Infraslow EEG activity

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http://eeg.re.kr
Outline

• Characteristics of EEG frequency
• Infraslow EEG and DC shift
• Clinical application of infraslow EEG (DC-shift)
• Ictal localization of infraslow EEG
• Pathophysiology of infraslow EEG
• How to get infraslow EEG
• Conclusions
Q: what is filter setting of digital EEG in your hospital?

<table>
<thead>
<tr>
<th>Low frequency filter (high pass filter)</th>
<th>High frequency filter (low pass filter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>① 0.1 Hz</td>
<td>① 35 Hz</td>
</tr>
<tr>
<td>② 0.3 Hz</td>
<td>② 50 Hz</td>
</tr>
<tr>
<td>③ 0.5 Hz</td>
<td>③ 70 Hz</td>
</tr>
<tr>
<td>④ 1.0 Hz</td>
<td>④ 100 Hz</td>
</tr>
<tr>
<td>⑤ &gt; 1.0 Hz</td>
<td>⑤ &gt; 100 Hz</td>
</tr>
</tbody>
</table>
Frequency range of EEG

- Conventional EEG: 0.3–70 Hz (0.1-100 Hz)
- Wideband, broadband, fullband EEG
Direct current EEG (DC-EEG)

• An frequency response of the EEG with a minimum at 0 Hz
• Two meanings of DC-EEG
  – Current without oscillation: true DC current
  – the low-frequency part of the EEG: infraslow EEG
• Localized, very slow (<0.5Hz), sustained voltage changes, which do not oscillate
  – Infraslow activity
  – DC baseline shift
Clinical applications of infraslow EEG

- Slow activity in the preterm human EEG
- Infraslow EEG oscillation and voltage shifts during sleep
- Infraslow activity during seizure: Ictal DC shift
- Infraslow activity related to cognitive states

Vanhatalo et al., Clin Neurophysiol 2005
Infraslow EEG during seizure

- Ikeda et al. Focal ictal direct current shifts in human epilepsy as studied by subdural and scalp recording. Brain. 1999
subdural electrodes with 1.5 Hz LFF settings

Epilepsia, 1996
0.016 Hz LFF settings
ictal DC shifts in intracranial EEG

- Intracranial EEG: 85%, scalp EEG: 23%
- ictal DC shifts were mainly surface-negative in polarity
- often coincided with the electrodecremental pattern
- started earlier than the conventional ictal EEG onset
- seen in a more restricted area compared with conventional ictal EEG changes

Ikeda et al., Brain, 1999
Analysis of Seizure Onset on the Basis of Wideband EEG Recordings


Departments of *Neurology, †Neurobiology, ‡Neurosurgery, and the §Brain Research Institute, UCLA School of Medicine, Los Angeles, California, U.S.A.

Summary: Seventy-five seizure onsets recorded with depth electrodes in the frequency band from 0.1 to 70 Hz were analyzed in 19 patients with intractable temporal lobe epilepsy. It was shown that 89% of low-voltage fast-type seizures contained an initial slow wave, whereas hypersynchronous-type seizures did not show an initial slow wave. Voltage depth profile analysis illustrated that the peak amplitude of the initial slow-wave onset was in white matter, whereas the peak amplitude of hypersynchronous onset was in deep temporal areas (hippocampus, entorhinal cortex, or amygdala). The difference in voltage depth profiles suggests that these two types of seizure onsets have different mechanisms of generation. The absence of phase reversal of the initial slow wave in white matter or at the border of deep temporal areas indicates a possible nonneuronal mechanism of generation. Key Words: Temporal lobe epilepsy—Seizure onset—Human—Entorhinal cortex—Hippocampus—EEG.
Very slow EEG responses lateralize temporal lobe seizures in scalp EEG

LFF: DC amplifier

LFF 0.5 Hz

Neurology, 2003
All seizures (35/35) from 7 pts were associated with negative DC shifts at temporal derivations (30 to 150 uV relative to vertex), beginning at the electrical seizure onset, and lasting for the whole seizure.

Polarity of the shift in the temporal derivations was either positive or negative in the beginning of the seizure, whereas it was always negative during the later, bilateral seizure activity.

The side of the DC EEG shift agreed with other diagnostic tests, and was more clearly lateralized than the conventional scalp EEG.
Infraslow activity in absence seizure in scalp EEG

Clin EEG Neurosci, 2007

Bandpass 0.01-0.1 Hz

1-75 Hz
Source localization of ISA

Neuroimage, 2007
Neuroimage, 2007
Infraslow oscillation during sleep

ISO (0.02-0.2 Hz)

FbEEG

Conventional EEG (>0.5 Hz)

100 μV

30s
Pathophysiology of infraslow activity

- Associated with
  - ictal epileptic activity (esp, with sustained paroxysmal activity, EDR)
  - abnormal gas tension in blood and tissue (hypoxia, hypercapnea, acidosis, and primary asphyxiation),
  - anesthetic and neurotropic drug effects
  - language, memory, cognitive tasks, and motor preparation
Generator mechanism

• Non-neuronal mechanism
  – Spatial potassium buffering by glial cells, especially during the slow unipolar DC shifts associated with seizure activity

• Non-cerebral mechanism
  – epithelial potentials modified by pH or blood flow (the “blood brain barrier potential”)
How to get infraslow EEG

1. DC amplifier
2. Sampling rate: DC-1K Hz
3. Non-polarizable electrode
4. Good skin-electrode contract
5. Skin potentials are short-circuited at the epithelium by scratching or puncturing with a tiny needle.

Clin Neurophysiol, 2005
M/30 CPS, Lt
F/59 right clonic sz, s/p Rt MCA infarction
Conclusions

• Infraslow EEG activity can be obtained using conventional digital EEG with extended filter setting or with DC amplifier.

• It may provide further information on pathophysiological state of brain.

• It may be helpful for localizing epileptogenic zone.

![Visible Light Spectrum](image)
감사합니다!
KU Computational Neuroscience Research Lab. (KUCNL)

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