

Systematic review of motor evoked potentials monitoring with transcranial and direct motor cortex stimulation in patients undergoing intracranial aneurysm surgery.

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Background

In intracranial aneurysm surgery, postoperative motor deficits are one of the serious complications. In order to prevent postoperative motor deficits, monitoring of motor evoked potential (MEP) has been widely applied. Two types of stimulating technique for MEP including transcranial stimulation (Tc-MEP) and direct motor cortex stimulation (D-MEP) can be applied. It is unknown which technique is preferable to the other. In this study, we conducted a systematic review of literatures regarding intraoperative MEP monitoring during intracranial aneurysm surgery and evaluated the reliability of MEP monitoring using Tc-MEP and/or D-MEP.

Methods

We searched studies that reported on MEP monitoring in patients scheduled for intracranial aneurysm clipping and that included clinical outcome such as postoperative motor function from MEDLINE, EMBASE, Cochrane Central, CINAHL and the Japanese Central Review of Medicine. Two researchers based on a data checklist carried out the data extraction from studies independently. We divided stimulation technique to Tc-MEP or D-MEP and evaluated the relationship between the results of MEP monitoring and postoperative motor function.

Figure 1. Flowchart of search result.

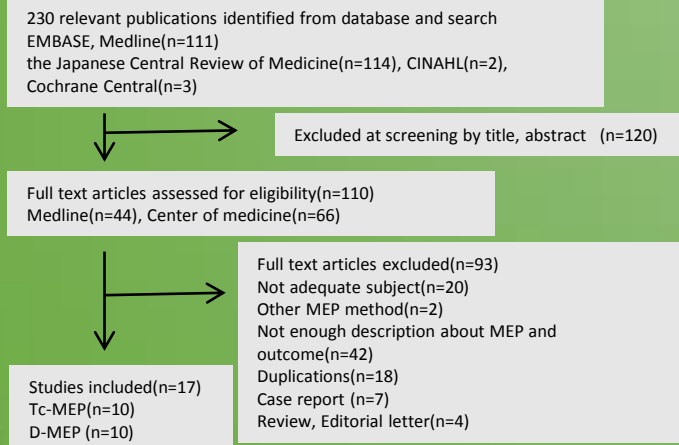


Table1. Included studies in Tc-MEP

Name(year)	Total number	Location of aneurism ICA/MCA/ACA/others	Anesthesia	Stimulation intensity	Monitoring number (success rate)	Paralysis	TP	TN	FN	FP
Morimoto(2007)	24	2/15/1/7	TIVA	200-600V	22(91%)	1	1	21	0	0
Irie(2010)	111	77/33/0/1	TIVA	500V	110(99%)	6	1	104	0	5
Je(2010)	98	19/62/34/0	TIVA	300-400V	98(100%)	0	0	98	0	0
Motoyama(2010)	48	19/25/4/0	TIVA	20V above threshold	48(100%)	1	0	47	0	1
Lin(2011)	45	9/20/1/21	TIVA	unknown	45(100%)	1	1	44	0	0
Ukita(2011)	61	59/11/3/4	TIVA	120V	61(100%)	3	0	58	0	3
Abe(2012)	99	Unknown	unknown	unknown	96(97%)	9	5	82	5	4
Tokutsu(2013)	31	Unknown	unknown	unknown	31(100%)	3	1	28	0	2
Suzuki(2013)	52	28/24/0/0	TIVA	20V above threshold	52(100%)	5	0	47	0	5
Yamashita(2013)	64	34/25/0/5	TIVA	unknown	64(100%)	3	0	61	0	3

Table2. Included studies in D-MEP

Name(year)	Total number	Location of aneurism ICA/MCA/ACA/other	Anesthesia	Stimulation intensity	Monitoring number (success rate)	Paralysis	TP	TN	FN	FP
Suzuki(2003)	108	108/0/0/0	TIVA	2mA above threshold	108(100%)	5	1	103	0	4
Suzuki(2006)	268	204/64/0/0	TIVA	2mA above threshold	265(99%)	11	2	254	0	9
Watanabe(2008)	14	5/9/0/0	unknown	unknown	14(100%)	2	2	11	1	0
Hisamon(2009)	10	3/6/1/0	unknown	10-20mA	10(100%)	0	0	10	0	0
Takebayashi(2009)	97	86/10/1/0	unknown	unknown	87(90%)	5	0	82	0	5
Motoyama(2010)	46	Unknown	TIVA	2mA above threshold	44(96%)	1	1	43	0	0
Watabe(2012)	38	38/0/0/0	unknown	2mA above threshold	38(100%)	1	1	37	0	0
Abe(2012)	99	unknown	unknown	2-5mA above threshold	87(89%)	4	4	73	10	0
Maruta(2012)	18	3/1/4/10	TIVA	2mA above threshold	18(100%)	2	0	16	0	2
Suzuki(2013)	52	28/24/0/0	TIVA	2mA above threshold	51(98%)	4	0	47	0	4

TP: true positive, TN: true negative, FN: false negative, FP: false positive, TIVA: total intravenous anesthesia

Figure 2. pooled sensitivity and pooled specificity of Tc-MEP

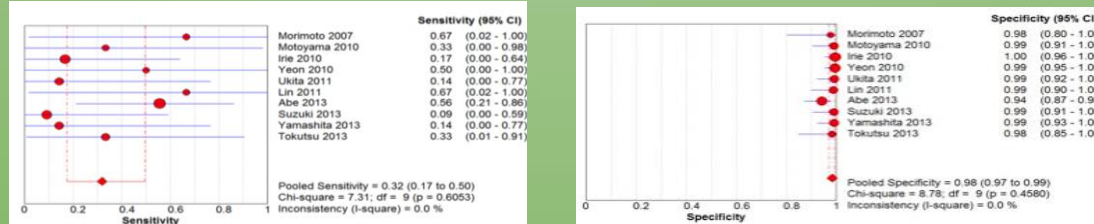
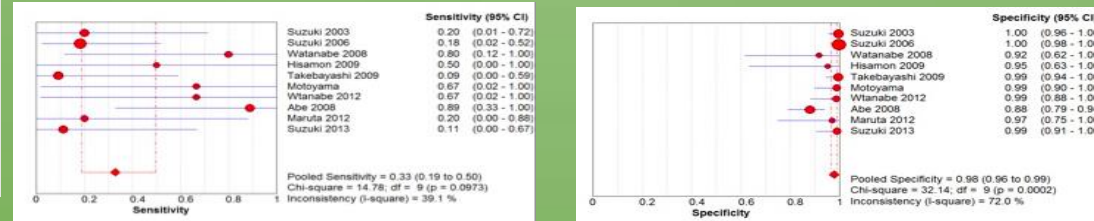


Figure 3. pooled sensitivity and pooled specificity of D-MEP



Results

Two hundred and thirty publications were identified, 17 of which were satisfied with the inclusion criteria (Fig.1). There are 10 studies for Tc-MEP (Table1) and for D-MEP(Table2) each other. There were low heterogeneity among publications. Tc-MEP monitoring was performed in 633 patients and was feasible 627 patients (success rate 99.1%). D-MEP monitoring was performed in 753 patients and was feasible 723 patients (success rate 96.0%). Figure 2 showed sensitivity was 32% and specificity was 98% in Tc-MEP. Figure 3 showed sensitivity was 33% and specificity was 99% in D-MEP.

Discussions

Both stimulation methods had high success rates, however, there also were the occurrences of postoperative motor dysfunctions without intraoperative MEP changes, that is, false negative results. In the future, we must make efforts to reduce the false negative results during in intracranial aneurysm surgery.

Conclusion

Reliability of intraoperative MEP monitoring with Tc-MEP and D-MEP was comparable in patients undergoing intracranial aneurysm surgery. However, further improvement would be required to reduce the false negative rates.

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