유발전위

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Evoked Potentials

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유발전위검사(evoked potential)

- 유발 (誘發) [명사] 어떤 것이 다른 일을 일어나게 함.
- Evoked: [동사] (감정・기억・이미지를) 떠올려 주다[환기시키다]
- 전위 (電位), electric potential
- 유발전위
  외부 자극에 대해 생체에서 얻어지는 전기적신호
- Evoked potential
  is an electrical potential recorded from the nervous system of a human or other animal following presentation of a stimulus, as distinct from spontaneous potentials as detected by electroencephalography (EEG) or electromyography (EMG)

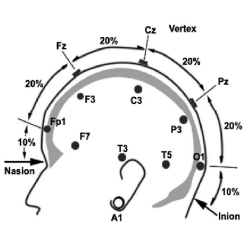
유발전위검사의 종류

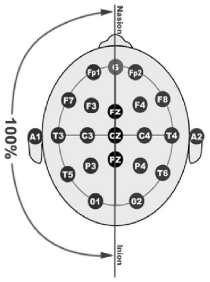
- Somatosensory evoked potential (SSEP)
- Visual evoked potential (VEP)
- Brainstem auditory evoked potential (BAEP)
- Motor evoked potential (MEP)
- Vestibular evoked myogenic potential (VMEP)

유발전위검사의 특징

- 파형의 크기가 작다
- Near VS Far field potentials
  파형이 기록되는 것이 근접 부위에서 기록
  근전도, 신경전도, 뇌파, 시각 유발 전위
  기록 위치와 방향에 따라 전위의 진폭 변화가 크다
  VS
  파형이 기록되는 것이 떨어진 부위에서 기록
  청각유발전위, 대부분의 유발전위
  전위형성부위와 기록부위가 멀리 떨어져 진폭이 작음

기록전극의 위치(10/20 system)





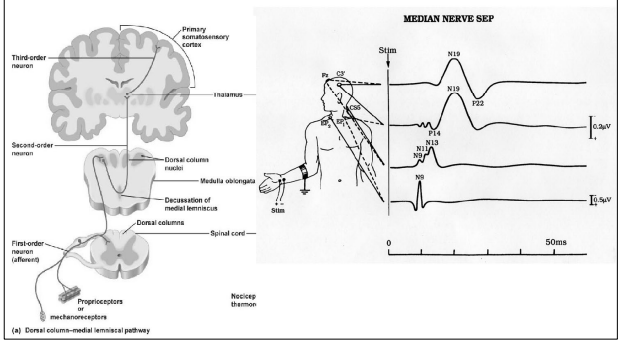
Somatosensory evoked potential (SSEP)

- Median nerve SEP

1. EP: Erb's point. (plexus)
2. N13: Cervical potential recorded from the dorsal neck. (spinal cord)
3. P14: Subcortically generated far-field potential, recorded from the broad scalp. (probably caudal medial lemniscus)
4. N18: Subcortically generated far-field potential, recorded from scalp electrodes ipsilateral to the stimulated nerve. (Probably brainstem and thalamus)
5. N20: Primary cortical Somatosensory area, recorded using a bipolar derivation to subtract the widespread far-field signals (e.g., P14 and N18) from the superimposed primary cortical activity recorded locally over the centroparietal region contra lateral to the stimulated median nerve.

Somatosensory evoked potential (SSEP)

- Median nerve SEP



Abnormal SSEP findings	Interpretation
Technical problems	
1. Absent SEPs to arm stimulation at all recording levels	Lack of stimulus; lack of synchronization between stimulator and average; faulty recording electrodes or equipment
2. Increased latency at SEPs at all recording levels	Hypothermia; inaccurate measurement of the distance between stimulating and recording electrodes
Lesions of the nervous system	
1. Absent N9 with normal N13 and N20	Normal
2. Absent N9 with absent or delayed N13 and N20	Peripheral nerve or plexus lesion; rule out technical problems
3. Increased latency of N9 with equally increased latency of N13 and N20: Decreased peripheral conduction velocity with normal central conduction times	Peripheral nerve or plexus lesion; rule out technical problems
4. Increased N9-N13 conduction time with normal N13 amplitude and shape, normal conduction velocity, normal N13-N20 conduction time	Defect above the brachial plexus and below the lower medulla
5. Absent N13 and absent or delayed N20	Defect above the brachial plexus and below or at the lower medulla
6. Increased N13-N20 central conduction time with normal N9-N13 conduction time and normal peripheral conduction velocity	Defect above the brachial plexus and at or below the somatosensory cortex
7. Absent N20 and normal N9-N13 conduction time and normal peripheral conduction velocity	Defect above the brachial plexus and at or below the somatosensory cortex
8. Decreased peripheral conduction velocity and increased central conduction times	Combination of peripheral nerve or plexus lesion and central defect

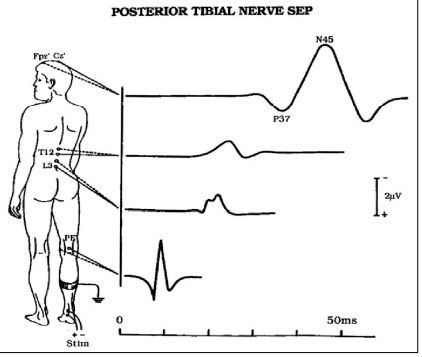
Somatosensory evoked potential (SSEP)

- Posterior tibial nerve SEP

- LP: lumbar potential, recorded over the dorsal lower thoracic and upper lumbar spines (lumbar cord)
- P31 and N34: Most likely analogous to P14 and N18 in MNSEP, recorded from Fpz
- P37: Primary cortical somatosensory area, recorded using bipolar derivations to subtract widespread signals from the primary cortical activity.
- Usually maximal somewhere between midline and centroparietal scalp locations ipsilateral to the stimulated leg.
- Considerable variability in the scalp topographic distribution of the P37 → it is necessary to record from both midline and ipsilateral scalp locations.

Somatosensory evoked potential (SSEP)

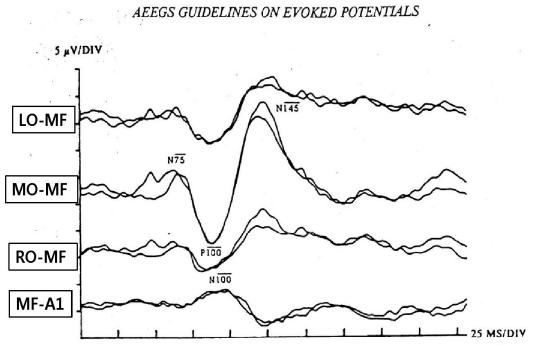
- Posterior tibial nerve SEP



Abnormal SSEP findings	Interpretation
Technical problems	
1. Absent SEPs to arm stimulation at all recording levels	Lack of stimulus; lack of synchronization between stimulator and average; faulty recording electrodes or equipment
2. Increased latency at SEPs at all recording levels	Hypothermia; inaccurate measurement of the distance between stimulating and recording electrodes
Lesions of the nervous system	
a. Absent FP potential with absent or normal L3 potentials and absent scalp SEPs or normal central conduction velocities	Normal
b. Absent FP potential with either absent spinal potentials and absent scalp SEPs or normal central conduction velocities	Lesion between ankle and PF
c. Decreased peripheral conduction velocity to PF and	Defect below cauda equina
(1) equally decreased peripheral conduction velocity to L3	Defect of both distal and proximal peripheral nerve
(2) no decrease of peripheral conduction velocity between PF and L3S	Defect between ankle and PF
d. Decreased peripheral conduction velocity to L3S with normal peripheral conduction velocity to PF	Lesion between PF and cauda equina
e. Absent L3 and T12 potentials, absent or delayed scalp SEP with normal peripheral conduction velocity to PF	Probably lesion between PF and cauda equina

Visual evoked potential (VEP)

- 자극 선택: Pattern VEPs, Flash VEPs
- 환자 상태: 각성도, 집중도, 시력, 피로도
- 자극의 구성: 다양한 방법으로 유발
  - 장기판 패턴(checkboard pattern)
- 자극의 기록 Queen Square System



Visual evoked potential (VEP)

- P100 latency
  임상적으로 가장 의미 있는 소견이며 환자의 상태에 가장 영향을 적게 받는 값.
  안구나 망막의 병이 없을 때에 시각경로의 이상을 반영
  한쪽 만 연장되었을 경우 한쪽 시신경 이상
  양쪽 모두 연장된 경우는 진폭의 비율 등 더 분석하지 않는 한
  시각교차 전 혹은 후 문제인지 감별은 어려움.

Visual evoked potential (VEP)

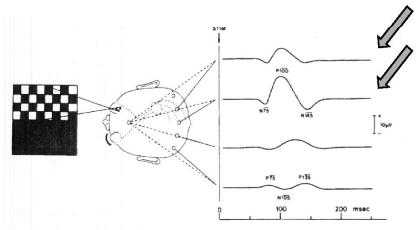
- P100 진폭
  진폭이나 진폭의 비율의 정상 값은 정해져 있지 않음.
  일반적으로 안구간 진폭 비율이 2:1 ~2.5:1 이내
  진폭의 이상은 안구의 질환이 없고, 환자가 주시점을 잘 집중했다면 시각 경로의 이상을 의미.
  안구나 망막의 병변을 발견해내는 데에 잠시보다 민감.

Visual evoked potential (VEP)

Visual evoked potential abnormality	Location
Binocular absence of VEPs	Technical problems; ocular abnormalitis:lack of fixation or acuity, severe bilateral optic nerve defect
Monocular absence of VEPs	Optic nerve or ocular lesion
Prolonged VEP latency	Optic nerve lesion
Increased interocular VEP latency difference	Optic nerve lesion
Monocular decreased VEP amplitude	Ocular lesion
Binocular decreased VEP amplitude	Ocular lesions or chiasmal lesion, any bilateral prechiasmal or chiasmal lesion; low amplitude with normal latencies may be normal

Half field VEP

- 자극되는 시야와 동측의 후두부에서 N75, P100, N145 가 더 잘 관찰된다. (paradoxical lateralization)



Half field VEP

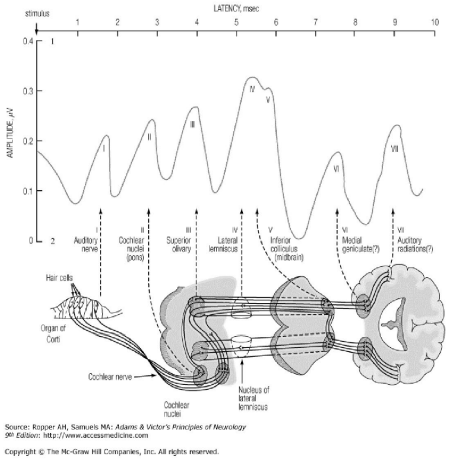
Visual evoked potential abnormality	Location
Abnormal bilateral temporal VEPs	Lesion at or near optic chiasm
Abnormal corresponding field VEPs	Lesion of posterior visual pathways, the optic radiations , or visual cortex
Abnormal monocular hemi-field VEP	Incomplete optic nerve lesion

Brainstem auditory evoked potential (BAEP)

- 발생기전
  음파 → 고막 진동 → ossicle → Cochlea → oval window
  → hair cell 변형 → 청각 수용체 전위 발생 → 청신경 신경섬유 탈 분극
  → 청신경을 통해 뇌간으로 전파
- 자극 후 반응의 잠시에 따라
  Short latency (~10 msec)
  Milddle-latency (10~50 msec)
  Long-latency (>50 msec)
- Short latency : 대부분 뇌간에서 생성됨,
  → brainstem auditory evoked potential , BAEP

Brainstem auditory evoked potential (BAEP)

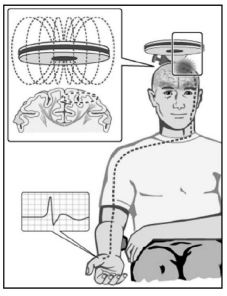
- 자극 종류
- 자극 강도
- 자극 극성
- Masking noise
- click에 대한 청각 역치의 결정
- 전극
  기록 전극은 귀나 귀 근방에 위치
  양 귀볼(A1, A2)나 유양돌기(M1, M2)
  기준전극은 두정(vertex)에 부착

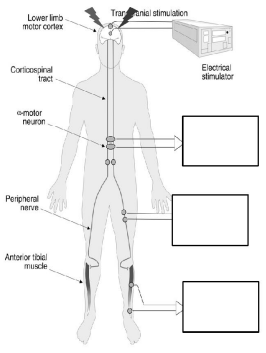


Abnormality	Interpretation
Absent bilaterally	Bilateral acoustic nerve lesion, brain death, rule out technical problems
Low amplitude or increased latency of entire AEP bilaterally	Peripheral hearing loss, acoustic nerve lesion, rule out reduced stimulus intensity
Absent, other side normal	Unilateral cochlear or acoustic nerve lesion
Absent, peaks after a normal wave I and subsequent waves, IPL III~V normal	Peripheral hearing loss or acoustic nerve lesion
Absent wave V or decreased amplitude ratio V/I	Ipsilateral lower or upper brainstem lesion
Increased IPLs I~III and III~V	Ipsilateral lower and upper brainstem lesion
Increased IPLs I~III ; normal III~V	Ipsilateral lower brainstem lesion, between acoustic nerve and lower pons
Increased IPLs III~V ; normal I~III	Ipsilateral upper brainstem lesion, between lower pons and midbrain
Abnormal increase of wave V latency with rapidly repeating stimuli	Suspect ipsilateral brainstem lesion
Increased BAEP threshold	Suspect peripheral hearing loss or distal acoustic nerve lesion
Shift of latency-intensity curve upward but parallel to normal curve	Conductive hearing loss
Shift of latency-intensity curve upward predominantly at low intensities	Sensorineural hearing loss

Motor evoked potential

- Motor evoked potential





Interesting Cases

그 외 알아야 할 것

- Time-locked
- Averaging