

## 소뇌 - 교각종양 수술시 수술 중 전기생리학적 신경감시에 따른 수술 후 기능적 결과

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= Abstract =

### Intraoperative Neurophysiologic Monitoring and Functional Outcome in Cerebellopontine Angle Tumor Surgery

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**Objectives :** Intraoperative neurophysiologic monitoring (INM) is a well known useful method to reduce intraoperative neurological complications during neurosurgical procedures. Furthermore, INM is required in most cerebello-pontine angle (CPA) surgery because cranial nerves or brain stem injuries can result in serious complications. Object of this study is to the correlation between the changes of intraoperative monitoring modalities during cerebellopontine angle tumor surgery and post-operative functional outcomes in auditory and facial functions.

**Material and Methods :** Fifty-seven patients who underwent intraoperative neurophysiologic monitoring during CPA tumor surgery were retrospectively reviewed. Their lesions were as follows ; vestibular schwannomas in 42, other cranial nerve schwannomas in seven, meningiomas in five and cysts in three cases. Pre- and postoperative audiologic examinations and facial nerve function tests were performed in all patients. Intraoperative neurophysiologic monitoring modalities includes brainstem auditory evoked potentials (BAEP) and facial electromyographies (EMG). We compared the events of INM during CPA tumor surgeries with the outcomes of auditory and facial nerve functions.

**Results :** The subjects who had abnormal changes during CPA tumor surgery were twenty cases with BAEP changes and facial EMG changes in twenty one cases. The changes of intraoperative neurophysiologic monitoring did not always result in poor functional outcomes. However, most predictable intraoperative monitoring changes were wave - complex losses in BAEP and continuous neurotonic activities in facial EMG.

**Conclusion :** These results indicate that intraoperative neurophysiologic monitoring in CPA tumor surgery usually provide predictive value for postoperative functional outcomes.

**KEY WORDS :** Intraoperative monitoring · Cerebellopontine angle tumor · Brain stem auditory evoked potentials · Electromyography · Hearing · Facial nerve.

서 론

17). 가

22).  
19  
, 1979 Delgado<sup>3)</sup>  
(auditory brainstem response) 1971 Jewett  
Williston<sup>8)</sup> 1978 Levine<sup>11)</sup>  
가  
가  
가

방 법

1. 대 상  
1995 1 1998 7  
(INM) 57 (Fig. 1).  
20, 37 가 ,  
48 (19 68 ) .  
(vestibular schwannoma) 42 , (trig-  
eminal schwannoma) 3 , (jugular for-  
amen schwannoma) 4 , (meningioma) 5 ,  
(cyst) 3 . 29 , 28 .  
(retro-  
mastoid suboccipital craniectomy) 38 ,  
(paramedian suboccipital craniectomy) 2 ,  
(translabirinthine approach) 10 ,  
(subtemporal approach) 3 , 4 [  
(transpetrosal approach) 2 , (petroo-  
cipital approach) 1 , - (orbitozygo-  
matic approach) 1 ]  
44 , 11 , 2 .

## 2. 수술 전 검사

House - Brackmann Grade  
7). ,  
(facial muscle electromyogram ; fEMG),  
(brain stem auditory evoked potential ;  
BAEP) (baseline stu-  
dy) modified Gardner - Ro-  
bertson system (Table 1).

## 3. 수술 중 준비

4 가  
2 가  
isoflurane(forane) 가  
minimal alveolar concentration(MAC) 1.0  
biturates .  
0.5  
bar -  
fentanyl

## 4. 수술중 신경계감시

8 Viking<sup>®</sup> (Nicolet, Inc.)  
4 , 2 , 2  
(somatosensory evoked potential ; SEP)  
(orbicularis oculi), (or-  
bicularis oris), (masseter), (mentalis)  
(free run-  
ning EMG) 가 (tonic activity)

**Table 1.** Functional classification of modified Gardner and Robertson system

Class	Description	PTA(dB)	SA(%)
Good-excellent		0 - 30	70 - 100
Serviceable		31 - 50	50 - 59
Nonserviceable		51 - 90	5 - 49
Poor		91-max	1 - 4
None		Not testable	0

\*PTA ; pure tone audiogram, SA ; speech discrimination score  
\*If PTA and SA do not qualify in same class, use the lower class

tubal insert 5 ( complex)  
 phone A1, A2 (0.2msec) (Ta-  
 Cz far field potential ble 3).  
 (median nerve)  
 (posterior tibial nerve)  
 5 (C5) 2cm (Cz') FPz  
 (Table 2).

5. 수술후 검사

가

3 (wave ) 4

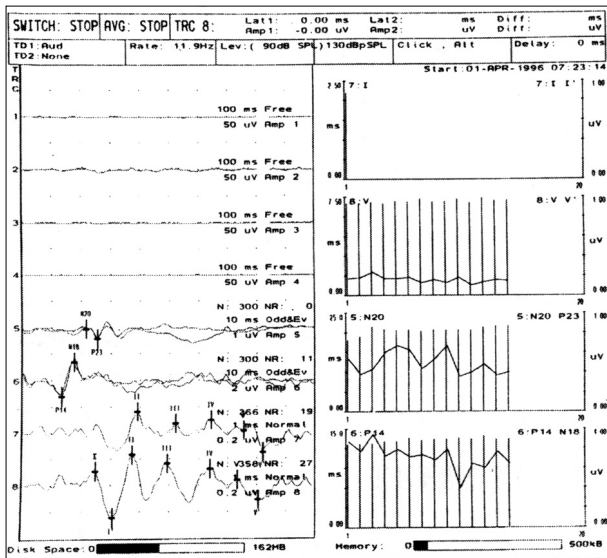


Fig. 1. Normal electrophysiologic neuromonitoring during cerebellopontine angle tumor surgery. Normal free running EMG on ipsilateral orbicularis oculi, oris, masseter and mentalis which were located on channel 1, 2, 3, 4, respectively. SEP of right median nerve stimulation on channel 5,6 and BAEP of right ear stimulation on channel 7, 8. The serial data of BAEP and SEP were plotted on right panel. Vertical bar indicates latency (msec) and continuous lines represent amplitude( $\mu$ V) of each wave.

11 (1 38 )

결 과

57 class 17 , class 7  
 , class 7 , class 9 , class 17 ,  
 class 16 , class 3 , class 3 , class  
 12 , class 20 (Fig. 2 - A). 2

15 Class ,  
 2 가  
 12  
 class , 26 가  
 class 31  
 20  
 12 가 8

pattern

1 (Wave loss)

Table 2. Intraoperative electrophysiologic neuromonitoring parameters during cerebellopontine angle surgery

	EMG	BAEP	SEP
Stimulation parameters	Device	Flush tip electrode	Tubal insertion phone
	Site	Facial muscle	Ear
	Type	Electrical	Broad band click
	Duration	0.2msec	100usec pulse
	Intensity	Less than 4V	120dBpeSPL
Recording parameters	+ Electrode	Muscle	Ear lobe(A1, A2)
	- Electrode	Subdermis	Cz
	Time base	100ms	1ms
	Sensitivity	50 $\mu$ V	0.1 - 0.05 $\mu$ V

\*EMG : Electromyography, BAEP : Brainstem auditory evoked potentials, SEP : Somatosensory evoked potentials, Cz' : 2cm posterior to Cz electrode, C5s : Spinous process of 5th cervical vertebra

6 2  
(interpeak latency)  
1 wave  
complex (Table 4).  
가

6 15 (Fig. 4)  
10 1 tonic activity  
8 trigger response가 6  
가 4  
가 36 1 가  
trigger response

Fig. 3  
class  
3 5  
가

83%(5/6),  
68.6%(35/51),  
23.8%(5/21)  
(Table 5).

가 가 1  
BAEP  
(sensitivity) 91.7%(11/12), (spe-  
cificity) 80%(36/45), (positive predi-  
cative value) 55%(11/20) (Table 4).

고 찰

House - Brackman grade  
38, 17, 2, House -  
Brackman grade 26, 11, 13, 3, 2  
, 2 (Fig. 2 - B).  
가 15

가 9)24). Colletti Fiorino 2)  
가

(transient) 6 (contin-  
uous) 26  
(45.6%), 25 (43.9%), 6 (10.  
5%) (Table 5).

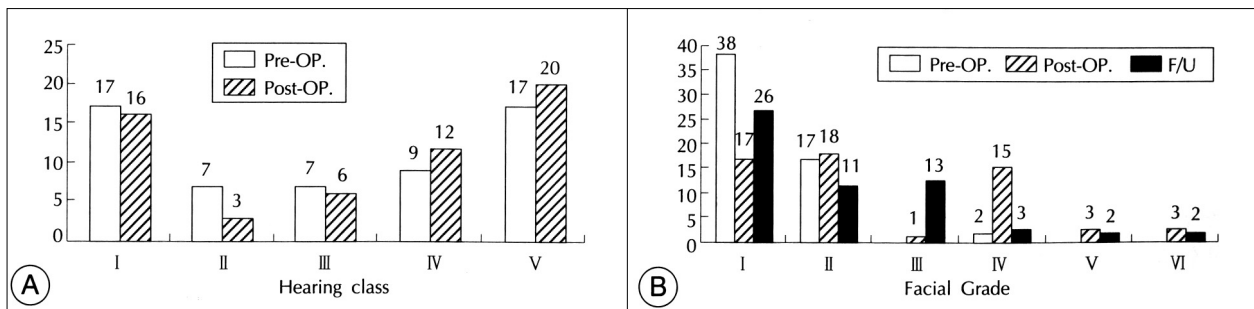
가  
26).  
가 1)10)23).

**Table 3.** Criteria for abnormal responses of intraoperative electro-physiologic neuromonitoring parameters

Intraoperative events	
BAEP*	Wave , , - complex loss Interpeak latency >0.2msec
EMG	Free running EMG ; neurotonic discharge Negative response in triggered EMG

\*Baseline data were obtained after intubation

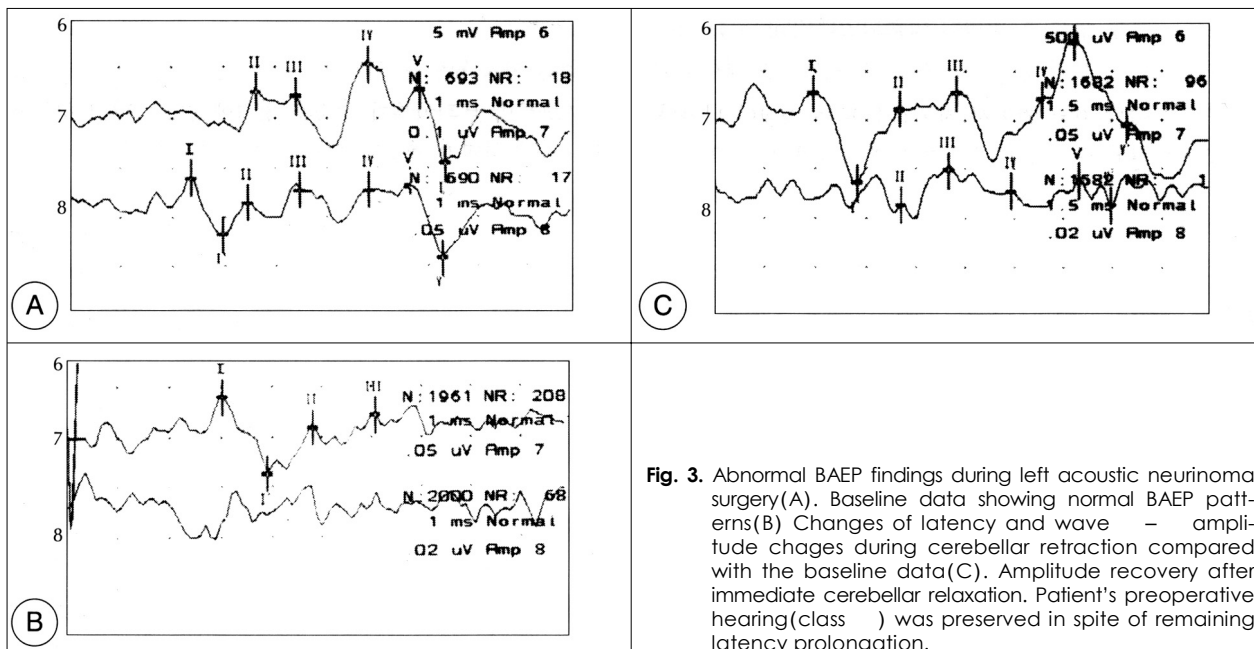
Kveton 9)  
가 (57% vs.  
44%), Harner 6) 가  
가 (67% vs.  
33%).



**Fig. 2.** Pre- and post-operative functional classification of auditory(A) and facial nerve function(B).

**Table 4.** Hearing outcomes according to intraoperative BAEP patterns

Intraoperative BAEP changes	Hearing outcomes			
	Improved	No change	Transient impairment	Permanent impairment
Transient wave loss or amplitude change (N = 6)	-	4	-	2
Transient Interpeakal latency prolongation (N = 6)	-	5	-	1
Wave I and Wave V - complex loss (N = 8)	-	-	-	8
Normal or not changed (N = 37)	2	32	2	1
Total (N = 57)	2	41	2	12



**Fig. 3.** Abnormal BAEP findings during left acoustic neurinoma surgery (A). Baseline data showing normal BAEP patterns (B). Changes of latency and wave I amplitude changes during cerebellar retraction compared with the baseline data (C). Amplitude recovery after immediate cerebellar relaxation. Patient's preoperative hearing (class II) was preserved in spite of remaining latency prolongation.

Niparko<sup>16)</sup> 2cm

29

75

1

Fisher<sup>5)</sup> 4cm

가 86%

Samii<sup>21)</sup> 1000

93%

Erikson<sup>4)</sup>

1

가

가

가

가 1

가

50%

가 1ms

가가

5)

5

가

가

internal auditory artery  
 가  
 8  
 Matties 13)  
 B5 5  
 Type B1  
 가가  
 가 65%

가  
 Nadol 15)  
 가  
 Levine  
 가  
 11)  
 Wadanabe  
 68 66  
 2  
 12 2  
 10  
 13 3  
 24)  
 가

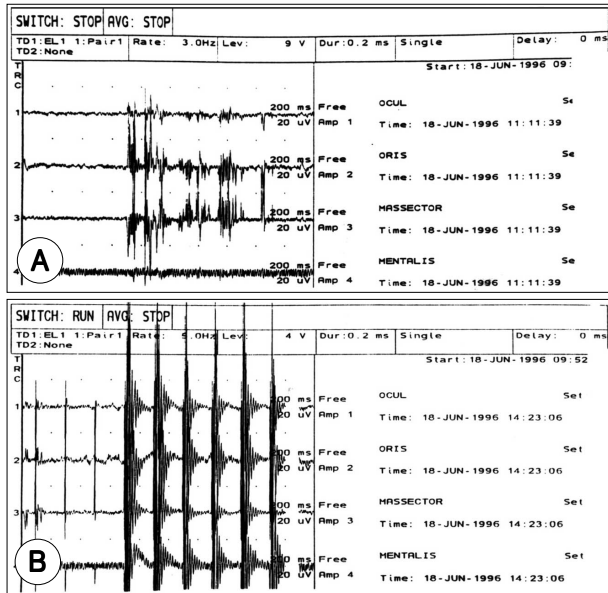


Fig. 4. EMG activities during Lt. acoustic neurinoma surgery (A). Neurotonic activities were seen mainly on orbicularis oris and masseter for about 1 second, which was occurred by touching facial nerve (B). Facial nerve triggered EMG revealed excellent EMG activities when trains of 5Hz, 4 volt, 0.2msec electrical stimuli were given. Patient showed postoperative transient facial paralysis (grade 4). But, functional recovery was obtained 6 months after surgery.

가  
 monitoring  
 15) 20). Raudzen 19)  
 가  
 7  
 가  
 Roberson 20)  
 6  
 3 22  
 4 가  
 가  
 가 1 가  
 가 가  
 (cochlear)  
 15)  
 가  
 가  
 가

Table 5. Facial functional outcomes according to intraoperative EMG patterns

Intraoperative EMG changes	Facial outcomes		
	No change	Transient paresis	Permanent paresis
Transient neurotonic activity (N = 15)	4	10	1
Continuous neurotonic activity or Negative response in triggered EMG (N = 6)	-	2	4
No changes (N = 36)	32	3	1
Total (N = 57)	36	15	6

Fig. 3

가

가

가

(averaging) 2

(far field technique)

electrocochleography 14)

electrocochleography 2)

결 론

가

trigger

• : 1999 9 29

• : 2000 2 29

• : 135 - 710 50

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tonic activity

가

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