



Intraoperative Neuromonitoring: Lessons Learned from 32 Case Events in 2095 Spine Cases

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Introduction

Intraoperative neuromonitoring is becoming the standard of care for many more spinal surgeries, especially with deformity correction and instrumentation. We reviewed our institution's neuromonitored spine cases over the past four years to see the immediate intraoperative and postoperative clinical findings when an intraoperative neuromonitoring event was noted. The main question addressed in this review is how has multimodality intraoperative neuromonitoring affected our ability to avoid potential neurologic injury during spine surgery.

Methods

We retrospectively reviewed 2095 neuromonitored spine cases at one institution performed over a period of 4 years. Data from the single neuromonitoring provider (Impulse Monitoring, Inc.) at our institution was collected and any cases with possible intraoperative events were isolated. The intraoperative and immediate postoperative clinical documentation of these 32 cases were reviewed.

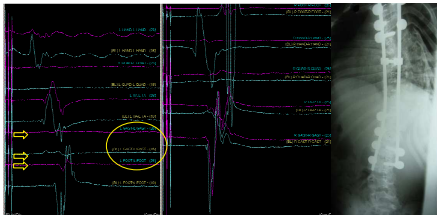


Figure 1: Example of neuromonitoring changes during a deformity correction case. After insertion of the convex rod: decreased motor evoked potentials in the left foot of 80% amplitude, and the tibialis anterior has dropped 30%, right side is normal for gastrocs and tibialis anterior responses. Correction was decreased and MEP returned to baseline.

Results

There were 17 cases where changes noted on EMG, SSEP, and/or MEPs affected the course of the surgery, and prevented possible postoperative neurological deficits. Of these 17, five were related to hypotension, seven due to deformity correction, one screw had a low triggered EMG threshold and it was repositioned, and four cases had changes related to patient positioning and external pressure (e.g. brachial plexus stretch). None of these 17 cases had postoperative motor or sensory deficits.

Four cases consisted of intradural cord biopsies or tumor resections which had various positive neuromonitoring findings that essentially serve as controls. These cases confirm that the expected changes were seen on neuromonitoring. Four cases had false-positive neuromonitoring findings due to one technical issue requiring needle repositioning, one low threshold with triggered EMG without a pedicle breach, one case had decreased MEP responses with stable SSEPs, and one case had decreased SSEPs after positioning the patient prone. None of these four cases had any postoperative deficits. Four cases showed improved SSEPs after decompression; three cervical corpectomies, and one thoracic discectomy.

Three cases of lumbar instrumentation with spontaneous EMGs each had a medial screw breach without intraoperative findings. They all had a postoperative motor deficit (foot drop). None of these three cases had triggered EMGs performed with the index procedure.

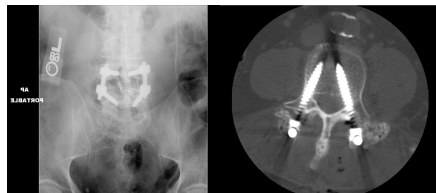


Figure 2: Left L4 pedicle screw medial breach. Triggered EMGs were not performed during the index procedure. Post operative foot drop required a second surgery to reposition the screw, providing relief.

Data Table

| Case | Procedure | Intraoperative Findings | Intraoperative Intervention | Postoperative Findings |
|------|--|--|---|--|
| 1 | Posterior cervical decompression | Loss of MEP | Increased blood pressure | No deficit |
| 2 | Cervicothoracic spinal cord lesion biopsy | Loss of MEP in lower extremities | None | Bilateral lower extremity paresis |
| 3 | Thoracic spinal cord tumor debulking | Loss of MEP in right lower extremity | None | Right lower extremity paralysis |
| 4 | Posterior lumbosacral decompression/fusion TLIF | Low S1 screw threshold | Screw checked, repositioned | No deficit |
| 5 | Posterior lumbar decompression/fusion | None | None | Foot drop, medial L4 screw breach |
| 6 | Cervicomedullary spinal cord tumor resection | Loss of left upper extremity SSEP | None | Left upper extremity sensory deficit |
| 7 | Anterior thoracic discectomies/partial corpectomies | Left upper extremity decreased SSEP | Arm pressing on arm, removed | No deficit |
| 8 | Posterior lumbosacral decompression/fusion TLIF | Right upper extremity decreased SSEP | Arm repositioned | No deficit |
| 9 | C7-T1 anterior decompression/fusion | Right lower extremity decreased MEP | Increased blood pressure | No deficit |
| 10 | T11-L5 anterior discectomy/fusion | Right lower extremity decreased SSEP, MEP | Increased blood pressure | No deficit |
| 11 | Posterior thoracolumbar decompression/fusion TLIF | Left lower extremity decreased SSEP | Increased blood pressure | No deficit |
| 12 | Posterior thoracolumbar decompression/fusion costovertebral T11, T12, L1 partial vertebrolectomies | Right lower extremity decreased SSEP, MEP | Stopped procedure, stage 1 of 2 | No deficit |
| 13 | Posterior thoracolumbar decompression/fusion TLIF | Variable SSEP, MEP | Labile blood pressure | No deficit |
| 14 | Posterior occipitocervical decompression/fusion | Right upper extremity decreased SSEP | Positioning effect, arm tucked | No deficit |
| 15 | Anterior thoracic osteotomies | Right lower extremity loss of SSEP after graft placement | None | No deficit |
| 16 | Posterior thoracolumbar decompression/fusion TLIF | Right lower extremity loss MEP, SSEP stable | None | No deficit |
| 17 | Anterior cervical corpectomy and fusion | No baseline SSEPs | None | Improved SSEPs |
| 18 | Posterior thoracolumbar decompression/fusion TLIF | Bilateral lower extremity SSEPs decreased with rod placement | Rods placed, baseline SSEPs returned | No deficit |
| 19 | T7 spinal cord tumor resection | Loss of bilateral lower SSEPs (no MEPs present at baseline) | None | No change from preoperative function |
| 20 | Posterior then anterior cervicothoracic fusion | Decreased SSEPs post flap | None | No deficit |
| 21 | Anterior thoracolumbar discectomies/fusion | Thoracotomy, left upper extremity (down arm) loss SSEPs | Repositioned, large pt, procedure shortened | Transient sensory changes |
| 22 | Posterior thoracolumbar decompression/fusion TLIF | Right lower extremity loss of MEP with distraction | Needs repositioned, signals resquired | No deficit |
| 23 | Posterior thoracic fusion | Bilateral lower extremity loss of MEP | Variable signal changes, returned to baseline | No deficit |
| 24 | Posterior thoracolumbar deformity correction with fusion | Left lower extremity decreased SSEP, loss of MEP during correction | Correction held, increased blood pressure | No deficit |
| 25 | Posterior cervicothoracic deformity correction with fusion | Bilateral lower extremity loss of MEP, decreased SSEPs | Correction decreased | No deficit |
| 26 | Posterior lumbosacral decompression/fusion | Low screw threshold | No breach, screw replaced | No deficit |
| 27 | Posterior lumbosacral decompression/fusion TLIF | None, spontaneous EMG only | None | Sorew in canal |
| 28 | Posterior lumbar decompression/fusion | None, spontaneous EMG only | None | Foot drop, medial left L4 screw breach |
| 29 | Posterior thoracolumbar deformity correction with fusion | Bilateral lower extremity loss of MEP | Decreased correction | No deficit |
| 30 | Anterior cervical corpectomy and fusion | Improved MEP after decompression | None | Improved function |
| 31 | Anterior thoracic discectomy and fusion | Improved MEP after decompression | None | Improved function |
| 32 | Anterior cervical corpectomy and fusion | Improved MEP after decompression | None | Improved function |

Conclusions

Overall, this review reinforces the importance of multimodality neuromonitoring for spinal surgery. The incidence of possible events in our series was 1.5%. In a majority of those cases, possible postoperative neurologic deficits were avoided by intraoperative intervention. Clearly, in the three cases with lumbar pedicle screw malposition, triggered EMGs would have likely shown low thresholds. This would allow for screw reposition, and thus avoid a postoperative lumbar radiculopathy and revision surgery. The incidence of false-positive findings was very low in this review, and unfortunately the true incidence of false-negative findings is not able to be elucidated with this database.

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