AANS/CNS Joint Cerebrovascular Annual Meeting

February 20-21, 2017
Houston, TX

Intraoperative Use of Motor/sensory Evoked Potential Monitoring, is it Really Reliable During Clipping of Intracranial Aneurysm? Evaluation of False Positive and False Negative in Intraoperative Motor/sensory Evoked Potential Monitoring.

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Introduction: Intraoperative neurophysiology monitoring such as SEP and MEP became popular to prevent ischemic complication during aneurysm surgery. However, surgeons often encounter cases of suspicious false positive and false negative of MEP/SEP monitoring from experience, but the incidence and risk factors for these events are not well established.

Methods: From January 2012 to April 2016, 1514 patients underwent UIA surgery with intraoperative EP monitoring. Patients with previous brain lesion or neurologic deficits were excluded to avoid interfere of EP monitoring results. Correlation between immediate post-operative motor weakness and EP monitoring results were reviewed retrospectively. Sensitivity, specificity, and the positive and negative predictive values, incidence of false positive and false negative of intraoperative MEP monitoring were calculated.

Results: EP amplitude decrease of 50% or more compare to the baseline amplitude was defined as significant EP change. There were 10 cases of immediate post-operative motor weakness, however there was no significant EP change in 8 cases among them. Therefore, MEP results during UIA surgery resulted in a sensitivity of 0.10, a specificity of 0.94, a positive predictive value of 0.01, and a negative predictive value of 0.99. The incidence of false positive was 1.25%, whereas false negative was 0.53%.

Table 1. Patient demographic data and Characteristic of the aneurysms

Variables	UIA Clipping with EP monitoring (n=1514)
Sex (Female)	1061 (70.07%)
Age, year	57.14 ± 9.30
Hypertension	150 (9.91%)
DM	747 (49.34%)
History of Coronary artery disease	29 (1.92%)
Aneurysm location (%, size (mm ± SD))	1845 (4.80 ± 3.38)
Anterior circulation	
ICA	
Cavernous	2 (0.11 %, 23.00 ± 8.28)
Paraclinoid	145 (7.86 %, 5.91 ± 4.21)
P-com	209 (11.33 %, 4.87 ± 3.00)
AChA	143 (7.75 %, 3.27 ± 1.65)
ICA	85 (4.61 %, 6.91 ± 7.51)
A-com	324 (17.56 %, 4.89 ± 2.60)
ACA	98 (5.31 %, 4.13 ± 4.57)
MCA	792 (42.93 %, 4.60 ±2.58)
Posterior circulation	
Basilar top	19 (1.03 %, 4.71 ± 2.92)
PCA	2 (0.11 %, 2.50 ± 0.28)
SCA	13 (0.70 %, 4.08 ± 2.72)
AICA & PICA	13 (0.70 %, 5.62 ± 3.50)

Table 2. False positive cases

Case No.	Age	Sex	An. location	An. Size (mm)	Muscle Relaxant	MEP change pMEPC	MEP change aMEPC	SEP Change pSEPC	SEP Change aSEPC	Post-OP. Motor Weakness	GOS	mRS
1	F	52	P-com	4	Continuous	+	+	-	-	-	5	0
2	F	46	A-com	6.3	Continuous	+	+	-	-	-	5	0
3	F	69	A-com	1.7	Continuous	+	+	-	-	-	5	0
4	F	56	MCA	3.6	Single bolus	+	+	-	-	-	5	0
5	F	38	A-com	5	Continuous	+	+	-	-	-	5	0
6	M	65	MCA	2.06	Continuous	+	+	-	-	-	5	0
7	M	56	A-com	5.8	Single bolus	+	+	-	-	-	5	0
8	F	55	MCA	3.2	Continuous	+	+	+	+	-	5	0
9	F	60	MCA	5.3	Continuous	+	+	-	-	-	5	0
10	M	54	MCA	3.7	Continuous	+	+	-	-	-	5	0
11	M	53	MCA	2.3	Single bolus	+	+	-	-	-	5	0
12	M	47	MCA	3	Continuous	+	+	-	-	-	5	0
13	M	43	MCA	2.4	Continuous	+	+	-	-	-	5	0
14	F	56	ACA	4.58	Continuous	+	+	-	-	-	5	0
15	M	61	A-com	2	Single bolus	+	+	-	-	-	5	0

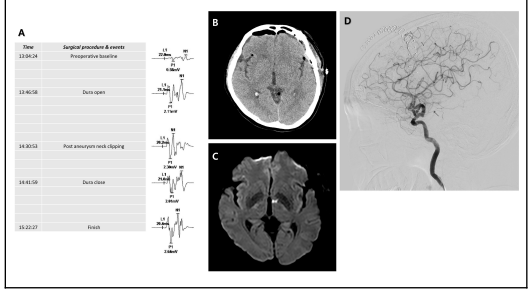
Table 3. False negative cases

Case No.	Age	Sex	An. location	An. Size (mm)	Muscle Relaxant	MEP change pMEPC	MEP change aMEPC	SEP Change pSEPC	SEP Change aSEPC	Perioperative complications	GOS	mRS
1	46	F	Paraclinoid	6.6	Continuous	–	–	–	–	Post-Op. ICH, SAH	5	0
2	75	F	MCA	13.2	Continuous	–	–	–	–	Acute infarction in the left MCA territory.	5	0
3	56	F	MCA	3	Continuous	–	–	–	–	Acute infarction in the left lateral lenticulostriate artery territory.	5	0
			AchA	2								
			ICA	3								
4	72	F	MCA	7.1	Continuous	–	–	–	–	Newly appeared several DW high signal cortical lesions in the left paracentral lobule.	5	0
5	69	F	P-com	5	Continuous	–	–	–	–	Right anterior choroidal artery territorial infarction	5	0
6	49	M	MCA	4.6	Continuous	–	–	–	–	Recent infarction with hemorrhage on Rt. Basal ganglia	4	1
7	71	F	AchA	4	Continuous	–	–	–	–	Focal acute infarction, left anteromedial thalamus.	5	0
8	60	F	A-com	10	Continuous	–	–	–	–	Ischemic change in Rt. ACA territory -> confusion	4	3
			MCA	2.9								
			AchA	2.9								

Table 4. Results of sensitivity, specificity, PPV and NPV

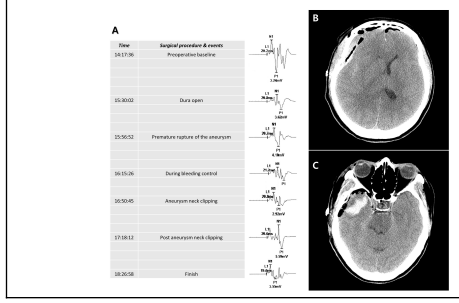
	SEP change (95% CI) pSEPC	SEP change (95% CI) aSEPC	MEP change (95% CI) pMEPC	MEP change (95% CI) aMEPC	Overall EP change
Sensitivity	0.000 (0.000 - 0.287)	0.000 (0.000 - 0.334)	0.000 (0.000 - 0.315)	0.000 (0.000 - 0.332)	0.100 (0.005 - 0.454)
Specificity	0.995 (0.995 - 0.997)	0.973 (0.973 - 0.975)	0.990 (0.990 - 0.992)	0.976 (0.976 - 0.978)	0.941 (0.940 - 0.943)
Positive Predictive Value	0.000 (0.000 - 0.359)	0.000 (0.000 – 0.081)	0.000 (0.000 - 0.210)	0.000 (0.000 – 0.092)	0.011 (0.001 - 0.050)
Negative Predictive Value	0.993 (0.993 - 0.995)	0.993 (0.993 - 0.995)	0.993 (0.993 - 0.995)	0.993 (0.993 - 0.995)	0.994 (0.993 - 0.996)

Figure 1.



71-year-old female had an aneurysm at the origin of the anterior choroidal artery of the left ICA. (A) There was no event of significant motor evoked potential change during the operation, but the patient showed motor deficit by grade 4 in right upper and lower extremities. (B) Immediate postoperative brain CT revealed no abnormal postoperative findings. (C) MR diffusion image was taken on 3rd day postoperatively and it revealed focal acute infarction at left anteromedial thalamus. However, the anterior choroidal artery was patent from postoperative DSA which was immediately performed after the MR diffusion image. (D)

Figure 2.



A 46-year-old female had paraclinoid aneurysm at right proximal ICA. And brain injury occurred during removal of anterior clinoid process. (A) There was no event of significant EP change during the operation. However, the patient showed motor deficit by grade 4 in left upper and lower extremities with ipsilateral ptosis. (B, C) The postoperative brain CT scan revealed ICH in temporal lobe and SAH with shifting of the midline toward the contralateral side due to mass effect.

Conclusions: The intraoperative EP monitoring has high specificity and negative predictive value. However, there are existence of false positive and false negative. Therefore, intraoperative EP monitoring combined with other intraoperative monitoring method will provide maximum safety during aneurysm surgery.