

# montage

## The Concepts of Montage in Somatosensory Evoked Potentials.

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### - Abstract -

Although somatosensory evoked potentials(SSEPs) have been utilized as the useful diagnostic tools in evaluating the wide variety of pathological conditions, such as focal lesions affecting the somatosensory pathways, demyelinating diseases, and detecting the clinically occult abnormality, their neural generators is still considerably uncertain. To appreciate the basis for uncertainties about the origins of SSEPs, consider criteria that must be met to establish a causal relationship between activity in a neural structure and a spine/ scalp-recorded potential. Electrode locations and channel derivations for SSEPs recordings are based on two principles:(1) the waveforms are best recorded from electrode sites on the body surface closest to the presumed generator sources along the somatosensory pathways, and(2) studies of the potential-field distribution of each waveform of interest dictate the best techniques to be used. In this article, authors will describe followings focused on ;(1) the concepts of near field potentials(NFPs) and far field potentials(FFPs) - the voltage of NFPs is highly dependent upon recording electrode position, FFPs are unlike NFPs in that they are widely distributed, their latencies and amplitudes are independent of recording electrode.(2) appropriate montage settings to detect the significant potentials in the median nerve and posterior tibial nerve SSEPs(3) neural generators of various potentials(P9, N13, P14, N18, N20, P37) and their clinical significance in interpreting the results of SSEPs. Especially, Characteristics of N18(longduration, small superimposed inflection) suggested that N18 is a complex wave with multiple generators including brainstem structures and thalamic nuclei. And N18 might be used as the parameter of braindeath. Precise understanding on these facts provide an adequate basis utilizing SSEPs for numerous clinical purposes.

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montage

(impedance ) far field potential(FFP) .<sup>4-10</sup>

(evoked potential)

stationary potential  
PSP NFP FFP

(averaging)

FFP (BAEP)

scalp FFP FFP

FFP (positive polarity)

FFP

(SEP) proximal plexus, dorsal root ganglion, (medial lemniscus) (posterior column), thalamic radiation

3가 가 (volume) 가

montage 1986 Kimura<sup>13</sup> (hand) (arm) 가 (wrist) FFP가

montage Fig. 1 0 1.5cm -1, -2, -3 가 1.5cm

Montage +1, +2, +3 (orthodromic) bipolar recording 가 가

montage montage (reference electrode) 가 referential recording 가

NFP FFP far field poten-

tial(PSP) postsynaptic poten- tial FFP NFP

near field potential(NFP) far field poten- tial(FFP) 가 (Fig. 1).

near field poten- tial(NFP) 가 FFP NFP

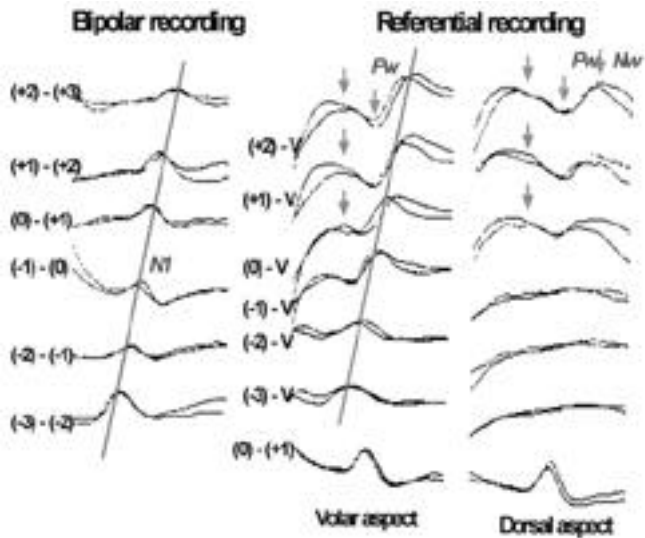


Figure 1. Sensory nerve potentials across the wrist recorded bipolarly(left), or referentially from volar(middle) or dorsal(right) aspect with distal reference.

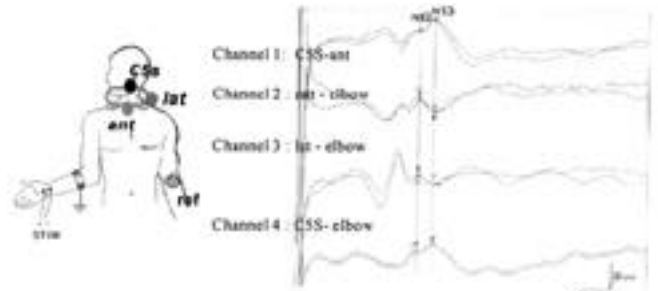


Figure 3. Median nerve SEPs recorded from a ring of electrodes about the neck using noncephalic reference site.

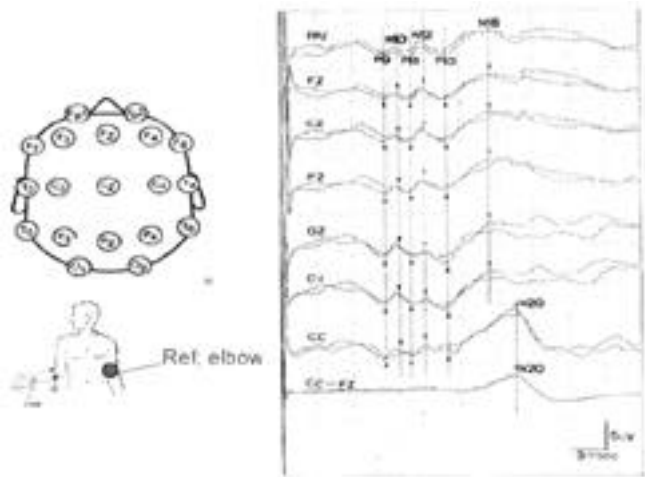


Figure 2. The differences of near field potential(N20) and far field potentials(P9,N10,P11,N12,P13) in scalp-scalp montage and scalp-noncephalic montage.

10-20 reference  
 Fig. 2 P9, N10,  
 P11, N12, P13, N18  
 가 FFP  
 C3  
 N20 가  
 NFP  
 Fig. 3 N13 reference  
 polarity가 NFP  
 N12 polarity 가 FFP  
 FFP

P9 가 Erb's  
 가 , Fig. 4 FFP  
 가 FFP 3가  
 FFP  
 . FFP (EKG) EKG  
 EKG가 FFP  
 NFP FFP montage  
 1. FFP montage가  
 가  
 2. NFP montage setting cortical potential scalp-scalp derivation montage가 , cervical NNF potential montage가  
 3. 가 ( P13/14, montage  
 montage  
 NFP FFP 가  
 . Fig. 5 NFP FFP monatge setting scalp-noncephalic reference (channel 1, 2, 3) FFP (channel

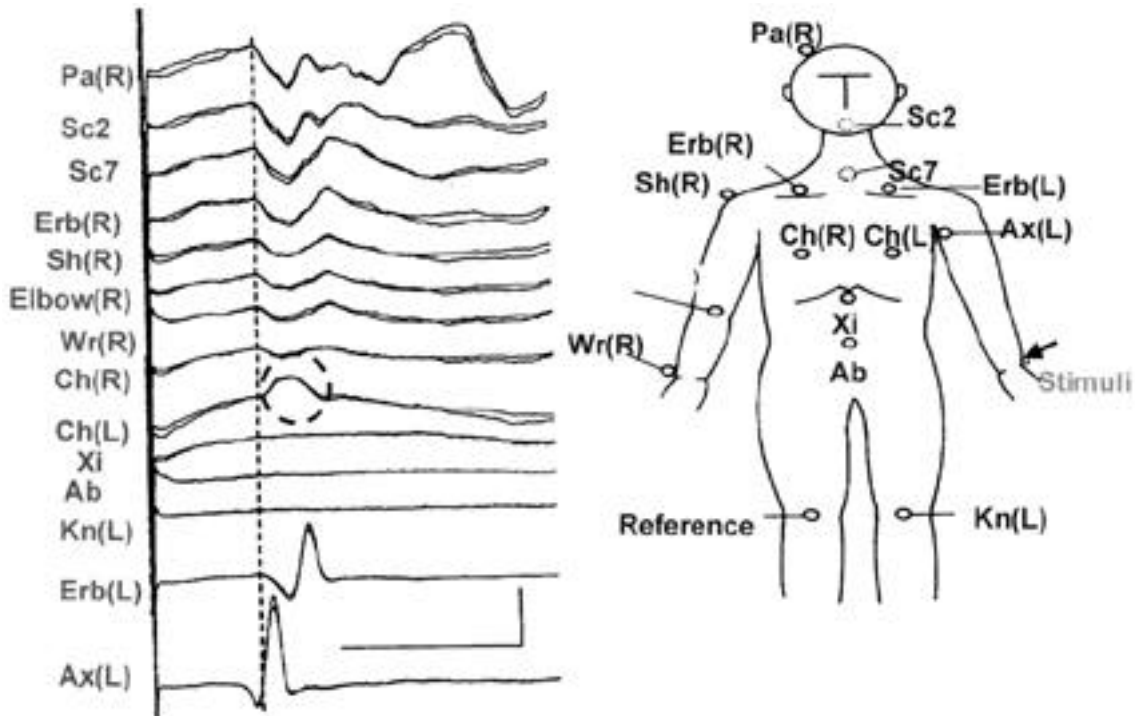


Figure 4. Distribution of P9s in response to stimulation of the left median at the wrist.

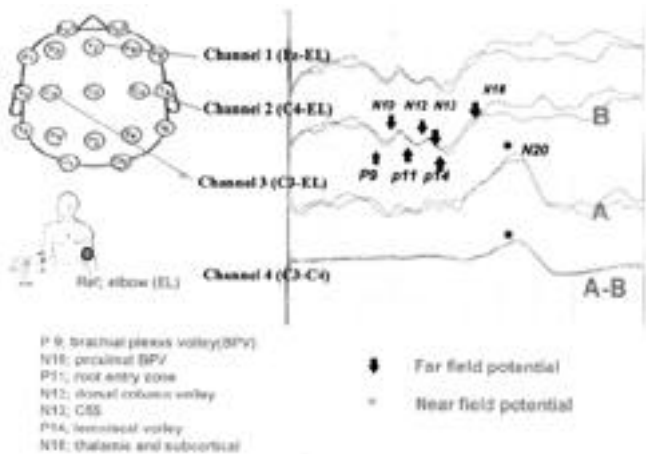


Figure 5. Basic concept of FFP and NFP in Median Nerve SEP

1 -Fz, channel 2-C4)  
 (C3) FFP NFP  
 Fig. 5 channel 1, 2 noncephalic refer-  
 ence elbow reference  
 FFP P9, N10, P11, N12, P14, N18  
 channel 3 FFP  
 P9, N10, P11, N12, P14, N18 NFP  
 N20, P23 Fig. 5  
 channel 4 scalp-scalp montage (C3-C4)  
 scalp electrode  
 P9, P11, P13 FFP NFP  
 Fig. 1  
 American EEG Society14 montage

Table 1. Comparison of montage ; AEEG society guideline and HYUH & Dong-A montage in median nerve SEP

AEEG Society guideline	HYUH and DongA Montage
Ch 1 ; C4'-Erbc	Ch 1 ; C3'-Fz(NFP)
Ch 2 ; C4'-Fz	Ch 2 ; C4'-Erbc(FFP)
Ch 3 ; C5S-Fz	Ch 3 ; C5S-Fz(N/P 13)
Ch 4 ; Erbi-Erbc	Ch 4 ; Erbi-Erbc(Erb)
	Ch 5 ; C5S-Ant neck(N13)
	Ch 6 ; Fz-Erbc(FFP)

NFP  
 scalp-scalp montage, FFP  
 scalp-  
 noncephalic montage, central conduction time  
 spine-scalp montage, Erb's  
 montage 4 channel  
 4 channel  
 가  
 montage  
 montage AEEG soci-  
 FFP  
 (chan-  
 nel 5) NFP  
 montage (channel 6) 가  
 Table 1  
 FFP  
 montage scalp-

scalp montage  
parasagittal 가 P37 Cz central  
NFP  
central parasagittal  
dipole  
15-17 PTSEP NFP FFP  
scalp-noncephalic  
reference 2 scalp-scalp montage가  
Table 2  
PTSEP scalp-ear lobe montage  
MNSEP P14 P30  
PTSEP montage  
(Fig. 6).

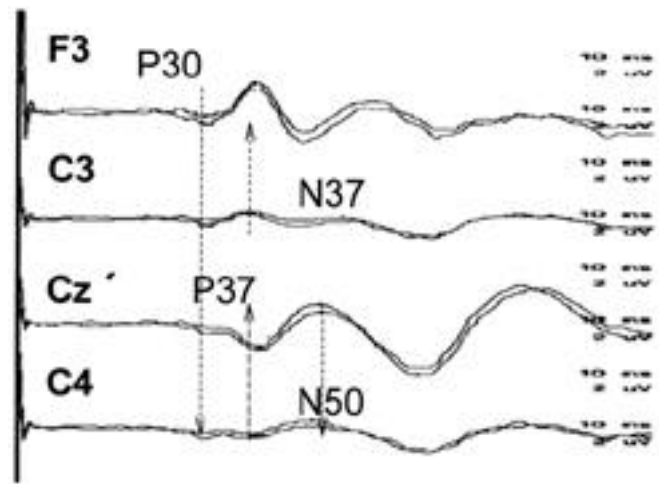
brachial plexus 가  
P9 FFP가  
Fig. 7  
brachial plexus  
(shoulder joint) P9 가  
19  
2) N13  
가  
cervical  
cord(C5)-scalp(Fz) montage  
N13 NFP scalp P13 FFP  
가  
가  
scalp P13  
thyroid cartilage  
reference  
Fig. 8

1) P9  
P9 가 brachial plexus volley  
FFP , N10 plexus  
.18 P9 가

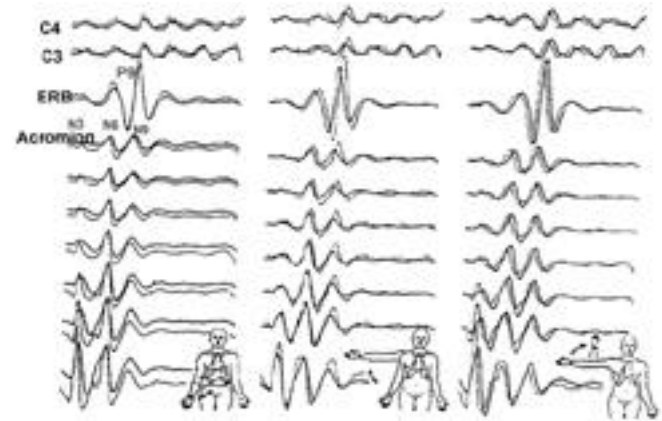
**Table 2.** Comparison of montage ; AEEG society guideline and HYUH & Dong-A montage in posterior tibial nerve SEP

AEEG Society guideline	HYUH Montage
Ch 1 ; Cz'-FPz(NFP)	Ch 1 ; Cz'-PFz(NFP)
Ch 2 ; T12S-r4cm T12S	Ch 2 ; T12S-ICc
Ch 3 ; L3S-r4cm L3S	Ch 3 ; L5S-ICc
Ch 4 ; PF-Kn	Ch 4 ; PF-Kn
	Ch 5 ; Cz'-elbow(FFP)
	Ch 6 ; C4'-PFz(NFP)

montage  
N13  
21  
P13 1991 Restuccia Mau-  
guiere 22 syringomyelia  
9 N13 P14가  
N13 가  
가  
가



**Figure 6.** Scalp somatosensory evoked potentials to the right tibial nerve stimulation(ear lobe reference). All Channels showed P30 potential.



**Figure 7.** Wave form changes of P9 with right median nerve stimulation in different arm positions.



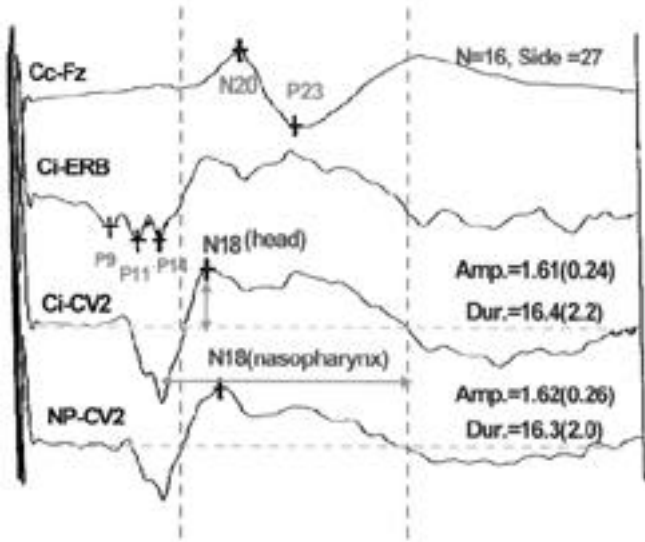


Figure 11. Somatosensory evoked potential to the right median nerve stimulation. Cc: contralateral cortex to stimulation, Ci: ipsilateral cortex to stimulation, CV2: 2nd cervical vertebra, NP: nasopharyngeal electrode.

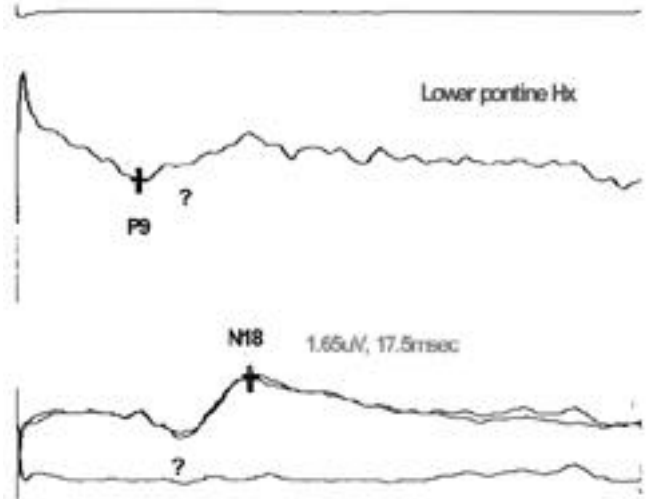


Figure 12. Somatosensory evoked potential in patient with pontomedullary junction hemorrhage. P13/14 was not recorded, but N18 was preserved.

cervico-medullary junction  
P14

P14, P30, N18

FFP

(cervico-medullary junction)

4) N18  
N18  
(duration) N18 가 N18  
25-29 1996 Sonoo<sup>30</sup>  
(medial medullary syndrome)  
P14 N18  
N18 가  
1999<sup>31</sup> nasopharyngeal  
scalp N18  
가 가 N18 가  
(Fig. 11),  
P14 N18 가  
(Fig.  
12). N18 (cuneate  
nucleus) 가 N18  
(brain death)

NFP, FFP

montage

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