

1초
4Hz
8Hz
13Hz
δ
θ
α
β

표 2-2. 뇌파의 특징

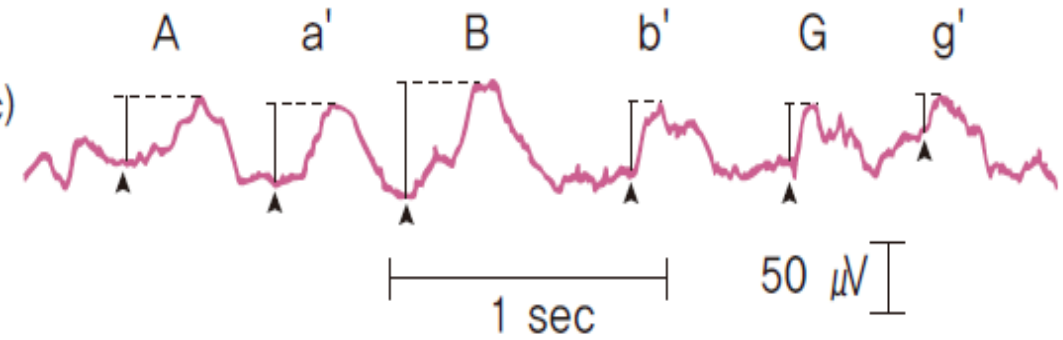
리듬	δ(delta)	θ(theta)	α(alpha)	β(beta)
주파수(frequency)	0.5~3 Hz	4~7 Hz	8~13 Hz	14~30 Hz
진폭(amplitude)	100 μV	아동 : 50 μV 성인 : 10 μV	유아 : 20 μV 아동 : 70 μV 성인 : 50 μV	10~20 μV
출현부위 (appearance location)	이마부	관자부	뒤통수부, 마루부	이마부
출현 상황 (appearnce condition)	깊은 수면(성인)	졸음이 오는 상황	안정, 눈감기	안정, 눈뜨기
파형(wave)				


Eyes opened
Attenuated on eye opening
P3 – O1
Waxing and waning of alpha
P3 – O1

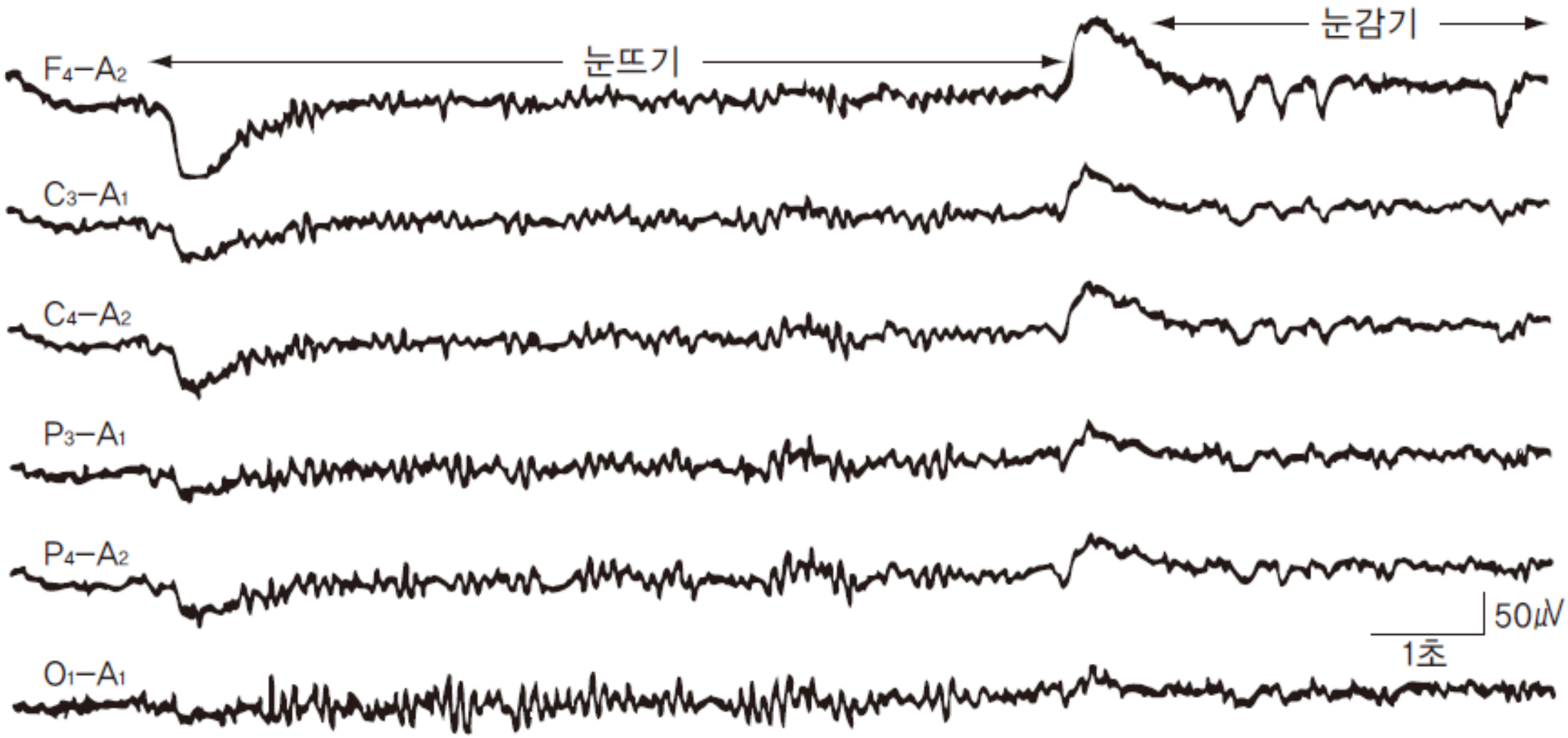

C
A
D
B
A'
B'
5.5Hz파
period(주기) = A'B', 단위(msec)
amplitude = CD, 단위(μV)
1초


7 mm = 50 μV
교정곡선
진폭(μV) = 50 × X mm / 7 mm

A


A
a'
B
b'
G
g'
1 sec
50 μV

B


눈뜨기
눈감기
F4–A2
C3–A1
C4–A2
P3–A1
P4–A2
O1–A1
50μV
1초



뇌파계 부속품

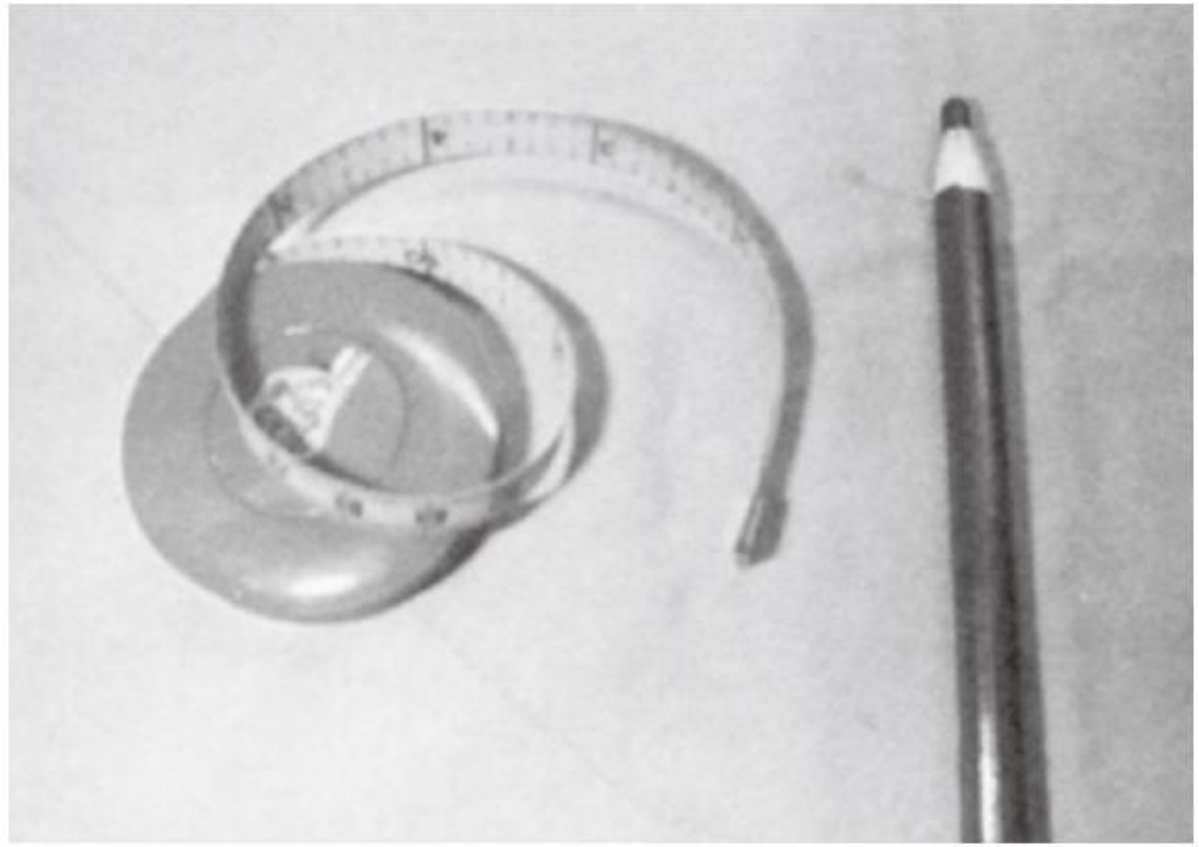


디지털 뇌파계

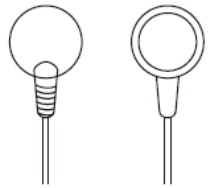


전극접속상자(electrode junction box)

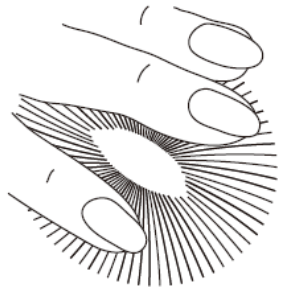

Biotach



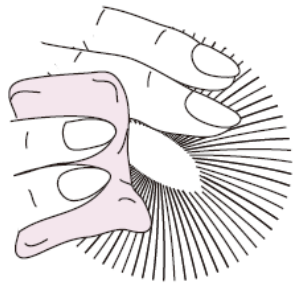
A. 준비단계



은평판 전극



머리카락을 나누어
두피가 나오게 한다

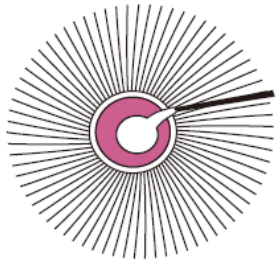


알코올 솜으로
깨끗이 닦는다

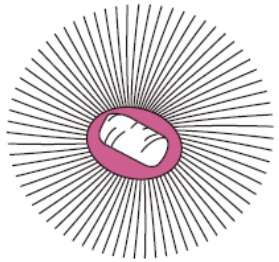
B. 전극부착(단시간용)



전극풀을 충분히
바른다

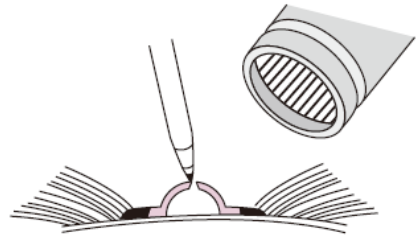


전극을 압착한다

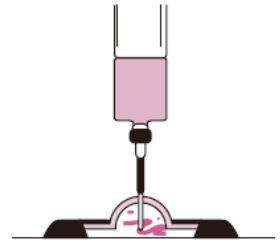


거즈 등으로 덮는다

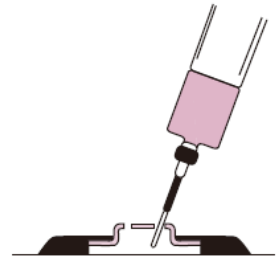
C. 전극부착(장시간용)



전극의 주위에 콜로디온을
도포하고 볼펜 등으로 전극을
고정하여 드라이어로 건조시킨다



전극내에 gel을 주입한다
(stick on disc 전극)



전극내에 gel을 주입한다
(콜로디온 전극)



코뿌리점(nasion)의 위치



귓바퀴앞(pre auricular)



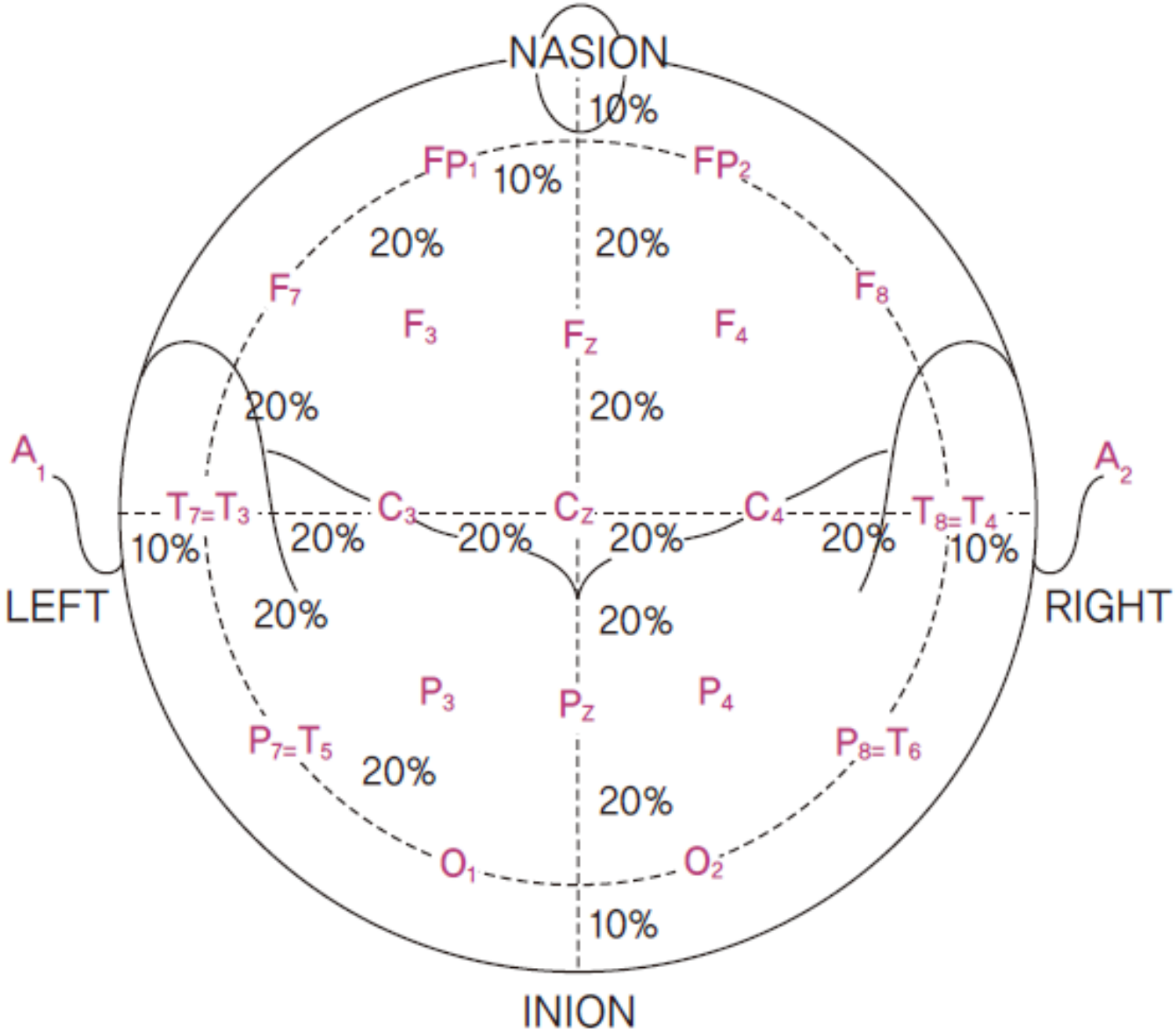
뒤통수점(inion)

표 4-1. 10–20법의 전극명과 부위명

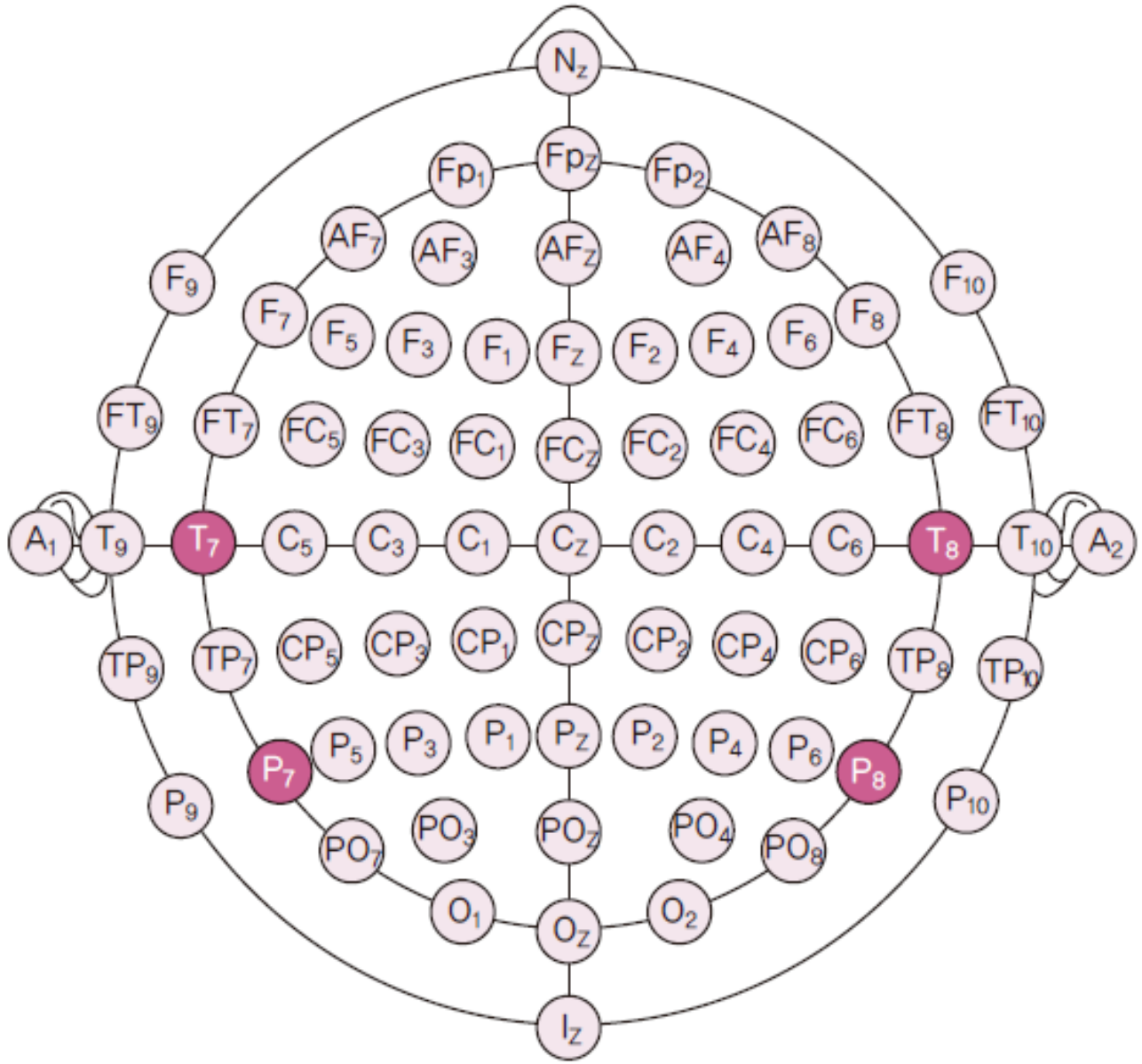
10-20법 전극명	부위명	
Fp_1, Fp_2	좌, 우 이마극	lt, rt. frontal-pole
F_3, F_4	좌, 우 이마부	lt, rt. frontal
C_3, C_4	좌, 우 중심부	lt, rt. central
P_3, P_4	좌, 우 마루부	lt, rt. parietal
O_1, O_2	좌, 우 뒤통수부	lt, rt. occipital
F_7, F_8	좌, 우 관자전부	lt, rt. antero-temporal
T_7, T_8†	좌, 우 관자중부	lt, rt. mid-temporal
P_7, P_8‡	좌, 우 관자후부	lt, rt. post-temporal
Fz	정중 이마 부위	midline frontal
Cz	정중 중심 부위	midline central
Pz	정중 마루 부위	midline parietal
A_1, A_2	좌, 우 귓불	lt, rt. ear (auricular)

† $T_7 = T_3$, $T_8 = T_4$

‡ $P_7 = T_5$, $P_8 = T_6$


NASION
10%
FP1
FP2
10%
20%
20%
F7
F8
F3
FZ
F4
20%
20%
A1
A2
T7=T3
C3
CZ
C4
T8=T4
10%
20%
20%
20%
20%
10%
LEFT
RIGHT
20%
20%
P3
PZ
P4
P7=T5
P8=T6
20%
20%
O1
O2
10%
INION

MODIFIED COMBINATORIAL NOMENCLATURE



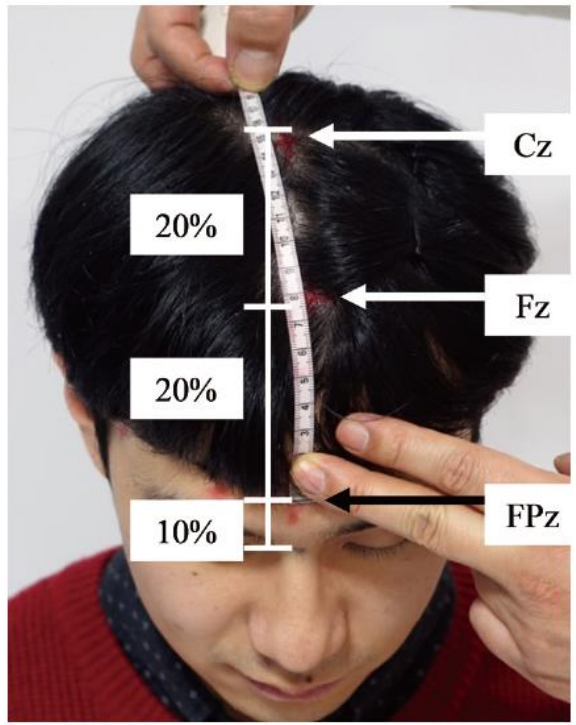


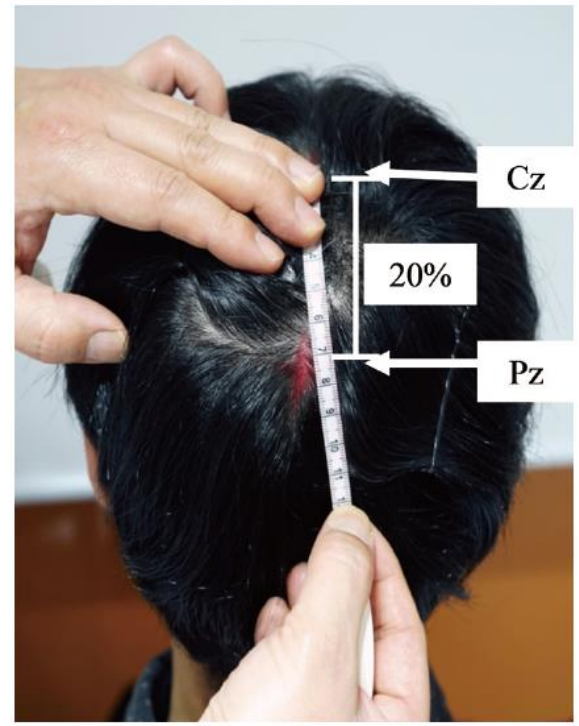


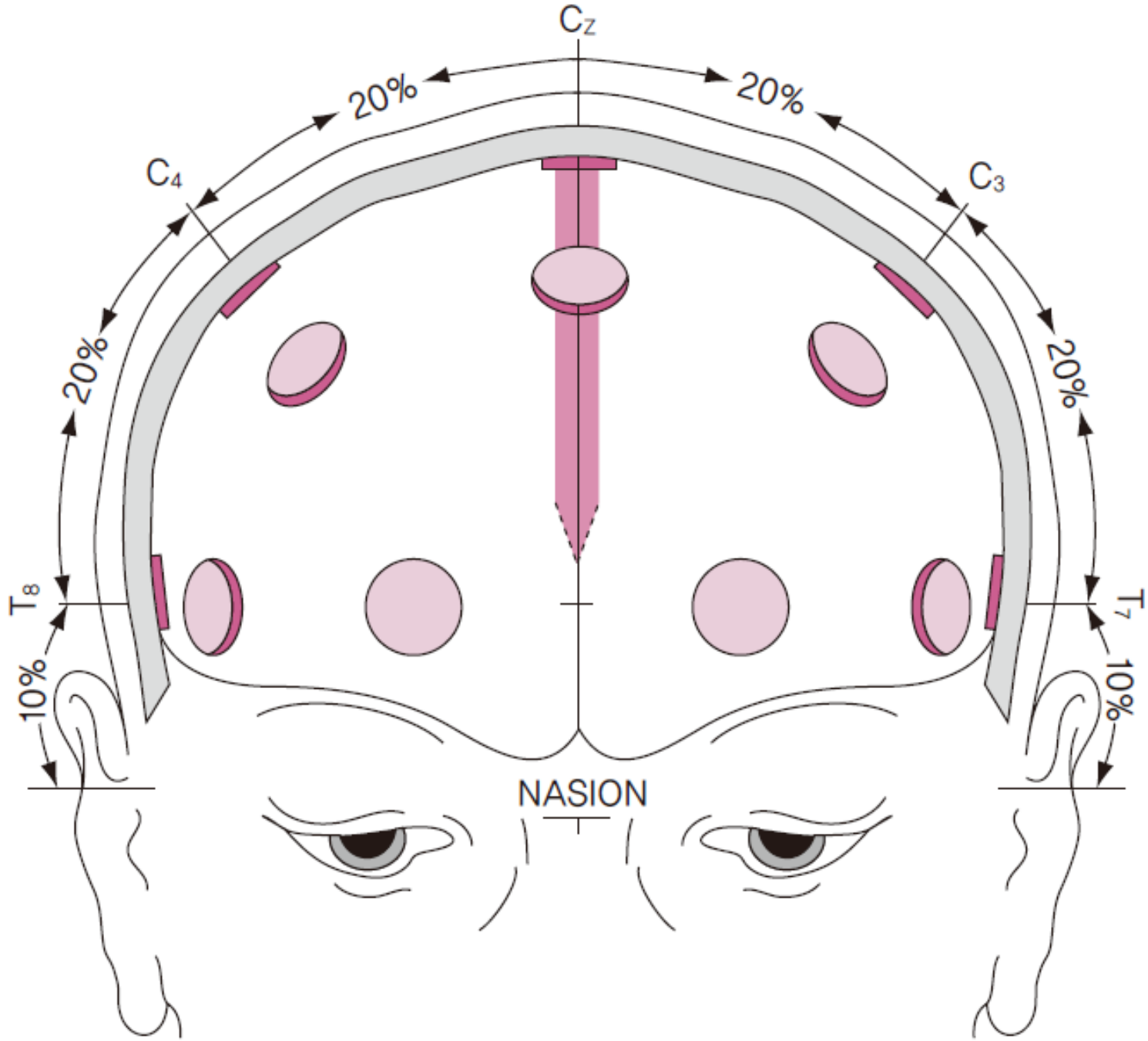


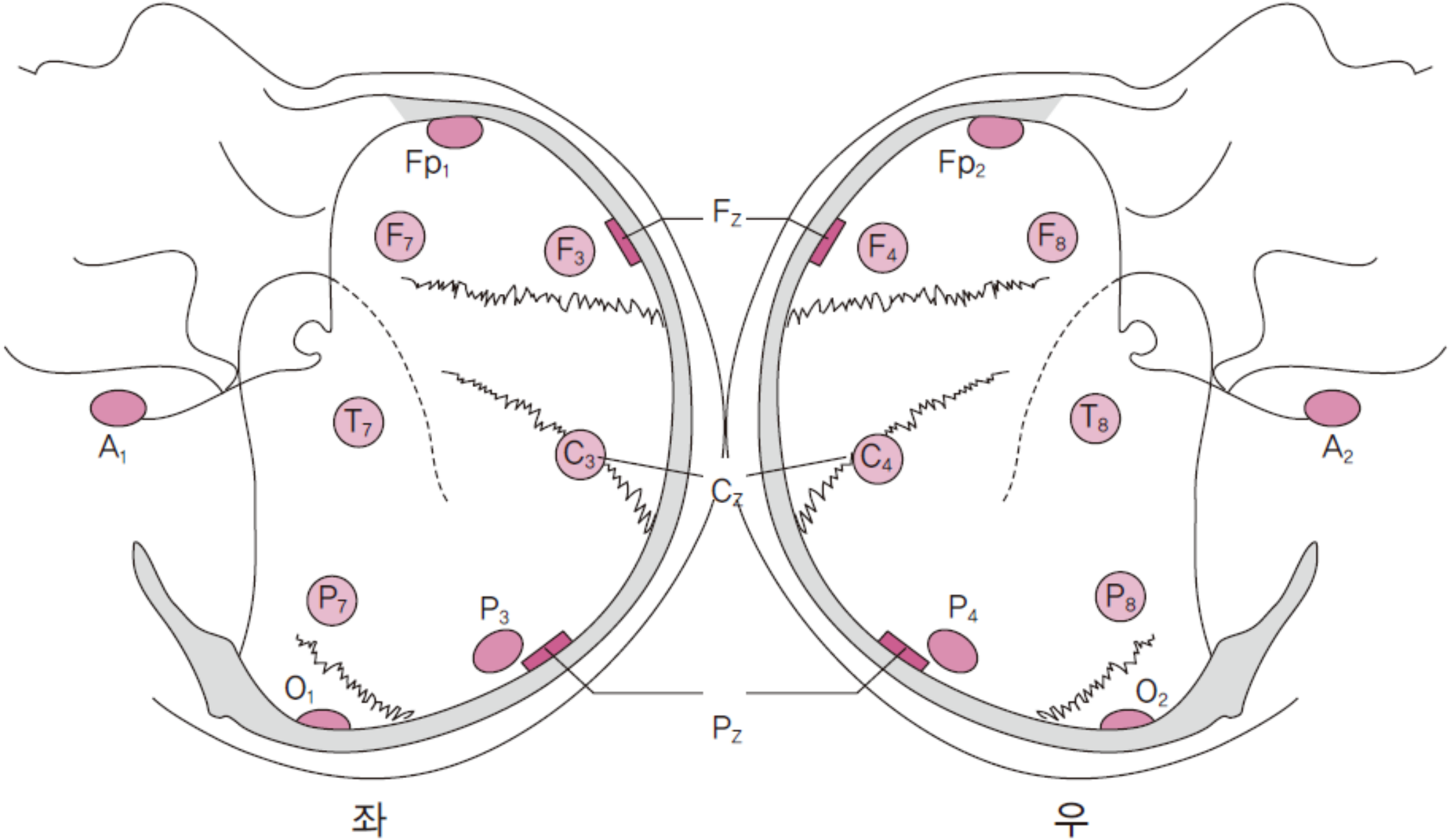


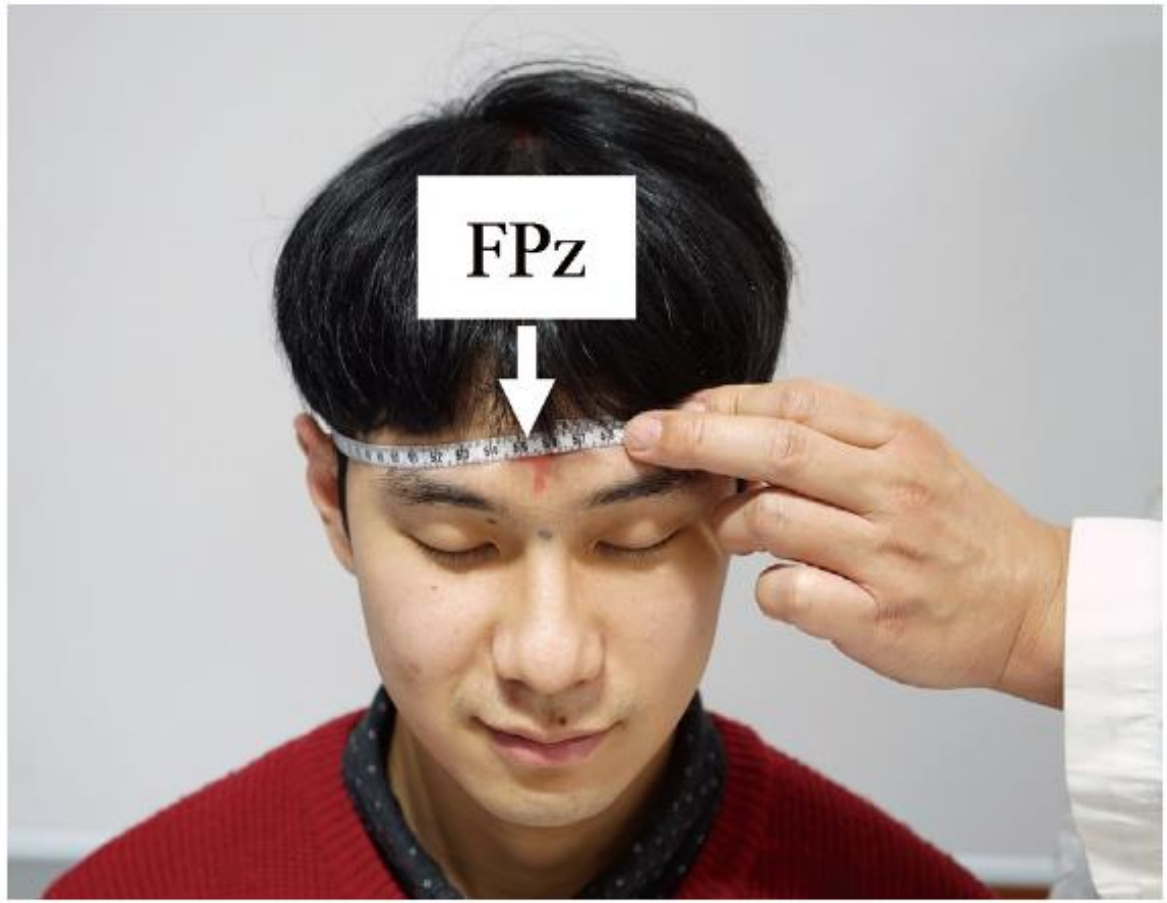


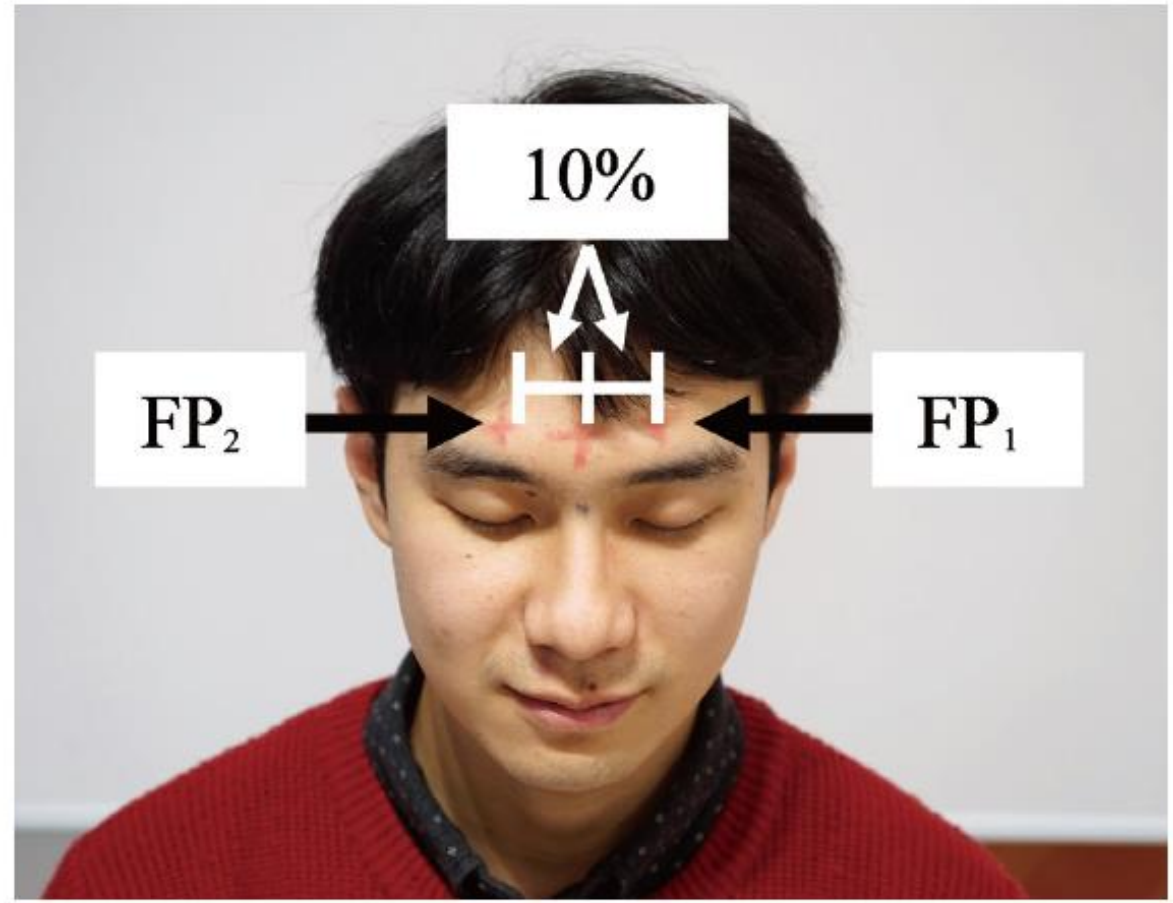

Cz
20%
Fz
20%
FPz
10%

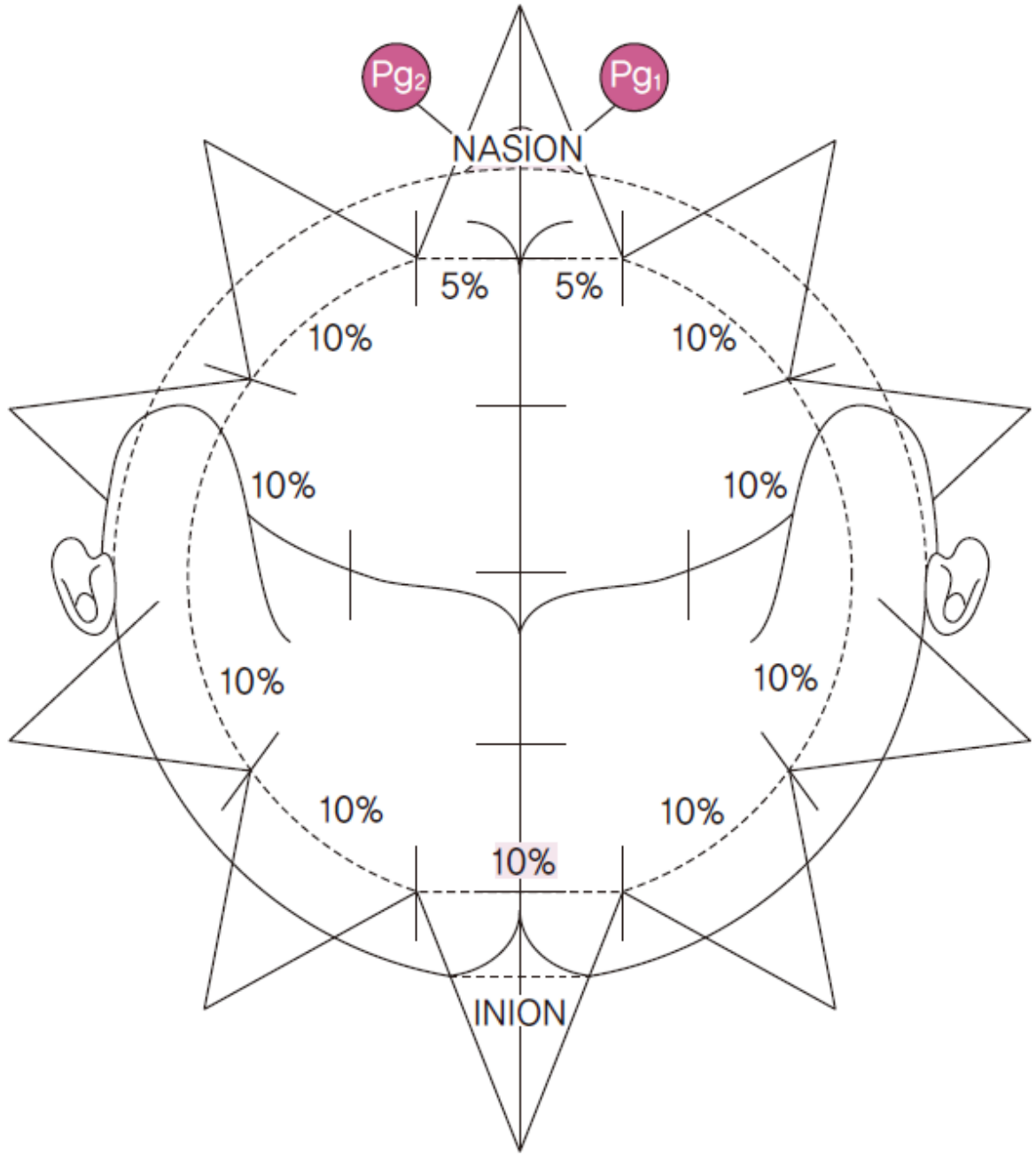

Cz
20%
Pz

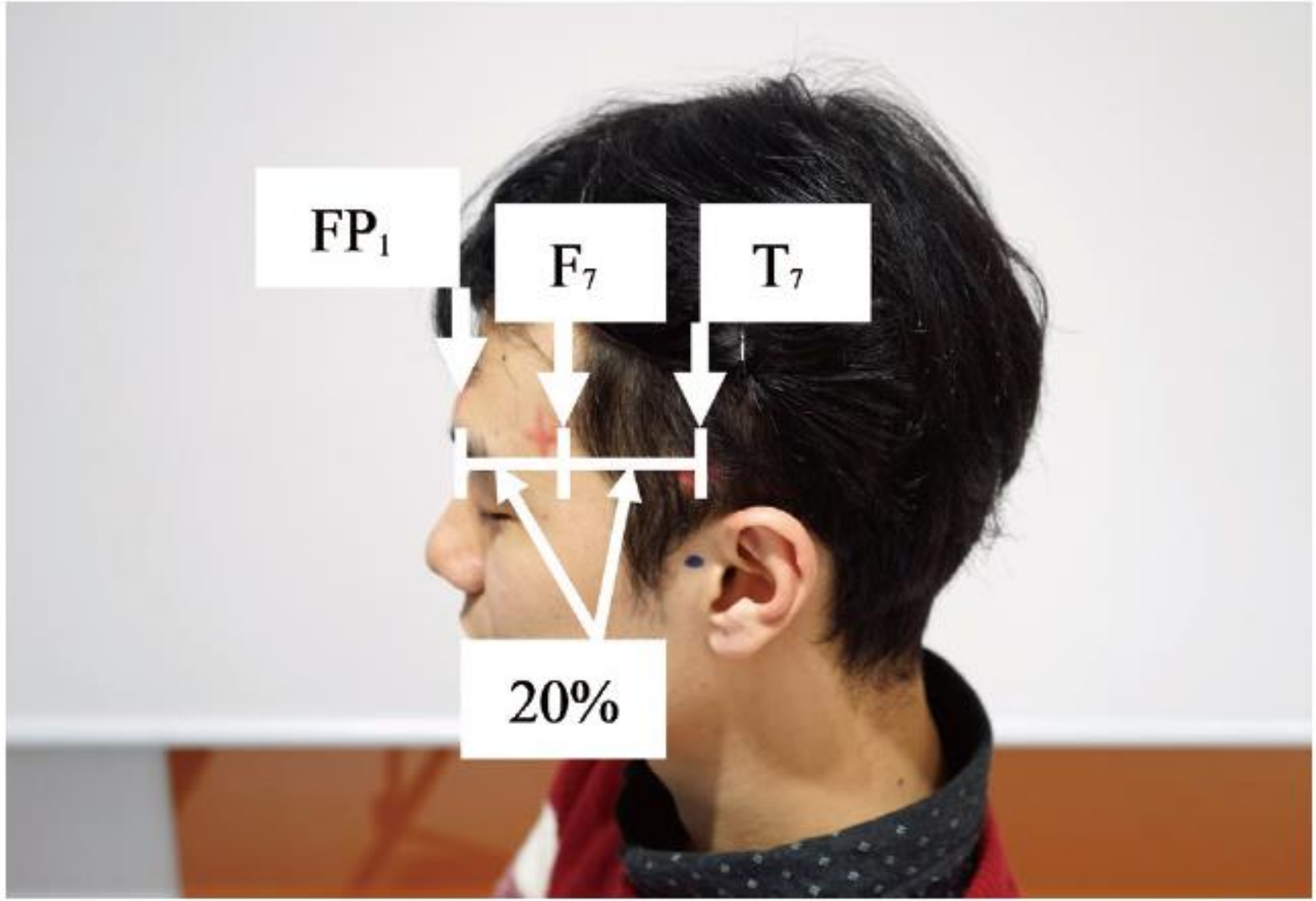

Cz
20%
20%
C4
C3
20%
20%
T8
T7
10%
10%
NASION

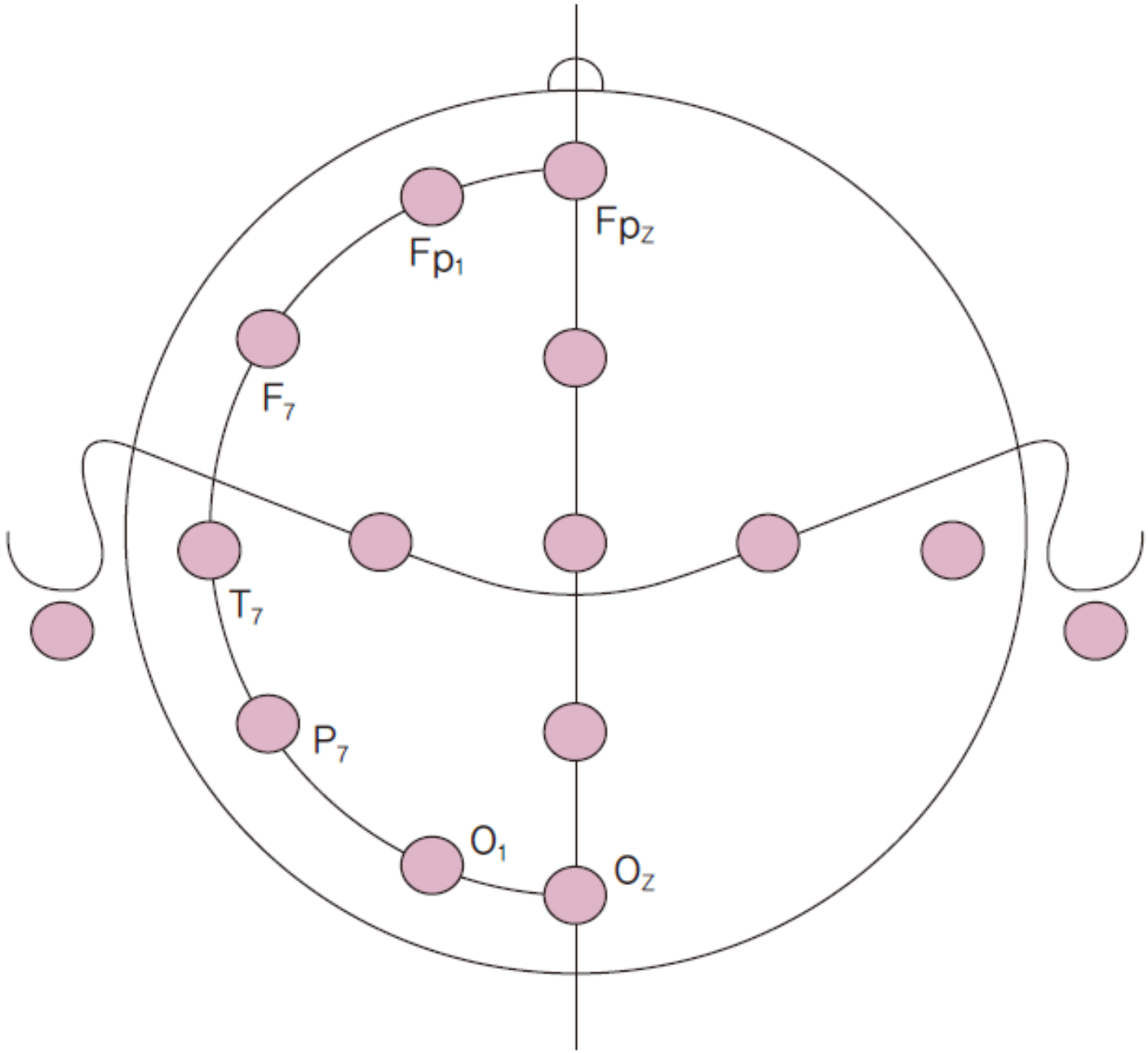

Fp1
Fp2
F7
F3
Fz
F4
F8
A1
T7
C3
Cz
C4
T8
A2
P7
P3
Pz
P4
P8
O1
O2
좌
우

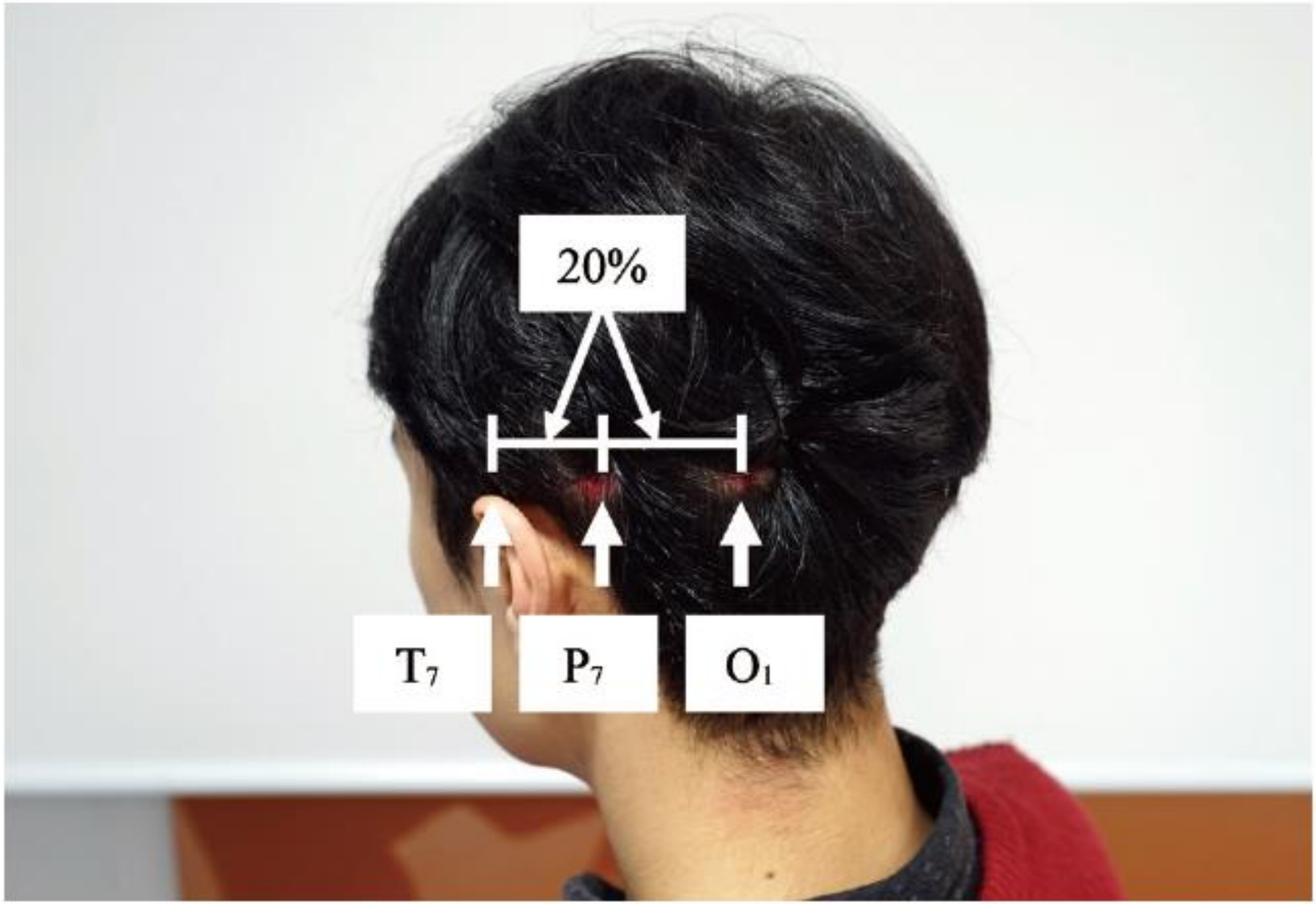

FPz

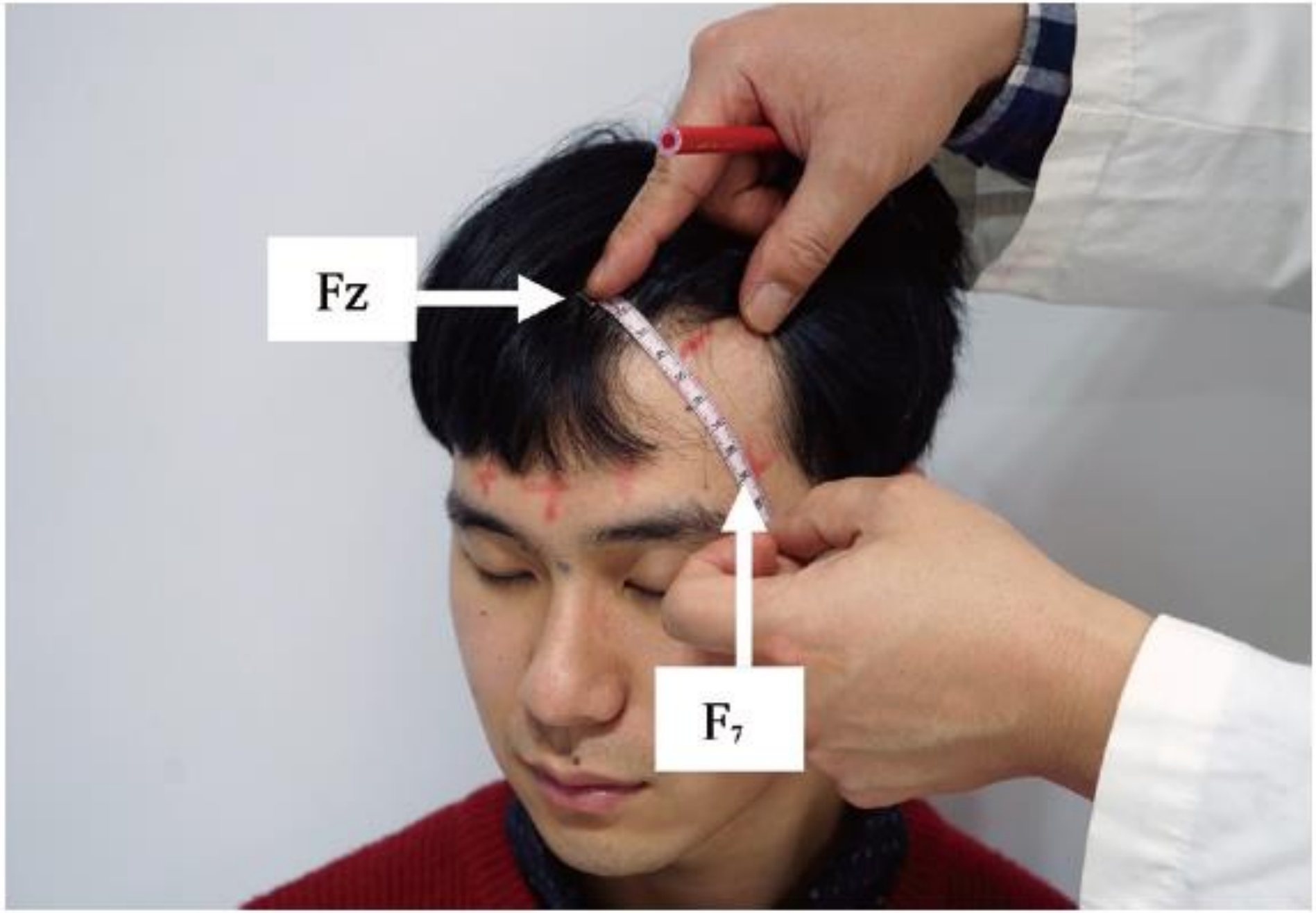

10%
FP2
FP1

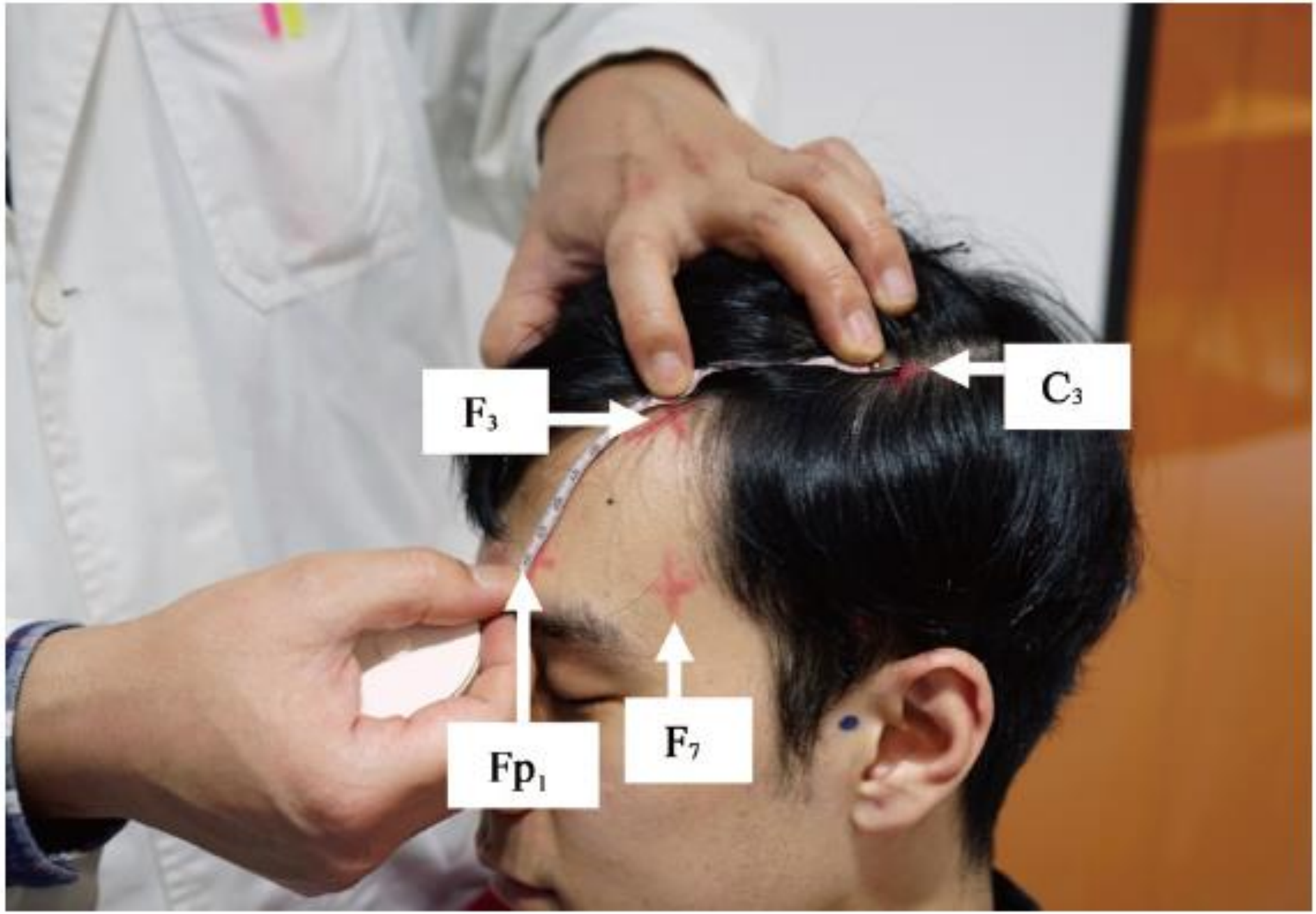

Pg2
Pg1
NASION
5%
5%
10%
10%
10%
10%
10%
10%
10%
10%
10%
INION

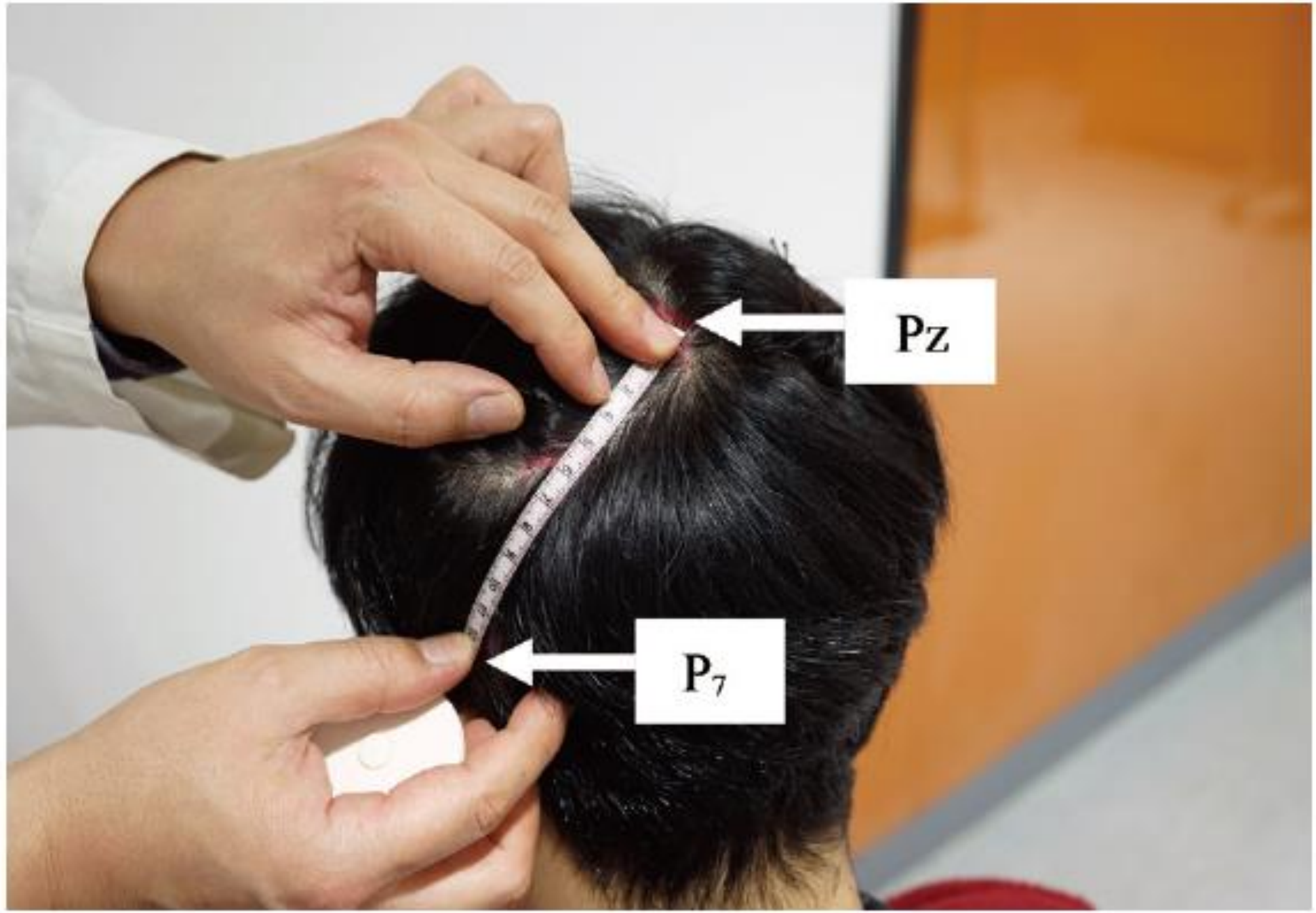

FP1
F7
T7
20%

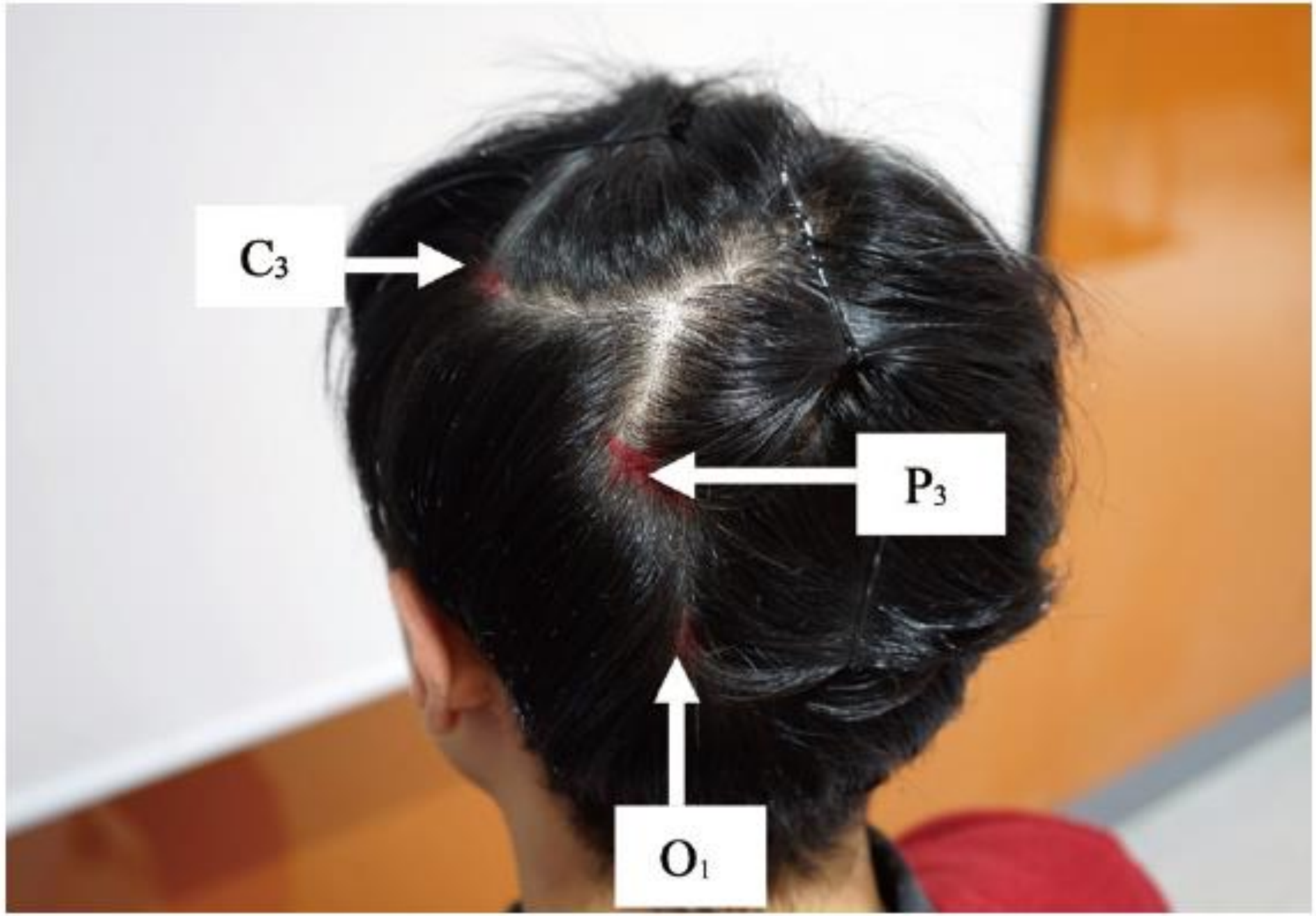

Fp1
FpZ
F7
T7
P7
O1
OZ

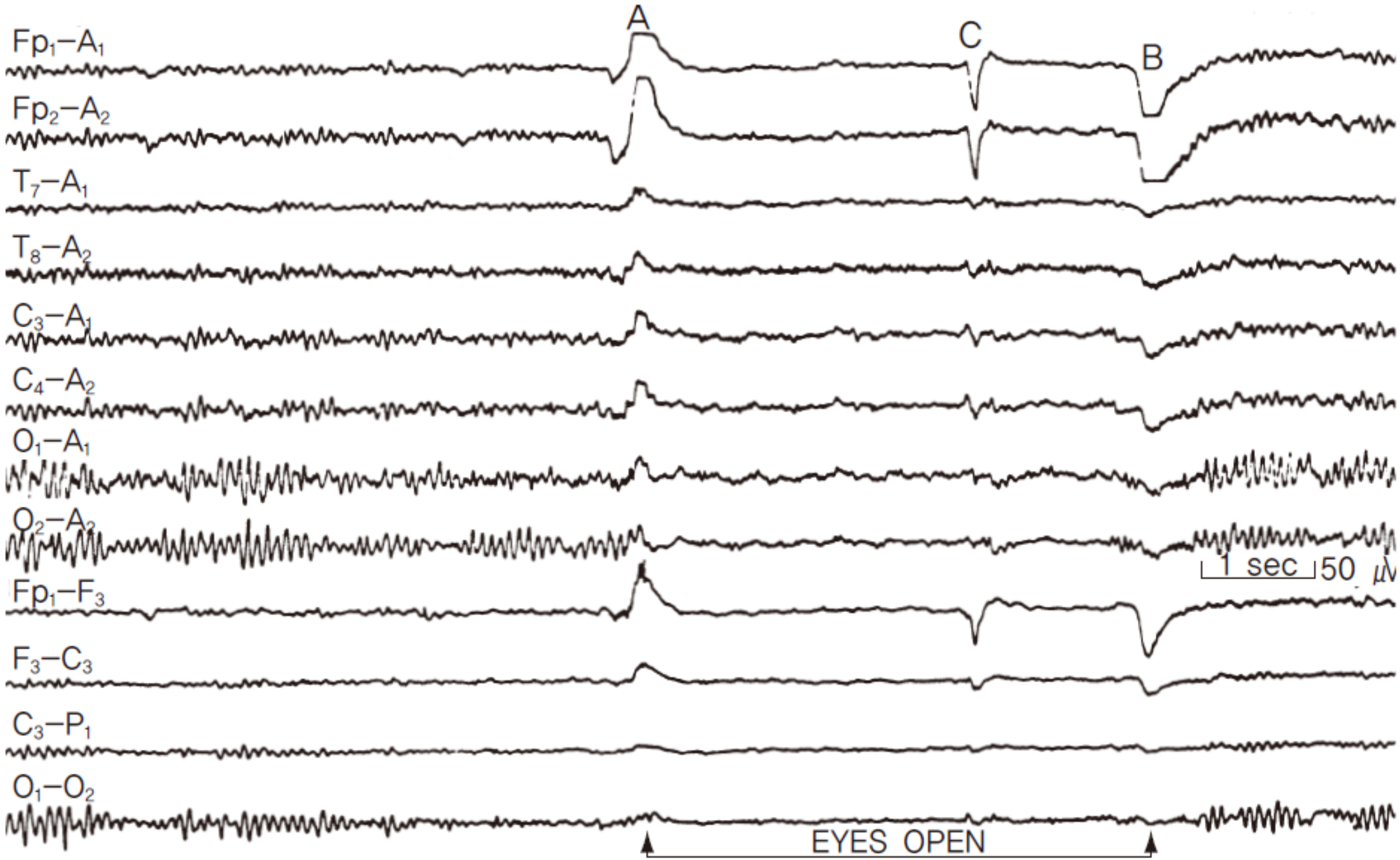

20%
T7
P7
O1

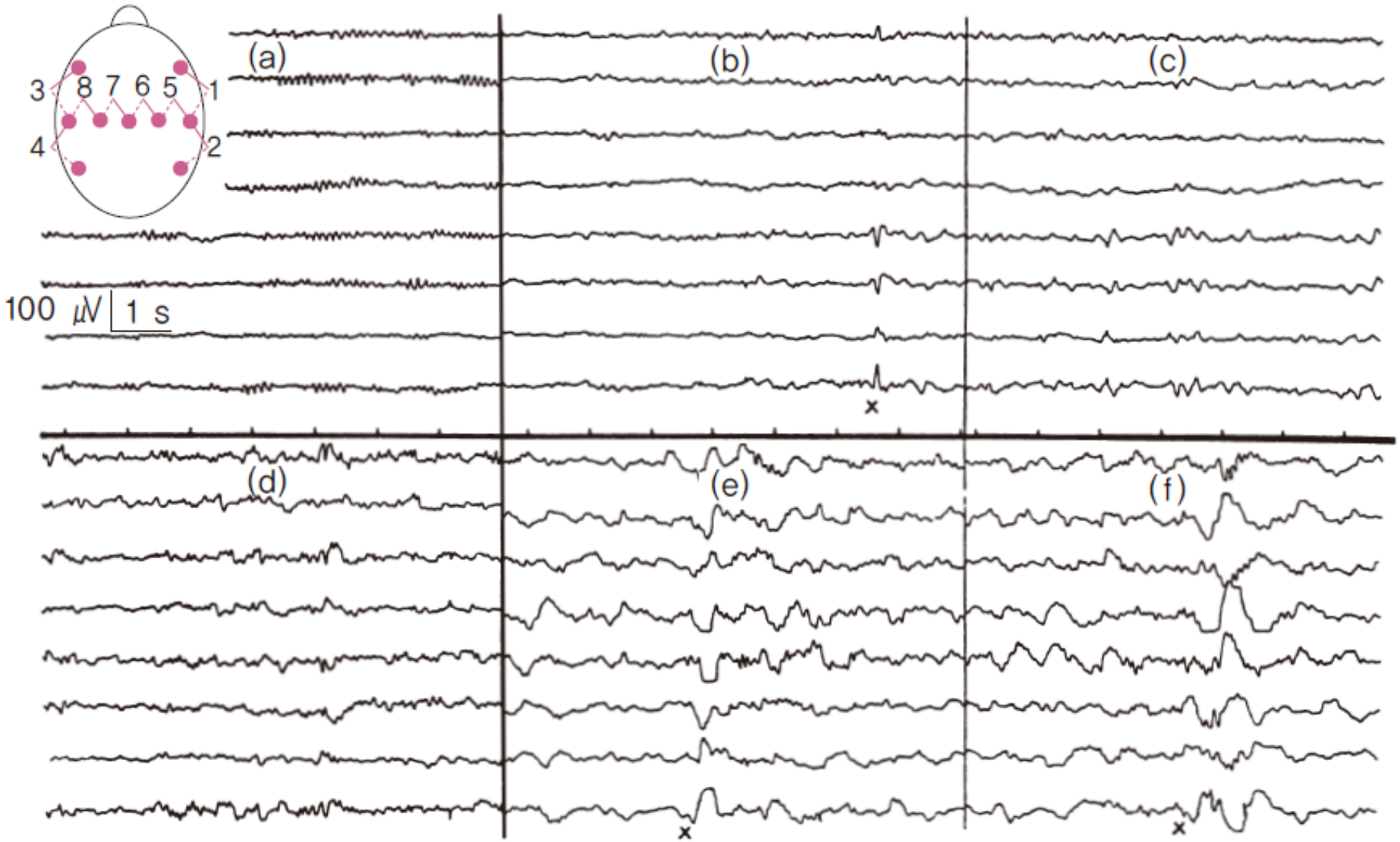

Fz
F7


F3
C3
Fp1
F7


Pz
P7


C3
P3
O1


A
C
B
Fp1–A1
Fp2–A2
T7–A1
T8–A2
C3–A1
C4–A2
O1–A1
O2–A2
1 sec
50 μV
Fp1–F3
F3–C3
C3–P1
O1–O2
EYES OPEN



(a) 각성 · 눈감은 상태에서 광범위하게 α파 출현(50% 이상)

(b) Stage Ⅰ, X는 각성 자극시 마루부에 봉우리파 출현

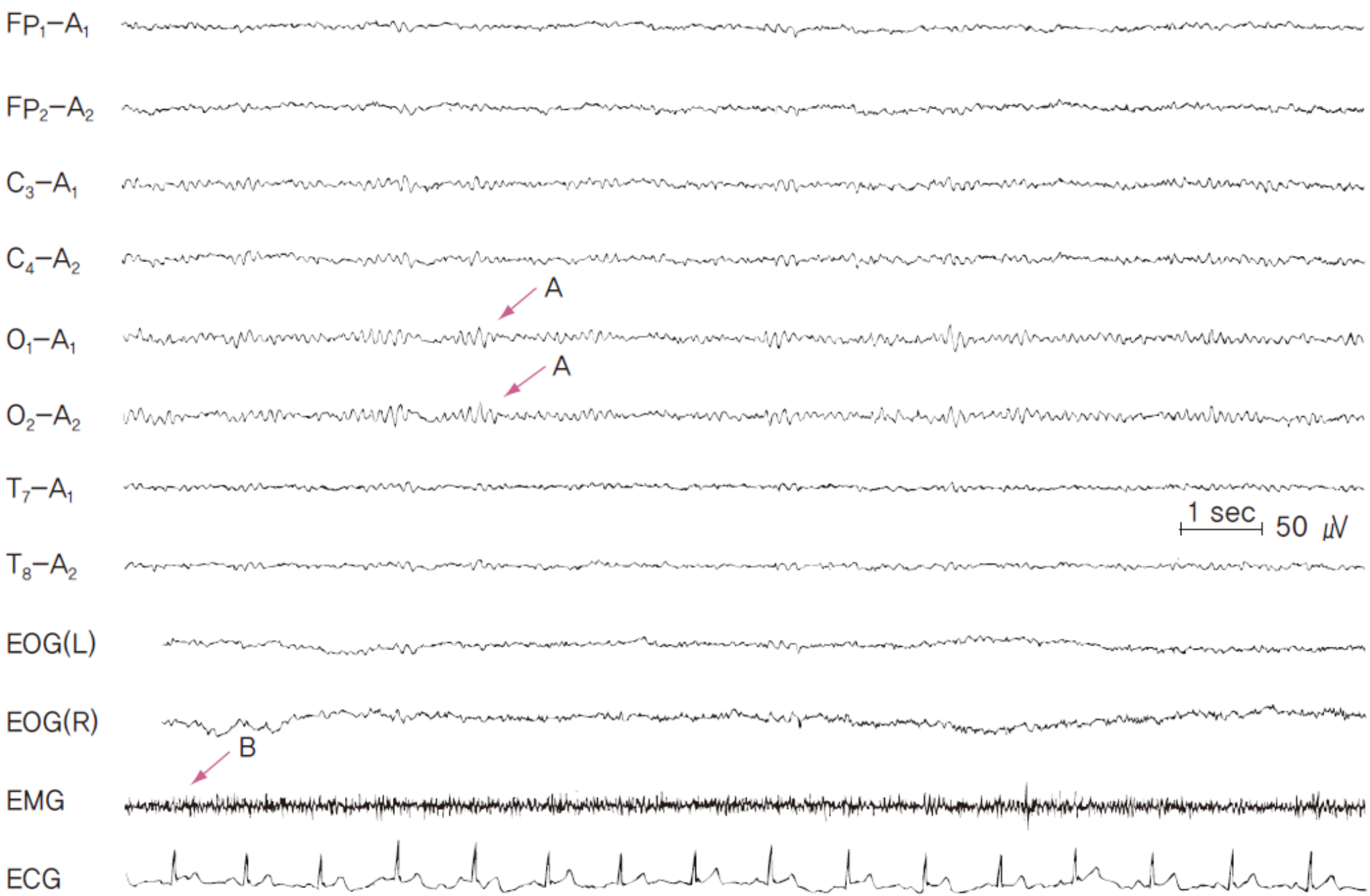
(c) Stage Ⅰ(얕은수면 시) θ파 우세

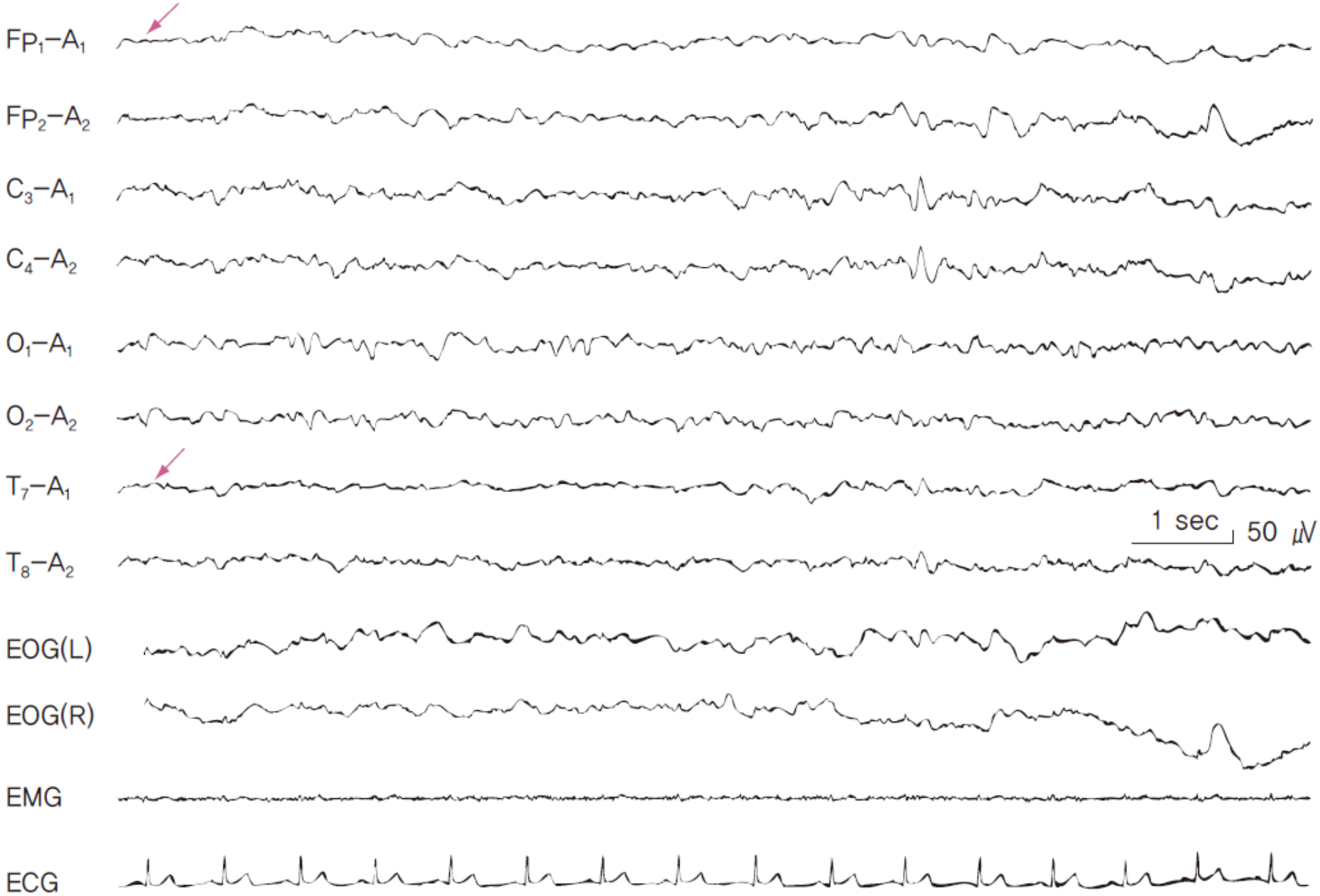
(d) Stage Ⅱ, 느린파활동 증가 방추파 출현

(e,f) Stage Ⅱ, 불규칙한 δ 활동 (20% 이하) ×는 음자극에 의한 K-complex 출현

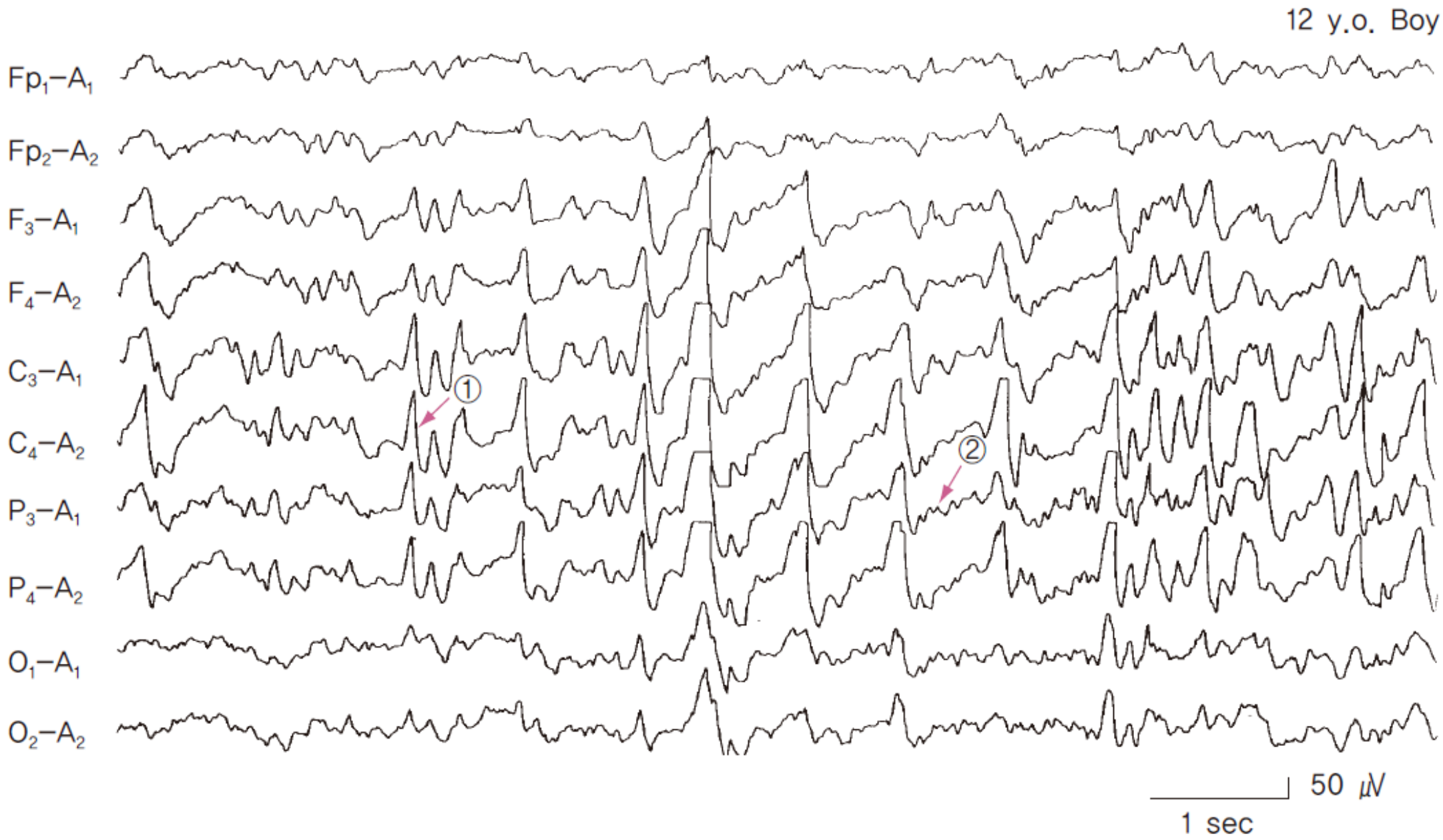
표 5-1. 수면 단계분류 및 뇌파소견

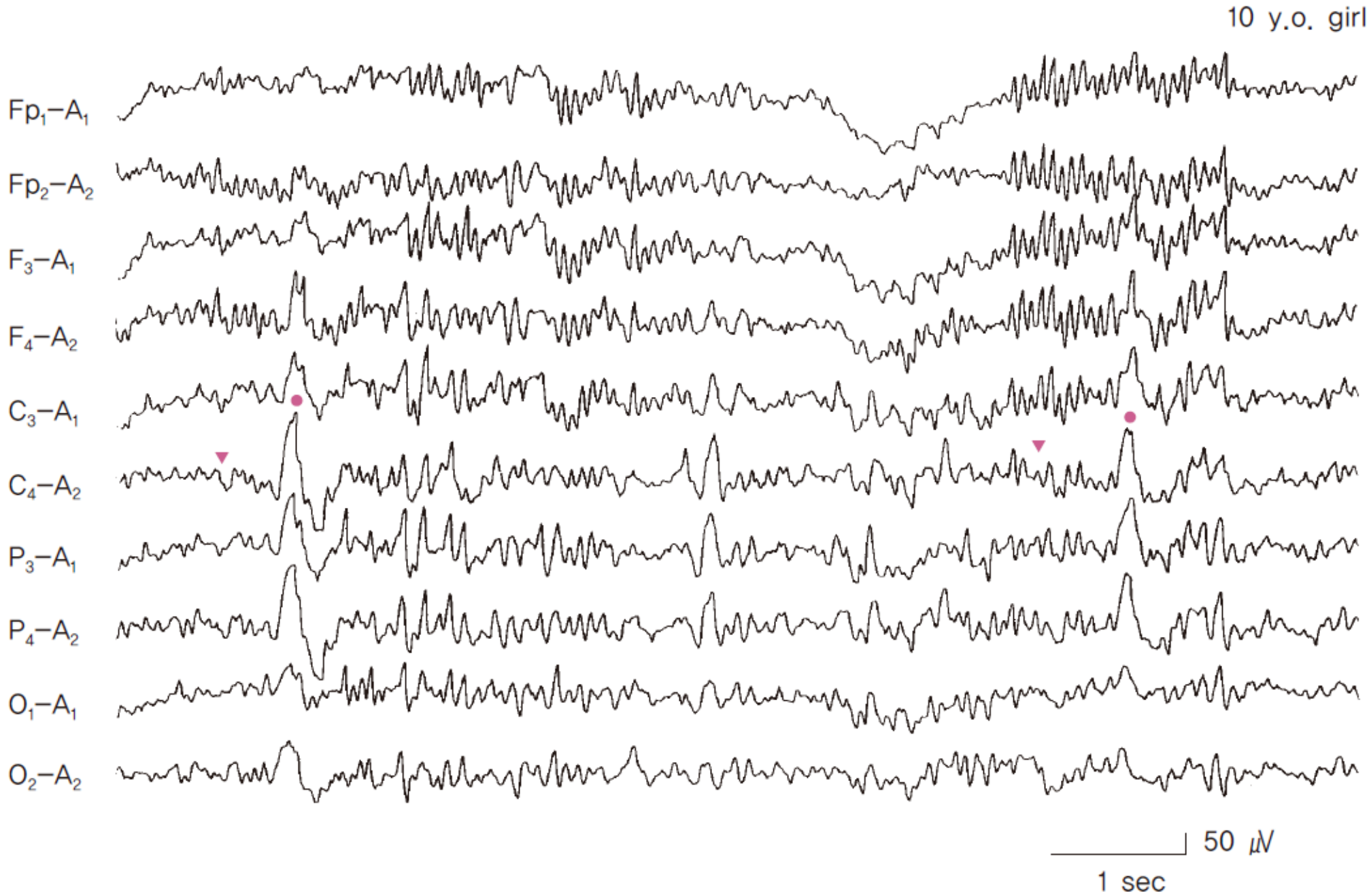
국제 분류	수면 깊이에 의한 분류	뇌파의 소견	생리학적 분류
각성 단계 (Stage W)	각성기	• α파 50% 이상	안정, 각성 눈감기
수면 1단계 (Stage I)	얕은 수면 초기	• α파가 50% 이하로 감소 • α파의 연속성과 진폭의 현저한 저하 • 낮은 진폭의 β파와 θ파 등 여러 가지 주파수의 뇌파가 나타난다. • 중심 · 마루 부위에서 봉우리파가 출현(50~100 μV) • 뒤통수부 양성 예파(POSTs)	비렘수면 (NREM)
수면 2단계 (Stage II)	얕은 수면기	• 수면 1단계 특징 잔존 (봉우리파와 방추파가 혼재) • 양쪽중심 · 마루 부위에 12~14 Hz의 방추파가 출현 • K-complex의 출현 • 이상뇌파 출현 증가	
수면 3단계 (Stage III)	깊은 수면기	• 높은 진폭 느린파 출현	
수면 4단계 (Stage IV)			
렘수면기 (REM, stage)		• 낮은 진폭의 파, 빠른파 등 여러 가지 주파수의 뇌파가 출현한다. • 자극에 대한 각성역치 증가 • 빠른 눈운동, 근긴장 저하, 뇌대사 활동 증가 • 꿈을 꾼다(하룻밤에 3~5회, 반복주기 90분). • 자율신경 기능변화(심박수, 호흡 불규칙적 증가, 발기, 내장운동정지)	렘수면 (REM)

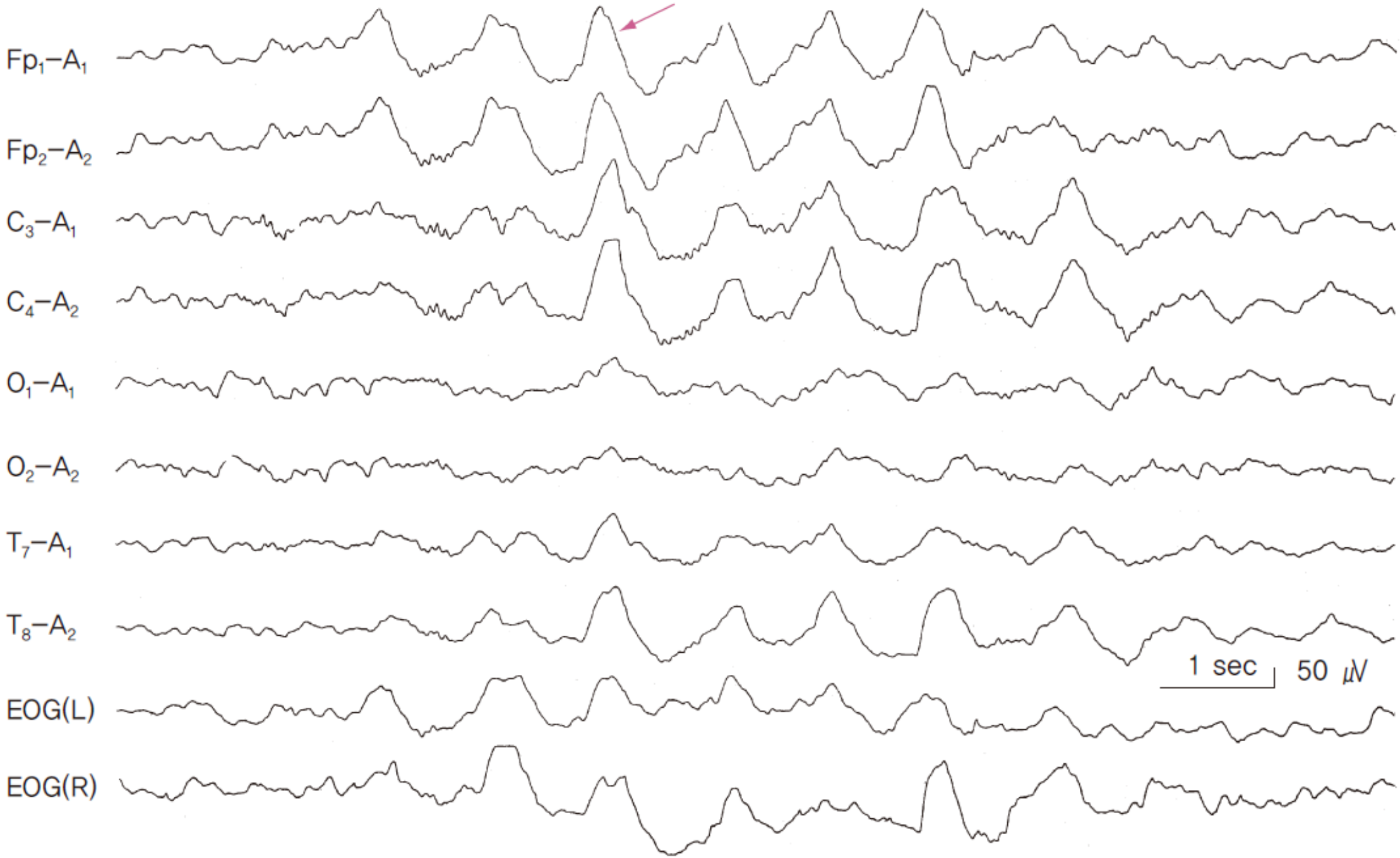

FP1–A1
FP2–A2
C3–A1
C4–A2
A
O1–A1
A
O2–A2
T7–A1
1 sec
50 μV
T8–A2
EOG(L)
EOG(R)
B
EMG
ECG

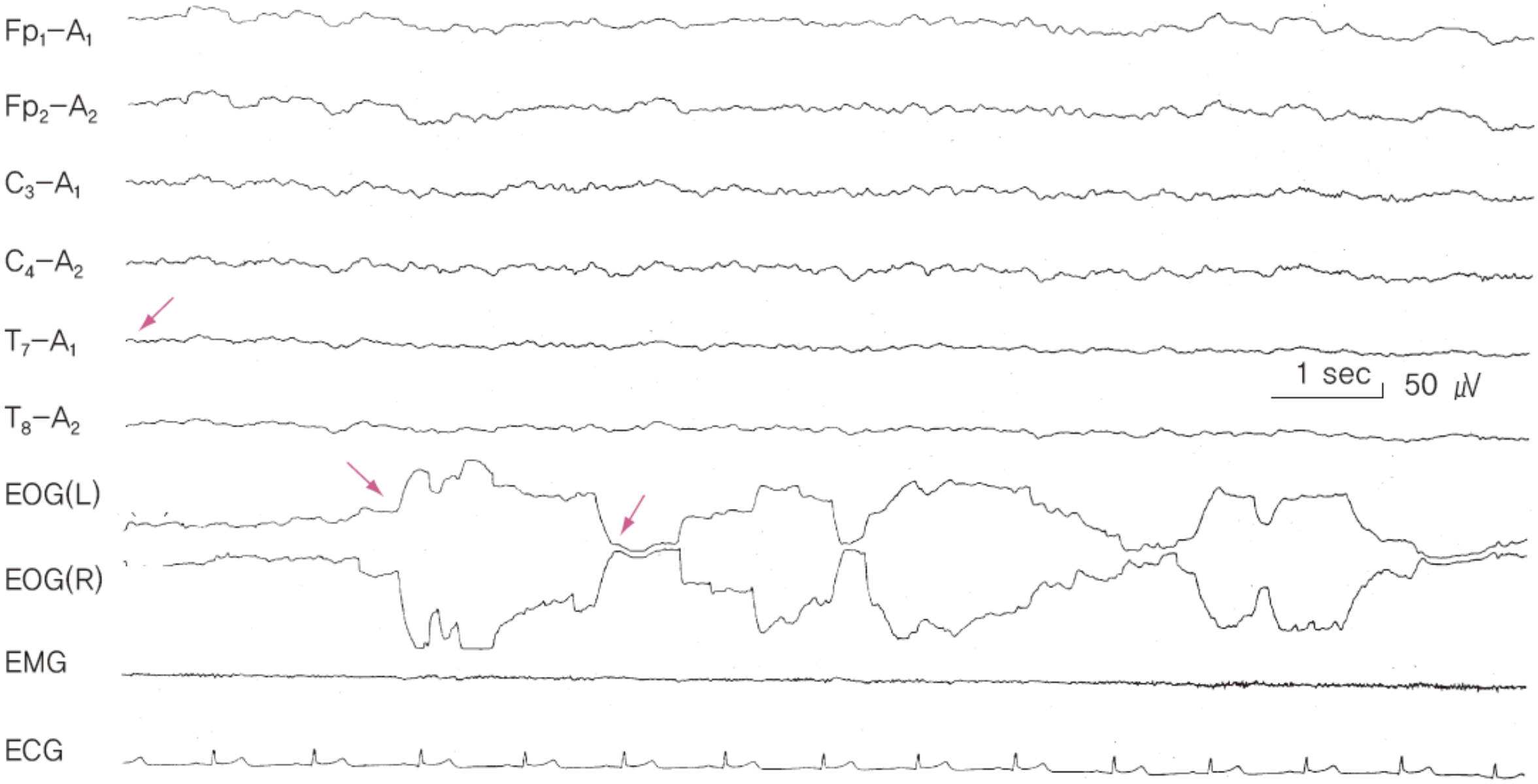

FP_1–A_1
FP_2–A_2
C_3–A_1
C_4–A_2
O_1–A_1
O_2–A_2
T_7–A_1
T_8–A_2
EOG(L)
EOG(R)
EMG
ECG
1 sec
50 μV


FP1–A1
FP2–A2
C3–A1
C4–A2
P3–A2
P4–A2
O1–A1
1 sec
50 μV
O2–A2
T7 –A1
T8–A2


12 y.o. Boy
Fp1–A1
Fp2–A2
F3–A1
F4–A2
C3–A1
C4–A2
P3–A1
P4–A2
O1–A1
O2–A2
①
②
50 μV
1 sec


10 y.o. girl
Fp1–A1
Fp2–A2
F3–A1
F4–A2
C3–A1
C4–A2
P3–A1
P4–A2
O1–A1
O2–A2
50 μV
1 sec


Fp_1–A_1
Fp_2–A_2
C_3–A_1
C_4–A_2
O_1–A_1
O_2–A_2
T_7–A_1
T_8–A_2
1 sec
50 μV
EOG(L)
EOG(R)


Fp_1-A_1
Fp_2-A_2
C_3-A_1
C_4-A_2
T_7-A_1
T_8-A_2
EOG(L)
EOG(R)
EMG
ECG
1 sec
50 μV

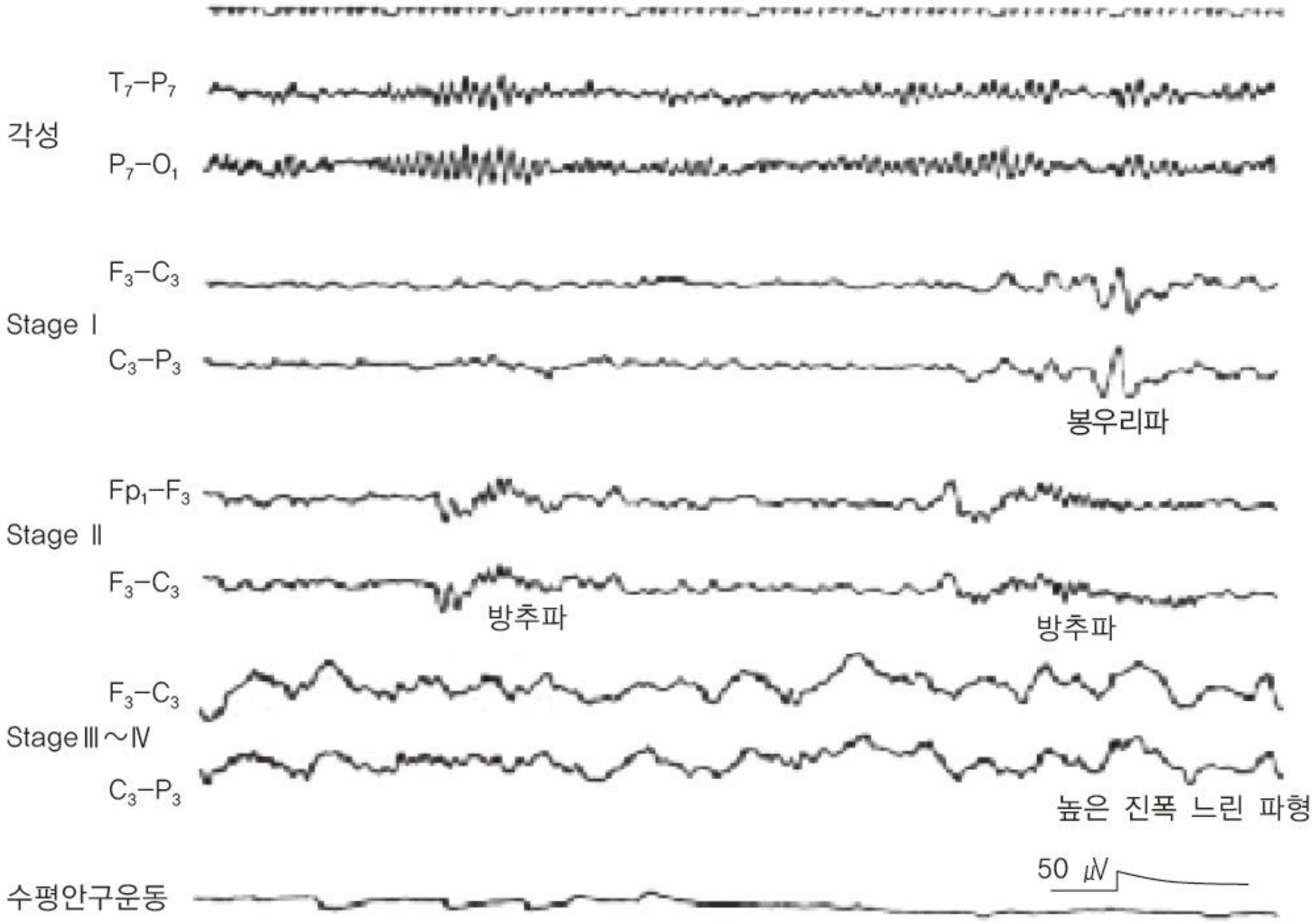

각성
T_7–P_7
P_7–O_1
Stage Ⅰ
F_3–C_3
C_3–P_3
봉우리파
Stage Ⅱ
Fp_1–F_3
F_3–C_3
방추파
방추파
Stage Ⅲ～Ⅳ
F_3–C_3
C_3–P_3
높은 진폭 느린 파형
50 μV
수평안구운동

표 5-2. 소아의 수면 단계별 뇌파소견

구분	신생아기	소아기
각성기	광범성 불규칙 느린파 (30 μV 이하)	6~8 Hz (마루–뒤통수부 우세, 50~15 μV)
얕은 수면 초기	불규칙 느린파 (저–중진폭)	낮은 진폭 느린파, 돌발성 높은 진폭 느린파군 (3~6 Hz)
얕은 수면기	불규칙 느린파 (50~100 μV) 낮은 진폭 방추파, 교대성 뇌파	중진폭 느린파와 봉우리파, 14 Hz 방추파(가끔)
깊은 수면기		중진폭 느린파, 14 Hz 방추파, 광범성 율동성 θ파
		불규칙한 높은 진폭 느린파

Section 07

수면다원검사
(Overnight polysomnography, PSG)

학습 목표

1. 야간 수면다원검사의 임상적 의의를 설명할 수 있다(A).
2. 야간 수면다원검사의 센서종류 및 역할을 이해할 수 있다(A).
3. 수면다원검사의 파형을 이해할 수 있다(A).
4. 야간 수면다원검사의 대상 질환을 설명할 수 있다(A).
5. 수면무호흡증의 종류와 특징을 이해할 수 있다(A).

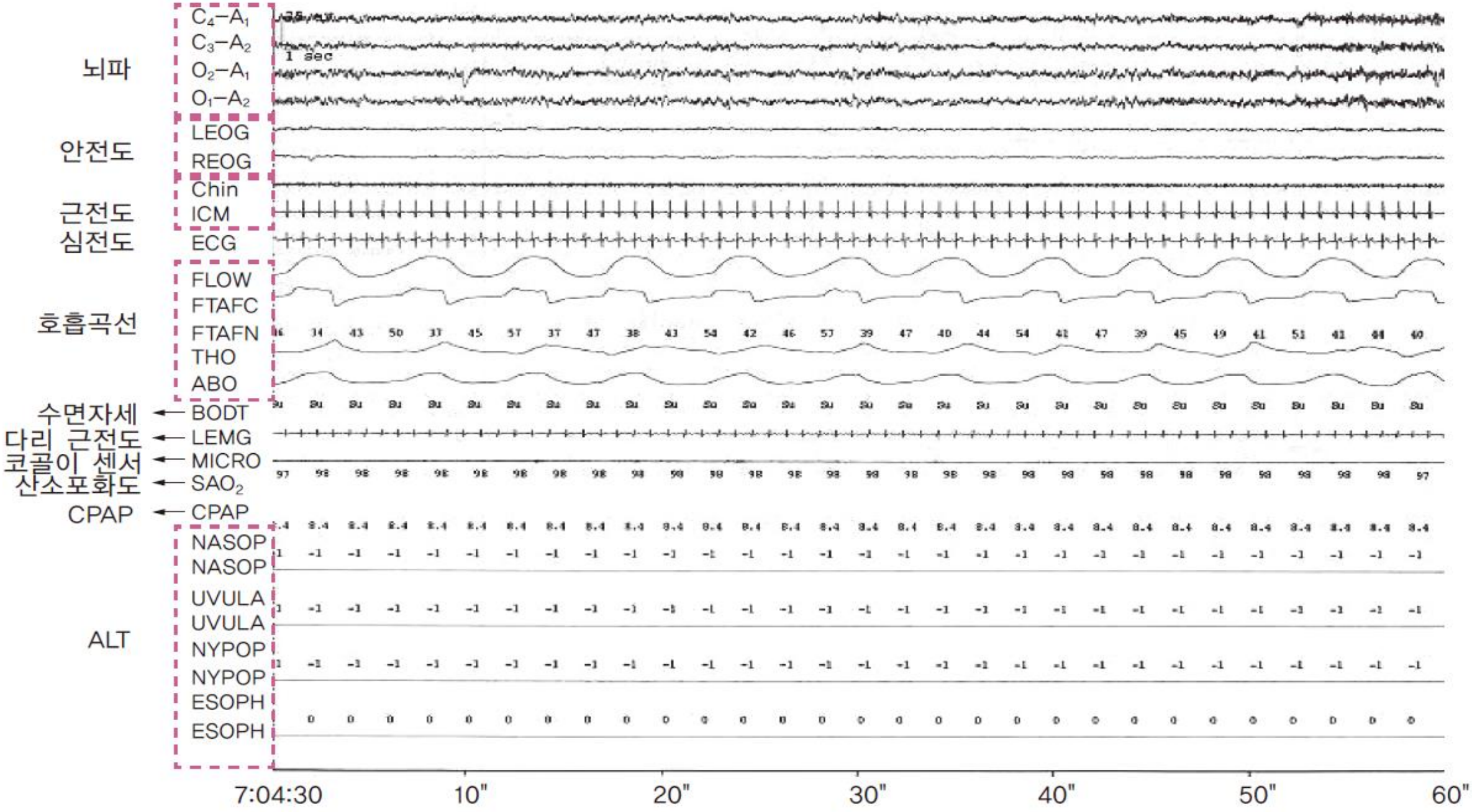

뇌파
안전도
근전도
심전도
호흡곡선
수면자세
다리 근전도
코골이 센서
산소포화도
CPAP
ALT
C4–A1
C3–A2
O2–A1
O1–A2
LEOG
REOG
Chin
ICM
ECG
FLOW
FTAFC
FTAFN
THO
ABO
BODT
LEMG
MICRO
SAO2
CPAP
NASOP
NASOP
UVULA
UVULA
NYPOP
NYPOP
ESOPH
ESOPH
1 sec
7:04:30
10"
20"
30"
40"
50"
60"

표 7-1. 수면 polygram의 판정기준(백분율은 % time, *표는 중요 지표)

	Stage W	M T	Stage N_1	Stage N_2	Stage N_3	Stage R
L. EOG		* 				* 
R. EOG		* 				* 
EMG		* 				* 
EEG	*ALPHA ACTIVITY 8~13 Hz  50% ≤ LOW VOLT MIXED FREQ. 	MOVEMENT TENSION  EMG 50% ≤	MIXED FREQUENCY 2~7 Hz  VERTEX SHARP WAVE 	* SPINDLE 12~14 Hz  0.5 sec < * SLOW ACTIVITY 2 Hz≥ 75 μV≤  <20% K-COMPLEX 	SLOW ACTIVITY 2 Hz≥ 75 μV≤  20% ≥	MIXED FREQUENCY 2~7 Hz 

* 미국수면의학회(American Academy of Sleep Medicine, AASM, 2007)에 의해 작성된 수면단계 판정모식도



EEG용 전극



다리근전도 전극



심전도용 전극



micro phone 센서



호흡(oral, nasal)센서



호흡센서



혈중산소포화농도(oximetry)
기계 및 센서



수면자세용 기기 및 센서



지속적 혈압 측정용 기계



(전극 부착)용액 콜로디온



줄자



Omniprep



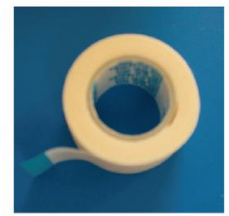
아세톤(콜로디온제거제)



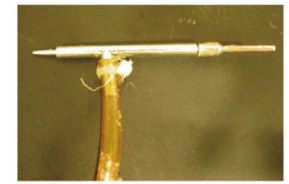
Electrode jelly



Air compressor



Surgical tape



Stylus



Intercom



양면 tape



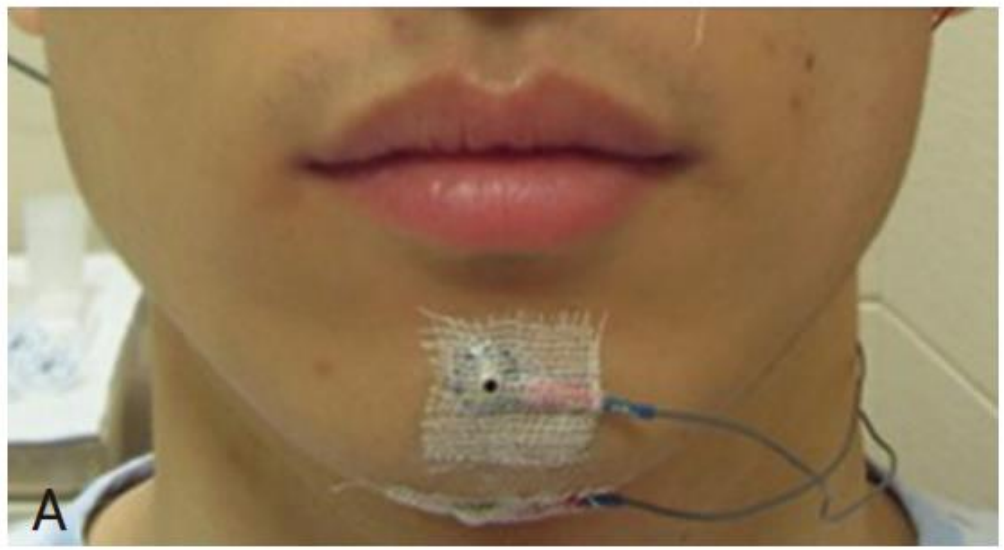
Paper



CPAP remote controller



Mini electrode board


A

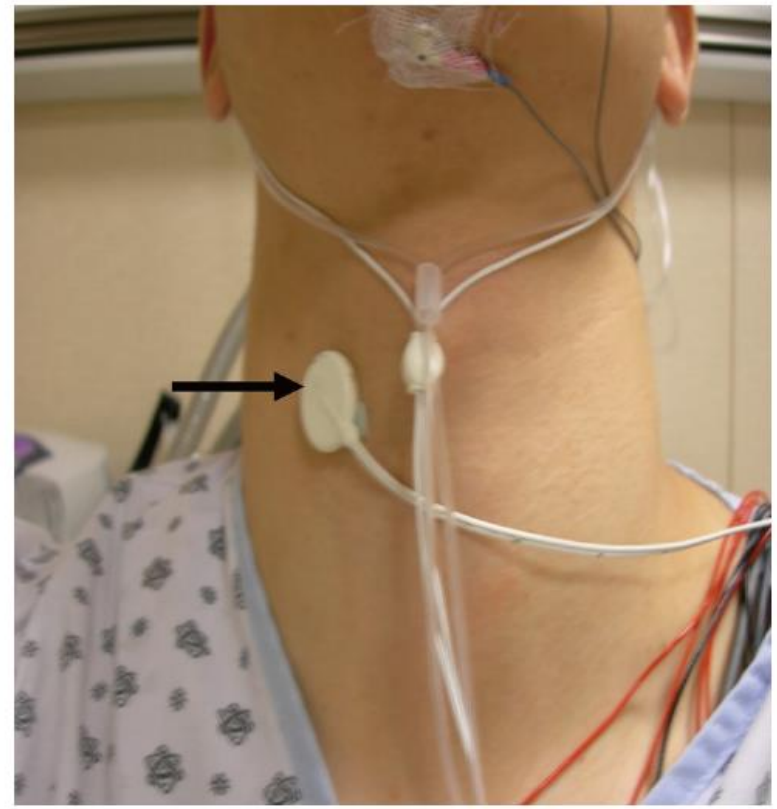

B



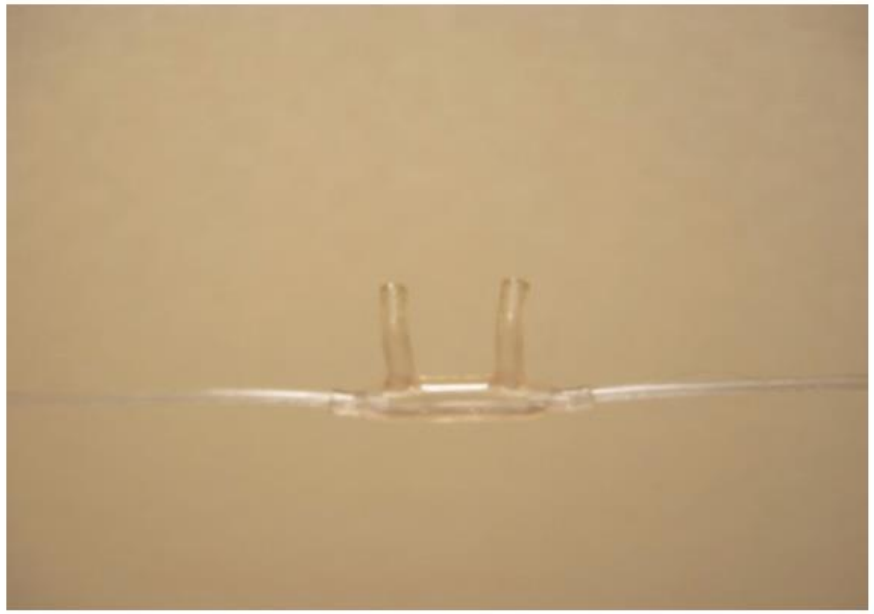
마이크로폰 부착한 모습



Microphone 센서



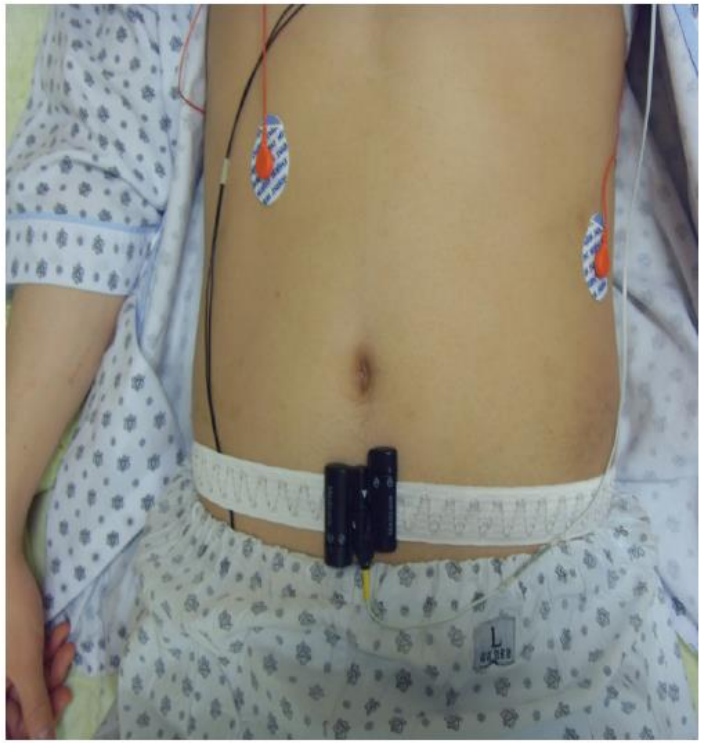
Airflow sensor





흉 복부 호흡운동과 수면 체위 센서



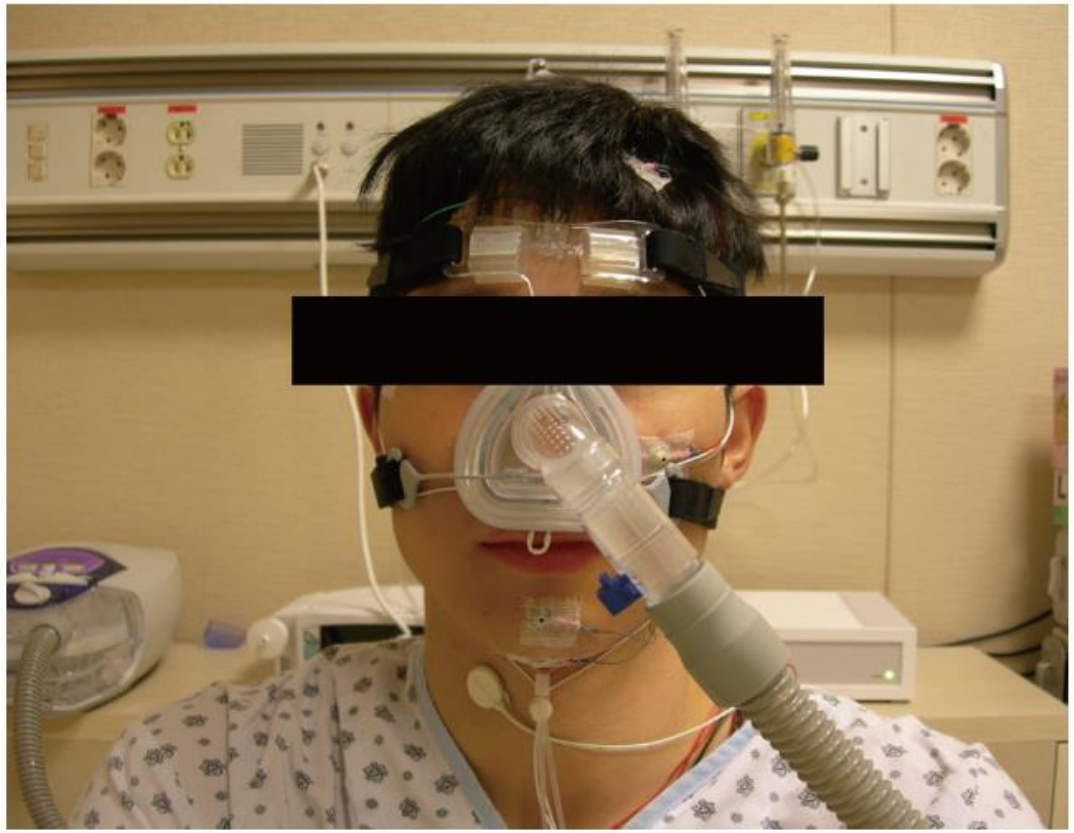


산소포화도 센서 (Pulse Oximeter)

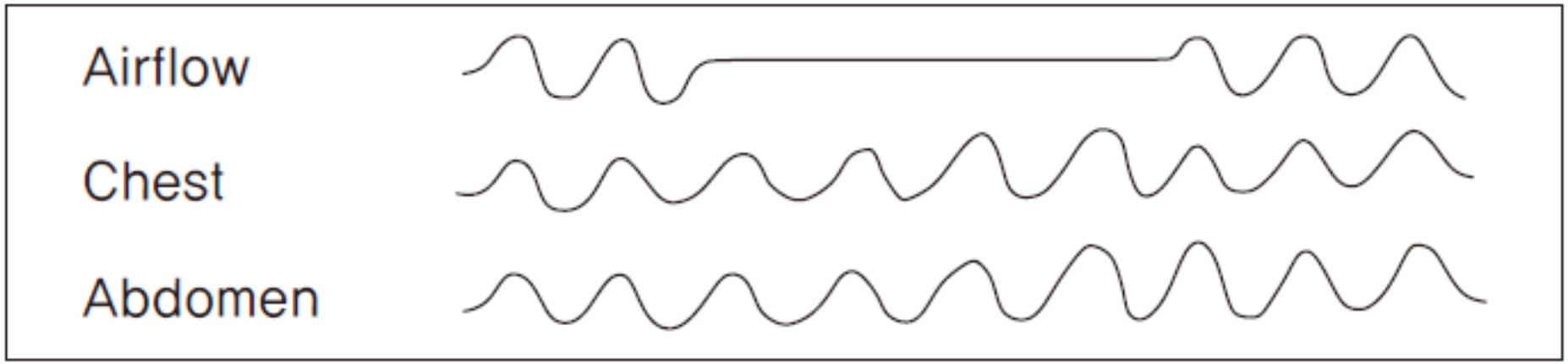


지속적 양압기 (CPAP: Continuous Positive Airway Pressure)

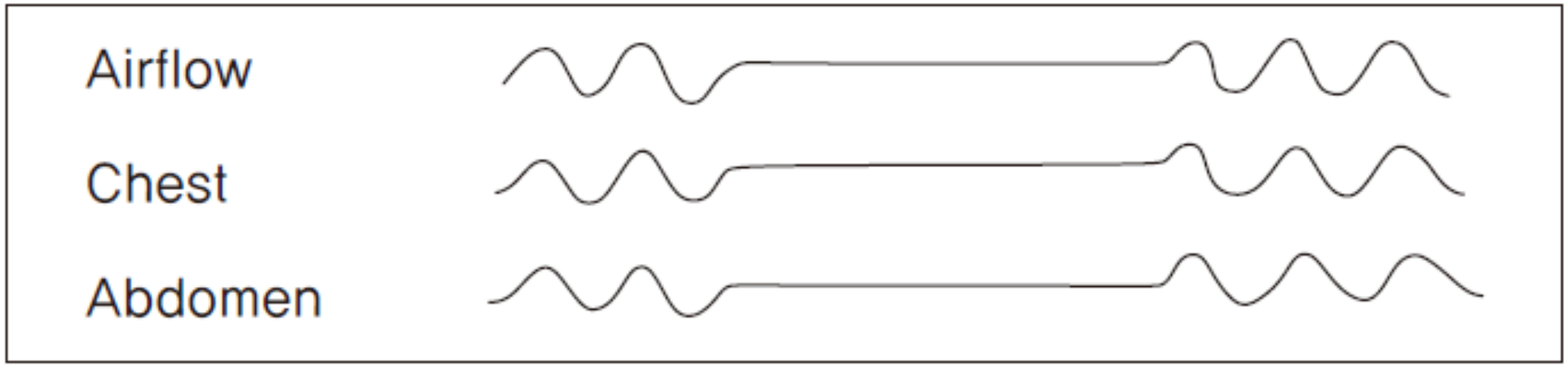




폐쇄성 수면 무호흡 (Obstructive Sleep Apnea: OSA)



Central Sleep Apnea



Mixed Sleep Apnea

