Neuromonitoring in Spine Surgery: An Evidence Based Update

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Disclosure – Prior ownership of a FULL SERVICE neuromonitoring company.

I do advocate the use of neuromonitoring in SELECTED MIS and OPEN Surgeries

What is being measured?

- Lumbar
  - Efferent – Motor -- YES
  - Afferent – Sensory -- NO

- Cervical
  - Efferent – Motor -- YES
  - Afferent – Sensory -- YES
Types of Surgery
- Deformity
- Multi-Level
- Degenerative
- Tumor

What are the Risks?
- False Positives
- False Negatives
- Too reliant on technology, technique suffers?

Is the technology reliable?
- Patient comorbidity
- Experience of team
- Effects of anesthesia

SRS Information Statement - 2009

"The majority of SRS members utilize neurophysiological monitoring routinely in the correction of spinal deformity. The Scoliosis Research Society considers neurophysiological monitoring the preferred method for the early detection of an evolving or impending spinal cord deficit during surgical manipulation of the spine. The wake up test is a useful adjunct to neurophysiological monitoring for the detection of neurologic spinal cord deficits."
Cervical

Hillbrand, 2004
- YES - Cervical spondylotic myelopathy and when ossification of the PLL

Cole, 2014
- NO - Single level ACDF’s as there was no difference in neurological complications. Payment increased 16.24% for ACDF with neuromonitoring.

Epstein, 2013 (Review)
- YES – Safe/effective, MEP should be used with SEP and EMG in cervical surgery

Harel, 2013 (Commentary to Epstein, 2013)
- YES/NO – Author’s opinion to use in tumor deformity and patient positioning poses a risk. Not in the majority of cervical degenerative cases.

Traynelis, 2012

“With the continuing increase in health care costs, it is our responsibility as providers to minimize expenses when possible. This should be accomplished without compromising the quality of care to patients. This study demonstrates that decompression and reconstruction for symptomatic cervical spine disease without IOM may reduce the cost of treatment without adversely impacting patient safety.”
Cervical

Khor, 2015
- NO – Adjusting for all variables associated with intraoperative monitoring, the odds ratio of a new neurological event was 1.04 (95% CI 0.64-1.71)
- Study included 17,043 patients with 34.7% cervical and 65.3% lumbar
- Consecutive patients from 20 hospitals participating in Spine Surgical Care and Outcomes Assessment Program (SCOAP) (2012-2014)

Cervical

Spitz, 2015
- YES/NO – IOM did not detect or predict C5 palsy post-operatively
- 356 patients, with 262 anterior procedures
- Sensitivity 0%, specificity 85.6%, positive predictive value 0%, negative predictive value 97.8%
- Patients with C5 palsy regained function of the muscle groups within 6 months

Cervical

Jenkins, 2016
- YES – ACDF when myelopathic symptoms present or risk of spinal cord injury
- NO – May not be cost effective in cases without the above inclusion, and the false positives could complicate routine surgery in non-myelopathic patients
Cervical

- Ajiboye, 2016
  - NO – Review of 15,395 ACDF cases from PearlDiver Patient Record Database. Use of intraoperative monitoring did not prevent postoperative neurologic complications in ACDF when compared to cases without intraoperative monitoring.

Lumbar

- Alemo, 2010
  - YES/NO - Valuable as additional tool
    - 414 screws placed with 4 false positives and 3 false negatives requiring reoperation
    - Postoperative CT scan is the ultimate test for accuracy of titanium pedicle screw placement
    - Proposes continued wake-up test

- Uribe, 2010 (Review. MIS)
  - YES
    - Well established for pedicle screws
    - Safe approach through psoas: utilize IOM as well as image guidance, lumbar plexus anatomy knowledge and patient position

- Hamilton, 2011 (SRS Database Review)
  - Neutral – Report of new neurologic deficits
    - Of the 61 patients with new spinal cord deficit, 26 had changes reported with intraop monitoring.
    - Room for improvement in neuromonitoring techniques
Lumbar

- Eccher, 2011 (Commentary to Hamilton, SRS review)
  - Further study should be done
    - Post-op neuro detection demands high-sensitivity, with cost of more false positives. False positives promote surgeon anxiety.
    - Adverse events reported are high and without resolution in 50%. Neurophysiologic and Surgical professions must work together to improve this.

Lumbar

- Joglekar, J Clin Neurophysiol, 2012
  - Surgeon’s View of Pedicle Screw Implantation for the Monitoring Neurophysiologist.

“While all imaging and electrophysiologic modalities should be applied on an individualized basis, finally no adjunctive technique can fully replace the need for surgical expertise and experience.”

Lumbar

- Garces, 2014 (TLIF)
  - NO – Unnecessary costs, increases surgery time, little effect on post-op outcomes.
    - 5.5% with monitoring and 5.1% without had re-op for screw malpositioning.

- Ajiboye, 2016 (PLF)
  - YES/NO - Review of 9,957 cases from PearlDiver Patient Record Database. Concomitant interbody fusions and deformity surgeries were excluded.
    - Rates of neurological complications were low for both groups. 1.36% (34/2495) with EMG and 1.34% (100/7462) without EMG
Lumbar

- Nandyala, 2015 (XLIF, pedicle screw placement)
  - YES – Paramount in preventing injury to the lumbar plexus. Ensures optimal placement of percutaneous screws.
  - Still need to establish stimulation thresholds and classification system for suspected neural injury

Lumbar

- Bhagat, 2015
  - YES – Multimodal monitoring sensitivity was 100% with specificity of 99.3%.
  - Retrospectively collected, 354 consecutive spinal deformity cases, June 2003-October 2013

Lumbar

- Khor, 2015 (Found NO for cervical)
  - YES – Adjusting for all variables associated with intraoperative monitoring, the odds ratio of a new neurological event was 0.67 (95% CI 0.46-0.97).
  - Study included 17,043 patients with 34.7% cervical and 65.3% lumbar.
  - Consecutive patients from 20 hospitals participating in Spine Surgical Care and Outcomes Assessment Program (SCOAP) (2012-2014)
Lumbar Block, 2015
- YES – LLIF with MEP for femoral nerve protection
- Surgical side only degraded amplitudes of the femoral motor an/or sensory evoked potentials
- More study is needed

Lumbar Berends, 2016
- YES – XLIF procedures. Recommends use of transcranial electrical stimulation with motor evoked potential (TESMEP) in addition to sEMG and tEMG.
- Addition of TESMEP confirmed events measured with sEMG, and recorded new events (specifically table breaking in the OR frequently resulted in decreased MEP amplitudes)

Lumbar Trobisch, 2016
- NO – Absence of neuromonitoring did not increase risk of neurological injury in pedicle subtraction osteotomy (PSO)
- Single site study, all 22 patients did not have neuromonitoring during surgery
  - Total complication rate of 36% and neurologic complication rate of 9%
YES – Vertebral column resections in severe spinal deformity cases.

Retrospectively collected 77 patients, severe spine deformity undergoing VCR, January 2012-May 2015.

Patients with pre-operative spinal deficits had great IOM losses.

What’s Next

Eccher in commentary to SRS database review of new neurologic deficits said,

“More than half of the cases in all categories did not resolve. Patients are coming to harm. This is an opportunity for neurophysiologic and surgical professionals to improve one another’s practice-together.”

What’s Next

Hashmi, Dodwad, Patel: Contemporary Spine Surgery, March 2016

“The literature regarding use of multimodal IONM in spine surgery demonstrates strong sensitivity and specificity for detecting intraoperative neurologic deficit or impending injury. However, as IONM has not been established as the standard of care, the decision to use neuromonitoring is still based upon surgeon preference. Selecting a specific IONM modality should be considered judiciously on the basis of the assessment of surgical complexity and the risk of injury to the spinal cord and peripheral neural structures. Although the literature supports the use of IONM to recognize neurologic injury, there is a deficiency in high-level evidence to confirm its utility in reducing or preventing new or worsening neurologic deficits. There are many factors involved in increasing the safety of spine surgery. In this context, the use of IONM seems promising.”
It’s All Clear now!

DISCUSSION

Thank You!