신경기능검사학

CHAPTER I

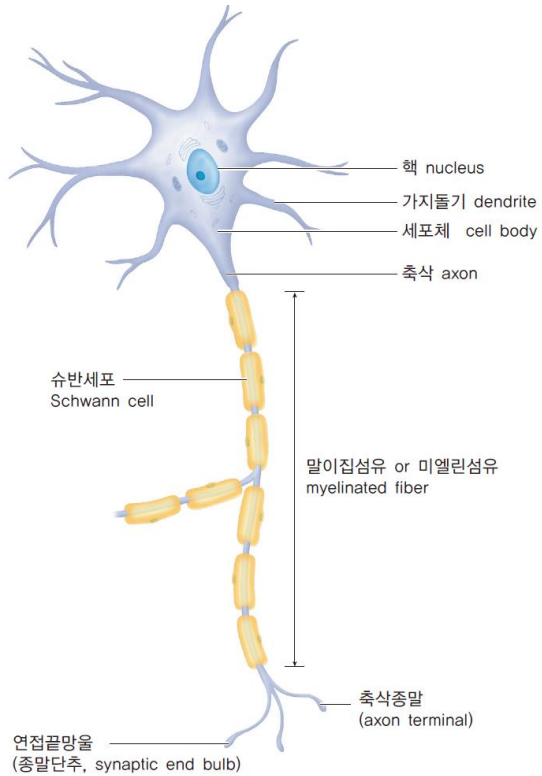
뇌파검사

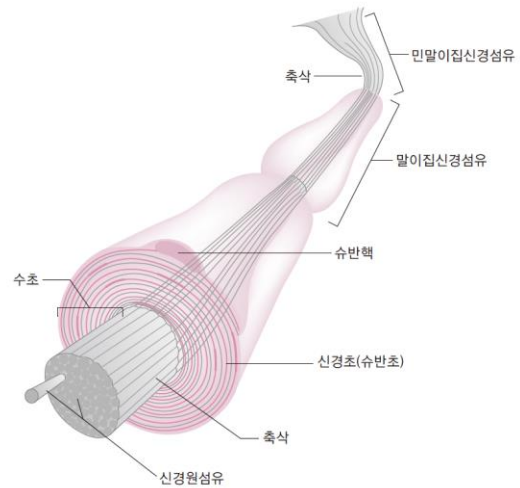
Section 01

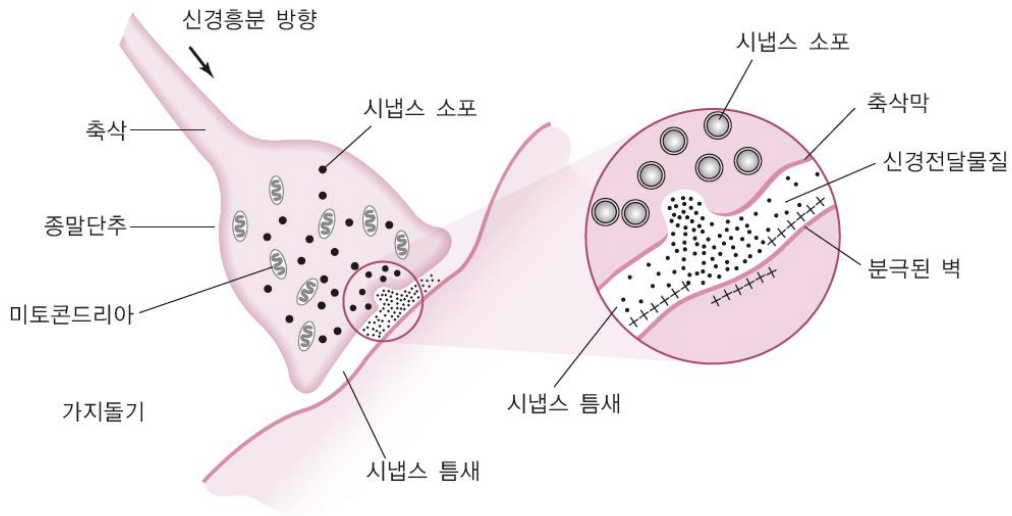
뇌파검사를 위한 해부생리

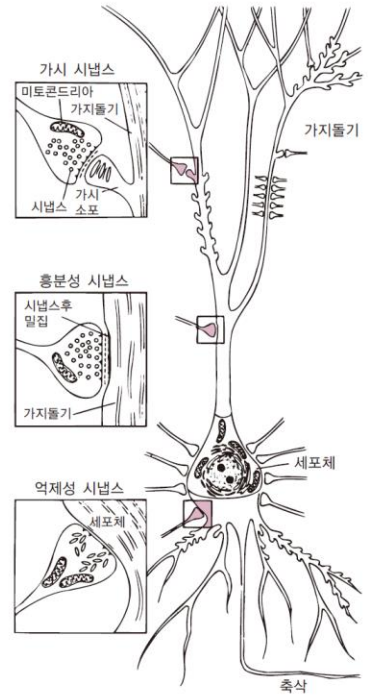
학습 목표

1. 신경계의 구조와 기능을 설명할 수 있다(A).
2. 뉴런(neuron)에 대해 설명할 수 있다(A).
3. 말이집(유수)신경과 민말이집(무수)신경의 차이점을 설명할 수 있다(A).
4. 시냅스(synapse)에 대해 설명할 수 있다(A).
5. 안정막 전위(정지전위)와 활동전위를 설명할 수 있다(A).
6. 흥분성 시냅스후 전위와 억제성 시냅스후 전위를 설명할 수 있다(B).
7. 대뇌겉질(대뇌피질)의 구조를 설명할 수 있다(B).
8. 대뇌겉질(대뇌피질)의 기능을 설명할 수 있다(A).
9. 대뇌반구 4개의 엽(lobe)을 설명할 수 있다(A).
10. 맞교차섬유(교련섬유), 연합섬유, 투사섬유를 설명할 수 있다(B).
11. 뇌줄기(뇌간)의 구조를 설명할 수 있다(B).

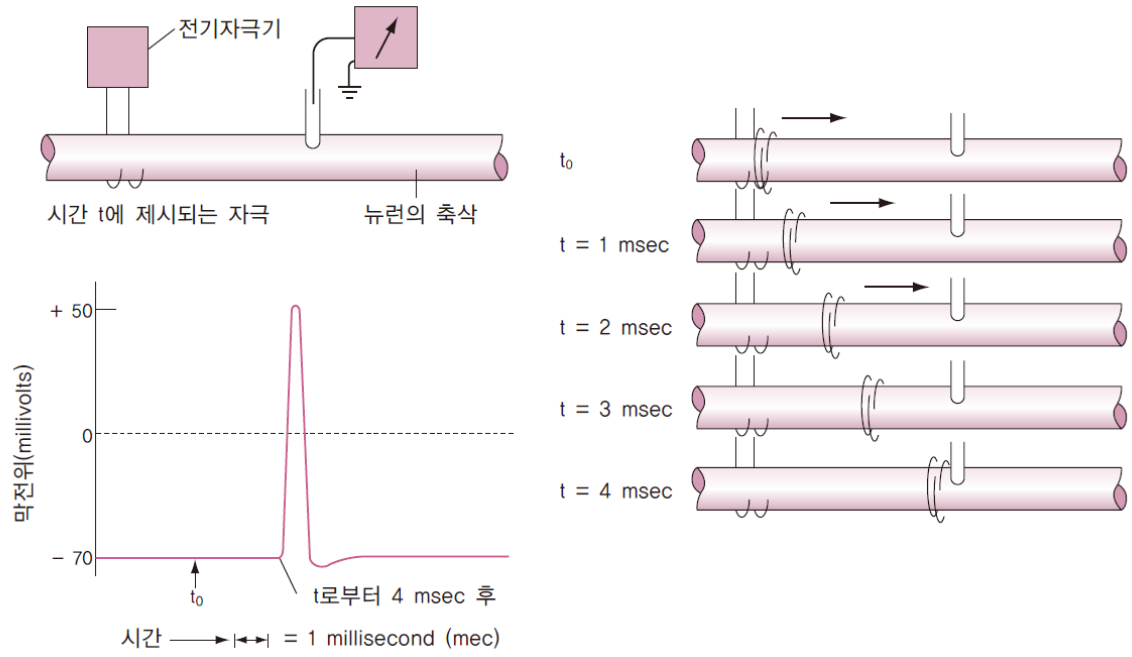

핵 nucleus
가지돌기 dendrite
세포체 cell body
축삭 axon
슈반세포
Schwann cell
말이집섬유 or 미엘린섬유
myelinated fiber
축삭종말
(axon terminal)
연접끝망울
(종말단추, synaptic end bulb)

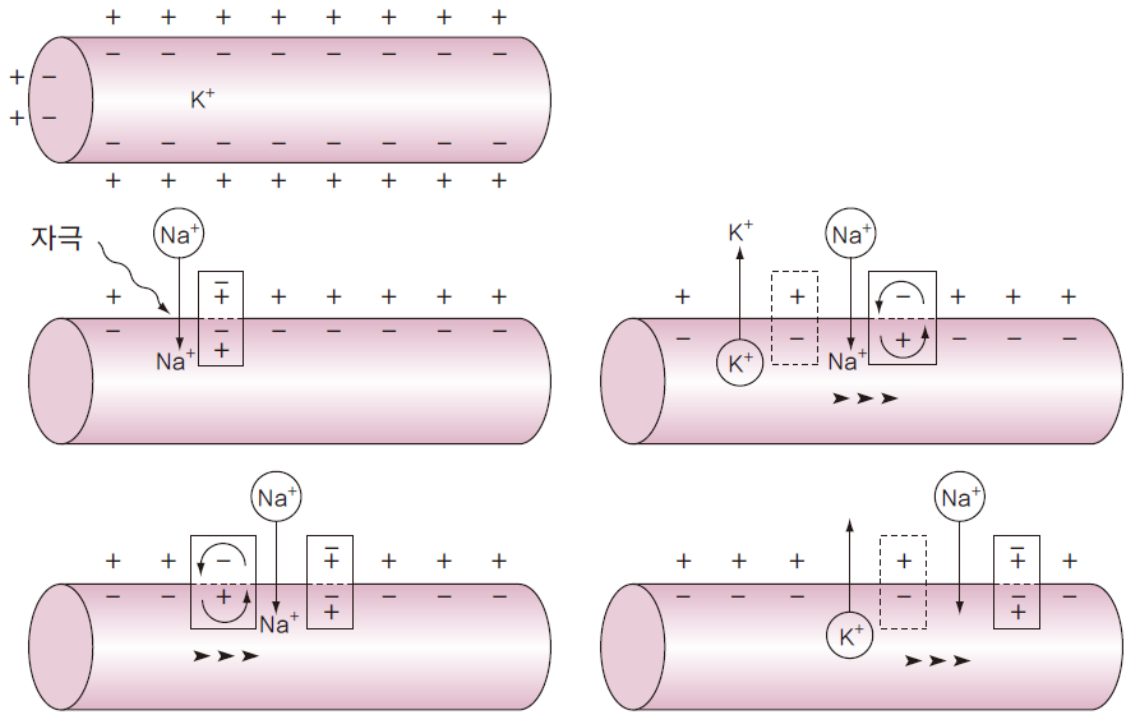

민말이집신경섬유
축삭
말이집신경섬유
슈반핵
수초
신경초(슈반초)
축삭
신경원섬유


신경흥분 방향
축삭
종말단추
미토콘드리아
가지돌기
시냅스 소포
시냅스 틈새
시냅스 소포
축삭막
신경전달물질
분극된 벽
시냅스 틈새



아세틸콜린(acetylcholine)	콜린의 아세트산에스테르로 몸운동신경과 부교감신경섬유에서 신경전달물질로 사용한다.
GABA(gamma-aminobutyric acid)	중추신경계에서 억제성 신경전달물질로 작용하는 아미노산
카테콜아민(catecholamine)	에피네프린, 노르에피네프린, L-도파민 등을 포함하는 분자의 그룹으로 이 카테콜아민의 효과는 교감신경의 활성에 의해 생긴 효과와 유사하다.


전기자극기
시간 t에 제시되는 자극
뉴런의 축삭
+ 50
0
− 70
막전위(millivolts)
t_0
t로부터 4 msec 후
시간
= 1 millisecond (mec)
t_0
t = 1 msec
t = 2 msec
t = 3 msec
t = 4 msec


K+
자극
Na+
Na+
K+
Na+
Na+
Na+
K+
Na+
K+

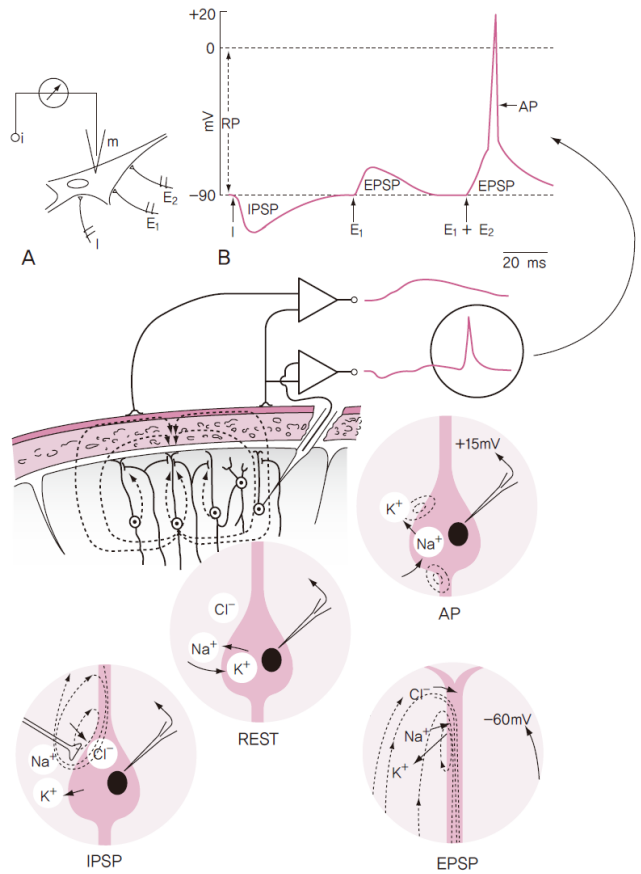
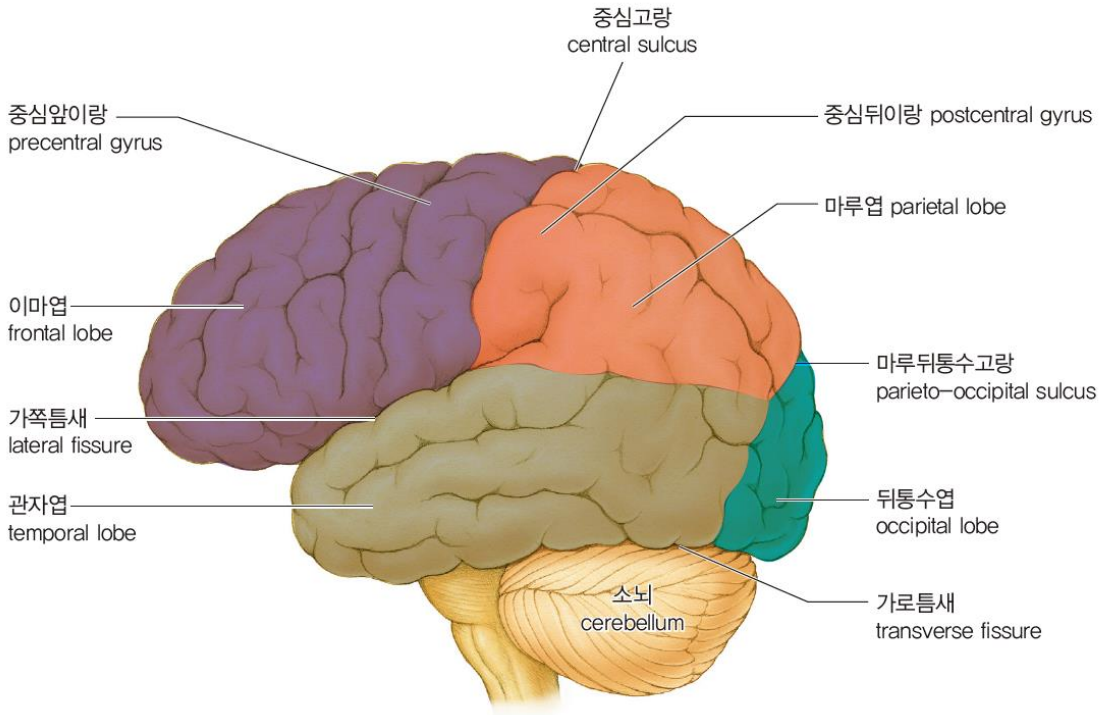
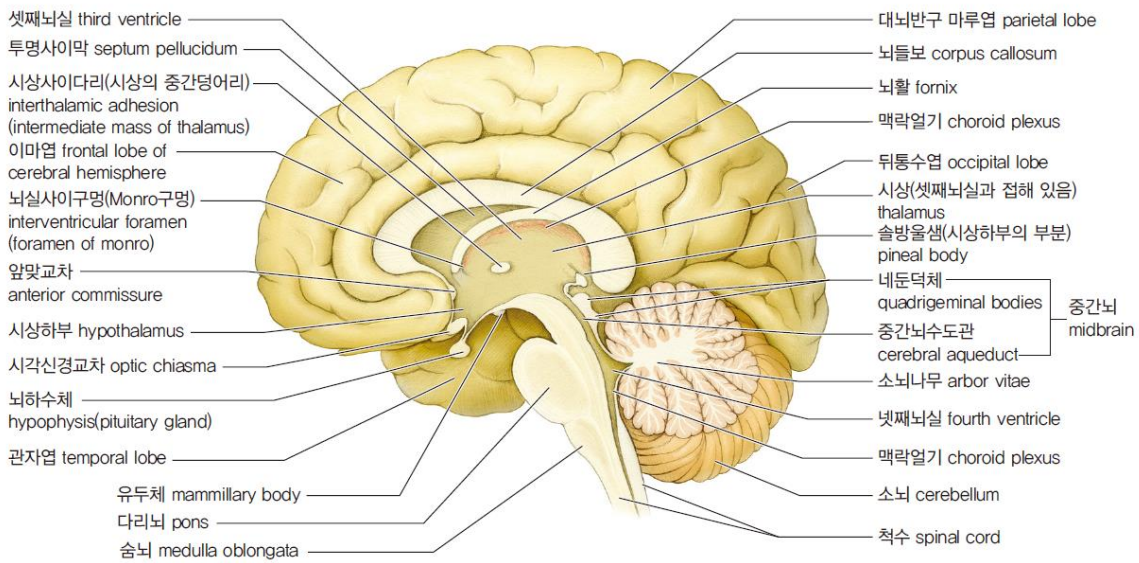
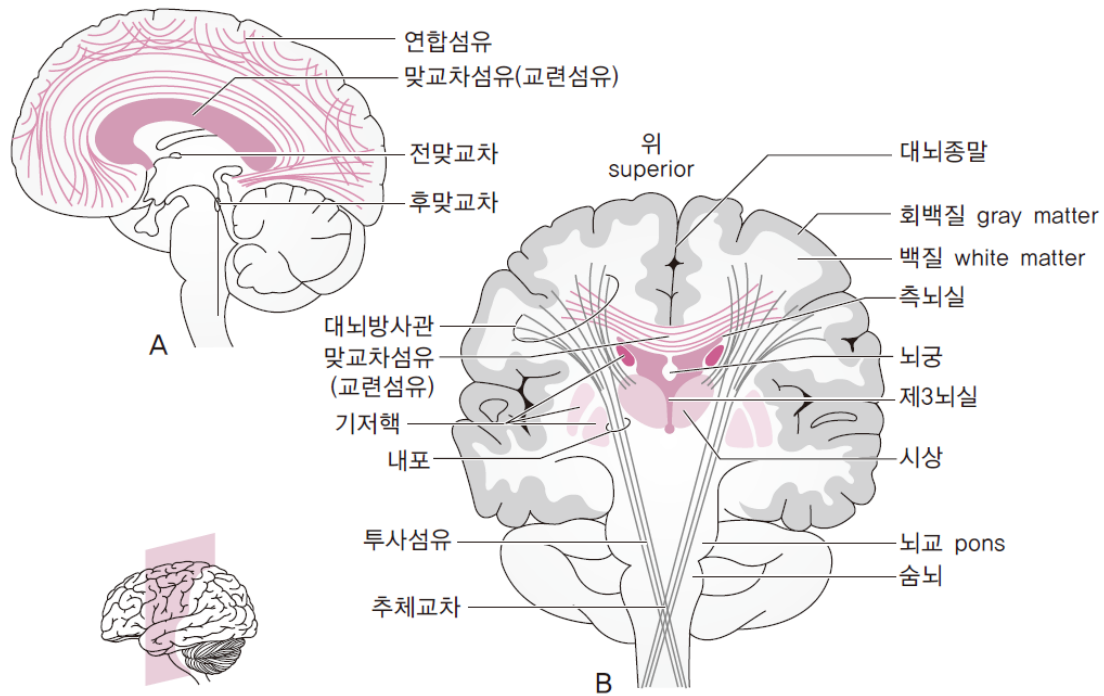

+20
0
−90
mV
RP
AP
EPSP
EPSP
IPSP
I
E1
E1 + E2
20 ms
i
m
E2
E1
I
A
B
+15mV
K+
Na+
AP
Cl−
Na+
K+
REST
Na+
Cl−
K+
IPSP
Cl−
Na+
K+
−60mV
EPSP

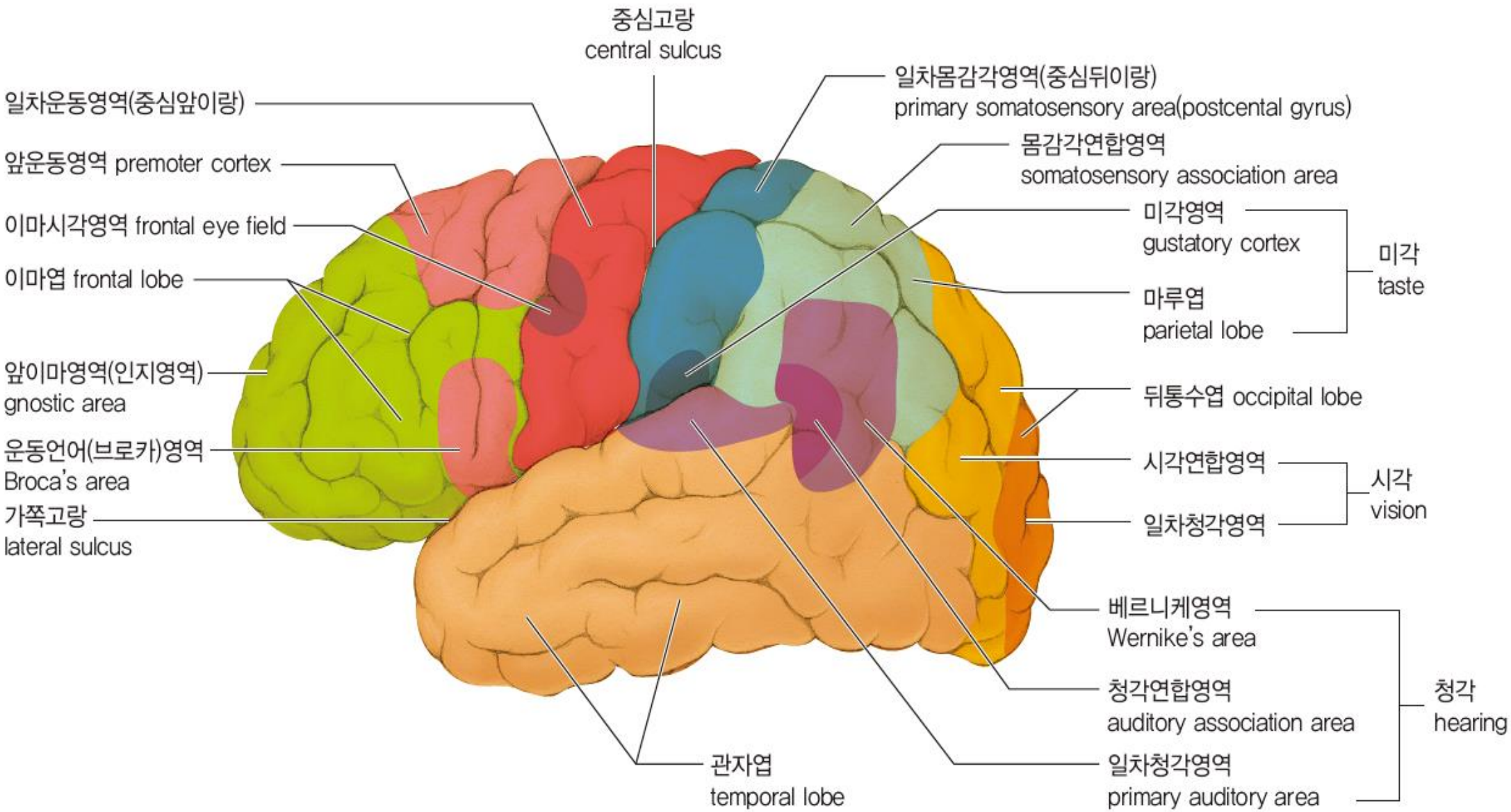
표 1-1. 신경계의 구조

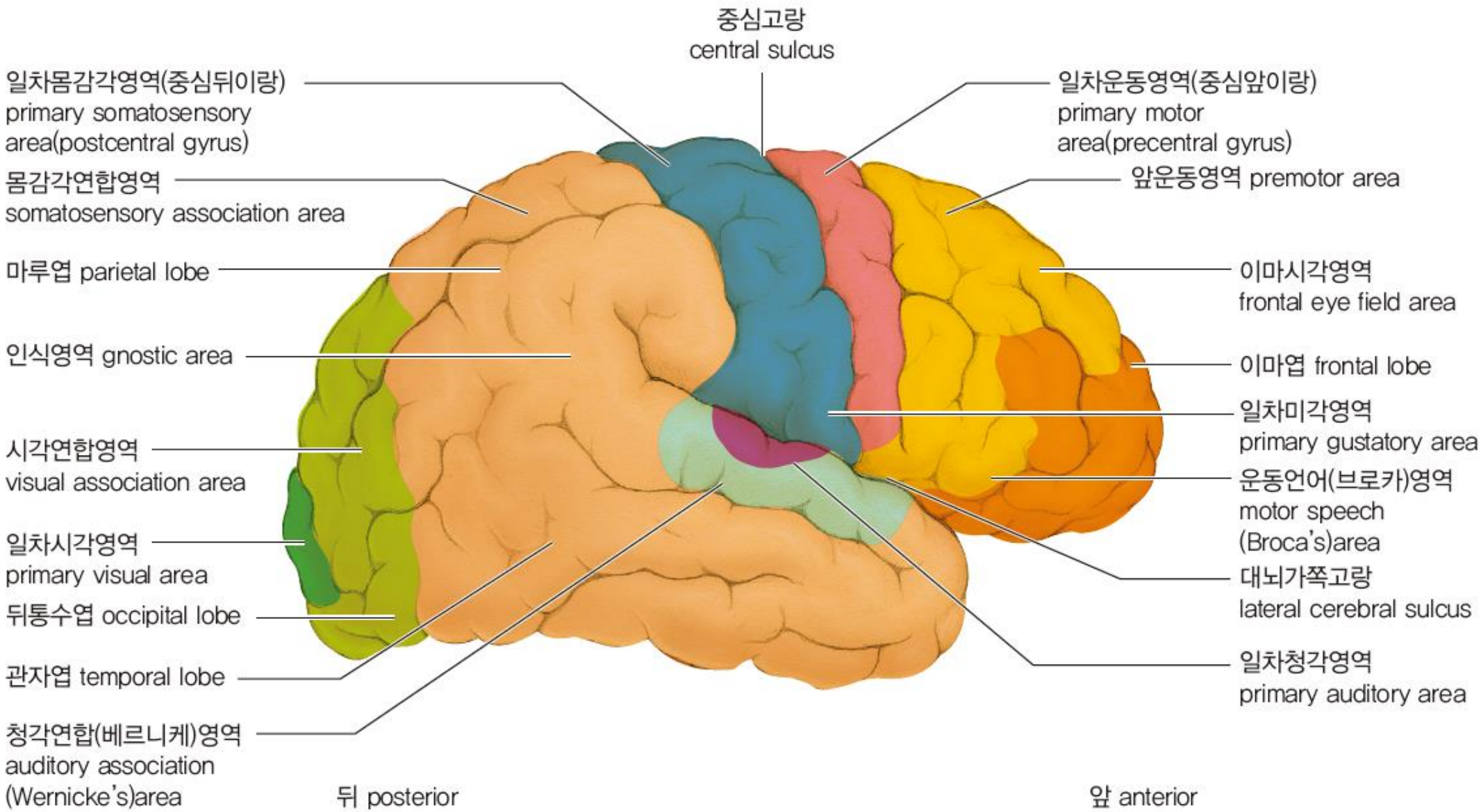
중추신경계 (CNS)	뇌(brain)	앞뇌 (prosencephalon)	끝뇌(telencephalon)	대뇌반구, 줄무늬체, 뒤뇌
			사이뇌(diencephalon)	시상, 시상상 · 하 · 후부
		중뇌 (mesecephalon)	중뇌(mesencephalon)	대뇌다리, 중덮개, 덮개
		마름뇌 (rhombencephalon)	뒤뇌(metencephalon)	소뇌(cerebellum)
				다리뇌(pons)
				숨뇌(medulla oblongata)
	척수(spinal cord)	척수(spinal cord)		
말초신경계 (PNS)	들쪽 뉴런	몸감각		
		내장감각		
	날쪽 뉴런	몸신경계(수의적)		골격근
		자율신경계 (불수의적)	교감신경	심근, 평활근, 선
			부교감신경(미주신경)	심근, 평활근, 선


중심고랑
central sulcus
중심앞이랑
precentral gyrus
중심뒤이랑 postcentral gyrus
마루엽 parietal lobe
이마엽
frontal lobe
마루뒤통수고랑
parieto–occipital sulcus
가쪽틈새
lateral fissure
관자엽
temporal lobe
뒤통수엽
occipital lobe
소뇌
cerebellum
가로틈새
transverse fissure


셋째뇌실 third ventricle
투명사이막 septum pellucidum
시상사이다리(시상의 중간덩어리)
interthalamic adhesion
(intermediate mass of thalamus)
이마엽 frontal lobe of
cerebral hemisphere
뇌실사이구멍(Monro구멍)
interventricular foramen
(foramen of monro)
앞맞교차
anterior commissure
시상하부 hypothalamus
시각신경교차 optic chiasma
뇌하수체
hypophysis(pituitary gland)
관자엽 temporal lobe
유두체 mammillary body
다리뇌 pons
숨뇌 medulla oblongata
대뇌반구 마루엽 parietal lobe
뇌들보 corpus callosum
뇌활 fornix
맥락얼기 choroid plexus
뒤통수엽 occipital lobe
시상(셋째뇌실과 접해 있음)
thalamus
솔방울샘(시상하부의 부분)
pineal body
네둔덕체
quadrigeminal bodies
중간뇌수도관
cerebral aqueduct
중간뇌
midbrain
소뇌나무 arbor vitae
넷째뇌실 fourth ventricle
맥락얼기 choroid plexus
소뇌 cerebellum
척수 spinal cord


연합섬유
맞교차섬유(교련섬유)
전맞교차
후맞교차
A
위
superior
대뇌종말
회백질 gray matter
백질 white matter
측뇌실
대뇌방사관
맞교차섬유
(교련섬유)
뇌궁
제3뇌실
기저핵
내포
시상
투사섬유
뇌교 pons
숨뇌
추체교차
B


중심고랑
central sulcus
일차운동영역(중심앞이랑)
일차몸감각영역(중심뒤이랑)
primary somatosensory area(postcental gyrus)
앞운동영역 premoter cortex
몸감각연합영역
somatosensory association area
이마시각영역 frontal eye field
미각영역
gustatory cortex
미각
taste
이마엽 frontal lobe
마루엽
parietal lobe
앞이마영역(인지영역)
gnostic area
뒤통수엽 occipital lobe
운동언어(브로카)영역
Broca's area
시각연합영역
시각
vision
가쪽고랑
lateral sulcus
일차청각영역
베르니케영역
Wernike's area
청각연합영역
auditory association area
청각
hearing
관자엽
temporal lobe
일차청각영역
primary auditory area


중심고랑
central sulcus
일차몸감각영역(중심뒤이랑)
primary somatosensory
area(postcentral gyrus)
몸감각연합영역
somatosensory association area
마루엽 parietal lobe
인식영역 gnostic area
시각연합영역
visual association area
일차시각영역
primary visual area
뒤통수엽 occipital lobe
관자엽 temporal lobe
청각연합(베르니케)영역
auditory association
(Wernicke's)area
일차운동영역(중심앞이랑)
primary motor
area(precentral gyrus)
앞운동영역 premotor area
이마시각영역
frontal eye field area
이마엽 frontal lobe
일차미각영역
primary gustatory area
운동언어(브로카)영역
motor speech
(Broca's)area
대뇌가쪽고랑
lateral cerebral sulcus
일차청각영역
primary auditory area
뒤 posterior
앞 anterior

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).

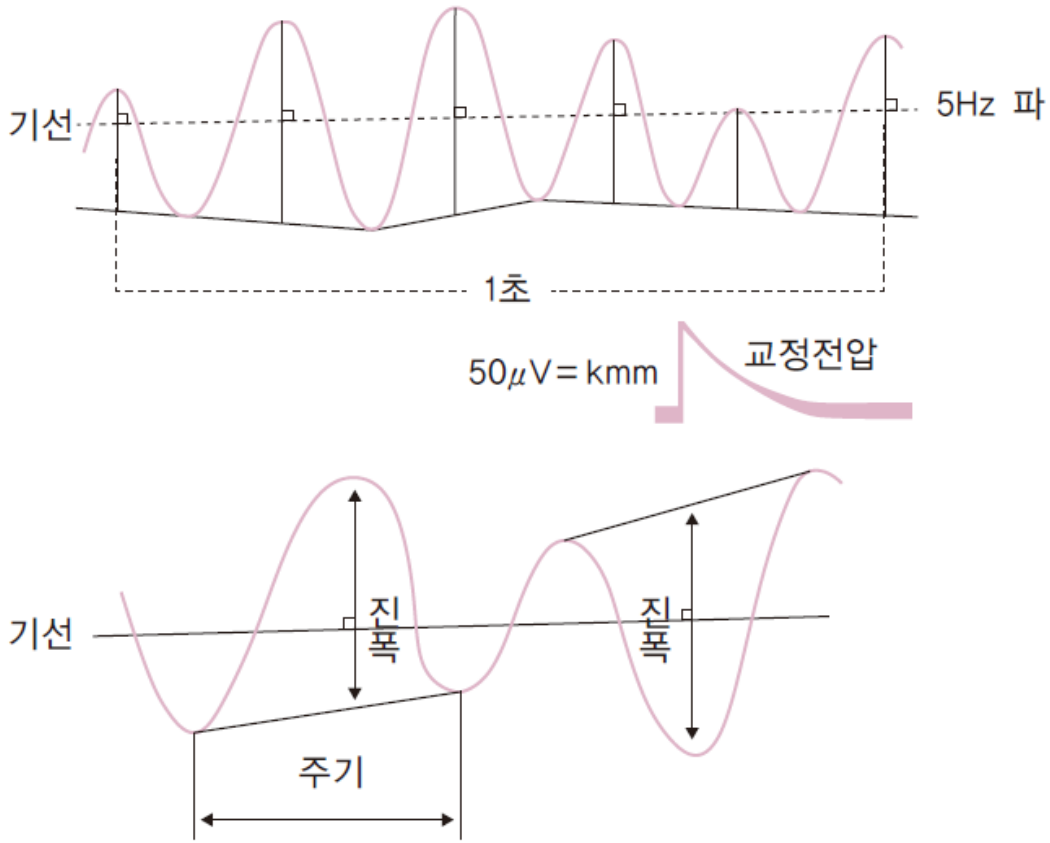
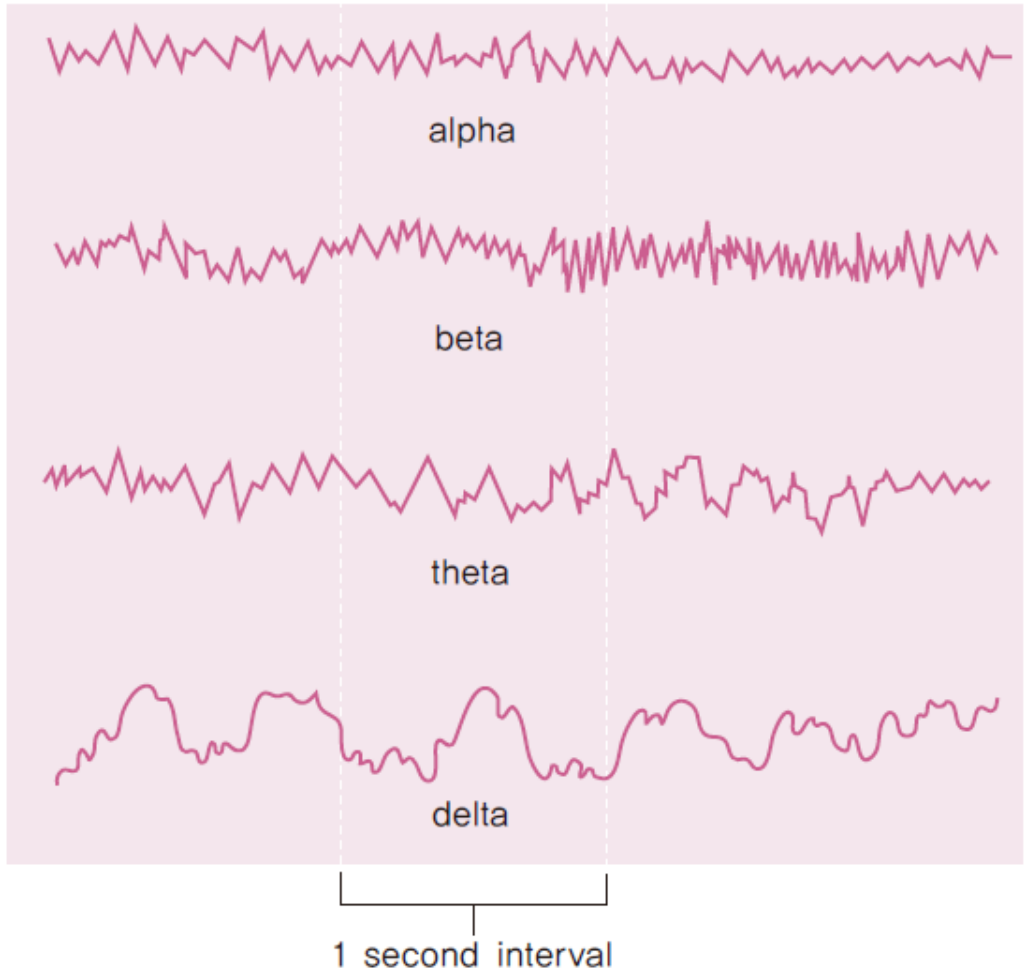

기선
5Hz 파
1초
50μV = kmm
교정전압
기선
진폭
진폭
주기

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

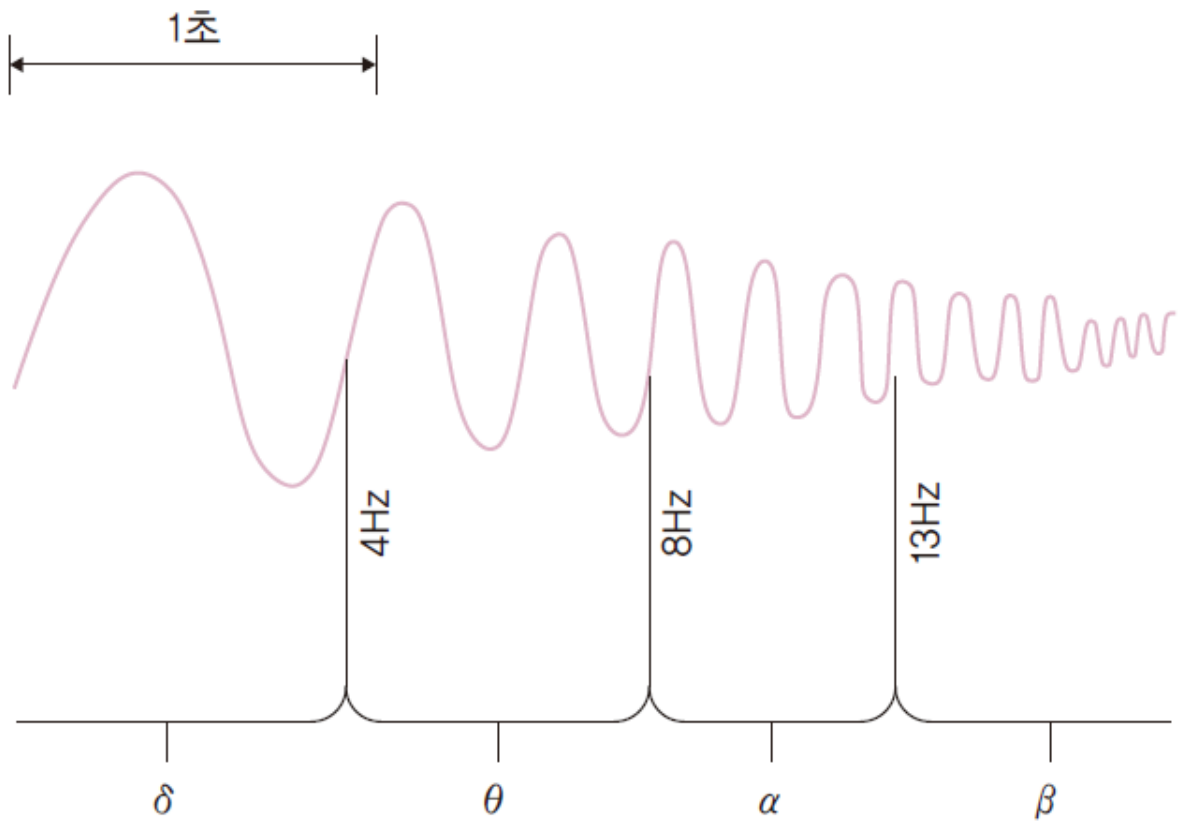
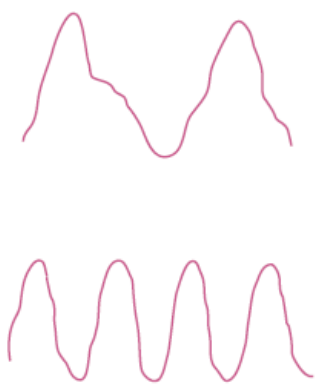
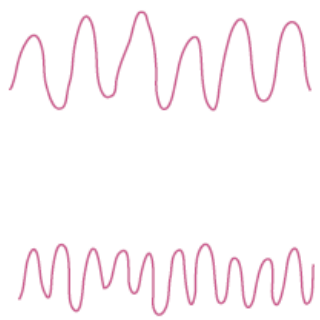
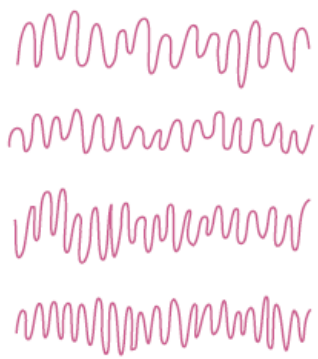
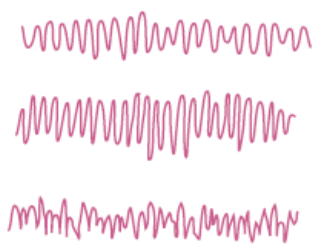
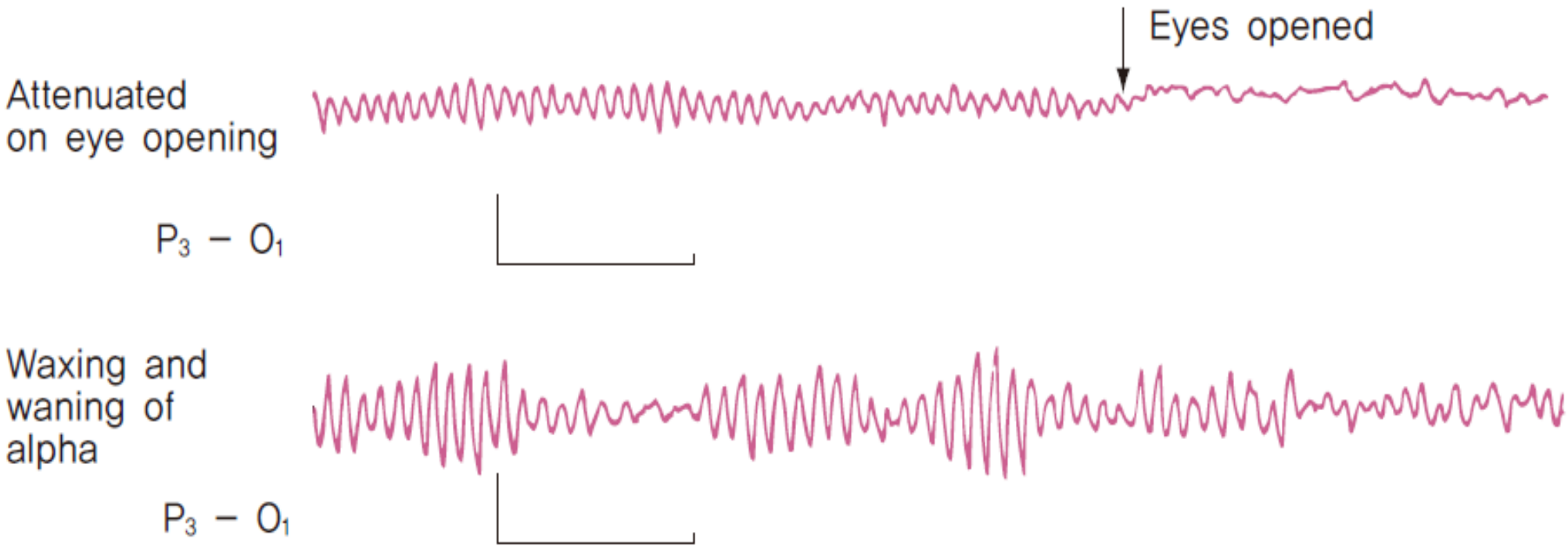
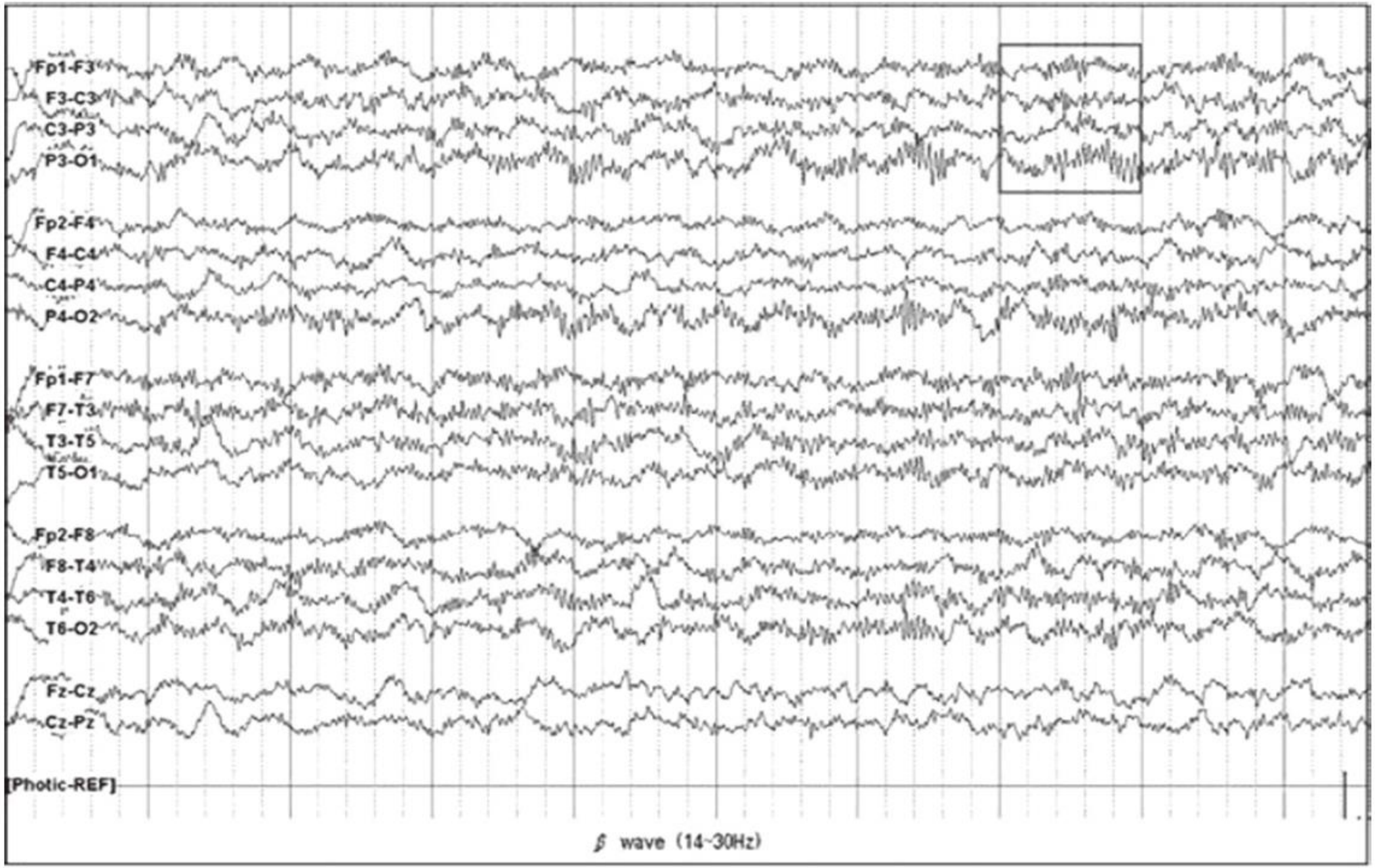

1초
4Hz
8Hz
13Hz
δ
θ
α
β

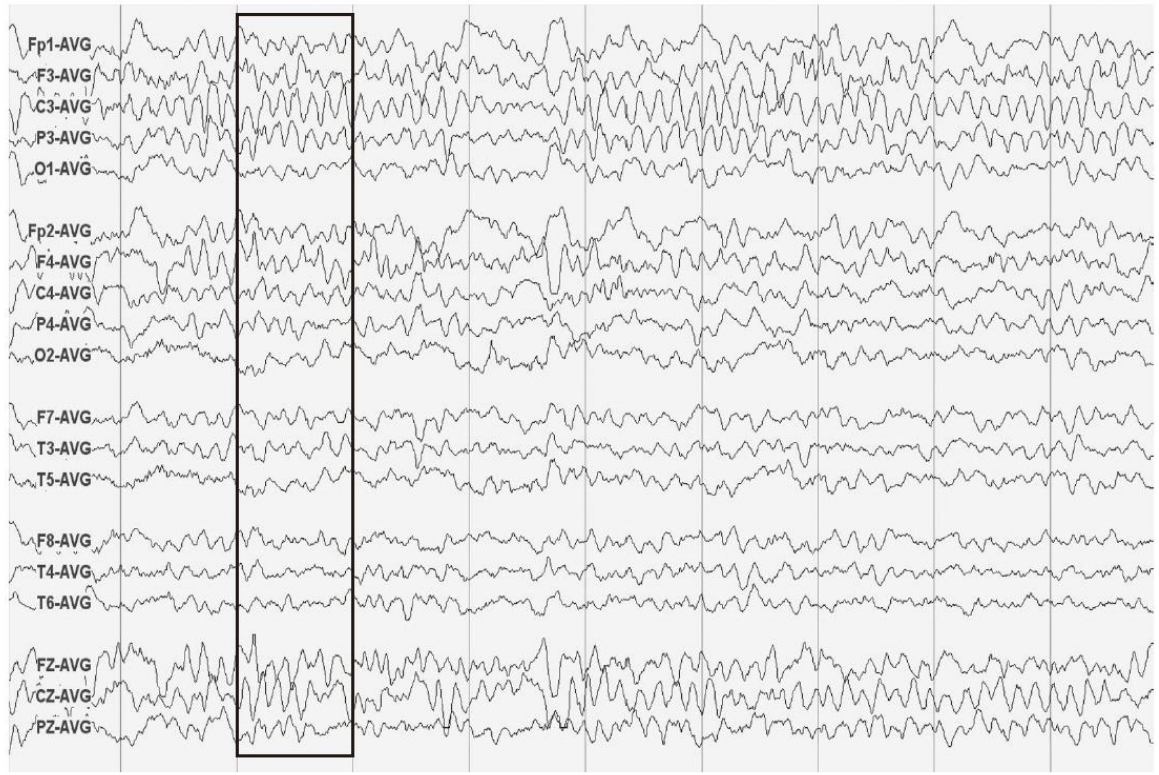
표 2-2. 뇌파의 특징

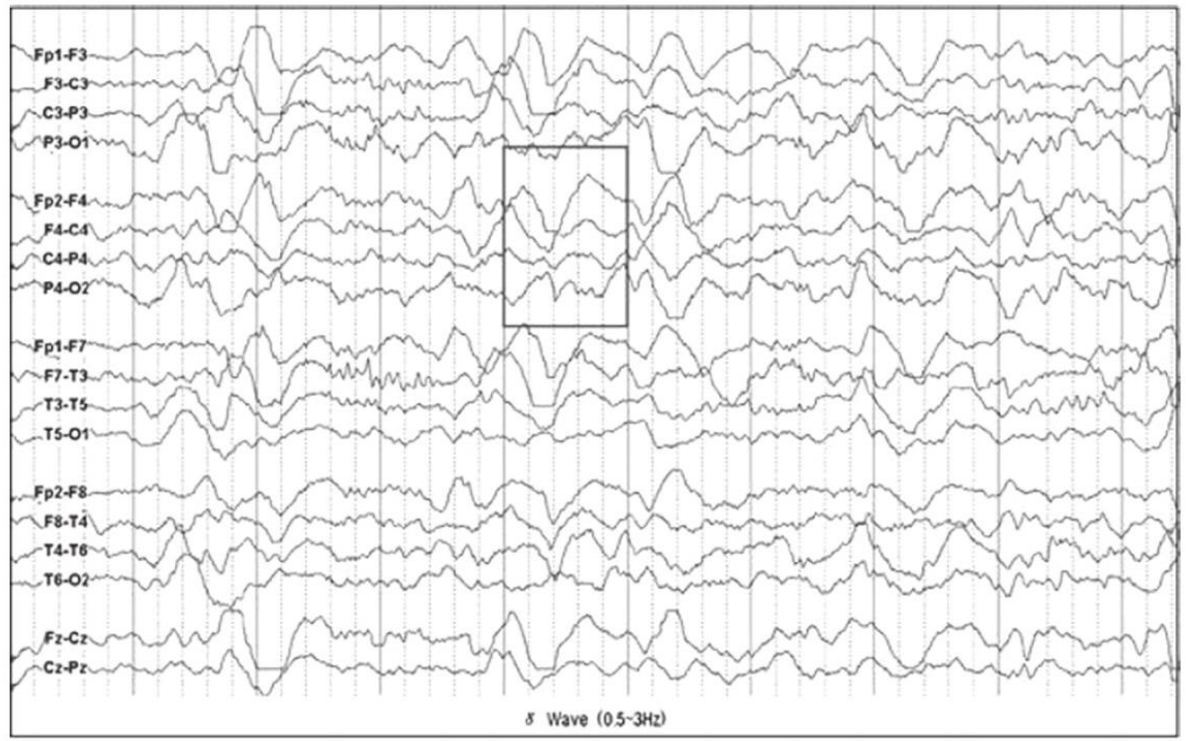
리듬	δ(delta)	θ(theta)	α(alpha)	β(beta)
주파수(frequency)	0.5~3 Hz	4~7 Hz	8~13 Hz	14~30 Hz
진폭(amplitude)	100 μV	아동 : 50 μV 성인 : 10 μV	유아 : 20 μV 아동 : 70 μV 성인 : 50 μV	10~20 μV
출현부위 (appearance location)	이마부	관자부	뒤통수부, 마루부	이마부
출현 상황 (appearnce condition)	깊은 수면(성인)	졸음이 오는 상황	안정, 눈감기	안정, 눈뜨기
파형(wave)				

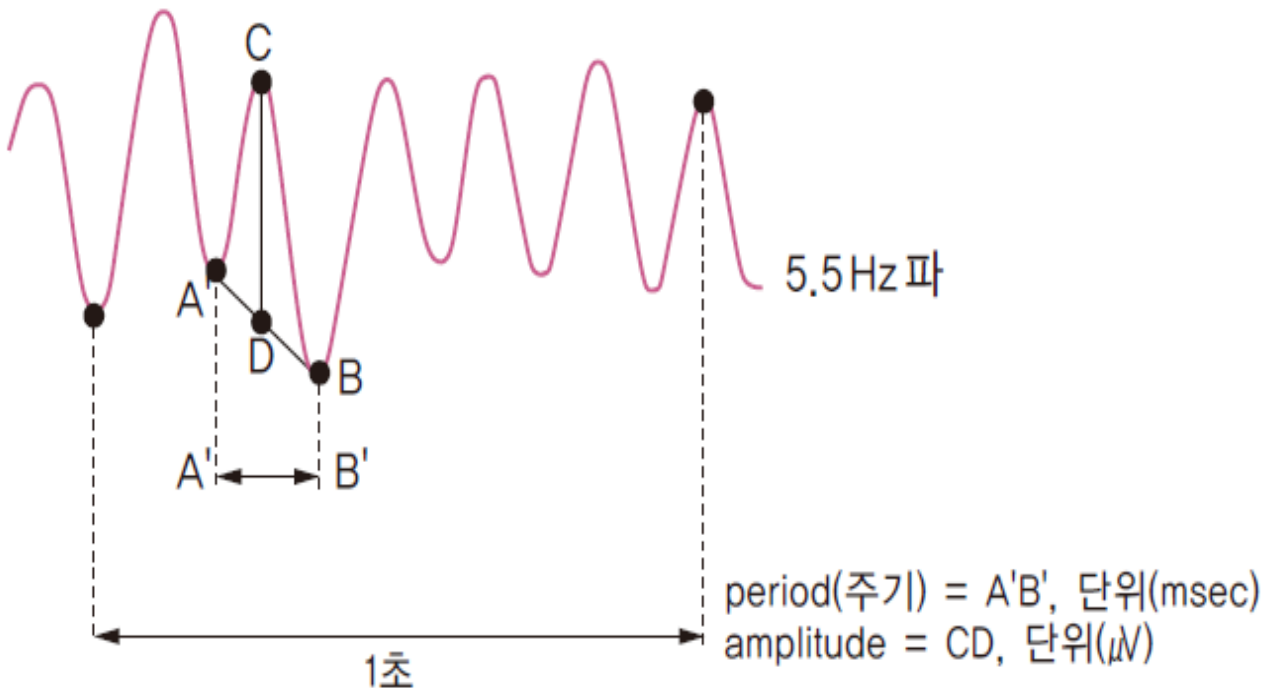

Eyes opened
Attenuated on eye opening
P3 – O1
Waxing and waning of alpha
P3 – O1

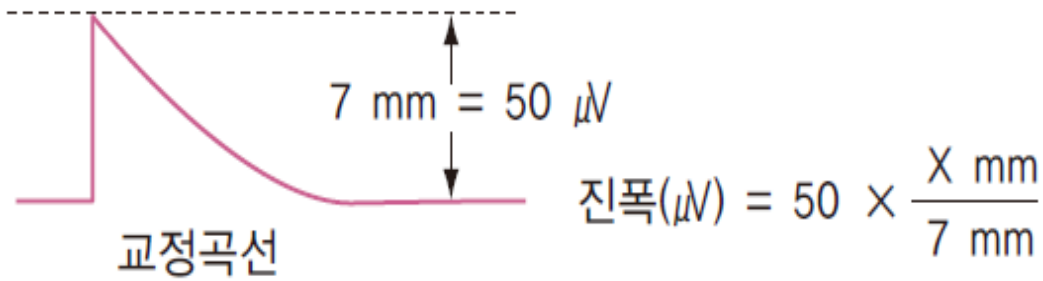

Start Recording
New Montage - Montage 001
Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
P4-O2
Fp1-F7
F7-T3
T3-T5
T5-O1
Fp2-F8
F8-T4
T4-T6
T6-O2
Fz-Cz
Cz-Pz
α wave (8~13Hz)


Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
P4-O2
Fp1-F7
F7-T3
T3-T5
T5-O1
Fp2-F8
F8-T4
T4-T6
T6-O2
Fz-Cz
Cz-Pz
[Photic-REF]
β wave (14~30Hz)

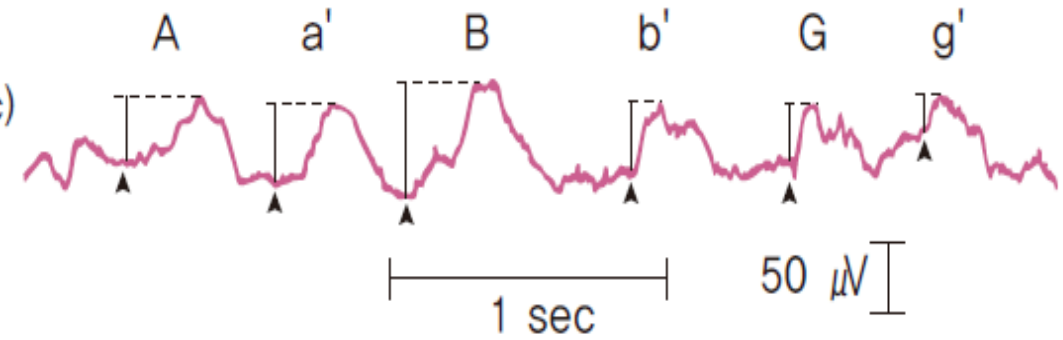

Fp1-AVG
F3-AVG
C3-AVG
P3-AVG
O1-AVG
Fp2-AVG
F4-AVG
C4-AVG
P4-AVG
O2-AVG
F7-AVG
T3-AVG
T5-AVG
F8-AVG
T4-AVG
T6-AVG
FZ-AVG
CZ-AVG
PZ-AVG


Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
P4-O2
Fp1-F7
F7-T3
T3-T5
T5-O1
Fp2-F8
F8-T4
T4-T6
T6-O2
Fz-Cz
Cz-Pz
δ Wave (0.5~3Hz)


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

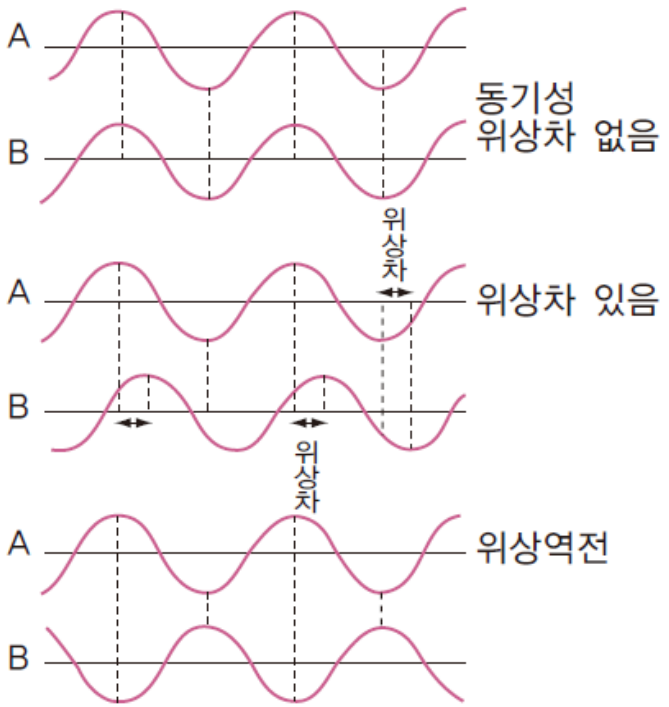

A
a'
B
b'
G
g'
1 sec
50 μV

B

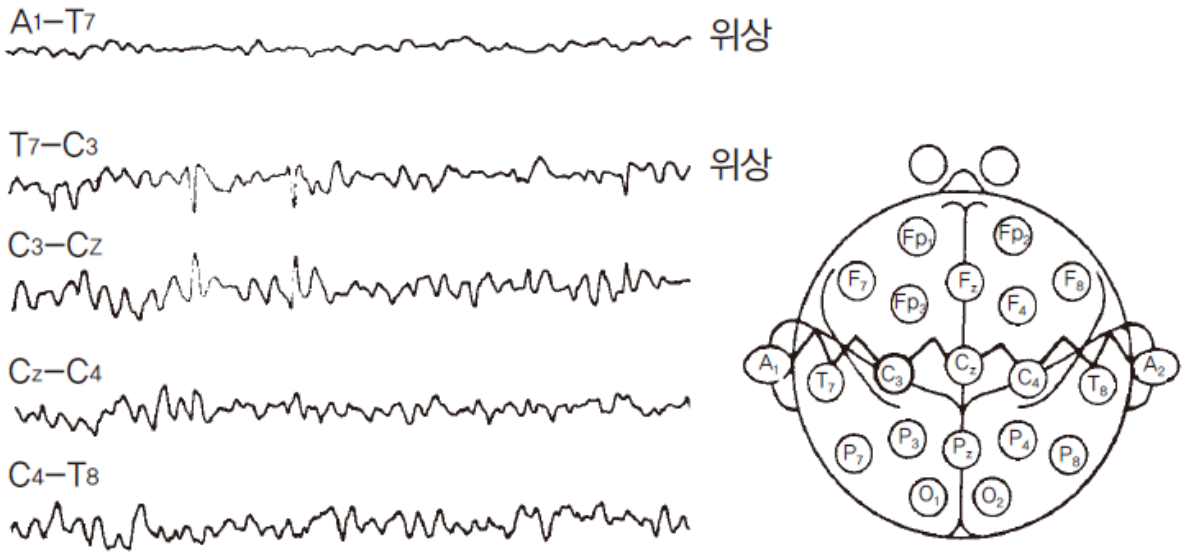


단상성파 (음성) 단상성파 (양성) 2상성파(양성–음성) 3상성파(양성–음성–양성) 다상성파

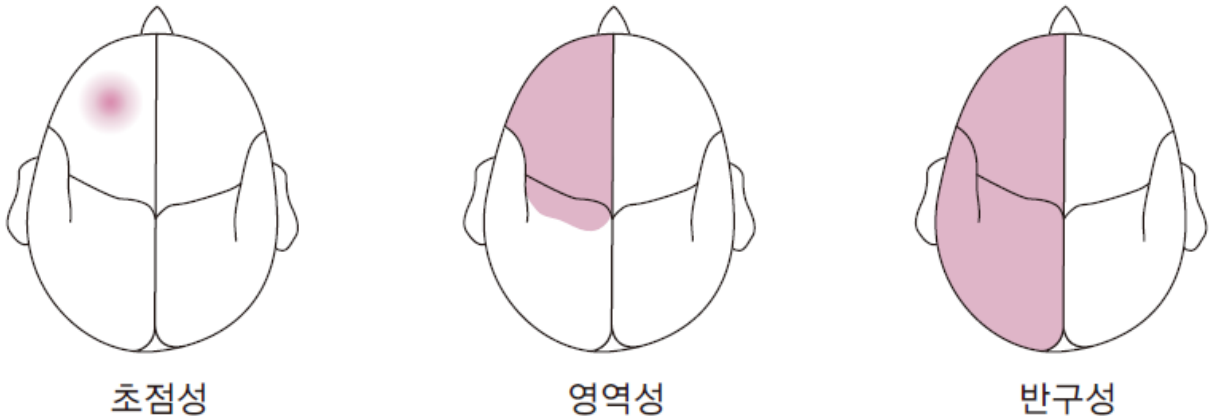
A. 파의 위치적 관계에 따른 위상의 분류



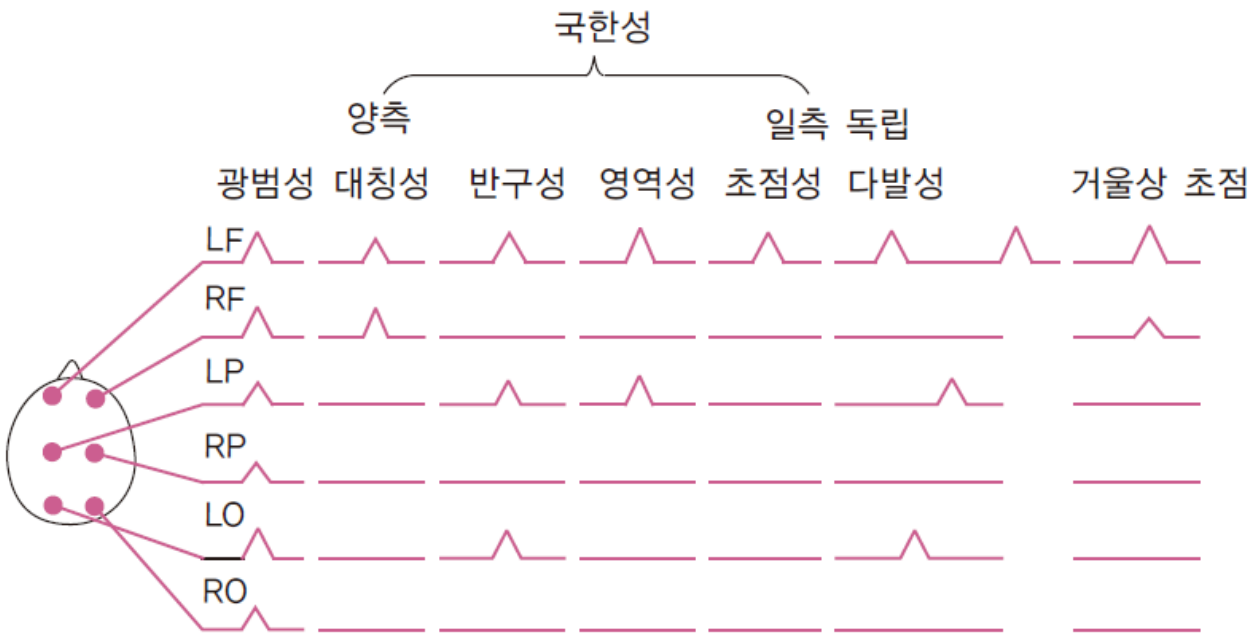
B. 여러가지 위상



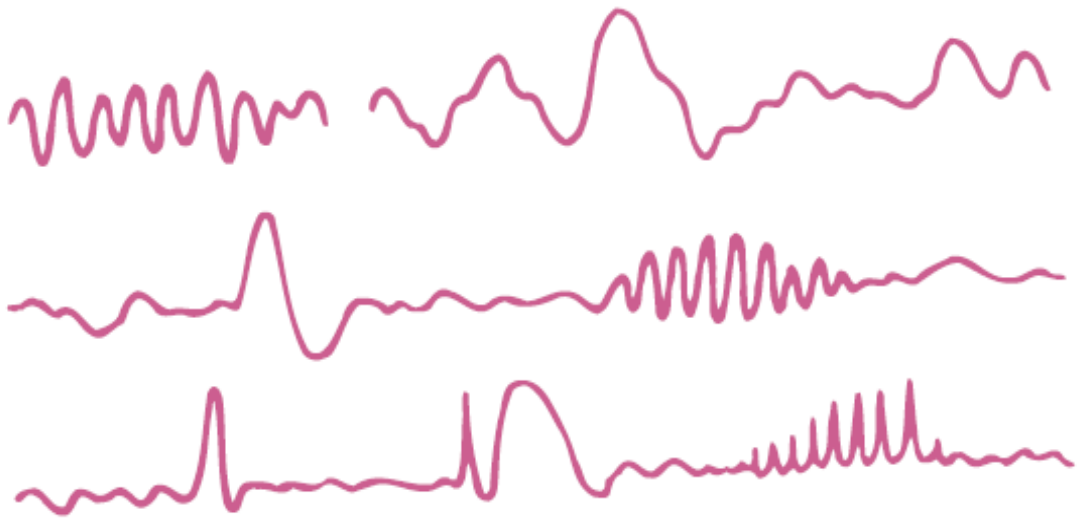
C. 위상역전에 의한 이상초점 확인(초점은 C_3에 있다)



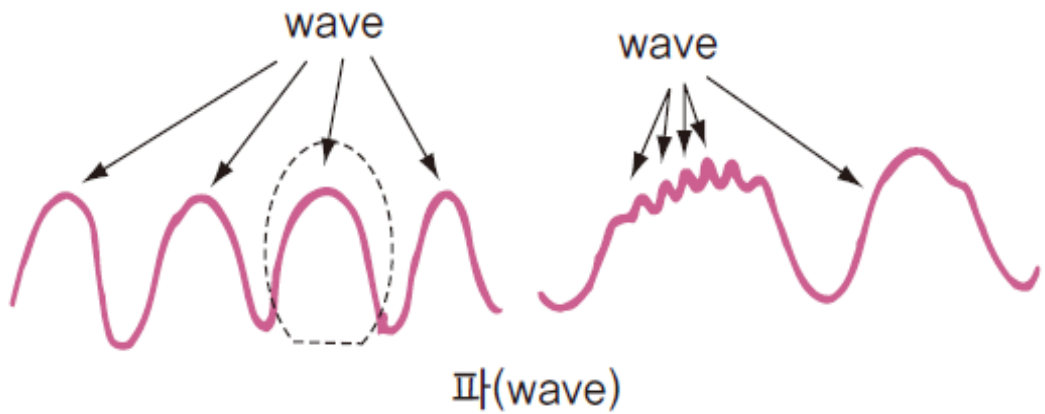
A. 일측성 국재의 종류 및 확산에 의한 용어



B. 이상뇌파 국재의 종류를 표시한 모식도



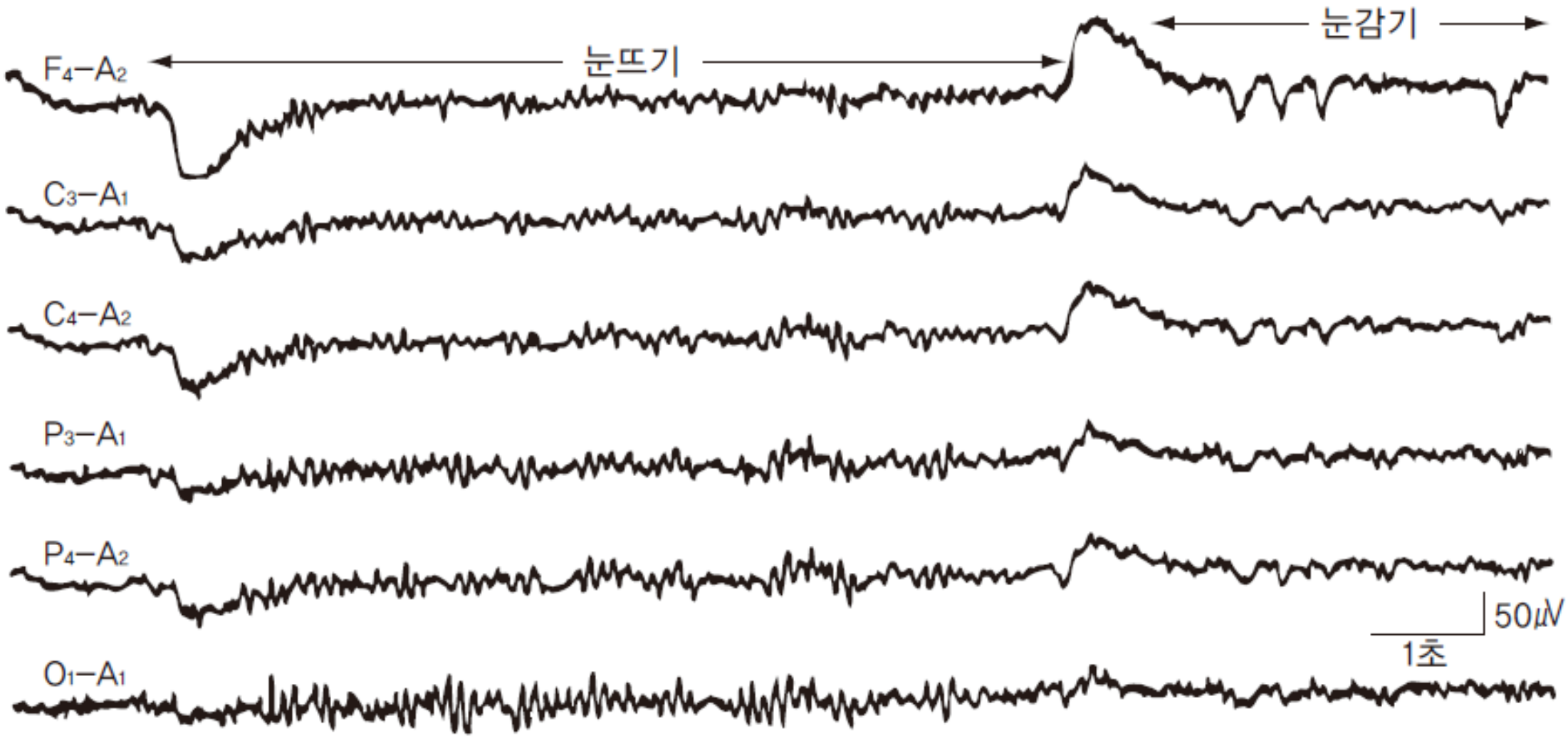
활동(activity)



파(wave)



율동(rhythm)


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

Section 03

뇌파검사실

학습 목표

1. 뇌파검사의 흐름을 이해할 수 있다(A).
2. 뇌파검사 전 준비사항에 대하여 설명할 수 있다(B).
3. 뇌파검사와 관련된 용어를 설명할 수 있다(A).
4. 뇌파검사 결과보고서를 작성할 수 있다(B).





뇌파계 부속품

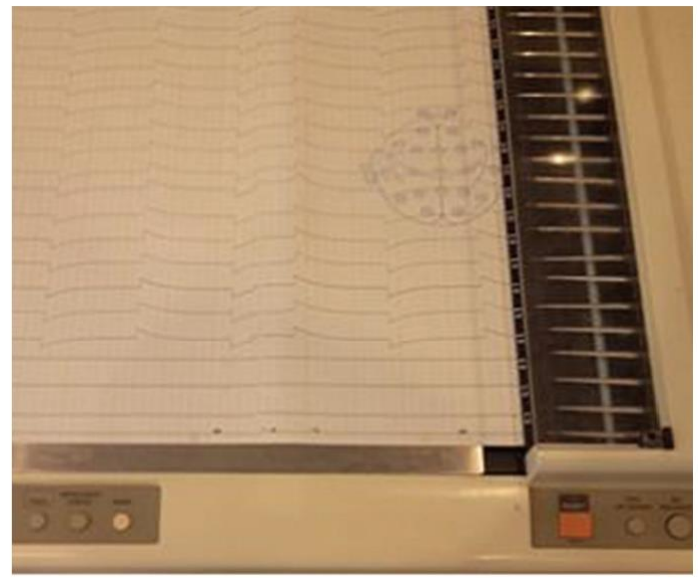


디지털 뇌파계

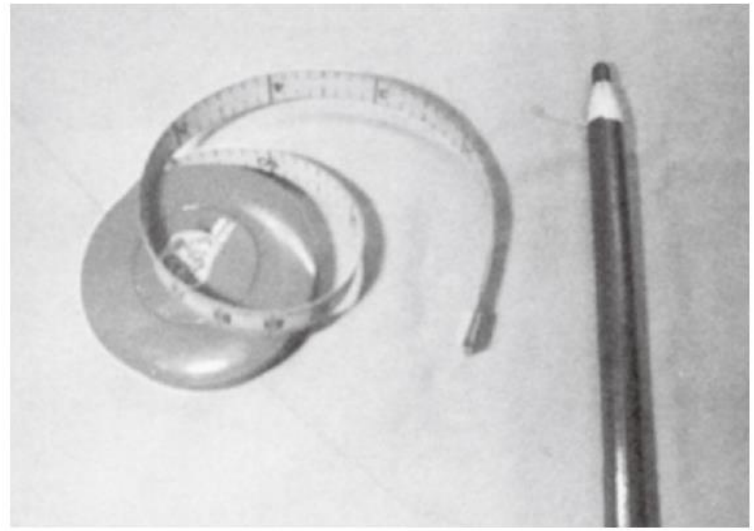


전극접속상자(electrode junction box)

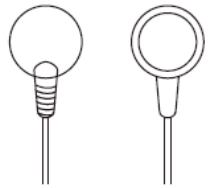

SYNAFIT 1000



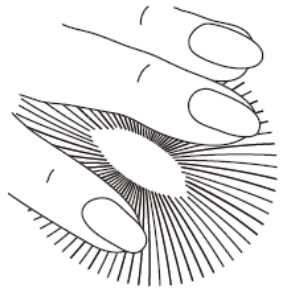

Biotach



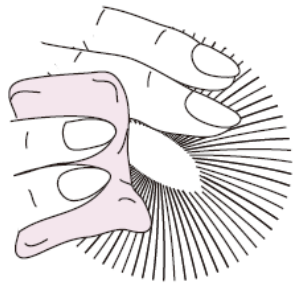
A. 준비단계



은평판 전극



머리카락을 나누어
두피가 나오게 한다

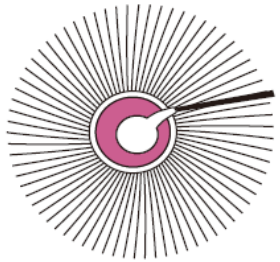


알코올 솜으로
깨끗이 닦는다

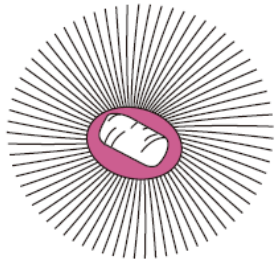
B. 전극부착(단시간용)



전극풀을 충분히
바른다

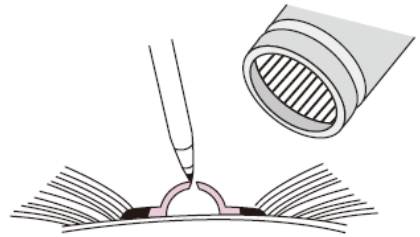


전극을 압착한다

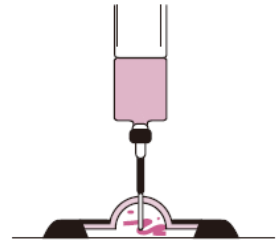


거즈 등으로 덮는다

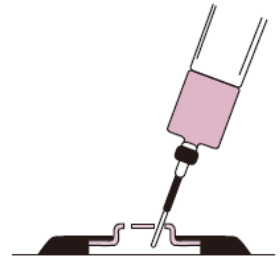
C. 전극부착(장시간용)



전극의 주위에 콜로디온을
도포하고 볼펜 등으로 전극을
고정하여 드라이어로 건조시킨다



전극내에 gel을 주입한다
(stick on disc 전극)



전극내에 gel을 주입한다
(콜로디온 전극)

표 3-1. 뇌파의 이상 정도에 따른 분류(Saunders GH et al., 1965)

EEG abnormality	Examples of abnormal fin dings	Clinical pathology
1. Borderline abnormal	• Alpha asymmetry in voltage only • Prolonged overbreathing response	No known clinical significa-nce
2. Slightly abnormal	• Diffuse theta activity • Low amplitude sharp • Waves, spikes or localized delta pattern	Probably and organic cause, but possibly secondary to some other disorders not necessarily neurological process
3. Undoubtedly abnormal	• Spike discharges, comple xes appearing repeatedly • Local delta, theta, fast activity often with concomitant alpha changes	Mostly neurological or neuro surgical diseases
4. Definitely and severely abnormal	• High amplitude local arrhythmic delta activity • Continous spike or complex dis-charges	Severe cerebaral pathology
5. Extremely abnormal	• Hypsarrhythmia • Electrocerebral silence	Very poor prognosis

신경과 뇌파 보고서

성명	병록번호	병동	성별	나이
주치의	전공의	검사일시		EEG No.

Brief medical history :

Activity	Freq.	Volt.*	Distribution	Special Comments
			Awake (Appropriately %)	
Post. Background				
Beta				
			Sleep (Appropriately %)	
Slow				
Vertex Sharp				
Spindle				
POSTs.				
			Photic simulation	
			Hyperventilation	

* L=low(<20uV), M=medium(20-70uV), H=high(70-150uV)

Classification :

Impression :

신경과

신경과 뇌파 보고서

성명 병록번호 병동 GS 성별 M 나이 41
주치의 전공의 검사일시 2005/01/17 EEG No. 05-84

Brief medical history :

Activity	Freq.	Volt.*	Distribution	Special Comments
			Awake (Appropriately %)	
Post. Background	11Hz	M	Post.head regions, symmetric	Continuous, wax & wane, rhythmical, reduced by eye opening
Beta	15-30Hz	L	Fronto-central, symmetric	Continuous, wax & wane rhythmical
			Sleep (Appropriately %)	
Slow	3-6Hz	M	Diffuse	
Vertex Sharp	180-220ms	M	Both frontocentral symmetric distribution	
Spindle	12-14Hz	M	Both frontocentral symmetric distribution	
POSTs.	80-120ms	M	Both occipital areas	

Photic simulation

No photic driving

Hyperventilation

No change

* L=low(<20uV), M=medium(20-70uV), H=high(70-150uV)

Classification : Normal (awake & sleep)

Impression : This EEG is normal
No epileptiform discharges were seen

신경과

신경생리 검사 예약서

성명 :　　연령 :　　성별 : M, F
검사일시 :　　월　　일 (오전 · 오후)　시　　분
검사항목 : ① 뇌파 검사(각성, 수면, 유발)
② 디지탈뇌파검사, 수면뇌파검사, 비디오뇌파 검사
③ 유발전위 검사
④ 신경 근전도 검사

검사 전 주의사항

1) 식사는 평소처럼 하시고 약도 평소와 같이 드십시오.
2) 머리를 감고 오시고 머리 기름은 바르지 마십시오.
(스프레이 포함 화장도 하지 마십시오)
3) 검사 후 머리를 감아야 함으로 수건을 준비 하십시오.
4) 수면뇌파 및 유발전위 검사를 받으실 분은 검사전날 가능한 늦게 주무시고 당일 아침 일찍 기상 하십시오.
5) 검사실시 10분 전까지 도착하여 주십시오.
(경우에 따라 시간이 지연될 수도 있습니다)
6) 목이 긴 폴라 티셔츠나 원피스의 복장을 피해 주십시오.
7) 검사를 연기 취소할 때에는 필히 1일 전에 연락 하십시오.
8) 모든 문의 사항은 ☎000－0000로 하여 주십시오.

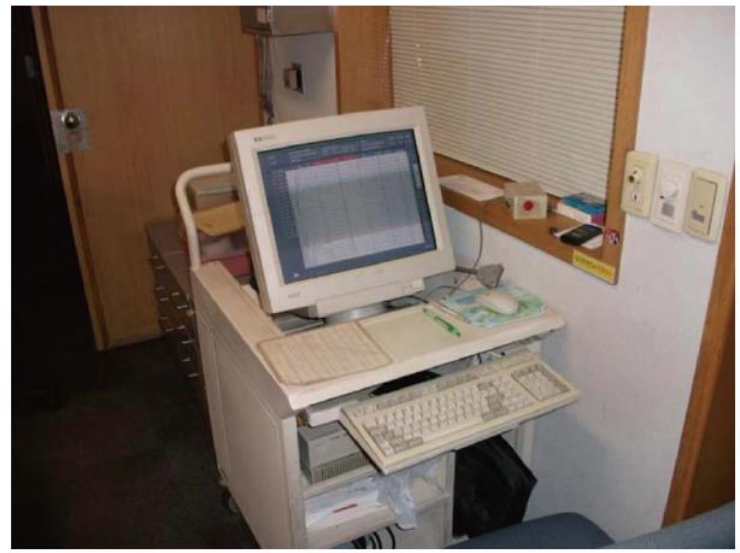
신경생리 검사실

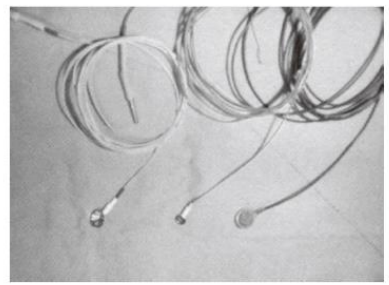
Section 04

뇌파검사

학습목표

1. 뇌파계의 구성을 이해할 수 있다(A).
2. 10–20 system의 전극배치법을 설명할 수 있다(A).
3. 뇌파의 유도법을 이해할 수 있다(A).
4. 몽타주를 설명할 수 있다(A).
5. 뇌파검사 시 주의사항을 설명할 수 있다(A).
6. 뇌파검사의 유발법을 실시하고, 특징을 설명할 수 있다(A).
7. 인공산물의 종류, 발생원인 및 해결방안을 이해할 수 있다(A).

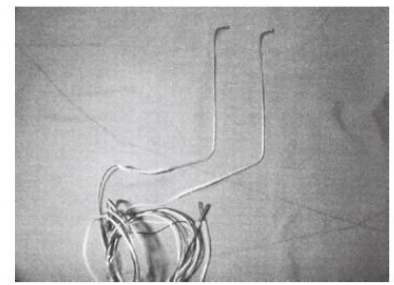




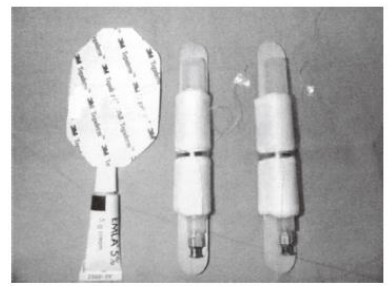
A. 평판전극
(plate electrode)



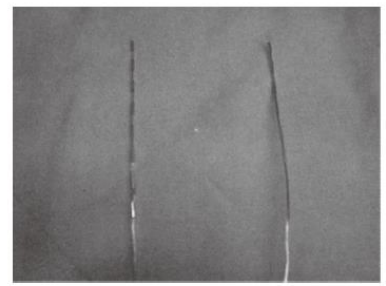
B. 침 전극
(needle electrode)



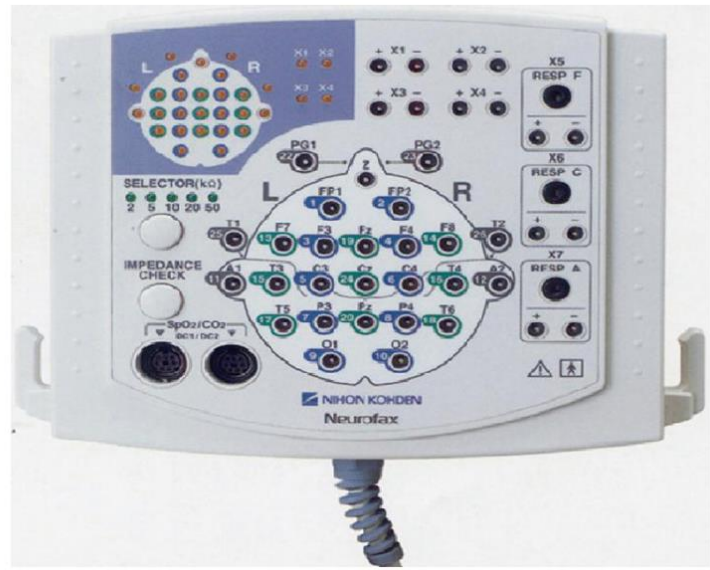
C. 코인두전극
(nasopharyngeal electrode)

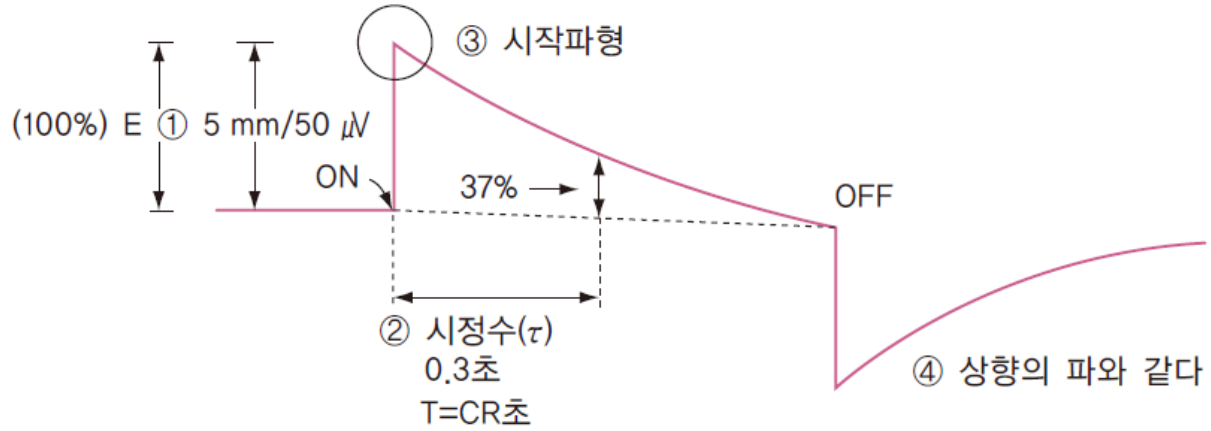


D. 나비뼈 전극
(sphenoidal electrode)

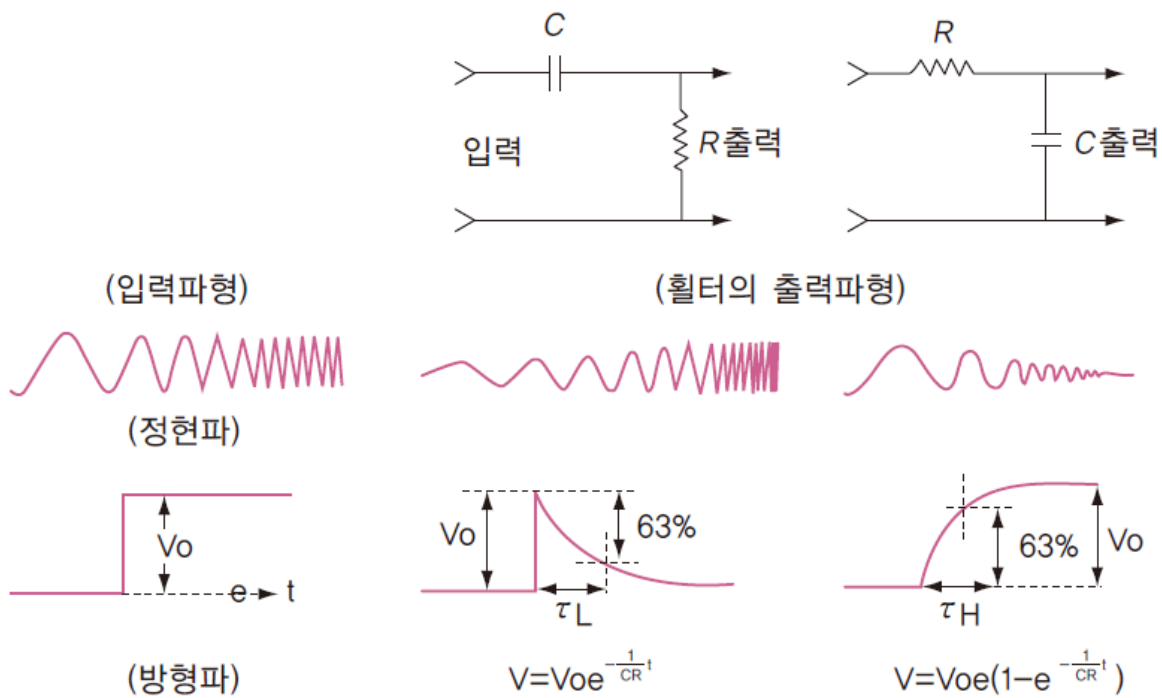


E. 심부전극
(deph electrode)

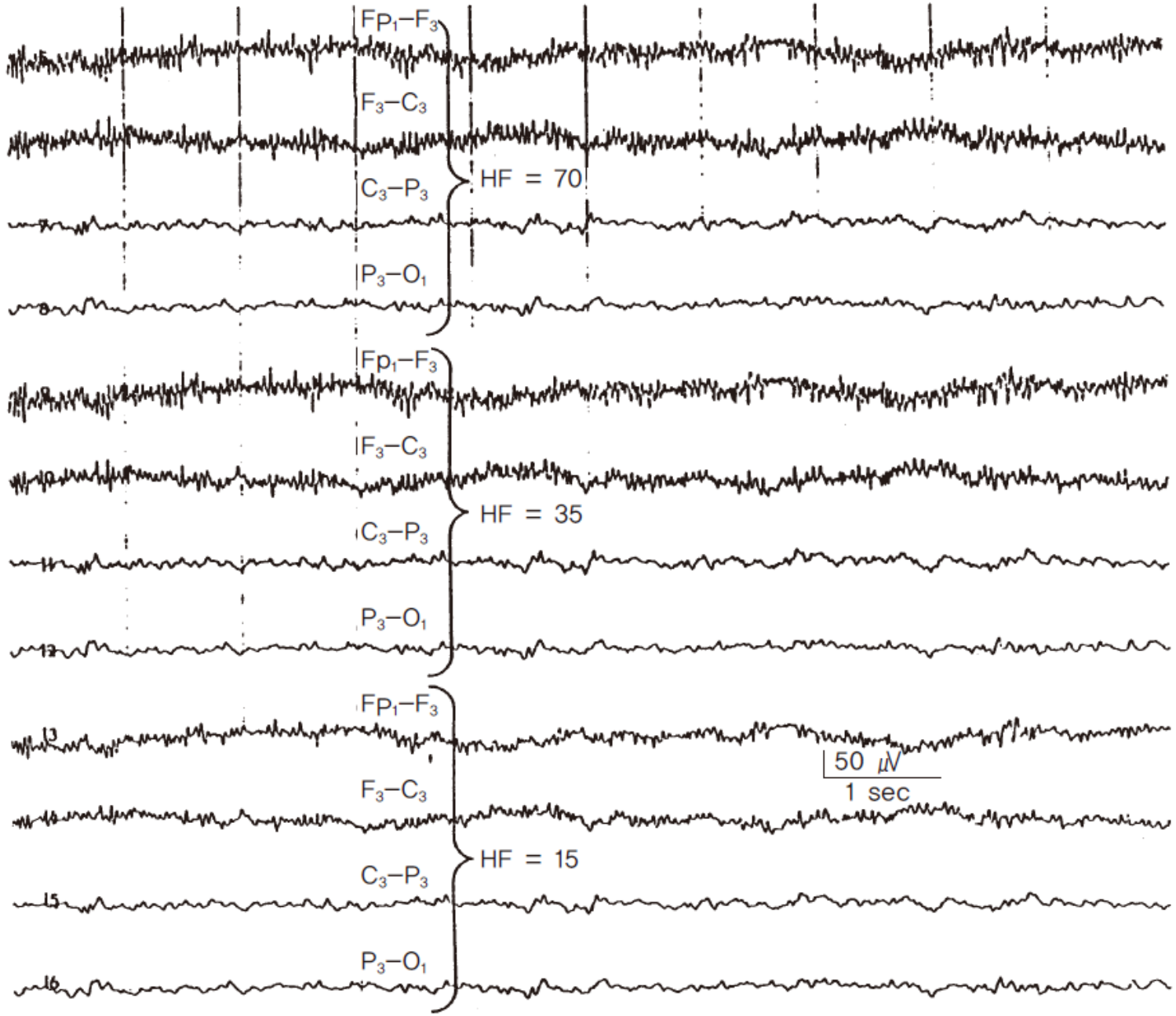

L
R
X1 X2
X3 X4
+ X1 −
+ X2 −
+ X3 −
+ X4 −
X5
RESP F
X6
RESP C
X7
RESP A
PG1
PG2
Z
SELECTOR(kΩ)
2 5 10 20 50
IMPEDANCE CHECK
SpO2/CO2
DC1 / DC2
FP1
FP2
F7
F3
Fz
F4
F8
T3
C3
Cz
C4
T4
T5
P3
Pz
P4
T6
O1
O2
NIHON KOHDEN
Neurofax

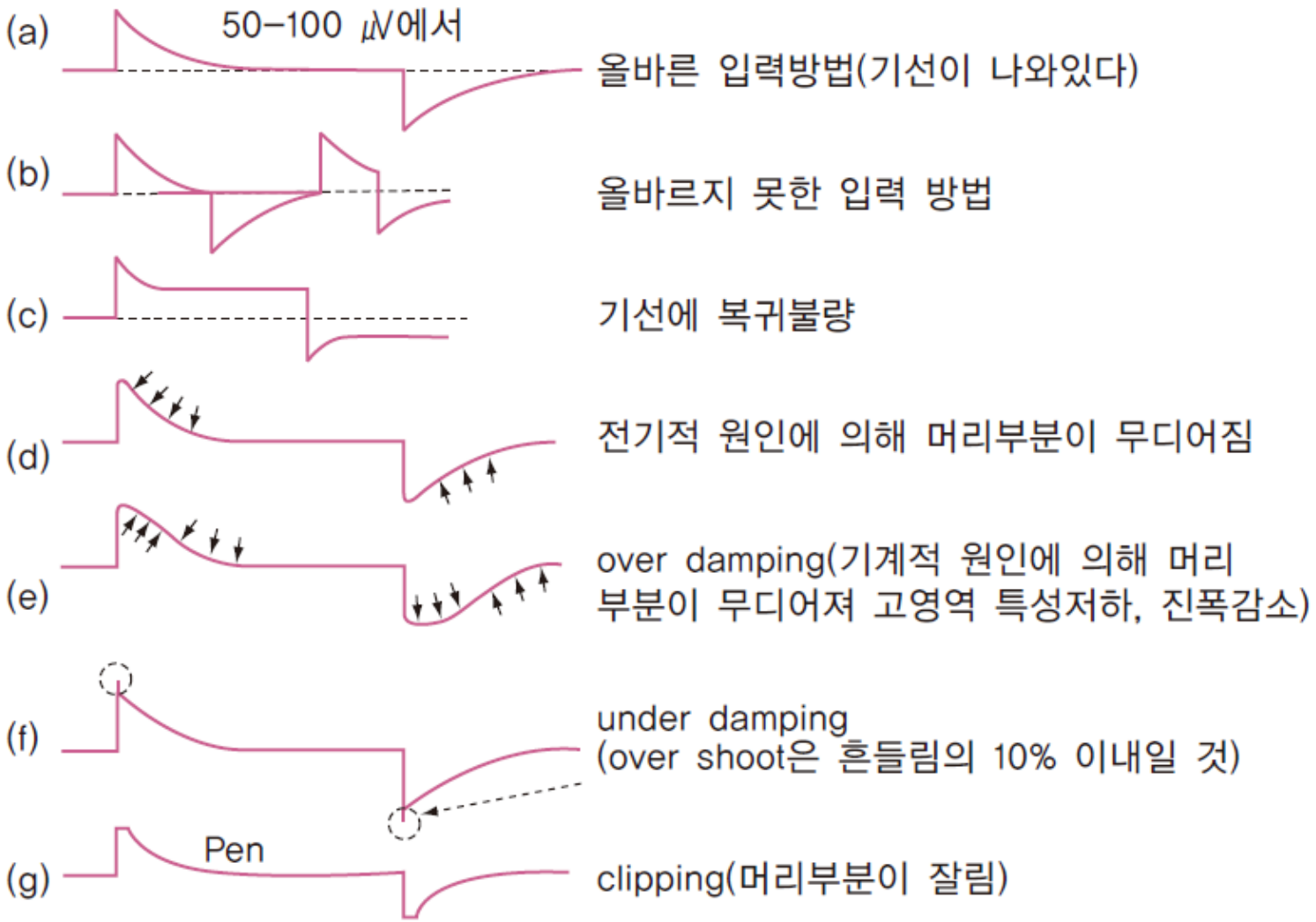


A. 교정파형

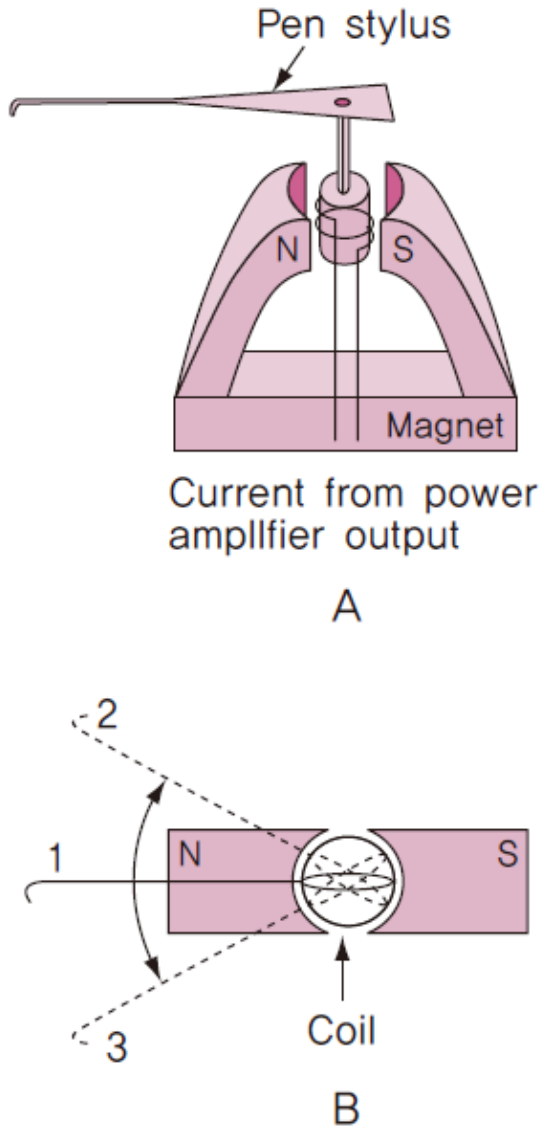


B. 시정수 회로와 그 입출력 파형의 변화


Fp_1–F_3
F_3–C_3
C_3–P_3
HF = 70
P_3–O_1
Fp_1–F_3
F_3–C_3
C_3–P_3
HF = 35
P_3–O_1
Fp_1–F_3
F_3–C_3
C_3–P_3
HF = 15
P_3–O_1
50 μV
1 sec



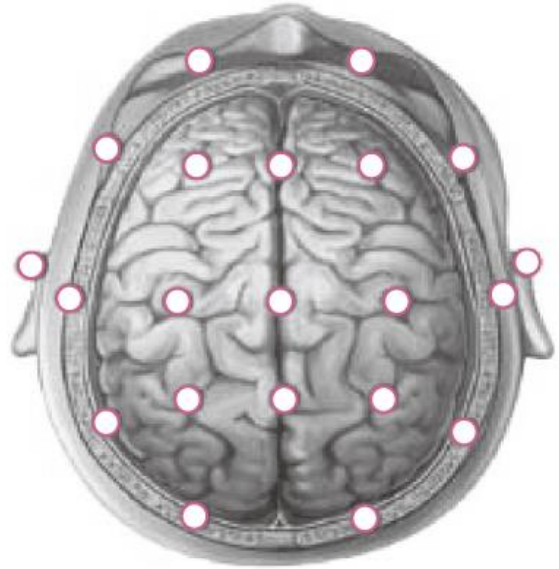
A. 기록부 상태확인을 위한 교정전압 파형의 비교

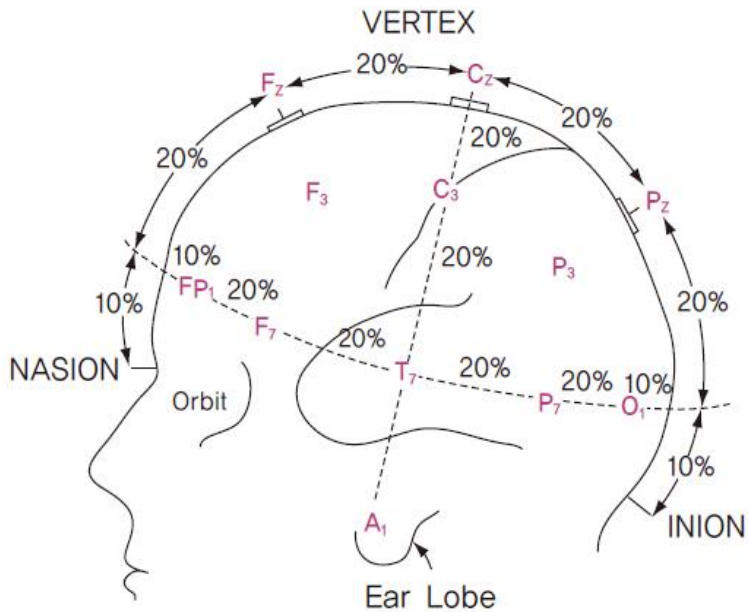


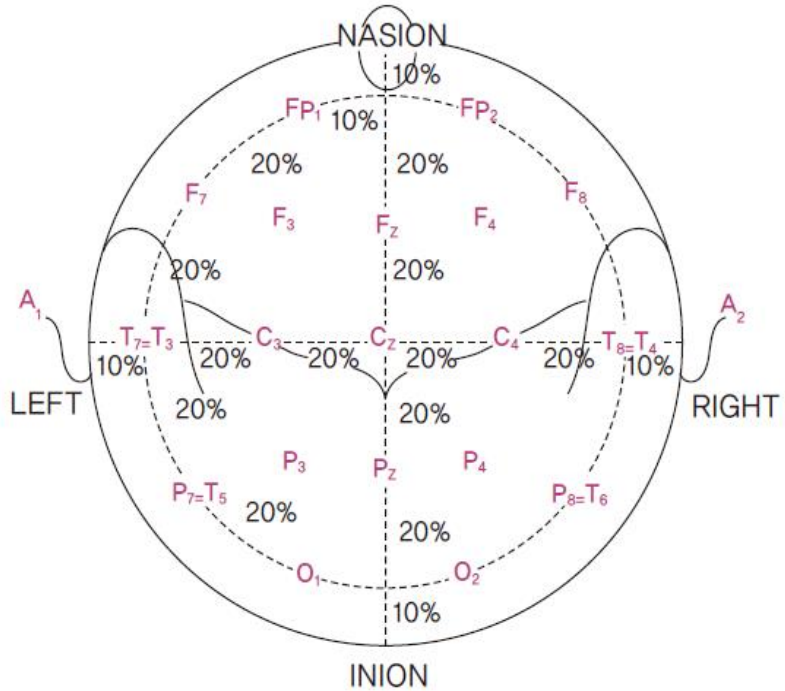
B. 기록 펜 A: 측면 B: 상면








VERTEX
NASION
INION
LEFT
RIGHT
Orbit
Ear Lobe
F_Z
C_Z
P_Z
F_3
C_3
P_3
FP_1
F_7
T_7
P_7
O_1
A_1
20%
10%


NASION
INION
LEFT
RIGHT
FP_1
FP_2
F_7
F_3
F_Z
F_4
F_8
A_1
A_2
T_7=T_3
C_3
C_Z
C_4
T_8=T_4
P_3
P_Z
P_4
P_7=T_5
P_8=T_6
O_1
O_2
10%
20%



코뿌리점(nasion)의 위치



귓바퀴앞(pre auricular)



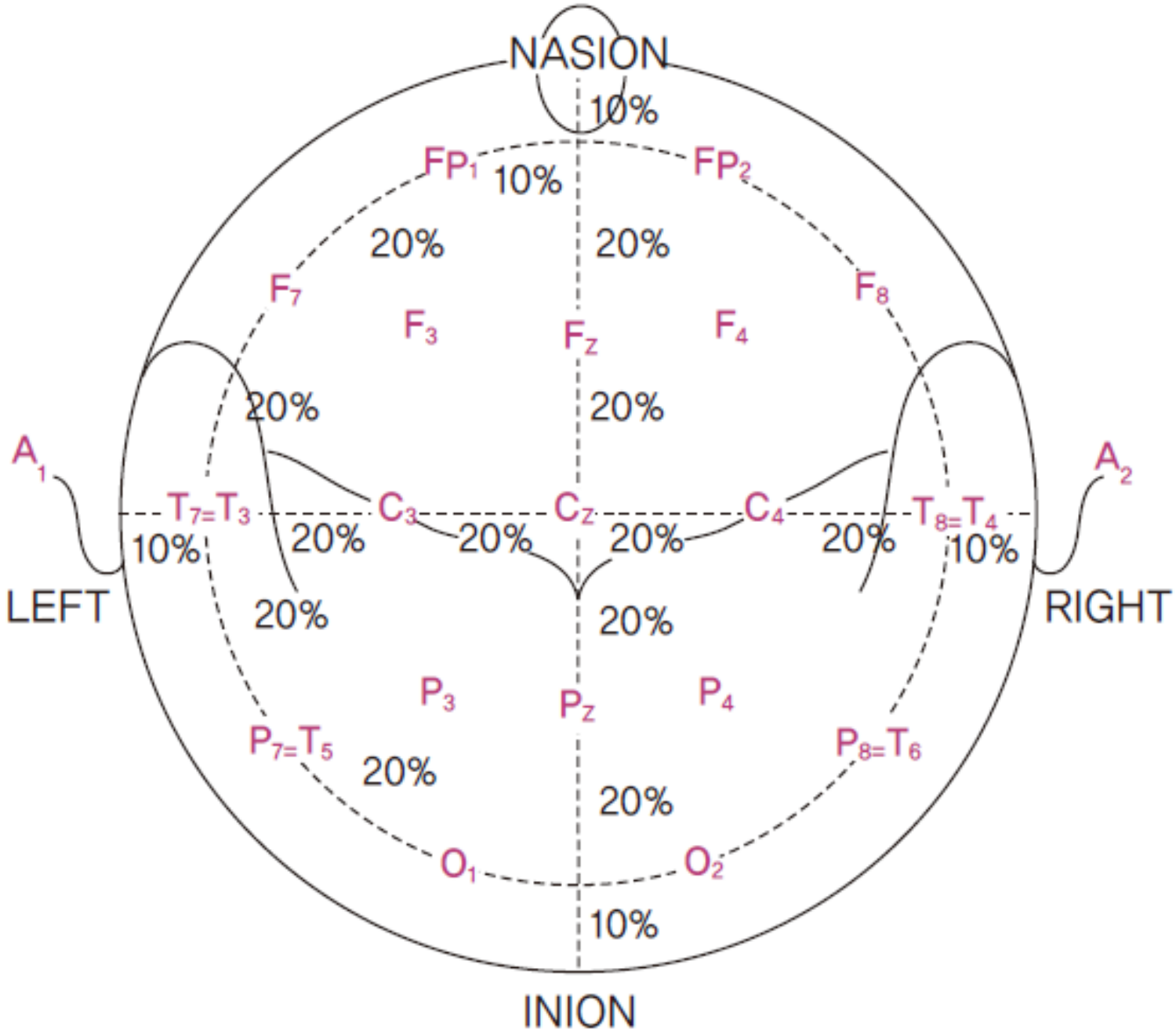
뒤통수점(inion)

표 4-1. 10–20법의 전극명과 부위명

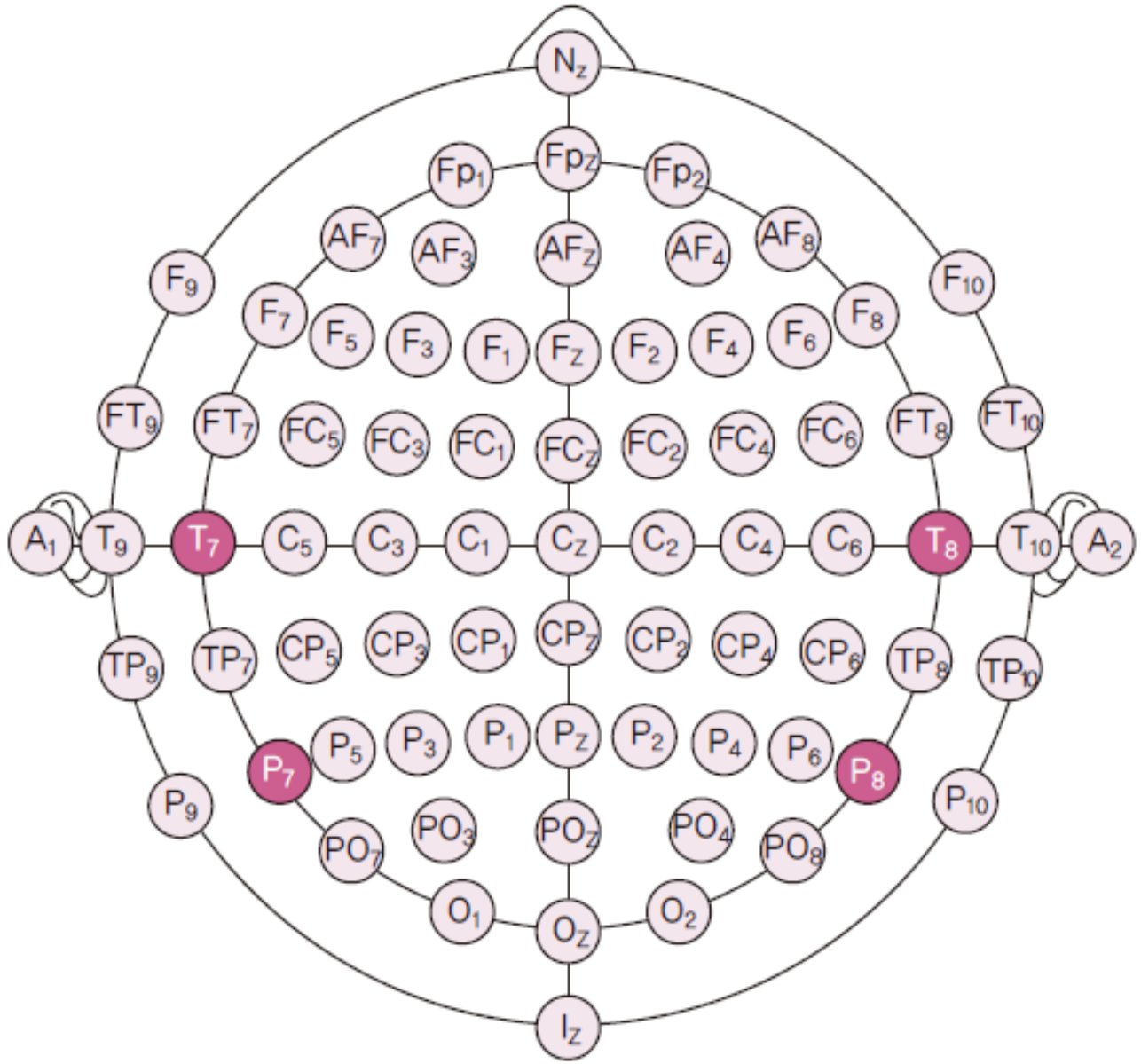
10-20법 전극명	부위명	
Fp_1, Fp_2	좌, 우 이마극	lt, rt. frontal-pole
F_3, F_4	좌, 우 이마부	lt, rt. frontal
C_3, C_4	좌, 우 중심부	lt, rt. central
P_3, P_4	좌, 우 마루부	lt, rt. parietal
O_1, O_2	좌, 우 뒤통수부	lt, rt. occipital
F_7, F_8	좌, 우 관자전부	lt, rt. antero-temporal
T_7, T_8†	좌, 우 관자중부	lt, rt. mid-temporal
P_7, P_8‡	좌, 우 관자후부	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



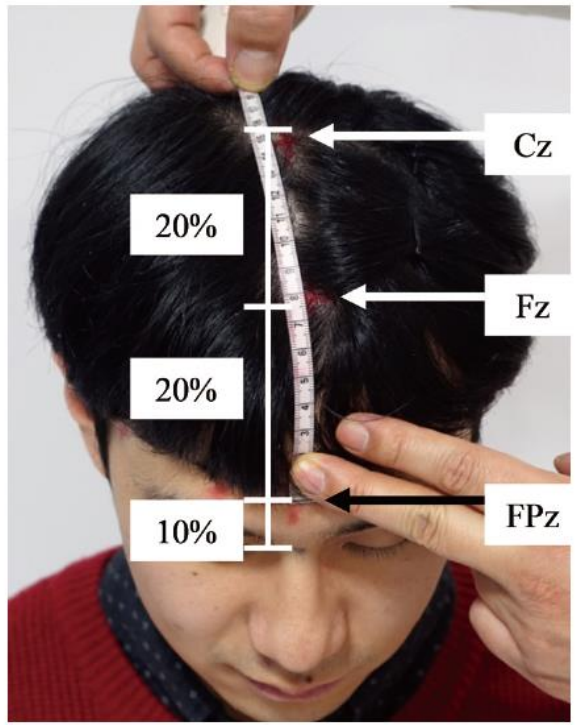


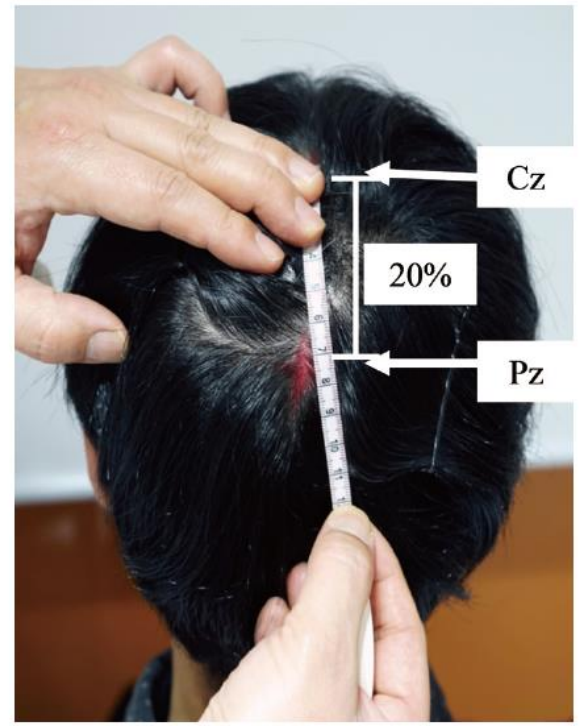


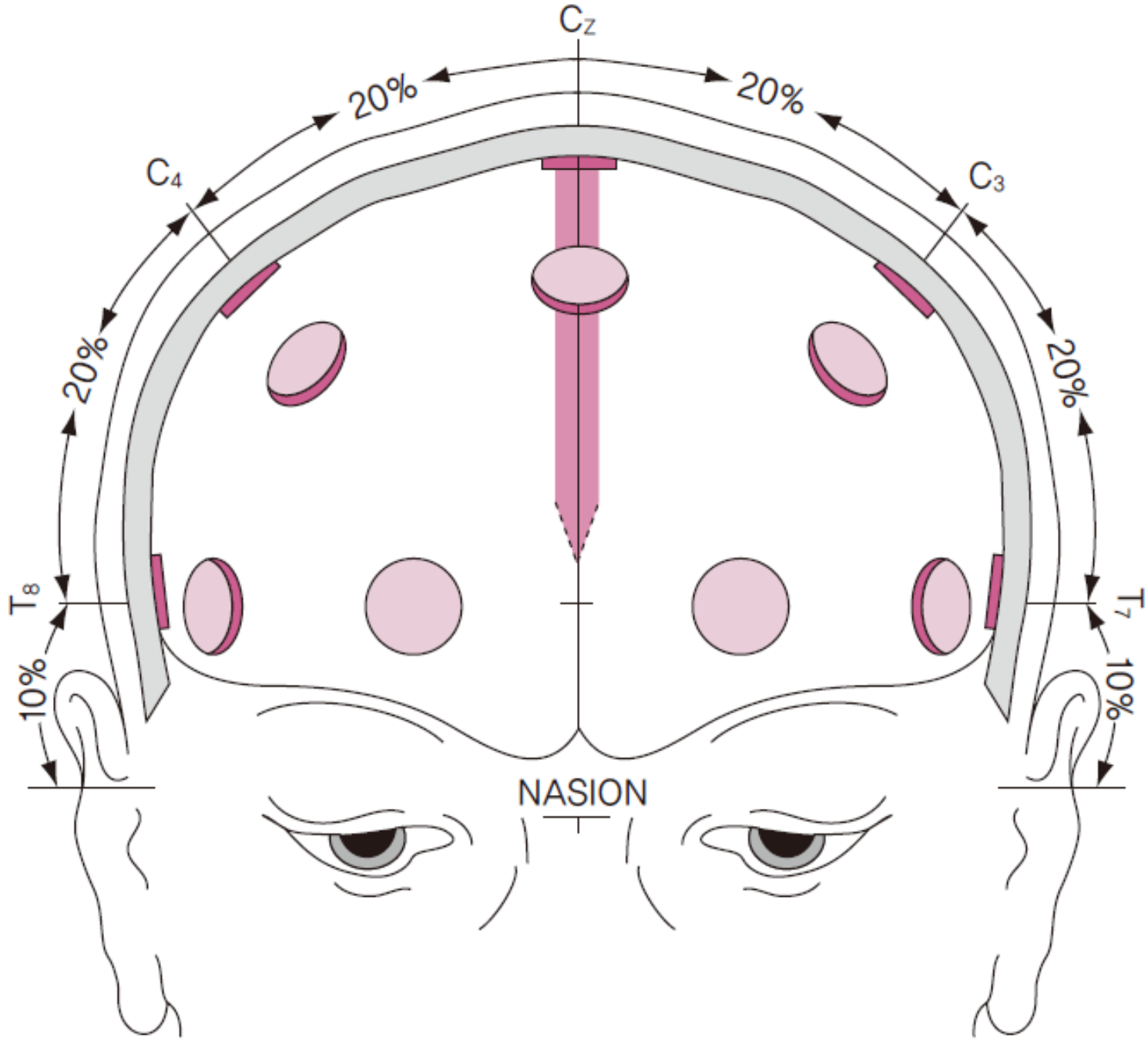


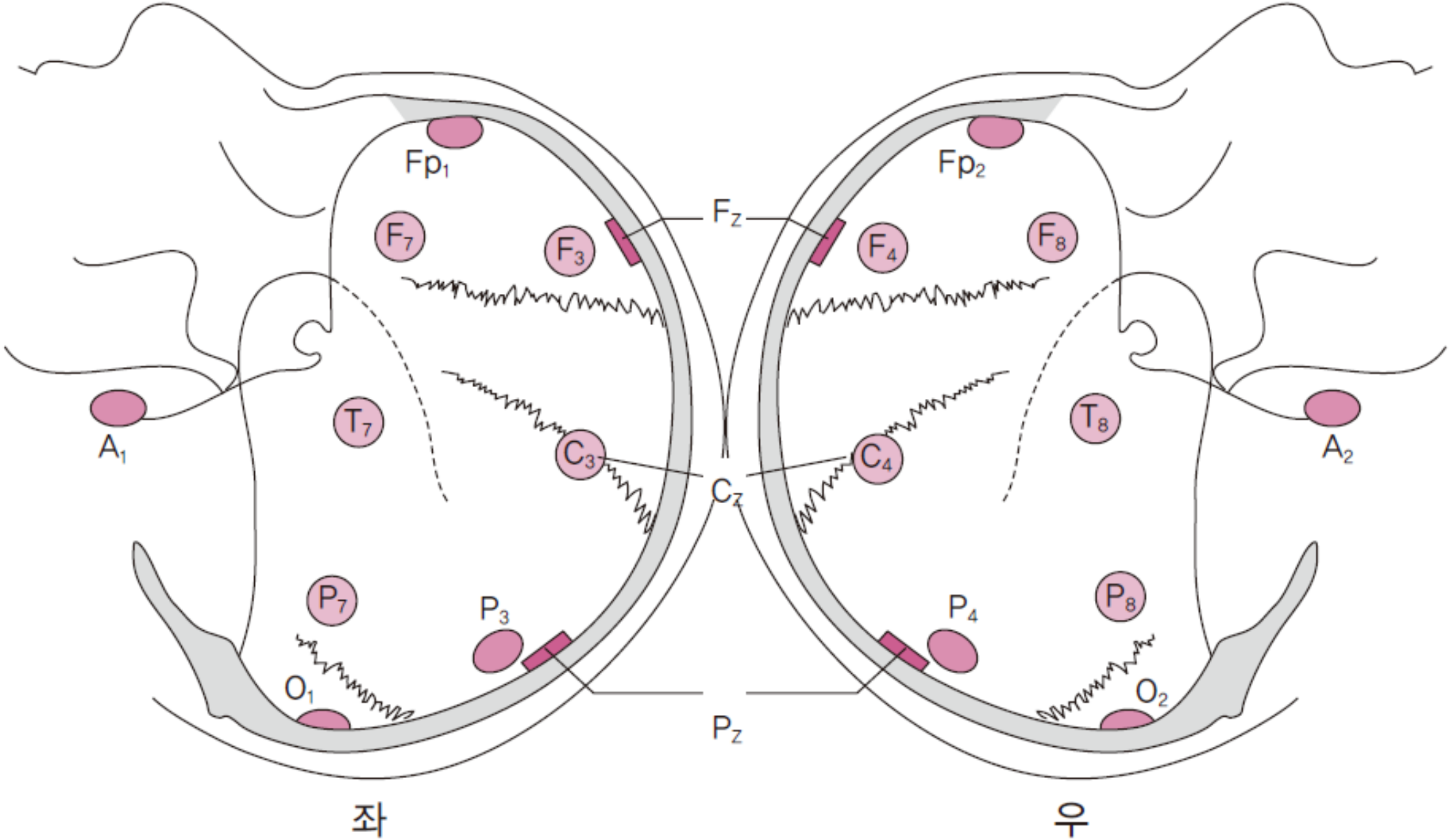


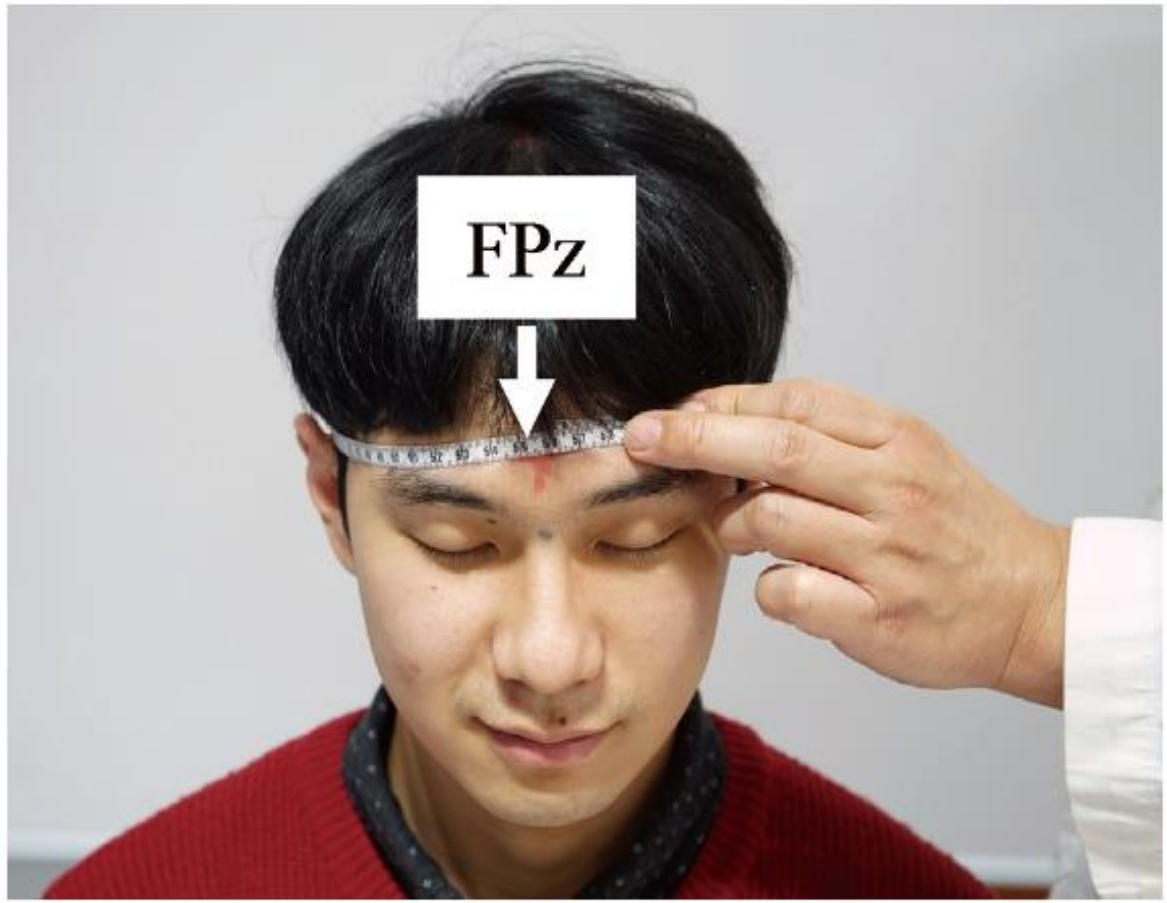


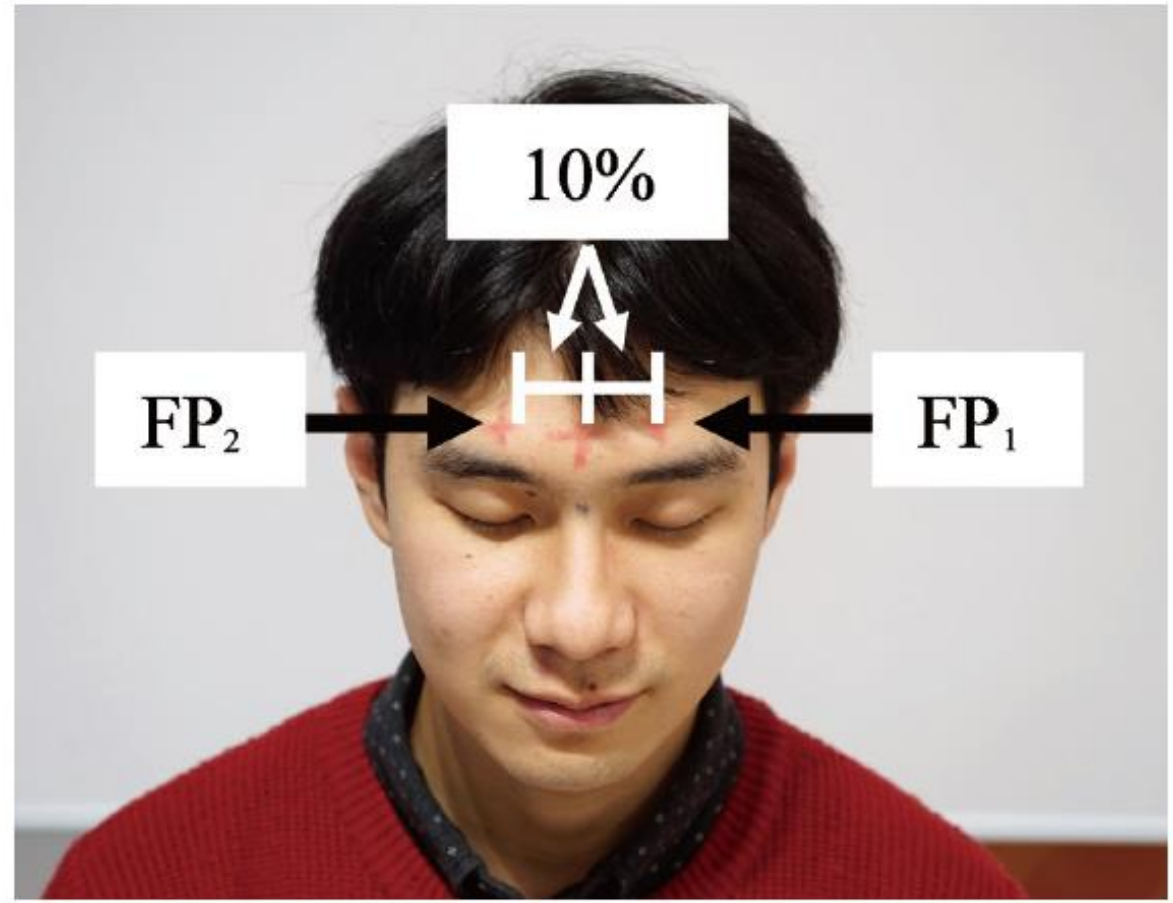

Cz
20%
Fz
20%
FPz
10%

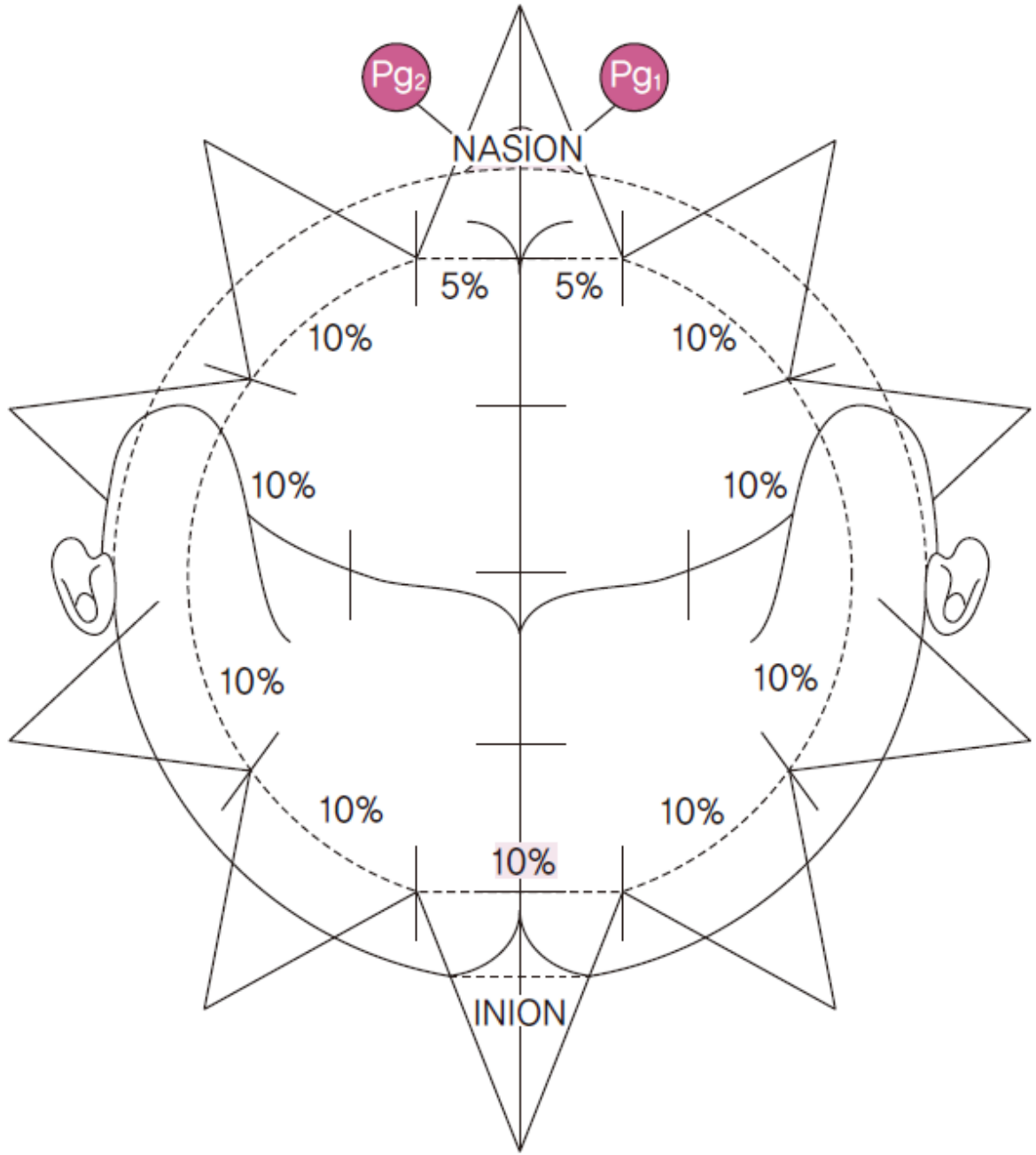

Cz
20%
Pz

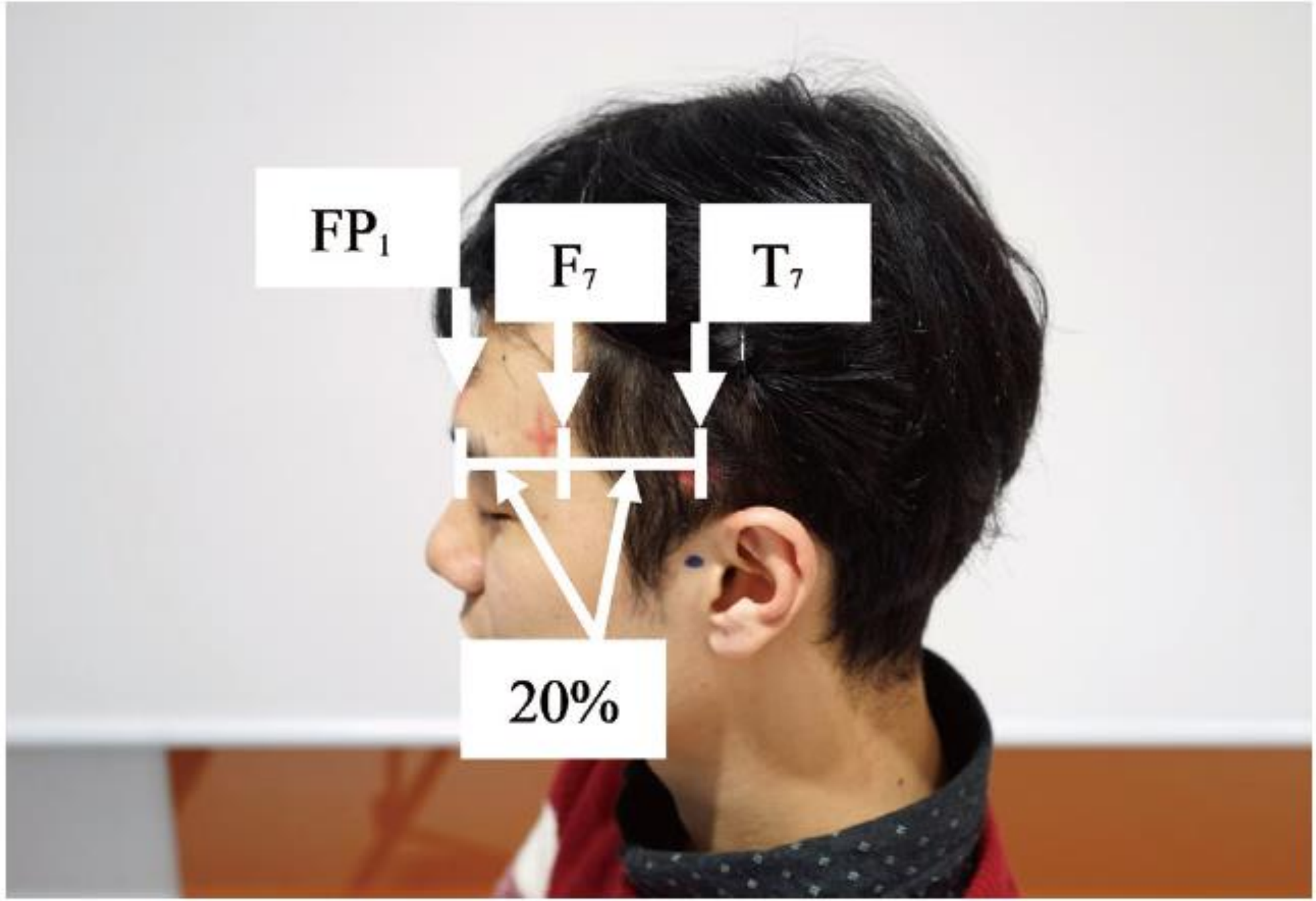

Cz
20%
20%
C4
C3
20%
20%
T8
T7
10%
10%
NASION

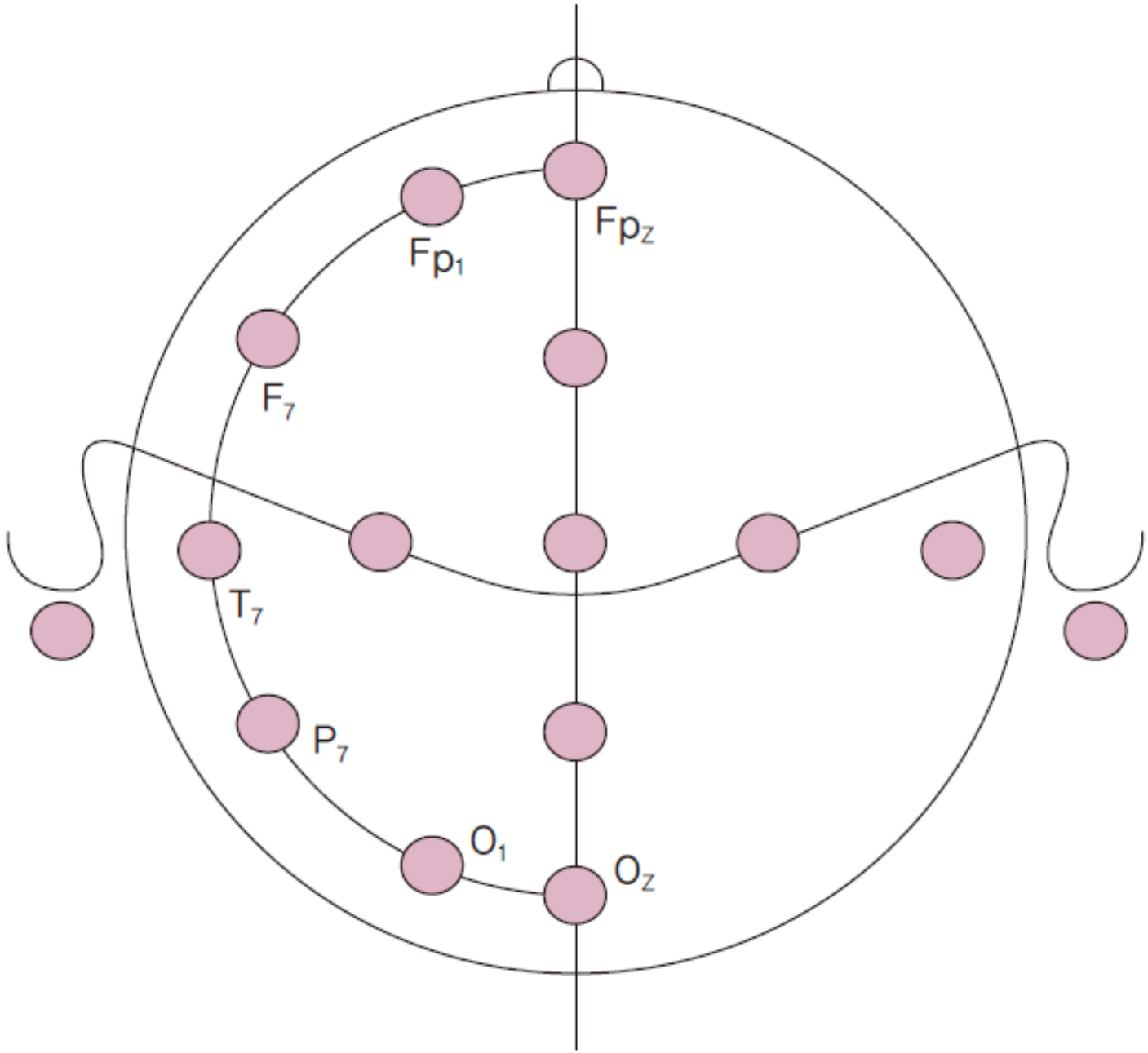

Fp1
Fp2
F7
F3
Fz
F4
F8
A1
T7
C3
Cz
C4
T8
A2
P7
P3
Pz
P4
P8
O1
O2
좌
우

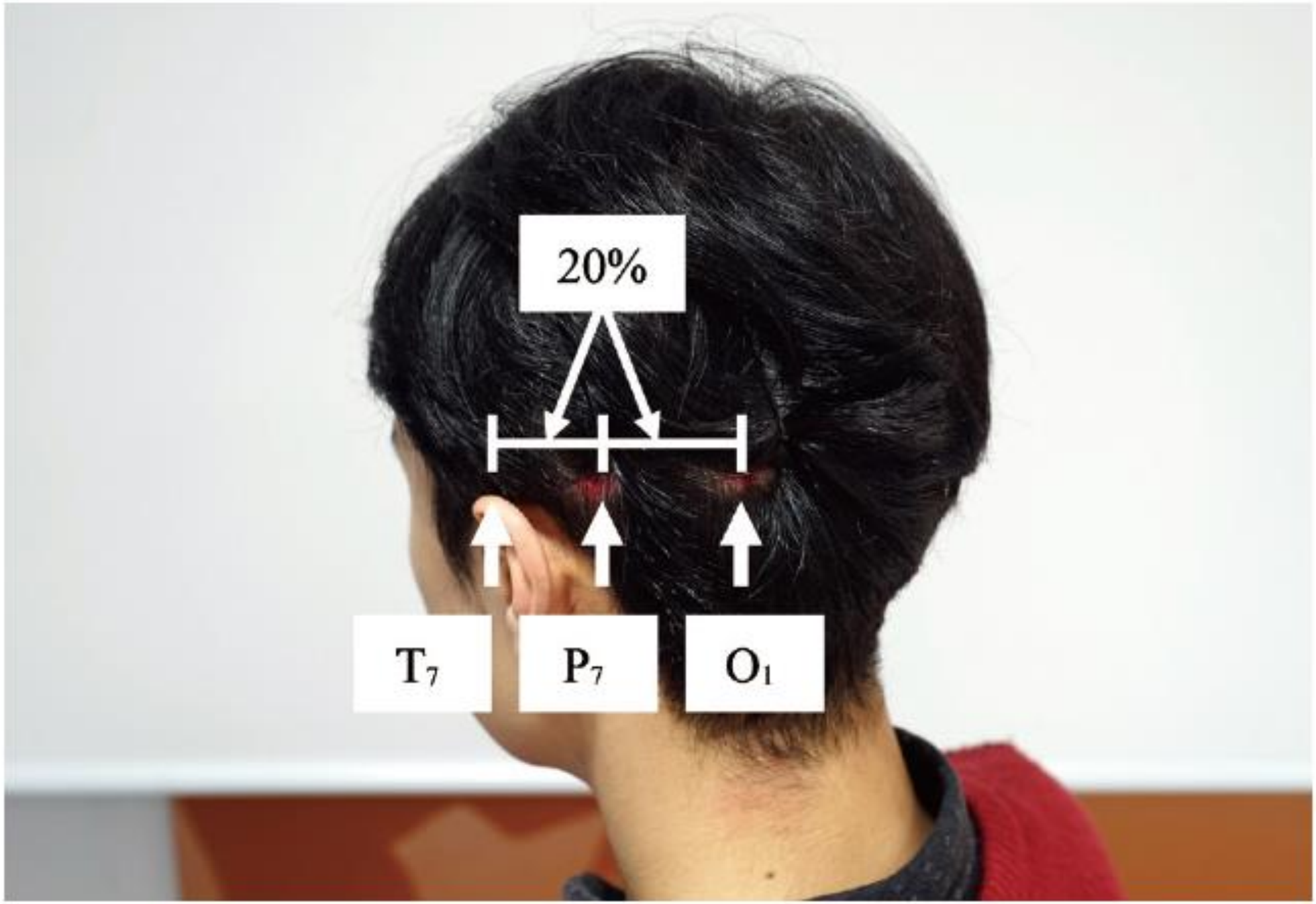

FPz

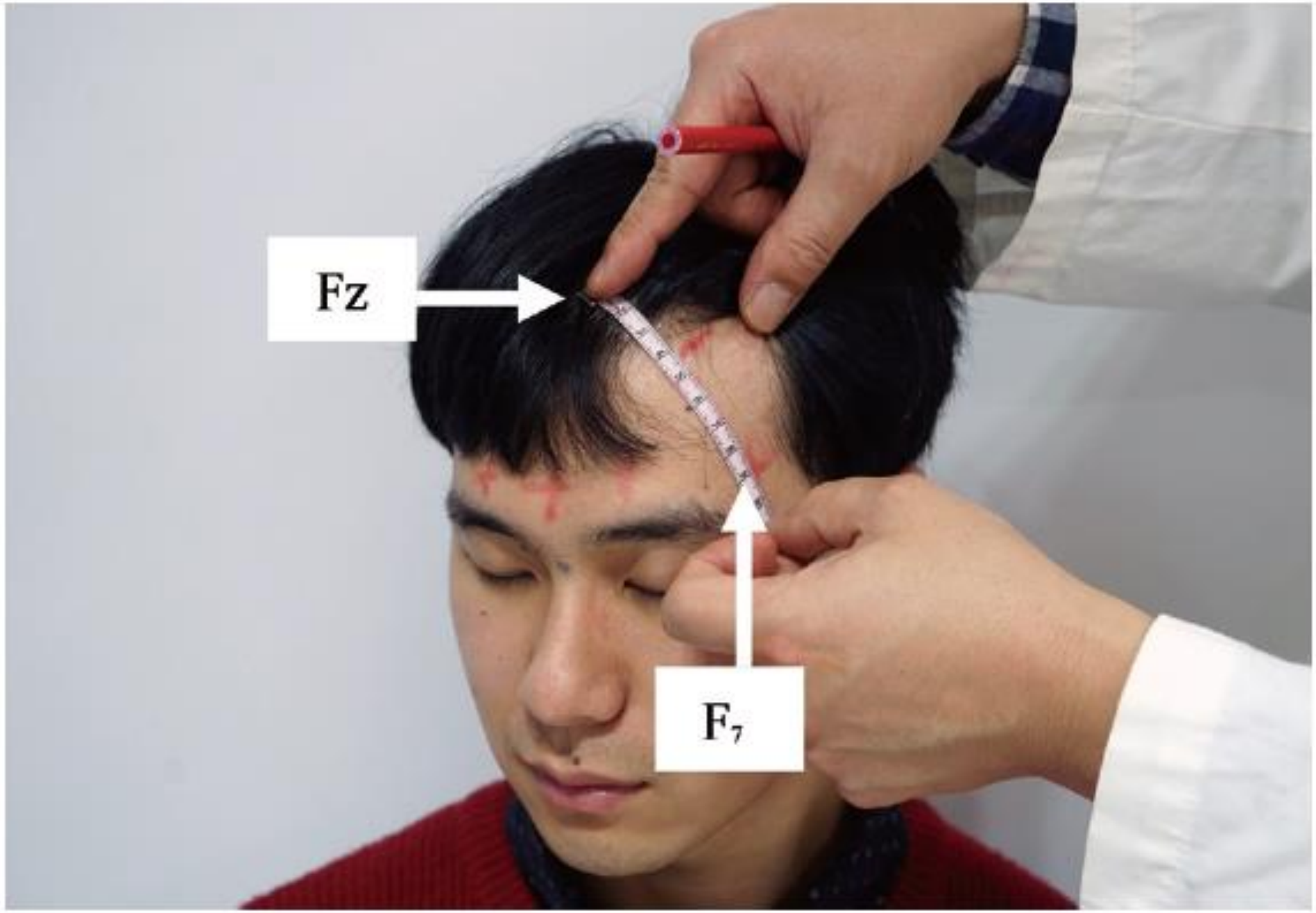

10%
FP2
FP1

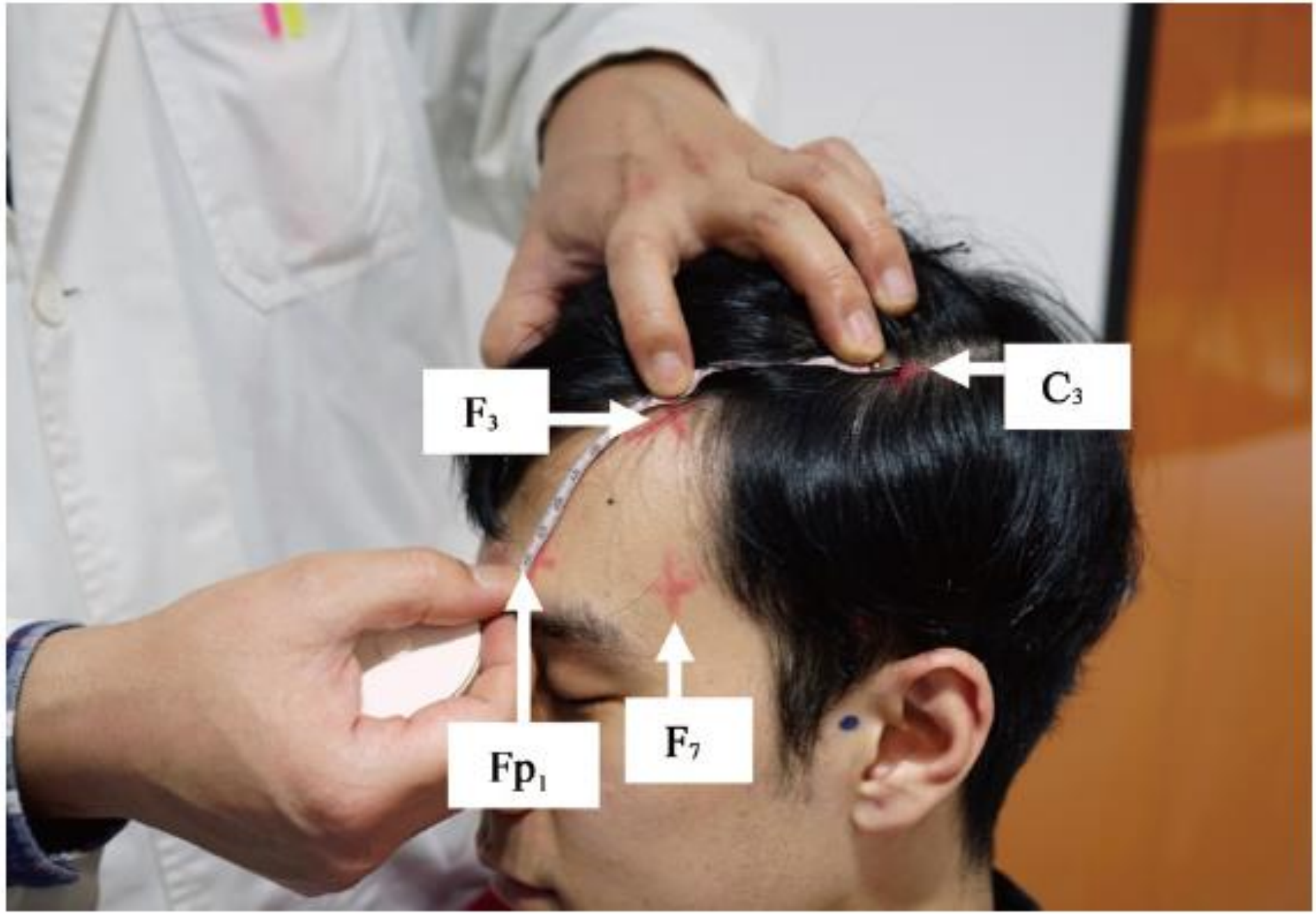

Pg2
Pg1
NASION
5%
5%
10%
10%
10%
10%
10%
10%
10%
10%
10%
INION

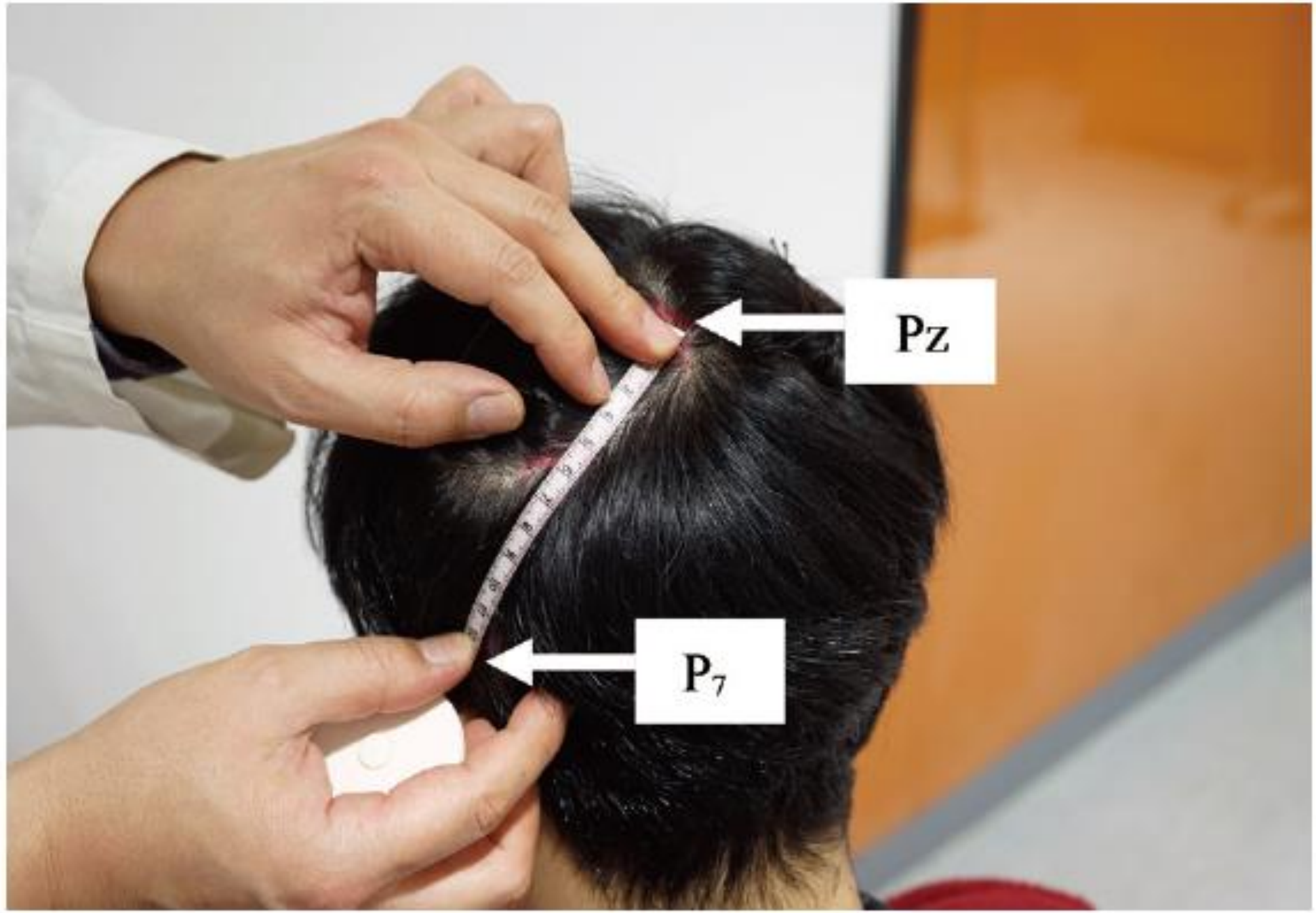

FP1
F7
T7
20%

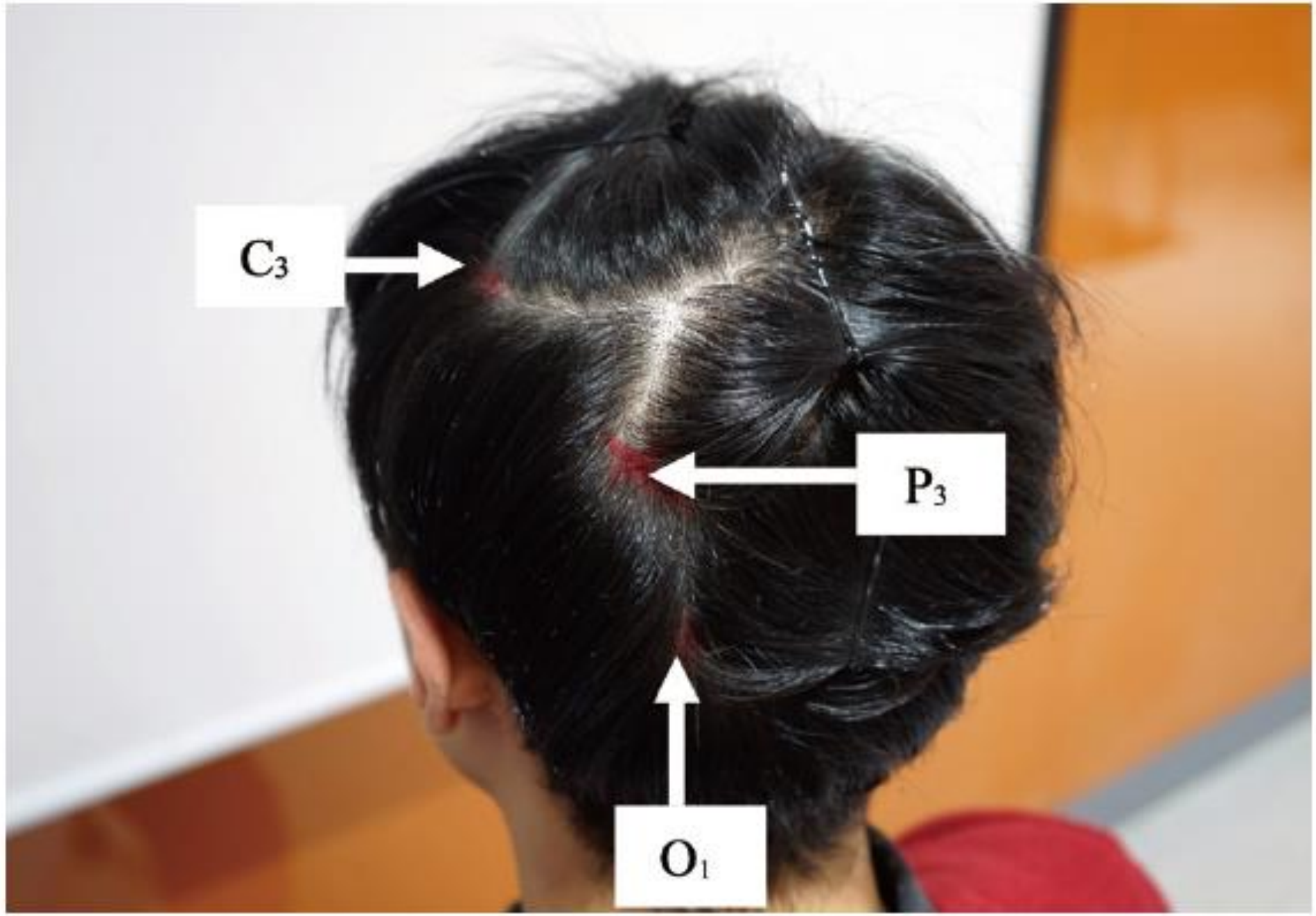

Fp1
FpZ
F7
T7
P7
O1
OZ

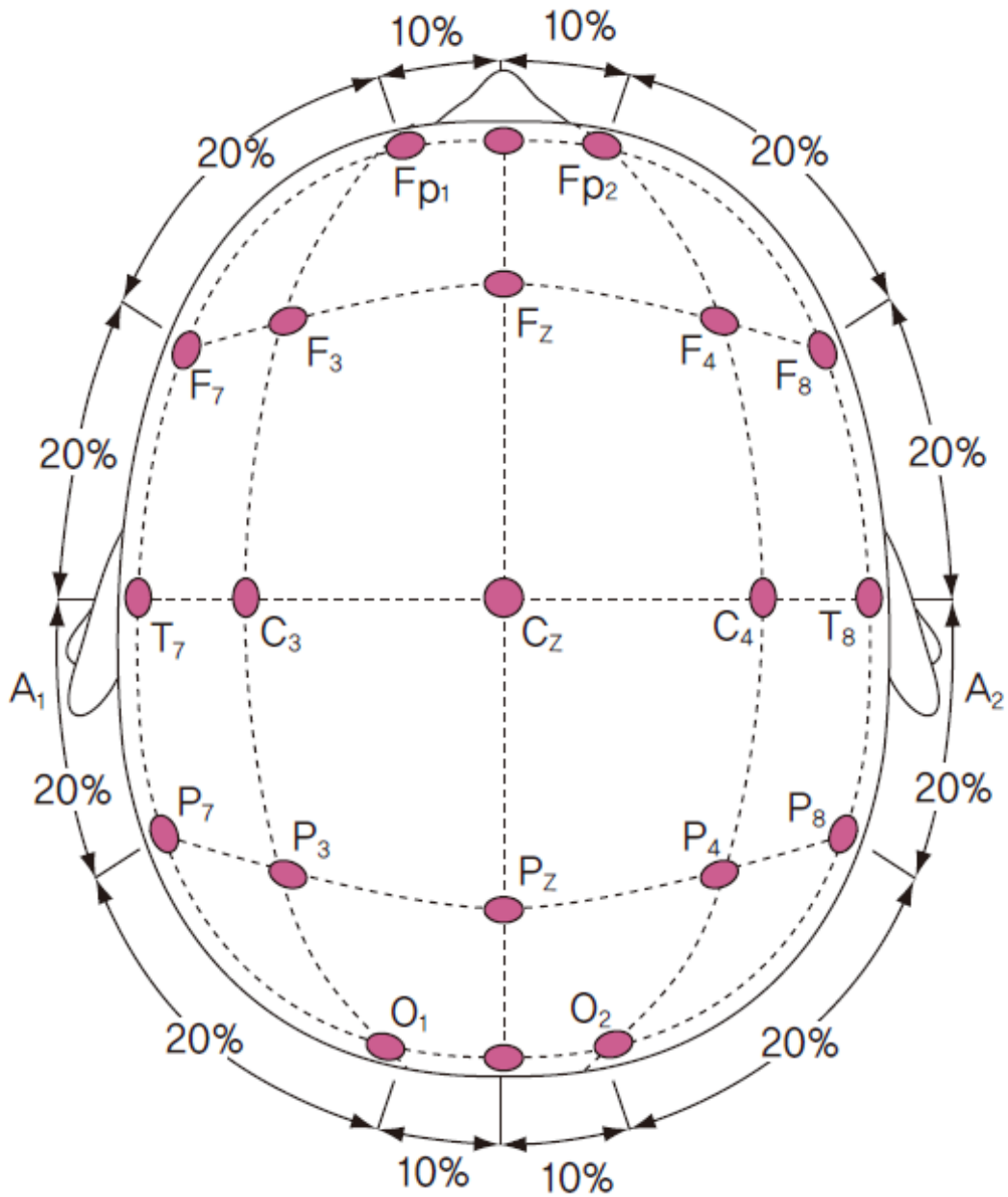

20%
T7
P7
O1

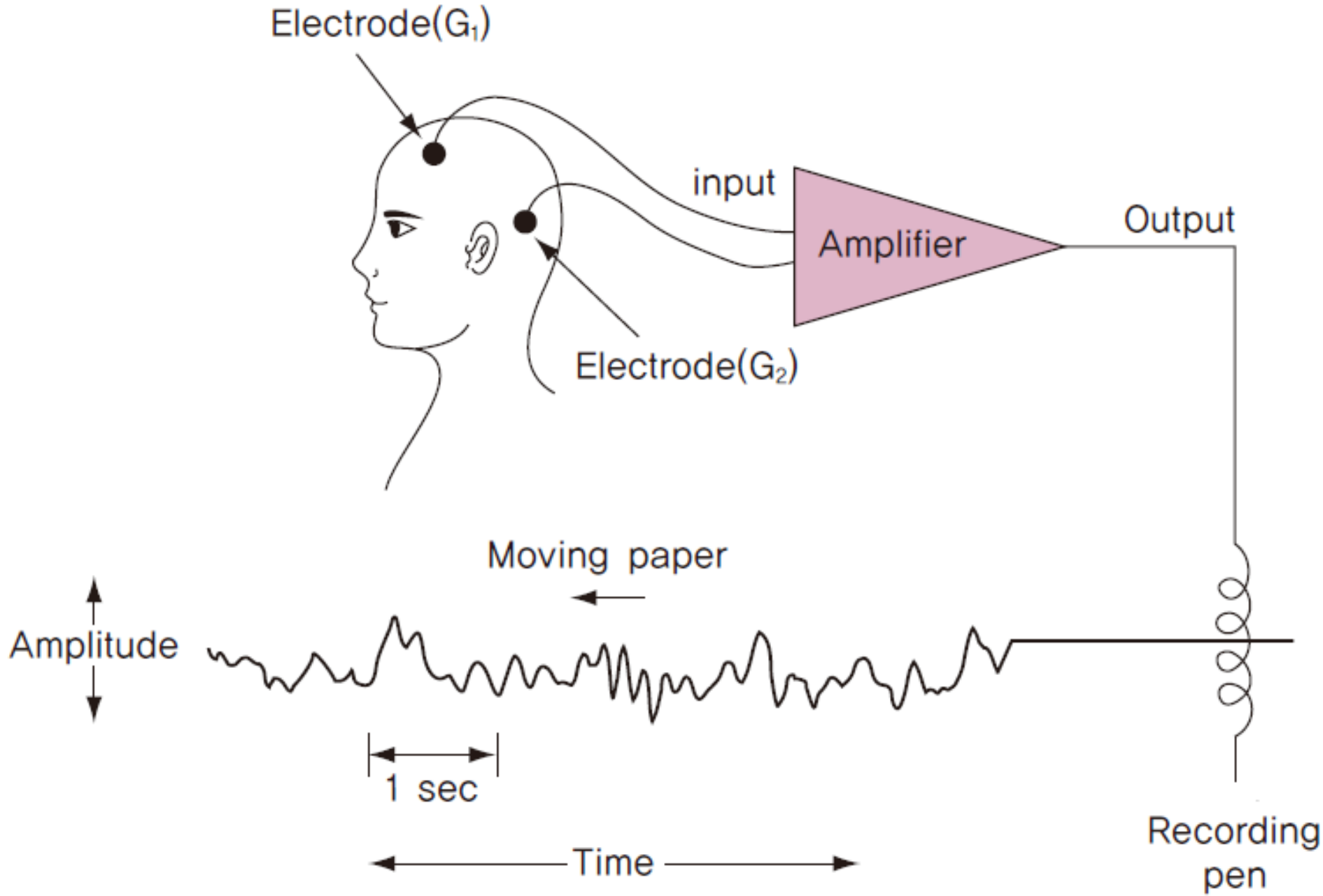

Fz
F7

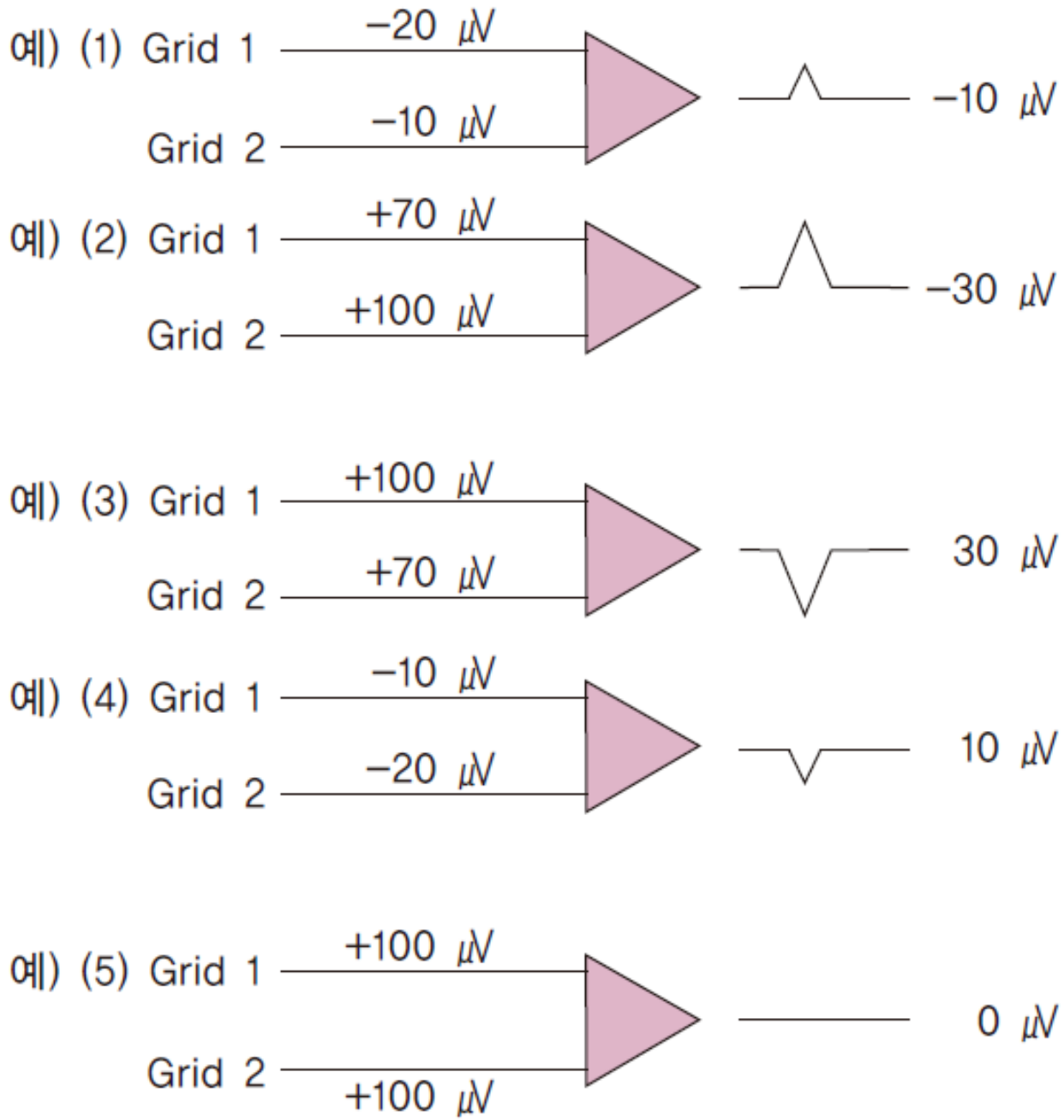

F3
C3
Fp1
F7

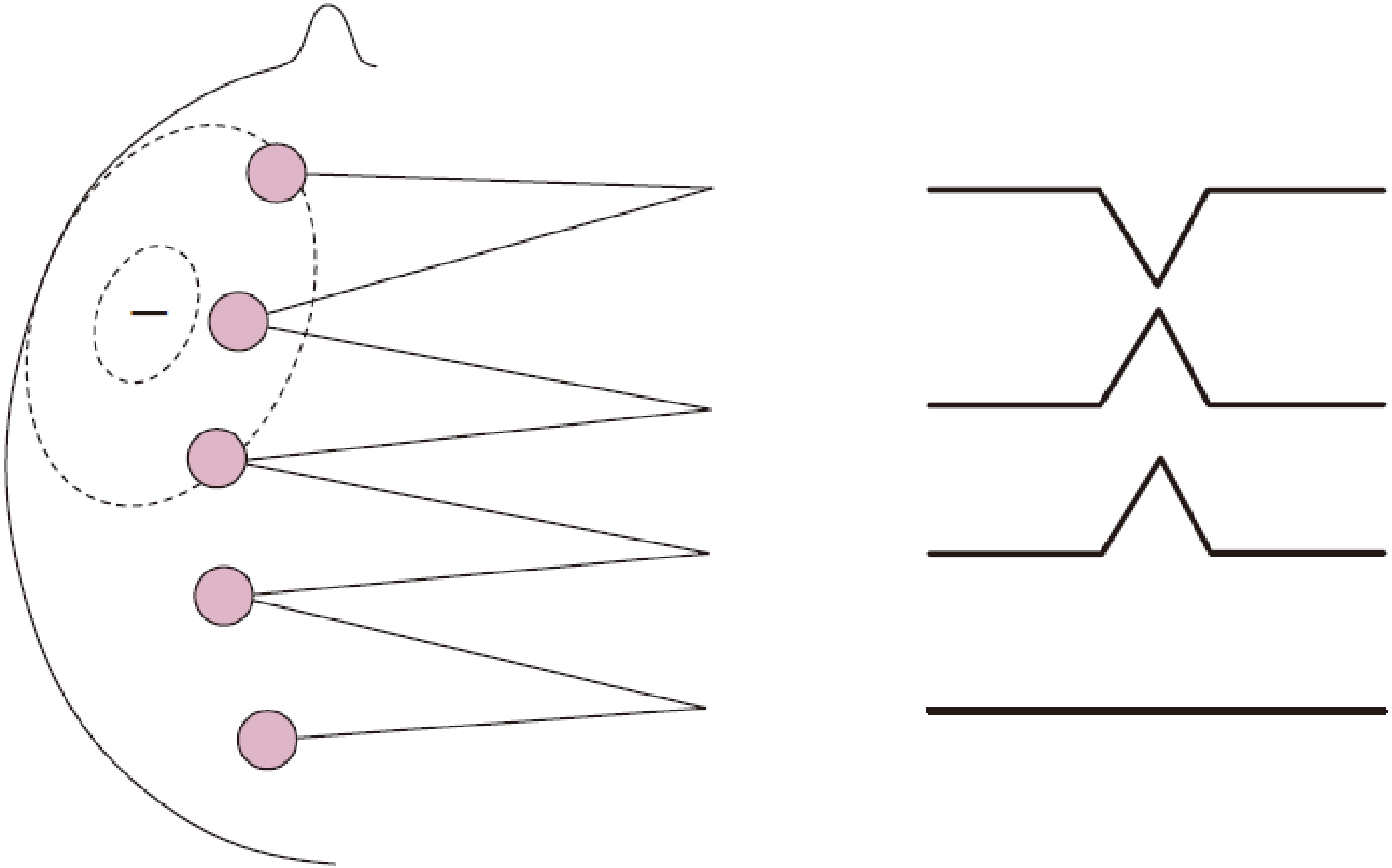

Pz
P7


C3
P3
O1

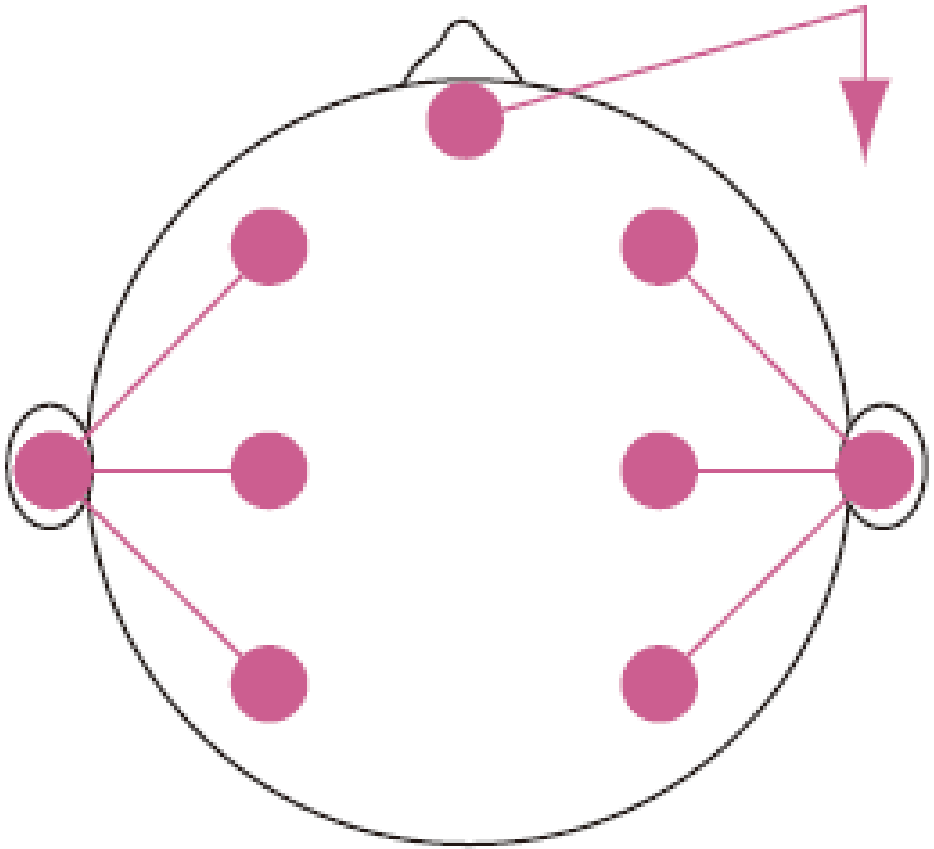

10%
10%
20%
20%
Fp1
Fp2
Fz
F7
F3
F4
F8
20%
20%
T7
C3
Cz
C4
T8
A1
A2
20%
20%
P7
P3
Pz
P4
P8
O1
O2
20%
20%
10%
10%


Electrode(G_1)
input
Amplifier
Output
Electrode(G_2)
Moving paper
Amplitude
1 sec
Time
Recording pen

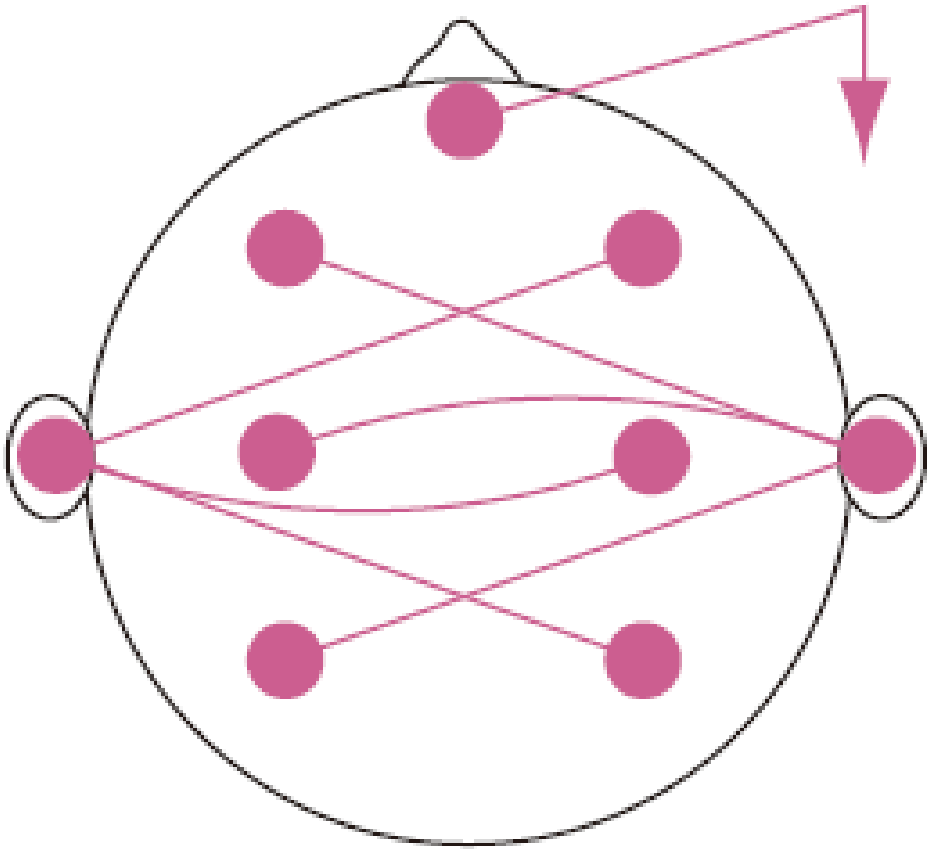

예) (1) Grid 1
−20 μV
Grid 2
−10 μV
−10 μV
예) (2) Grid 1
+70 μV
Grid 2
+100 μV
−30 μV
예) (3) Grid 1
+100 μV
Grid 2
+70 μV
30 μV
예) (4) Grid 1
−10 μV
Grid 2
−20 μV
10 μV
예) (5) Grid 1
+100 μV
Grid 2
+100 μV
0 μV



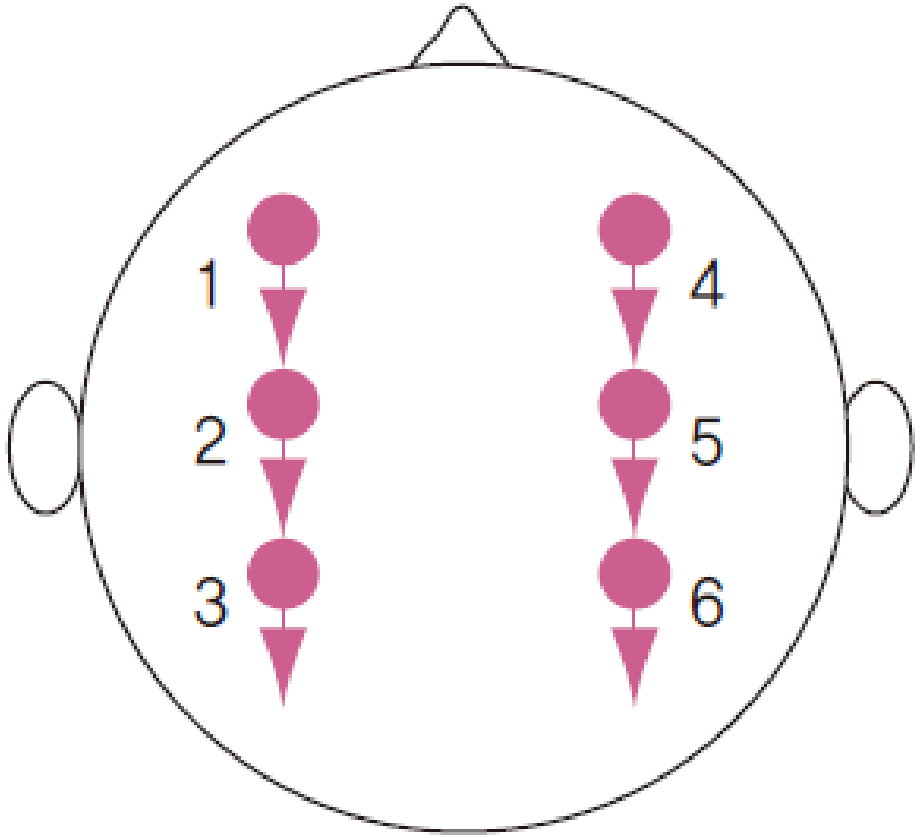
(1) 동측 귓불법
(ipsilateral)



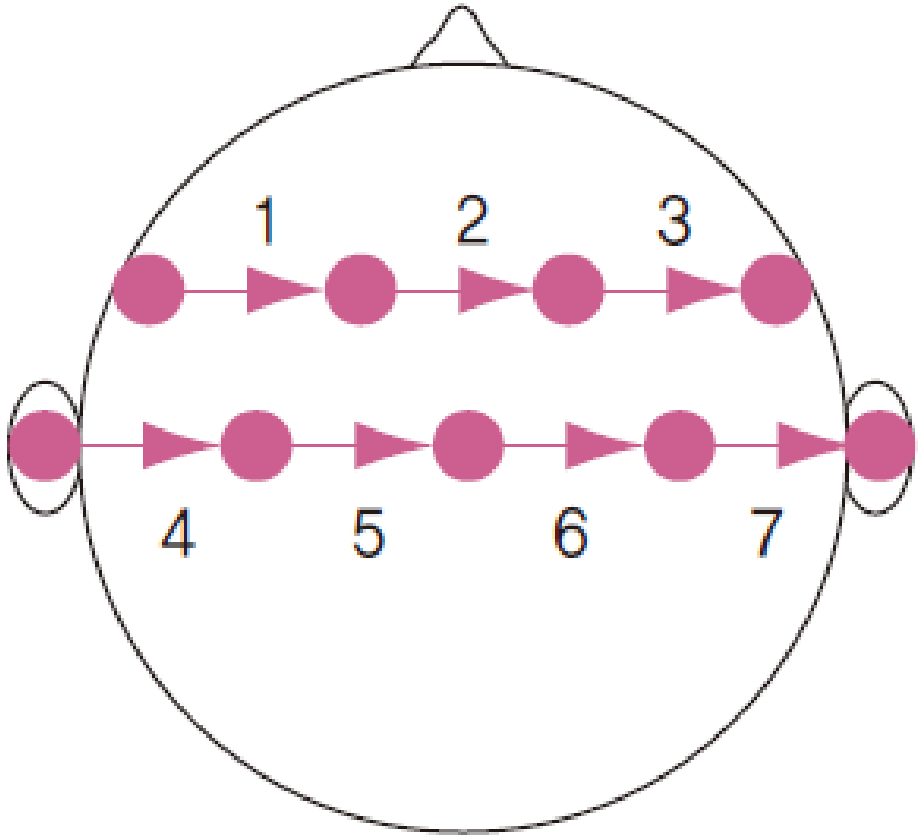
(2) 반대측 귓불법
(contralateral)

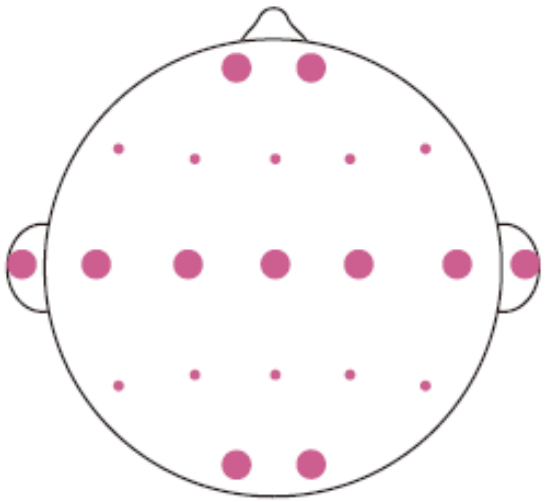


(1) 세로연결 쌍극
(longitudlinal)

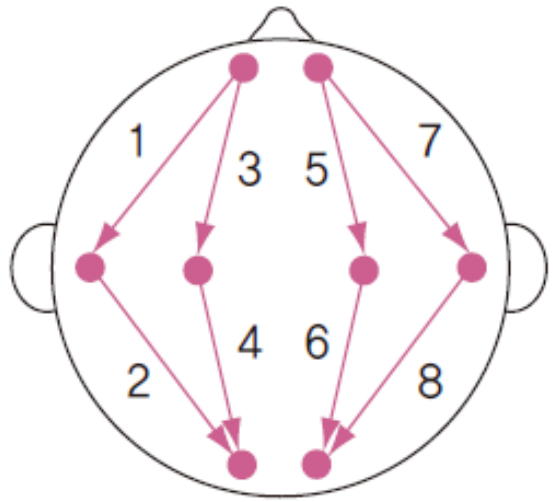


(2) 가로(관상)연결 쌍극
(transverse or coronal)

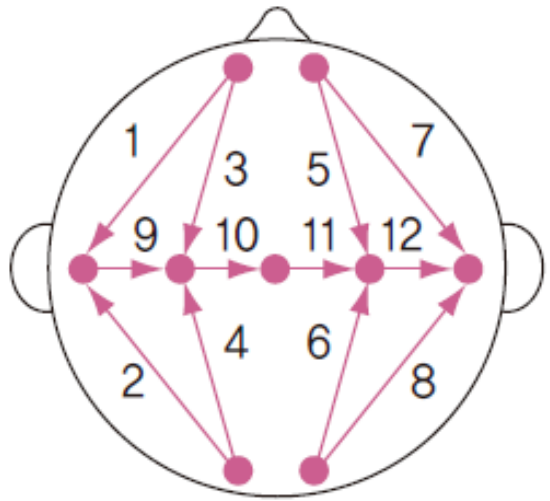




신생아용
전극배치

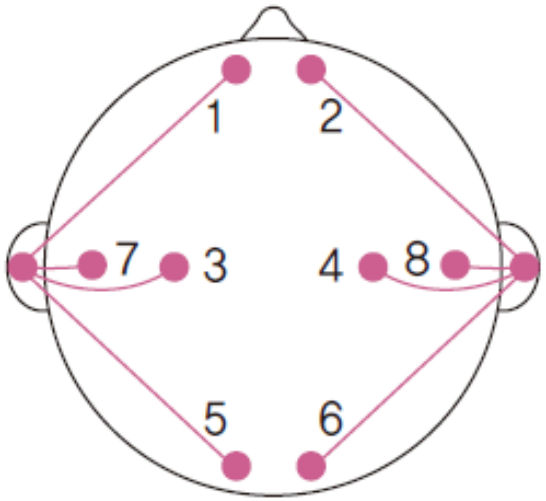


N8Lb–a

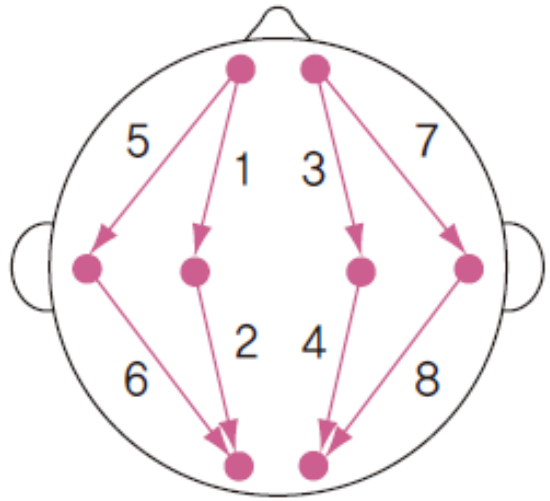


N12B–a

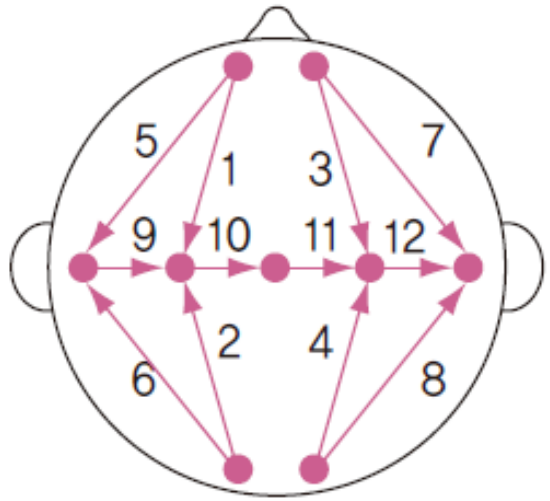
or



N8R

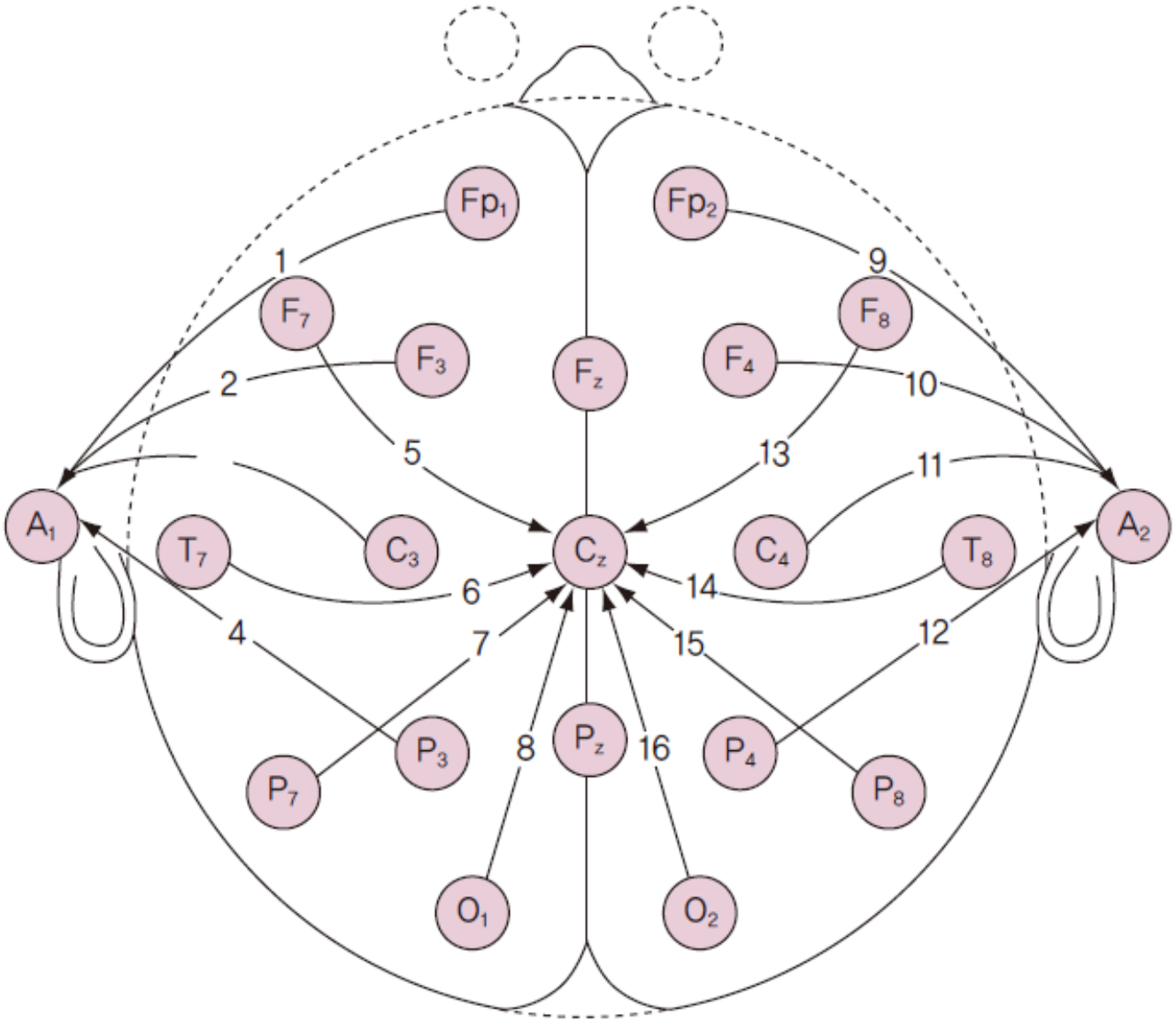


NN8LB–b

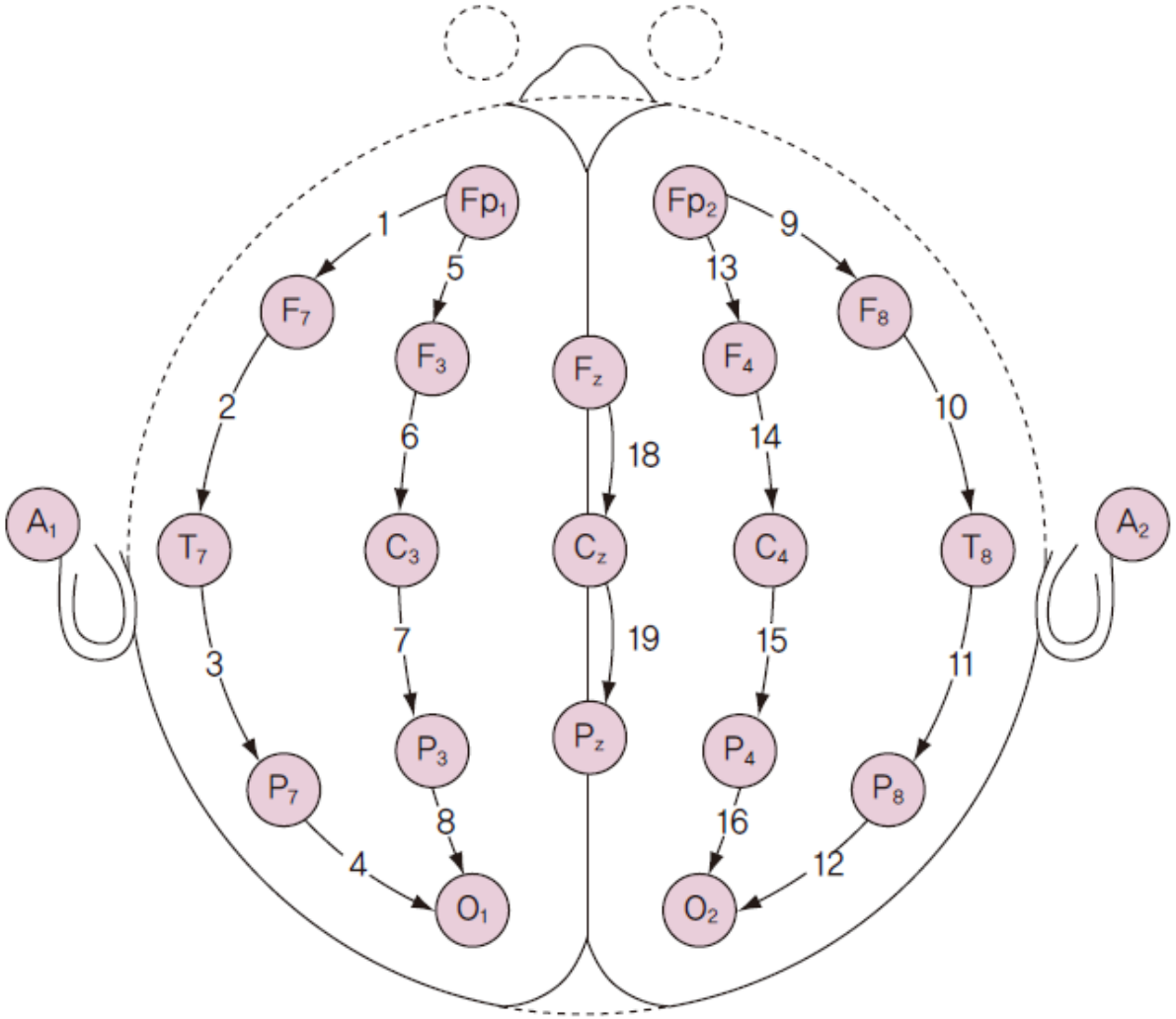


N12B–b

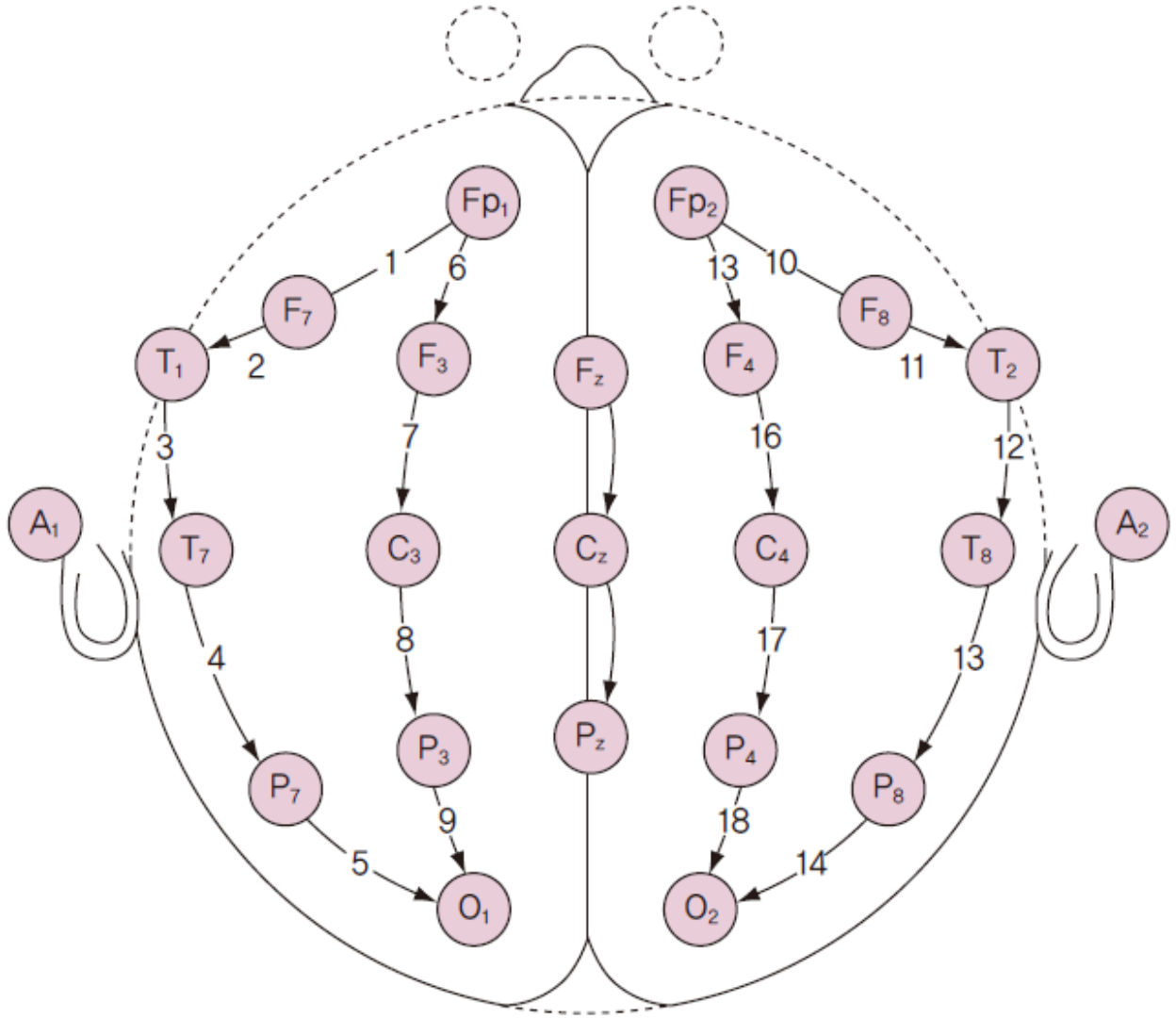
or



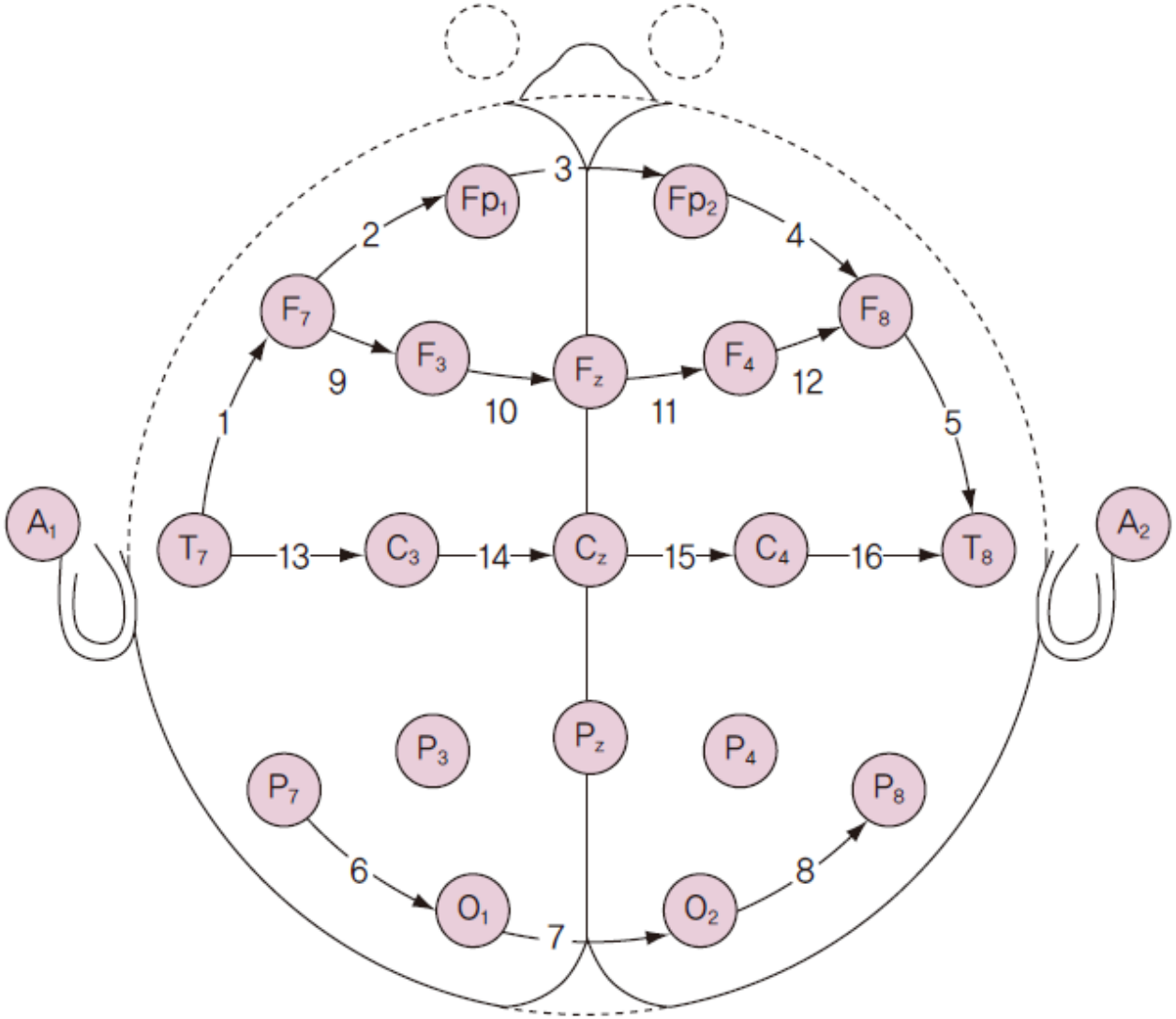
No.	입력1	입력2	No.	입력1	입력2
1	FP_1	A_1	12	P_4	A_2
2	F_3	A_1	13	F_8	Cz
3	C_3	A_1	14	T_8	Cz
4	P_3	A_1	15	P_8	Cz
5	F_7	Cz	16	O_2	Cz
6	T_7	Cz	17	심전도(EKG)	
7	P_7	Cz	18	Fz	A_1
8	O_1	Cz	19	Cz	A_1
9	FP_2	A_2	20	Pz	A_1
10	F_4	A_2	21	Resp.	
11	C_4	A_2			



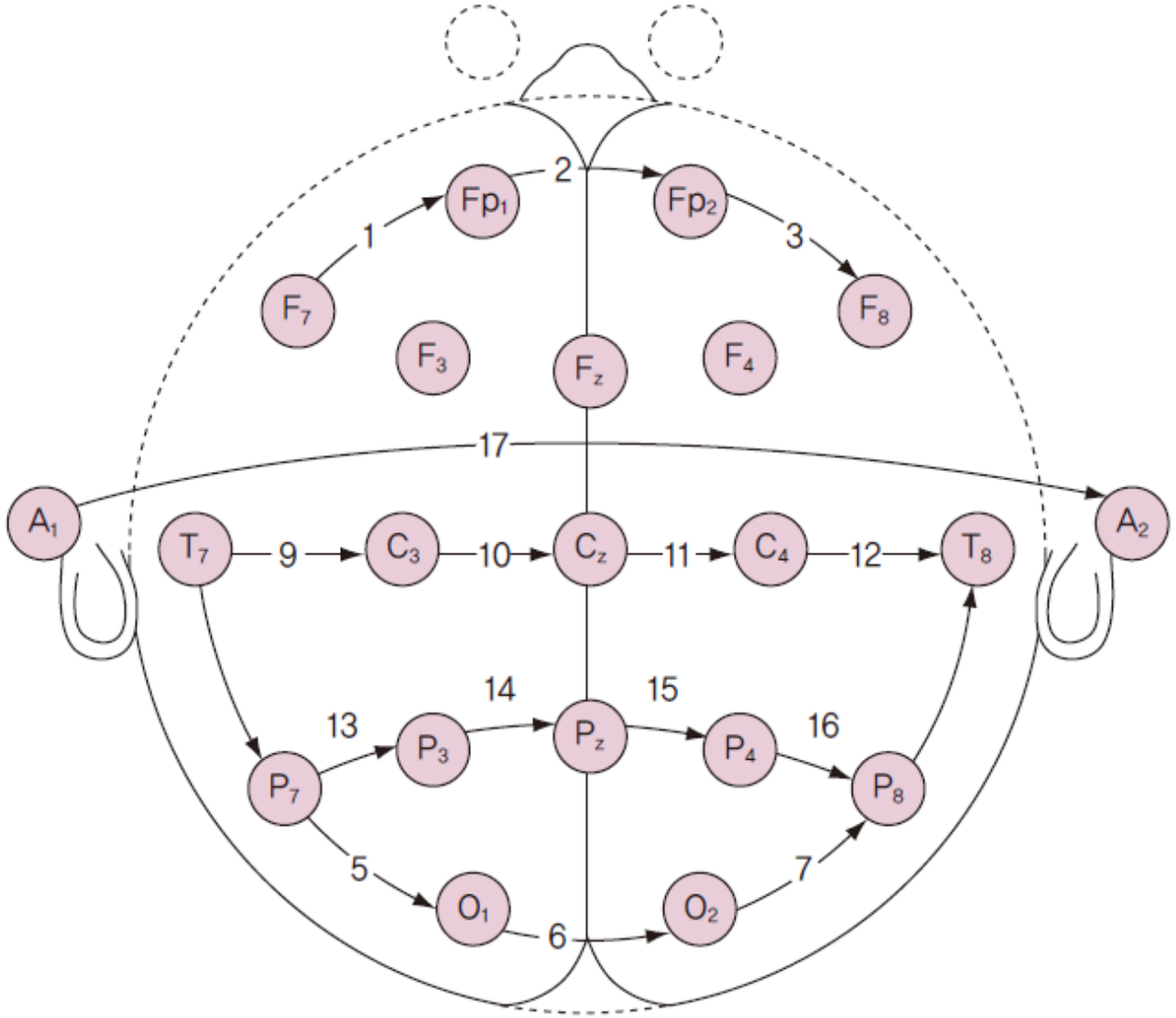
No.	입력1	입력2	No.	입력1	입력2
1	FP_1	F_7	12	P_8	O_2
2	F_7	T_7	13	FP_2	F_4
3	T_7	P_7	14	F_4	C_4
4	P_7	O_1	15	C_4	P_4
5	FP_1	F_3	16	P_4	O_2
6	F_3	C_3	17	A_1	A_2
7	C_3	P_3	18	Fz	Cz
8	P_3	O_1	19	Cz	Pz
9	FP_2	F_8	20	심전도(EKG)	
10	F_8	T_8	21	Resp.	
11	T_8	P_8			



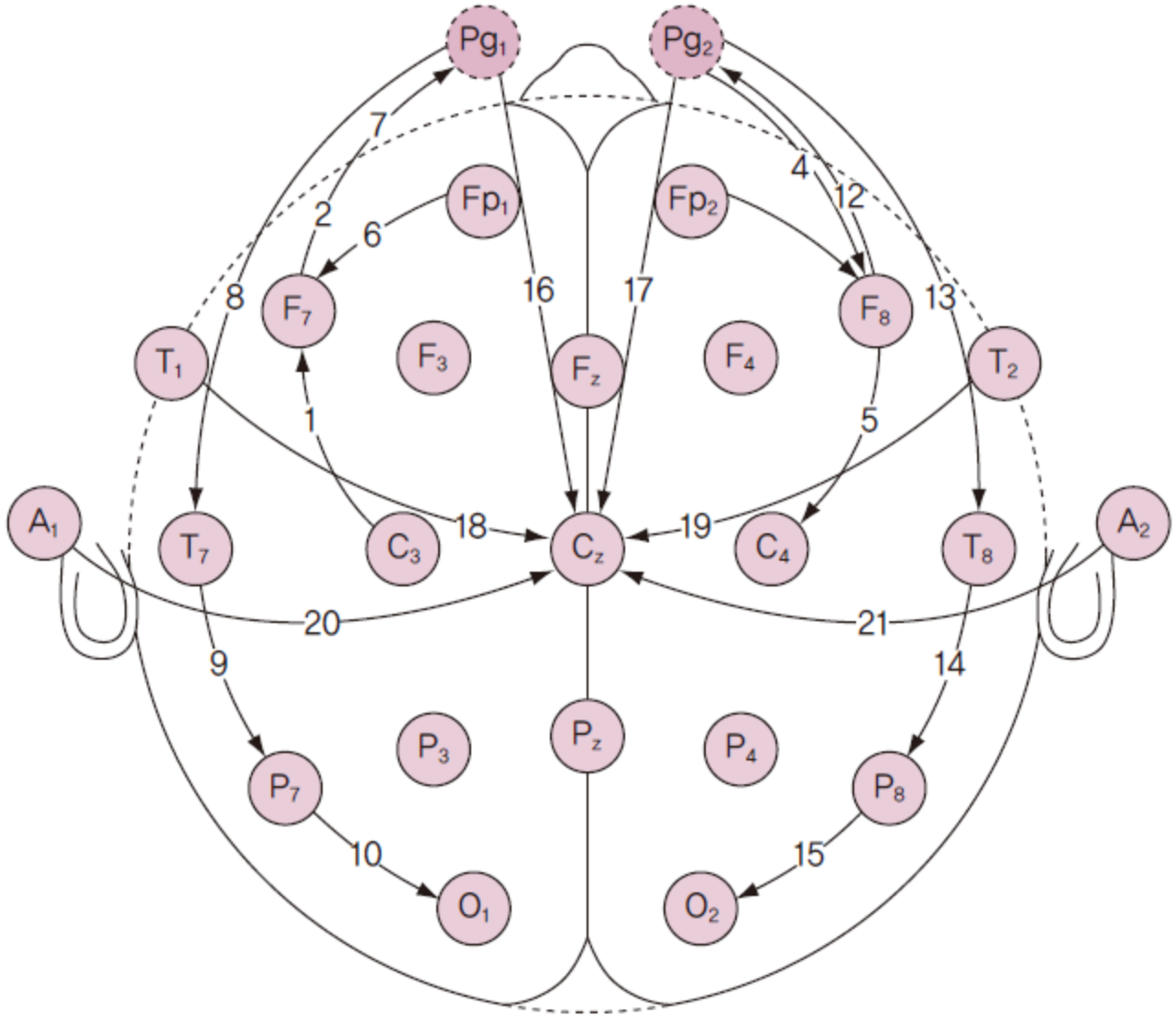
No.	입력1	입력2	No.	입력1	입력2
1	FP_1	F_7	12	T_2	T_8
2	F_7	T_1	13	T_8	P_8
3	T_1	T_7	14	P_8	O_1
4	T_7	P_7	15	FP_2	F_4
5	P_7	O_1	16	F_4	C_4
6	FP_1	F_3	17	C_4	P_4
7	F_3	C_3	18	P_4	O_2
8	C_3	P_3	19	심전도(EKG)	
9	P_3	O_1	20	T_1	T_2
10	FP_2	F_8	21	Resp.	
11	F_8	T_2			



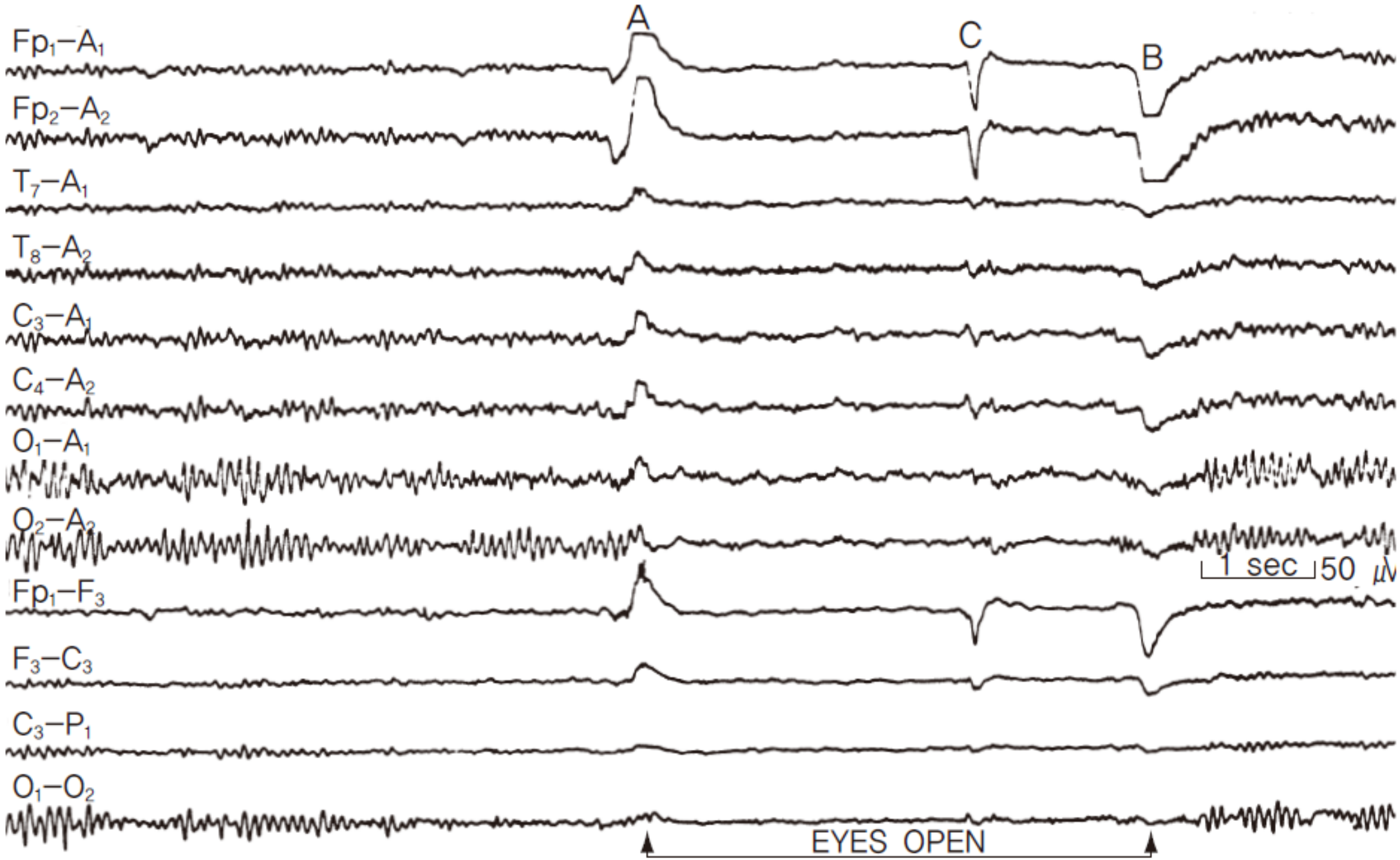
No.	입력1	입력2	No.	입력1	입력2
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2	F_7	FP_1	13	T_7	C_3
3	FP_1	FP_2	14	C_3	Cz
4	FP_2	F_8	15	Cz	C_4
5	F_8	T_8	16	C_4	T_8
6	P_7	O_1	17	A_1	A_2
7	O_1	O_2	18	EOG	
8	O_2	P_8	19	EMG	
9	F_7	F_3	20	심전도(EKG)	
10	F_3	F_z	21	Resp.	
11	F_z	F_4			

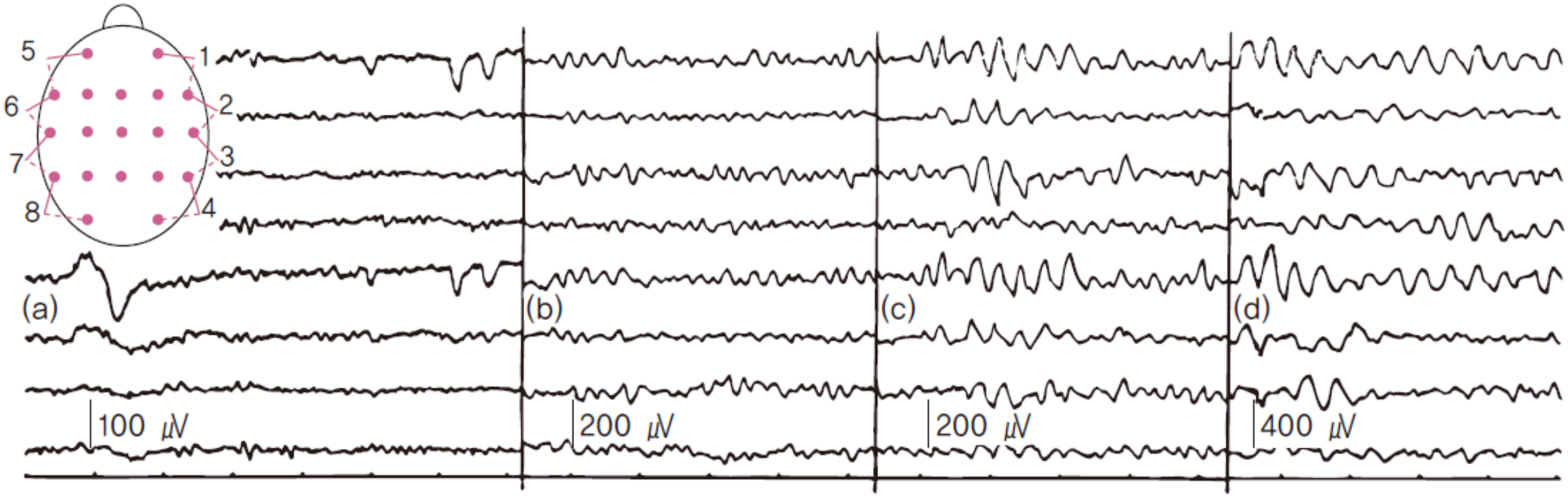


No.	입력1	입력2	No.	입력1	입력2
1	F_7	FP_1	12	C_4	T_8
2	FP_1	FP_2	13	P_7	P_3
3	FP_2	F_8	14	P_3	Pz
4	T_7	P_7	15	Pz	P_4
5	P_7	O_1	16	P_4	T_6
6	O_1	O_2	17	A_1	A_2
7	O_2	P_8	18	EOG	
8	P_8	T_8	19	Chin EMG	
9	T_7	C_3	20	심전도(ECG)	
10	C_3	Cz	21	Resp.	
11	C_z	C_4			

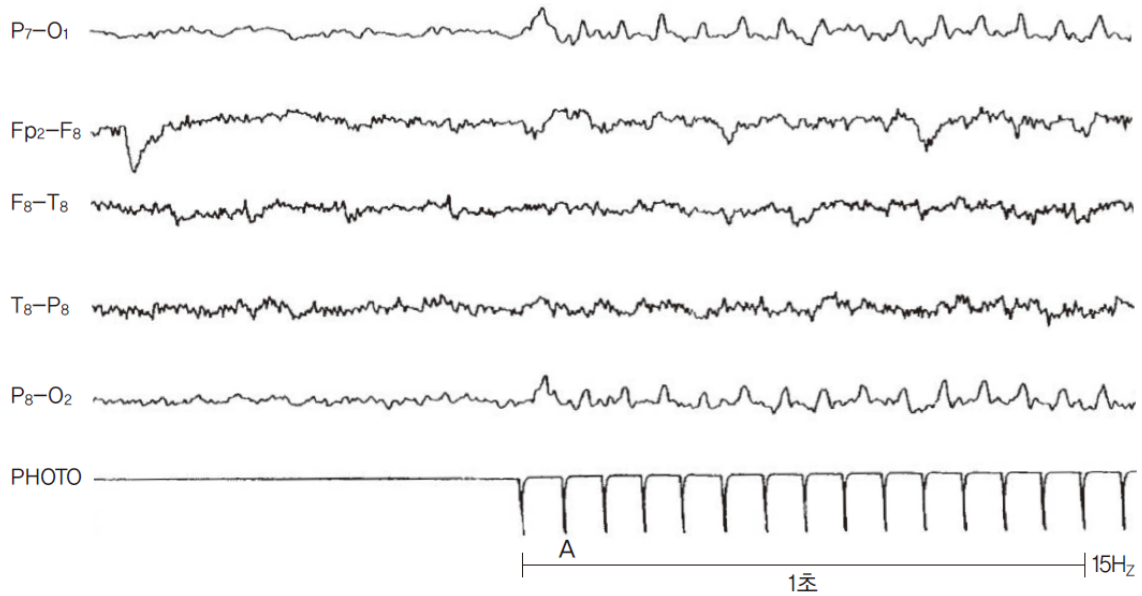


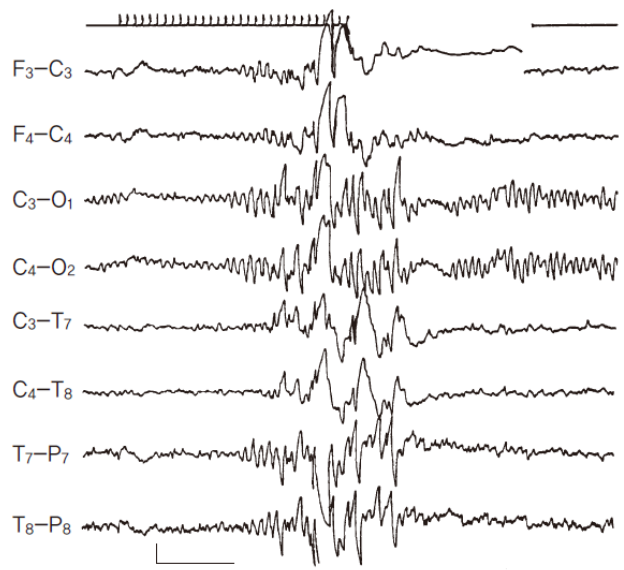
No.	입력1	입력2	No.	입력1	입력2
1	C_3	F_7	12	F_8	Pg_2
2	F_7	Pg_1	13	Pg_2	T_8
3	Pg_1	Pg_2	14	T_8	P_8
4	Pg_2	F_8	15	P_8	O_2
5	P_7	O_1	16	Pg_1	Cz
6	FP_1	F_7	17	Pg_2	Cz
7	F_7	Pg_1	18	T_1	Cz
8	Pg_1	T_7	19	T_2	Cz
9	T_7	P_7	20	A_1	Cz
10	P_7	O_1			
11	FP_2	F_8			


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

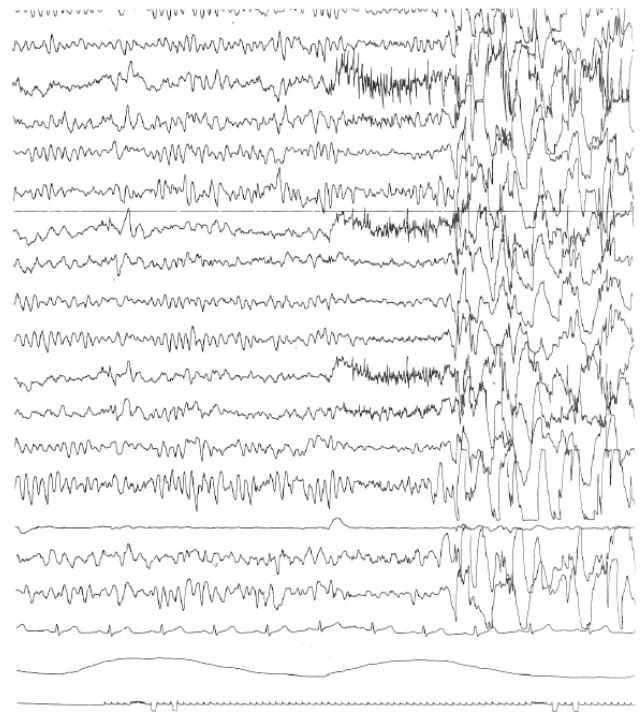


(a) 7~8 Hz의 성분, 40 μV peak 출현(과호흡 전)
(b) 4~6 Hz의 성분, 100 μV peak 출현(과호흡 30초 후)
(c) 3 Hz파, 200 μV peak 출현(과호흡 90초 후)
(d) 3 Hz의 연속, 500 μV peak 출현(과호흡 2분 30초 후)



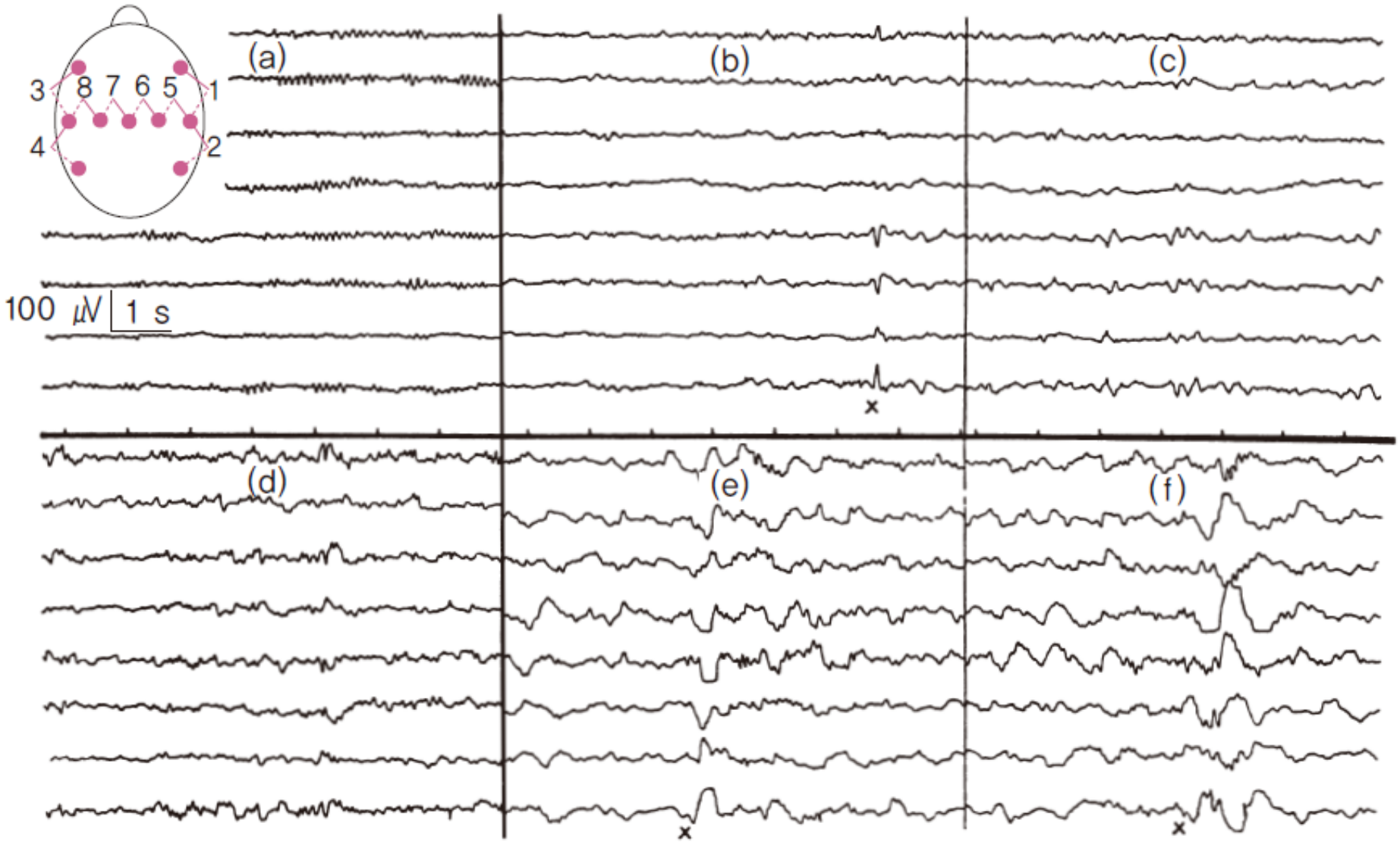


B



C

A. 광 자극유도반응(광자극과 같은 Hz의 파형이 보인다.)
B. 광 근원반응
C. 광 경련반응(불빛에 의한 자극으로 극파가 나타나고 있다.)



(a) 각성 · 눈감은 상태에서 광범위하게 α파 출현(50% 이상)

(b) Stage Ⅰ, X는 각성 자극시 마루부에 봉우리파 출현

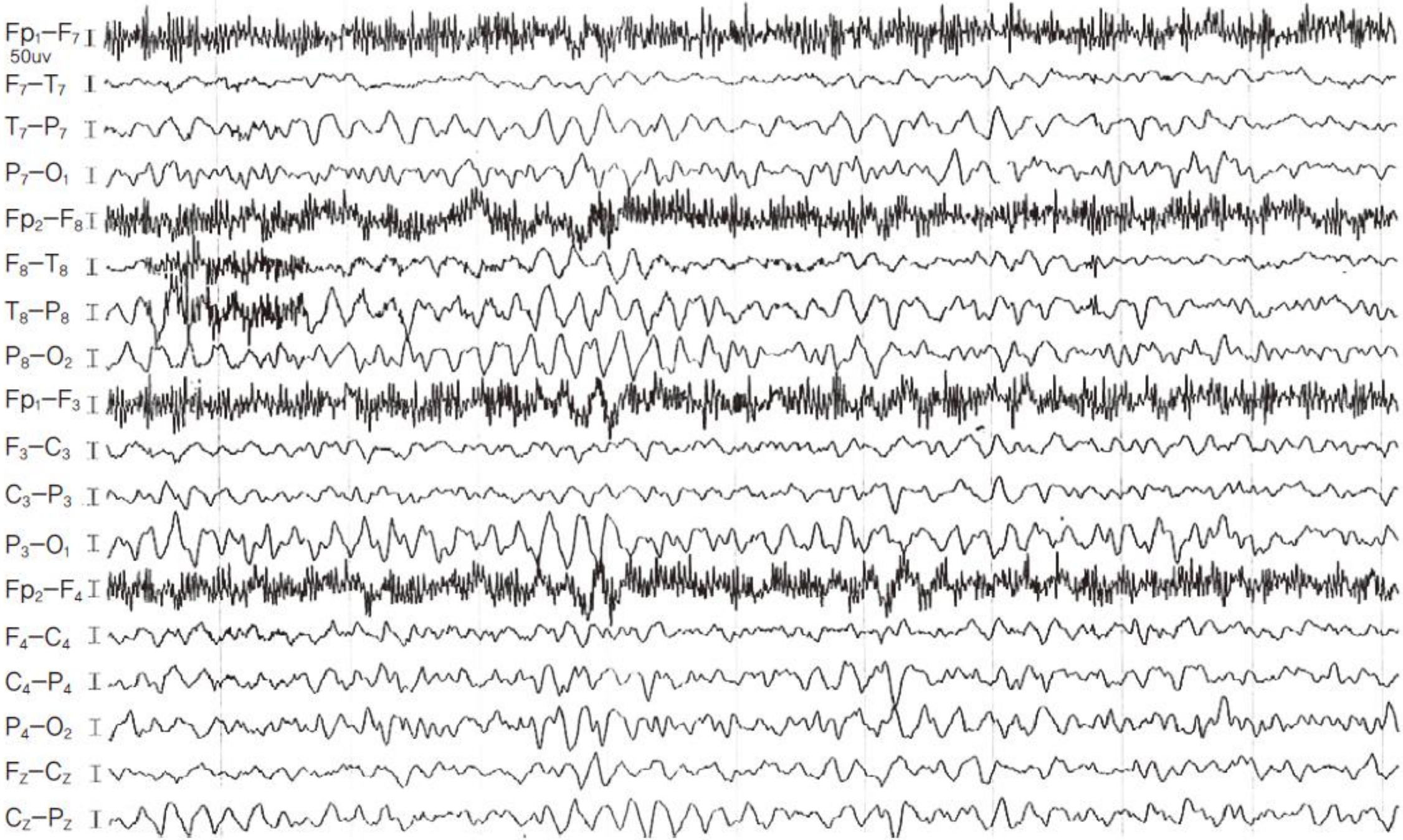
(c) Stage Ⅰ(얕은수면 시) θ파 우세

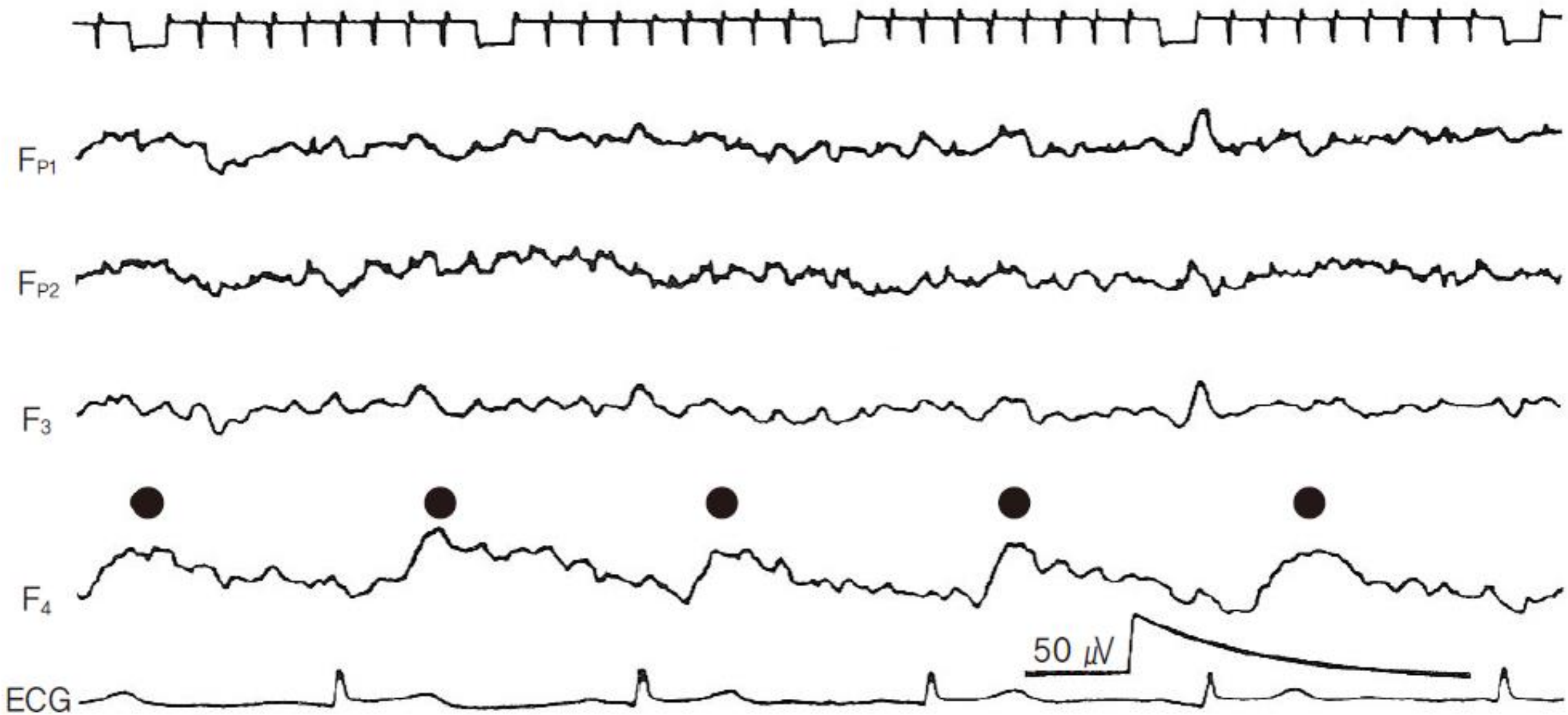
(d) Stage Ⅱ, 느린파활동 증가 방추파 출현

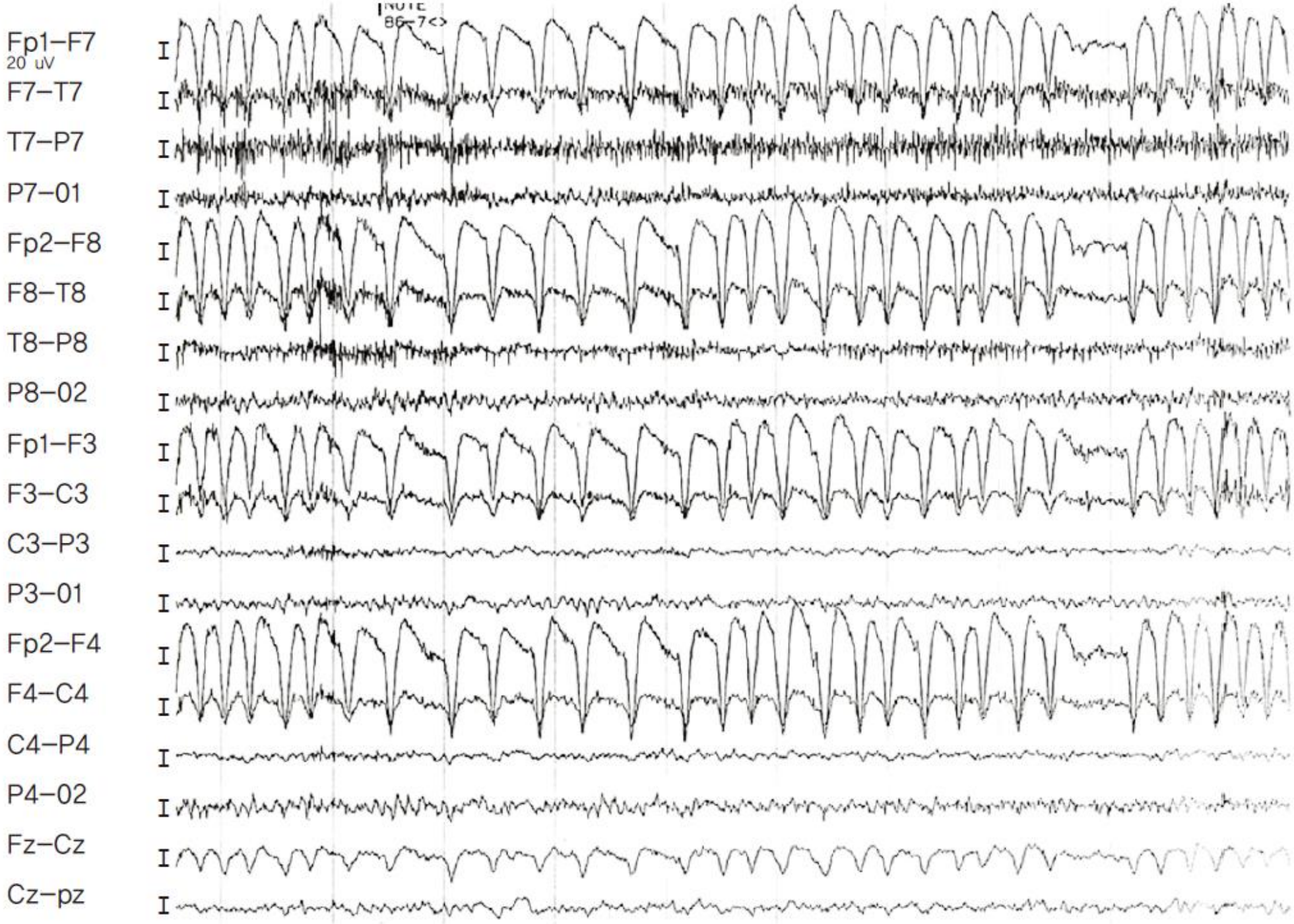
(e,f) Stage Ⅱ, 불규칙한 δ 활동 (20% 이하) ×는 음자극에 의한 K-complex 출현

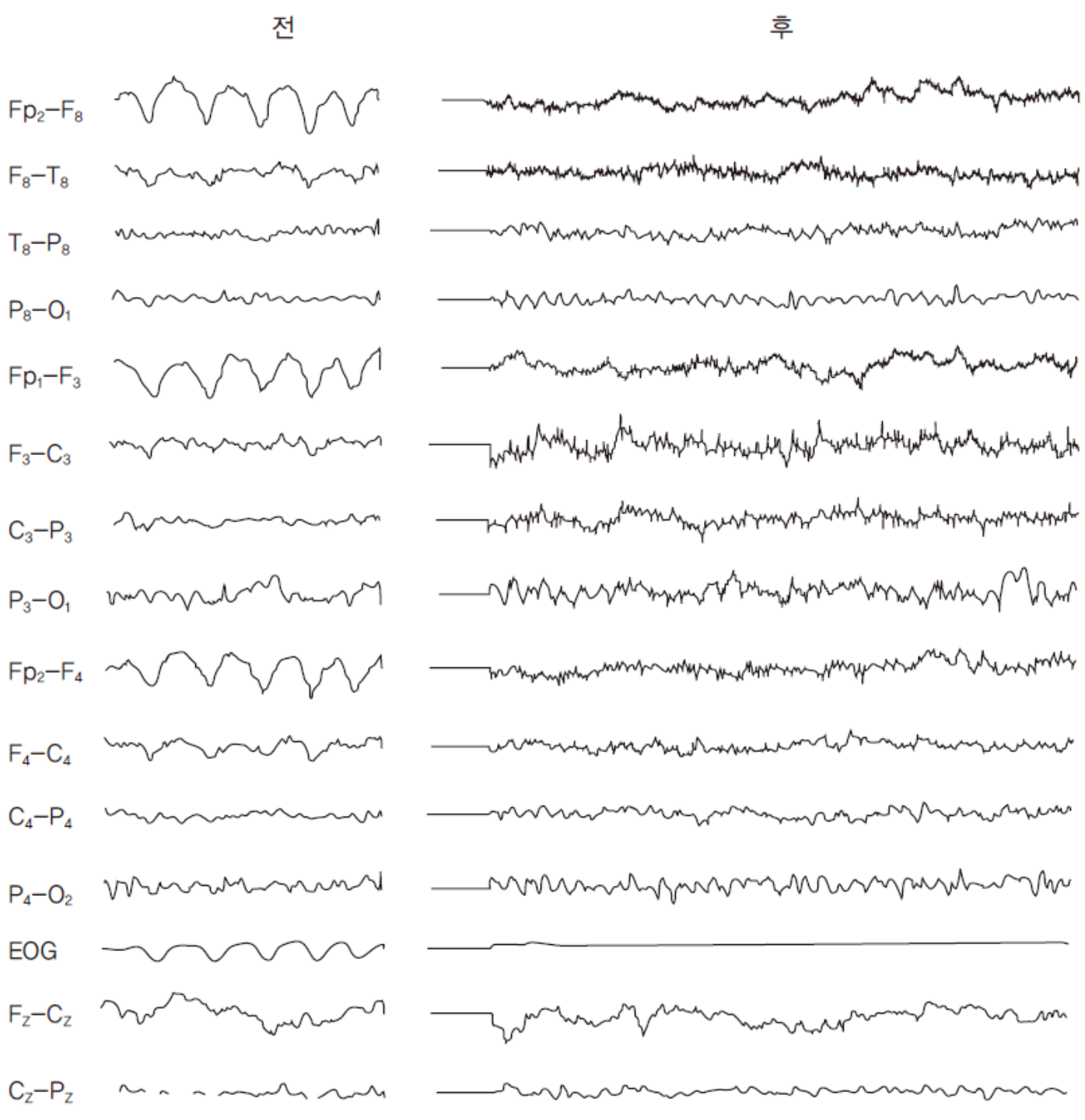
표 4-2. 뇌파 유발방법 및 특징

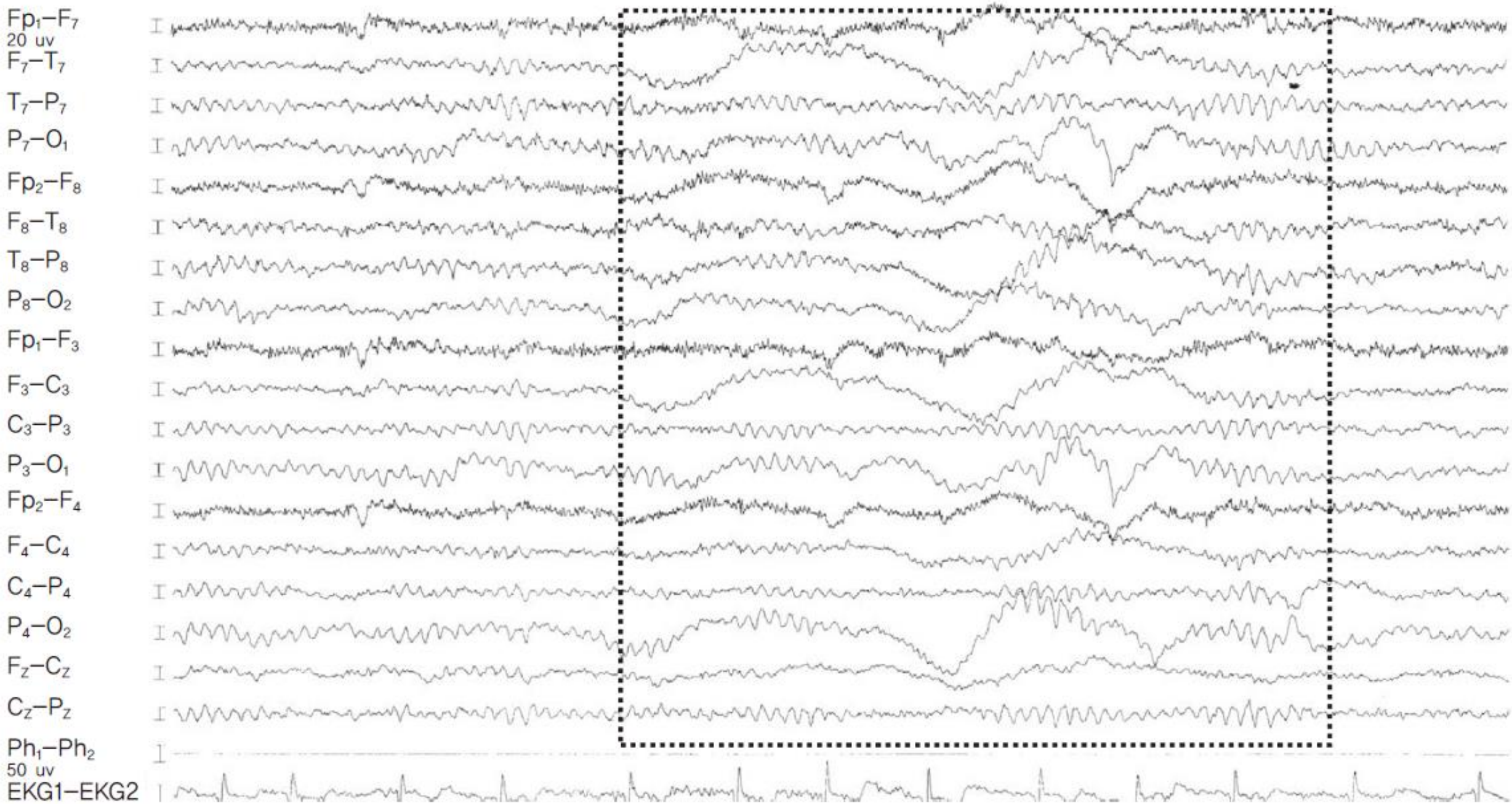
유발법	눈뜨기/눈감기	과호흡	섬광자극	수면
방법	• 안정, 각성, 눈감기 상태의 기록 중 5~10초간 눈뜨기 실시(2~3회 반복)	• 안정, 각성, 눈감기 상태에서 20~30회/분의 심호흡을 3분간 지속	• 섬광자극기를 눈앞 30 cm 시야 중앙에 위치시키고 1~30 Hz 빈도를 다양하게 10초 간격으로 실시	• 자연수면과 약물에 의한 수면 유도 • stage 1~2가 포함 10~20분 기록
뇌파상 특징	• a-blocking : 눈뜨기에 의해 a가 억제되는 현상	• 증강(build up) : 느린파가 혼입, 증대되는 것	• 광자극유도(photic driving) 반응은 뒤통수부에서 광자극의 빈도와 일치한 파가 출현 • 연소자일수록 뚜렷함	• 수면의 단계에 따른 특징적 뇌파변화 관찰
임상적 의의	• a-blocking 이상 • 이상파의 명확화 : 겉질의 국한성, 초점성은 출현하나 심부장애 유래의 느린파는 억제된다. • 연령요인(+)	• 소아나 간질환자에 효과적(성인의 경우 공복 시에 쉽게 출현) • 돌발성 이상파 : 양측동기성 3 Hz 극느린파 율동(absence Sz) • 재증강 또는 지연성 증강의 관찰 • 연령요인(++)	• 좌, 우차 : 해당 쪽 뇌의 시각계의 기능장애 • 광, 돌발반응 : 광과민성으로 소발작 및 간대성 경련 뇌전증 시 극느린파, 다극느린파 복합파가 특징 • 광근육간대경련반응 : 섬광과 일치하여 안면, 사지에 경련이 유발 • 연령요인(+)	• 발작성 이상파의 출현(관자부 극파상 초점) • 수면파형의 좌우차(lazy activity) • 각성 시의 국재성 이상파의 잔존 • 방추파의 좌우 비동기 • 연령요인(++)

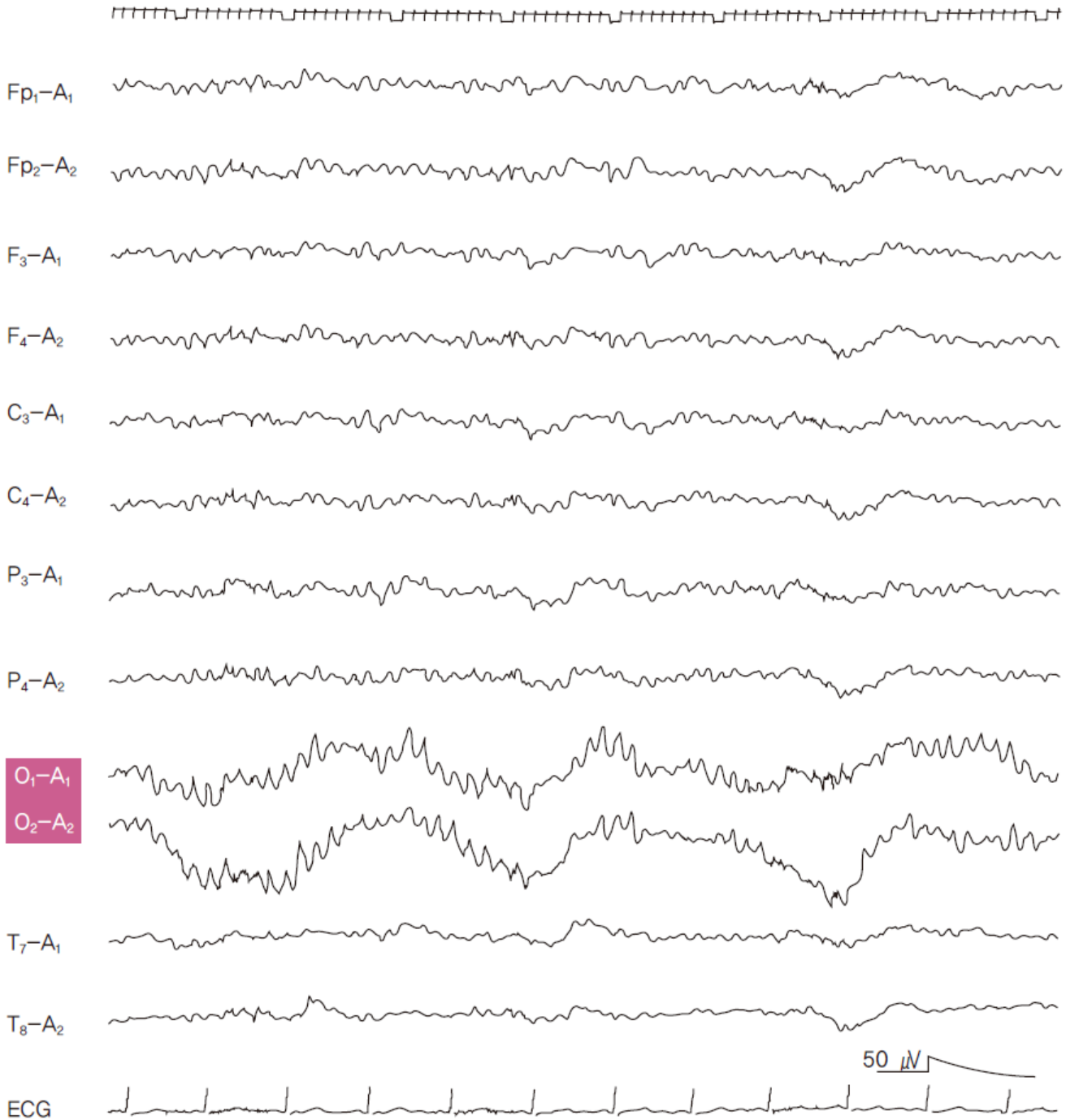

Fp1–F7
50uv
F7–T7
T7–P7
P7–O1
Fp2–F8
F8–T8
T8–P8
P8–O2
Fp1–F3
F3–C3
C3–P3
P3–O1
Fp2–F4
F4–C4
C4–P4
P4–O2
FZ–CZ
CZ–PZ


F_{P1}
F_{P2}
F_3
F_4
50 μV
ECG


Fp1–F7
20 uV
F7–T7
T7–P7
P7–01
Fp2–F8
F8–T8
T8–P8
P8–02
Fp1–F3
F3–C3
C3–P3
P3–01
Fp2–F4
F4–C4
C4–P4
P4–02
Fz–Cz
Cz–pz

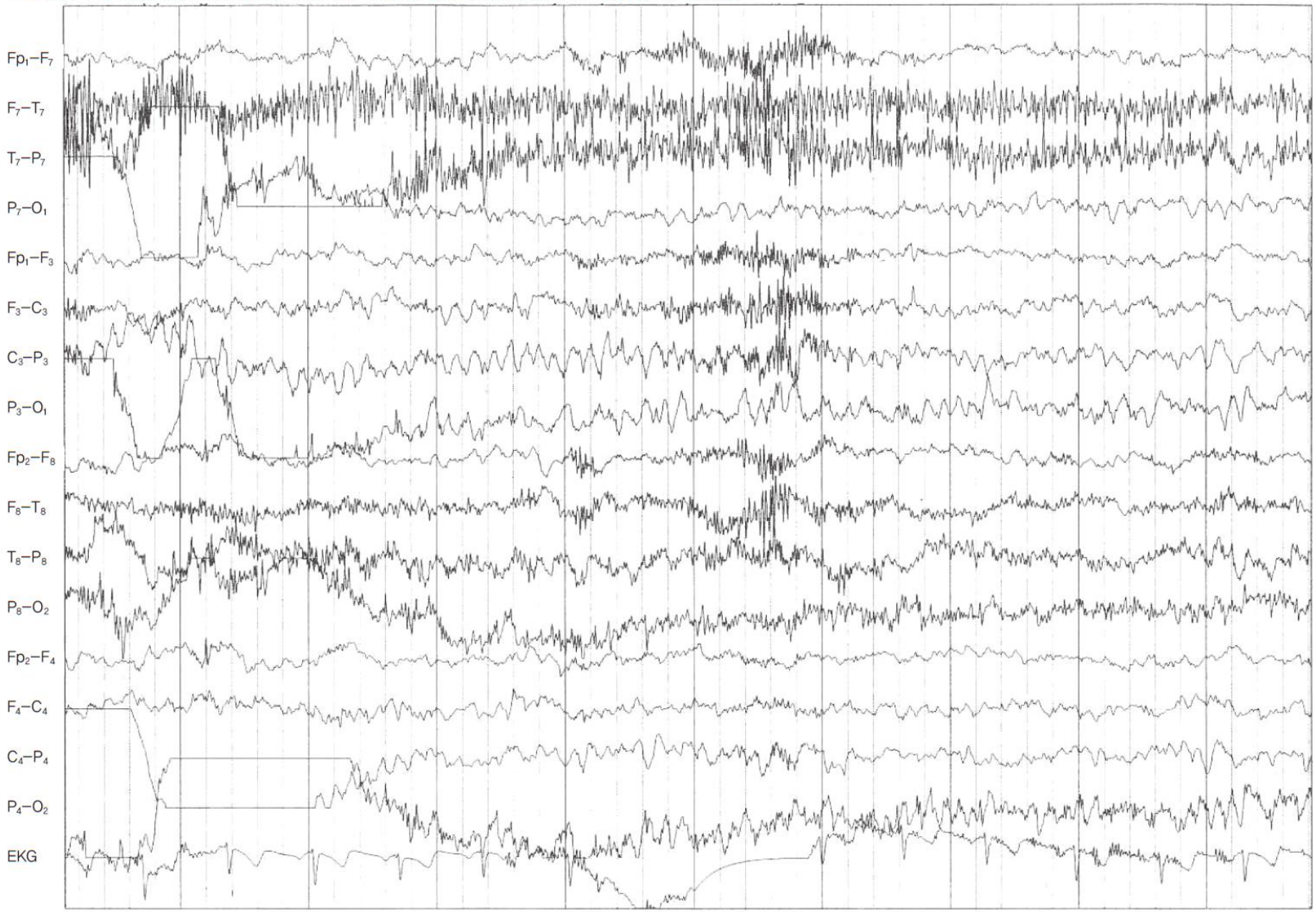

전
후
Fp2–F8
F8–T8
T8–P8
P8–O1
Fp1–F3
F3–C3
C3–P3
P3–O1
Fp2–F4
F4–C4
C4–P4
P4–O2
EOG
FZ–CZ
CZ–PZ

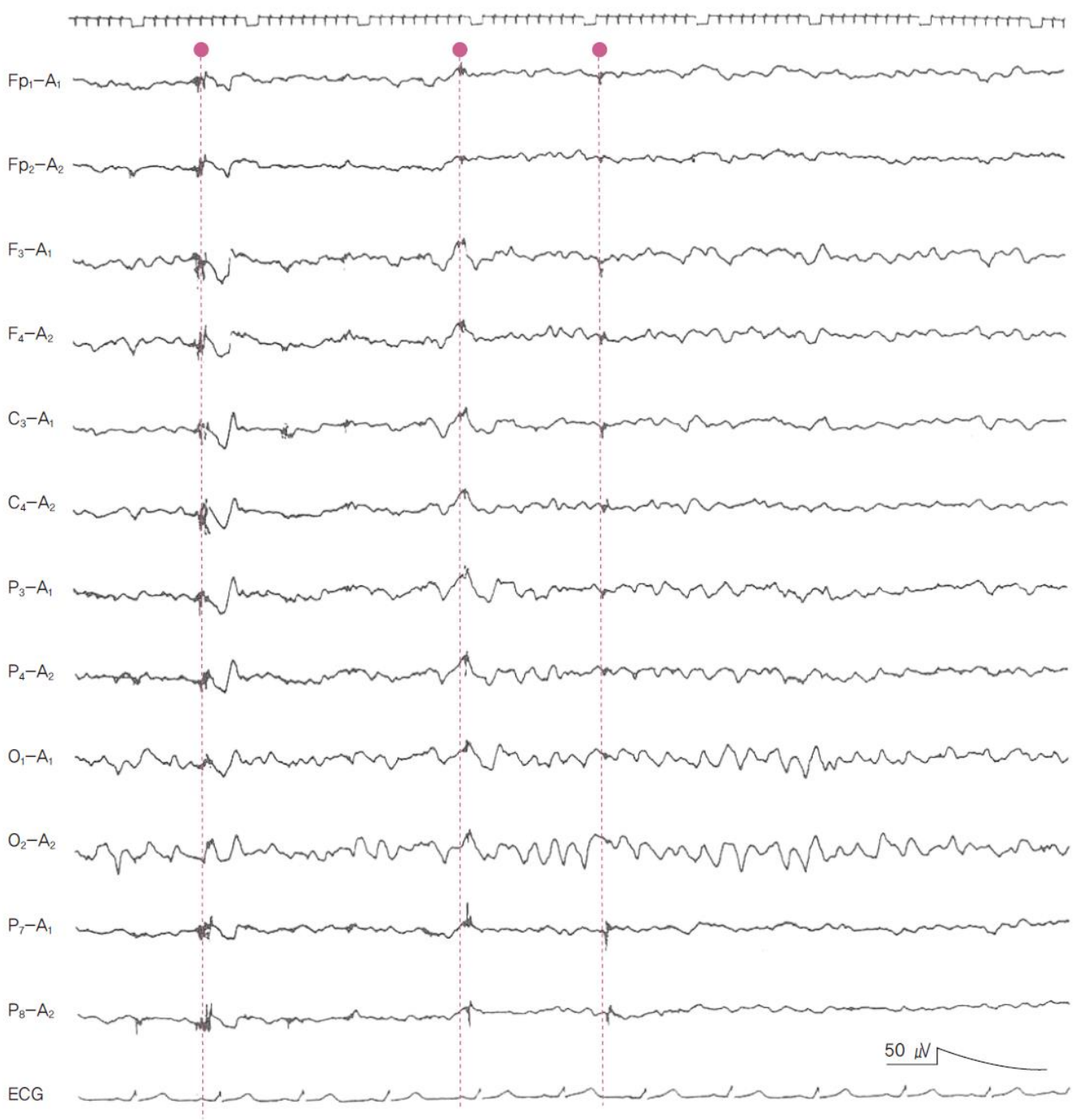

Fp1–F7
20 uv
F7–T7
T7–P7
P7–O1
Fp2–F8
F8–T8
T8–P8
P8–O2
Fp1–F3
F3–C3
C3–P3
P3–O1
Fp2–F4
F4–C4
C4–P4
P4–O2
Fz–Cz
Cz–Pz
Ph1–Ph2
50 uv
EKG1–EKG2

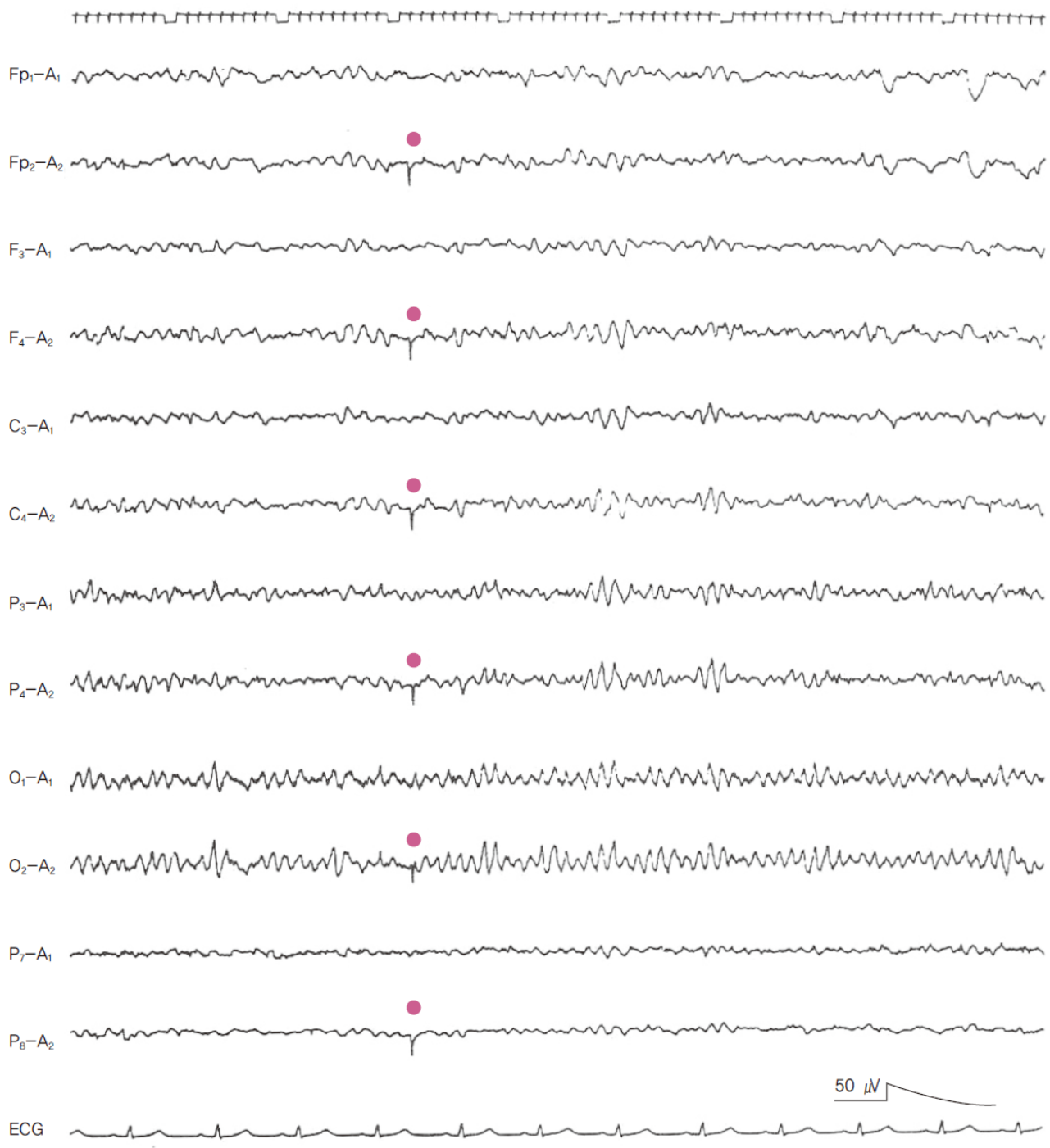

Fp1–A1
Fp2–A2
F3–A1
F4–A2
C3–A1
C4–A2
P3–A1
P4–A2
O1–A1
O2–A2
T7–A1
T8–A2
50 μV
ECG

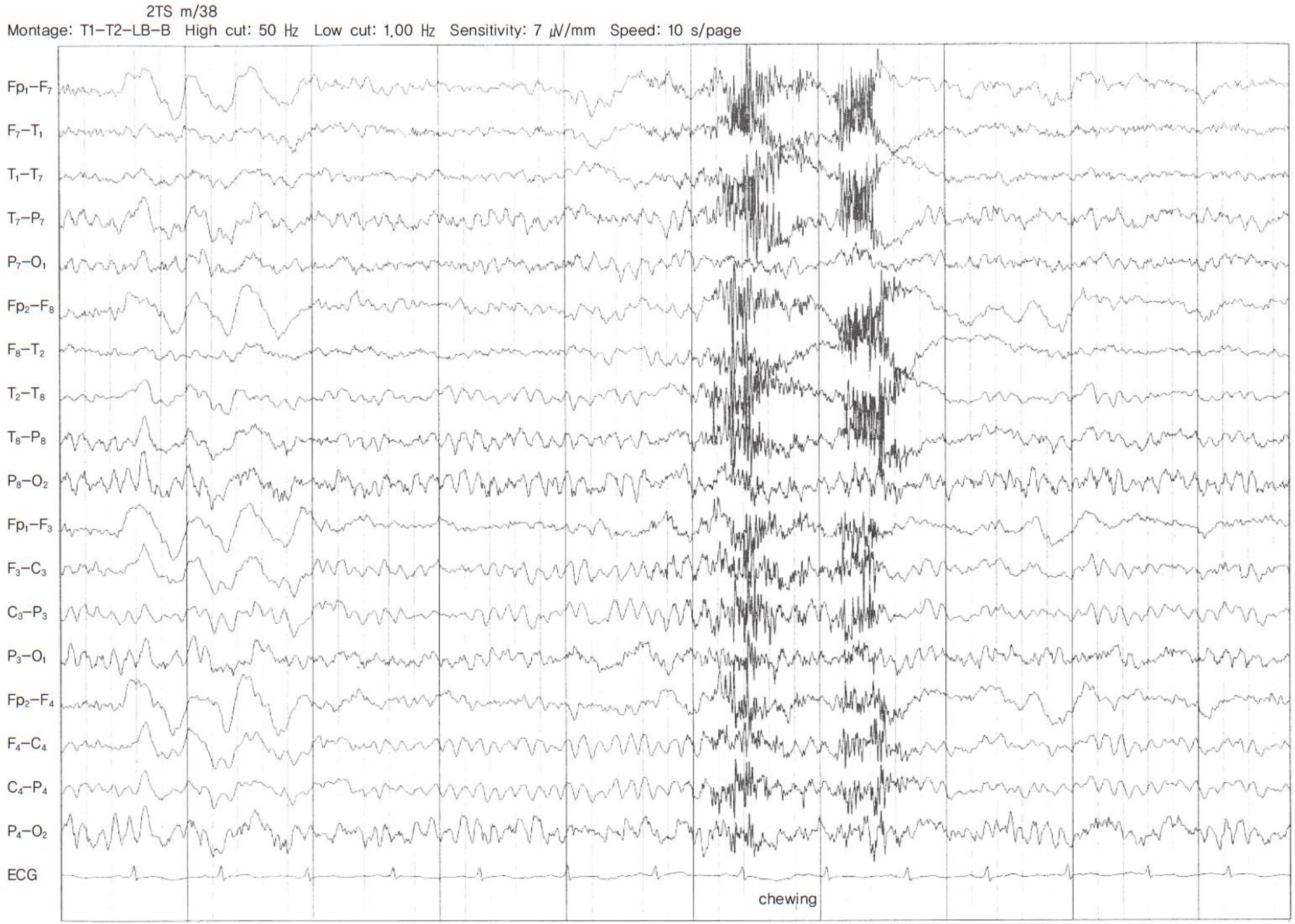
Patient ID: 수탁검사 ET 00:06:29.0 04-08-12 오후 3:30:42

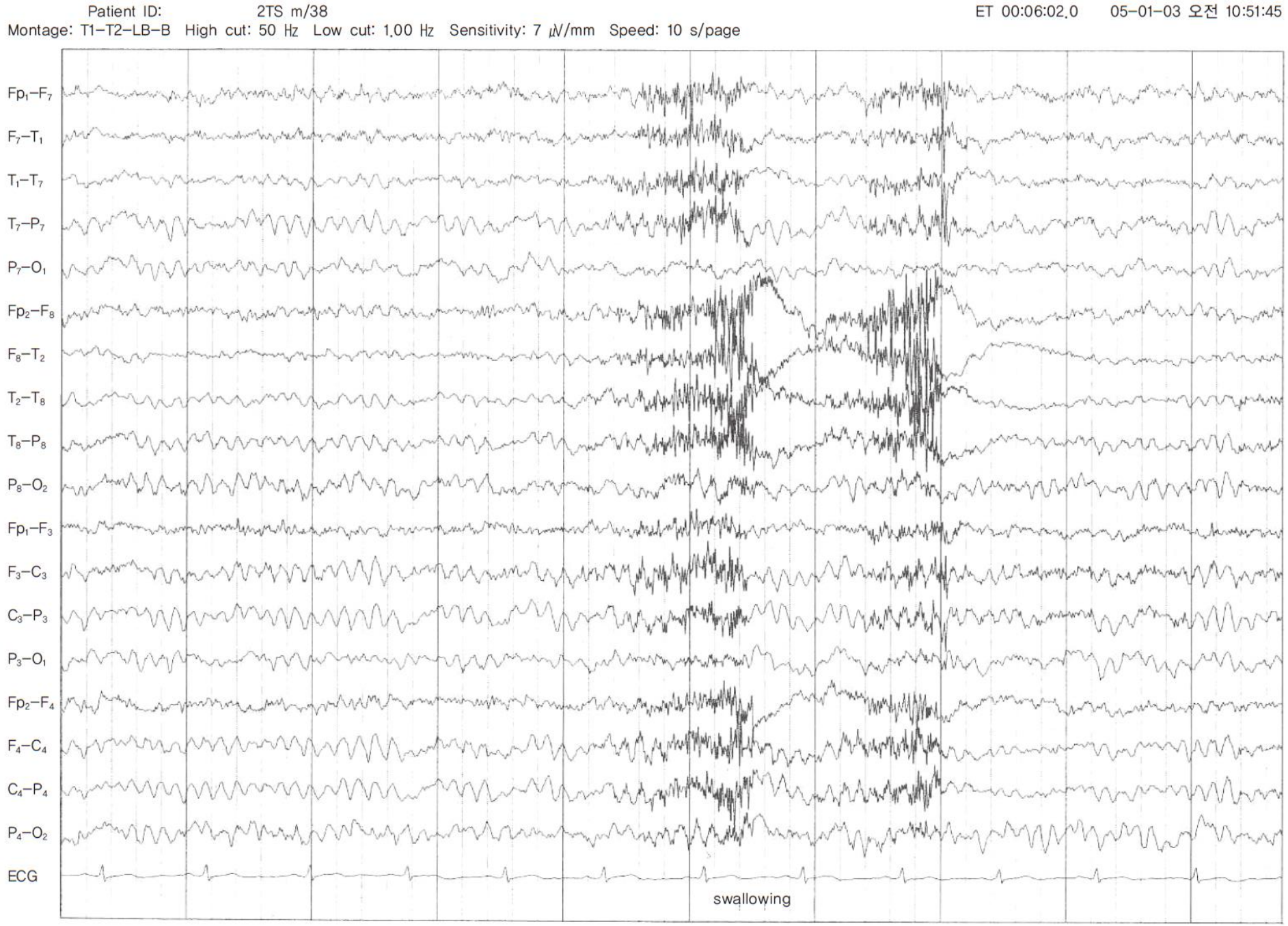
Montage: T-B II(A) High cut: 50 Hz Low cut: 1.00 Hz Sensitivity: 10 μV/mm Speed: 10 s/page

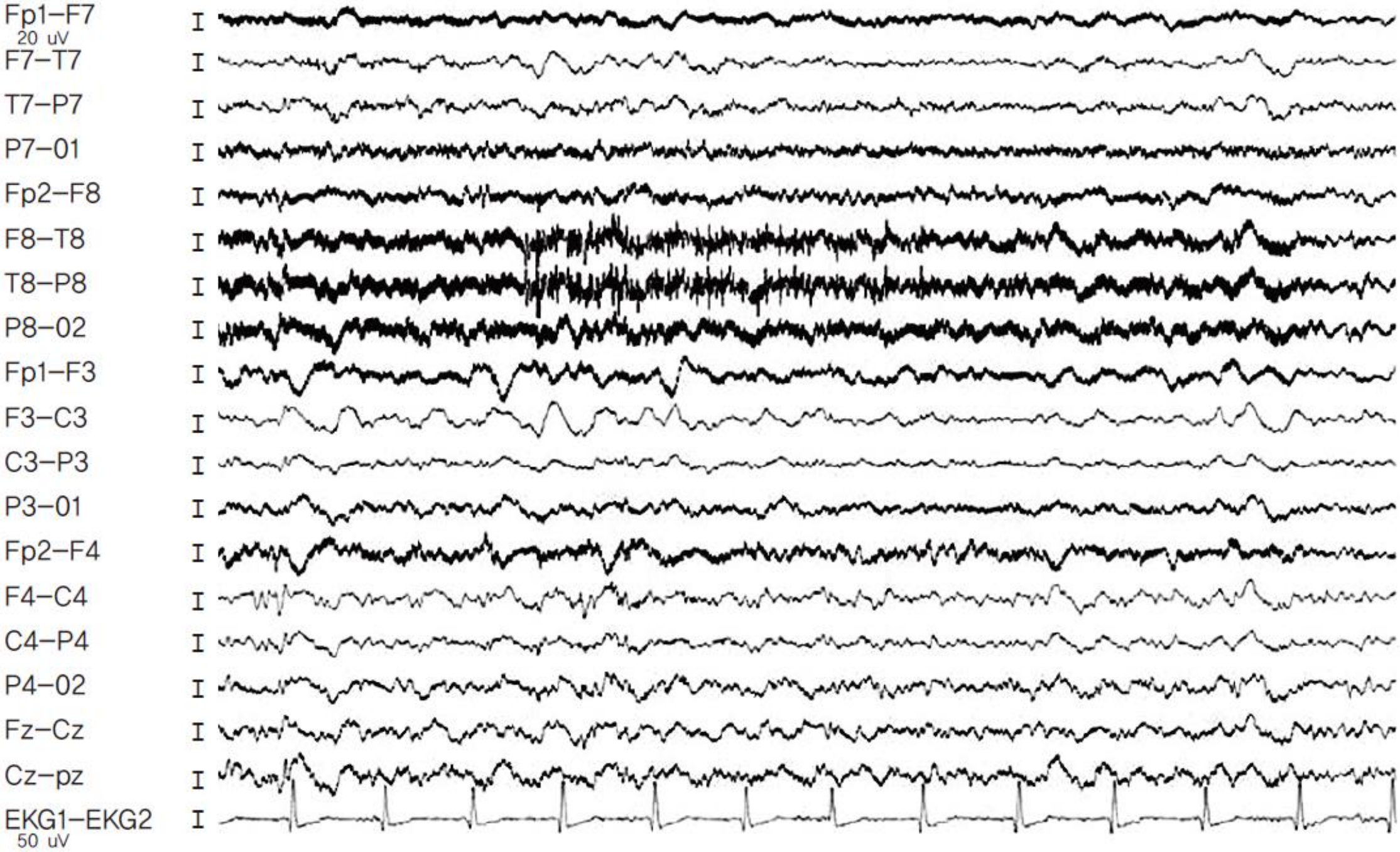


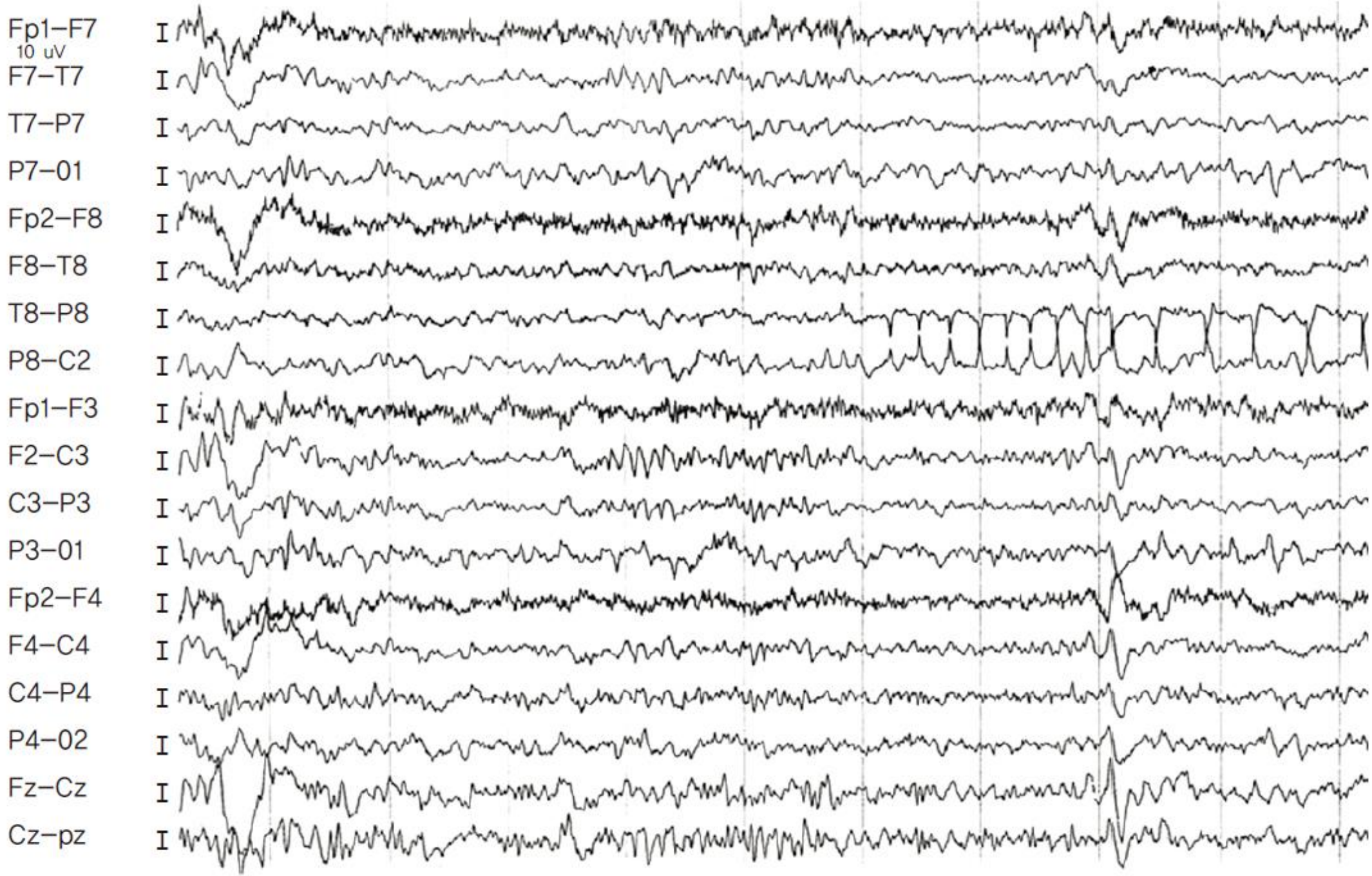

Fp1–A1
Fp2–A2
F3–A1
F4–A2
C3–A1
C4–A2
P3–A1
P4–A2
O1–A1
O2–A2
P7–A1
P8–A2
50 μV
ECG


Fp1–A1
Fp2–A2
F3–A1
F4–A2
C3–A1
C4–A2
P3–A1
P4–A2
O1–A1
O2–A2
P7–A1
P8–A2
50 μV
ECG

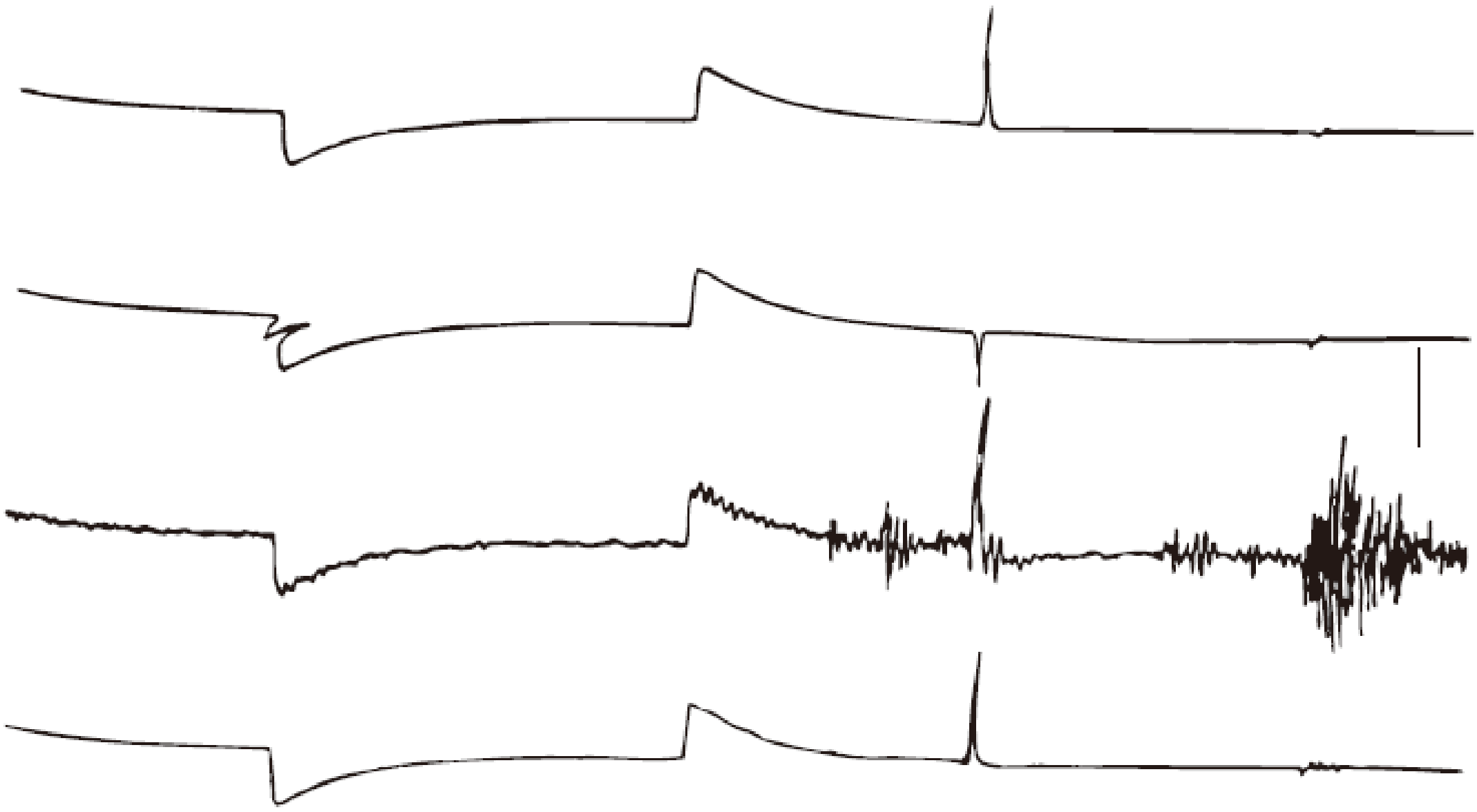

2TS m/38
Montage: T1-T2-LB-B High cut: 50 Hz Low cut: 1.00 Hz Sensitivity: 7 μV/mm Speed: 10 s/page
Fp1-F7
F7-T1
T1-T7
T7-P7
P7-O1
Fp2-F8
F8-T2
T2-T8
T8-P8
P8-O2
Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
P4-O2
ECG
chewing


Patient ID: 2TS m/38
ET 00:06:02.0 05-01-03 오전 10:51:45
Montage: T1-T2-LB-B High cut: 50 Hz Low cut: 1.00 Hz Sensitivity: 7 μV/mm Speed: 10 s/page
Fp1-F7
F7-T1
T1-T7
T7-P7
P7-O1
Fp2-F8
F8-T2
T2-T8
T8-P8
P8-O2
Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
P4-O2
ECG
swallowing


Fp1–F7
20 uV
F7–T7
T7–P7
P7–01
Fp2–F8
F8–T8
T8–P8
P8–02
Fp1–F3
F3–C3
C3–P3
P3–01
Fp2–F4
F4–C4
C4–P4
P4–02
Fz–Cz
Cz–pz
EKG1–EKG2
50 uV


Fp1–F7
10 uV
F7–T7
T7–P7
P7–01
Fp2–F8
F8–T8
T8–P8
P8–C2
Fp1–F3
F2–C3
C3–P3
P3–01
Fp2–F4
F4–C4
C4–P4
P4–02
Fz–Cz
Cz–pz


Fp1–AVG
F3–AVG
C3–AVG
P3–AVG
Fp2–AVG
F4–AVG
C4–AVG
P4–AVG
F7–AVG
T1–AVG
T3–AVG
T5–AVG
O1–AVG
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O2–AVG
Fz–AVG
Cz–AVG
Pz–AVG

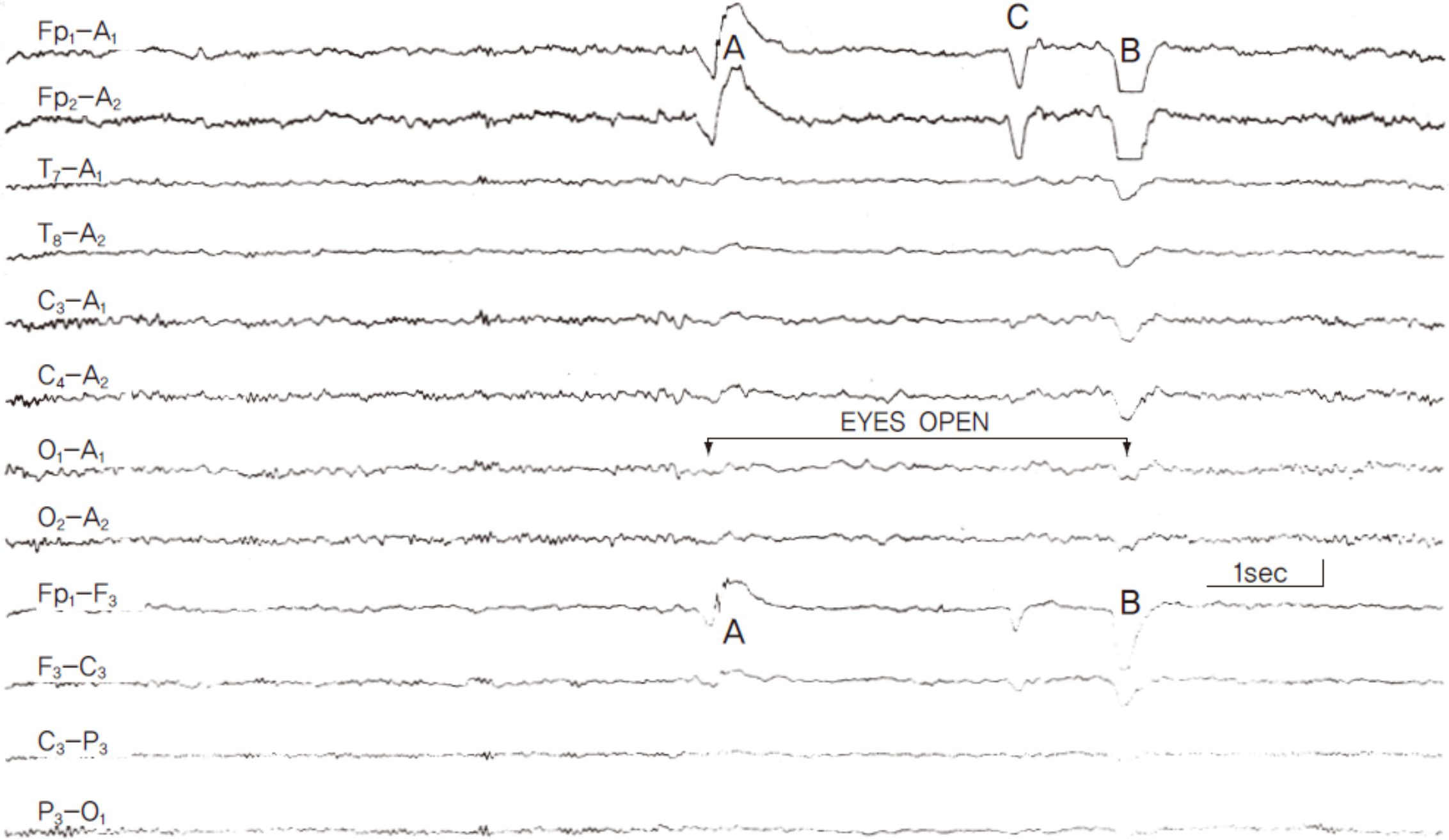


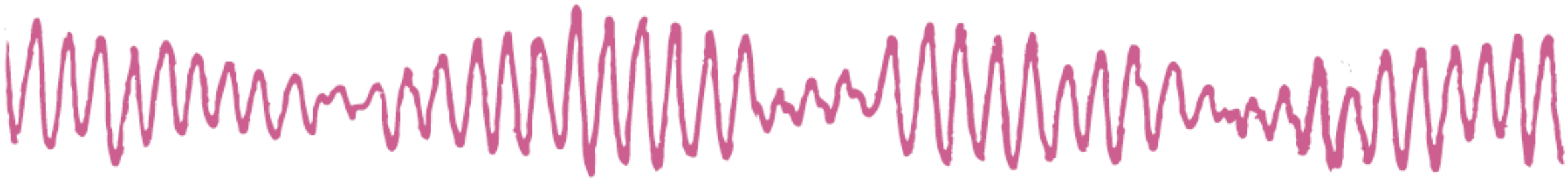
Section 05

정상뇌파

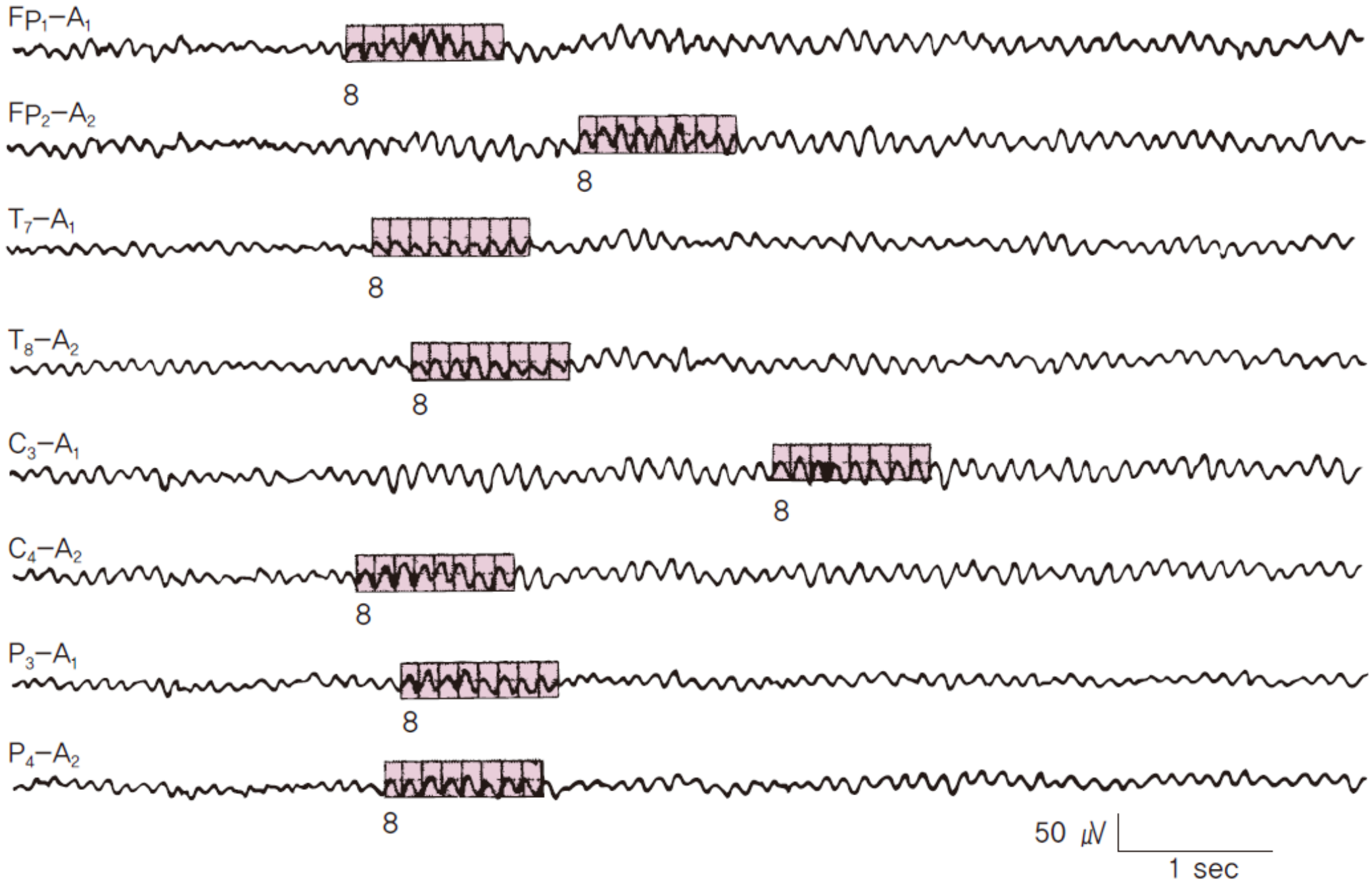
학습목표

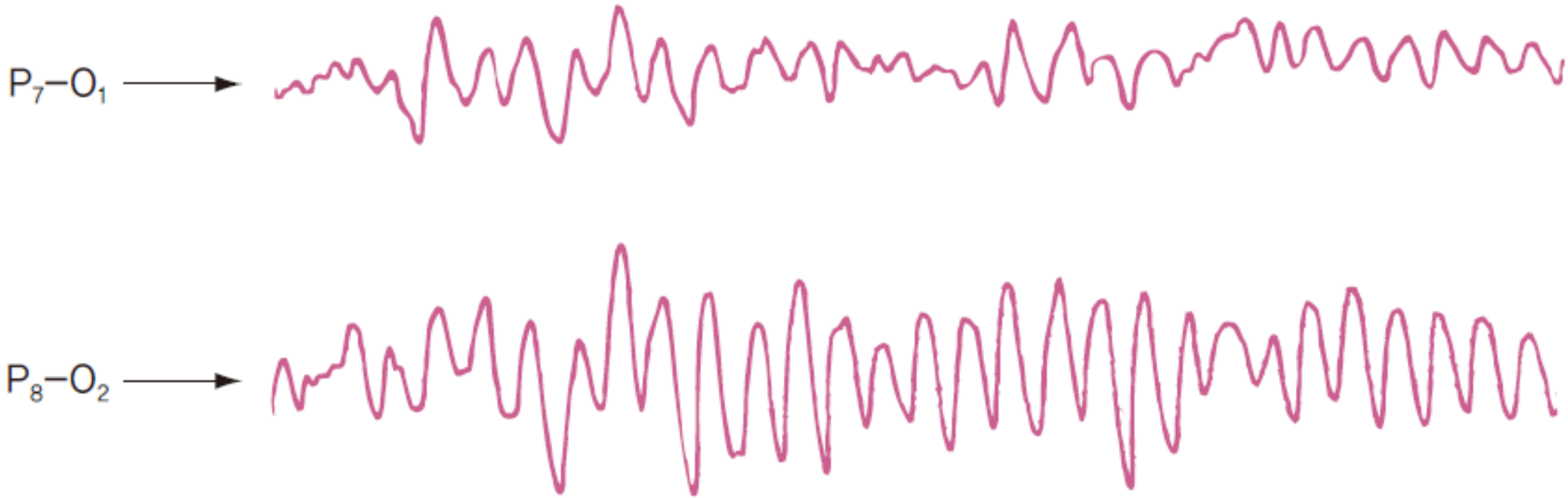
1. 정상 뇌파에 대해 설명할 수 있다(A).
2. 기초율동을 설명할 수 있다(A).
3. α-blocking과 역설적 α-blocking을 설명할 수 있다(A).
4. 연령의 뇌파변화를 설명할 수 있다(신생아, 소아, 성인, 고령자)(A).
5. 뇌파의 수면단계 및 특징을 설명할 수 있다(REM 수면과 Non-REM 수면의 단계별 특징)(A).

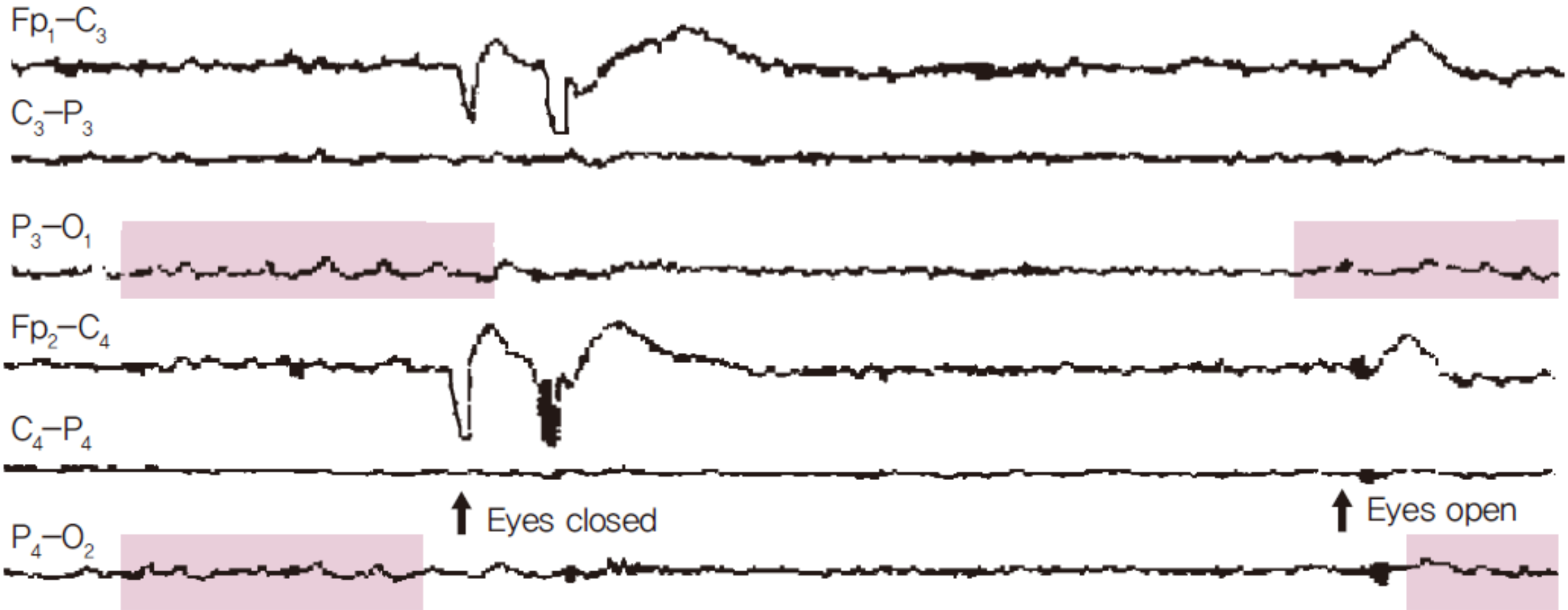

Fp1–A1
Fp2–A2
T7–A1
T8–A2
C3–A1
C4–A2
O1–A1
O2–A2
Fp1–F3
F3–C3
C3–P3
P3–O1
A
C
B
EYES OPEN
1sec

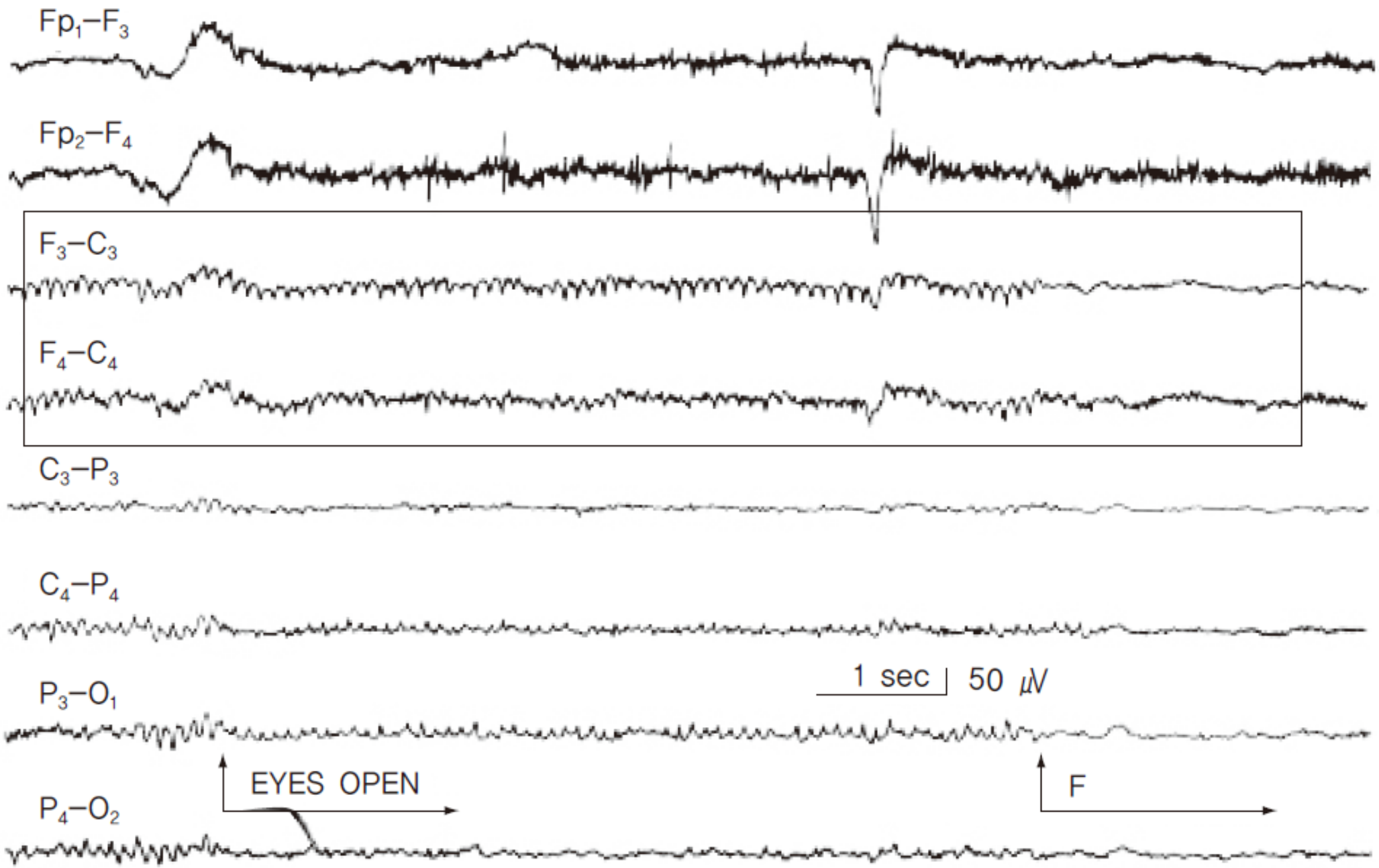


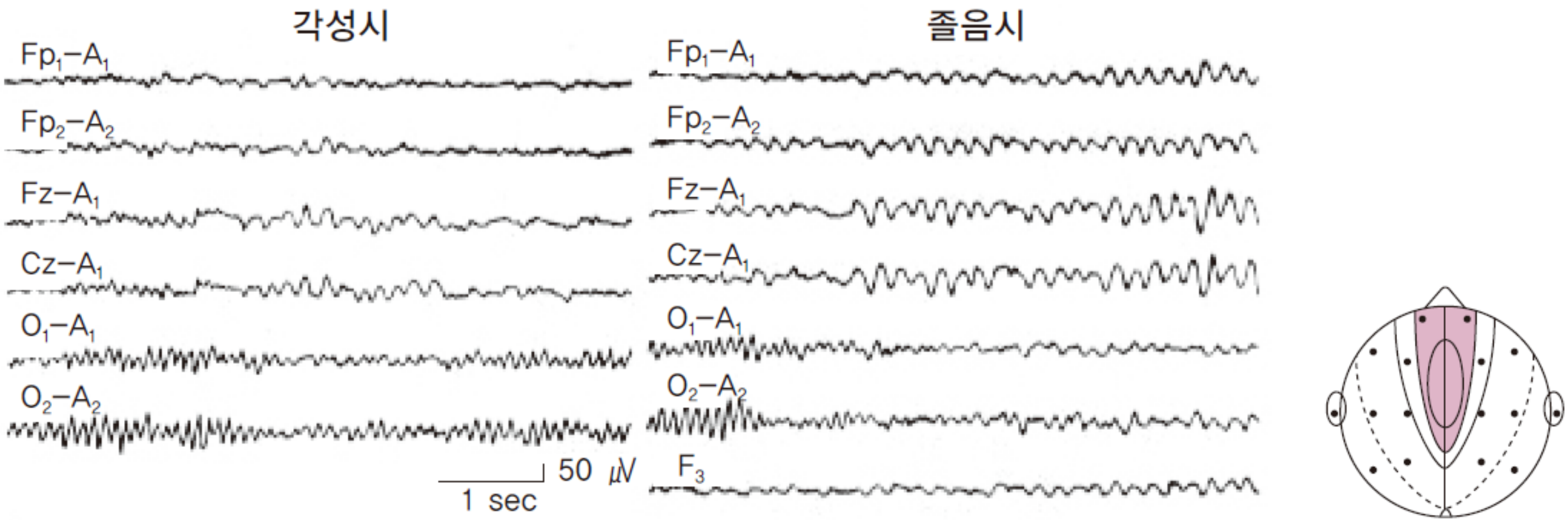
1) waxing and waning을 나타내는 α파

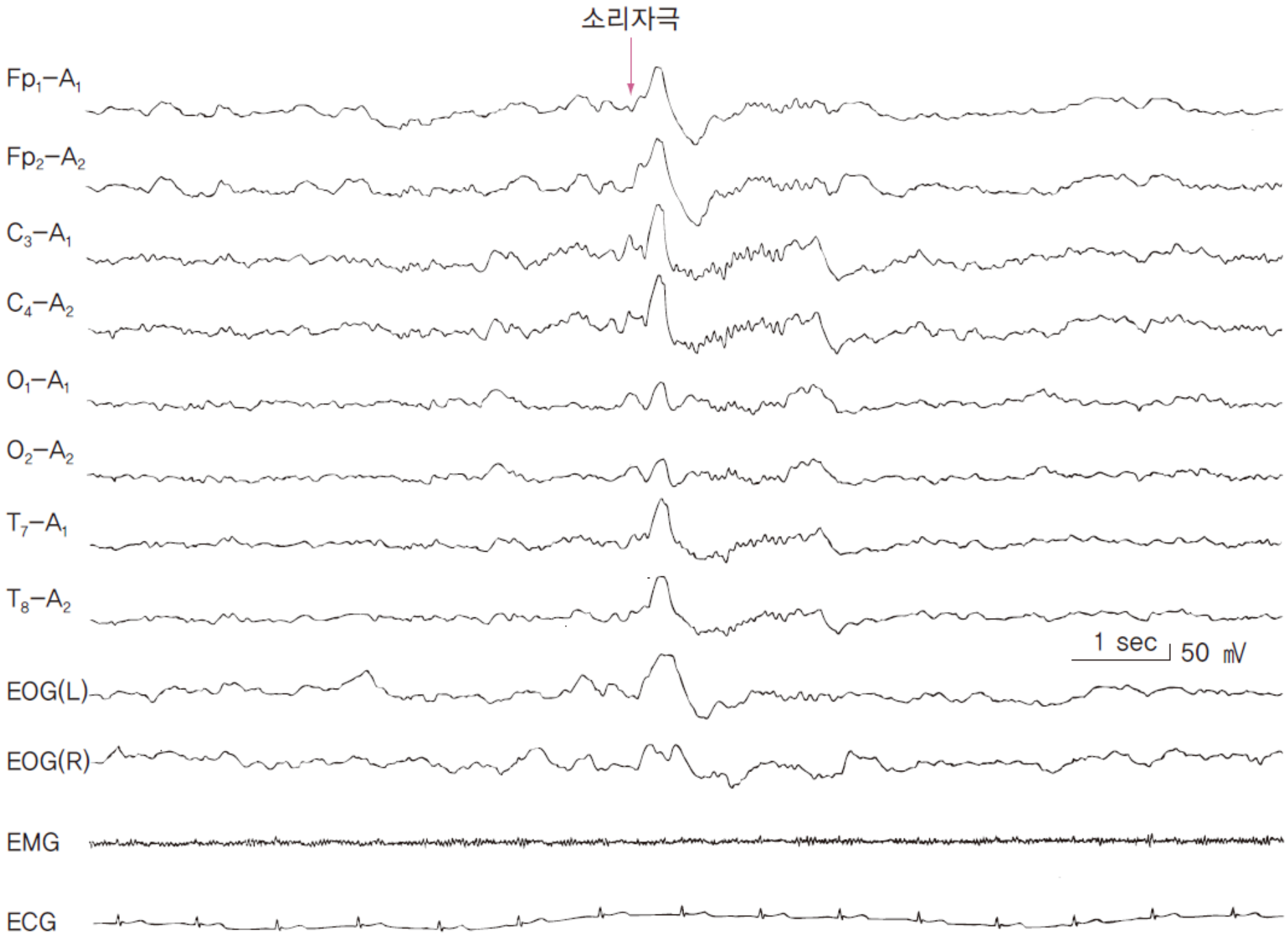

FP_1-A_1
8
FP_2-A_2
8
T_7-A_1
8
T_8-A_2
8
C_3-A_1
8
C_4-A_2
8
P_3-A_1
8
P_4-A_2
8
50 μV
1 sec

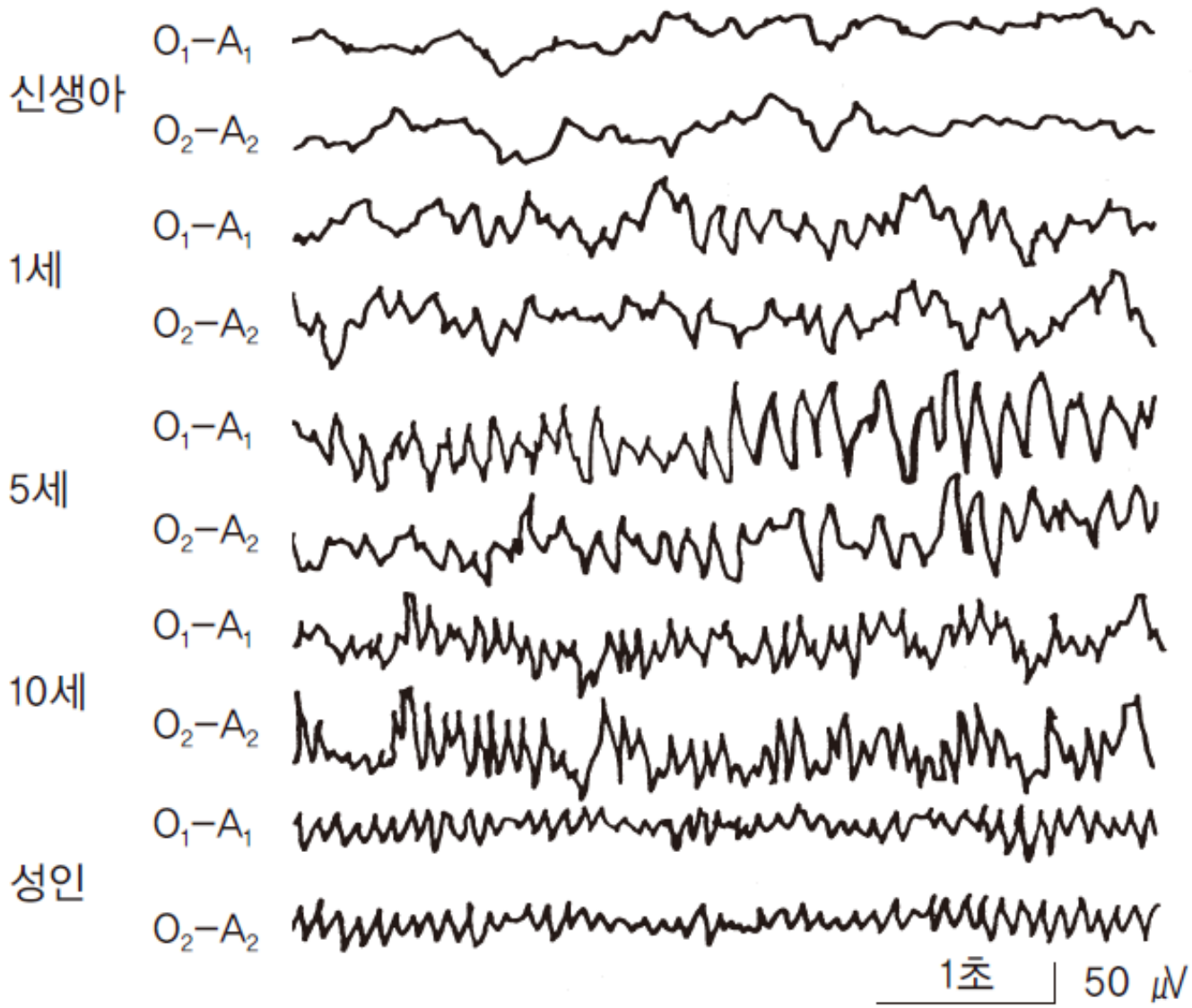

P_7–O_1
P_8–O_2


Fp_1–C_3
C_3–P_3
P_3–O_1
Fp_2–C_4
C_4–P_4
Eyes closed
Eyes open
P_4–O_2

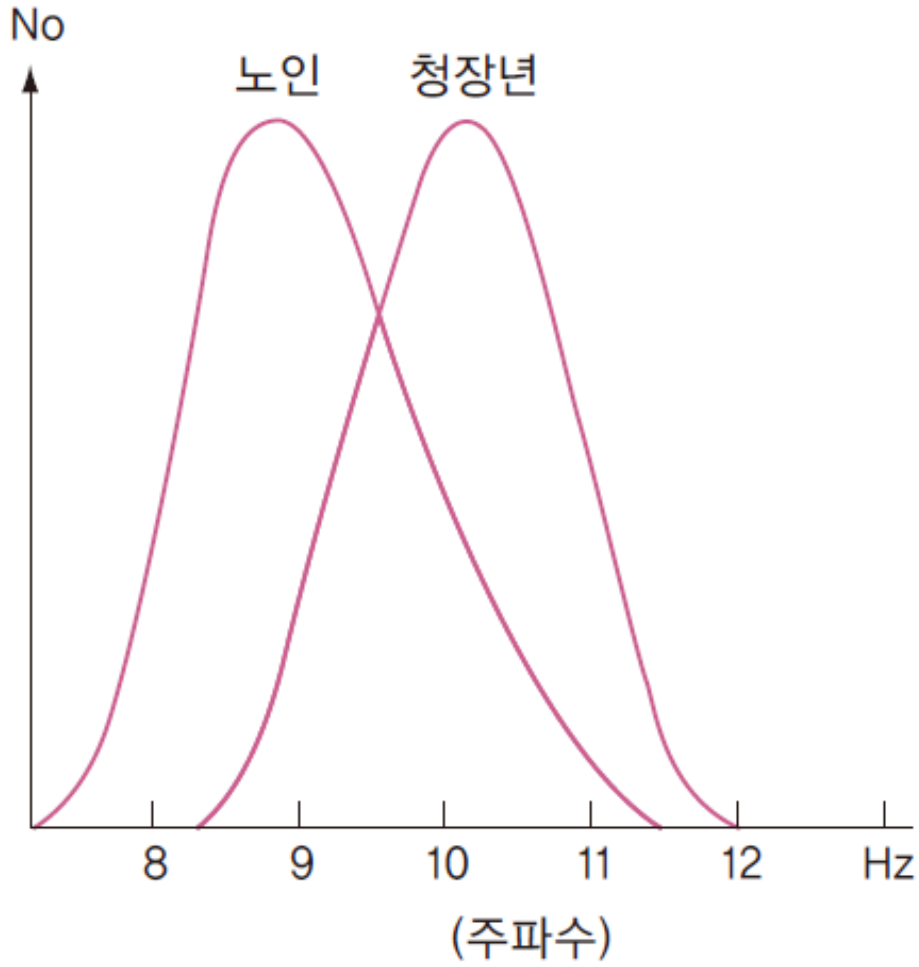

Fp1–F3
Fp2–F4
F3–C3
F4–C4
C3–P3
C4–P4
1 sec
50 μV
P3–O1
EYES OPEN
F
P4–O2


각성시
졸음시
Fp1–A1
Fp2–A2
Fz–A1
Cz–A1
O1–A1
O2–A2
50 μV
1 sec
Fp1–A1
Fp2–A2
Fz–A1
Cz–A1
O1–A1
O2–A2
F3


소리자극
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 ㎷
EOG(L)
EOG(R)
EMG
ECG



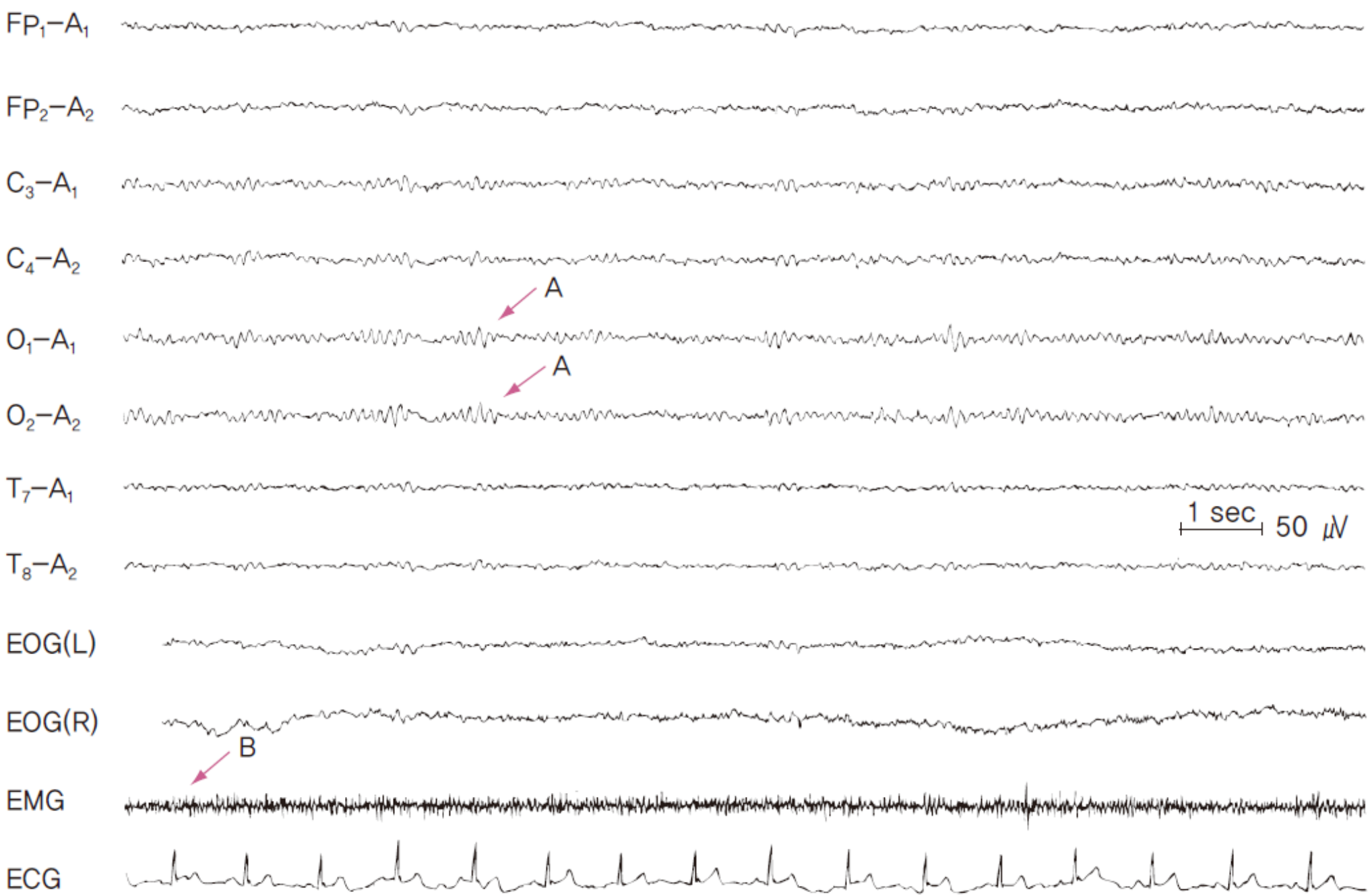
A

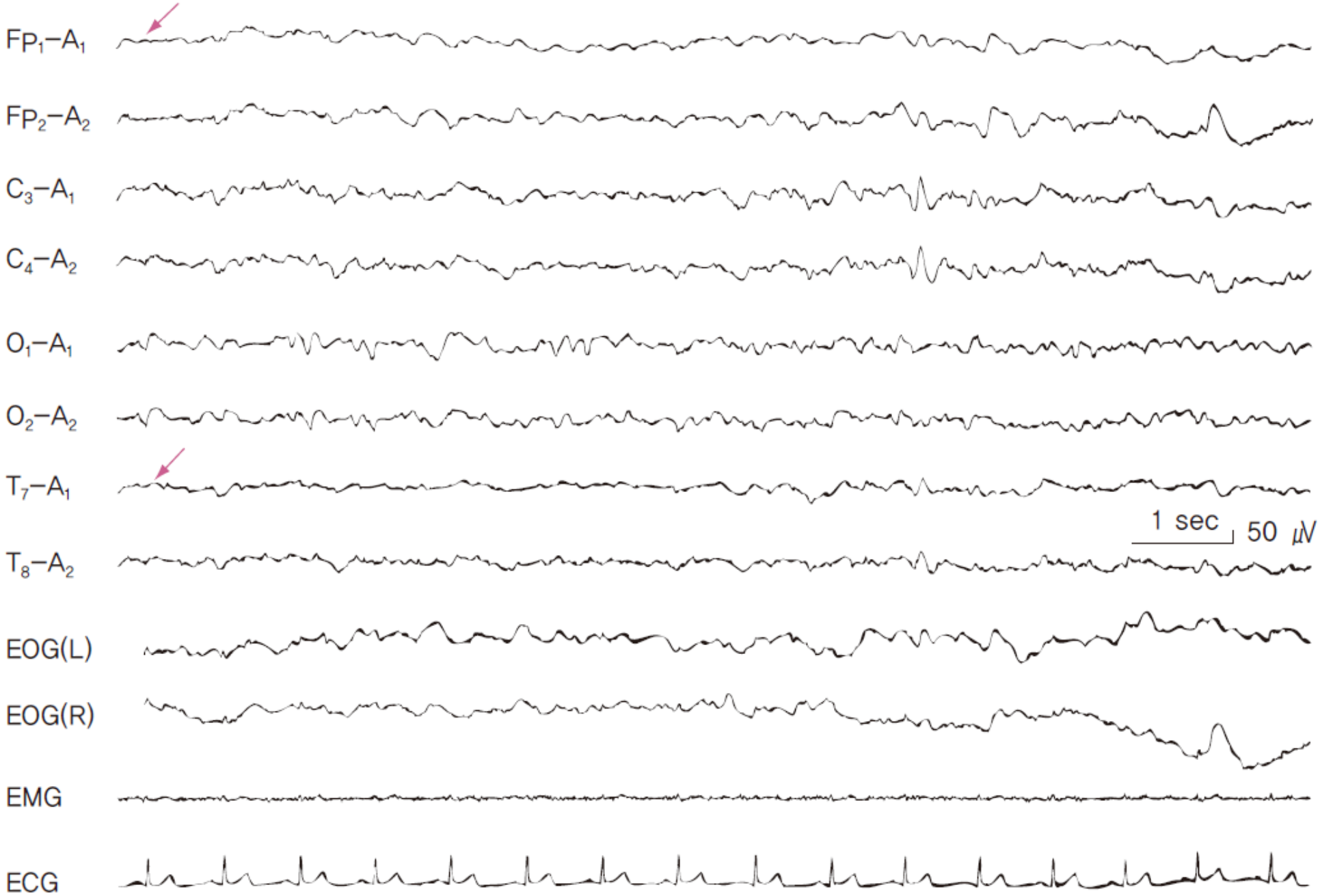


B

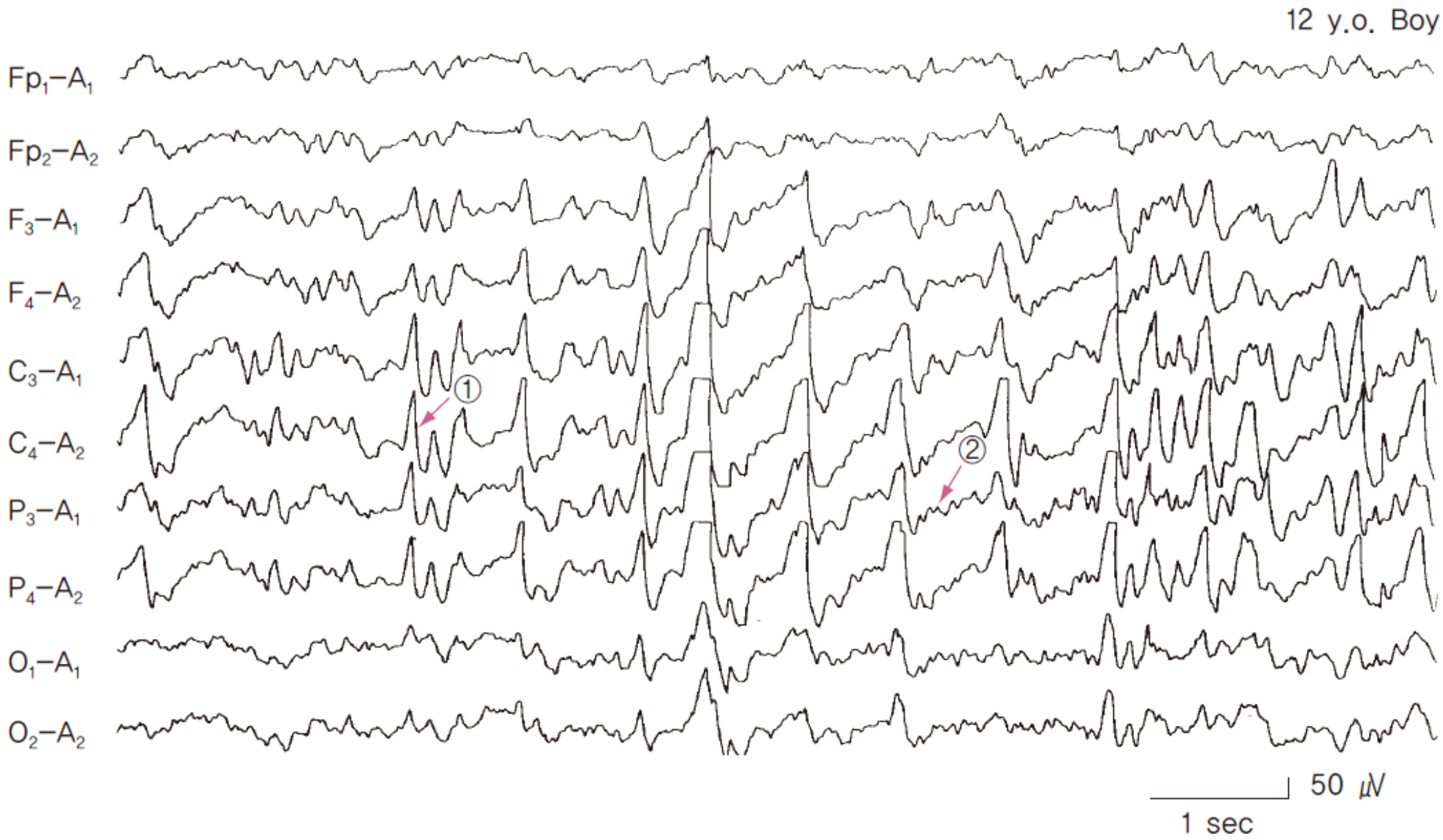
표 5-1. 수면 단계분류 및 뇌파소견

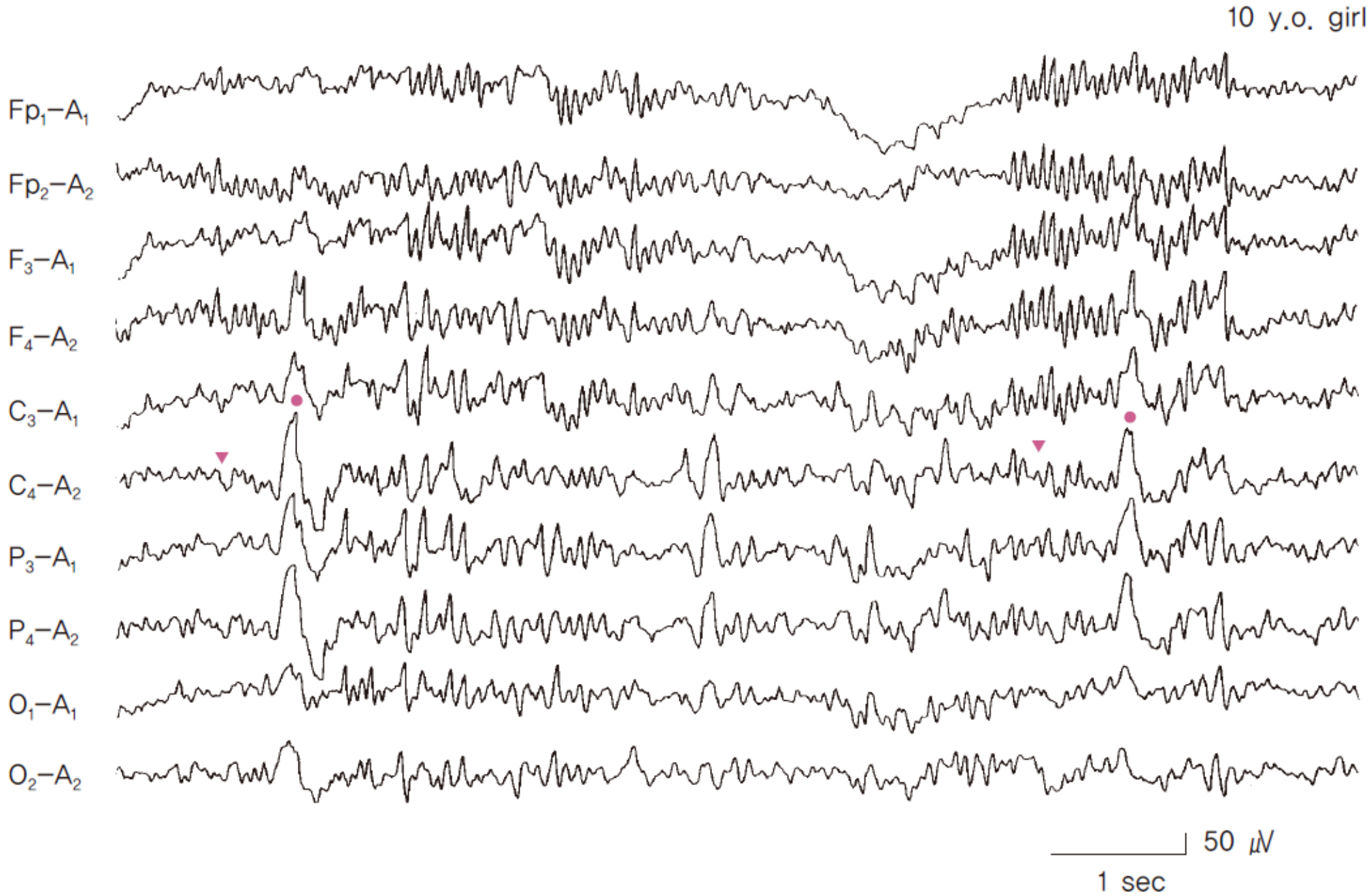
국제 분류	수면 깊이에 의한 분류	뇌파의 소견	생리학적 분류
각성 단계 (Stage W)	각성기	• α파 50% 이상	안정, 각성 눈감기
수면 1단계 (Stage I)	얕은 수면 초기	• α파가 50% 이하로 감소 • α파의 연속성과 진폭의 현저한 저하 • 낮은 진폭의 β파와 θ파 등 여러 가지 주파수의 뇌파가 나타난다. • 중심 · 마루 부위에서 봉우리파가 출현(50~100 μV) • 뒤통수부 양성 예파(POSTs)	비렘수면 (NREM)
수면 2단계 (Stage II)	얕은 수면기	• 수면 1단계 특징 잔존 (봉우리파와 방추파가 혼재) • 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)

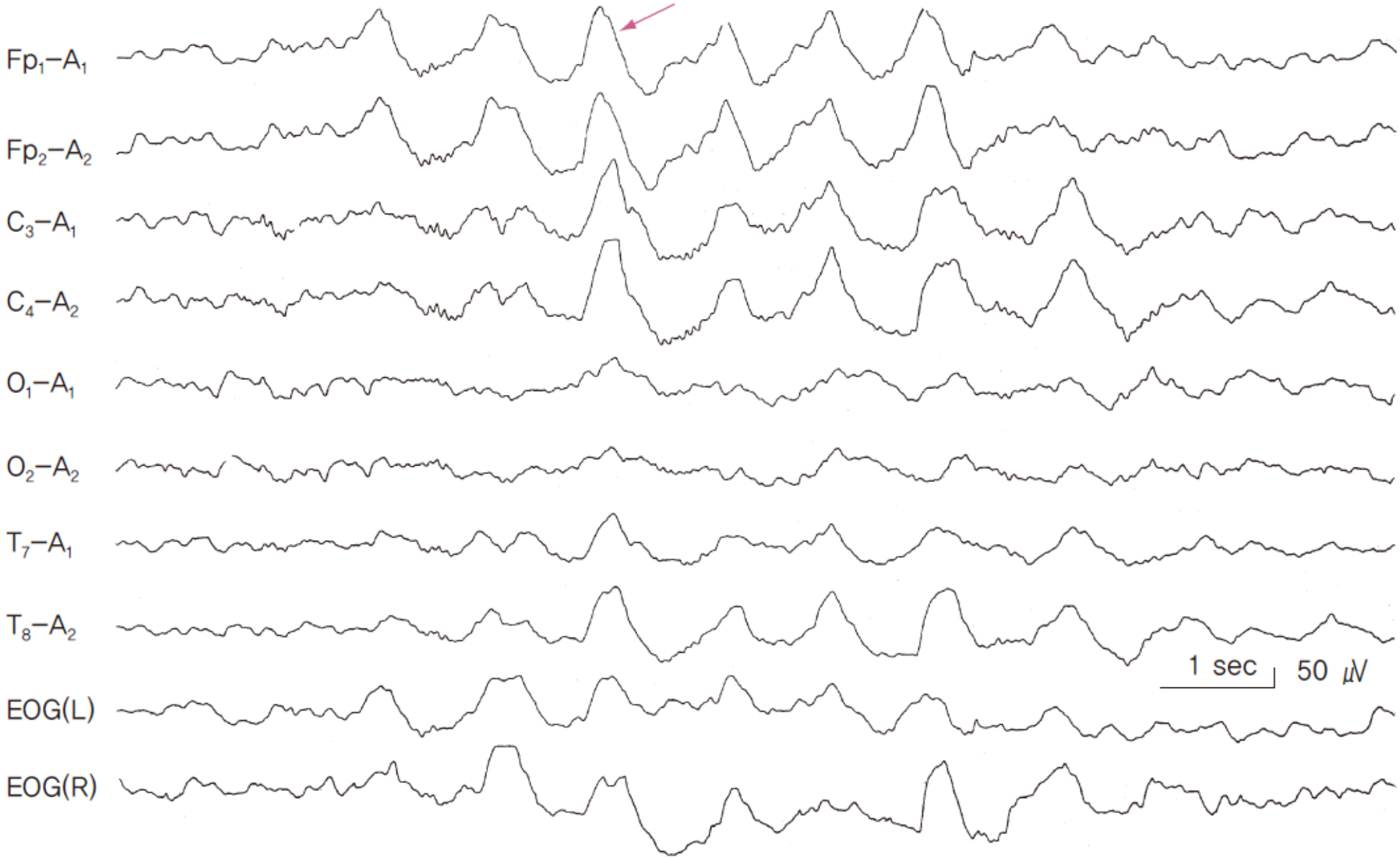

FP1–A1
FP2–A2
C3–A1
C4–A2
A
O1–A1
A
O2–A2
T7–A1
1 sec
50 μV
T8–A2
EOG(L)
EOG(R)
B
EMG
ECG

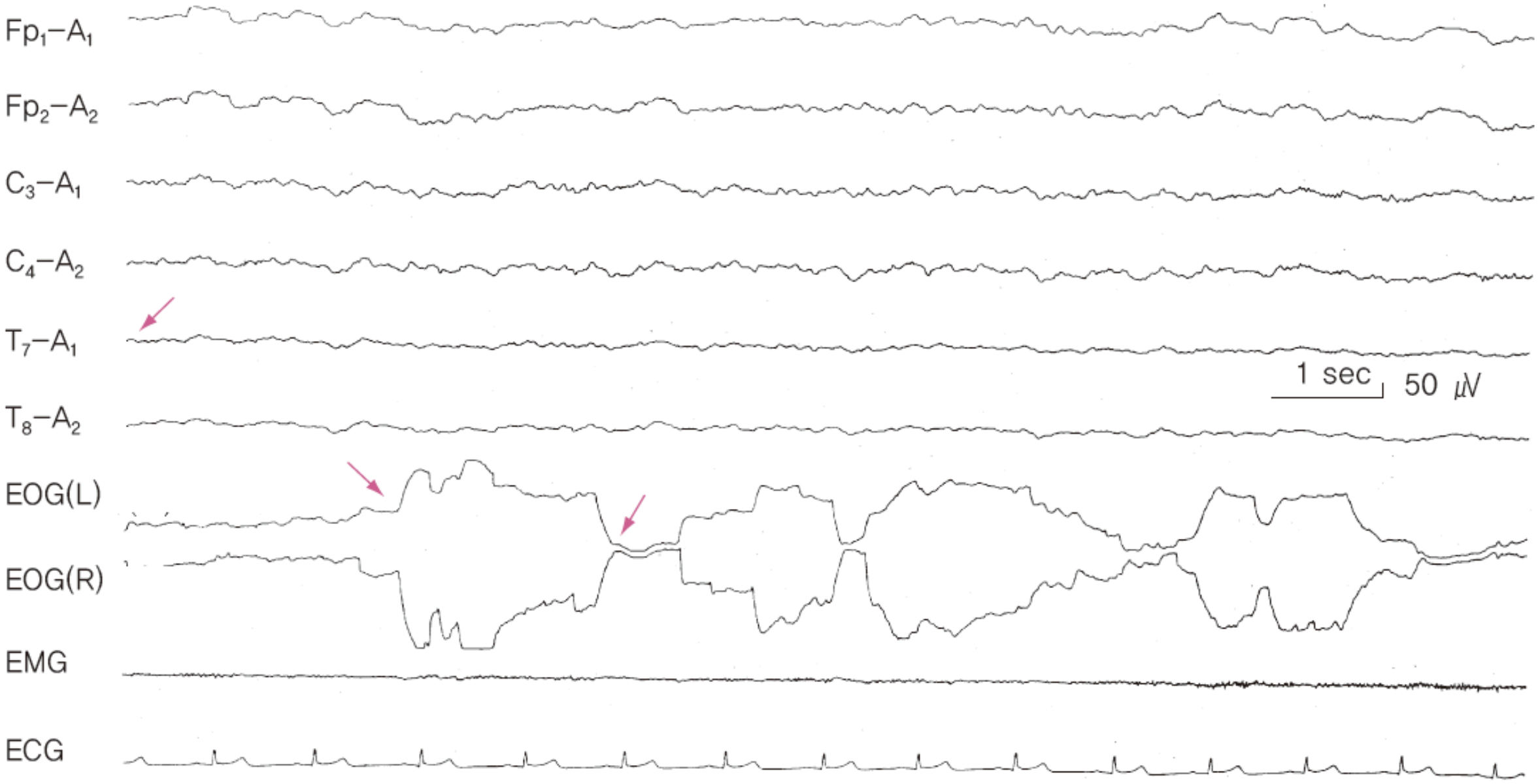

FP_1–A_1
FP_2–A_2
C_3–A_1
C_4–A_2
O_1–A_1
O_2–A_2
T_7–A_1
T_8–A_2
EOG(L)
EOG(R)
EMG
ECG
1 sec
50 μV


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

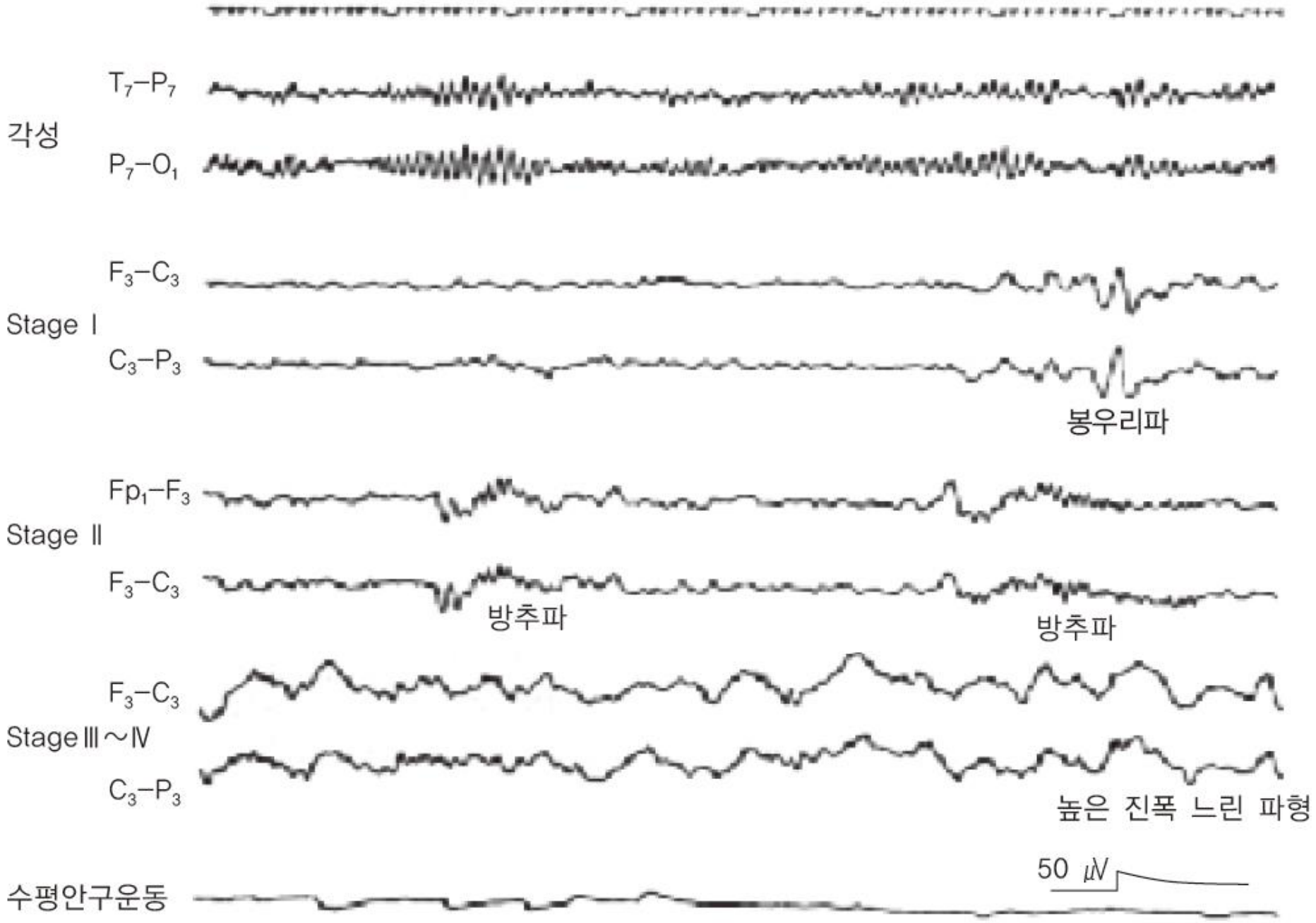

각성
T_7–P_7
P_7–O_1
Stage Ⅰ
F_3–C_3
C_3–P_3
봉우리파
Stage Ⅱ
Fp_1–F_3
F_3–C_3
방추파
방추파
Stage Ⅲ～Ⅳ
F_3–C_3
C_3–P_3
높은 진폭 느린 파형
50 μV
수평안구운동

표 5-2. 소아의 수면 단계별 뇌파소견

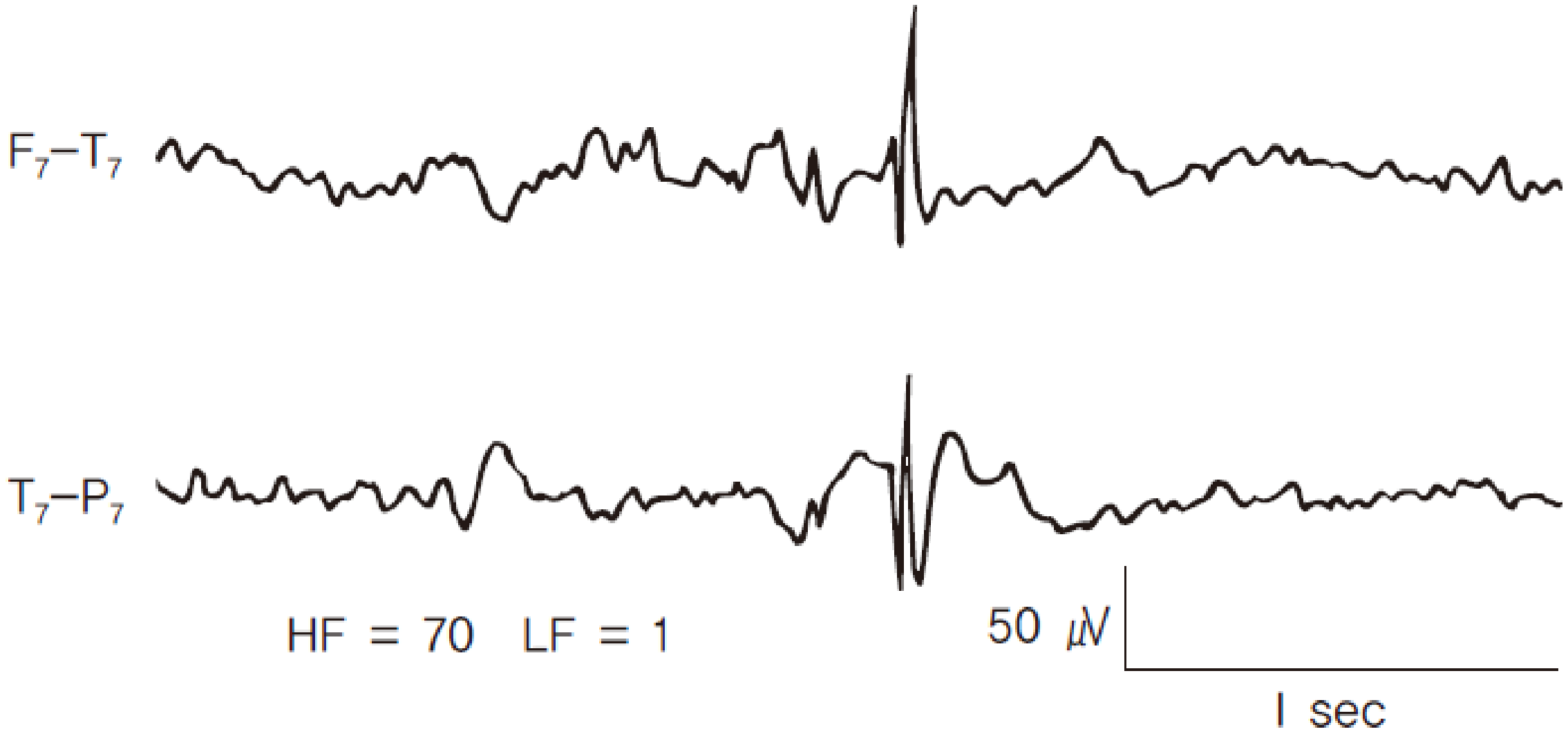
구분	신생아기	소아기
각성기	광범성 불규칙 느린파 (30 μV 이하)	6~8 Hz (마루–뒤통수부 우세, 50~15 μV)
얕은 수면 초기	불규칙 느린파 (저–중진폭)	낮은 진폭 느린파, 돌발성 높은 진폭 느린파군 (3~6 Hz)
얕은 수면기	불규칙 느린파 (50~100 μV) 낮은 진폭 방추파, 교대성 뇌파	중진폭 느린파와 봉우리파, 14 Hz 방추파(가끔)
깊은 수면기		중진폭 느린파, 14 Hz 방추파, 광범성 율동성 θ파
		불규칙한 높은 진폭 느린파

Section 06

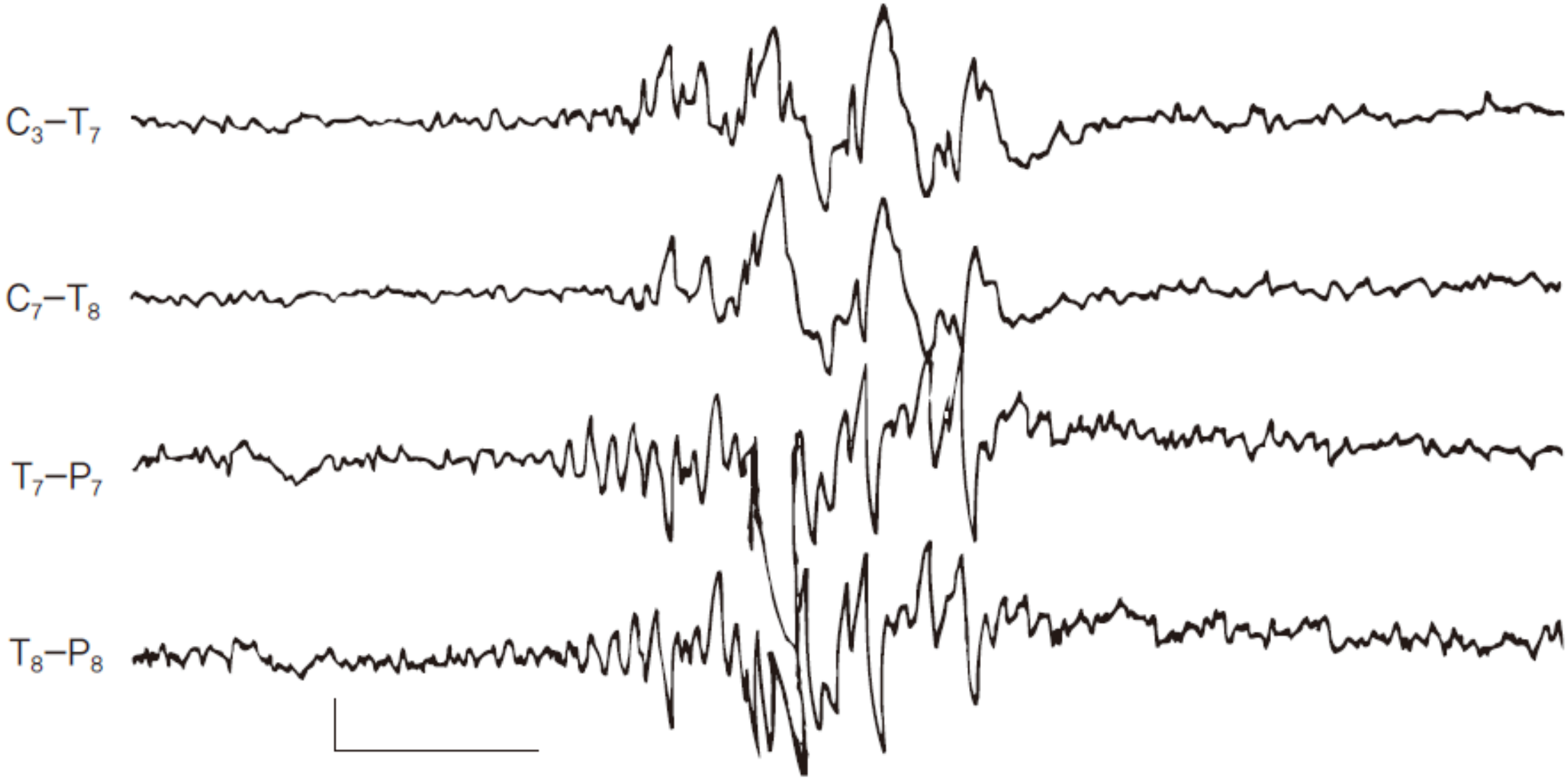
비정상뇌파의 특징

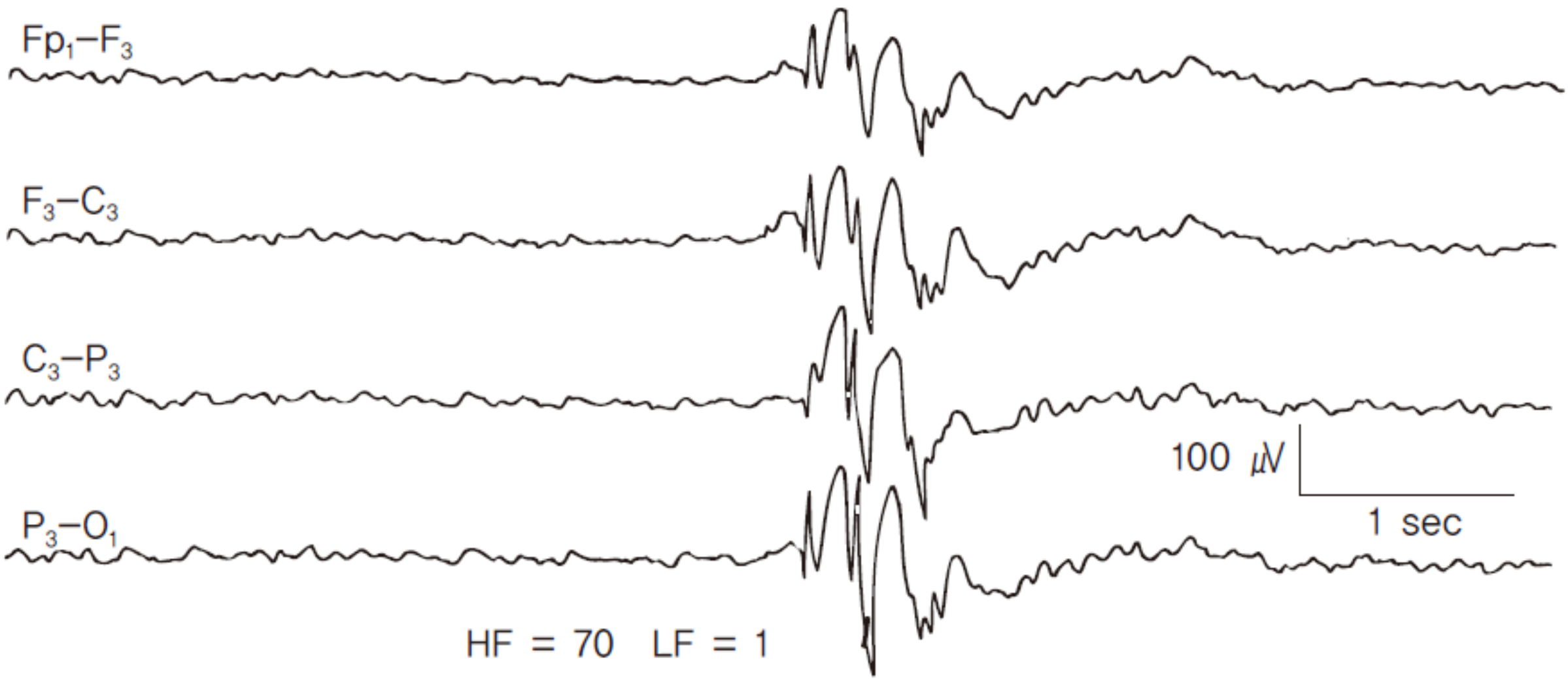
학습목표

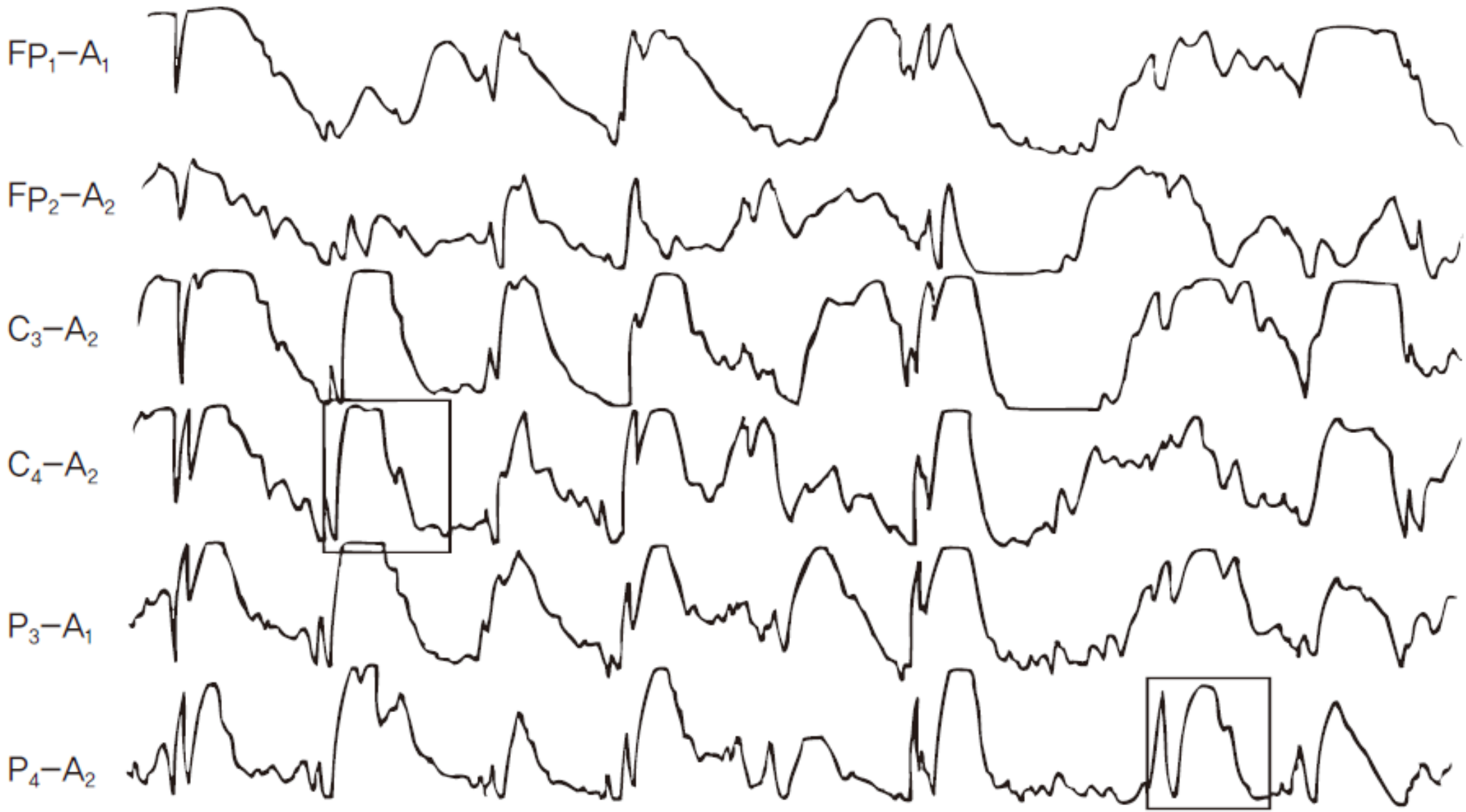
1.극파계 이상과 느린파계 이상파를 설명할 수 있다(A).
2.뇌전증의 분류와 특징을 이해할 수 있다(B).
3.뇌전증 관련 용어를 설명할 수 있다(B).
4.혼수에 따른 뇌파 유형을 설명할 수 있다(B).
5.뇌사판정을 위한 뇌파검사법과 판정기준을 이해할 수 있다(B).

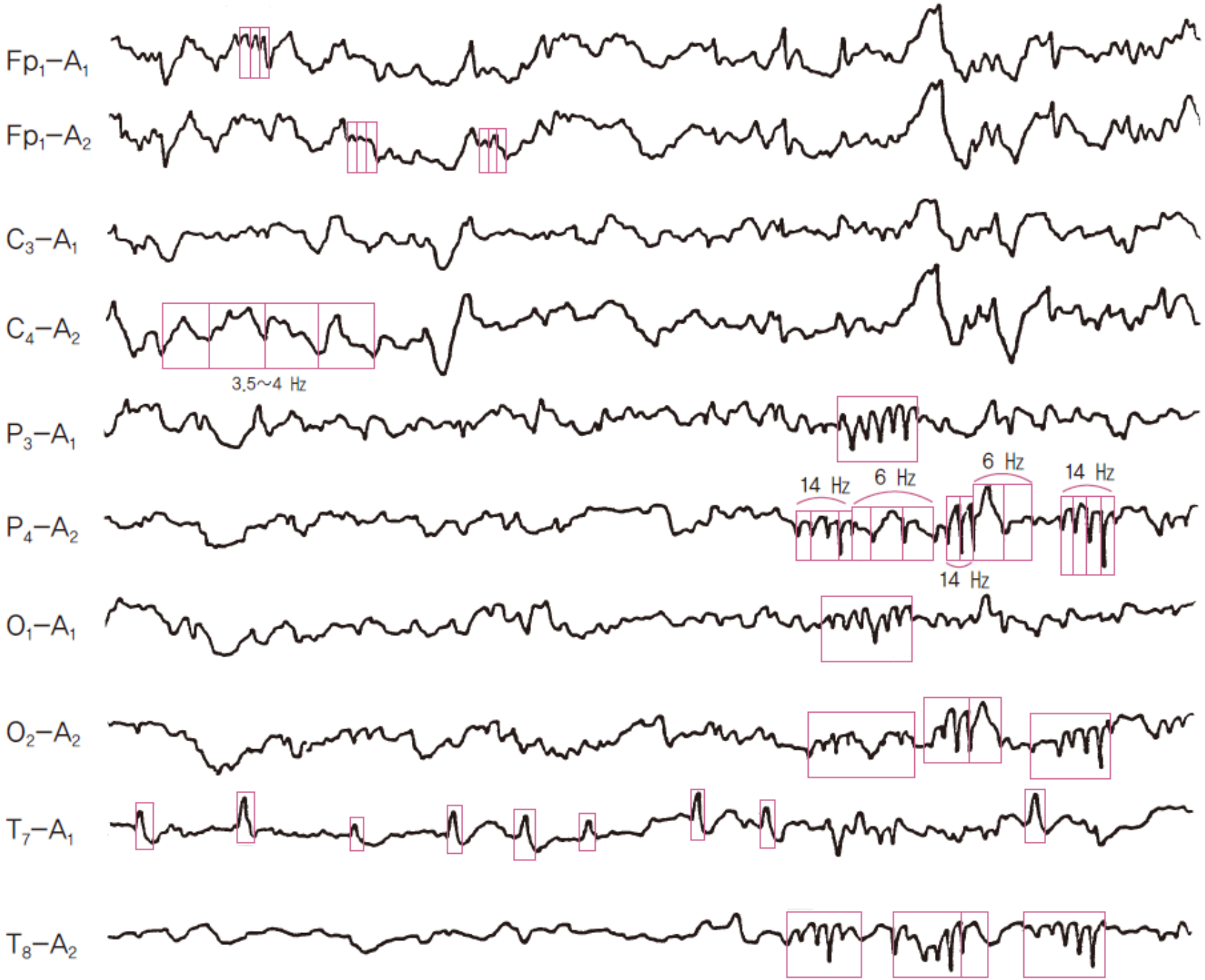

F7–T7
T7–P7
HF = 70 LF = 1
50 μV
1 sec

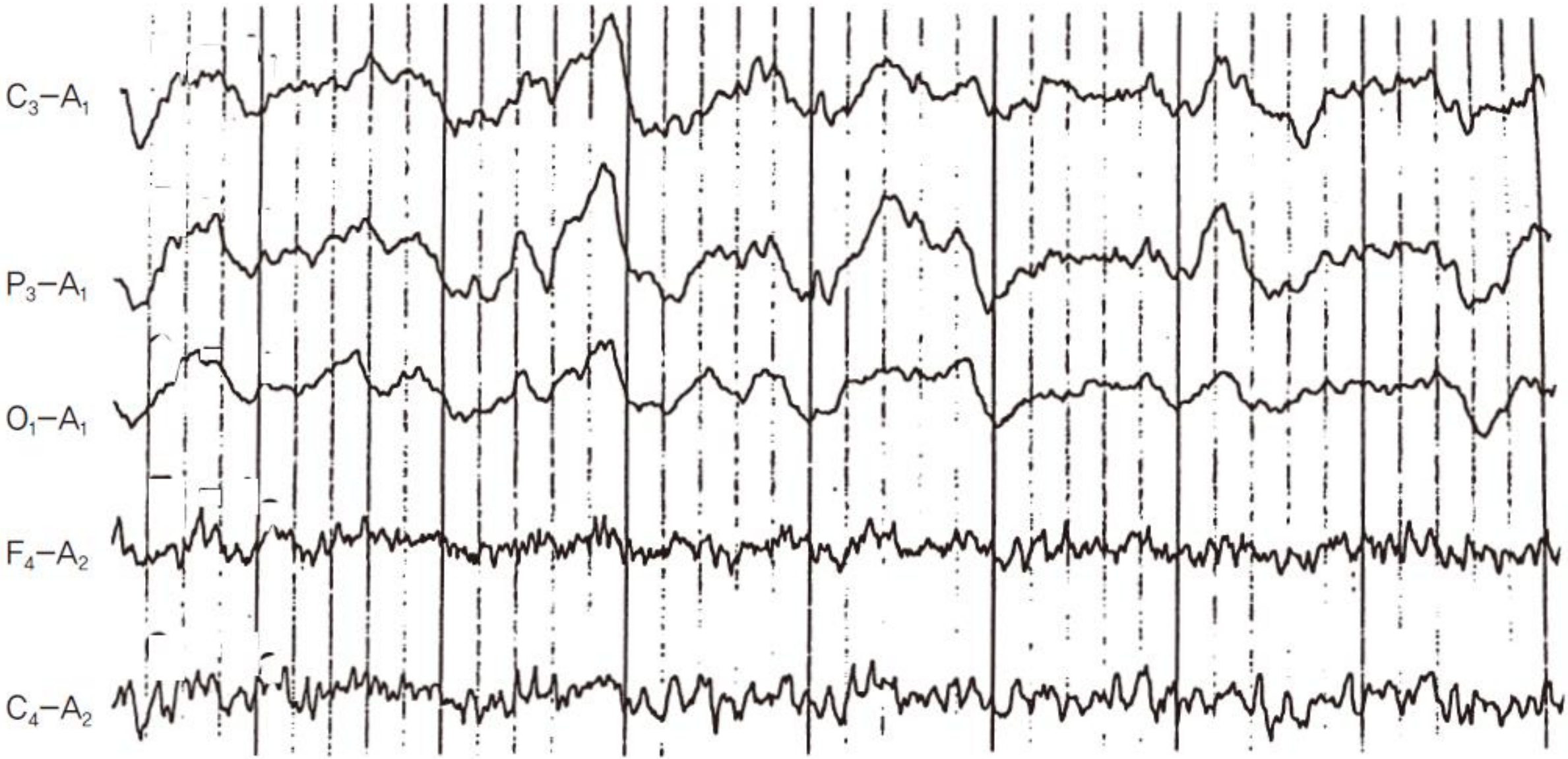

F3–C3
200 μV
1 sec
HF = 70 LF = 1

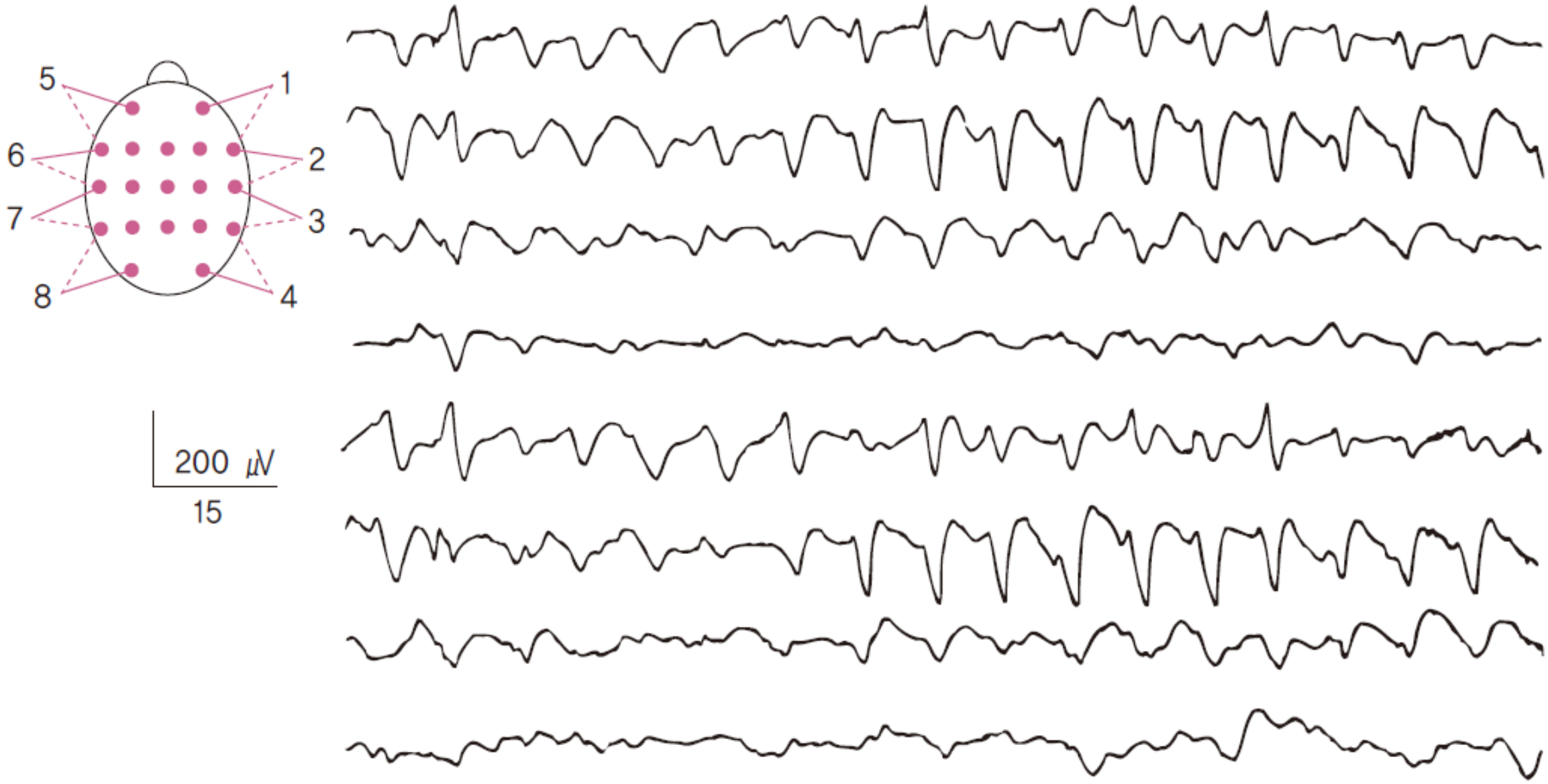

C_3–T_7
C_7–T_8
T_7–P_7
T_8–P_8


Fp1–F3
F3–C3
C3–P3
P3–O1
100 μV
1 sec
HF = 70 LF = 1


$FP_1–A_1$
$FP_2–A_2$
$C_3–A_2$
$C_4–A_2$
$P_3–A_1$
$P_4–A_2$

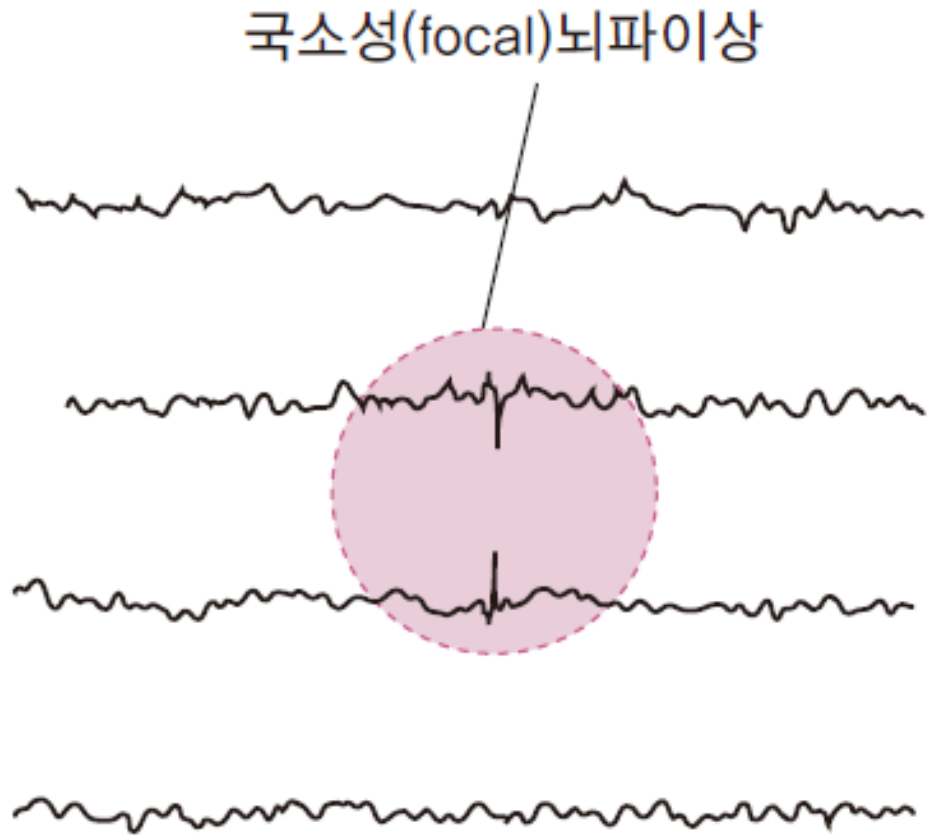

Fp1–A1
Fp1–A2
C3–A1
C4–A2
3.5~4 Hz
P3–A1
P4–A2
14 Hz
6 Hz
14 Hz
6 Hz
14 Hz
O1–A1
O2–A2
T7–A1
T8–A2

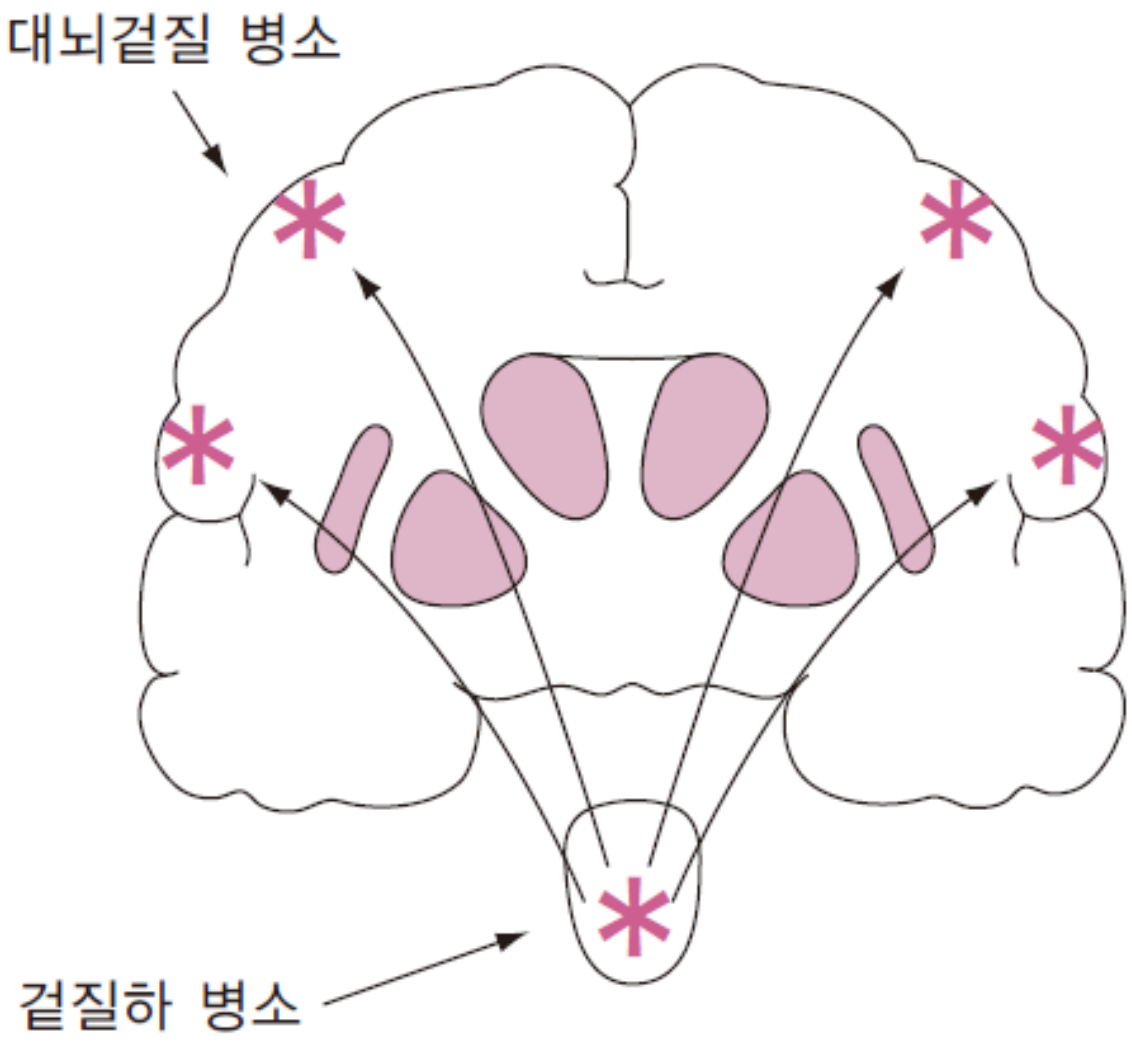

C_3–A_1
P_3–A_1
O_1–A_1
F_4–A_2
C_4–A_2



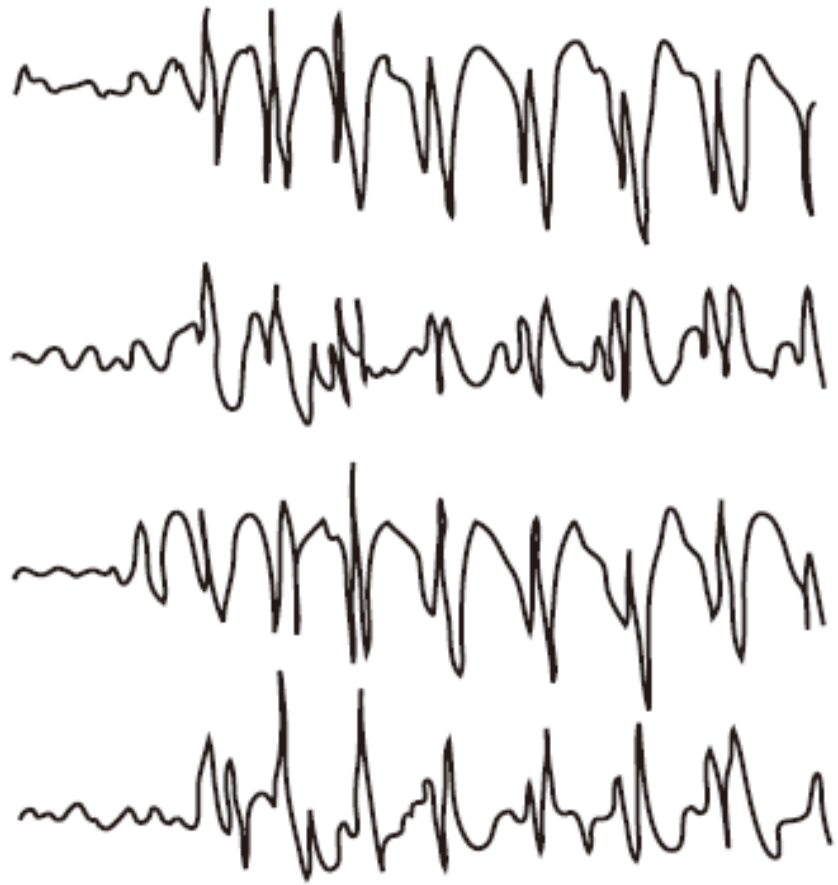
47세 남자 간성혼수(hepatic coma)환자 이마부 우세의 2 Hz의 δ 파가 양측성으로 출현


대뇌겉질 병소

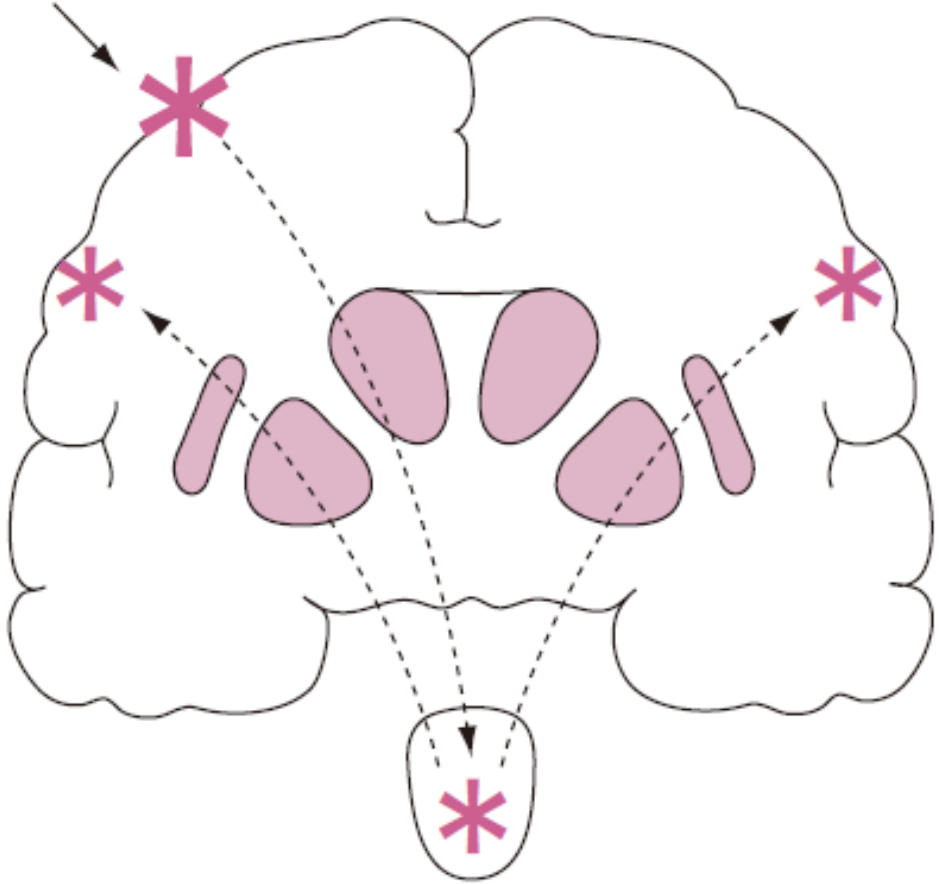

국소성(focal)뇌파이상



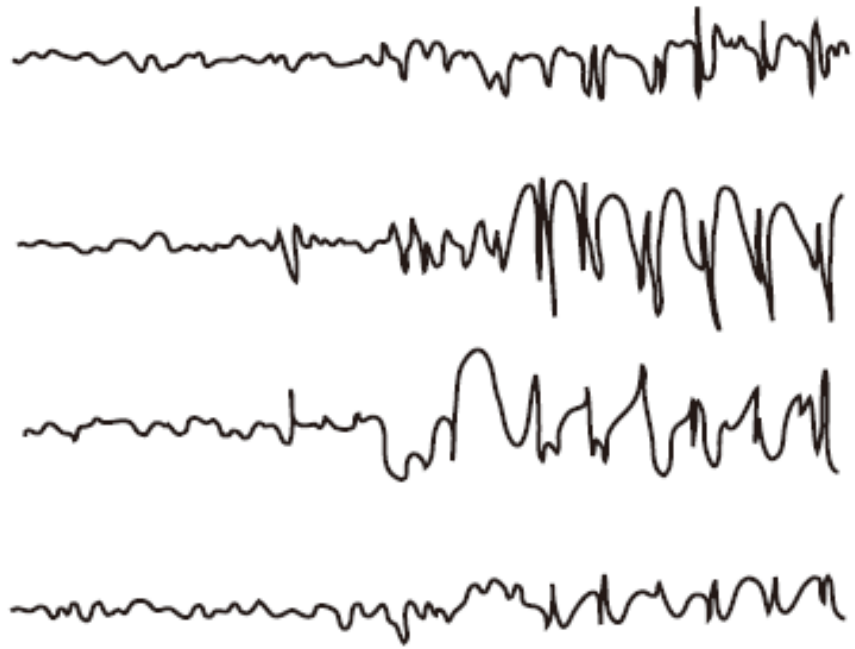
전신형(generalised)뇌파이상

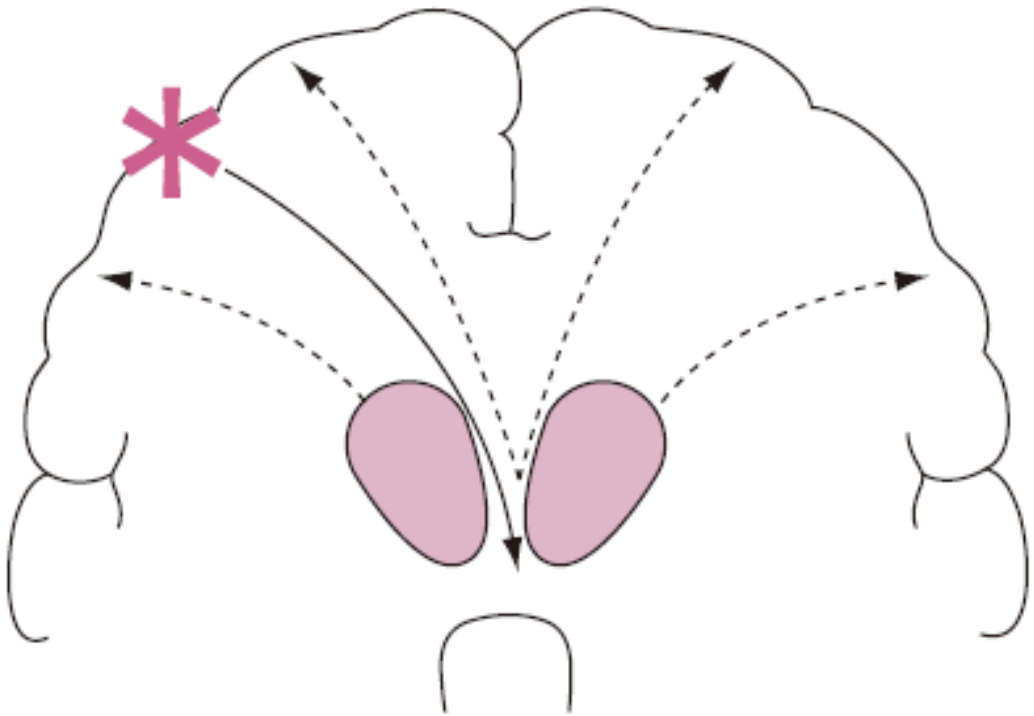


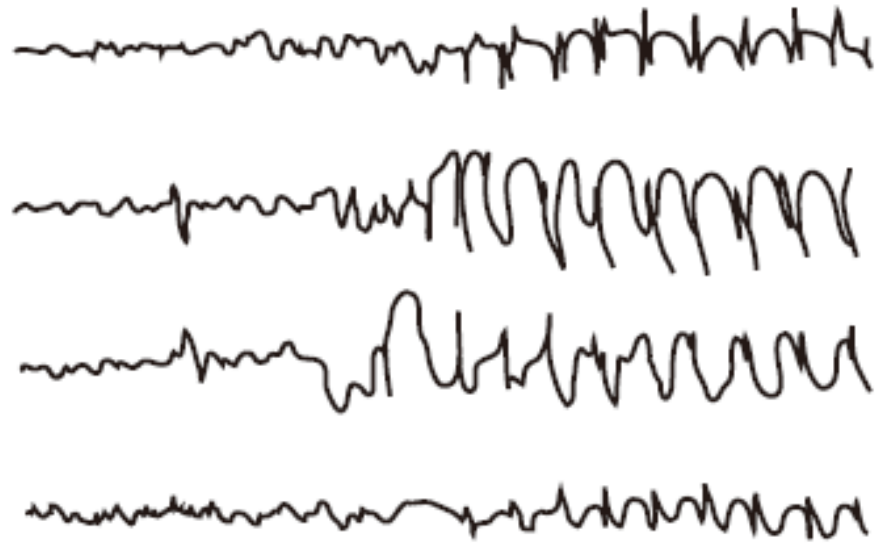
대뇌겉질 병소

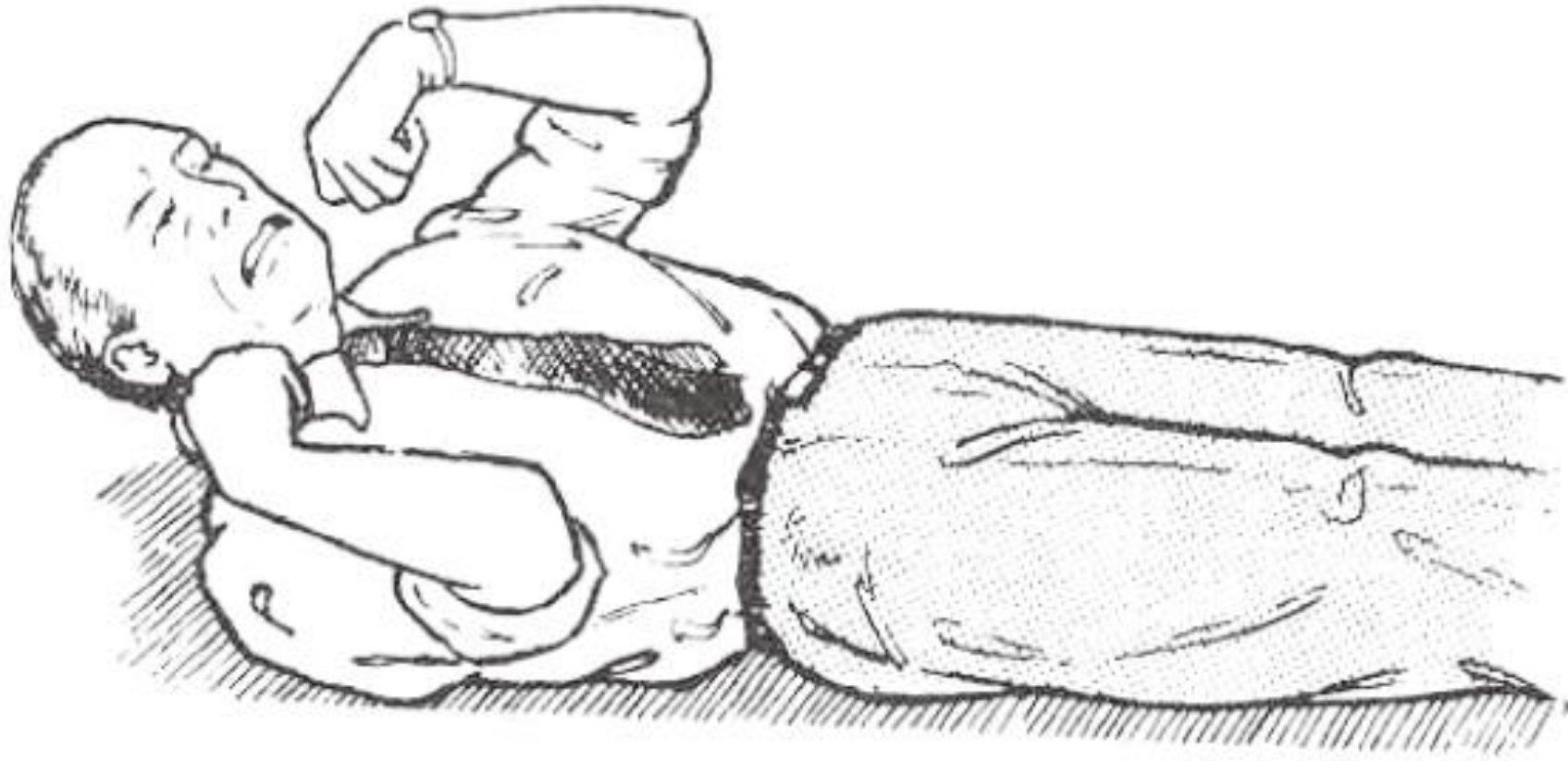


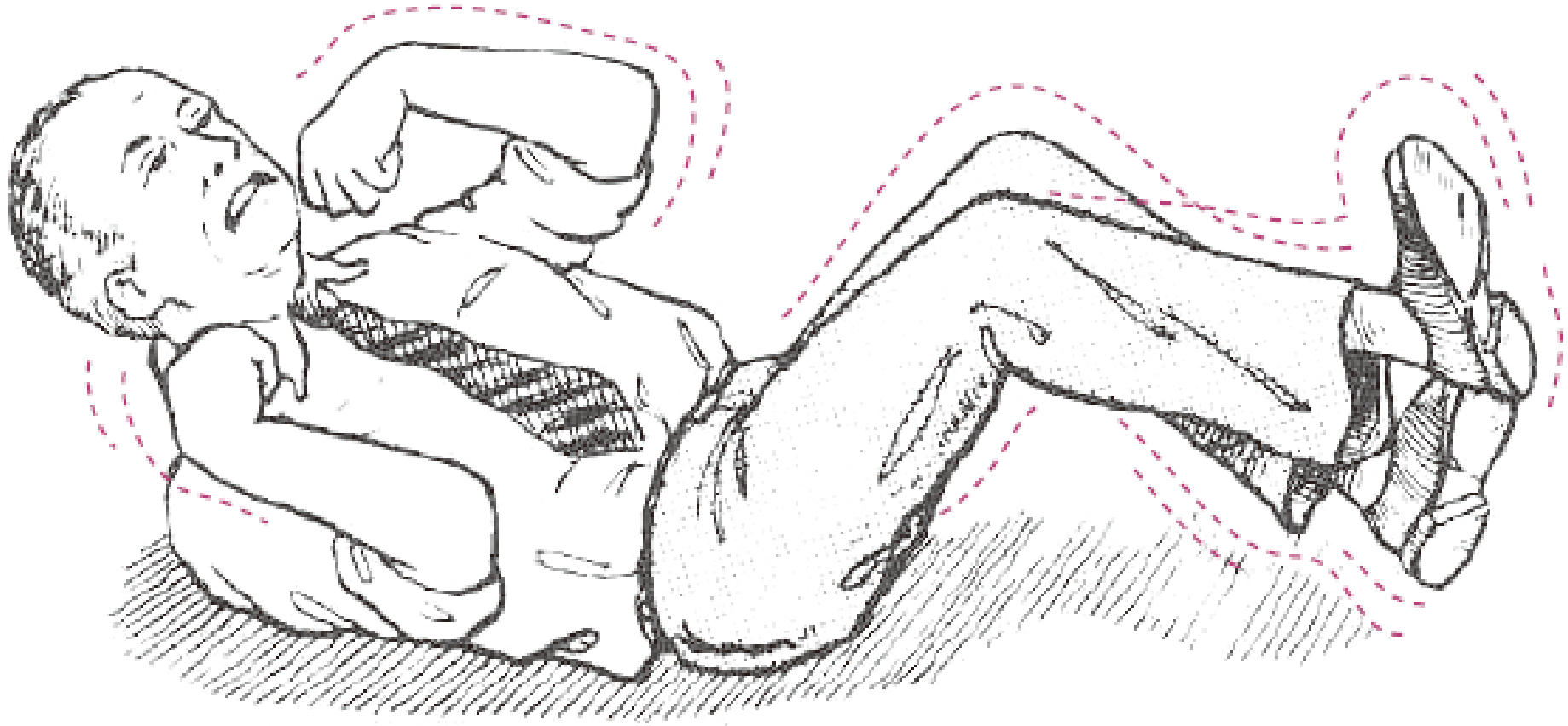
국소성(focal) → 전신형(generalised)뇌파이상

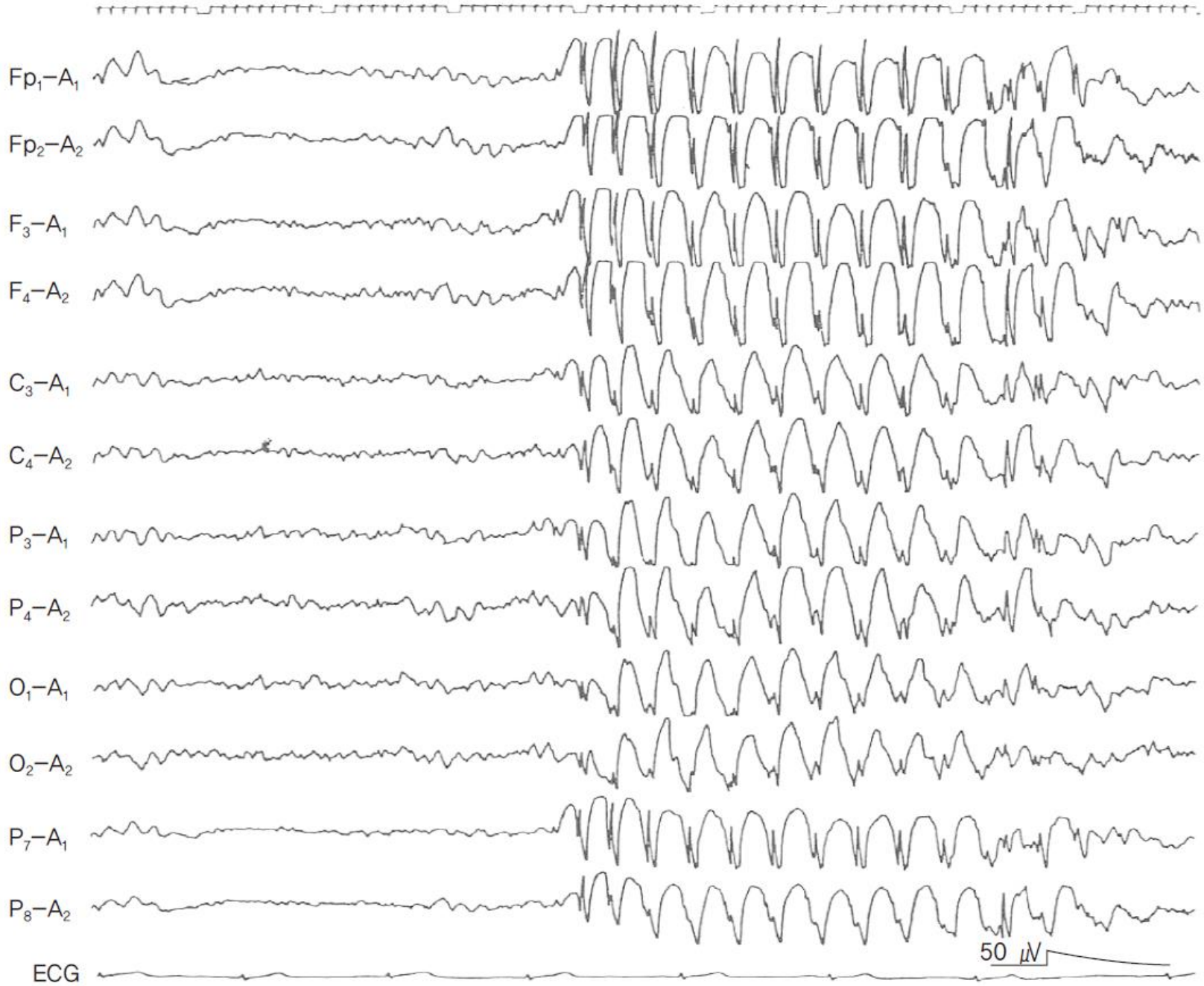




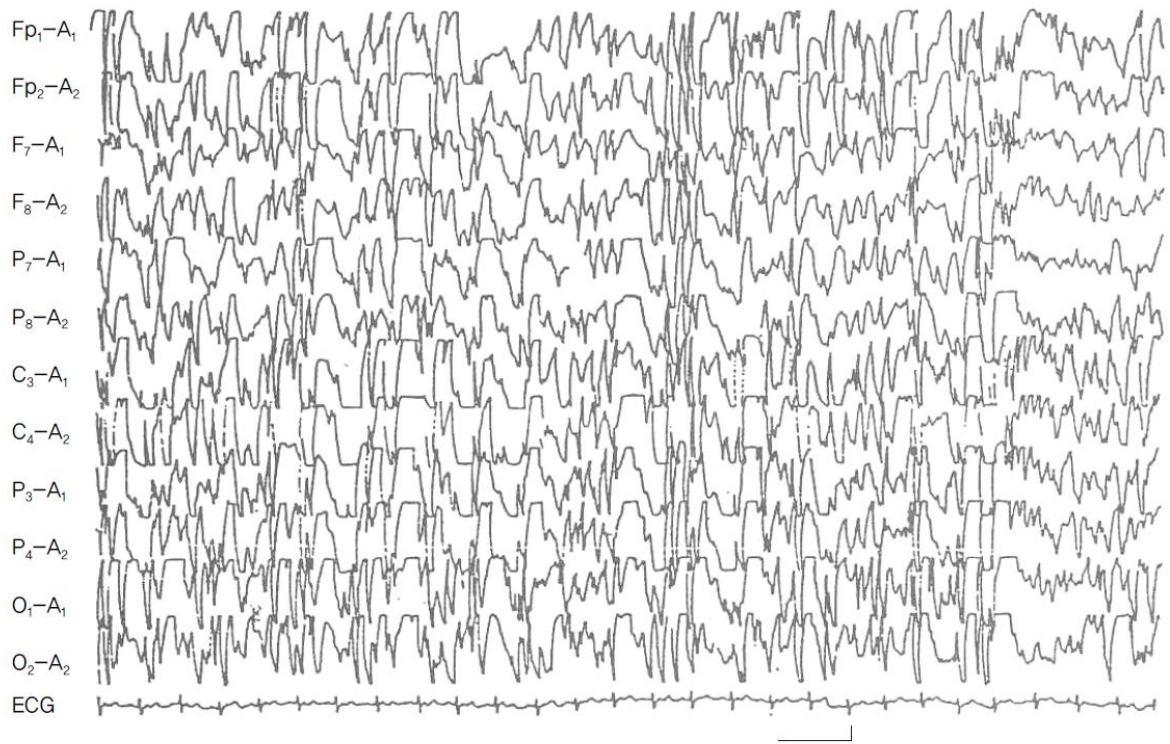


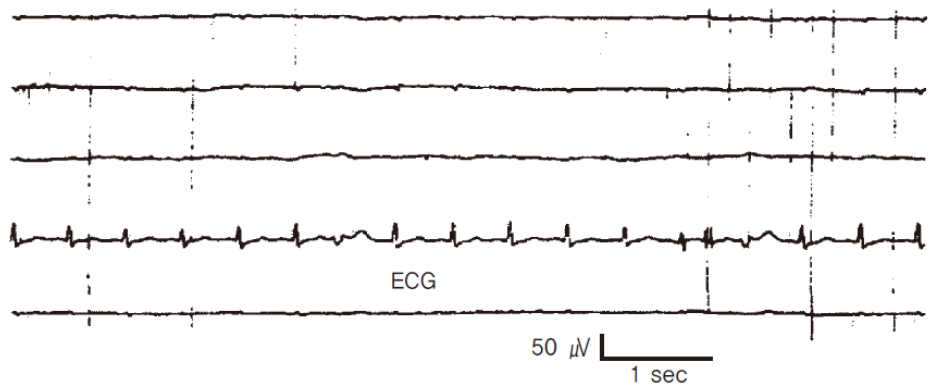





Fp1–A1
Fp2–A2
F3–A1
F4–A2
C3–A1
C4–A2
P3–A1
P4–A2
O1–A1
O2–A2
P7–A1
P8–A2
ECG
50 μV


Fp1–A1
Fp2–A2
F3–A1
F4–A2
C3–A1
C4–A2
P3–A1
P4–A2
O1–A1
O2–A2
P7–A1
P8–A2
50 μV
ECG


$Fp_1–A_1$
$Fp_2–A_2$
$F_7–A_1$
$F_8–A_2$
$P_7–A_1$
$P_8–A_2$
$C_3–A_1$
$C_4–A_2$
$P_3–A_1$
$P_4–A_2$
$O_1–A_1$
$O_2–A_2$
ECG



대뇌피질의 전기적 활동은 없고 심전도에 의한 인공파형만 나타나고 있다

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).

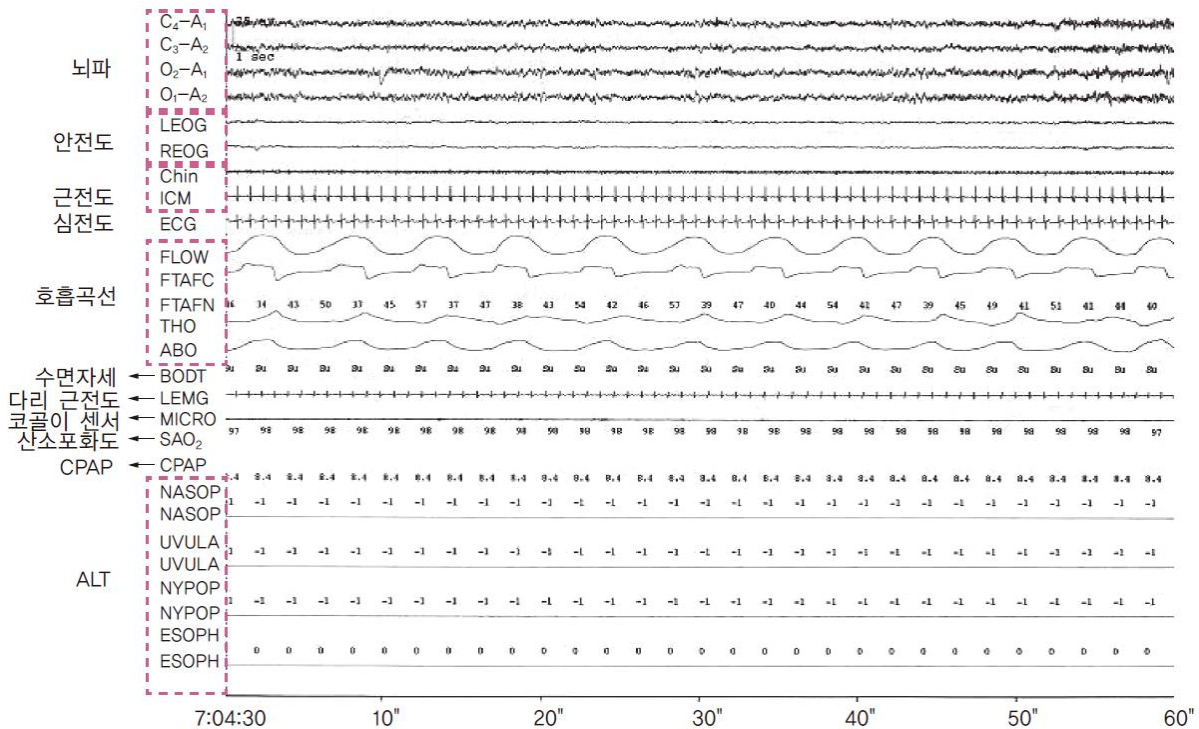

뇌파
안전도
근전도
심전도
호흡곡선
수면자세
다리 근전도
코골이 센서
산소포화도
CPAP
ALT
C4–A1
C3–A2
O2–A1
O1–A2
LEOG
REOG
Chin
ICM
ECG
FLOW
FTAFC
FTAFN
THO
ABO
BODT
LEMG
MICRO
SAO2
CPAP
NASOP
NASOP
UVULA
UVULA
NYPOP
NYPOP
ESOPH
ESOPH
1 sec
7:04:30
10"
20"
30"
40"
50"
60"

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



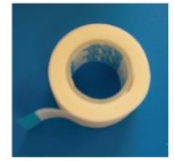
EEG용 전극



다리근전도 전극



심전도용 전극



Surgical tape



Stylus



Intercom



micro phone 센서



호흡(oral, nasal)센서



호흡센서



양면 tape



Paper



CPAP remote controller



Mini electrode board



혈중산소포화농도(oximetry) 기계 및 센서



수면자세용 기기 및 센서



지속적 혈압 측정용 기계



(전극 부착)용액 콜로디온



줄자



Omniprep



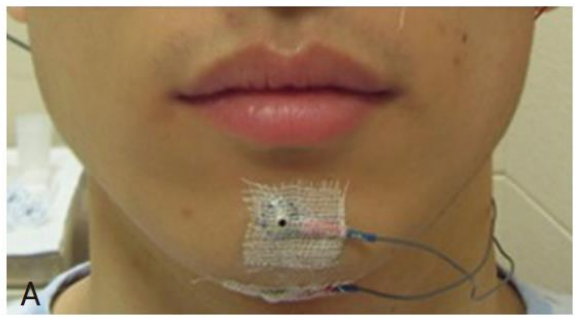
아세톤(콜로디온제거제)

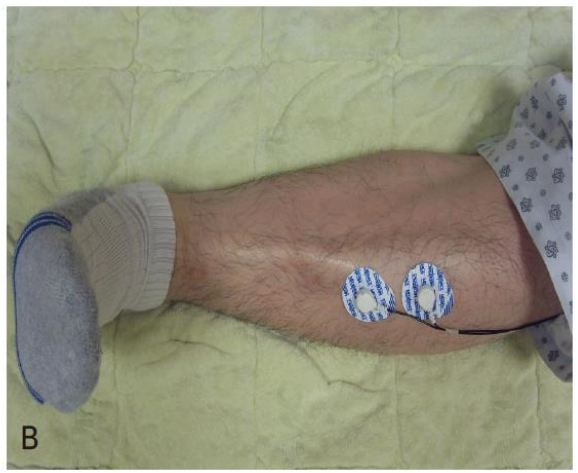


Electrode jelly



Air compressor


A

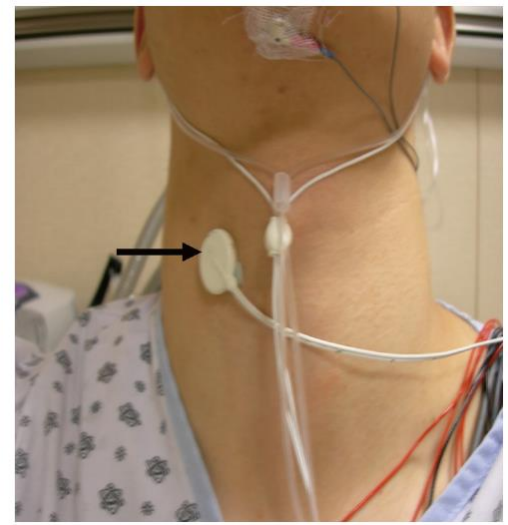

B

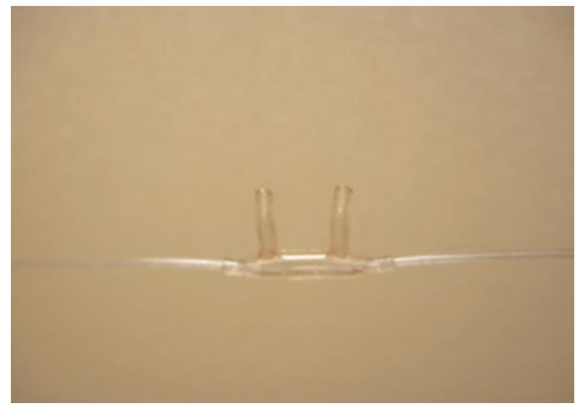


마이크로폰 부착한 모습



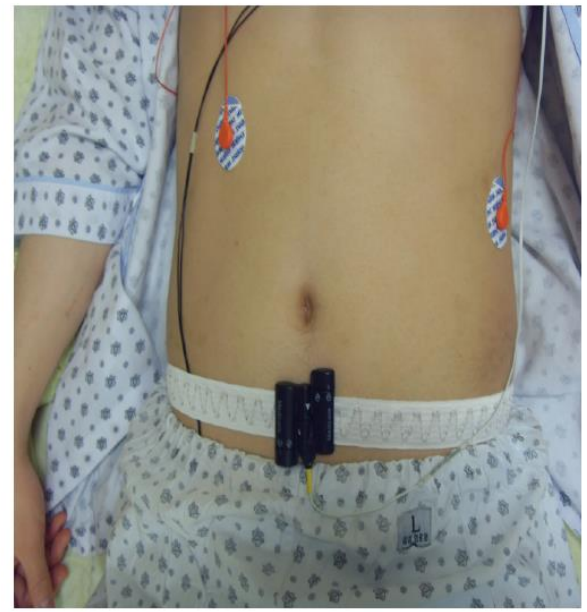
Microphone 센서







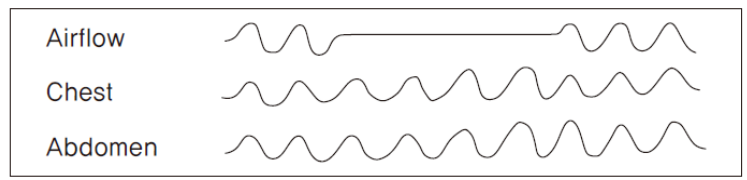


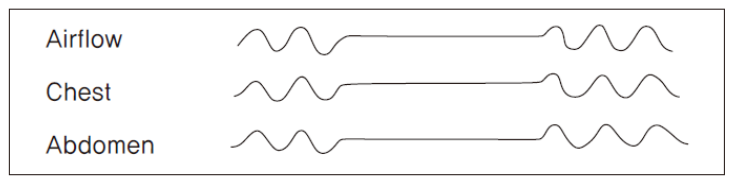


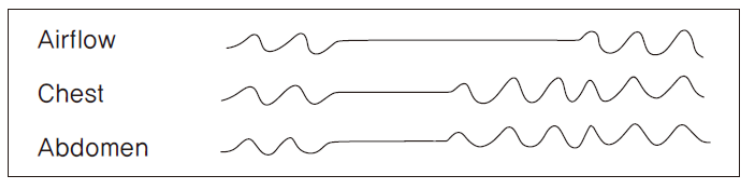


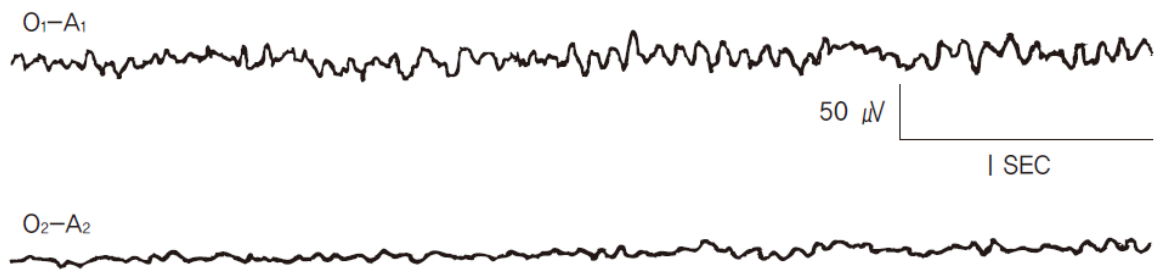

ResMed




Airflow
Chest
Abdomen


Airflow
Chest
Abdomen


Airflow
Chest
Abdomen


O1–A1
50 μV
1 SEC
O2–A2

신경기능검사학

CHAPTER II

근전도 검사

Section 08

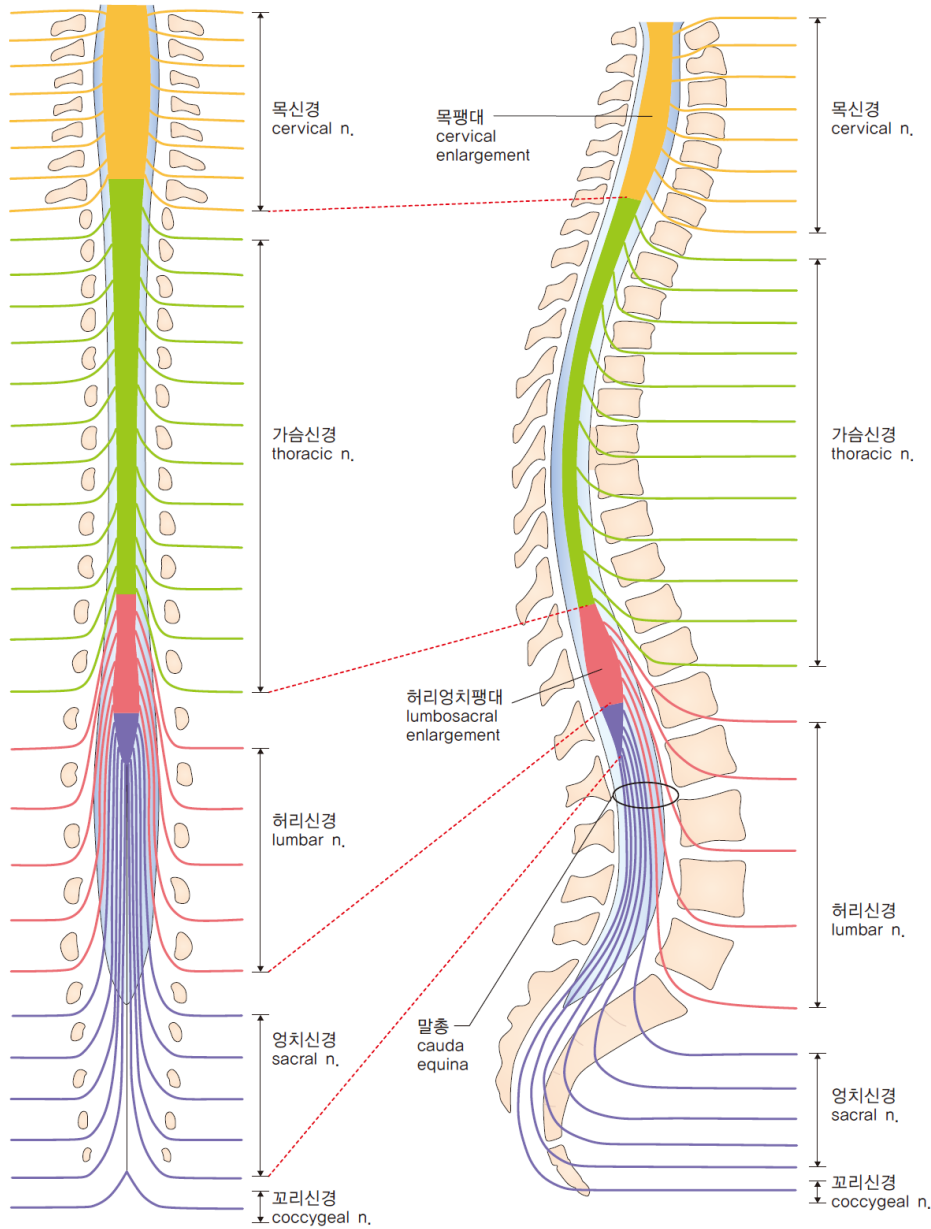
근전도 검사를 위한 해부생리

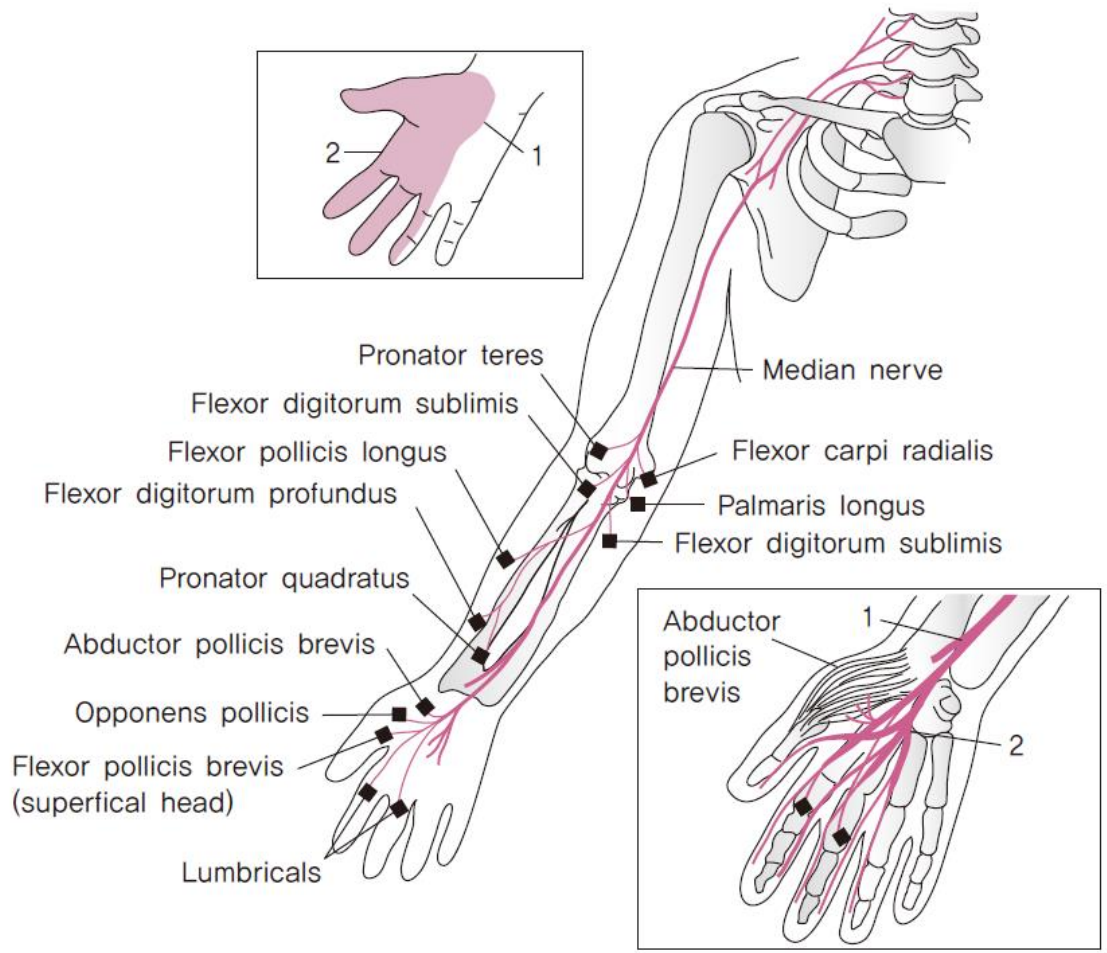
학습 목표

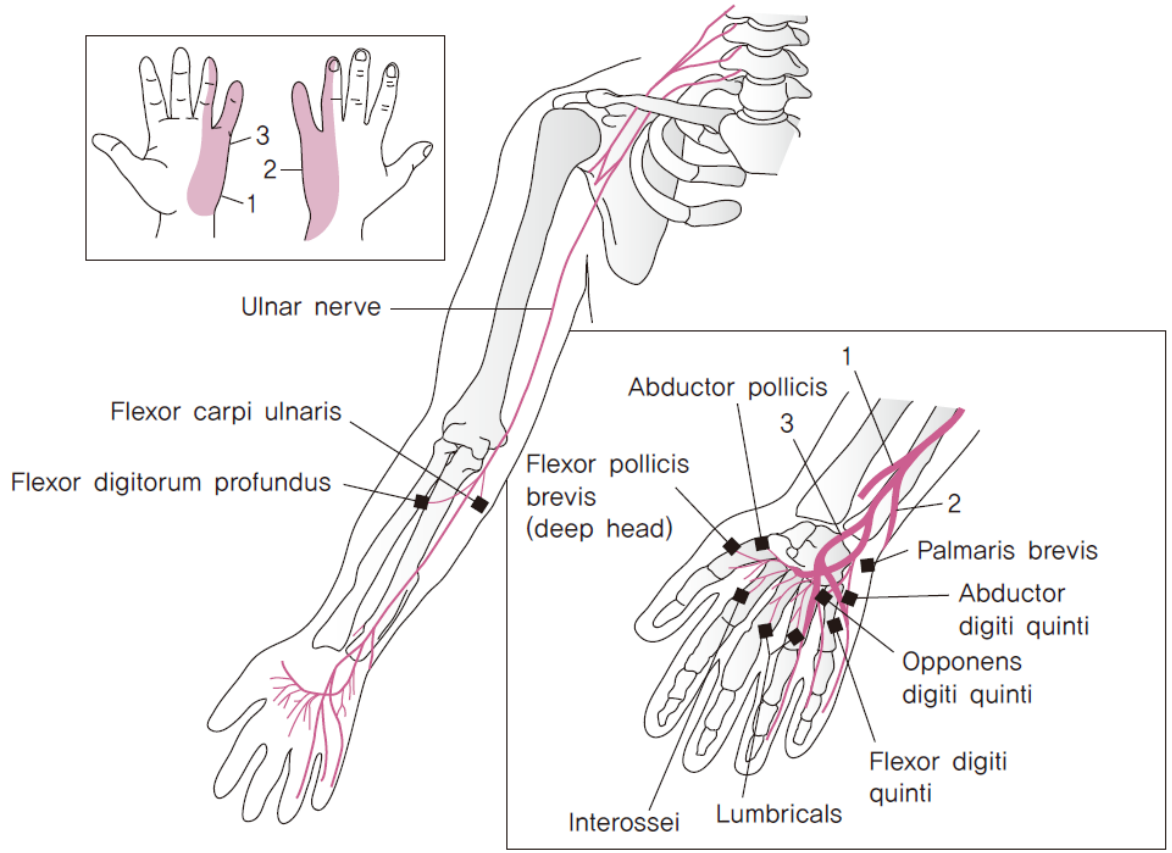
1. 말초신경의 구조를 설명할 수 있다(A).
2. 말초신경의 신경흥분전달기전을 이해할 수 있다(A).
3. 신경전기생리의 과정을 설명할 수 있다(A).
4. 상지와 하지의 주요 말초신경의 해부학적 경로를 이해할 수 있다(A).

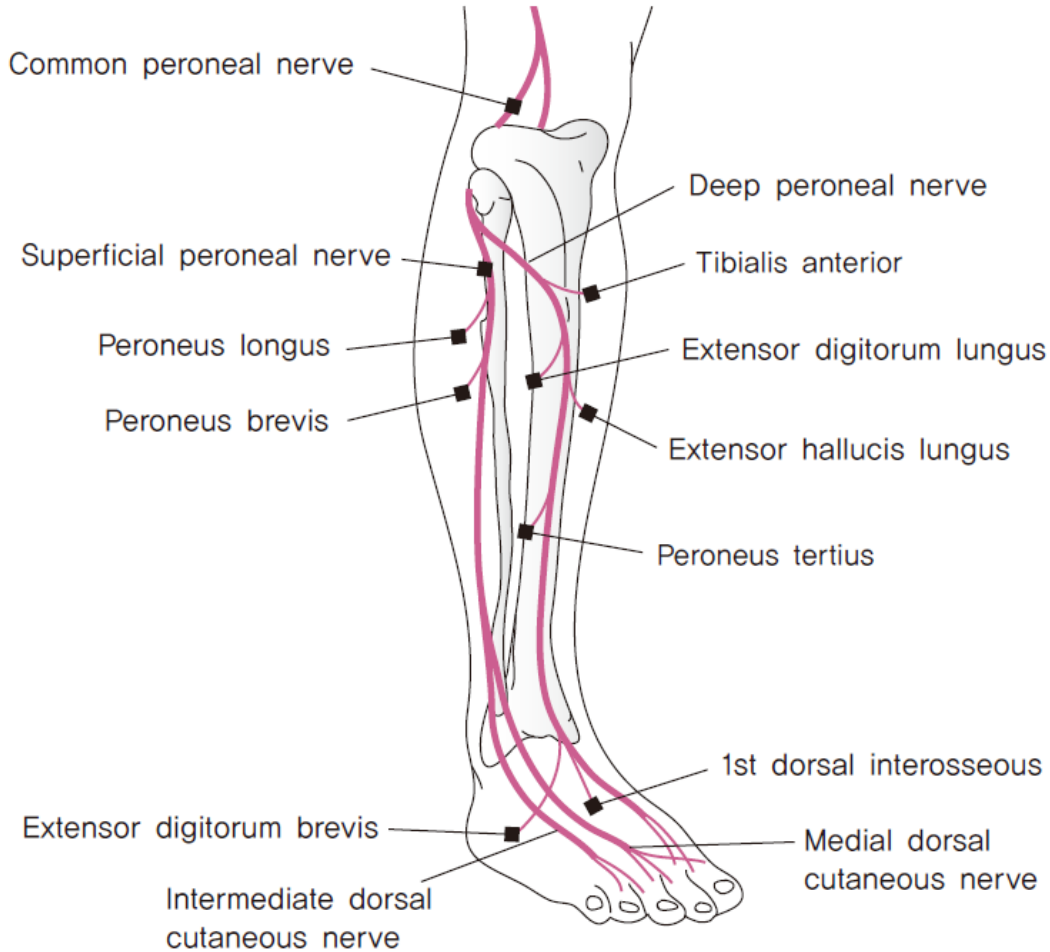
표 8-1. 뇌신경(Cranial nerve)

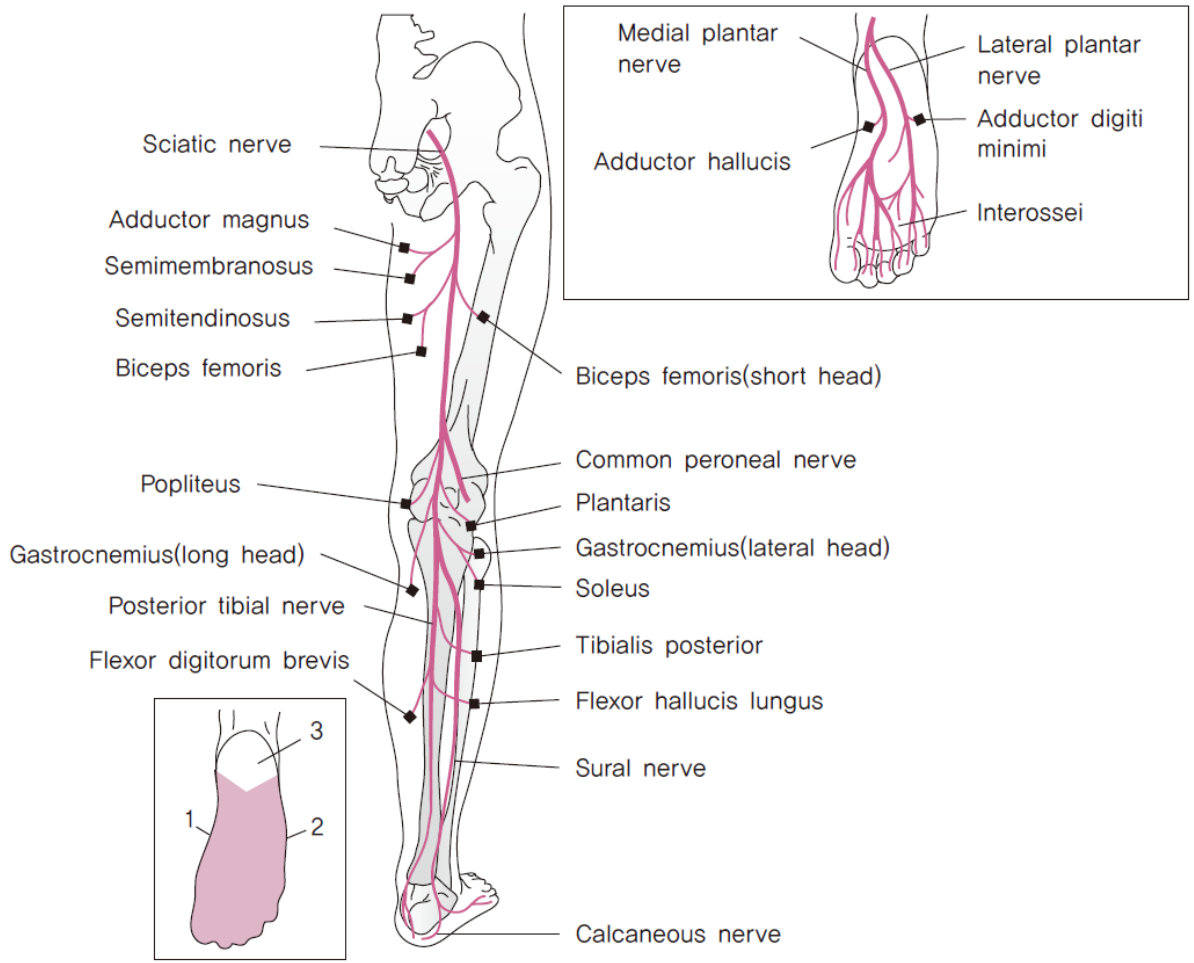
번호	신경명	구성	머리뼈통과부	전도 및 기능
I	후신경 (**olfactory N.**)	감각	사판	냄새 : 후각세포 → 후각고랑 → 후각신경로 → 대뇌겉질 관자엽
II	시신경 (**optic N.**)	감각	시신경구멍	시각 : 망막시세포 → 중뇌상구 → 시각반사 → 시각로 → 뒤통수엽
III	눈돌림신경 (**oculomotor N.**)	운동	위눈확틈새	눈동자의 위곧은근, 아래곧은근, 안쪽곧은근, 아래빗근
IV	도르래신경 (**trochlear N.**)	운동	위눈확틈새	눈동자의 위빗근
V	삼차신경 (**trigiminal N.**)	혼합	위눈확틈새 원형구멍 타원구멍	눈신경(ophthalmic) division 위턱신경 부분(maxillary) 아래턱신경 부분(manclibular)
VI	갓돌림신경 (**abducens N.**)	운동	위눈확틈새	눈동자의 가쪽곧은근
VII	얼굴신경 (**facial N.**)	혼합	속귓구멍	표정근, 혀 및 타액선
VIII	속귀신경 (**vestibulocochlear N.**)	감각	속귓구멍	달팽이신경, 안뜰신경
IX	혀인두신경 (**glossopharyngeal N.**)	혼합	목정맥구멍	미각, 인두근, 귀밑샘, 혀의 뒤 1/3 담당
X	미주신경(**vagus N.**)	혼합	목정맥공	인두근, 후두근과 가슴배의 내장
XI	더부신경 (**accessory N.**)	운동	목정맥공	목빗근, 등세모근, 인후두근
XII	혀밑신경 (**hypoglossal N.**)	운동	혀밑신경관	혀의 근육


목신경
cervical n.
가슴신경
thoracic n.
허리신경
lumbar n.
엉치신경
sacral n.
꼬리신경
coccygeal n.
목팽대
cervical
enlargement
허리엉치팽대
lumbosacral
enlargement
말총
cauda
equina
목신경
cervical n.
가슴신경
thoracic n.
허리신경
lumbar n.
엉치신경
sacral n.
꼬리신경
coccygeal n.


2
1
Pronator teres
Flexor digitorum sublimis
Flexor pollicis longus
Flexor digitorum profundus
Pronator quadratus
Abductor pollicis brevis
Opponens pollicis
Flexor pollicis brevis
(superfical head)
Lumbricals
Median nerve
Flexor carpi radialis
Palmaris longus
Flexor digitorum sublimis
Abductor
pollicis
brevis
1
2


3
2
1
Ulnar nerve
Flexor carpi ulnaris
Flexor digitorum profundus
1
Abductor pollicis
3
Flexor pollicis brevis (deep head)
2
Palmaris brevis
Abductor digiti quinti
Opponens digiti quinti
Flexor digiti quinti
Interossei
Lumbricals


Common peroneal nerve
Deep peroneal nerve
Superficial peroneal nerve
Tibialis anterior
Peroneus longus
Extensor digitorum lungus
Peroneus brevis
Extensor hallucis lungus
Peroneus tertius
1st dorsal interosseous
Extensor digitorum brevis
Medial dorsal cutaneous nerve
Intermediate dorsal cutaneous nerve

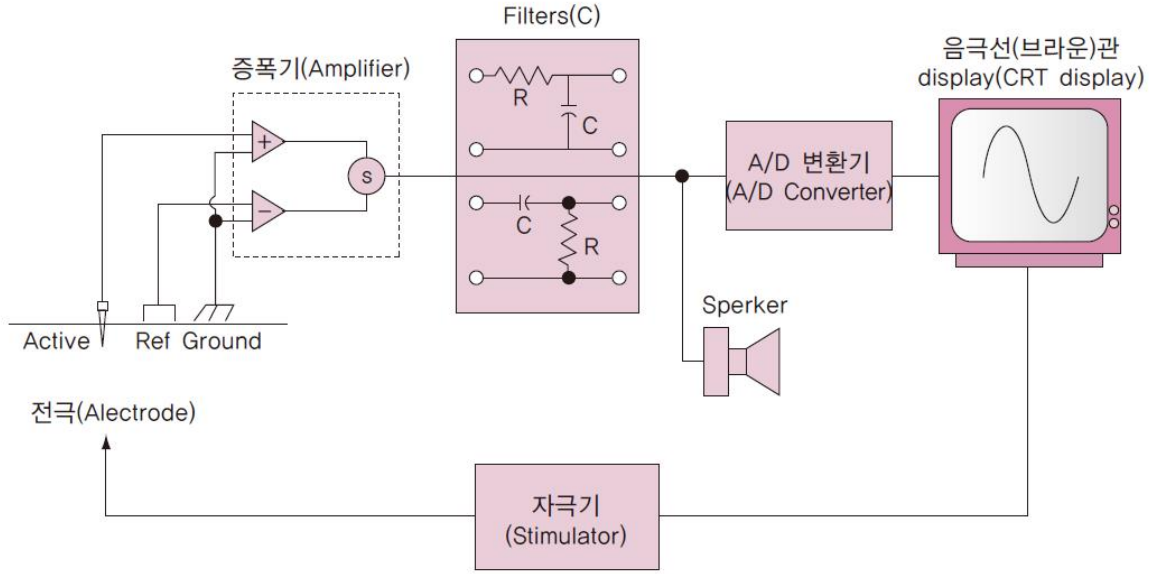

Medial plantar nerve
Lateral plantar nerve
Adductor digiti minimi
Adductor hallucis
Interossei
Sciatic nerve
Adductor magnus
Semimembranosus
Semitendinosus
Biceps femoris
Biceps femoris(short head)
Common peroneal nerve
Popliteus
Plantaris
Gastrocnemius(lateral head)
Gastrocnemius(long head)
Soleus
Posterior tibial nerve
Tibialis posterior
Flexor digitorum brevis
Flexor hallucis lungus
Sural nerve
1
2
3
Calcaneous nerve

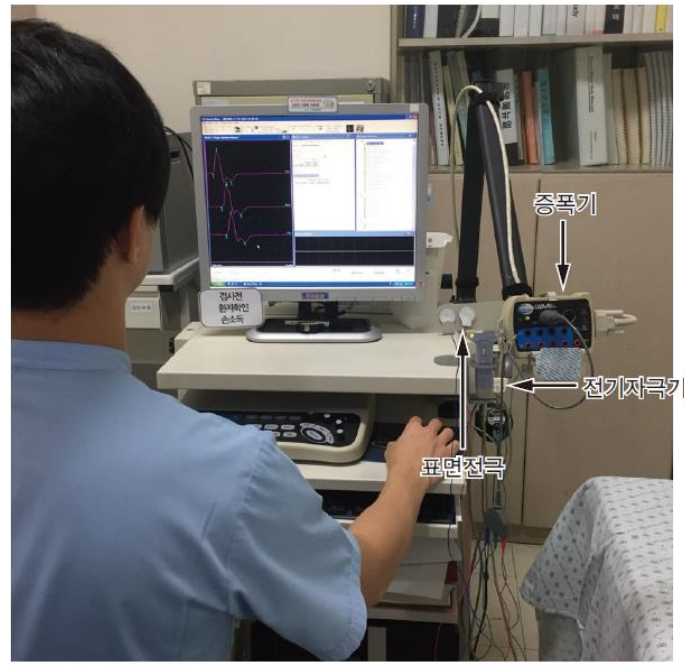
Section 09

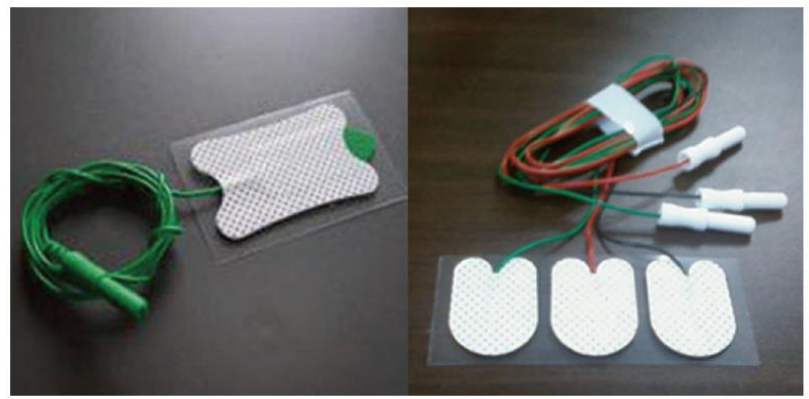
근전도검사의 기본개념

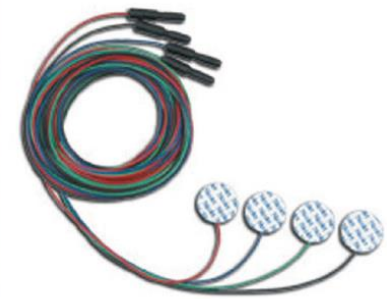
학습 목표

1. 근전도검사의 개념을 설명할 수 있다(A).
2. 근전도검사의 임상적 의의를 설명할 수 있다(A).
3. 근전도 검사구분과 기기의 기본 구성을 설명할 수 있다(A).
4. 근전계의 구성을 이해할 수 있다(A).
5. 근전도기기의 주파수 대역을 설명할 수 있다(A).
6. 근전도 기록전극의 종류와 표면전극과 침전극을 비교 설명할 수 있다(A).

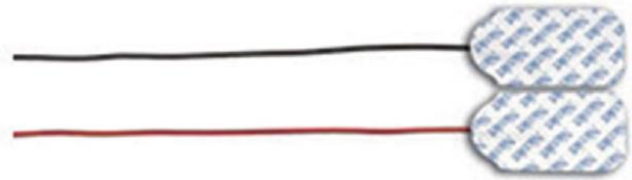

Filters(C)
증폭기(Amplifier)
음극선(브라운)관
display(CRT display)
R
C
C
R
A/D 변환기
(A/D Converter)
Sperker
Active
Ref
Ground
전극(Alectrode)
자극기
(Stimulator)


증폭기
전기자극기
표면전극











N6003



019-435500

















Section 10

근전도검사실

학습목표

1. 근전도 검사 전 준비사항에 대하여 설명할 수 있다(A).
2. 근전도검사와 관련된 용어를 설명할 수 있다(A).
3. 근전도검사 결과보고서를 이해할 수 있다(A).

표 10-1. 신경전도 검사용어

용어	설명
MNCV (Motor nerve conduction study)	운동신경전도검사
SNCV (Sensory nerve conduction study)	감각신경전도검사
Electrode	전극
: Recording electrode	기록전극 또는 활성전극
: Reference electrode	기준전극
: Ground	접지전극
Electrical Stimulater	전기 자극기
: Anode	양극
: Cathode	음극
latency	잠복기
: Onset latency	최초잠복기
: Peak latency	정점잠복기
: Terminal latency	말단잠복기
Duration	지속시간
Amplitude	진폭
: CMAP (Compound Muscle Action Potential)	복합근육활동전위
: SNAP (Sensory Nerve Action Potential)	감각신경활동전위
Repetitive nerve stimulation test, Jolly test	반복신경자극검사
Blink reflex	눈깜박검사
Facial nerve test	얼굴신경검사

Department of Neurology

Test Date :

I D : **Patient :** **Sex :** **Age :** **Technician :**

Nerve Conduction Studies

Motor Summary Table

Site	NR	Onset (ms)	P-T Amp (mV)	Site1	Site2	Dist (cm)	Vel (m/s)
Right Median Motor (Abd Poll Brev)							
Wrist		2.8	13.0	Wrist	Elbow	20.0	62.5
Elbow		6.0	12.5	Elbow	Axilla	10.0	66.7
Axilla		7.5	11.8				
Right Peroneal Motor (Ext Dig Brev)							
Ankle		2.9	7.3	Ankle	FH	28.0	50.0
FH		8.5	6.9	FH	Poplt	10.0	55.6
Poplt		10.3	6.9				
Right Tibial Motor (Abd Hall Brev)							
Ankle		3.0	27.0	Ankle	Poplt	36.0	50.7
Poplt		10.1	20.9				

Anti Sensory Summary Table

Site	NR	Onset (ms)	Peak (ms)	O-P Amp (μV)	Site1	Site2	Dist (cm)	Vel (m/s)
Right Median Anti Sensory (2nd Digit)								
Wrist		2.3	3.1	24.5	Wrist	2nd Digit	14.0	60.9
Elbow		5.4	6.3	16.0	Elbow	Wrist	20.0	64.5
Axilla		6.6	7.6	14.0	Axilla	Elbow	8.0	66.7
Right Sup Peron Anti Sensory (Ankle)								
Lower leg		2.1	2.7	25.0	Lower leg	Ankle	12.0	57.1
Right Sural Anti Sensory (Ankle)								
Lower leg		2.3	3.0	19.3	Lower leg	Ankle	14.0	60.9

F Wave Studies

NR	F-Lat (ms)	L-R F-Lat (ms)
Right Median (Mrkrs) (Abd Poll Brev)		
	24.03	

Department of Neurology

Test Date :

I D :	Patient :	Sex :	Age :	Technician :

Nerve Conduction Studies

Motor Summary Table

Site	NR	Onset (ms)	P-T Amp (mV)	Site1	Site2	Dist (cm)	Vel (m/s)
Right Median Motor (Abd Poll Brev)							
Wrist		2.8	13.0	Wrist	Elbow	20.0	62.5
Elbow		6.0	12.5	Elbow	Axilla	10.0	66.7
Axilla		7.5	11.8				
Right Peroneal Motor (Ext Dig Brev)							
Ankle		2.9	7.3	Ankle	FH	28.0	50.0
FH		8.5	6.9	FH	Poplt	10.0	55.6
Poplt		10.3	6.9				
Right Tibial Motor (Abd Hall Brev)							
Ankle		3.0	27.0	Ankle	Poplt	36.0	50.7
Poplt		10.1	20.9				

Anti Sensory Summary Table

Site	NR	Onset (ms)	Peak (ms)	O-P Amp (μV)	Site1	Site2	Dist (cm)	Vel (m/s)
Right Median Anti Sensory (2nd Digit)								
Wrist		2.3	3.1	24.5	Wrist	2nd Digit	14.0	60.9
Right Ulnar Anti Sensory (5st Digit)								
Wrist		2.2	3.0	21.4	Wrist	5st Digit	14.0	63.6
Right Sup Peron Anti Sensory (Ankle)								
Lower leg		2.1	2.7	25.0	Lower leg	Ankle	12.0	57.1
Right Sural Anti Sensory (Ankle)								
Lower leg		2.3	3.0	19.3	Lower leg	Ankle	14.0	60.9

F Wave Studies

NR	F-Lat (ms)	L-R F-Lat (ms)
Right Median (Abd Poll Brev)		
	24.03	
Left Median (Abd Poll Brev)		
	25.1	0.7

H-reflex Studies

NR	H-Lat (ms)	L-R H-Lat (ms)
Right Pot. tibial (Medial Gasto)		
	35.77	
Left Pot. tibial (Medial Gasto)		
	36.21	0.44

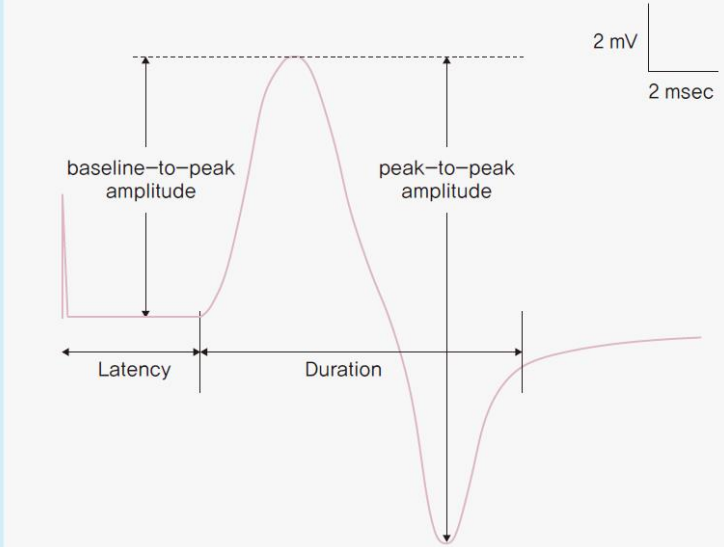
Section 11

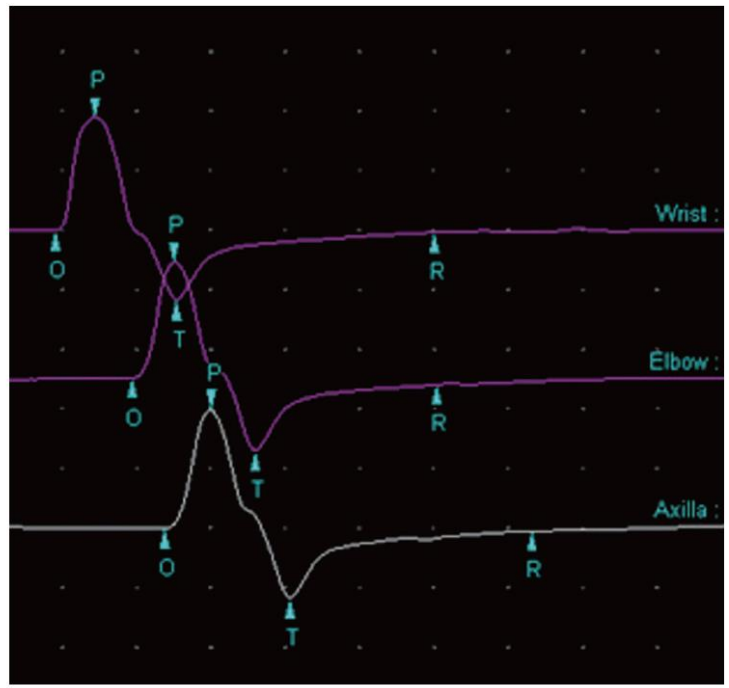
신경전도검사

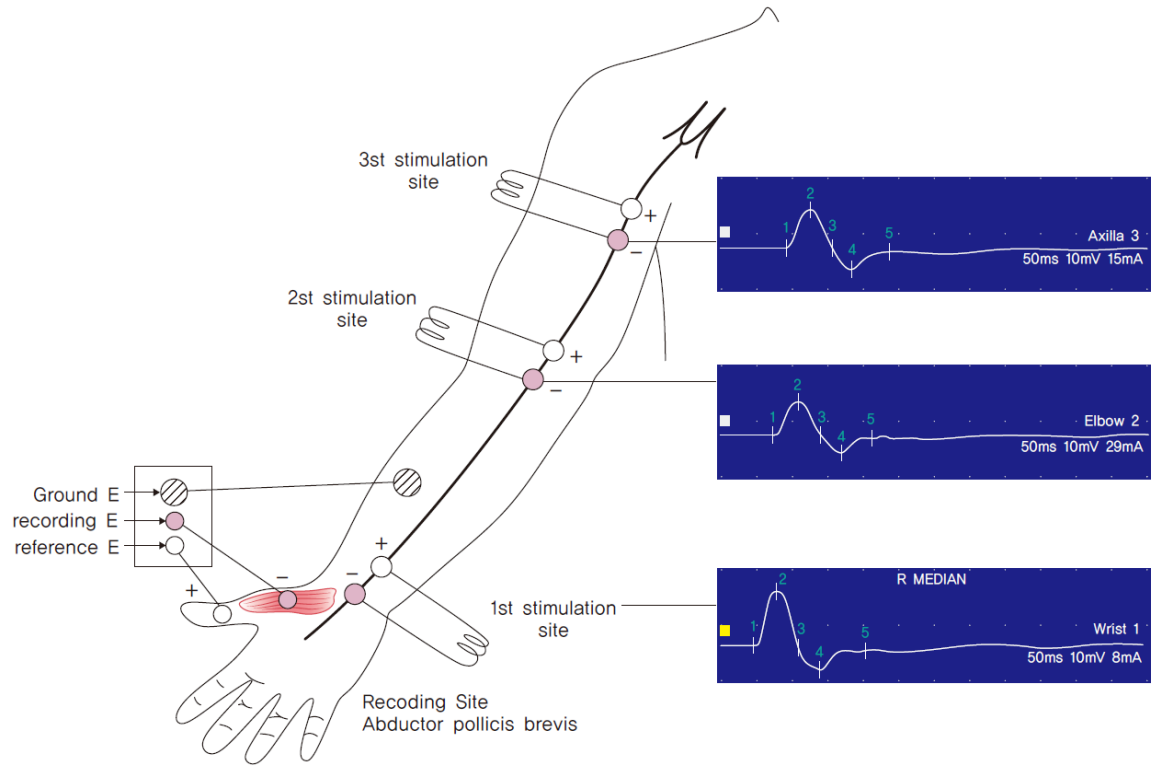
학습목표

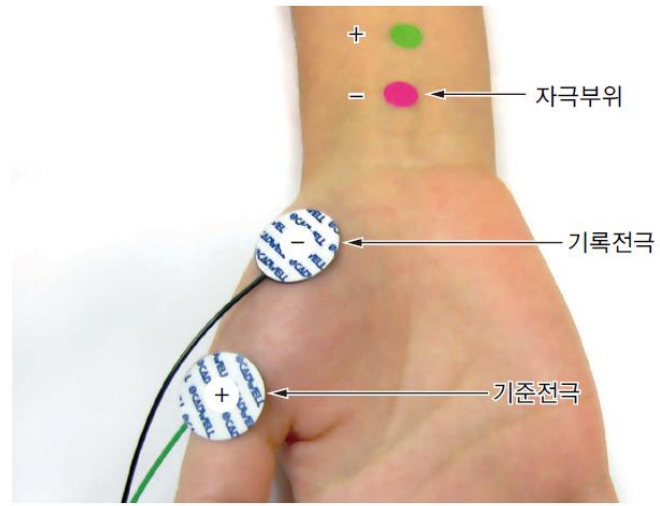
1. 신경전도검사의 임상적 의의와 대상 질환을 설명할 수 있다(A).
2. 신경운동단위를 설명할 수 있다(A).
3. 운동신경전도검사, 감각신경전도검사, 혼합신경전도검사, 후기반응검사 방법을 이해할 수 있다(A).
3. 신경전도검사의 영향인자를 설명할 수 있다(A).
4. 신경자극방법과 전극의 위치에 대하여 설명할 수 있다(A).
5. 운동신경전도검사의 측정법, 관련용어 및 결과를 이해할 수 있다(A).
   (정중신경, 자신경, 뒤정강신경, 종아리신경)
6. 감각신경전도검사의 측정법, 관련용어 및 결과를 이해할 수 있다(A).
   (정중신경, 자신경, 장딴지신경)
7. 후기반응에서 나타나는 파의 종류를 설명할 수 있다(A).
8. F-파 반응의 측정위치 및 정상과 비정상을 설명할 수 있다(A).
9. H-반사파의 측정위치와 잠복기에 대하여 설명할 수 있다(A).
10. 얼굴신경전도검사의 측정법, 관련용어 및 결과를 이해할 수 있다(A).
11. 눈깜박검사의 개념과 자극경로를 설명할 수 있다(A).
12. 눈깜박검사의 잠복기 및 임상응용을 설명할 수 있다(A).
13. 반복신경자극검사의 측정법, 관련용어 및 결과를 이해할 수 있다(A).

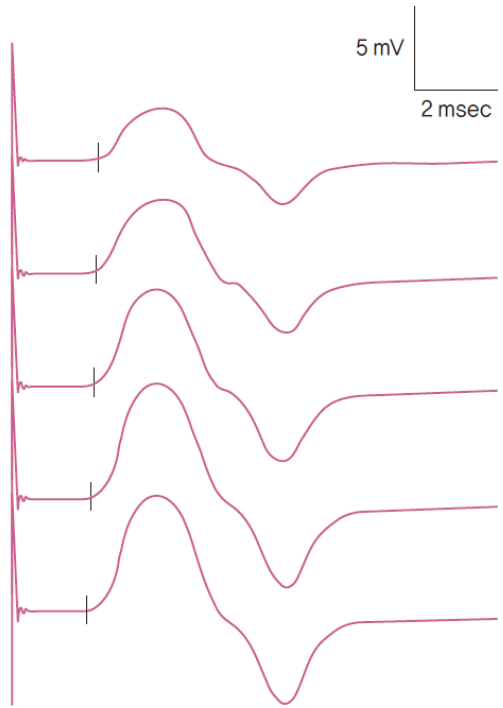
- Latency
- Amplitude
- Area
- Duration



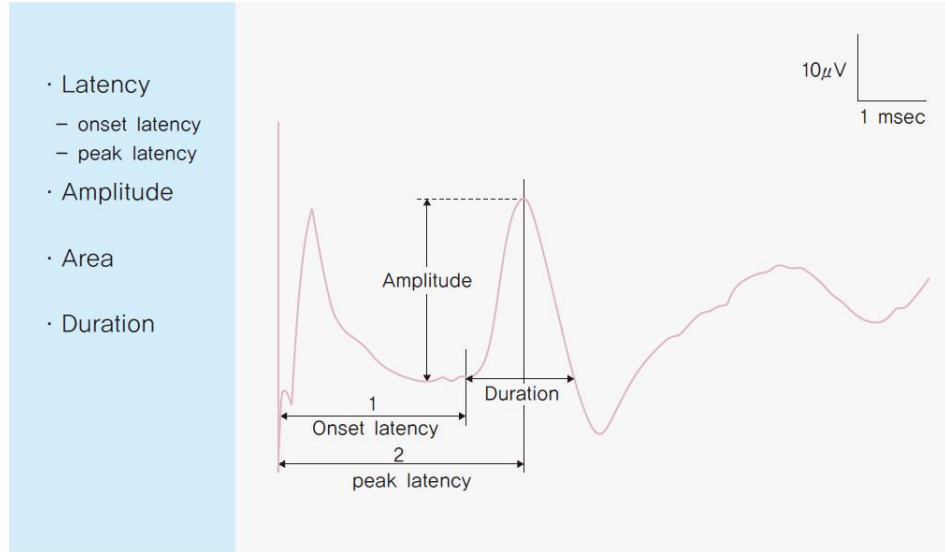



3st stimulation site
2st stimulation site
1st stimulation site
Ground E
recording E
reference E
Recoding Site
Abductor pollicis brevis
Axilla 3
50ms 10mV 15mA
Elbow 2
50ms 10mV 29mA
R MEDIAN
Wrist 1
50ms 10mV 8mA

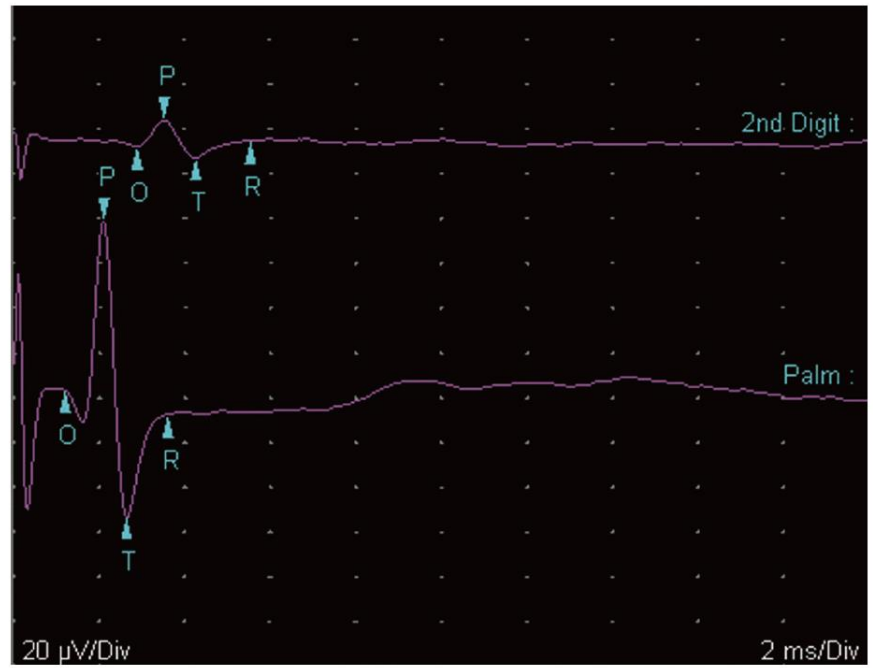

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자극부위
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기록전극
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기준전극



Current	Amplitude	Latency
6.0 mA	4.5 mV	3.6 msec
7.2 mA	6.8 mV	3.5 msec
9.0 mA	9.3 mV	3.5 msec
11.0 mA	10.5 mV	3.2 msec
14.0 mA	10.5 mV	3.1 msec



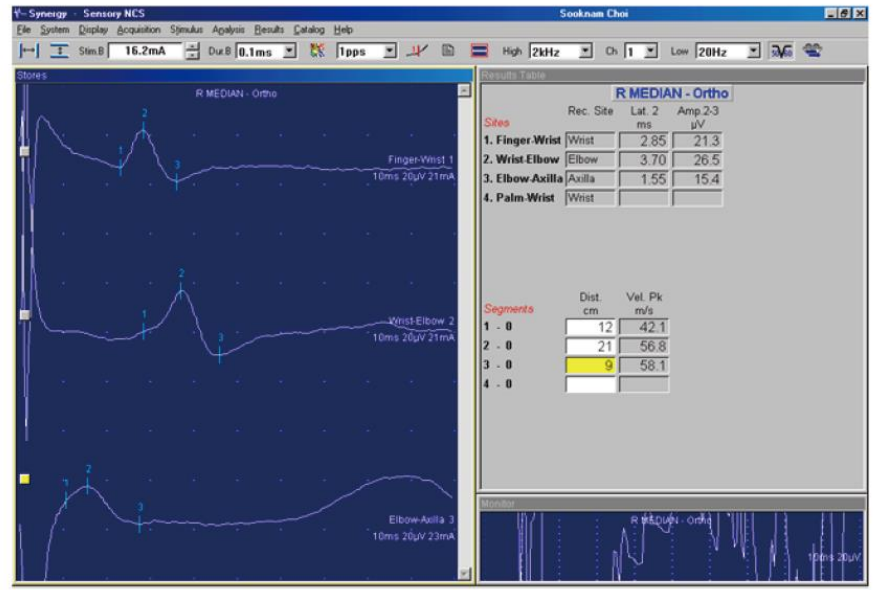
1. Onset latency(최초잠복기), 2. Peak latency(정점잠복기)

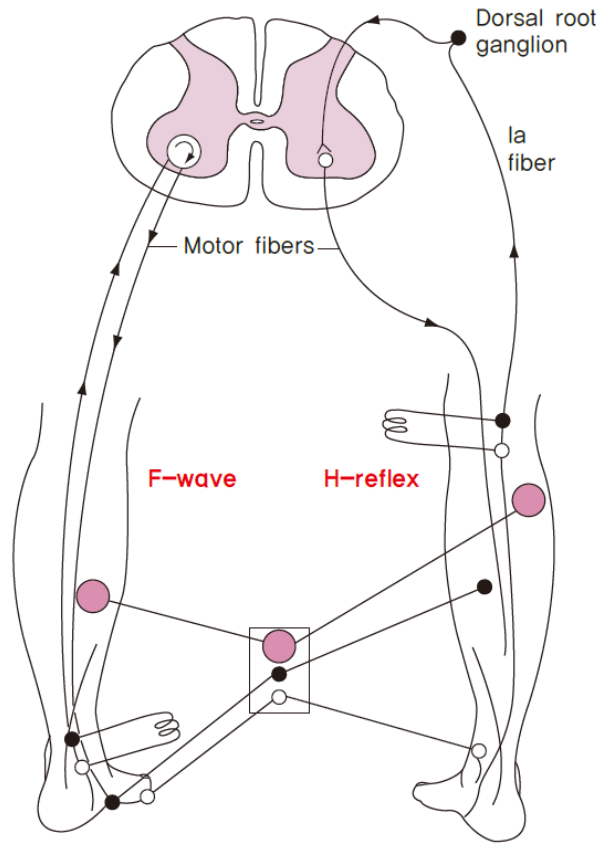


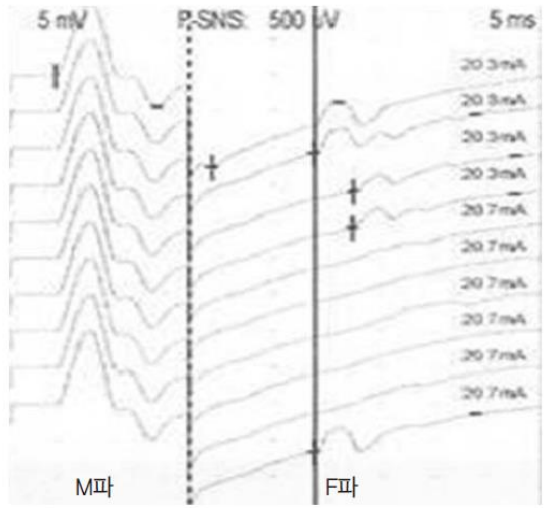
감각신경
(Finger-Wrist)

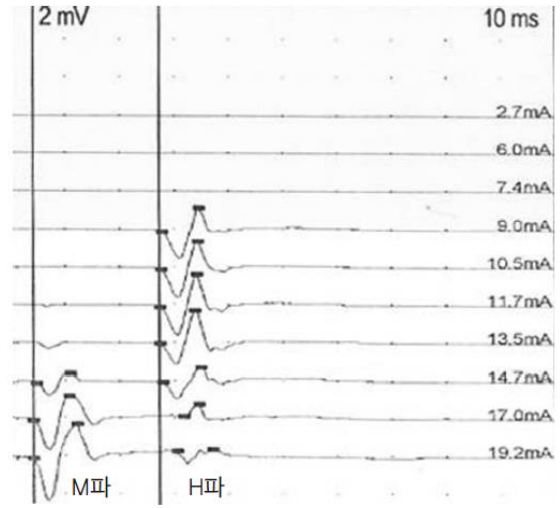
혼합신경
(Wrist-Elbow)

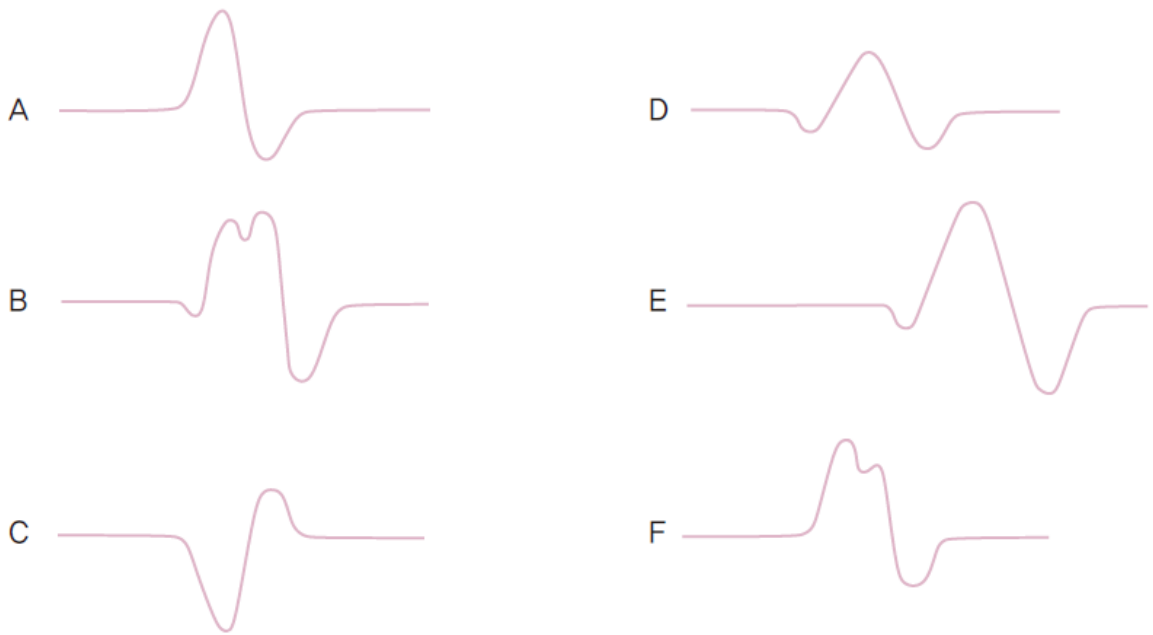
혼합신경
(Elbow-Axilla)

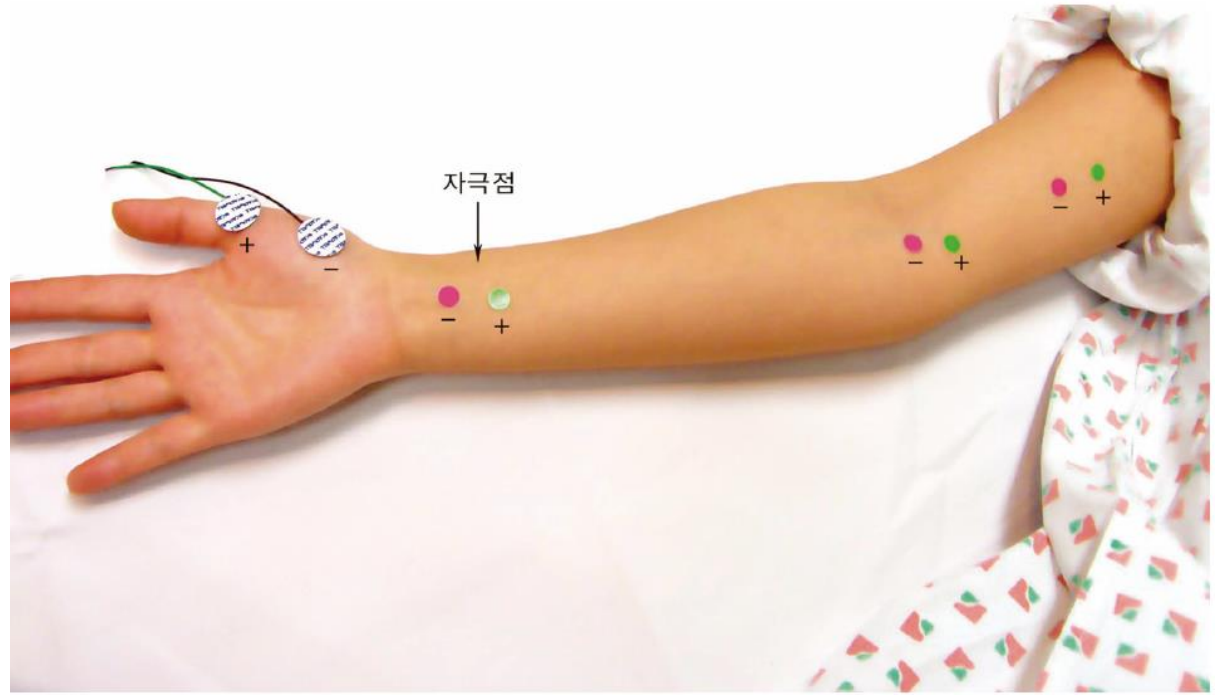



Dorsal root ganglion
Ia fiber
Motor fibers
F-wave
H-reflex


5 mV
P-SNS
500 μV
5 ms
M파
F파


2 mV
10 ms
2.7mA
6.0mA
7.4mA
9.0mA
10.5mA
11.7mA
13.5mA
14.7mA
17.0mA
19.2mA
M파
H파


A
B
C
D
E
F


자극점
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+
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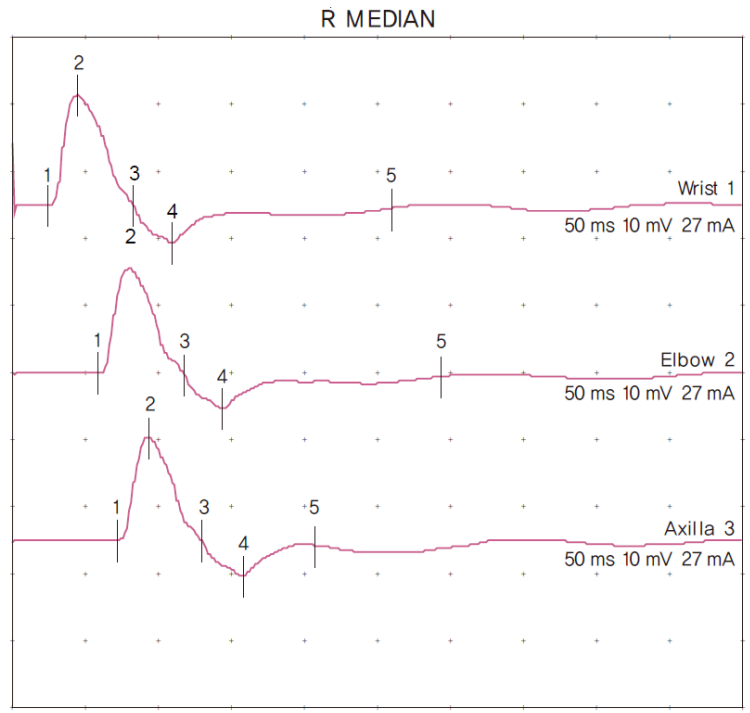
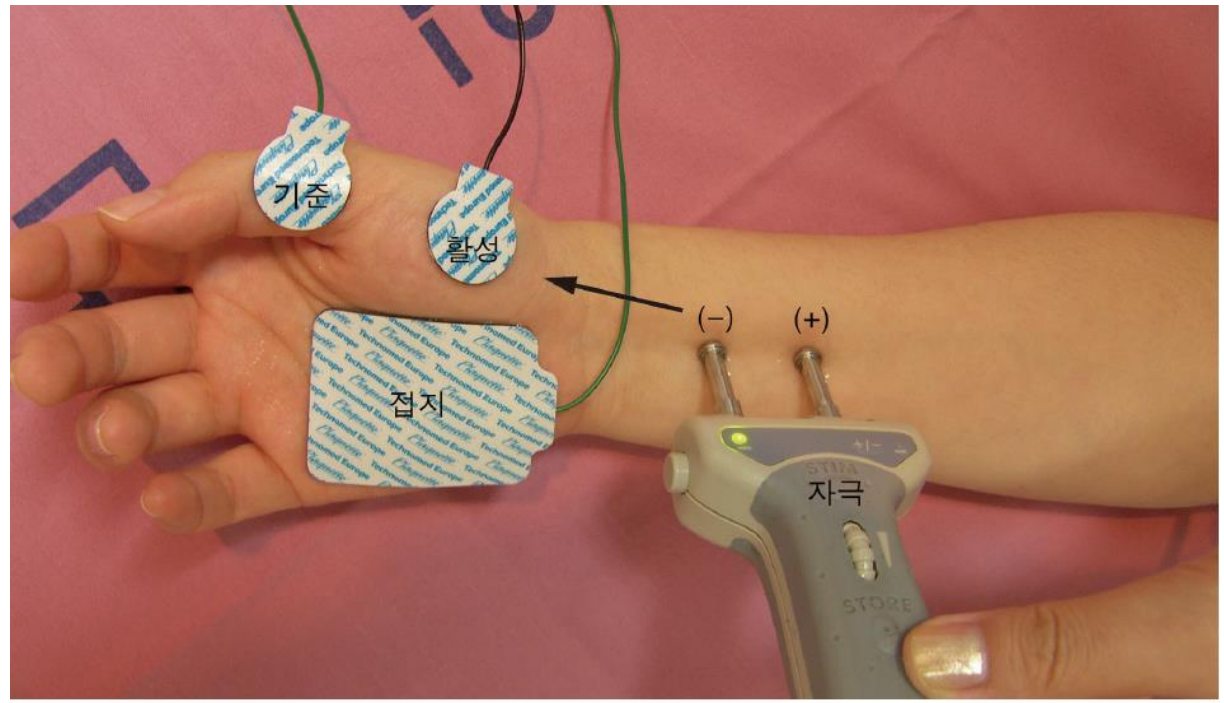
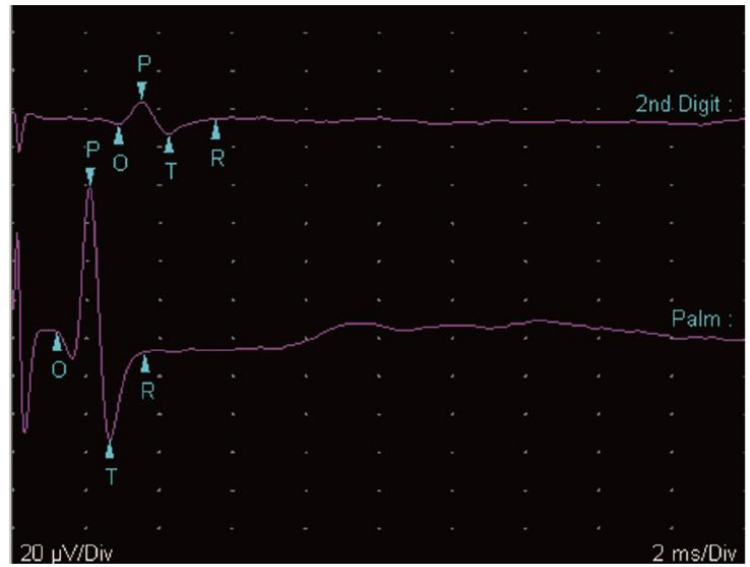
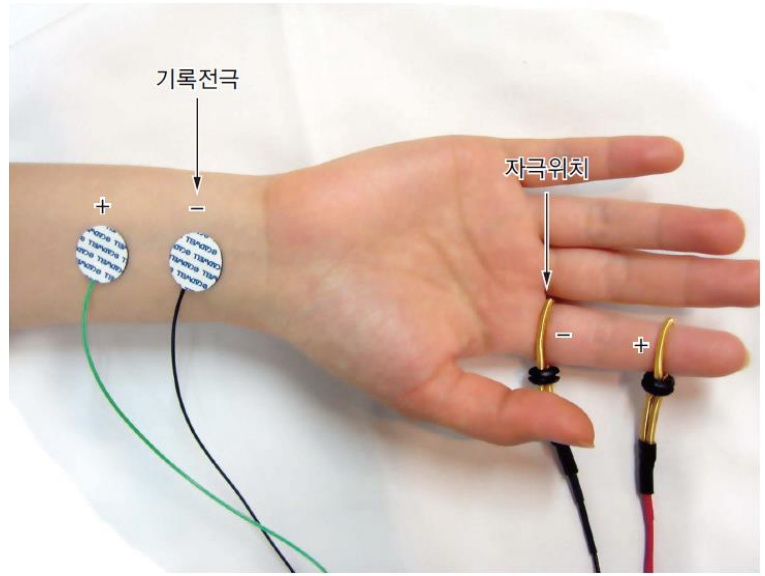

R MEDIAN
Wrist 1
50 ms 10 mV 27 mA
Elbow 2
50 ms 10 mV 27 mA
Axilla 3
50 ms 10 mV 27 mA

표 11-1. 정중신경의 운동신경전도검사 결과

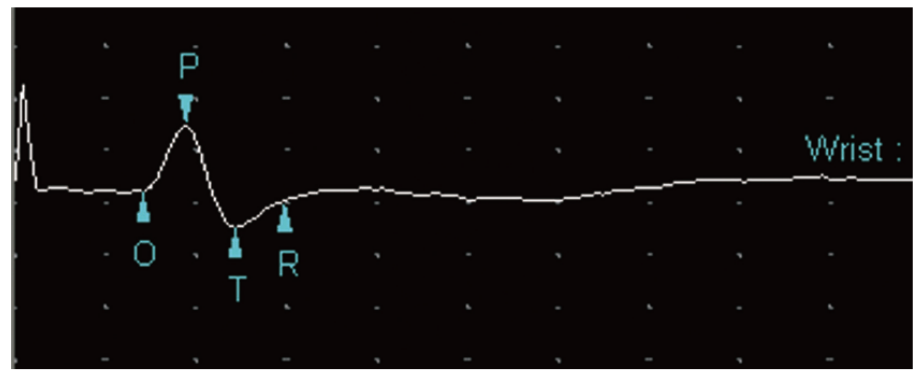
Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (mV) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Median Motor (Abd Poll Brev)					
Wrist		3.1	21.5	23.0	65.7
Elbow		6.6	20.4	10.0	66.6
Axilla		8.1	20.1		

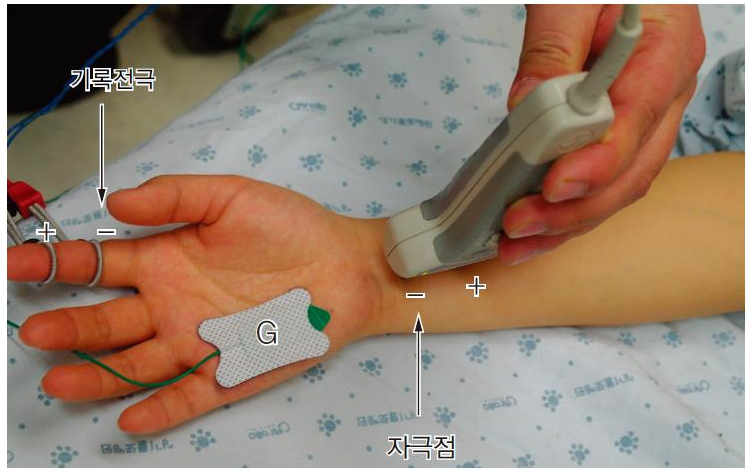

기준
활성
접지
(−)
(+)
자극


P
2nd Digit :
P
O
T
R
Palm :
O
R
T
20 µV/Div
2 ms/Div

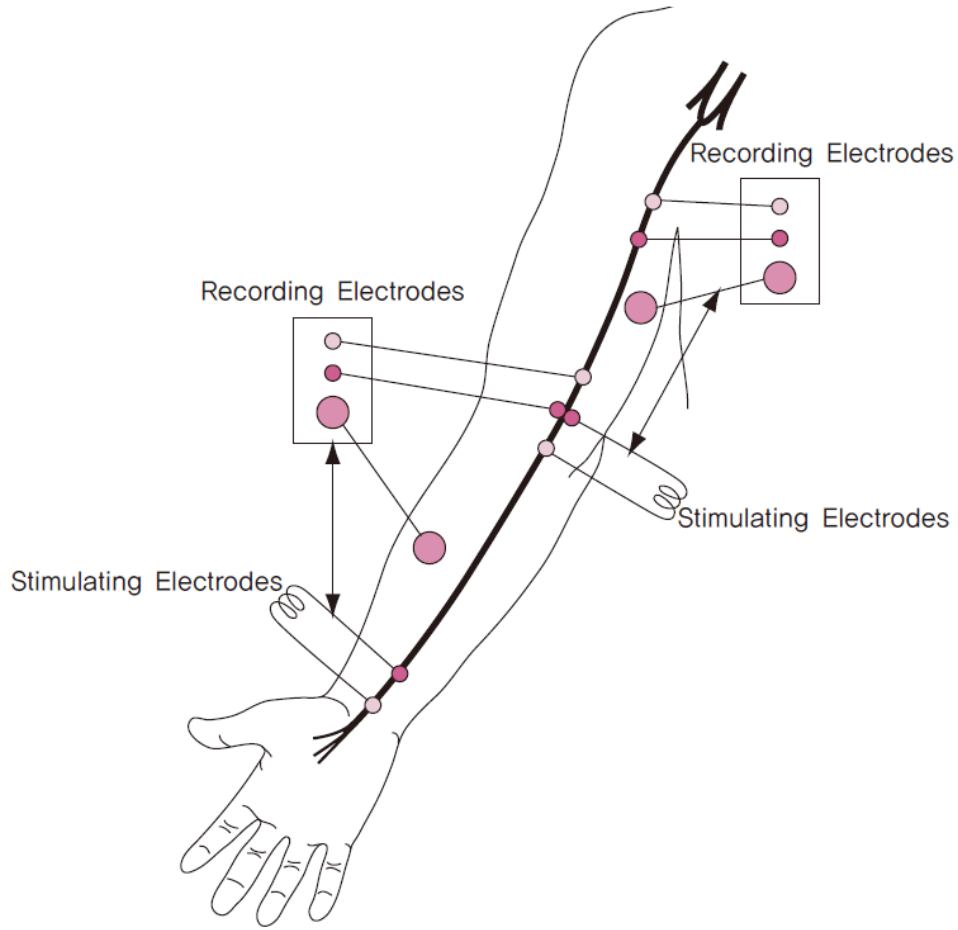

기록전극
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자극위치
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Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (μV) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Median Ortho sensory Run #1 (Record)					
Finger		2.5	29.6	13.0	52.0


P
O
T
R
Wrist :


기록전극
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자극점

Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (μV) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Median Anti Sensory Run #2 (Record)					
Finger		2.6	61.8	13.0	50.0


Recording Electrodes
Recording Electrodes
Stimulating Electrodes
Stimulating Electrodes


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자극점
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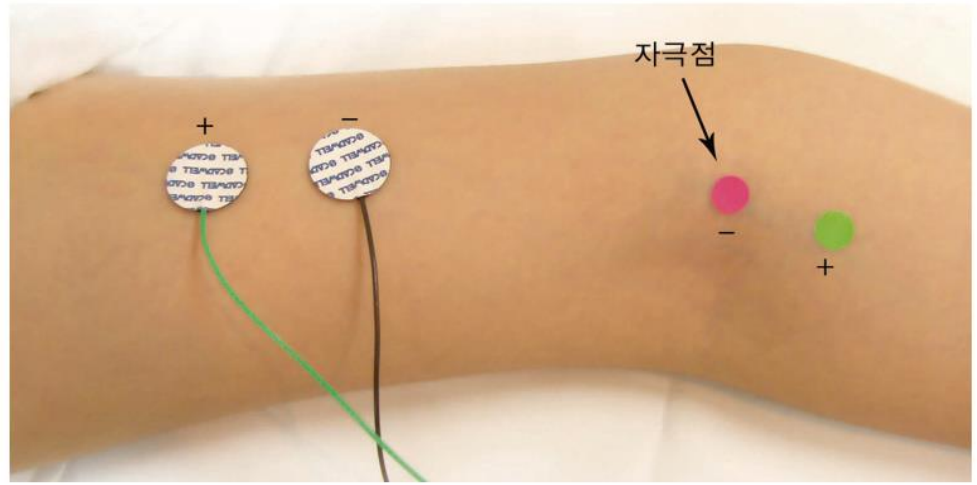
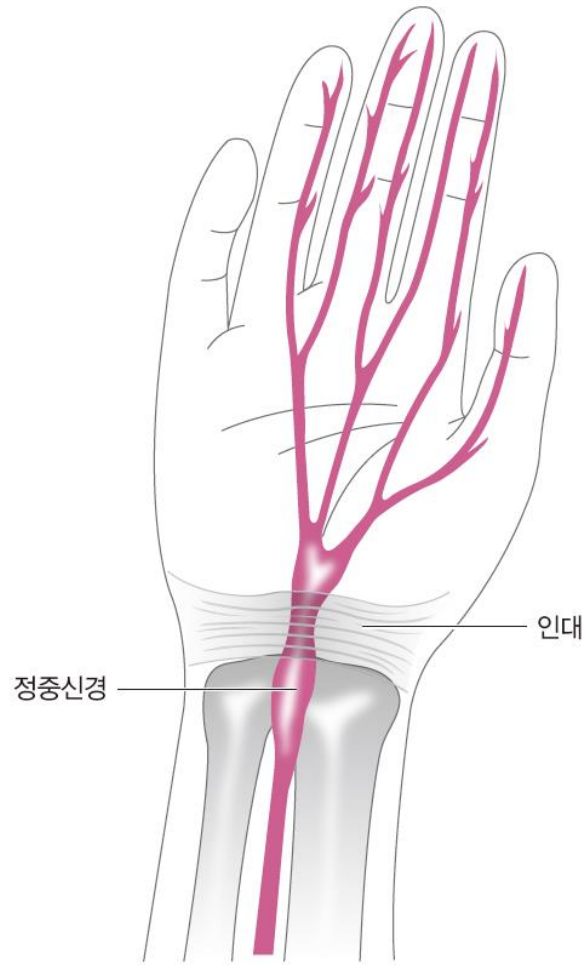

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표 11-4. 정중신경의 순수감각신경과 혼합신경전도검사 결과

Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (μV) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Median Sensory Run #1 (Record)					
Finger		2.5	29.6	13.0	52.0
Wrist		4.0	64.5	22.0	55.0
Elbow		1.8	47.5	11.0	61.0


인대
정중신경

Department of Neurology

Test Date :

I D :	Patient :	Sex :	Age :	Technician :

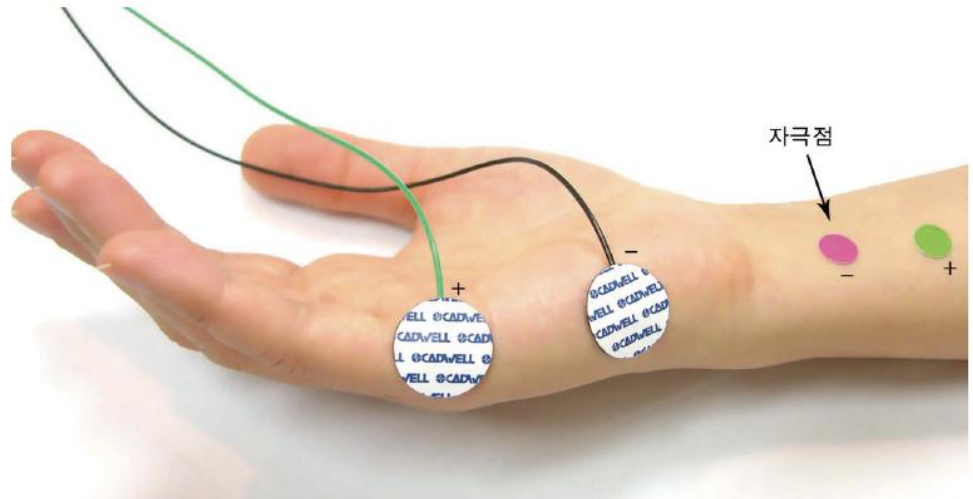
Nerve Conduction Studies

Motor Summary Table

Site	NR	Onset (ms)	P-T Amp (mV)	Site1	Site2	Dist (cm)	Vel (m/s)
Left Median Motor (Abd Poll Brev)							
Wrist		*4.5	*6.4	Wrist	Elbow	20.0	57.1
Elbow		8.0	*6.2	Elbow	Axilla	10.0	58.8
Axilla		9.7	*6.2				
Right Median Motor (Abd Poll Brev)							
Wrist		*4.3	*7.7	Wrist	Elbow	20.0	57.1
Elbow		7.8	*7.5	Elbow	Axilla	10.0	58.8
Axilla		9.5	*6.9				
Left Ulnar Motor (Abd Dig Min)							
Wrist		3.1	10.4	Elbow	Wrist	20.0	51.3
Elbow		7.0	10.2	Axilla	Elbow	10.0	52.6
Axilla		8.9	10.0				
Right Ulnar Motor (Abd Dig Min)							
Wrist		2.8	10.3	Elbow	Wrist	20.0	51.3
Elbow		6.7	10.2	Axilla	Elbow	10.0	52.6
Axilla		8.6	10.2				

Ortho Sensory Summary Table

Site	NR	Peak (ms)	P-T Amp (μV)	Site1	Site2	Dist (cm)	Vel (m/s)
Left Median Ortho Sensory (Rec)							
2nd Digit-Wrist		*4.3	16.0	2nd Digit-Wrist	Rec	14.0	*32.6
Wrist-Elbow		3.7	31.0	Wrist-Elbow	Rec	20.0	54.1
Elbow-Axilly		1.8	91.8	Elbow-Axilly	Rec	10.0	55.6
Palm-Wist		2.5	24.5	Palm-Wist	Rec	7.0	*28.0
Right Median Ortho Sensory (Rec)							
2nd Digit-Wrist		*4.2	*9.3	2nd Digit-Wrist	Rec	14.0	*33.3
Wrist-Elbow		3.7	43.2	Wrist-Elbow	Rec	20.0	54.1
Elbow-Axilly		1.7	75.0	Elbow-Axilly	Rec	10.0	58.8
Palm-Wist		2.4	35.2	Palm-Wist	Rec	7.0	*29.2
Left Ulnar Ortho Sensory (Rec)							
5th Digit-Wrist		3.2	16.8	5th Digit-Wrist	Rec	14.0	43.8
Wrist-Elbow		3.8	47.7	Wrist-Elbow	Rec	20.0	52.6
Elbow-Axillary		1.7	108.1	Elbow-Axillary	Rec	10.0	58.8
Right Ulnar Ortho Sensory (Rec)							
5th Digit-Wrist		2.9	15.8	5th Digit-Wrist	Rec	14.0	48.3
Wrist-Elbow		3.9	42.9	Wrist-Elbow	Rec	20.0	51.3
Elbow-Axillary		1.5	59.8	Elbow-Axillary	Rec	10.0	66.7


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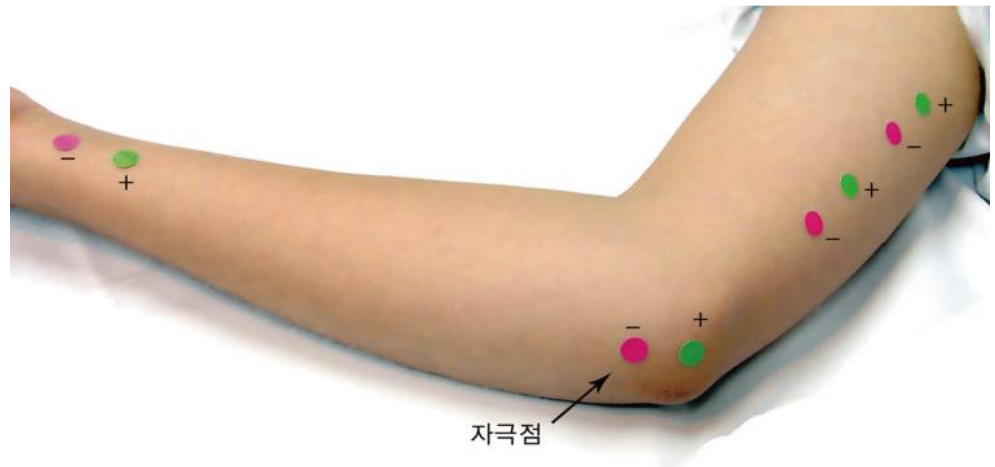
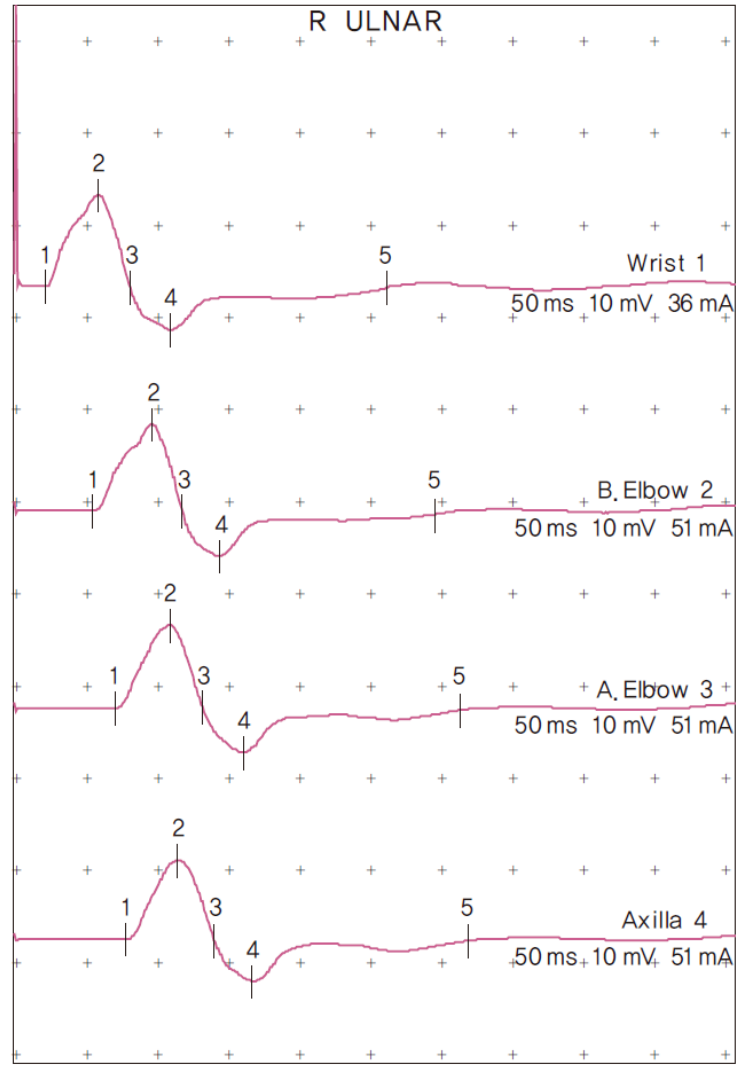
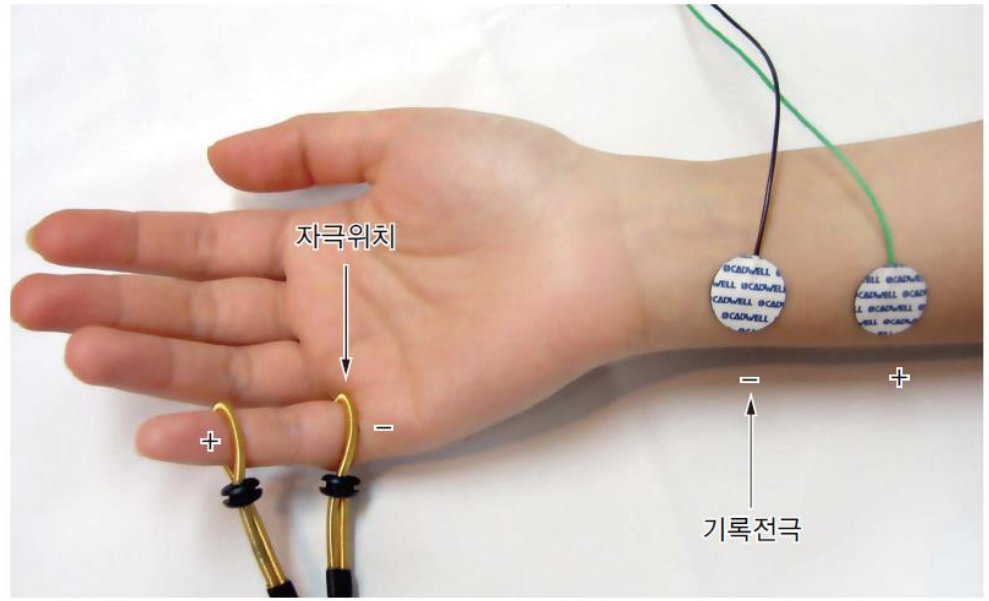
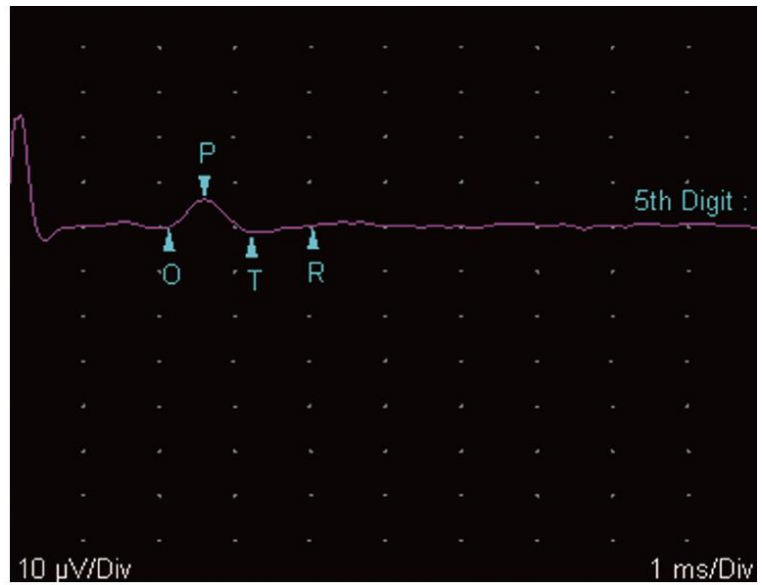

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자극점

표 11-6. 자신경의 운동신경전도검사 결과

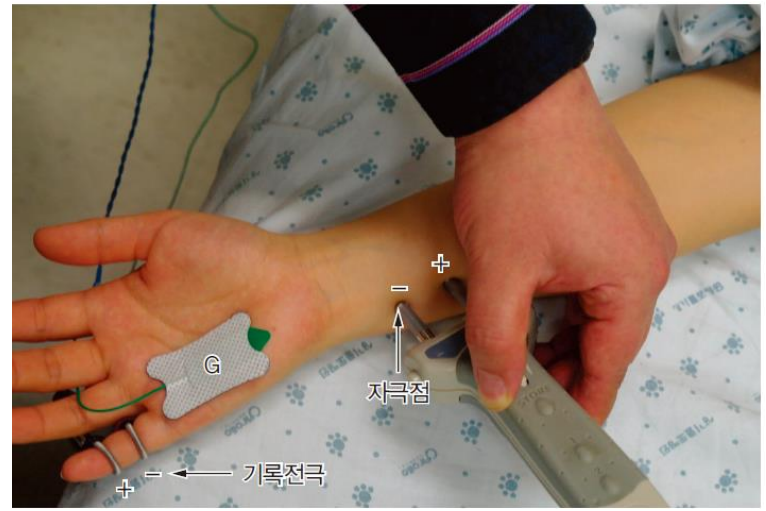
Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (mv) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Ulnar Motor (Abd Dig Minimi)					
Wrist		2.5	14.8	22.0	61.1
B Elbow		6.1	14.0	8.0	47.1
A Elbow		7.8	13.2	4.0	50.0
Axilla		8.6	12.9		


R ULNAR
1
2
3
4
5
Wrist 1
50 ms 10 mV 36 mA
B. Elbow 2
50 ms 10 mV 51 mA
A. Elbow 3
50 ms 10 mV 51 mA
Axilla 4
50 ms 10 mV 51 mA


자극위치
+
−
−
+
기록전극


P
O
T
R
5th Digit :
10 µV/Div
1 ms/Div

Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (μv) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Ulnar Ortho sensory (Record)					
Finger		2.3	19.1	11.0	47.8


G
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자극점
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기록전극

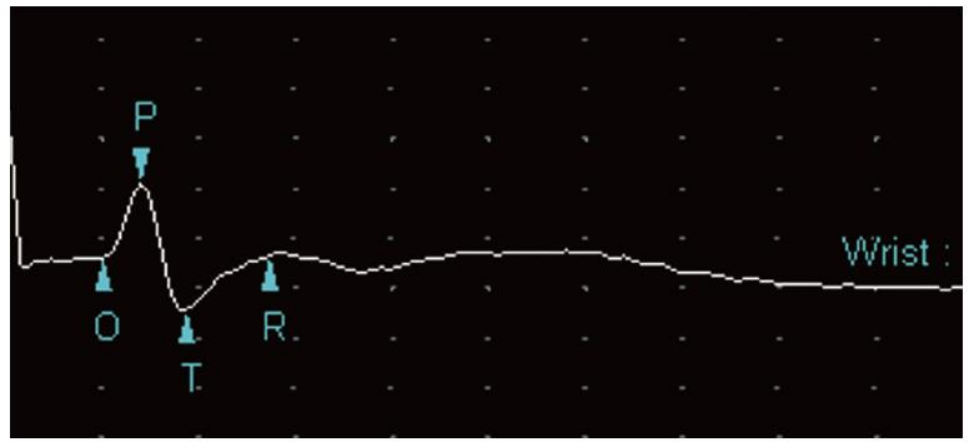
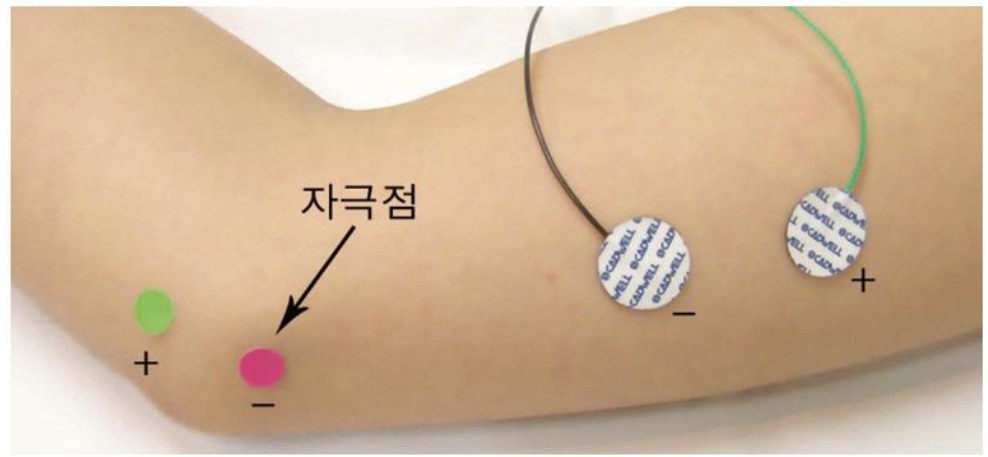

P
O
T
R
Wrist :

표 11-8. 자신경의 순수감각신경전도검사(역방향) 결과

Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (μv) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Ulnar Anti Sensory (Record)					
Finger		2.5	20.1	12.0	48.0


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자극점
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자극점
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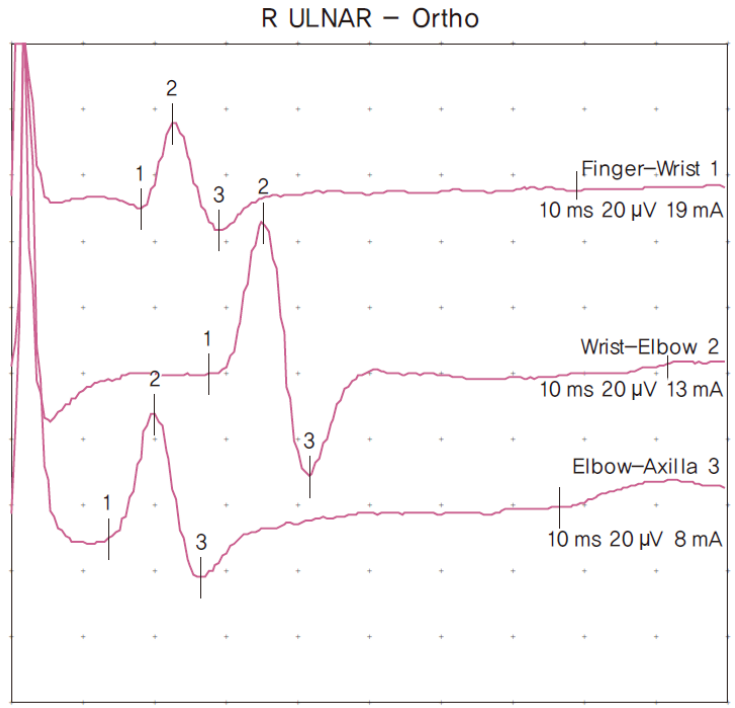
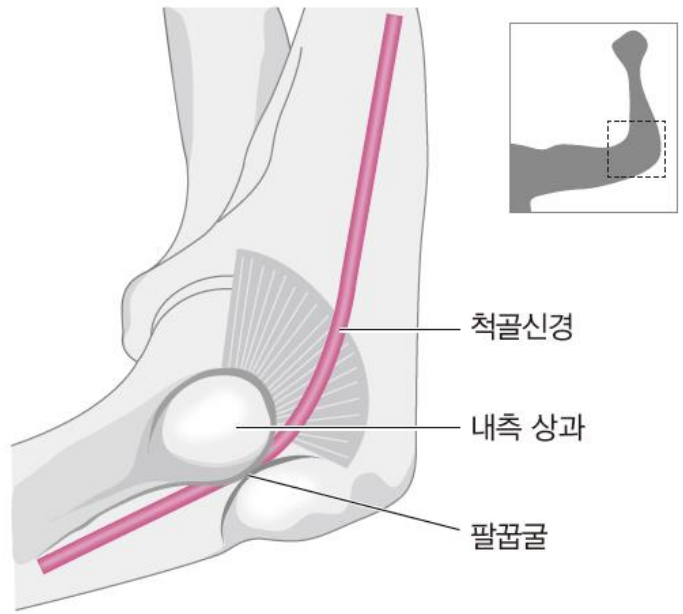

R ULNAR – Ortho
Finger–Wrist 1
10 ms 20 µV 19 mA
Wrist–Elbow 2
10 ms 20 µV 13 mA
Elbow–Axilla 3
10 ms 20 µV 8 mA

표 11-9. 자신경의 혼합신경전도검사 결과

Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (μv) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right 4 Ulnar Sensory (Record)					
Finger		2.3	19.1	11.0	47.8
Wrist		4.2	81.8	21.0	50.0
Elbow		2.0	79.1	11.0	55.0


척골신경
내측 상과
팔꿉굴

Department of Neurology

Test Date :

I D : **Patient :** **Sex :** **Age :** **Technician :**

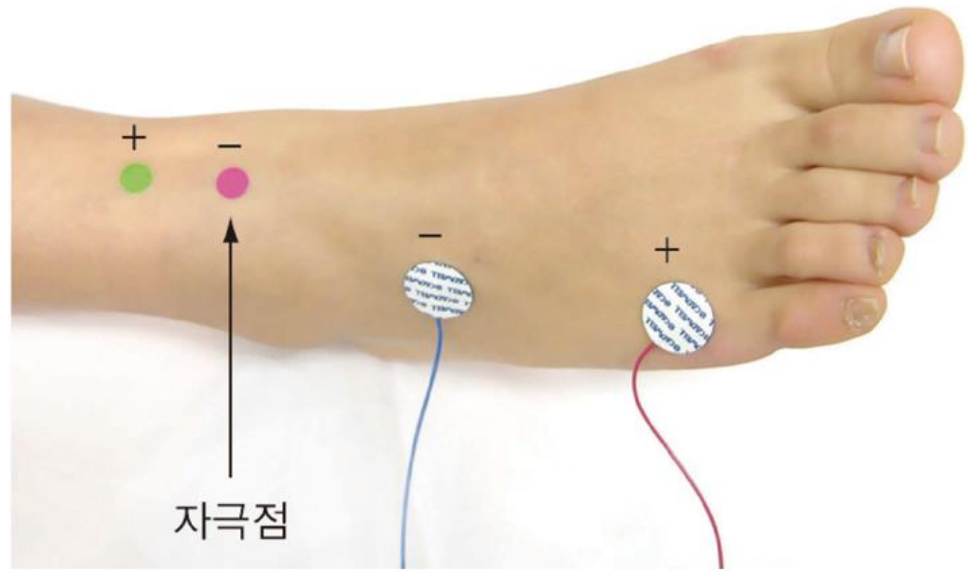
Nerve Conduction Studies

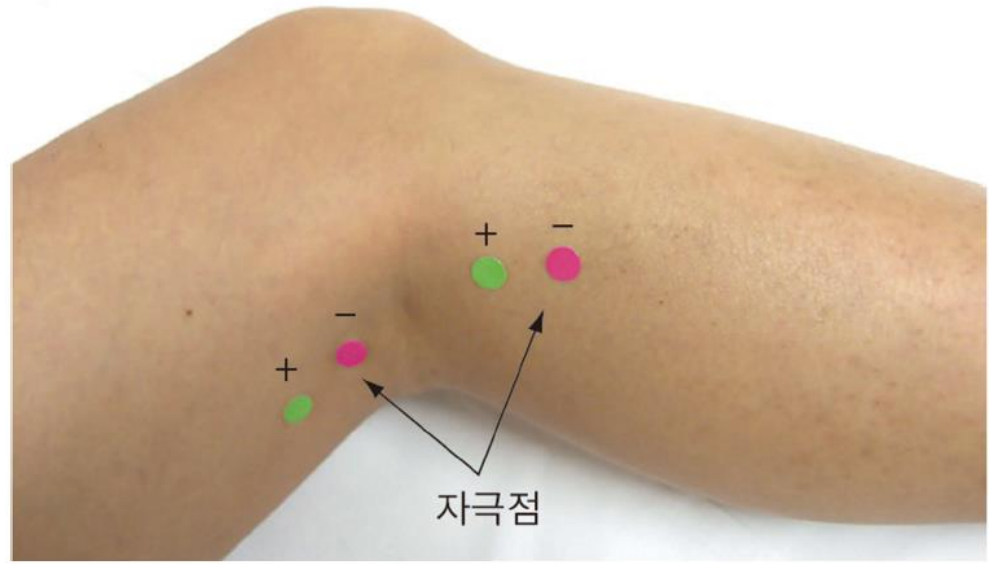
Motor Summary Table

Site	NR	Onset (ms)	P-T Amp (mV)	Site1	Site2	Dist (cm)	Vel (m/s)
Left Median Motor (Abd Poll Brev)							
Wrist		3.1	11.6	Wrist	Elbow	20.0	58.8
Elbow		6.5	11.0	Elbow	Axilla	10.0	66.6
Axilla		8.0	10.8				
Right Median Motor (Abd Poll Brev)							
Wrist		3.2	10.3	Wrist	Elbow	20.0	62.5
Elbow		6.4	9.6	Elbow	Axilla	10.0	62.5
Axilla		8.0	9.6				
Left Ulnar_inching1 Motor (Abd Dig Minimi)							
Wrist		3.2	13.1	B Elbow	Wrist	18.0	56.2
B Elbow		6.4	12.7	Elbow	B Elbow	4.0	57.1
Elbow		7.1	12.5	A Elbow	Elbow	4.0	57.1
A Elbow		7.8	12.1	Axilla	A Elbow	6.0	60.0
Axilla		8.8	11.9				
Right Ulnar_inching1 Motor (Abd Dig Minimi)							
Wrist		3.0	13.0	B Elbow	Wrist	18.0	56.3
B Elbow		6.2	12.7	Elbow	B Elbow	4.0	*33.3
Elbow		7.4	*8.6	A Elbow	Elbow	4.0	57.1
A Elbow		8.1	*6.9	Axilla	A Elbow	6.0	60.0
Axilla		9.1	*6.2				

Anti Sensory Summary Table

Site	NR	Onset (ms)	Peak (ms)	O-P Amp (μV)	Site1	Site2	Dist (cm)	Vel (m/s)
Left Median Anti Sensory (2nd Digit)								
Wrist		2.6	3.1	11.2	Wrist	Palm	14.0	53.8
Right Median Anti Sensory (2nd Digit)								
Wrist		2.7	3.3	12.1	Wrist	Palm	7.0	51.9
Left Ulnar Anti Sensory (5th Digit)								
Wrist		2.1	3.2	12.5	Wrist	5th Digit	14.0	66.7
Right Ulnar Anti Sensory (5th Digit)								
Wrist		*3.6	*5.1	*5.3	Wrist	5th Digit	14.0	*38.9


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−
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+
자극점


+
−
−
+
자극점

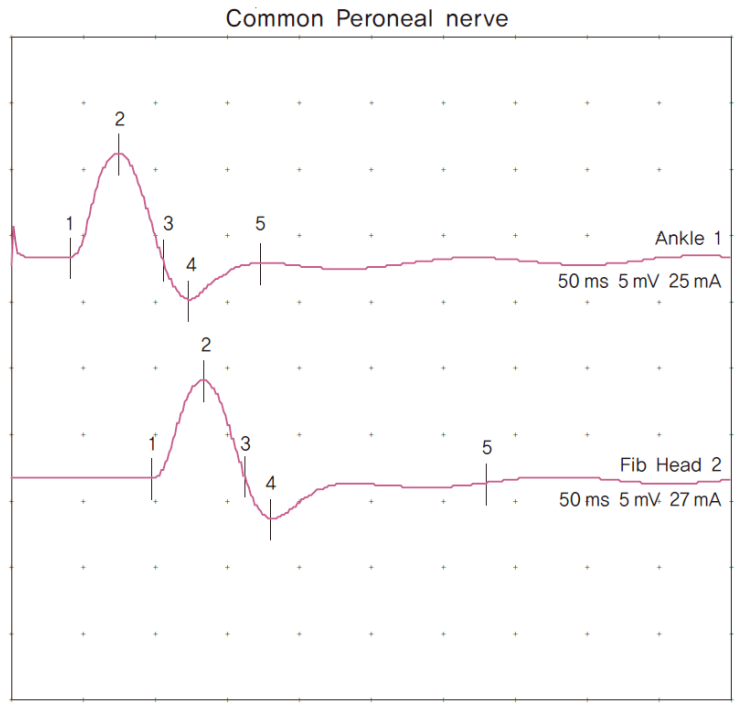
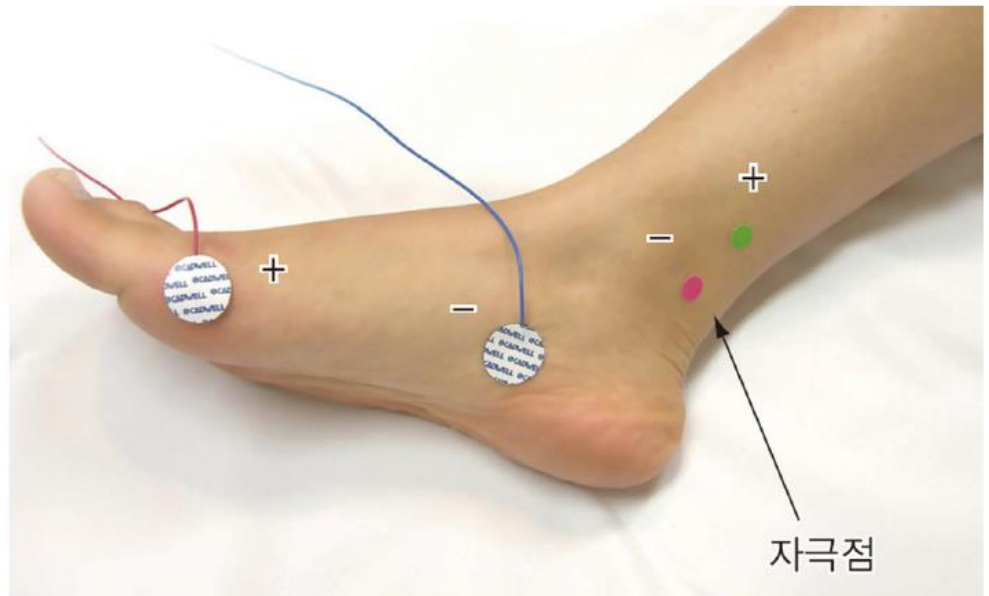
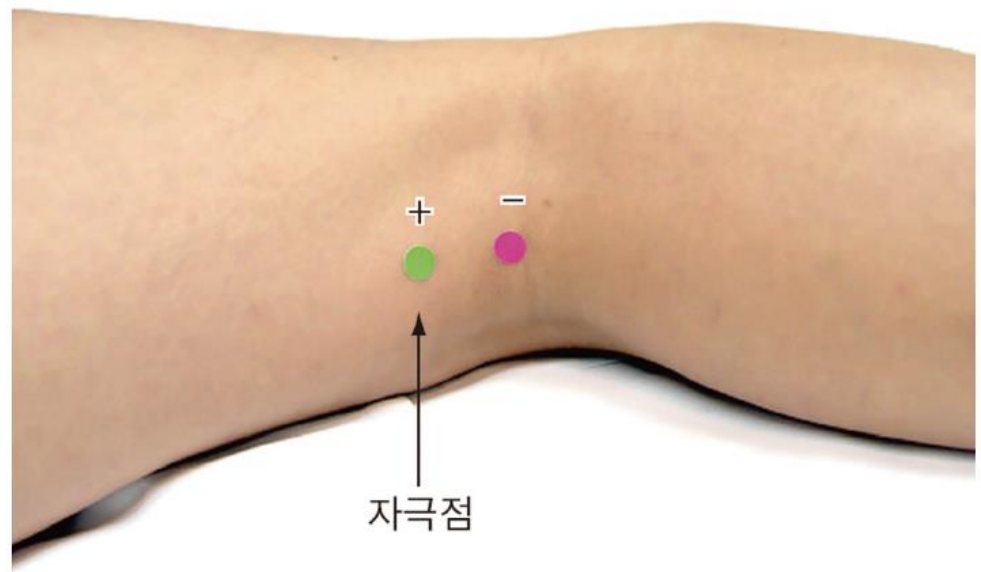

Common Peroneal nerve
1
2
3
4
5
Ankle 1
50 ms 5 mV 25 mA
1
2
3
4
5
Fib Head 2
50 ms 5 mV 27 mA

표 11-11. 종아리신경의 운동신경전도검사 결과

Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (mv) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Peroneal Motor (Ext Dig Brev)					
Ankle		4.9	4.0	30.0	46.2
B Fib		11.4	3.4	30.0	46.2
A Fib		13.4	3.0	10.0	50.0


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자극점


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자극점

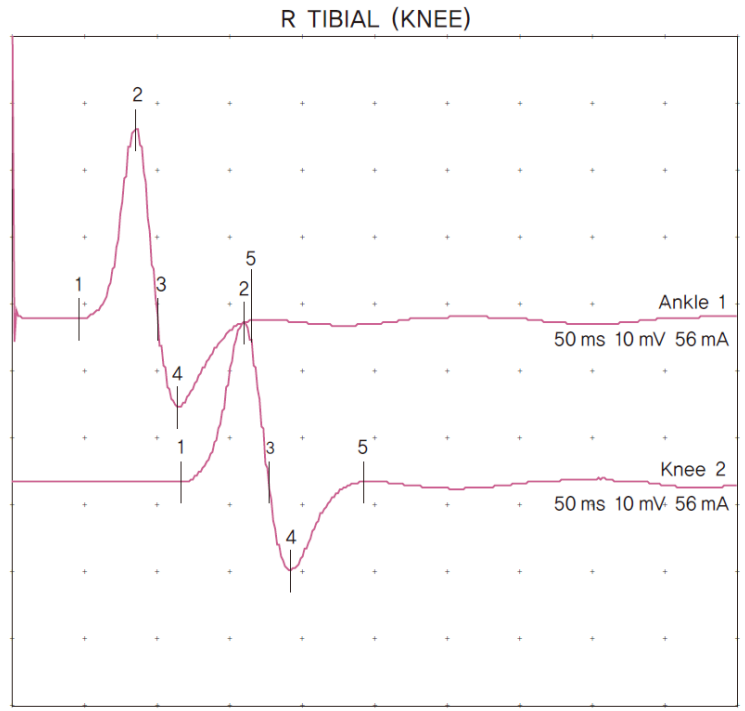
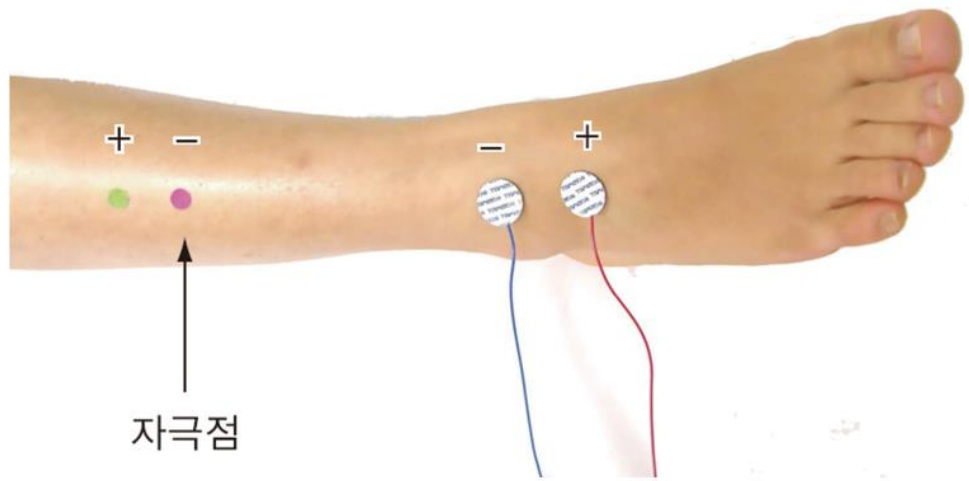

R TIBIAL (KNEE)
1
2
3
4
5
Ankle 1
50 ms 10 mV 56 mA
1
3
5
2
4
Knee 2
50 ms 10 mV 56 mA

표 11-12. 뒤정강신경의 운동신경전도검사 결과

Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (mv) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Tibial Motro (Abd Hall Brev)					
Ankle		3.8	20.9	35.0	47.9
Knee		11.1	17.9		

표 11-13. 얕은 종아리신경의 감각신경전도검사 결과

Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (μv) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Sup. Peroneal Nerve Sensory (Ant Lat Mall)					
Ankle		3.5	23.8	13.0	37.1


+
−
−
+
자극점

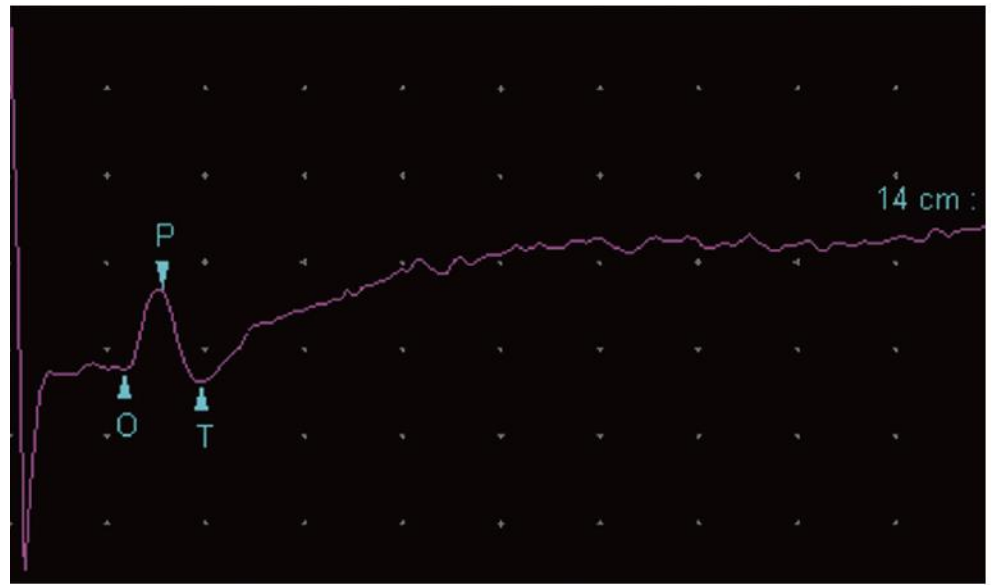
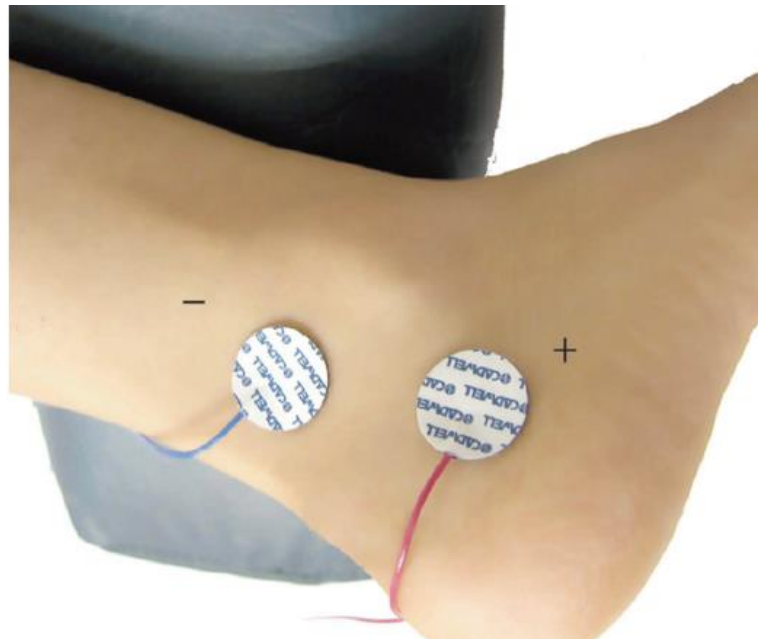
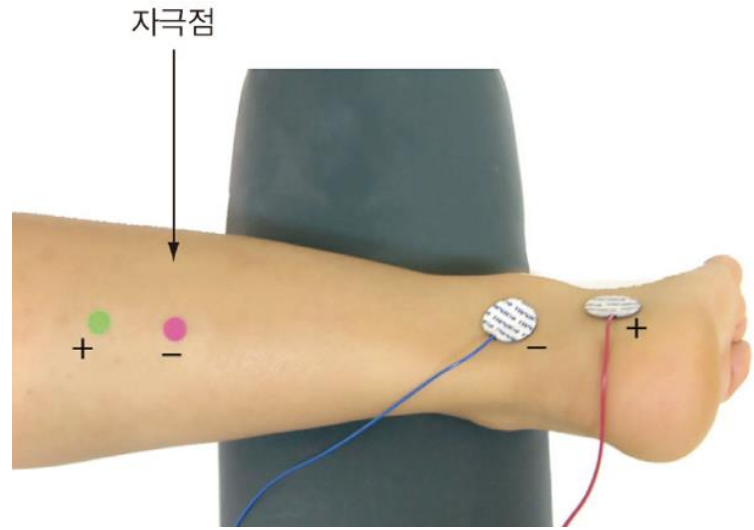

14 cm :
P
O
T

표 11-14. 장딴지신경의 감각신경전도검사 결과

Site	NR (no response) 무반응	Onset latency (ms) 잠복기	Amplitude (μv) 진폭	Distance (cm) 거리	Velocity (m/s) 전도속도
Right Sural sensory (Lat Mall)					
Calf		3.6	21.2	13.0	36.1




자극점
+
−
−
+

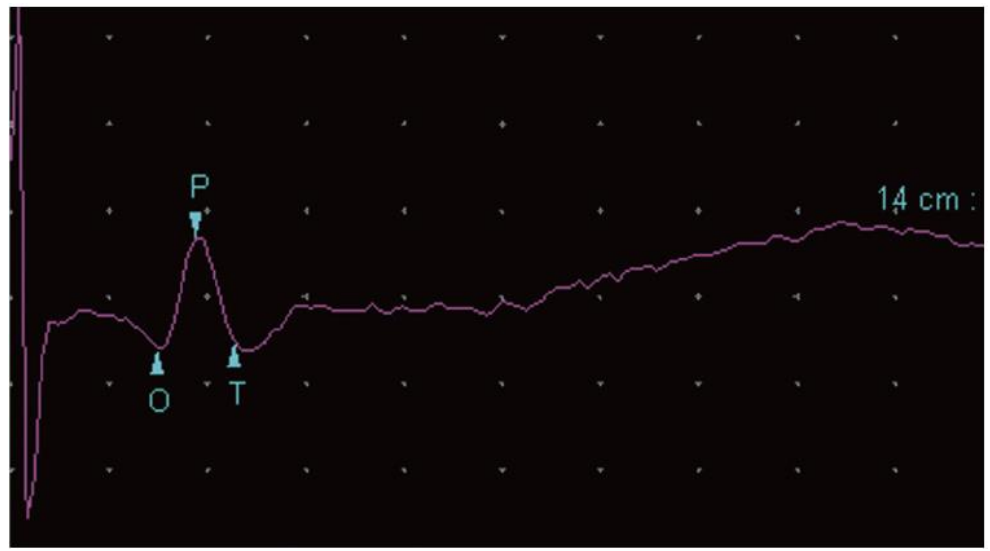
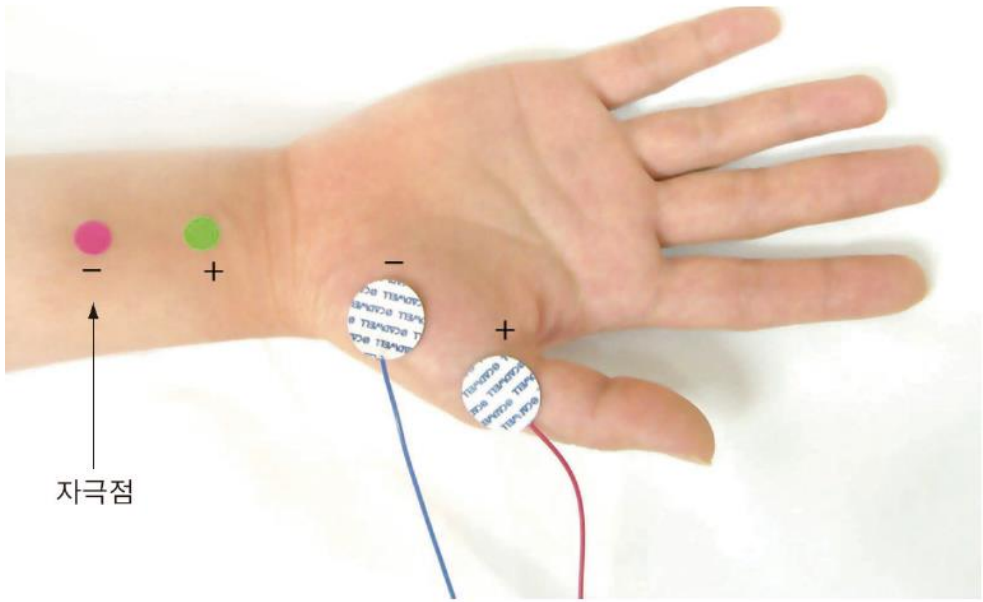

P
O
T
14 cm :

표 11-15. 정중신경의 F파 검사 결과치

	F-Lat (ms) F-wave 잠복기
Right Ulnar	32.38


−
+
−
+
자극점

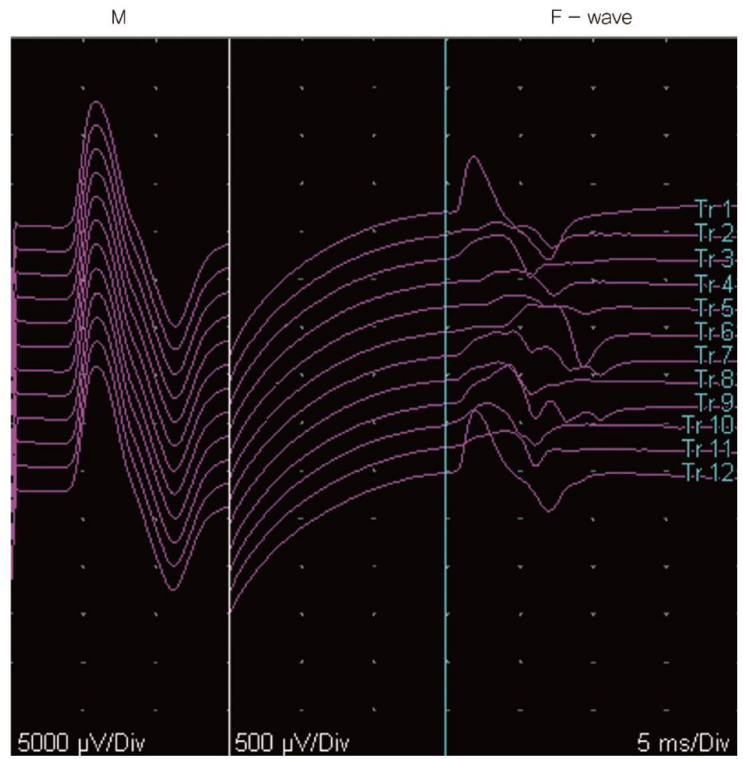
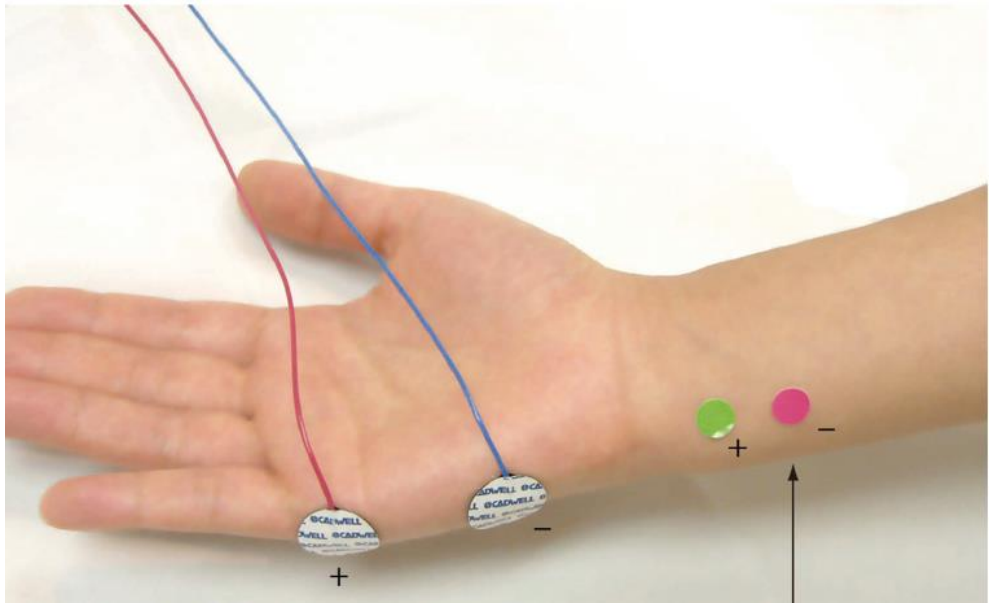
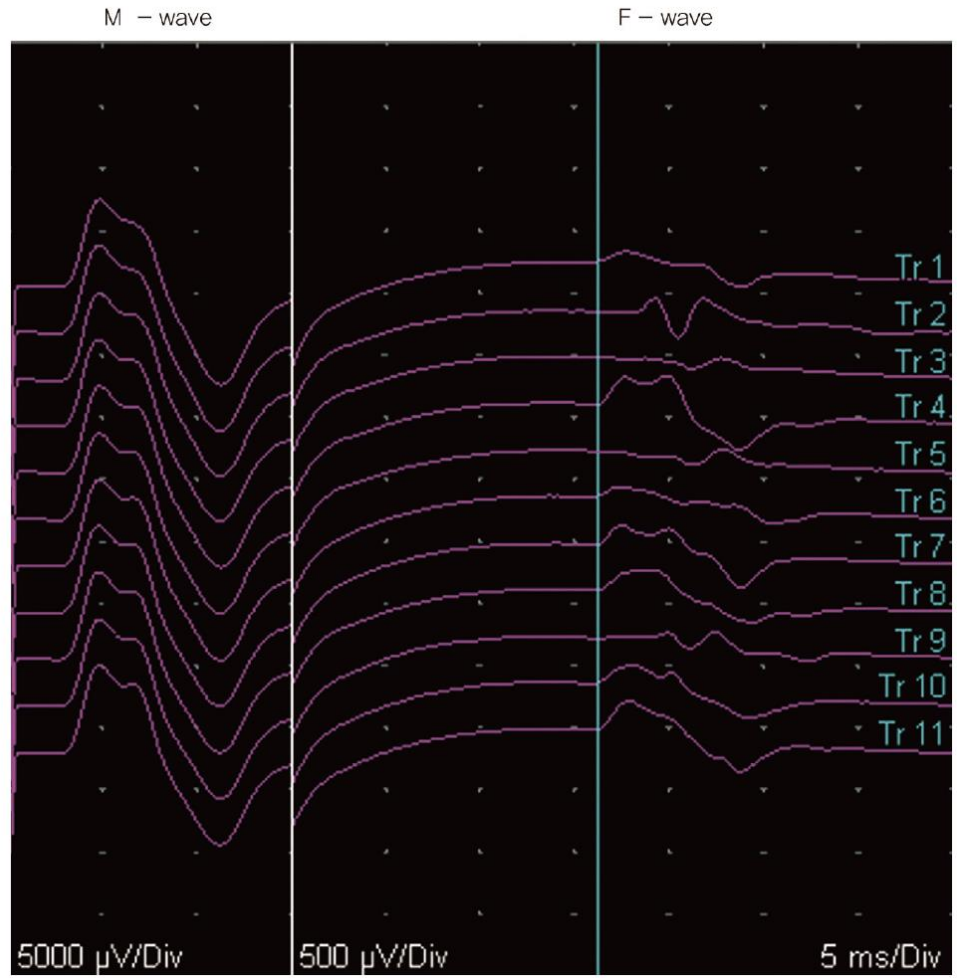
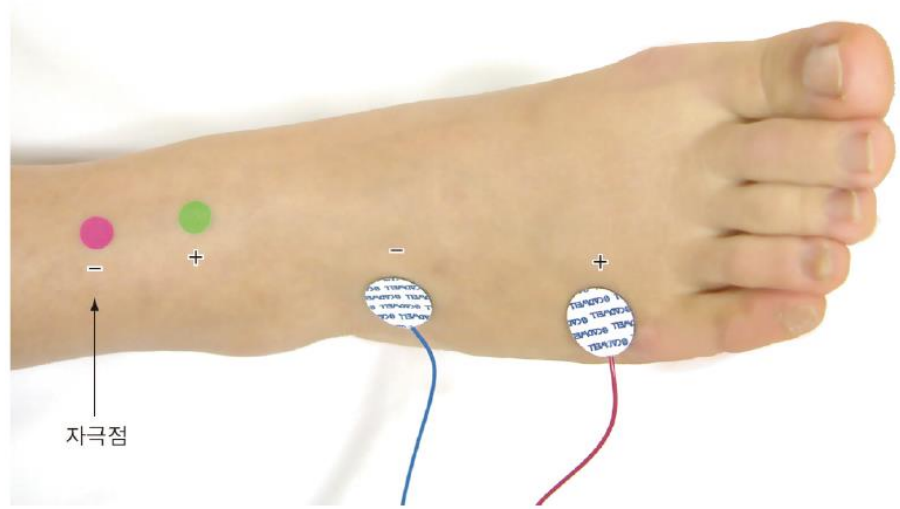

M
F – wave
Tr 1
Tr 2
Tr 3
Tr 4
Tr 5
Tr 6
Tr 7
Tr 8
Tr 9
Tr 10
Tr 11
Tr 12
5000 µV/Div
500 µV/Div
5 ms/Div

표 11-16. 자신경의 F파 검사 결과

	F-Lat (ms) F-wave 잠복기
Right Ulnar	32.18




M – wave
F – wave
Tr 1
Tr 2
Tr 3
Tr 4
Tr 5
Tr 6
Tr 7
Tr 8
Tr 9
Tr 10
Tr 11
5000 µV/Div
500 µV/Div
5 ms/Div


−
+
−
+
자극점

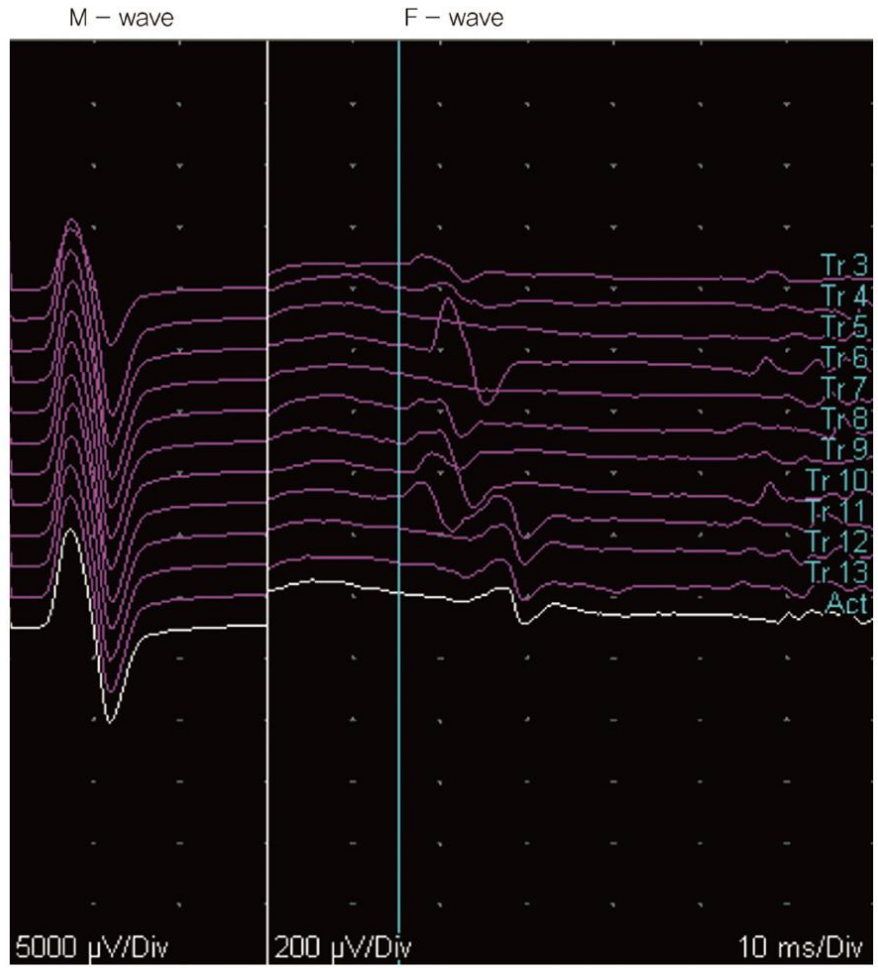
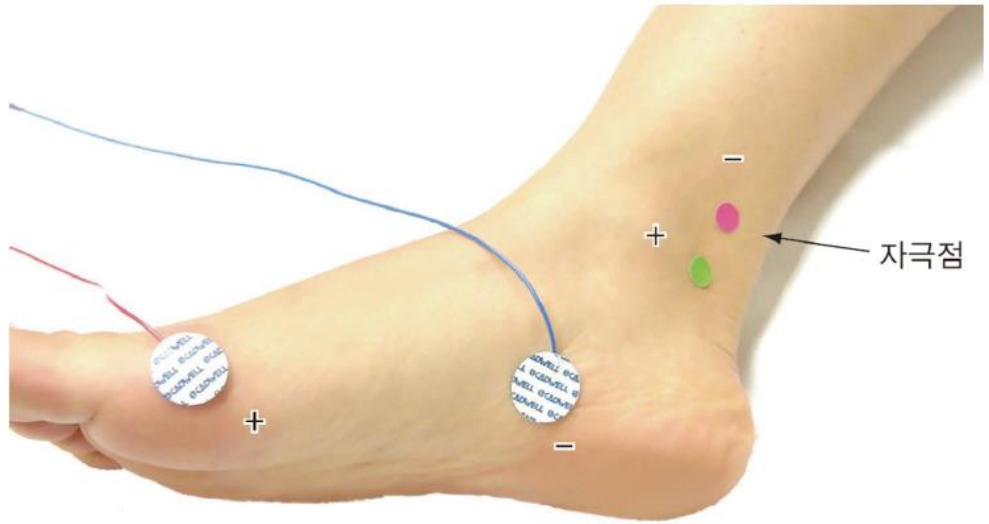

M – wave
F – wave
Tr 3
Tr 4
Tr 5
Tr 6
Tr 7
Tr 8
Tr 9
Tr 10
Tr 11
Tr 12
Tr 13
Act
5000 µV/Div
200 µV/Div
10 ms/Div

표 11-17. 종아리신경 F파 검사 결과

	F-Lat (ms) F-wave 잠복기
Right Peroneal	45.73

표 11-18. 뒤정강신경 F파 검사 결과

	F-Lat (ms) F-wave 잠복기
Right Peroneal	45.75


−
+
자극점
+
−

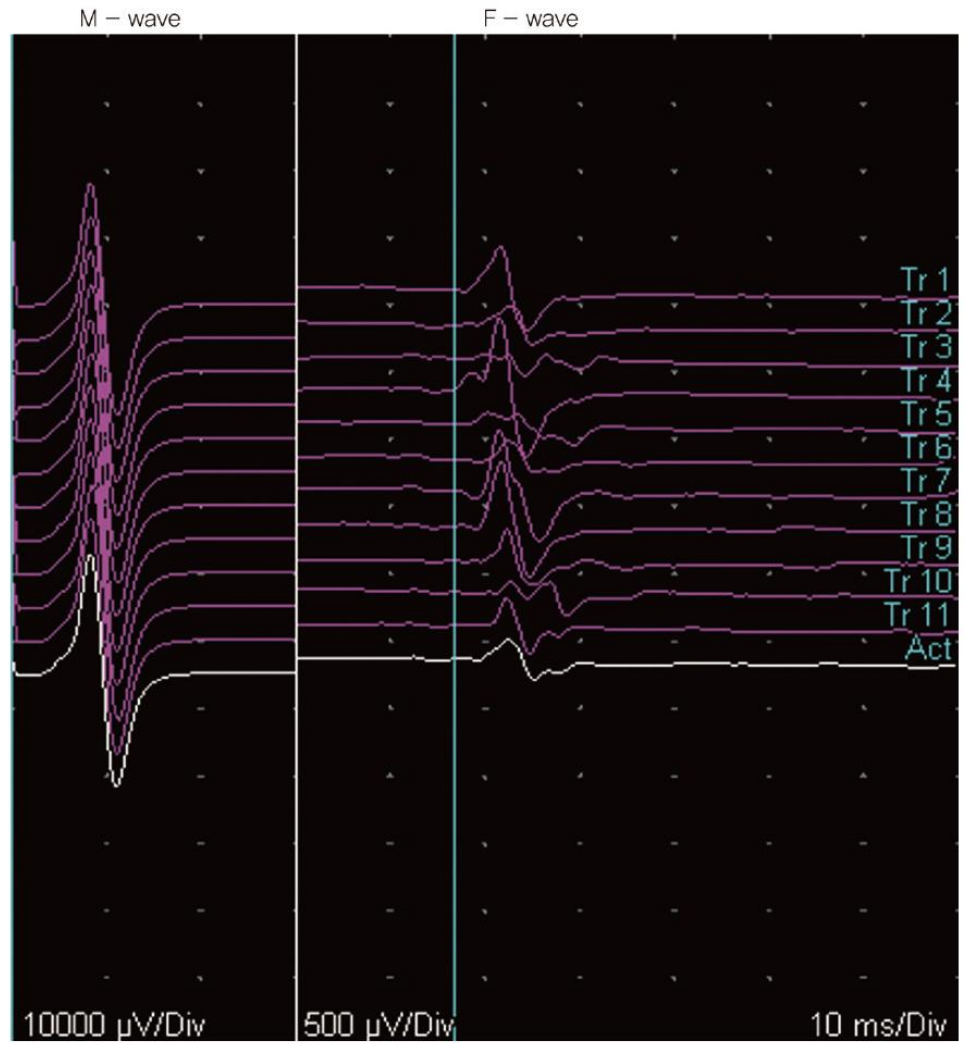
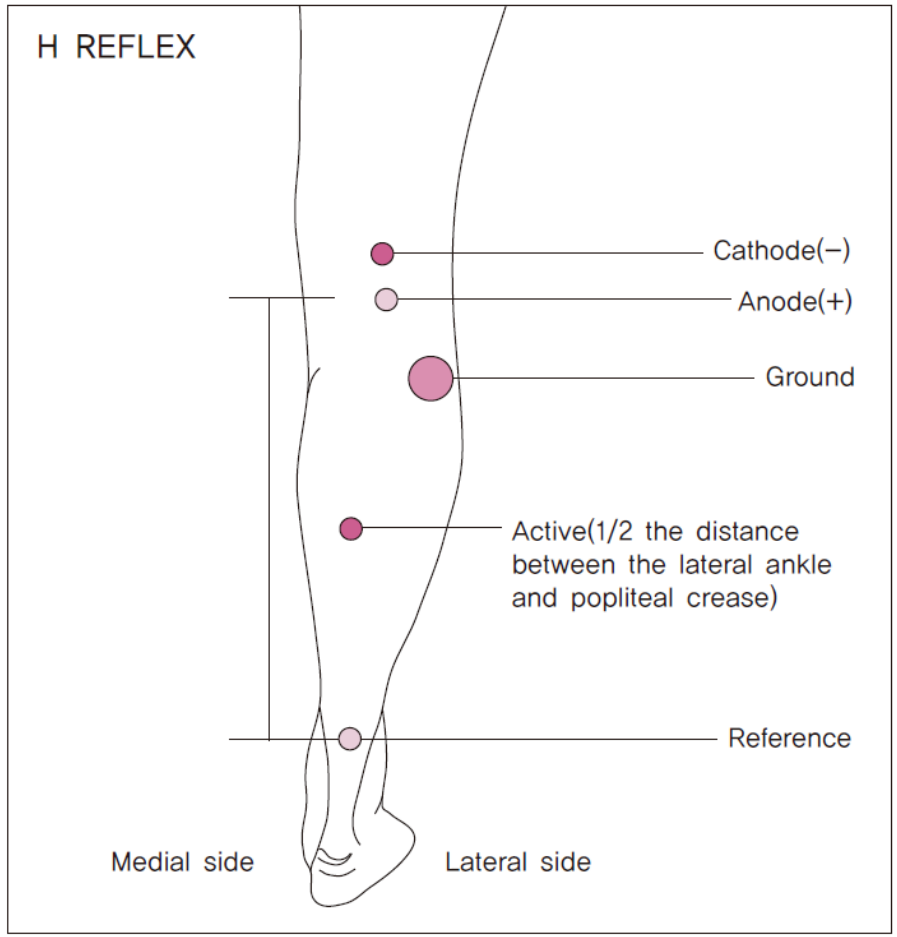
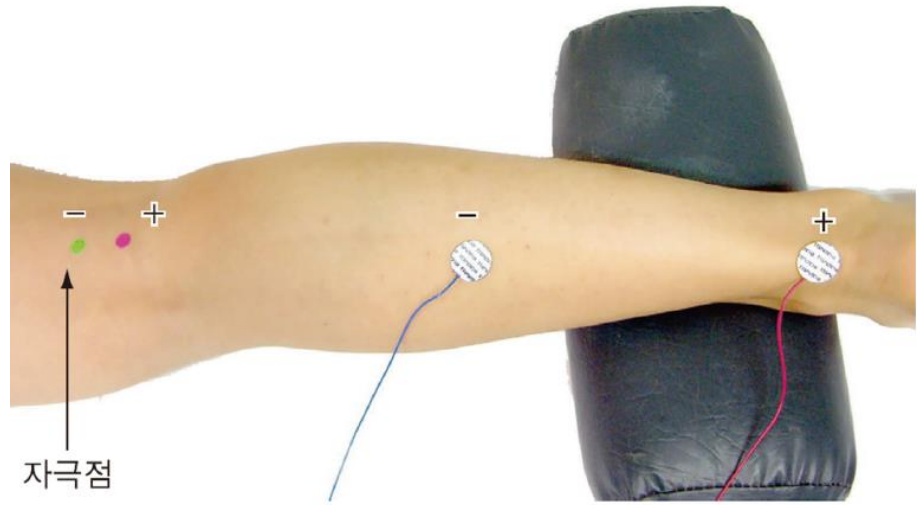

M – wave
F – wave
Tr 1
Tr 2
Tr 3
Tr 4
Tr 5
Tr 6
Tr 7
Tr 8
Tr 9
Tr 10
Tr 11
Act
10000 µV/Div
500 µV/Div
10 ms/Div

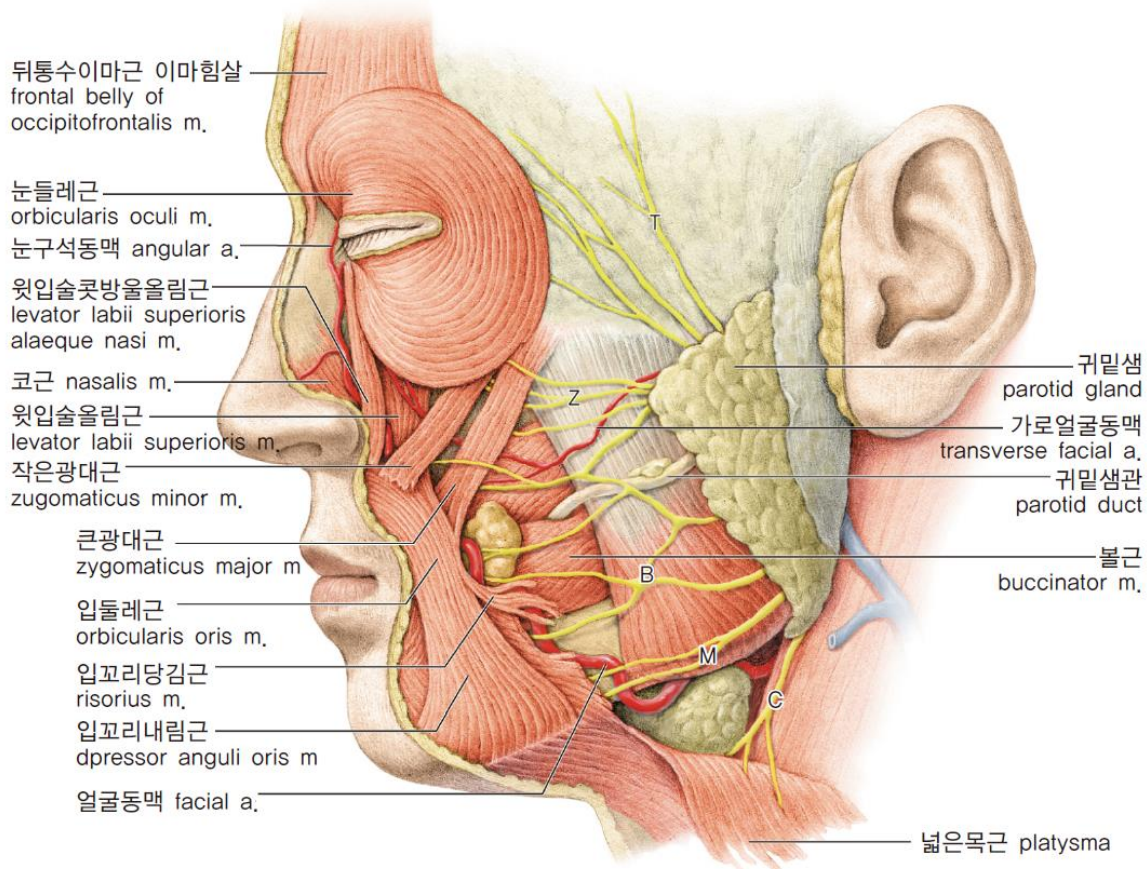
표 11-19. H-반사검사 결과

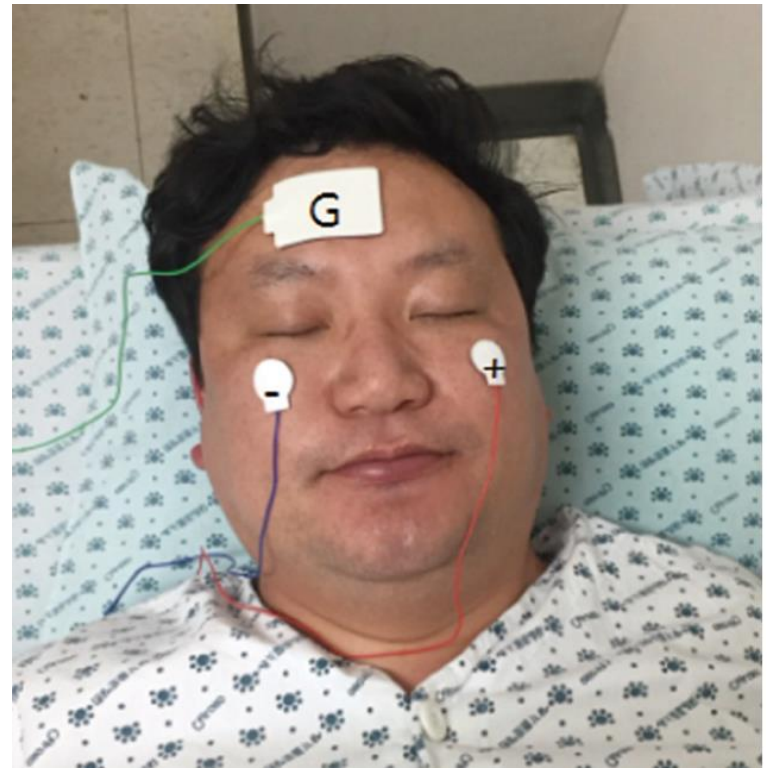
	H -lat (ms) H -반사 잠복기
Tibial (Gastroc)	33.75


H REFLEX
Cathode(−)
Anode(+)
Ground
Active(1/2 the distance between the lateral ankle and popliteal crease)
Reference
Medial side
Lateral side


−
+
−
+
자극점


M – wave
H – wave
Tr 1 : 12.5mA
Tr 2 : 13.5mA
Tr 3 : 14.5mA
Tr 4 : 15.5mA
Tr 5 : 16.5mA
Tr 6 : 16.5mA
Tr 7 : 22mA
2000 µV/Div
1000 µV/Div
10 ms/Div


뒤통수이마근 이마힘살
frontal belly of
occipitofrontalis m.
눈들레근
orbicularis oculi m.
눈구석동맥 angular a.
윗입술콧방울올림근
levator labii superioris
alaeque nasi m.
코근 nasalis m.
윗입술올림근
levator labii superioris m.
작은광대근
zugomaticus minor m.
큰광대근
zygomaticus major m
입둘레근
orbicularis oris m.
입꼬리당김근
risorius m.
입꼬리내림근
dpressor anguli oris m
얼굴동맥 facial a.
T
Z
B
M
C
귀밑샘
parotid gland
가로얼굴동맥
transverse facial a.
귀밑샘관
parotid duct
볼근
buccinator m.
넓은목근 platysma


G
-
+




G
-
+

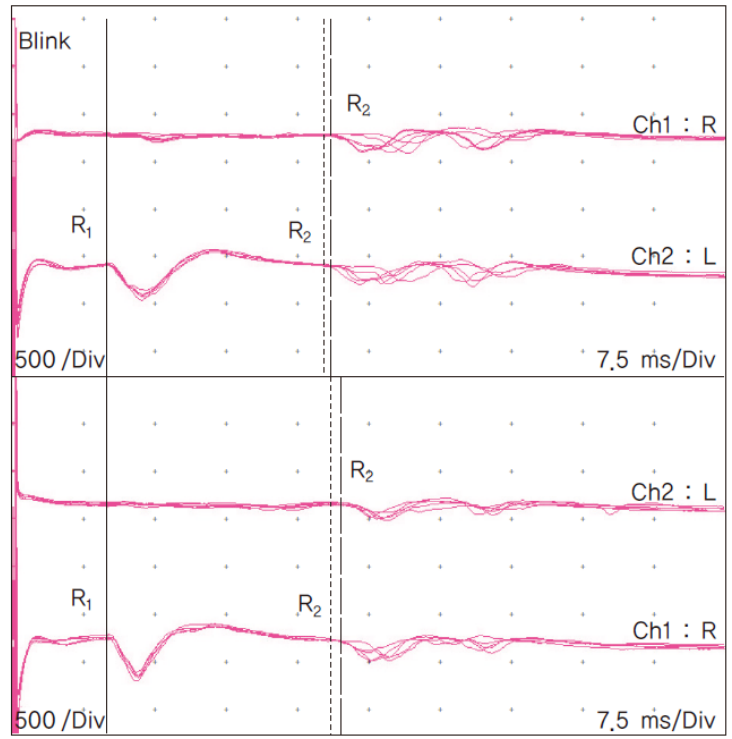
표 11-20. 눈둘레근, 코근에서의 얼굴 운동신경전도검사 결과

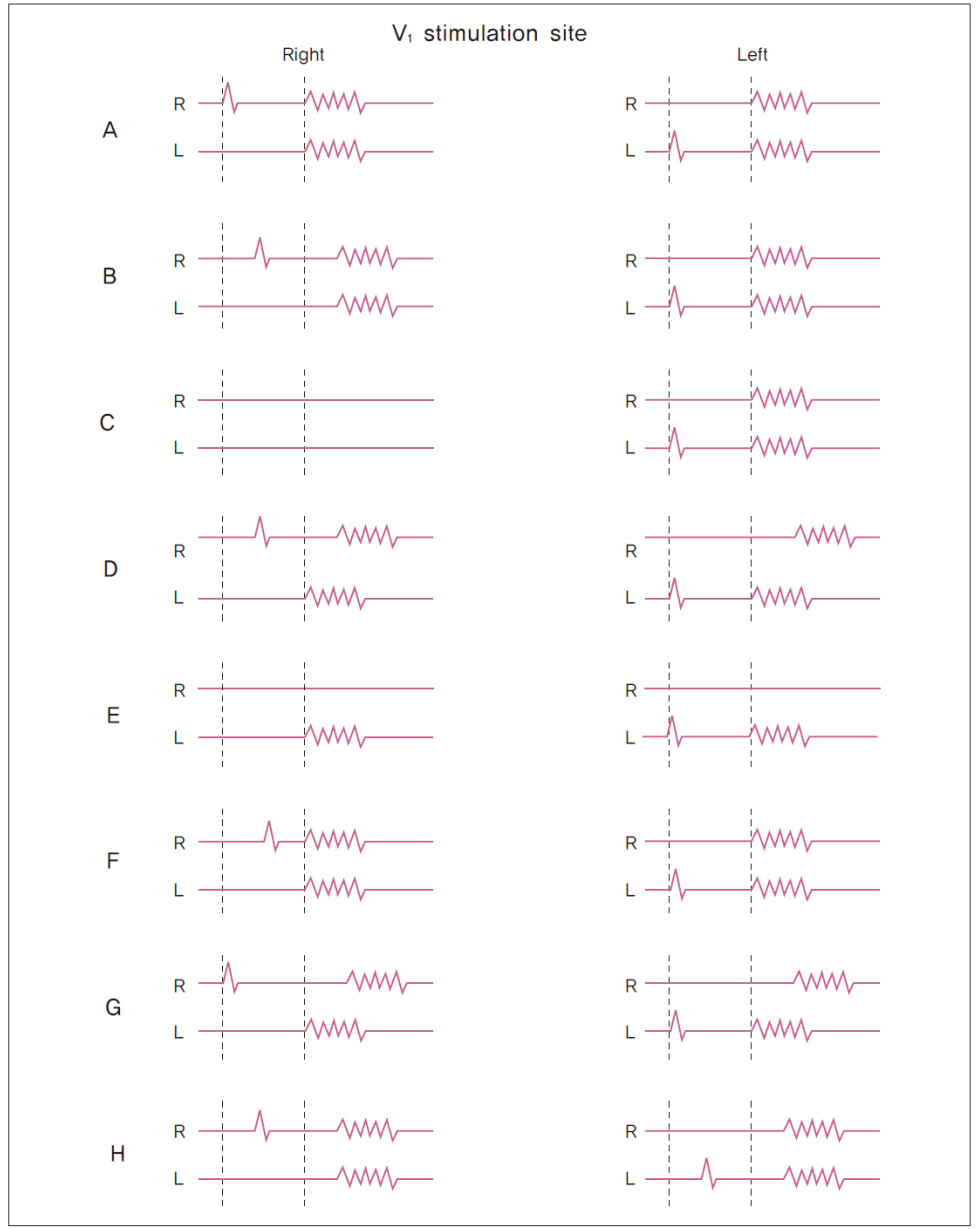
Site	Onset latency (ms) 잠복기	Amplitude (mV) 진폭
Right Facial - ALL Motor (Mastoid)		
Oculi(눈둘레근)	2.7	3.1
Nasalis(코근)	2.5	2.9


+
자극부위
−
+
−
−
+
G

표 11-21. 눈깜박반사검사의 결과

Site	R	R2i (동측 R)	R2c (편측 R)	R2i-R2 동측-편측 R2 차이
좌측 LT	10.00	32.86	33.60	0.74
우측 RT	10.00	33.63	34.76	1.14
좌우차 Diff (L-R)	0.00	0.77	1.17	0.40


Blink
R2
Ch1 : R
R1
R2
Ch2 : L
500 /Div
7.5 ms/Div
R2
Ch2 : L
R1
R2
Ch1 : R
500 /Div
7.5 ms/Div


V1 stimulation site
Right
Left
A
B
C
D
E
F
G
H
R
L

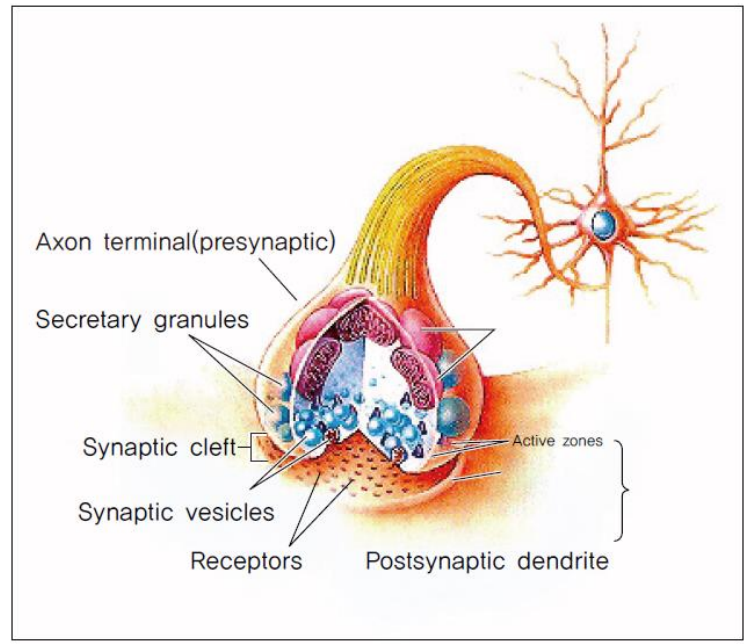
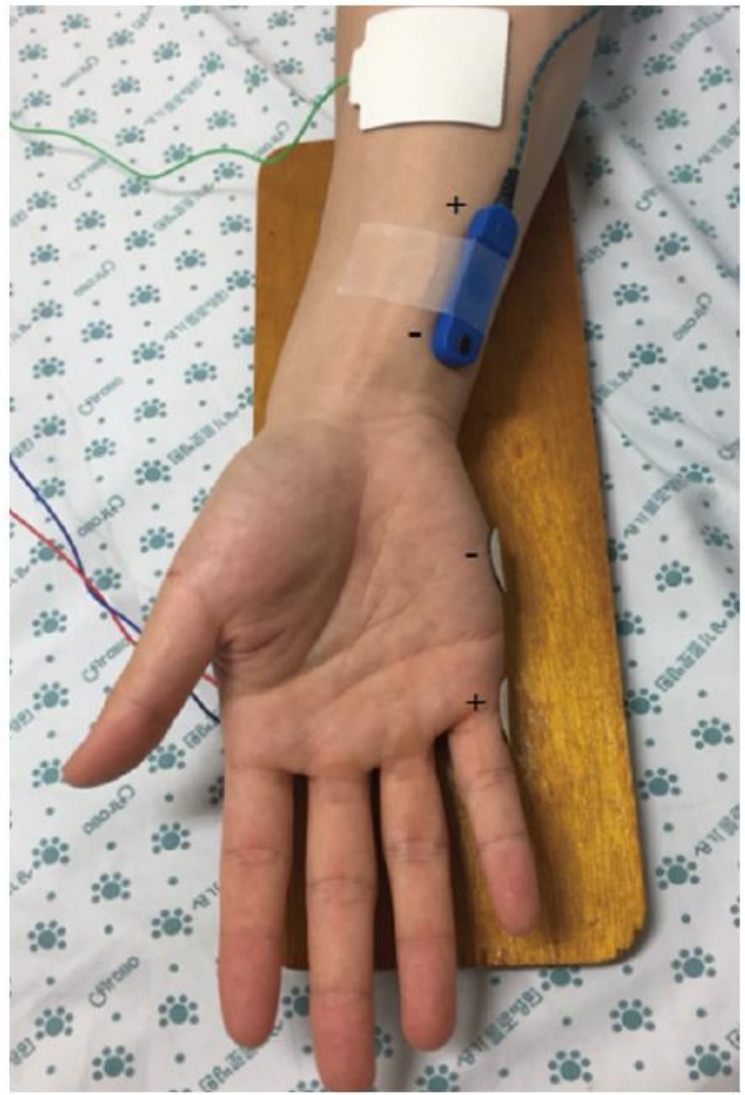
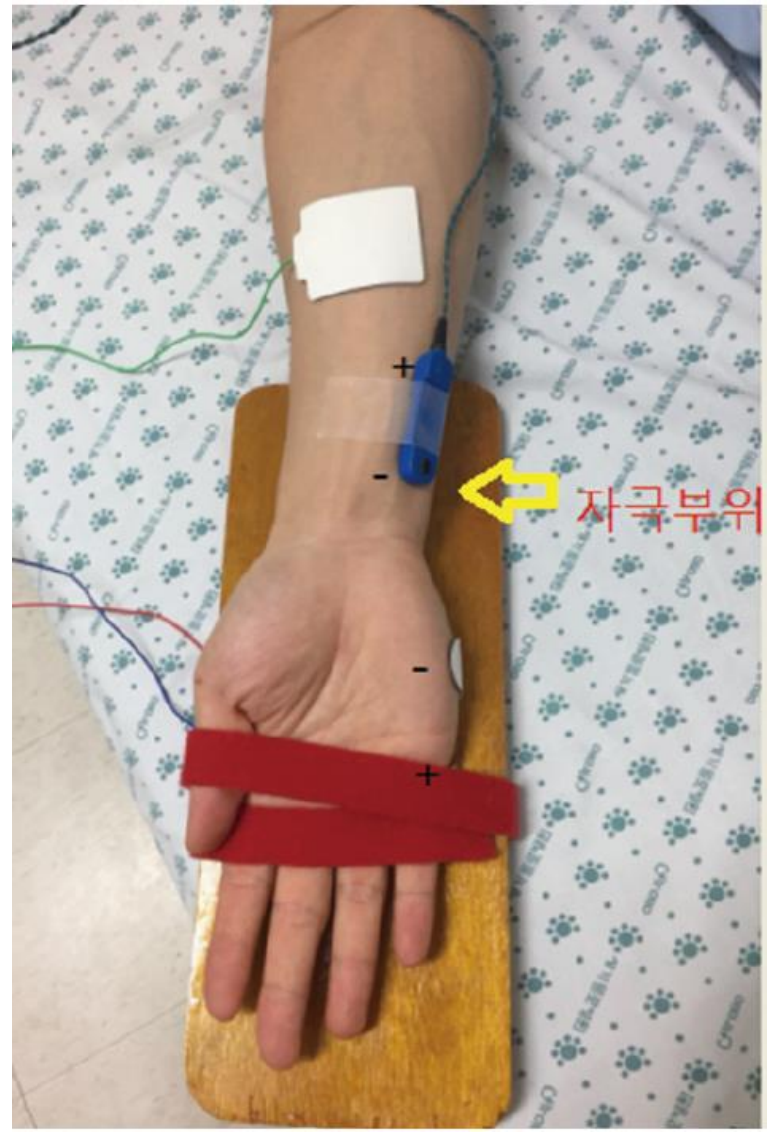
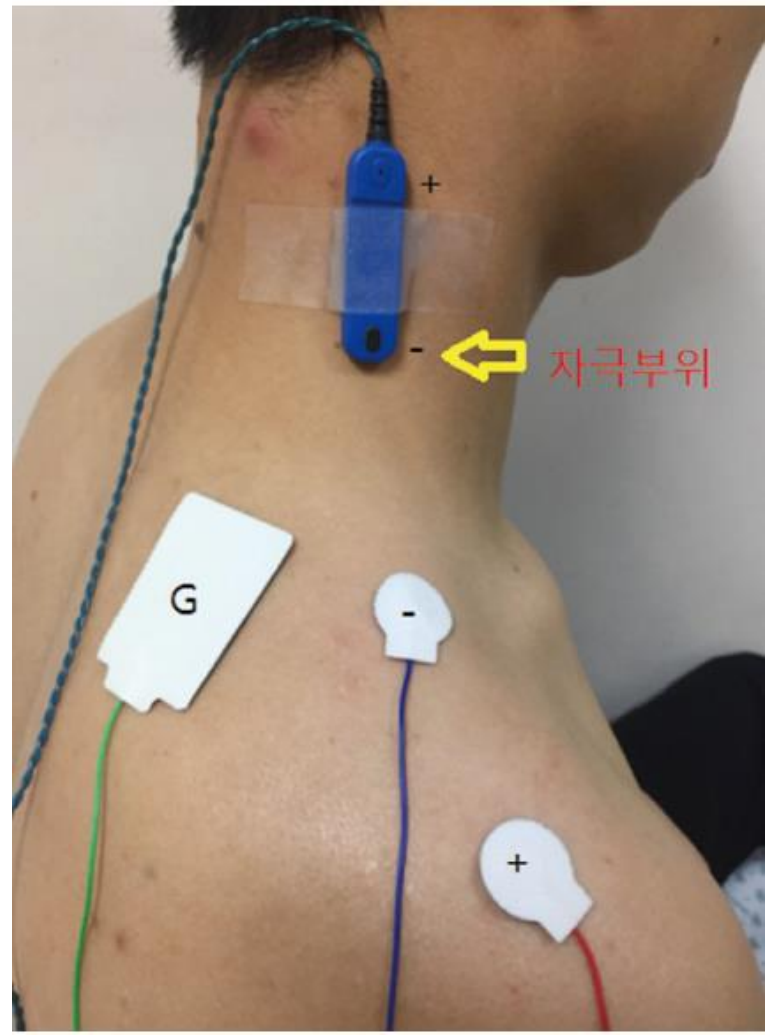

Axon terminal(presynaptic)
Secretary granules
Synaptic cleft
Synaptic vesicles
Receptors
Active zones
Postsynaptic dendrite

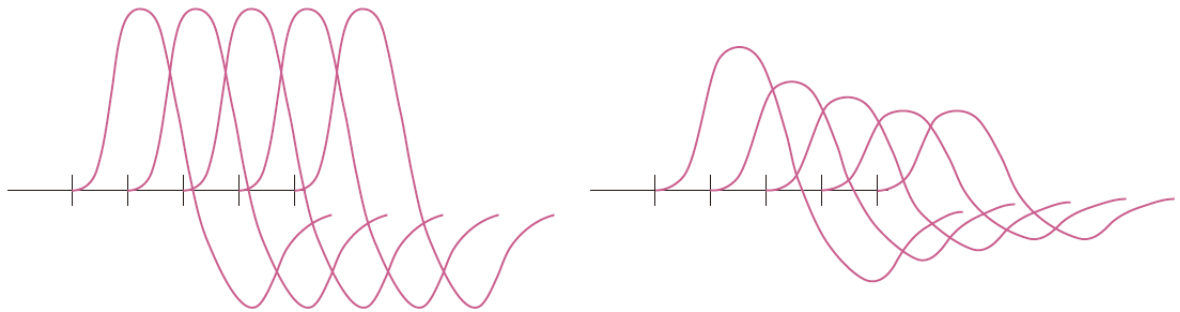
표 11-22. 반복신경자극검사 매뉴얼

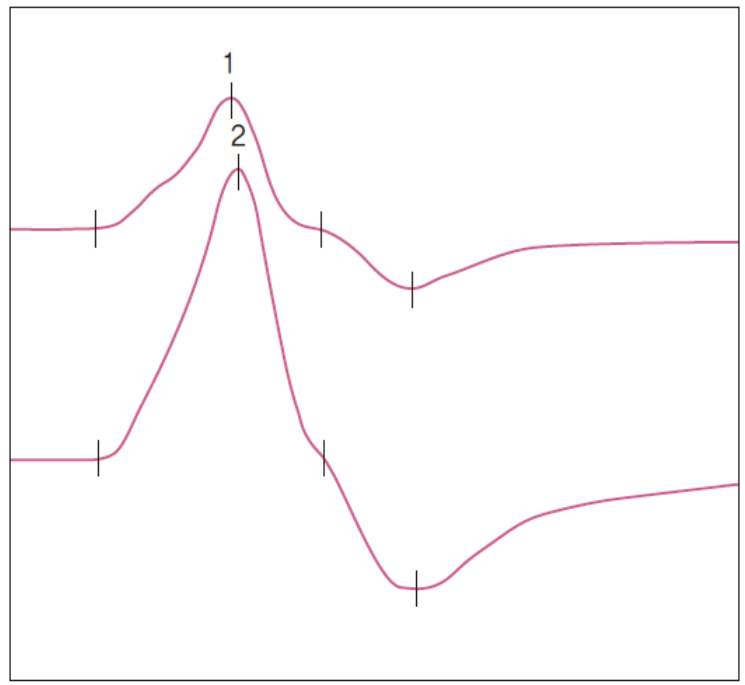
	Train(휴식)	Rep rate(pps) (초당 자극빈도)	Train length(자극횟수)	비고
	baseline	1	1	바닥선 동요주의
1	0 : 00	1	1	최대상자극
2	30초	1	1	자발적 근수축 후
3	1분	2	5~10	
4	1분	3	5~10	
5	1분	5	5~10	
6	1분	50	50	
7	0 : 00	5	5~10	
8	4분	5	5~10	

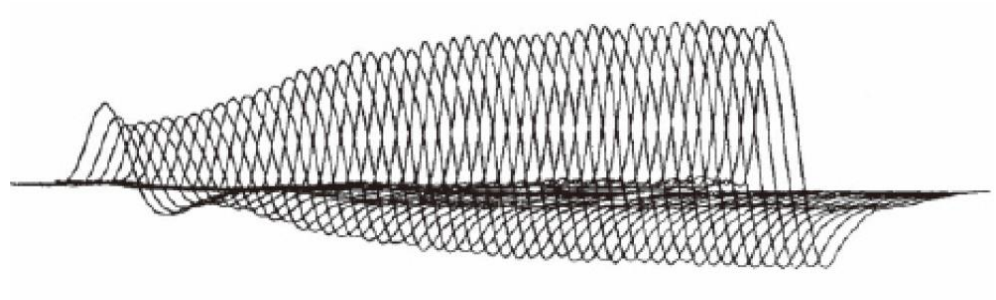



+
-
자극부위
-
+


+
-
자극부위
G
-
+




1
2



신경전도검사 정상치

Upper Extremity(상지)			
	latency (ms)	NCV range (m/sec)	Amplitude
Motor NCV			
Median			
onset latency	3.8 이내		10 mV 이상
Wrist-elbow		50 이상	
elbow-axilla		50 이상	
ulnar			
onset latency	3.5 이내		10 mV 이상
Wrist-elbow		50 이상	
Below-above elbow		50 이상	
above elbow-axilla		50 이상	
Sensory NCV			
Median			
Onset latency	3.5 이내		10 uV 이상
Peak latency	3.8 이내		
finger-wrist		40 이상	
wrist-elbow		50 이상	
elbow-axilla		50 이상	
palm-wrist		40 이상	
Ulnar			
Onset latency	3.2 이내		10 uV 이상
Peak latency	3.5 이내		
finger-wrist		40 이상	
wrist-elbow		50 이상	
elbow-axilla		50 이상	

Lower extremity(하지)			
	latency (ms)	NCV range (m/sec)	Amplitude
Motor NCV			
Peroneal			
onset latency	4.0 ± 0.8		3 mV
ankle-knee		40 이상	3 mV
Posterior tibial		40 이상	
onset latency	4.0 ± 0.8		10 mV
ankle-knee		40 이상	
Sensory NCV			
Sural			
onset latency	3.5 이내		10uV
peak latency	4.0 이내		
ankle-low leg		38 이상	

** 신경전도 검사의 정상치는 각 병원 검사실의 검사법 및 장비마다 다소 차이가 날 수 있습니다. 병변이 있는 부위와 건강한 부위의 비교 검사가 중요합니다.

F-wave

Nerve	latency(m/s)
Median	28
Ulnar	28
Peroneal	53
Posterior tibial	54

** 양쪽 잠복기 차이가 2 msec 이내여야 한다.

H-reflex

Nerve	latency(m/s)
Posterior tibial	32

** 양쪽 잠복기 차이가 1.5 msec 이내여야 한다.

Blink reflex

	Mean*SD	Normal limit
R1	10.6*0.8	12.2
Ipsilateral R1	31.3*3.3	37.9
contralateral R2	31.6*3.8	39.2

신경기능검사학

CHAPTER III

유발전위검사

Section 12

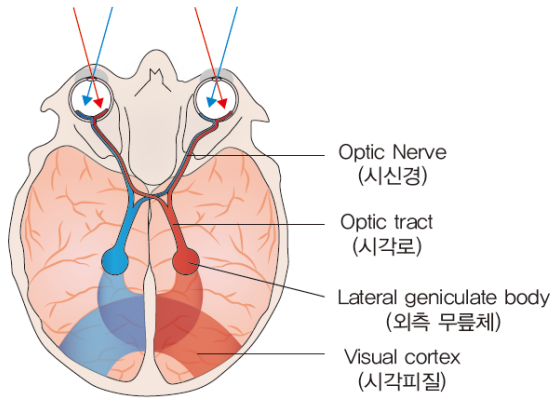
유발전위(Evoked potential, EP) 검사

1 유발전위검사의 기본 개념

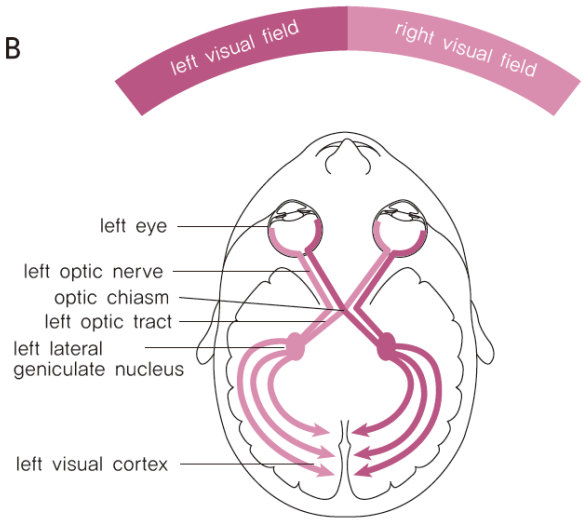
학습목표

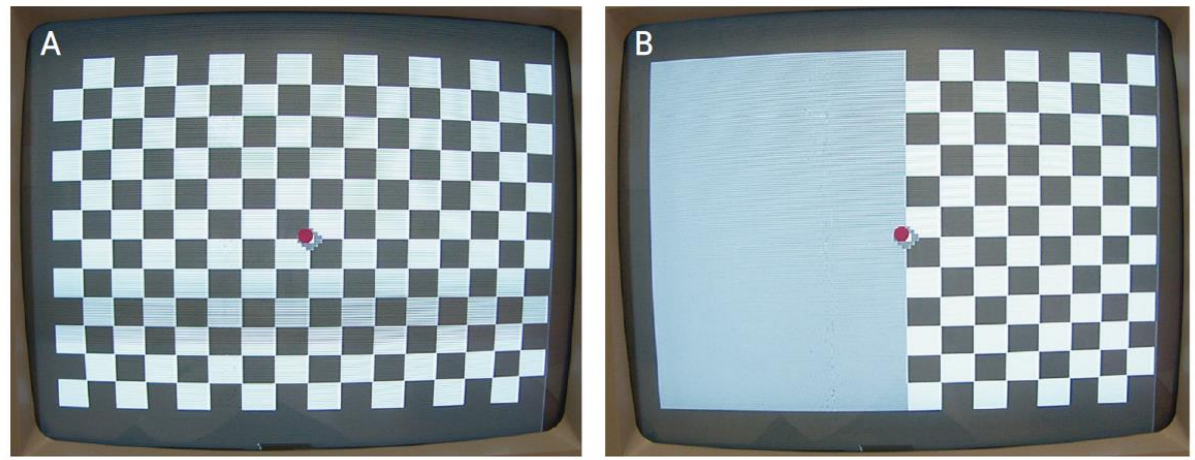
1. 유발전위검사의 원리와 주의사항을 이해할 수 있다(A).
2. 유발전위검사의 종류를 설명할 수 있다(A).
3. 유발전위검사의 구분을 설명할 수 있다(A).

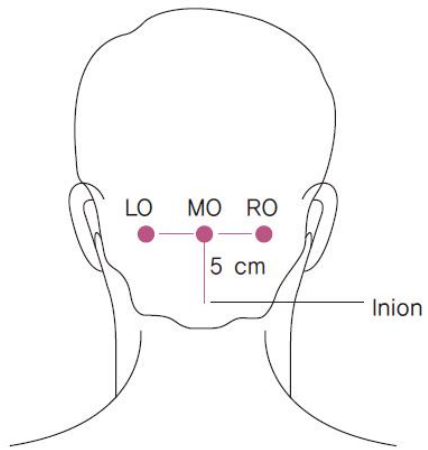
A

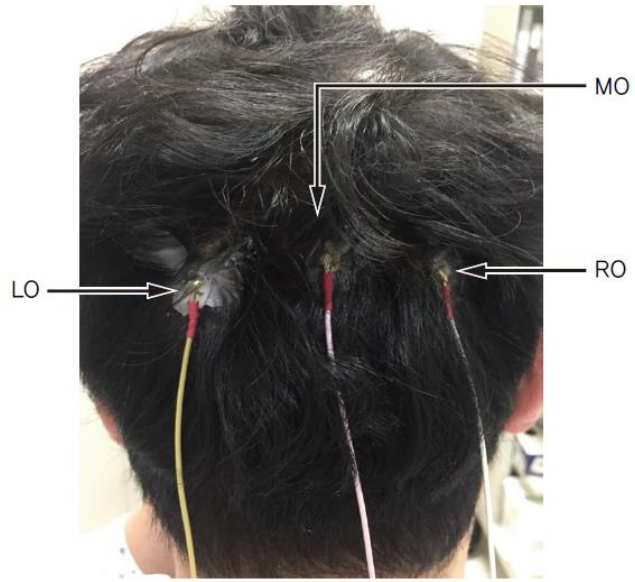

Optic Nerve
(시신경)
Optic tract
(시각로)
Lateral geniculate body
(외측 무릎체)
Visual cortex
(시각피질)

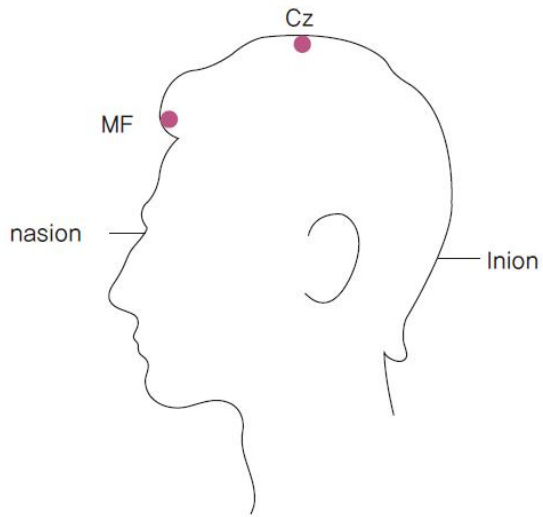
B


left visual field
right visual field
left eye
left optic nerve
optic chiasm
left optic tract
left lateral
geniculate nucleus
left visual cortex


A
B


LO
MO
RO
5 cm
Inion


MO
LO
RO


Cz
MF
nasion
Inion

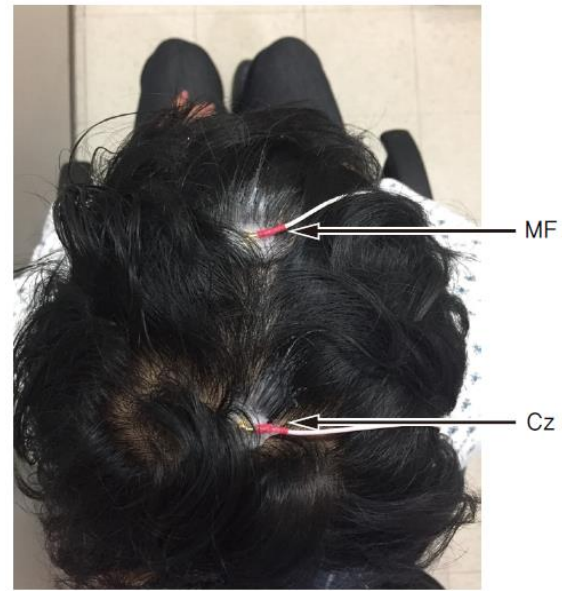

MF
Cz





표 12-1. 전시야 시각유발전위 전극 부착 부위

채널 몽타주	기록전극	기준전극
채널 1	LO	MF
채널 2	MO	MF
채널 3	RO	MF
접지전극	Cz	

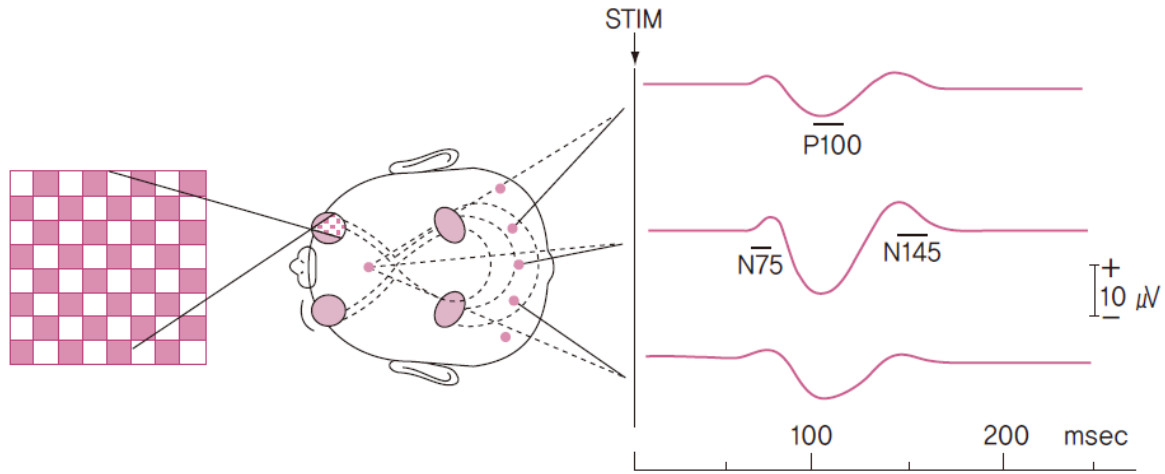

STIM
P100
N75
N145
+
10 μV
−
100
200
msec

표 12-2A. 좌측 반시야 검사 전극 부착 부위

채널 몽타주	기록전극	기준전극
채널 1	LO	MF
채널 2	MO	MF
채널 3	RO	MF
채널 4	RT	MF
접지전극	Cz	

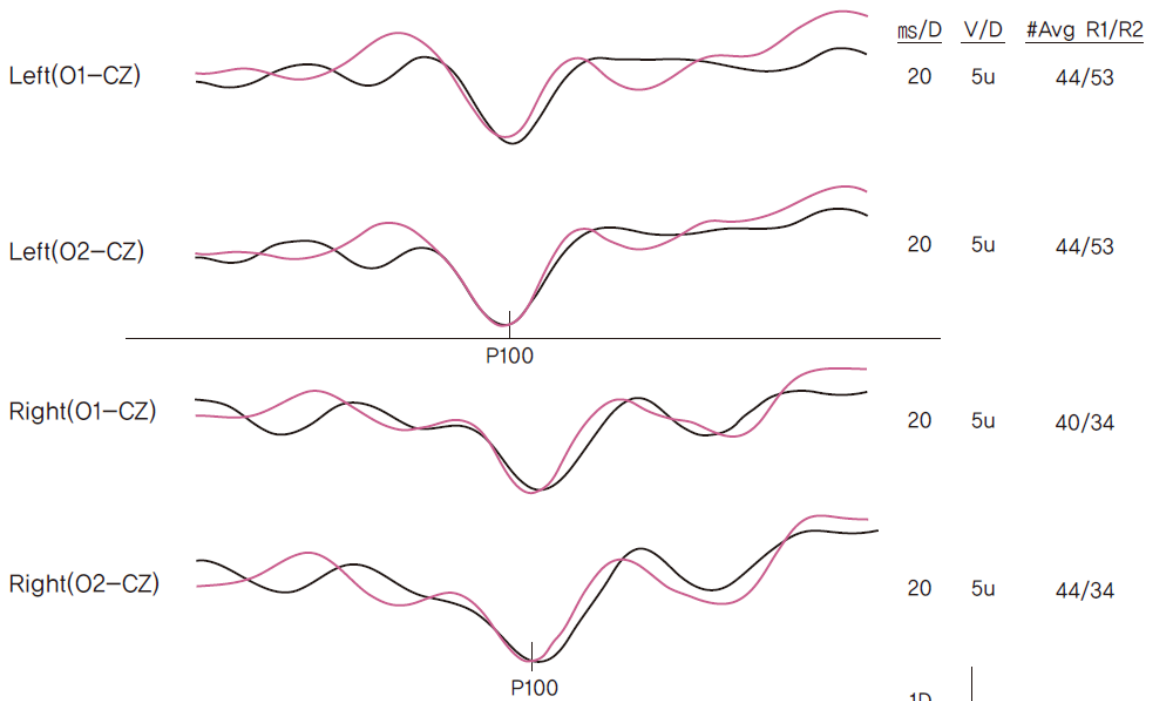
표 12-2B. 우측 반시야 검사 전극 부착 부위

채널 몽타주	기록전극	기준전극
채널 1	LO	MF
채널 2	MO	MF
채널 3	RO	MF
채널 4	LT	MF
접지전극	Cz	

표 12-3. 연령과 남·여 구별에 따른 정상 VEP값

	Sex	Decades					
		2nd	3rd	4th	5th	6th	7th
Mean age (y)	M	17.8	25.8	36.3	42.4	54.3	63.3
	F	18.2	24.0	35.7	43.6	53.9	62.9
Latency of P_1 (msec)	M	95.4 ± 3.6	93.6 ± 4.2	9.9 ± 4.9	93.6 ± 5.5	93.6 ± 5.5	95.7 ± 4.5
	F	95.2 ± 4.4	90.7 ± 4.0	91.1 ± 3.4	90.5 ± 5.3	90.5 ± 5.3	93.7 ± 4.7
Latency difference between two eyes (msec)	M	1.8 ± 1.3	1.7 ± 1.2	1.7 ± 0.9	1.4 ± 1.2	1.4 ± 1.2	1.8 ± 1.1
	F	1.4 ± 0.9	1.1 ± 1.2	1.2 ± 0.5	2.1 ± 1.1	2.1 ± 1.1	1.5 ± 1.4
Amplitude of P_1 (μV)	M	26.0 ± 11.0	20.7 ± 7.8	18.0 ± 9.5	12.2 ± 4.5	12.2 ± 4.5	15.1 ± 9.4
	F		19.4 ± 6.9	19.1 ± 6.3	18.3 ± 5.3	18.3 ± 5.3	22.9 ± 7.4
Amplitude difference between two eyes (μV)	M	26.8 ± 6.9	2.3 ± 3.2	4.4 ± 5.5	2.3 ± 1.9	2.3 ± 1.9	1.9 ± 1.1
	F	3.6 ± 3.2	3.3 ± 2.5	3.3 ± 2.5	3.0 ± 2.3	3.0 ± 2.3	3.9 ± 3.0
		2.6 ± 2.0					

VEP: PATERN 12*16



	ms/D	V/D	#Avg R1/R2
Left(O1–CZ)	20	5u	44/53
Left(O2–CZ)	20	5u	44/53
Right(O1–CZ)	20	5u	40/34
Right(O2–CZ)	20	5u	44/34

Display

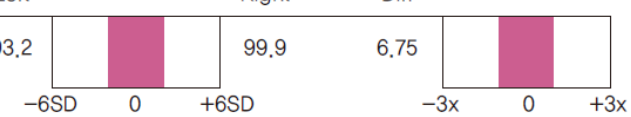
Left : Run1 Run2 Superimposed
Right : Run1 Run2 Superimposed
Run2 ——
Run1 ——

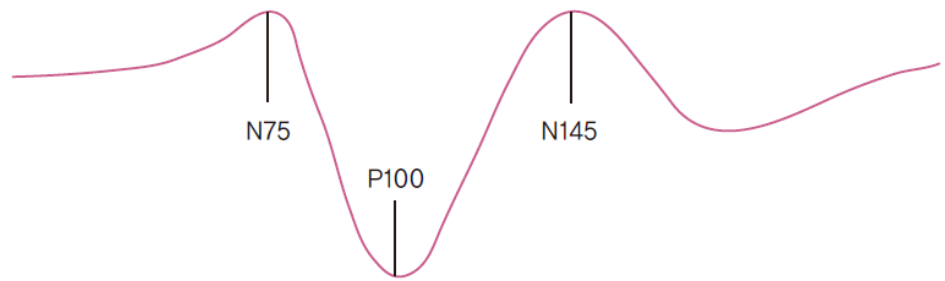
Stimulation

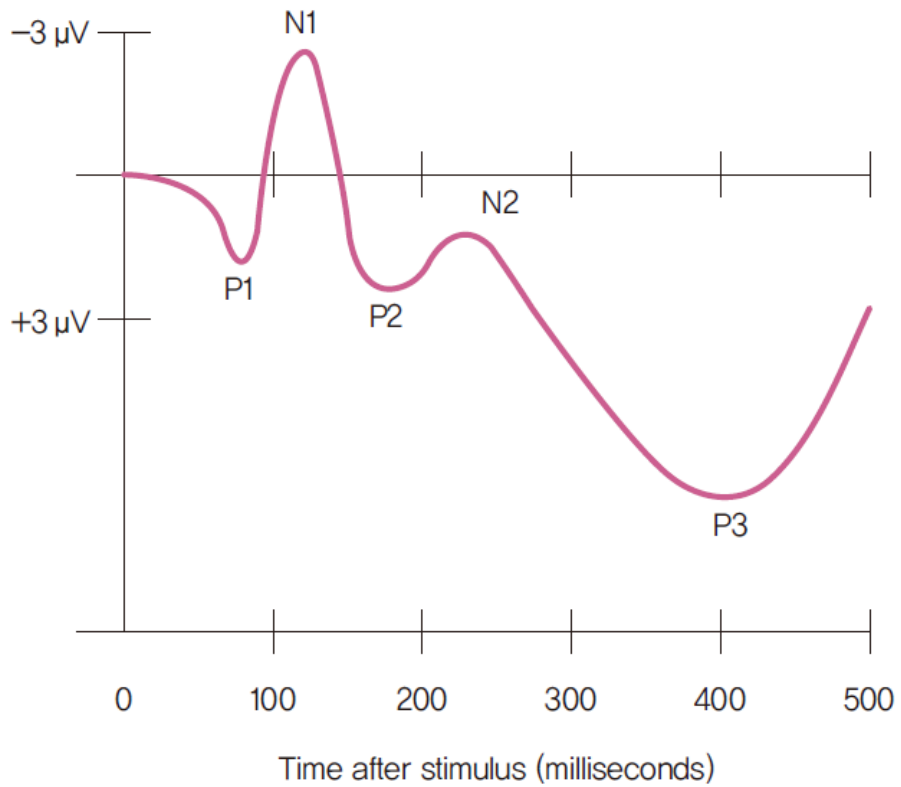
Left Run1: Left □ 1.9 Hz Reversal
Size: 12×16 checkers Fix:
Left Run1: Left □ 1.9 Hz Reversal
Size: 12×16 checkers Fix:
Right Run1: Left □ 1.9 Hz Reversal
Size: 12×16 checkers Fix:
Right Run1: Left □ 1.9 Hz Reversal
Size: 12×16 checkers Fix:

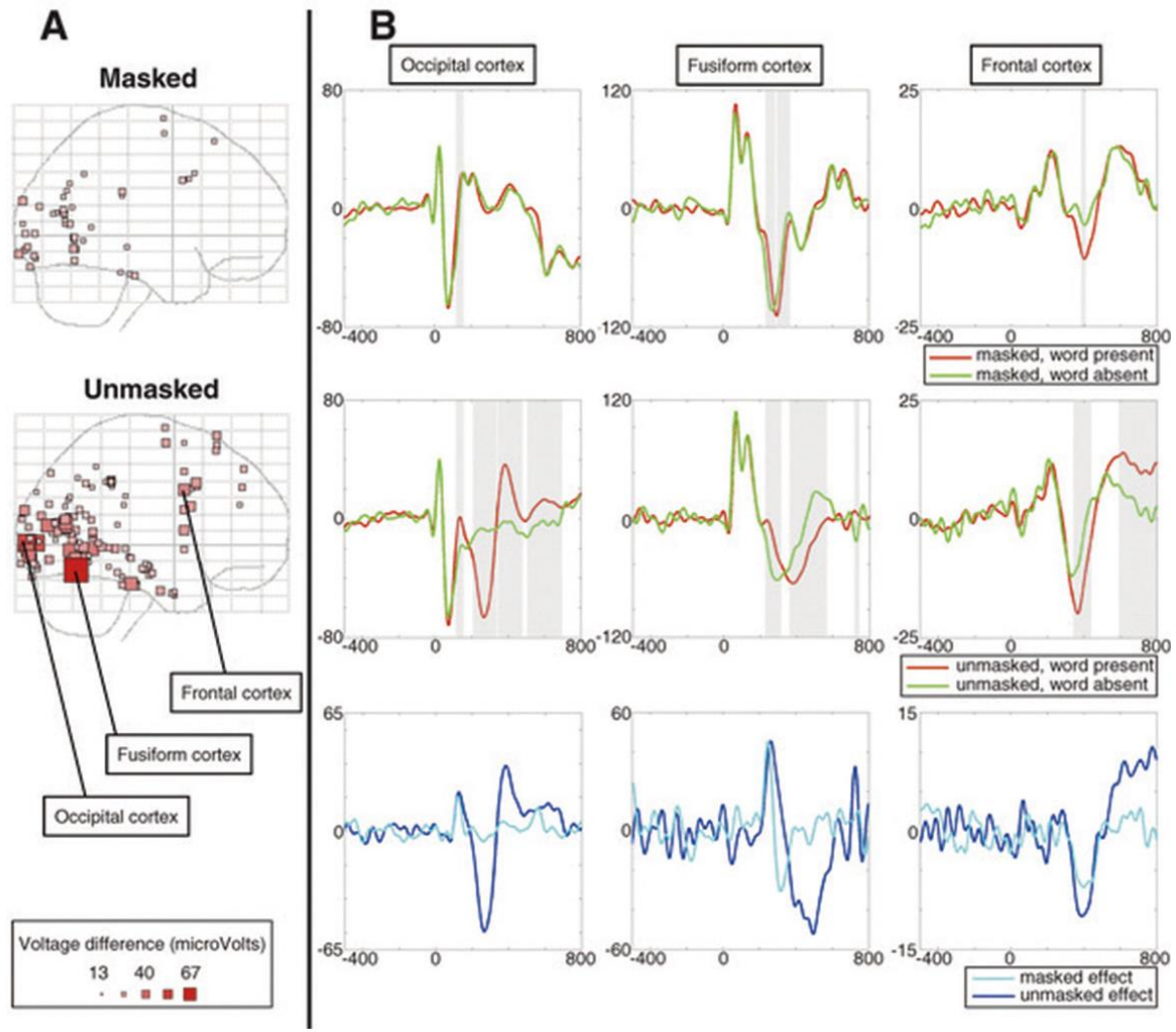
LATENCY(ms)

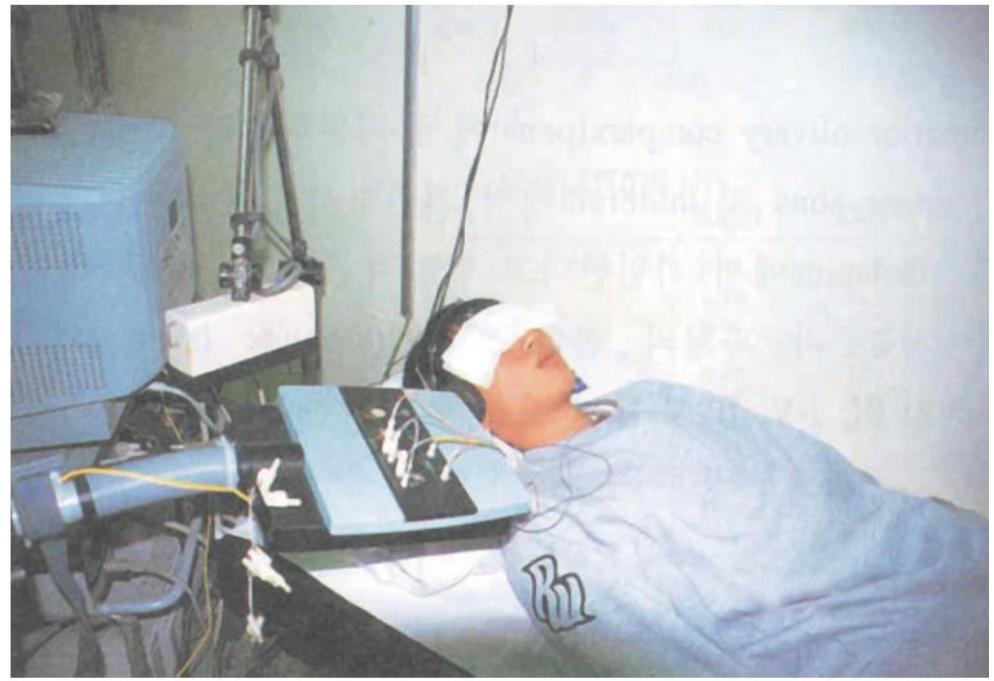
Channel	Montage	Marker	Left	Right	Diff
2	O2–CZ	P100	93.2	99.9	6.75

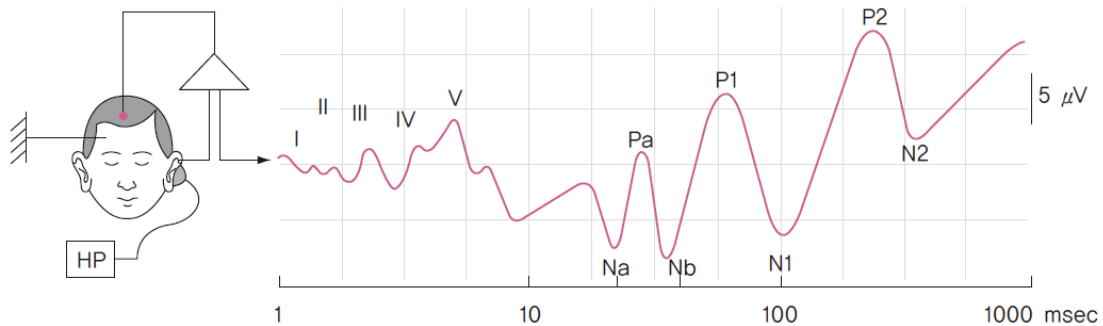



N75
P100
N145


−3 μV
+3 μV
N1
P1
N2
P2
P3
0
100
200
300
400
500
Time after stimulus (milliseconds)


A
Masked
Unmasked
Frontal cortex
Fusiform cortex
Occipital cortex
Voltage difference (microVolts)
13 40 67
B
Occipital cortex
Fusiform cortex
Frontal cortex
masked, word present
masked, word absent
unmasked, word present
unmasked, word absent
masked effect
unmasked effect




HP
I
II
III
IV
V
Pa
Na
Nb
P1
N1
P2
N2
5 μV
1
10
100
1000 msec

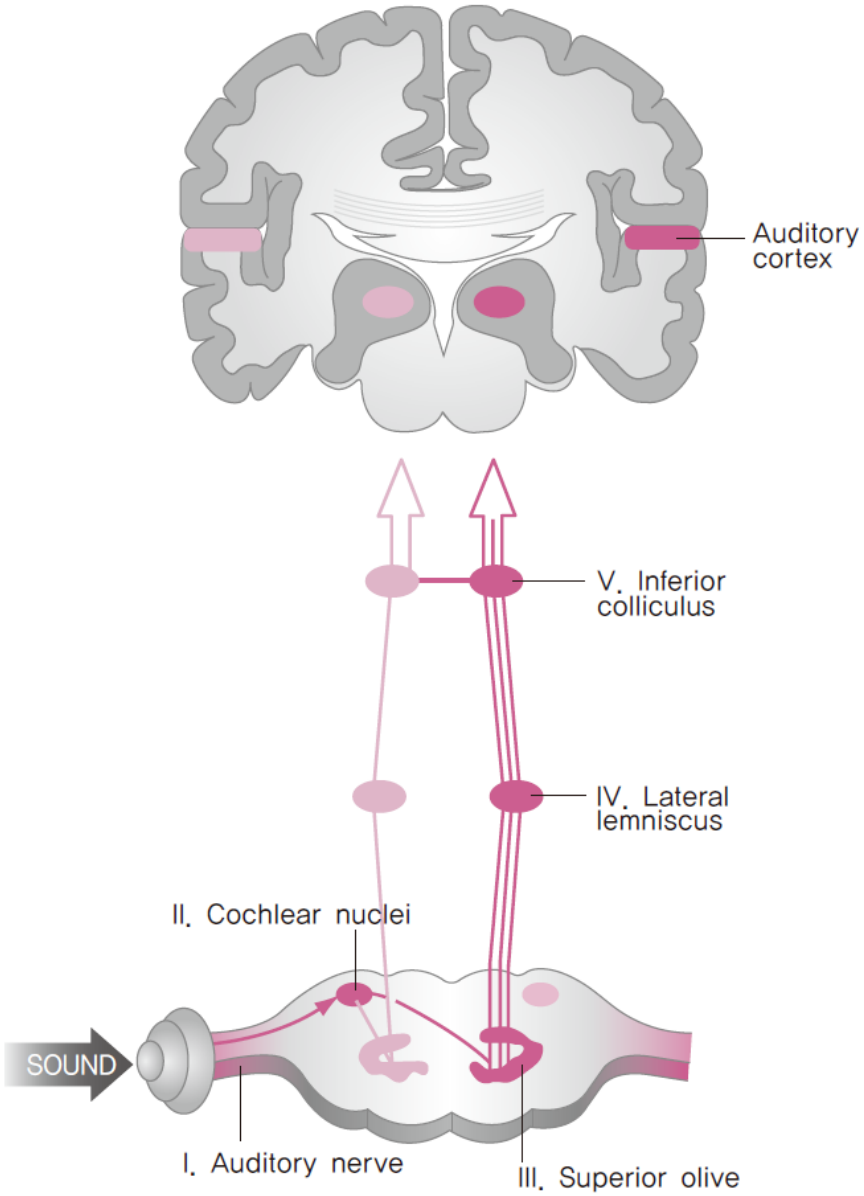
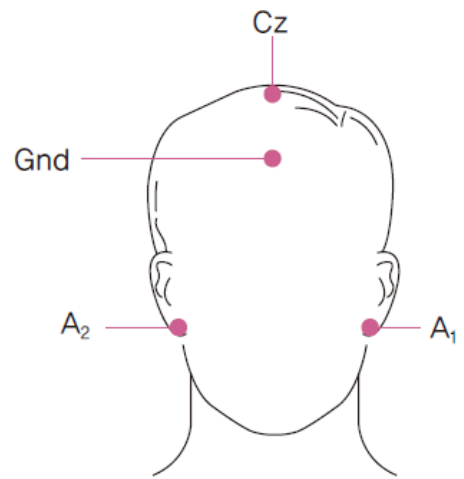

Auditory cortex
V. Inferior colliculus
IV. Lateral lemniscus
II. Cochlear nuclei
SOUND
I. Auditory nerve
III. Superior olive

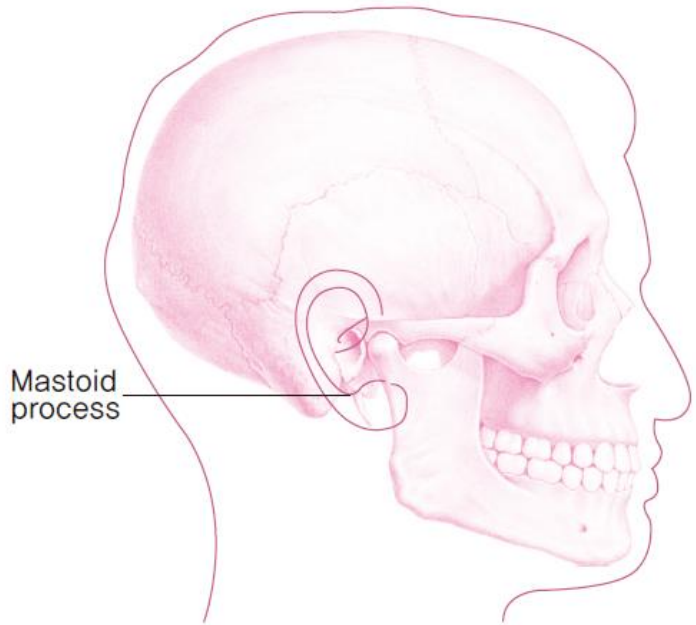
표 12-4. 뇌줄기청각유발전위 전극부착 부위

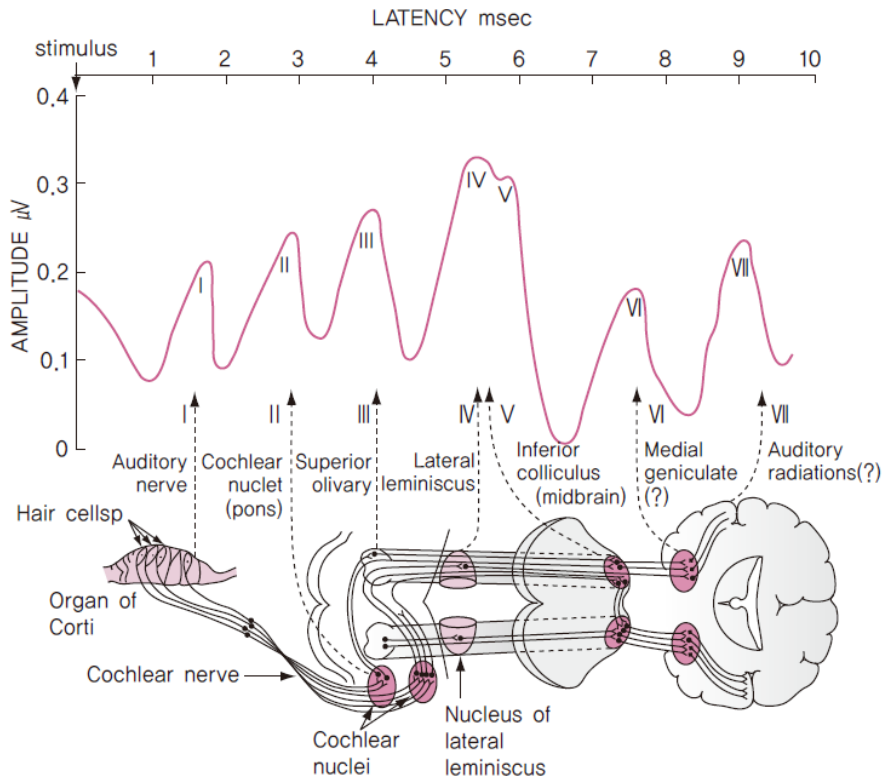
채널 몽타주	기록전극	기준전극
채널 1	$A_1(M_1)$	Cz
채널 2	$A_2(M_2)$	Cz
접지전극	Fpz	

* 두 개의 채널을 통해 자극하는 동측 및 반대측의 파형을 함께 기록한다.

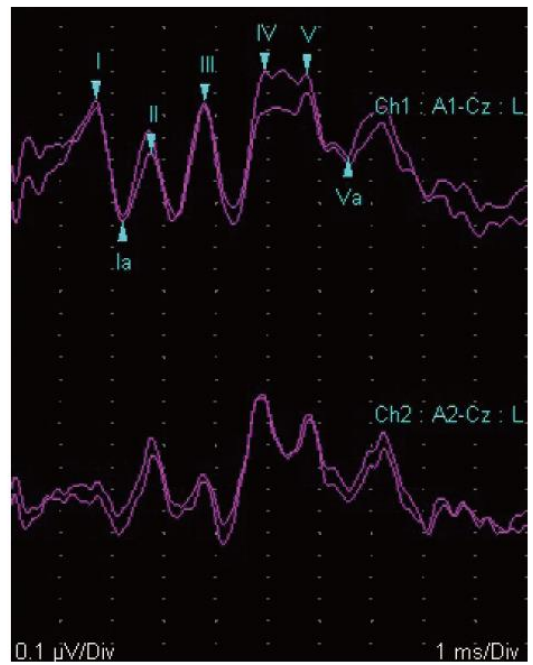


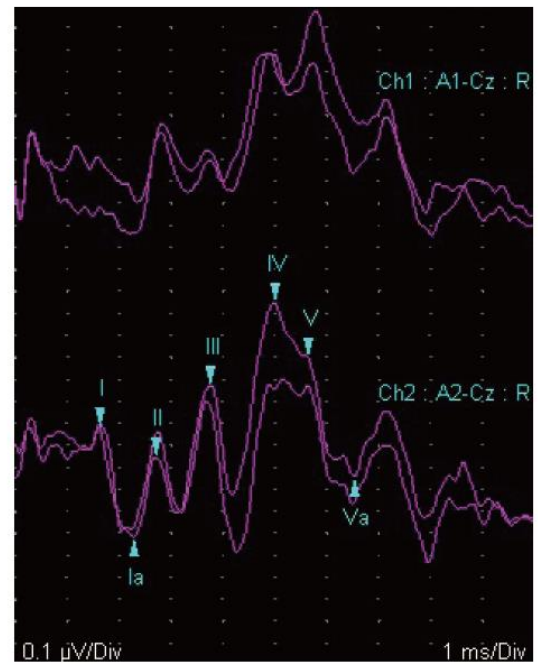
Montage :	Active :	Reference :
Channel 1 :	A_1	Cz
Channel 2 :	A_2	Cz


Mastoid
process


LATENCY msec
stimulus
1
2
3
4
5
6
7
8
9
10
0.4
0.3
0.2
0.1
0
AMPLITUDE μV
I
II
III
IV
V
VI
VII
Auditory nerve
Cochlear nuclet (pons)
Superior olivary
Lateral leminiscus
Inferior colliculus (midbrain)
Medial geniculate (?)
Auditory radiations(?)
Hair cellsp
Organ of Corti
Cochlear nerve
Cochlear nuclei
Nucleus of lateral leminiscus

절대잠복기	파간 잠복기
I : 1.41~1.89 msec	I~III : 1.89~2.49 msec
III : 3.46~4.22 msec	III~V : 1.63~2.19 msec
V : 5.35~6.15 msec	I~V : 3.90~4.30 msec

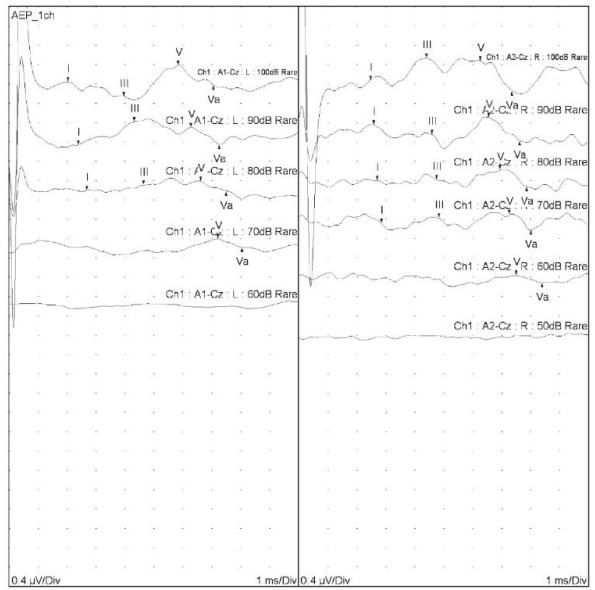




A

Test Date:

I D :	Patient:	Sex :	Age :	Technician :



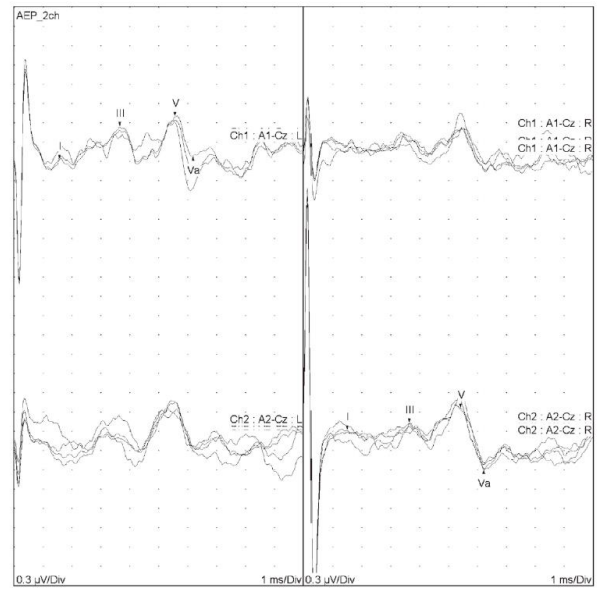
AEP_1ch

Trace	I (ms)	III (ms)	V (ms)	I-III (ms)	III-V (ms)	V-Va (µV)
Ch1 : A1-Cz : L : 100dB Rare	2.03	3.97	5.84	1.94	1.87	0.42
Ch1 : A1-Cz : L : 90dB Rare	2.39	4.33	6.28	1.94	1.95	0.35
Ch1 : A1-Cz : L : 80dB Rare	2.69	4.64	6.63	1.95	1.99	0.21
Ch1 : A1-Cz : L : 70dB Rare	0.00	0.00	7.22	0.00	0.00	0.17
Ch1 : A2-Cz : R : 100dB Rare	2.47	4.41	6.27	1.94	1.86	0.62
Ch1 : A2-Cz : R : 90dB Rare	2.58	4.59	6.55	2.01	1.96	0.49
Ch1 : A2-Cz : R : 80dB Rare	2.70	4.75	6.94	2.05	2.19	0.35
Ch1 : A2-Cz : R : 70dB Rare	2.84	4.83	7.27	1.99	2.44	0.32
Ch1 : A2-Cz : R : 60dB Rare	0.00	0.00	7.50	0.00	0.00	0.16
Ch1 : A2-Cz : R : 50dB Rare	0.00	0.00	0.00	0.00	0.00	0.00

B

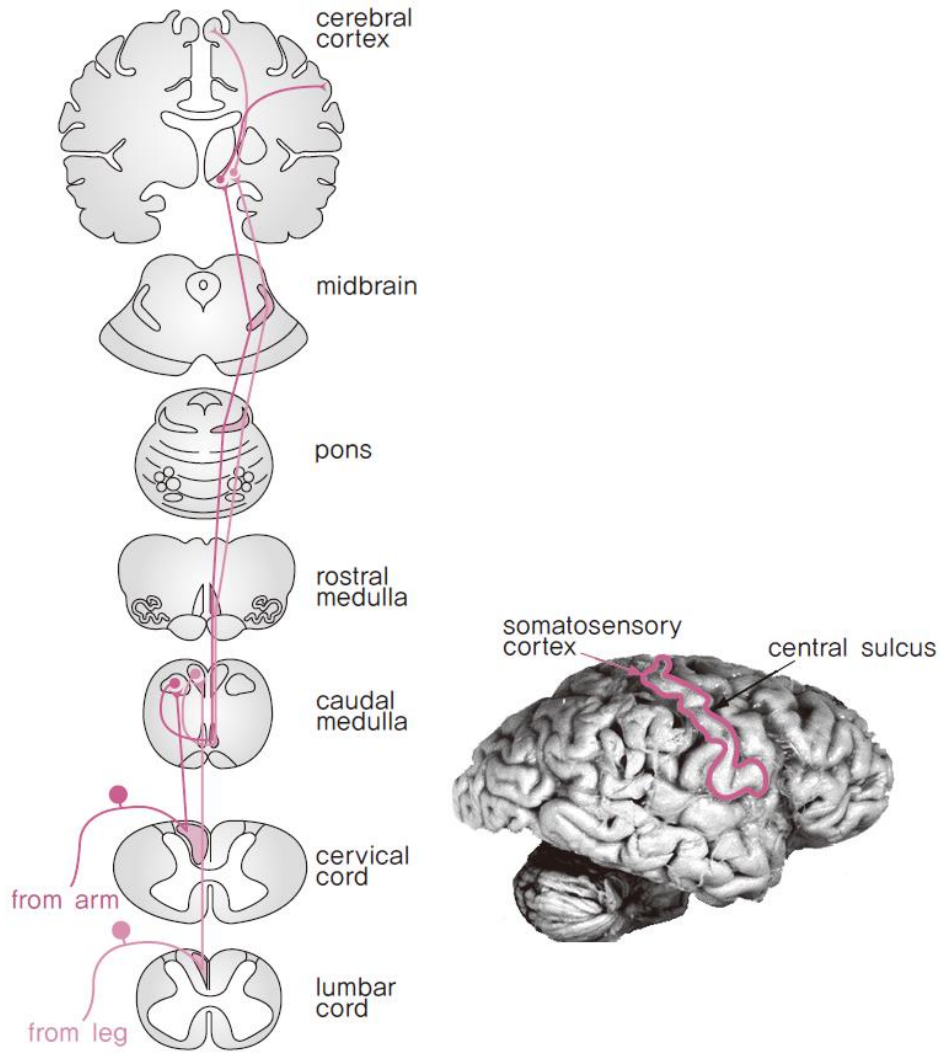
Test Date:

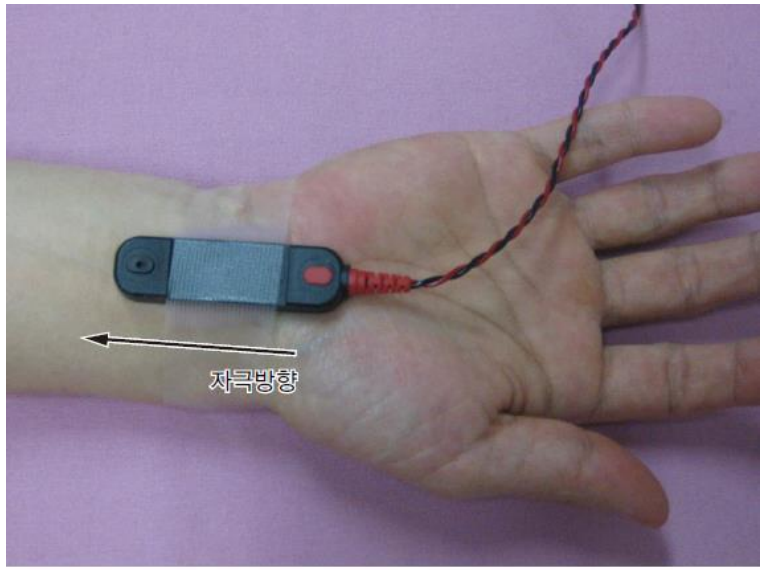
I D :	Patient:	Sex :	Age :	Technician :



AEP_2ch

Trace	I (ms)	III (ms)	V (ms)	I-III (ms)	III-V (ms)	I-V (ms)	V-Va (µV)
Ch1 : A1-Cz : L	1.56	3.66	5.56	2.10	1.90	4.00	0.62
Ch2 : A2-Cz : R	1.50	3.64	5.42	2.14	1.78	3.92	0.95
L-R	0.06	0.02	0.14	0.04	0.12	0.08	0.33


cerebral cortex
midbrain
pons
rostral medulla
caudal medulla
cervical cord
lumbar cord
from arm
from leg
somatosensory cortex
central sulcus


자극방향

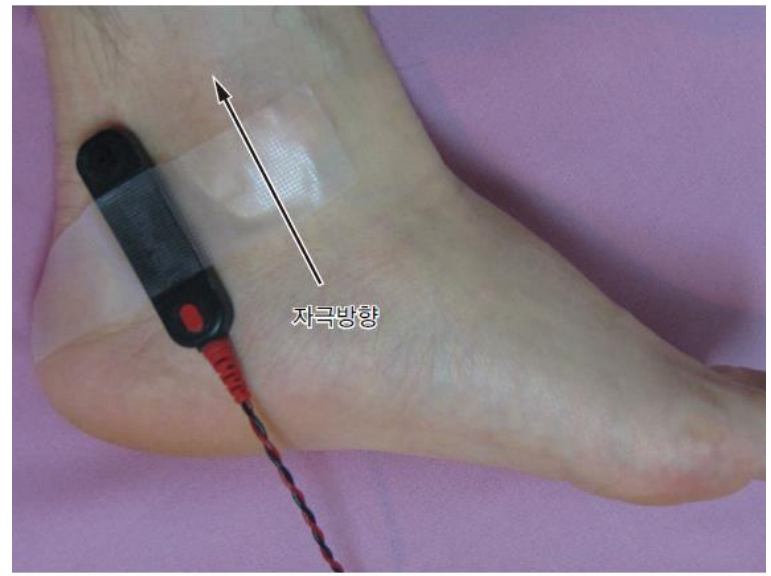
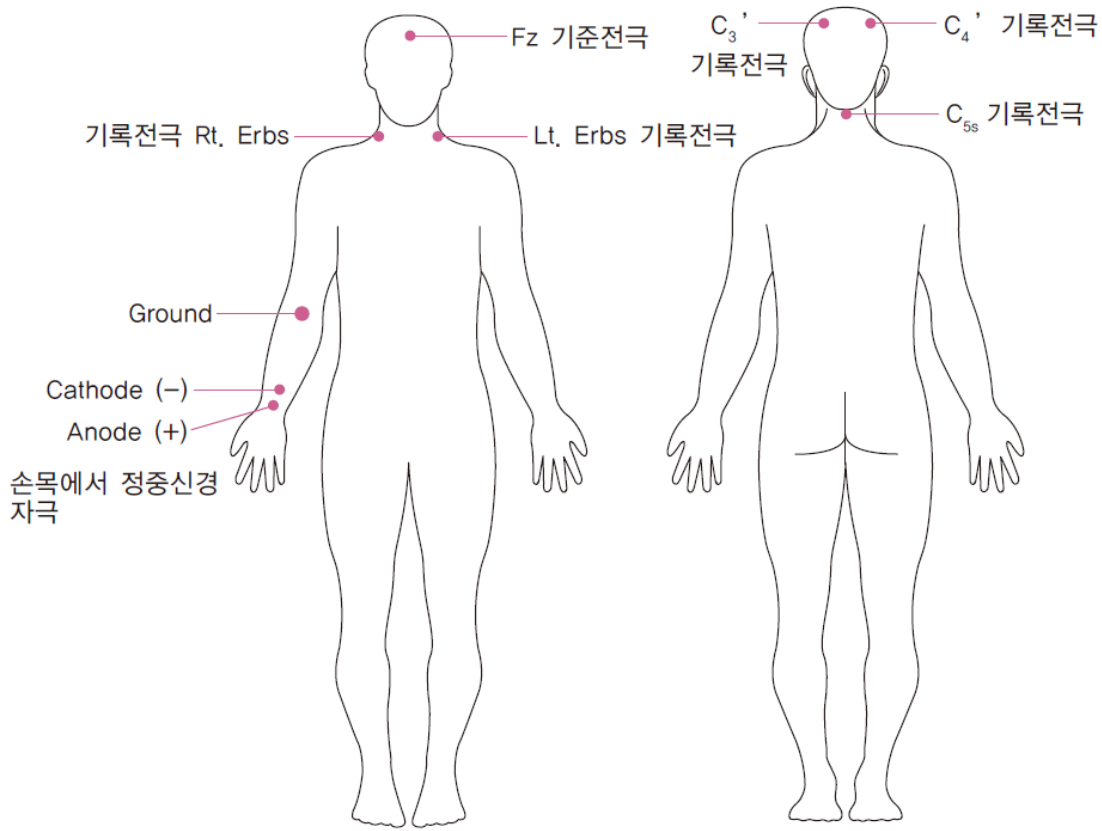

자극방향

표 12-5. 정중신경 SEP 파형의 발생기

파형	발생기
N_{10}	proximal brachial plexus(몸쪽 팔신경얼기)
N_{13}	postsynaptic potential gray matter spinal cord(시냅스 후 전위 척수 회색질)
N_{20}	cortex(겉질)
P_{22}	cortex(겉질)


Fz 기준전극
기록전극 Rt. Erbs
Lt. Erbs 기록전극
Ground
Cathode (−)
Anode (+)
손목에서 정중신경 자극
C3' 기록전극
C4' 기록전극
C5s 기록전극

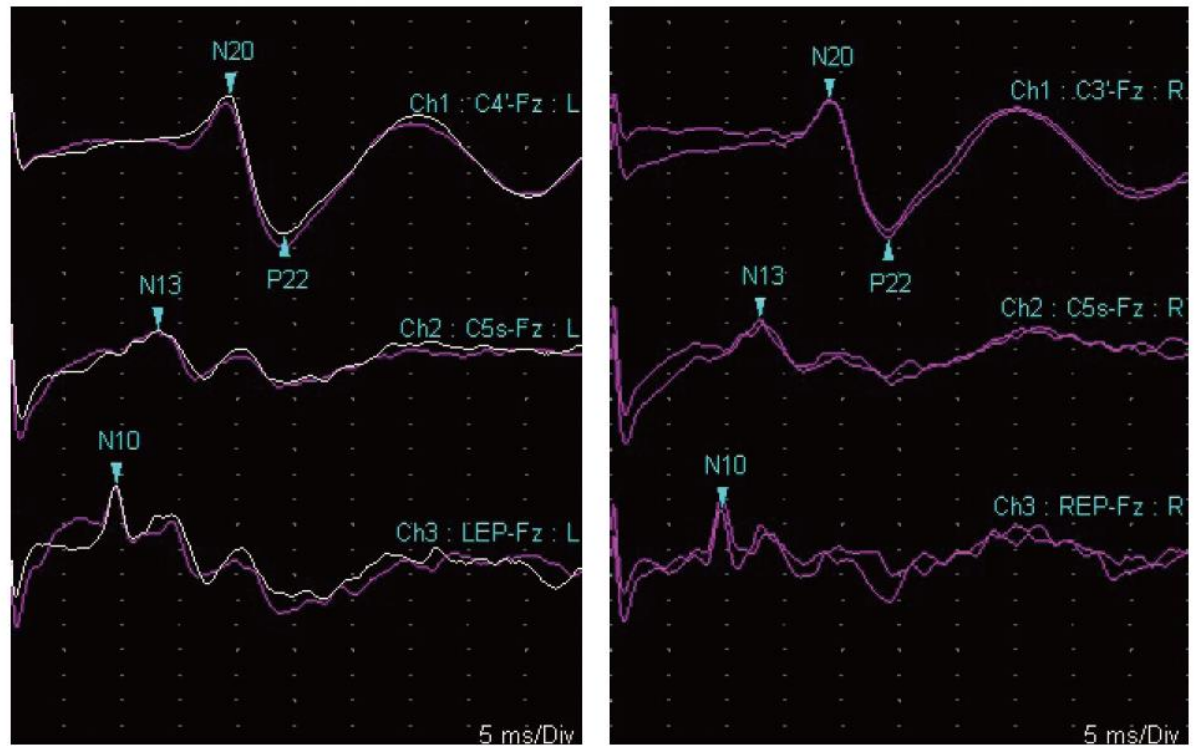
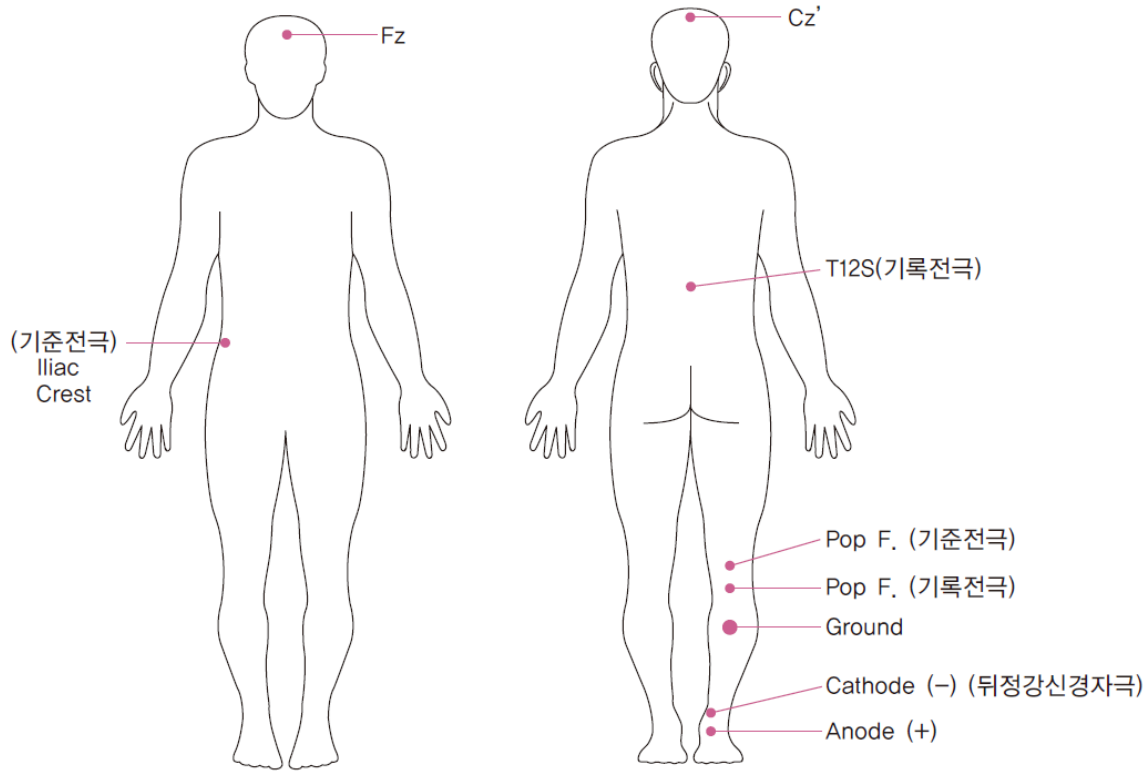
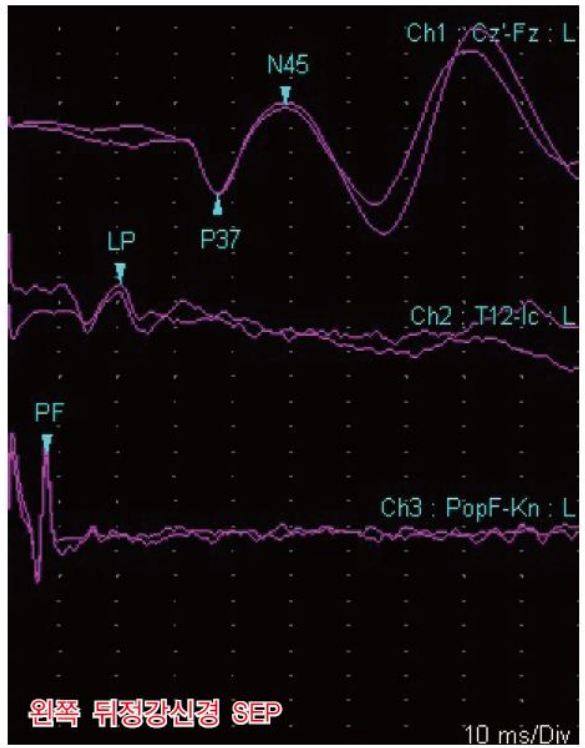
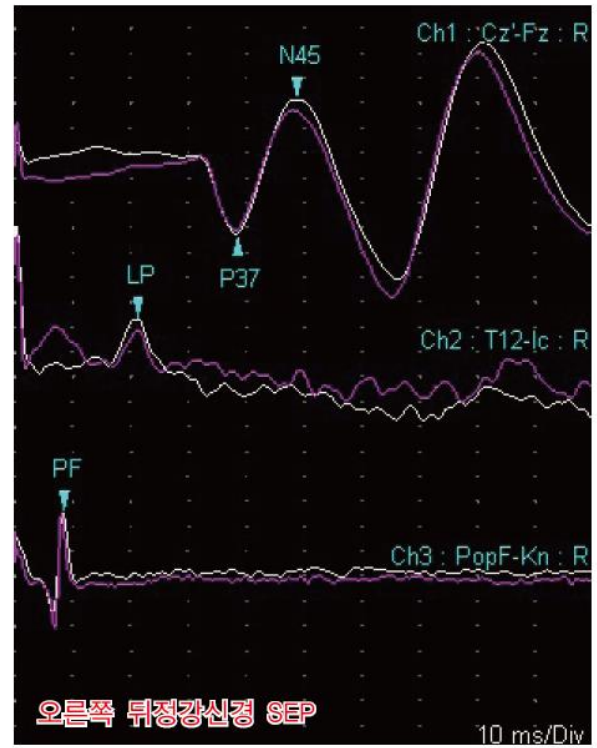

N20
Ch1 : C4'-Fz : L
P22
N13
Ch2 : C5s-Fz : L
N10
Ch3 : LEP-Fz : L
5 ms/Div
N20
Ch1 : C3'-Fz : R
P22
N13
Ch2 : C5s-Fz : R
N10
Ch3 : REP-Fz : R
5 ms/Div

표 12-6. 뒤정강신경 SEP 파형의 발생부위

파형	발생부위
PF	popliteal fossa(다리오금)
LP	lumbar potential(허리전위)
P_{37}	cortex(겉질)

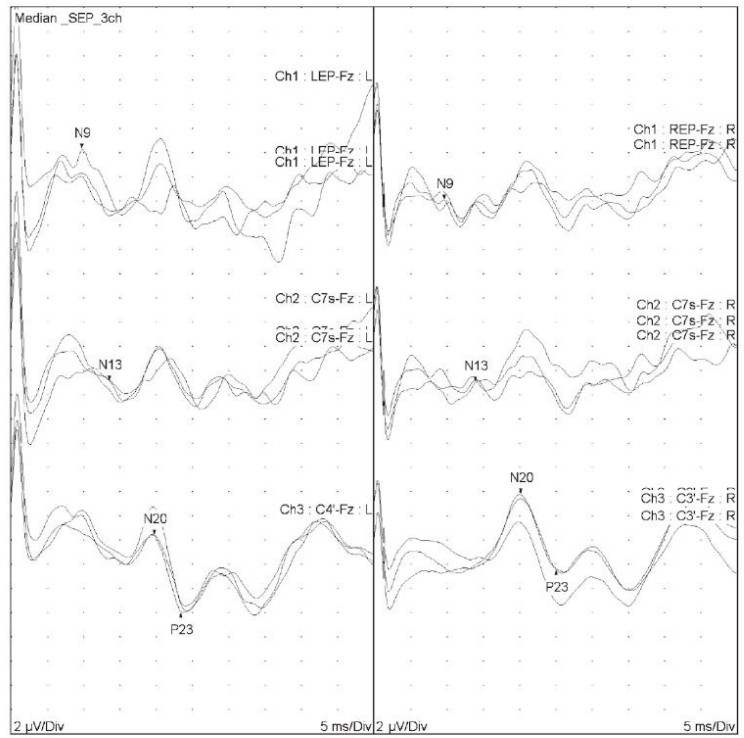

Fz
(기준전극)
Iliac
Crest
Cz'
T12S(기록전극)
Pop F. (기준전극)
Pop F. (기록전극)
Ground
Cathode (–) (뒤정강신경자극)
Anode (+)


Ch1 : Cz'-Fz : L
N45
P37
LP
Ch2 : T12-Ic : L
PF
Ch3 : PopF-Kn : L
왼쪽 뒤정강신경 SEP
10 ms/Div


Ch1 : Cz'-Fz : R
N45
P37
LP
Ch2 : T12-Ic : R
PF
Ch3 : PopF-Kn : R
오른쪽 뒤정강신경 SEP
10 ms/Div

Test Date:

I D :	Patient:	Sex :	Age :	Technician :



Median _SEP_3ch

Trial	N9 (ms)	N13 (ms)	N20 (ms)	P23 (ms)	N20-P23 (µV)
Trial1 - R	9.6	13.9	20.2	25.0	6.20
Trial6 - L	9.8	13.6	19.8	23.4	6.31
L-R	0.2	0.3	0.4	1.6	0.11