

## Posterior Tibial Nerve Somatosensory Evoked Potentials Recorded on Subdural Electrodes around Paracentral Lobule

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### - Abstract -

**Background** : Posterior tibial nerve somatosensory evoked potentials (PTSEP) have cortical potentials on primary sensory area of foot around 40 msec. The direct cortical recordings of the cortical potentials shows high voltage positive wave on medial hemisphere, especially on paracentral lobule (PCL). However, it is so difficult to record the potential directly on PCL that the cortical potential of PTSEP is not well understood. We investigated the cortical potential of PTSEP on subdural electrodes. **Methods** : We recorded cortical potentials to posterior tibial nerve stimulation on subdural electrodes which were on medial hemisphere near PCL in 15 intractable neocortical epilepsy patients. The numbers of subdural electrodes were 8 in 10 subjects (1 x 8 array) and 16 in 5 subjects (2x8 arrays). Seven subjects had three-dimensional imaging fusion (3D-fusion) of MRI and the electrodes using Analyze program. We investigated the amplitude, latency, polarity, and phase of the waves regarding location. **Results** : The waves had maximal amplitude on PCL in 4 subjects, precuneus in 1, cingulate gyrus nearest to PCL in 2 among 7 subjects with 3D-fusion. Also the electrodes were located on posterior area of PCL (2 out of 2 subjects with more than two electrodes put on PCL in 3D-fusion) and superior area of it (5 out of 5 subjects with 2 x 8 arrays). All the high (more than 20 uV) amplitude around 40msec had positive polarity in 7 subjects. The phase reversals were detected between the electrodes with the highest amplitude and the just posterior (2 subjects) or anterior (6 subjects) located electrodes. The just posterior located electrodes had sharper phase reversal than the anterior one. **Conclusion** : PTSEP might have maximal amplitude of cortical potentials on the more superior and posterior area of PCL. The highest amplitude potential has positivity. The wave with maximal amplitude could have phase reversal of cortical potentials with surrounding electrodes, especially shaper with posterior part than with anterior one.

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**Key Words** : Subdural electrode, PTSEP, Paracentral lobule, Medial hemisphere, Phase reversal

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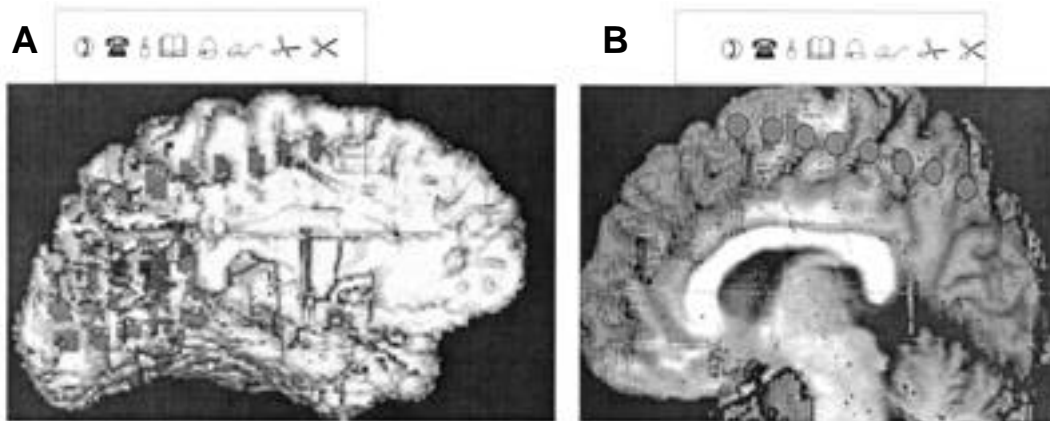
in stimulation) Penfield Brodrey (bra-  
 sory evoked potentials:SEP)<sup>2-4</sup> (somatosen  
<sup>5,6</sup>, (functional magnetic reso-  
 nance imaging:fMRI)<sup>7,8</sup>, (positron  
 emssion tomography:PET)<sup>9</sup>  
 SEP  
 10,11  
 12-14  
 가 2,3,15-19  
 SEP (median nerve)  
 nerve) (posterior tibial  
 가  
<sup>25</sup>  
 SEP  
 (median nerve somatosensory evoked poten-  
 tials :MNSEP)  
 Broadman area 3B  
 (postcentral gyrus)  
 (phase reversal) 10,15,20-22  
 (posterior tibial  
 nerve somatosensory evoked potentials:PTSEP)  
 Cz ' FPz 40msec  
 가  
 Pen-field Brod-rey (PMT, PMT Corporation, MN) 1  
 (falx) 2 x 8 14 1 x 8  
 (paracentral lobule) 1cm . 4  
 (cortical veins)  
 (superior sagittal sinus) 가 , 7  
 가 CT spoiled  
 PTSEP gradient echo magnetic resonance images(SPGR  
 MRI)  
 가 가 (superior frontal  
 gyrus), , (cingulate  
 gyrus)  
 MNSEP Analyze (Mayo Clinic, MN)  
 20msec (polarity), MNSEP (Fig. 2).

Allison et al<sup>23</sup>  
 4 가  
 , 40msec 가  
 volume conduction  
 (precuneus)  
 PTSEP  
 1995 2 199 10  
 130 가  
 15 7 ,  
 8 , 16 43  
 22 + 8.5 . 150cm 179cm .  
 9 , 4 ,  
 1 , 1 .  
 (encephalomalacia) 1 , 3  
 , 1  
 10  
 (Table 1).  
 (PMT, PMT Corporation, MN) 1  
 2 x 8 14 1 x 8  
 . 1cm . 4  
 , 7  
 CT spoiled  
 gradient echo magnetic resonance images(SPGR  
 MRI)  
 가 가 (superior frontal  
 gyrus), , (cingulate  
 gyrus)  
 Analyze (Mayo Clinic, MN)  
 (Fig. 2).

**Table 1.** Summary of subjects, and recorded subdural electrodes and cortical waves

No.	Sex/Age	Patient			SDE	Cortical waves			
		Height.	lesion	fusion		Lat (ms)	Amp (uV)	Rev.	phase.
1	F/17	165	no	not	8	48	6.7	Ant.	
2	M/25	177	ECM	not	16	40	24.0	-	
3	F/17	154	no	not	16	32	23.0	Ant.	poly
4	M/26	166	no	not	16	40	2.4	-	
5	M/16	179	no	not	16	41	2.6	Ant.	poly
6	M/12	161	ECM	not	8	36	4.0	-	
7	F/13	150	ECM	not	16	38	10.2	Post.	
8	F/10	144	no	not	8	41	114.2	Ant.	
9	F/24	165	ECM	yes	8	43	5.7	Post.	
10	M/24	171	no	yes	8	40	1.3	Ant.	
11	F/43	154	ODG	yes	8	39	25.2	Ant.	
12	M/27	176	no	yes	8	40	22.2	-	poly
13	F/27	164	no	yes	8	41	0.9	-	
14	F/20	164	no	yes	8	44	10.6	-	
15	M/30	166	no	yes	8	36	29.1	Post.	
AVG	22								
S.D.	8.5								

\*No.: number of patient, Lat:latency, Amp:amplitude,  
 ECM: encephalomalacia, ODG:oligodendroglioma, SDE: number of recorded subdural electrodes  
 Rev. phase reversal of cortical waves. Poly: polyphasic wave



**Figure 1.** The 3-dimensional fusion images of SPGR MRI and subdural electrodes. (A) The image of patient number 9. The 1x8 subdural strip electrodes were located from medial part of superior frontal gyrus (☒☓☓☓☓☓☓☓) through paracentral lobule (☒) to precuneus (☒☒☒). (B) The image of patient number 14. The ☒☓ and ☓☓ electrodes were put on precuneus, ☒ on marginal sulcus, ☒ on paracentral lobule ☒☒☒, and ☒ on medial part of superior frontal gyrus. The circle numbers in box are the ones on sub - bural strip electrode array.

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SEP -

SEP Viking VI 30Hz. 250Hz. (-3dB)

(Nicolet Instruments, Biomedical Division, 100msec (sensitivity) 1-

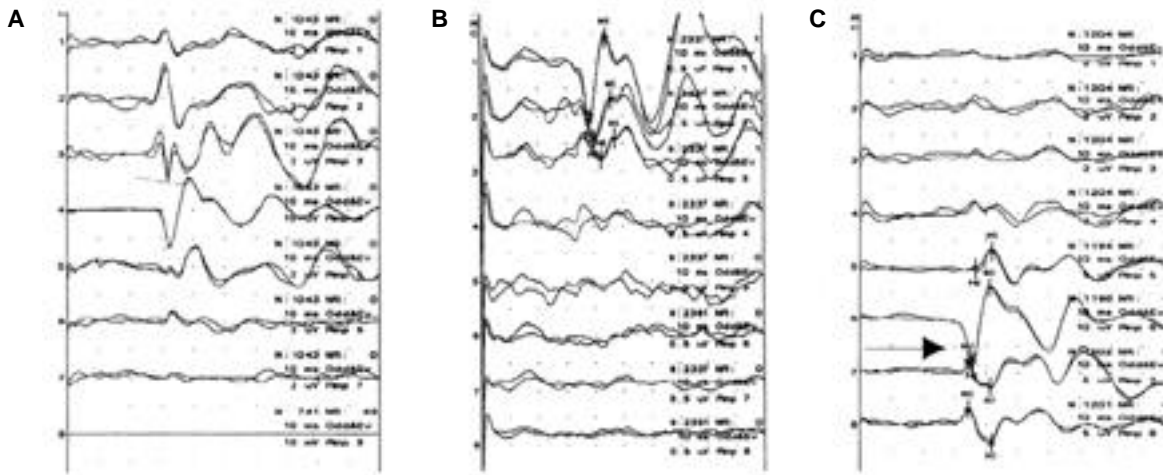
Madison, WI) 8 10uV/div. 1,000 2,000

0.2msec (constant cur-

가 ,

가 25%

4.7 40msec



**Figure 2.** Cortical waves of PTSEP on subdural electrodes in mesial hemisphere around paracentral lobule. (A) PTSEP of patients number 3. The wave with maximal amplitude was recorded on trace 4 around 32 msec, which had positive polarity. The polyphasic wave also was on trace 3 (anterior to the trace 3 in mesial hemisphere) and negative wave around 30 msec on trace 2. (B) PTSEP of patient number 5. The wave with maximal amplitude was on trace 1 around 38 msec. The phase was slowly reversed on trace 2, and 3 which were located just anterior to trace 1 in medial hemisphere). (C) PTSEP of patient number 6. The wave with maximal amplitude was recorded on trace 6 with positivity. And the electrode showing trace 6 were on paracentral lobule in 3-D fusion. . The phase was sharply reversed on trace 7,8 which were located just posterior trace 6 in medial hemisphere. Arrow indicates phase reversal between trace 6 and 7. The scale of amplitude were described on each trace. The time base of all traces was 10msec. Stimulus delivered at 0 msec. Positive is downward.

(peak to peak amplitude)

가 (polarity) (shape) (Table 1)

7 40msec

20uV 7 (Fig. 2A,C).

(Table 1)

9 (Fig. 2C)

3 (Fig. 2B).

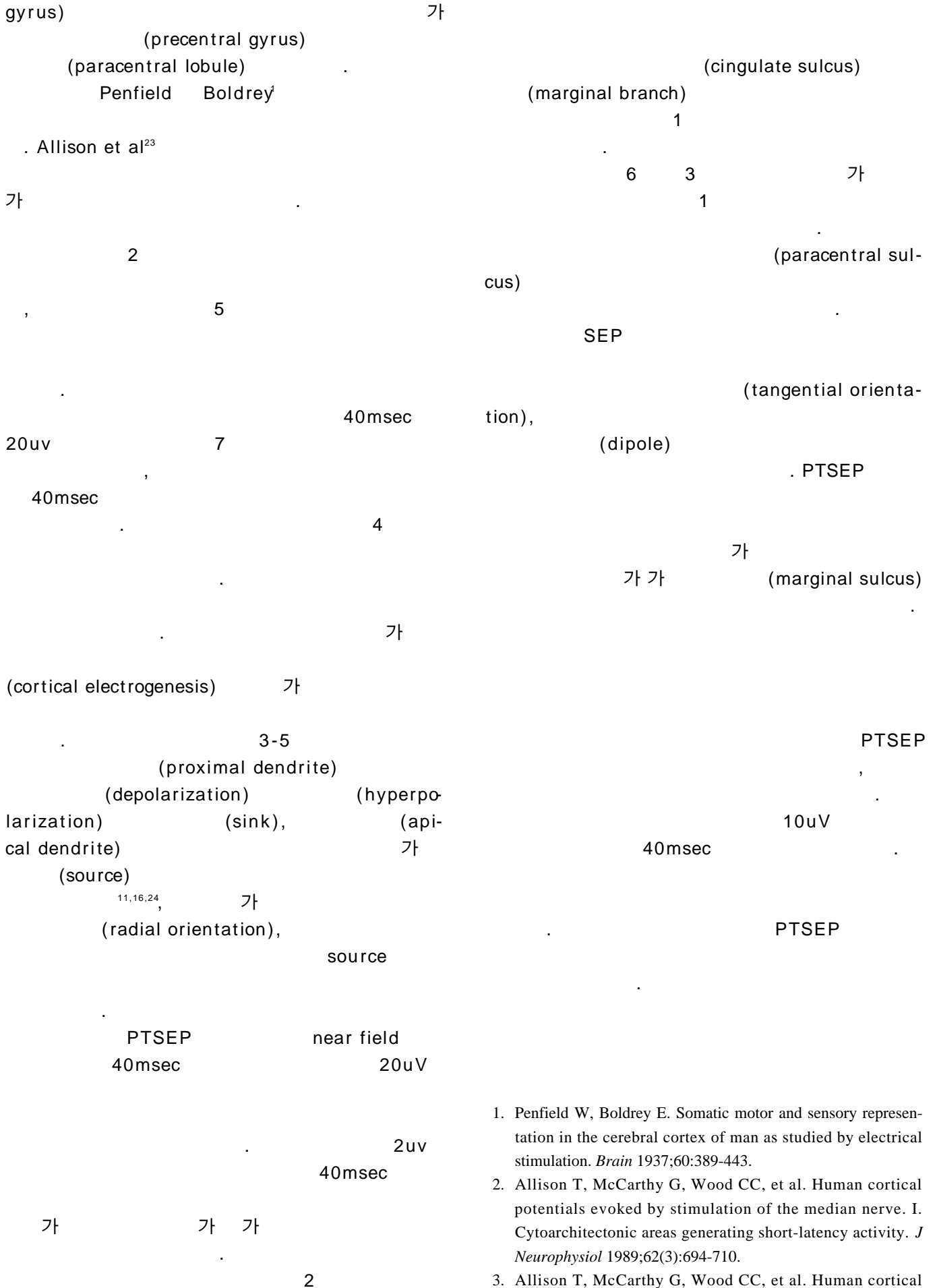
(superior frontal gyrus) (cingulate gyrus) (polyphasic) 가3 (Fig. 2A).

5 4 1

2 (Figure 2).

2 SEP N20 3b

2 x 8 5 SEP 가 (postcentral)



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