Intraoperative neuro-monitoring corner editorial: The need for preoperative SEP and MEP baselines in spinal surgery: Why can’t we and our monitoring colleagues get this right?

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Abstract

Background: The majority of spinal surgeons now utilize intraoperative neurophysiological monitoring (IONM) during spinal procedures to limit the risk of inadvertent injury. Nevertheless, probably the most frequent error is the failure of the surgeon and IONM to obtain adequate preoperative baselines (e.g. before intubation or positioning).

Methods: Intraoperative neural monitoring should begin with the spinal surgeon, anesthesiologist, and monitoring technician/neurologist reviewing the patient’s neurological deficits, the operative approach, the most anticipated risks and complications as well as the type of monitoring to be used (e.g. somatosensory evoked responses [SEP], motor evoked potential [MEP] monitoring, and electromyography [EMGs]). Baseline data should accurately reflect the preoperative status of the patient, and provide the appropriate data to be monitored and maintained throughout surgery.

Results: Significant but transient changes from the established preoperative baseline SEP and MEP often reflect alterations in the anesthetic technique (e.g. hypotension/hypoperfusion). However, when these changes persist, and resuscitative maneuvers have been exhausted (e.g. removing an oversized graft to avoid ischemia, utilizing total intravenous anesthesia [TIVA] correctly, reversing hypotension, changing the patient’s cervical position, checking the electrode placement, checking the position of the limbs, and other factors), significant MEP/SEP changes may signal a major impending neural injury.

Conclusion: IONM is only as good as how competently it is implemented by the technologist/neurologist, and understood by the surgeon and anesthesiologist. If any team member does not understand what and how the monitoring should be performed, then it becomes a useless adjunct to spinal surgery.

Key Words: EMG, intraoperative neural monitoring, MEP, preoperative baselines, SEP, spinal surgery
EDITORIAL

The majority of spinal surgeons now utilize intraoperative neurophysiological monitoring (IONM) during spinal procedures to limit the risk of inadvertent injury. Nevertheless, common mistakes on the part of the surgeon, monitoring specialists (e.g. technician and/or monitoring neurologist), and anesthesiologists, still contribute to new postoperative deficits. Probably the most frequent error is the failure of the surgeon and IONM to obtain adequate preoperative baselines (e.g., before intubation or positioning).

Intraoperative neural monitoring should begin with the spinal surgeon, anesthesiologist, and monitoring technician/neurologist reviewing the patient’s neurological deficits, the operative approach, and the most anticipated risks and complications. For example, when performing a posterior cervical procedure, baseline data should be obtained supine, prior to and following intubation, and before turning the patient prone. This should include not only somatosensory evoked responses (SEP) but also, with a small dose of Propofol, baseline motor evoked potential (MEP) monitoring (allowing to reverse quickly). The two baselines should accurately reflect the preoperative status of the patient, and provide the appropriate data to be monitored and maintained throughout surgery.

Significant but transient changes from the established preoperative baseline SEP and MEP often reflect alterations in the anesthetic technique (e.g., hypotension/hypoperfusion, or the inadvertent addition of inhalation anesthetic agents). However, when these changes persist, and resuscitative maneuvers have been exhausted (e.g., removing an oversized graft to avoid ischemia, utilizing total intravenous anesthesia [TIVA] correctly, reversing hypotension, changing the patient’s cervical position, checking the electrode placement, checking the position of the limbs, and other factors) significant MEP/SEP changes may signal a major impending neural injury. Here, it is critical that the spinal and surgeon, IONM technologist/neurologist, and anesthesiologist understand the importance of these changes, maintain an on-going dialogue (e.g., particularly with the “interpreting” neurologist) to avert permanent neurological sequelae.

Walking into the operating room recently in another country, I was astounded to find that a patient with severe cervical stenosis was already endotracheally intubated, and positioned prone with traction in place without IONM having been established. Only after all maneuvers were completed, did the IONM technologist/neurologist place electrodes for SEP/EMG/MEP on the patient. This “protocol” was the accepted norm for this operating room team, and they were surprised at the suggestion that IONM should have been initiated “from the get-go” (e.g. from the start).

IONM is only as good as how competently it is implemented by the technologist/neurologist, and how well it is understood by the surgeon and anesthesiologist. If any team member does not know what and how the monitoring should be performed, then it becomes a useless adjunct to spinal surgery. Can’t we encourage ourselves and our colleagues to familiarize ourselves with the “best practices” for IONM to achieve the optimal outcomes for our patients? To accomplish this, we need adequate preoperative baselines prior to intubation/positioning/manipulation/surgery. After all, together, we should be able to get this right.

COMMENTS FROM MEMBERS OF THE BOARD OF SURGICAL NEUROLOGY INTERNATIONAL SPINE SUPPLEMENT

Ron Pawl, MD.

This editorial by Epstein and Stecker should not be necessary in this day and age in any country, as we should know how to perform IONM. Given the ready availability of publications and electronic communication, between individuals in all medical specialties, a discourse between the monitoring neurologist and surgeon should be easily accomplished. IONM has been available since the 1970s and 90s, during which time I was operating regularly in both a University Hospital and in a private practice hospital. SSEP monitoring was evoked potentials used (e.g. MEPs were not yet available/routinely used), although initially in selected cases. Eventually motor and EMG monitoring was also carried out in all cases where the potential for vascular ischemic damage from manipulation of the spinal cord or a supplying blood vessel might occur.

It is well recognized that in the cervical region, the major arterial blood supply to the cord can come from a single radicular artery, usually entering at the C4-5 or C5-6 level on either side.[1] Consequently excessive manipulation of the nerve roots during surgery may result in serious deleterious results to the patient. Since these levels are very often herniations involved with degenerative processes and disc herniation, particular care is warranted when surgery is carried out in these locals. This is especially true if the patient exhibits severe myelopathy/radiculopathy, attributed to significant narrowing of the spinal canal and neural foramina. Preoperative base measurements of the electrical activities (SEP, MEP, EMG) are warranted with the unanesthetized patient placed in the planned operating position. Only after such preoperative monitoring is carried out does any
change in the electrical activity during the actual surgery become meaningful. The conclusions of the authors of the editorial are correct and warrant soul searching by all spinal surgeons.

**Philipp M Lippe, MD**
This is a useful addition to the subject of IONM. However, it is a very complex issue and perhaps one should reference the article by Dr. Stecker published in ISN in 2012 - Stecker MM. A review of intraoperative monitoring for spinal surgery. Surg Neurol Int 2012;3, Suppl S3:174-87.

Also, the editorial states: "The majority of spinal surgeons now utilize IONM during spinal procedures to limit the risk of inadvertent injury." This could imply that IONM is utilized in most spinal cases. Is this really true? Or is IONM used selectively when the risk of injury is high; that is, scoliosis?

**Howard Morgan, MD, MA, MS, FACS, FAANS, FCLM**
I have a few comments.
- Since the word ‘inadvertent’ carries a connotation of negligence, I’ve always tried to avoid using it when describing some unexpected or accidental occurrence during surgery
- What cases need to be monitored? I use it for spinal cord tumor surgery and decompression of cervical stenosis causing myelopathy but not for “routine” lumbar and cervical disc herniations causing radiculopathy. I have heard of surgeons who use it on all spinal cases. I think that is wasteful. Is there a precedent for practice?
- If the patient being monitored has critical stenosis or instability, I think your case for monitoring before anesthesia and intubation and positioning is valid. In many cases, that may not be needed.

**James Ausman, MD, Ph.D.**
To me it is obvious like getting BP values before starting surgery. But obviously, you have seen that it is not obvious.

**Clark Watts, MD.**
I read with much interest this short editorial on intraoperative monitoring. First, many of the techniques for this monitoring came from my laboratories in Missouri; the principle investigators were York and Levy. Because of the need for averaging over several minutes, sensory techniques were never satisfactory. Most surgeons I know who use the techniques do not know how to use them, especially in conjunction with anesthesia. There are few real situations where they have been found to affect outcome. I am commenting on spinal techniques, and not the very useful techniques with acoustics. We were one of the first laboratories to publish reliable motor techniques, which are more accurate, and more reliable than sensory techniques. In most monitored techniques, I am afraid that most of the time, these techniques are used because they do generate significant revenue. However, if they are to be used, they must be calibrated at the beginning, and tested with the major anesthesia techniques looking for variations to be guided by when interpreting the data.

**Vincent Traynelis, MD.**
Intraoperative monitoring, in my practice, is reserved for select pathology, which includes intramedullary tumors, vascular lesions, significant deformity, and significant craniovertebral junction stenosis. Many of these patients have preoperative neurological deficits referable to spinal cord dysfunction. It is imperative that baseline studies be performed prior to intubation (unless an awake intubation is performed and the patient can be clinically assessed). Most important is a set of recordings after intubation while the patient is anesthetized and has not been placed in the final surgical position. This is extremely important if the monitoring is to be of any value for prone positioning.

**Thomas Ducker MD.**
My monitoring indications were identical to those used by Dr Traynelis, when I was practicing, and are identical to what is commonly accepted by the certification/approval review companies used by the insurance/government payers.

**Paul J. Tortolani, MD.**
First, let me say that I enjoyed reading this well-written piece. Second, I believe the authors’ practice of obtaining baseline motor (MEP) and somatosensory evoked potentials (SSEP) prior to and subsequent to intubation makes sense, but is not something that I have ever done in my practice. For high risk patients, my practice has been to intubate with neutral head positioning, and to obtain baselines prior to and subsequent to positioning. I will plan on implementing the pre- and postintubation monitoring as a way to assess changes associated with the intubation. I believe having the conversation with the anesthesiologist and the monitoring team prior to the patient arriving in the operating room is of paramount importance in order to create a game plan for the case. Furthermore, including this discussion as part of a “time out” may serve to enhance patient safety.

**Robert McGuire, MD.**
I think the authors are indeed correct in their assessment and usage of intraoperative monitoring. Having trained when monitoring techniques were in their infancy and the fine tuning "trust" factor was not quite what it is today, we used the awake intubation and turned the patient prone in this twilight state to monitor the neurologic
status, determining whether or not changes were present after positioning. That allowed gross monitoring of the neurologic status as did the classic "wake up" test following surgical correction and instrumentation in deformity surgery. Presently, our monitoring techniques have improved to the point that they can be trusted. I think it is very important to use baseline studies when extreme lateral approaches to the lumbar spine are used due to the potential risk of injury to the lumbar roots and plexus with these surgical techniques. The use of these intraoperative monitoring techniques require a coordination between all members of the operating team due to the fact that certain anesthetic agents must not be used during the induction process that would interfere with the monitoring.

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