Utilization of Multimodality Monitoring During Cerebrovascular Procedures: Relative Sensitivity, Specificity, and Odds Ratios for Motor Deficits

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Introduction

When there is a change in IONM signals during intracranial vascular surgery, the surgeon (with consult from the IONM and anesthesiology teams) should weigh all variables in deciding the best course of action. This includes understanding the diagnostic accuracy of IONM. The first goal of this study was to compare diagnostic accuracy of multimodality monitoring with SSEPs vs SSEPs + MEPs. A second goal was to quantify sensitivity and specificity of SSEP + MEP monitoring during cerebrovascular surgery when a positive test is defined as a persisting change in one modality vs persisting changes in both. A third goal was to compare the odds of a postoperative deficit when there is a persisting change in one modality vs both.

Research Questions

1. Multimodality monitoring putatively increases sensitivity, but what is the associated reduction in specificity?
2. When both SSEPs and MEPs are used, how sensitive and specific is the IONM when a positive test is considered if EITHER modality is positive, versus if BOTH modalities are positive?
3. What is the increase in the odds of post-op deficit when EITHER or BOTH modalities are Unresolved or Partially Resolved at Closure?
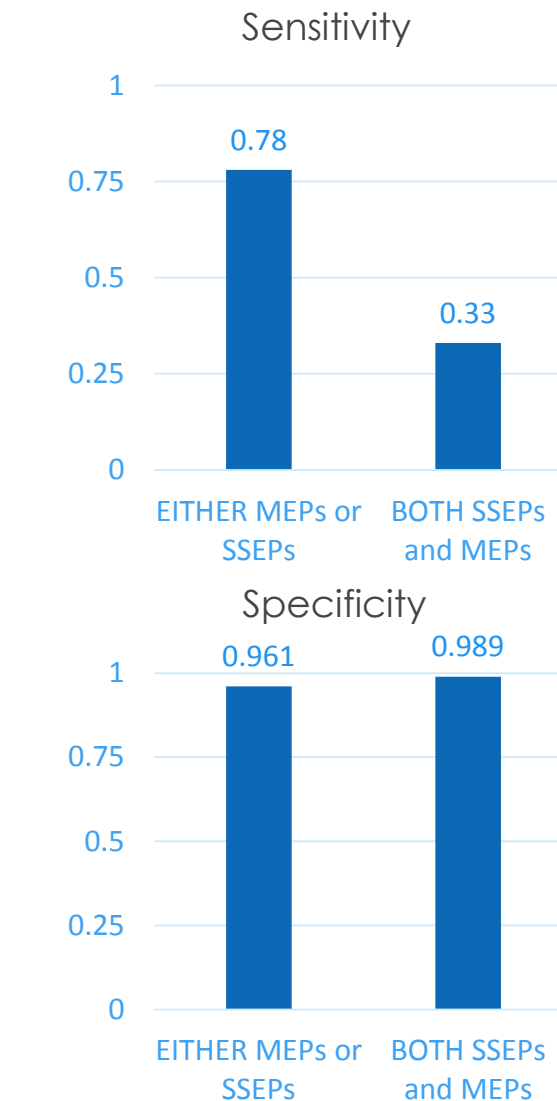
Methods

- We retrospectively reviewed a multi-institutional database of 1,786 cerebrovascular procedures conducted with intraoperative neuromonitoring between May-2013 and March-2017
- IONM Plan included SSEPs, but not MEPs, n=1049
- IONM Plan included both SSEPs and MEPs, n =737
- Motor function was assessed in the immediate postoperative period and compared to preoperative status: A) No change in motor function, B) Loss or Decrease in Motor Function was documented.
- SSEPs and MEPs were documented as having: 1) No alert, 2) Alert and Full Resolution, 3) Alert and Partial Resolution, or 4) Alert and No Resolution
- SSEP and MEP changes with No Resolution or only Partial Resolution (i.e. persisting changes) were considered a Positive Test.
- Cases were categorized as follows:
    - Cases with no SSEP/MEP alerts or all changes were resolved by the end of surgery (Neg/Neg)
    - Cases with SSEP and/or MEP alerts, where changes in one modality persisted through the end of surgery (Neg/Pos)
    - Cases with SSEP and MEP alerts, where changes in both modalities persisted through the end of surgery (Pos/Pos)
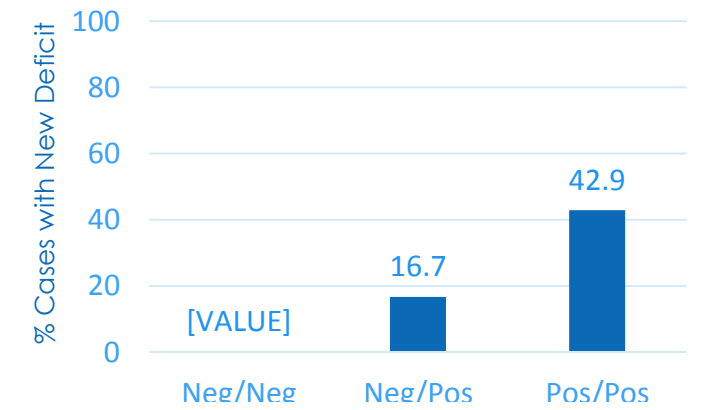
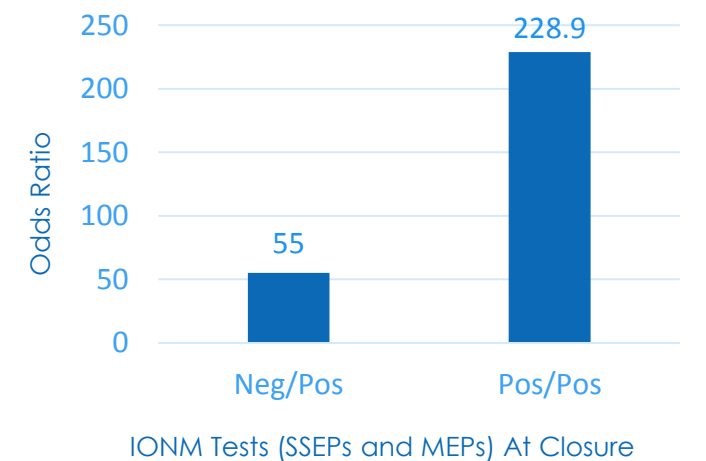### Unimodal vs Multimodal Monitoring: Increase in Sensitivity but Slight Decrease in Specificity

Sensitivity — Just SSEPs: 0.27; SSEPs & MEPs: 0.78

Specificity — Just SSEPs: 0.98; SSEPs & MEPs: 0.96
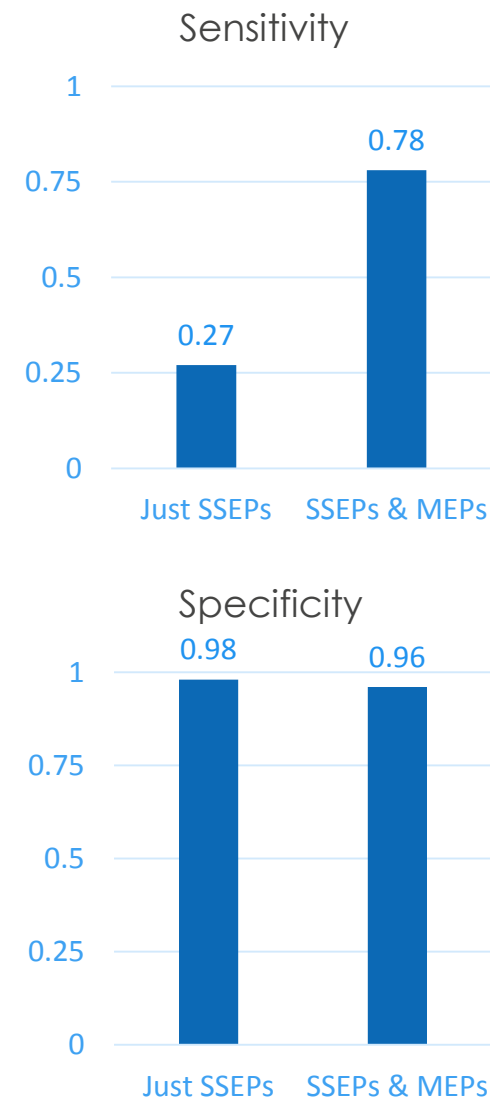
Multimodal Interpretations: EITHER as Positive IONM Test vs. Both as Positive IONM Test

Sensitivity — EITHER MEPs or SSEPs: 0.78; BOTH SSEPs and MEPs: 0.33

Specificity — EITHER MEPs or SSEPs: 0.961; BOTH SSEPs and MEPs: 0.989

If BOTH Modalities Positive at Closure, Incidence of New Deficit Highest

% Cases with New Deficit — Neg/Neg: [VALUE]; Neg/Pos: 16.7; Pos/Pos: 42.9

Odds of Motor Deficit Dramatically Increase if One or Both Modalities are Down at Closure

Odds Ratio — Neg/Pos: 55; Pos/Pos: 228.9

IONM Tests (SSEPs and MEPs) At Closure

Results

1. Multimodality Monitoring with SSEPs and MEPs increases Sensitivity to neurologic injury during cerebrovascular surgery, but there is a slight decrease in Specificity
2. If there are no SSEP/MEP changes, or changes are fully resolved, the incidence of motor post-op deficit is less than 0.5%
3. If changes in one modality persist through closure, the incidence of new motor deficits is 12.5%. If changes in both modalities persist, the incidence of new motor deficits is 42.9%
4. If there is a persisting uni-modality change in EITHER SSEPs or MEPs at closure, the odds of a post-op motor deficit is 55 times higher than if there was no change or all changes were fully resolved.
5. If there is persisting change in BOTH modalities, the odds of a post-op deficit is 229 times higher than if there was no change or all changes were fully resolved.

Conclusions

IONM sensitivity during cerebrovascular surgery increases when SSEP monitoring is supplemented by MEPs.

Persisting adverse changes in both SSEPs and MEPs are associated with a higher incidence of postoperative neurologic sequelae than persisting changes in either modality alone.