

Letter to the Editor

The value of neuromonitoring in cervical spine surgery

Ran Harel, Nachshon Knoller, Gilad Regev¹, Yoram Anekstein², Menashe Zaaroor³, Joseph Leitner⁴, Eyal Itshayek⁵, Michael P. Steinmetz⁶, Thomas E. Mroz⁷, Ajit Krishnaney⁷, Richard S. Schlenk⁷, Gordon R. Bell⁷, Iain H. Kalfas⁷, Edward C. Benzel⁷

Spine Surgery Unit, Departments of Neurosurgery, Sheba Medical Center, Tel Hashomer, Israel Affiliated with Sackler Faculty of Medicine, ¹Spine Surgery Unit, Tel-Aviv Sourasky Medical Center, Weitzman 6, ²Spine Surgery Unit, Assaf Harofeh Medical Center, Sackler Faculty of Medicine, Tel-Aviv University, ³Neurosurgery, Rambam Medical Center and Faculty of Medicine, Technion-Israel Institute of Technology, Haifa, ⁴Spinal Care Unit, Meir Hospital, Kfar-Sava, ⁵Neurosurgery, Hadassah University Hospital, Jerusalem, Israel, ⁶Neurosciences, Metro Health Medical Center, Case Western Reserve University, 2500 Metro Health Dr., Cleveland, OH 44109, ⁷Center for Spine Health, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, OH 44195, USA

E-mail: *Ran Harel - Ran.Harel@sheba.health.gov.il; Nachshon Knoller - Nachshon.Knoller@sheba.health.gov.il; Gilad Regev - gregev@gmail.com; Yoram Anekstein - nuritan@zahav.net.il; Menashe Zaaroor - m_zaaroor@rambam.health.gov.il; Joseph Leitner - leitner@clalit.org.il; Eyal Itshayek - eyal.itshayek@gmail.com; Michael P. Steinmetz - msteinmetz@metrohealth.org; Thomas E. Mroz - mrozt@ccf.org; Ajit Krishnaney - krishna@ccf.org; Richard S. Schlenk - schlenr@ccf.org; Gordon R. Bell - bellg@ccf.org; Iain H. Kalfas - kalfasi@ccf.org; Edward C. Benzel - benzele@ccf.org

*Correspondence author

Received: 19 February 2014 Accepted: 25 May 2014 Published: 02 August 14

This article may be cited as:Harel R, Knoller N, Regev G, Anekstein Y, Zaaroor M, Leitner J, et al. The value of neuromonitoring in cervical spine surgery. *Surg Neurol Int* 2014;5:120.Available FREE in open access from: <http://www.surgicalneurologyint.com/text.asp?2014/5/1/120/138032>

Copyright: © 2014 Harel R. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Dear Editor,

We read with interest the paper by Epstein entitled: The need to add motor evoked potential monitoring to somatosensory and electromyographic monitoring in cervical spine surgery.^[1] The paper reviews the spine surgery literature regarding the use of intraoperative neural monitoring (IONM). Theoretically, IONM should alert the operative team that impending neurological injury is possible and a corrective maneuver performed to prevent such. IONM may be problematic in that it might alarm and result in an abandonment or alteration of the surgical procedure when no true neurological deficit is subsequently demonstrated (false positive). More worrisome, however, is the situation when no alert is observed and neurological injury ensued (false negative). Debate may be held with regard to the most appropriate surgical procedures for the use of IONM. Ideally, this should involve procedures in which potentially harmful maneuvers can be reversed. A classic example is deformity correction, which can be reversed if IONM suggests such. In cases in which “surgical reversal” is not possible, IONM has been shown to demonstrate true and false positives, however, studies have not demonstrated improved outcomes.^[7] Many infer that IONM is associated with improved clinical results. However, it should be noted that the referenced studies compared outcomes with historical cohorts. Epstein *et al.*^[2] reported

100 cases of IONM monitored cervical surgeries with no new neurological deficit. The historical cohort of this study included 218 patients operated in years 1985-1989, 8 of which became quadriplegic. This control population is clearly an outlier, as quadriplegia following elective cervical spine surgery for degenerative conditions is, indeed, a rarity and the rate is far less than the nearly 4% reported in the referenced study. Other studies cited by Epstein^[1] show a high rate of false positives or false negatives with IONM, and low rate of true positives.^[3,5,6]

During degenerative cervical spine surgery, neurological injury may occur any of several phases. It may occur during induction of anesthesia with resultant hypotension, during positioning (flexion or extension) of the cervical spine in either prone or supine position, from intraoperative hypotension, and/or from direct surgical trauma. With the exception of hypotension and positioning, none of these potential causes of

Access this article online**Quick Response Code:****Website:**www.surgicalneurologyint.com**DOI:**

10.4103/2152-7806.138032

neurological injury are reversible. IONM, therefore can only signal that a neurological injury may have occurred, but does not afford the surgeon an enhanced opportunity to remedy or mitigate the neurological injury. When spinal cord injury occurs from direct surgical trauma, IONM serves only to document the timing of the trauma and cannot assist with altering the clinical outcome.

There may then be little utility for IONM in degenerative cervical spine surgery. This conclusion has been borne out in the literature. Resnick *et al.*^[7] reviewed the literature regarding IONM for degenerative cervical spine surgery. Their published guidelines concluded that relying on IONM changes as an indication for altering surgical procedure or administration of steroids has not been shown to reduce the incidence of neurological deterioration. The addition of IONM to degenerative cervical surgery has financial implications, however, cost-benefit analysis has not demonstrated benefit.^[4]

IONM is also often used for medico-legal reasons. Epstein reviewed the cervical spine surgery verdicts and determined the causes for verdicts were negligent surgery, lack of informed consent, failure to diagnose/treat, and failure to brace. She speculated that failure to adequately perform IONM may become the fifth reason for verdicts in cervical spine surgery. As the guidelines for cervical spinal surgery do not include the use of IONM,^[7] and no clear algorithm for intraoperative action when IONM changes are observed, the routine use of IONM cannot serve as protection against a plaintiffs' verdict.

Commentary

I think that my article on the need to utilize motor evoked potentials (MEP) when performing cervical spine surgery, in conjunction with somatosensory evoked potentials (SSEP) and electromyography, speaks for itself. I reviewed the data from multiple studies and demonstrated the "pros" for adding MEPs to monitoring cervical surgery.

I do not agree with Dr. Harel's assumption, that largely, when MEP or other changes occur, they are typically permanent or irrevocable. Rather, one of the greatest "pros" for MEP/SEP IONM is that changes are more often slowly progressive, and only rarely abrupt and irreversible reflecting a permanent injury. One major exception to this may be the MEP/SEP changes that can occur during the excision of intramedullary spinal cord tumors where severe IONM deficits more closely correlate with permanent neurological sequelae.

Even Dr. Harel *et al.* acknowledge that utilizing MEP along with SEP may be useful in operative positioning of patients with very severe spinal cord compression. Here in particular, obtaining adequate baseline MEP/SEP

In the authors' opinion, IONM in spine surgery has a definite role. This role includes intradural tumor surgery, deformity surgery, and cases in which patient positioning in and of itself poses neurological risk. IONM, however, has not been proven effective as a neuroprotective maneuver in the majority of cervical degenerative surgical procedures.

REFERENCES

1. Epstein NE. The need to add motor evoked potential monitoring to somatosensory and electromyographic monitoring in cervical spine surgery. *Surg Neurol Int* 2013;4(Suppl 5):S383-91.
2. Epstein NE, Danto J, Nardi D. Evaluation of intraoperative somatosensory-evoked potential monitoring during 100 cervical operations. *Spine (Phila Pa 1976)* 1993;18:737-47.
3. Khan MH, Smith PN, Balzer JR, Crammond D, Welch WC, Gerszten P, *et al.* Intraoperative somatosensory evoked potential monitoring during cervical spine corpectomy surgery: Experience with 508 cases. *Spine (Phila Pa 1976)* 2006;31:E105-13.
4. Lall RR, Hauptman JS, Munoz C, Cybulski GR, Koski T, Ganju A, *et al.* Intraoperative neurophysiological monitoring in spine surgery: Indications, efficacy, and role of the preoperative checklist. *Neurosurg Focus* 2012;33:E10.
5. Lee JY, Hilibrand AS, Lim MR, Zavatsky J, Zeiller S, Schwartz DM, *et al.* Characterization of neurophysiologic alerts during anterior cervical spine surgery. *Spine (Phila Pa 1976)* 2006;31:1916-22.
6. Li F, Gorji R, Allott G, Modes K, Lunn R, Yang ZJ. The usefulness of intraoperative neurophysiological monitoring in cervical spine surgery: A retrospective analysis of 200 consecutive patients. *J Neurosurg Anesthesiol* 2012;24:185-90.
7. Resnick DK, Anderson PA, Kaiser MG, Groff MW, Heary RF, Holly LT, *et al.* Electrophysiological monitoring during surgery for cervical degenerative myelopathy and radiculopathy. *J Neurosurg Spine* 2009;11:245-52.

with patients supine, prior to prone positioning, may be critical, along with maintaining normal SEP/MEP throughout awake positioning.

Finally, the incorporation of "more information" by effectively utilizing MEP should be considered an attribute as they help, in some hands, to avoid potential neurological injury. Although monitoring MEP may not guarantee the avoidance of all poor outcomes, the constant interaction between the monitoring physiologist, the surgeon who understands the monitoring protocol and responds "early" to "mini" true positives (e.g. before findings become significant), and the anesthesiologist may avoid permanent neurological deficits.

Nancy E. Epstein

Editor Surgical Neurology International Spine Supplement, Chief of Neurosurgical Spine and Education, Winthrop University Hospital, Long Island, New York, USA.
E-mail: nancy.epsteinmd@gmail.com