E-Poster #: 8

Impact of Neuromonitoring Alert Resolution on Neurologic Outcomes in Spine Surgery as a Function of Spine Region: A Review of 104,554 Procedures with Motor Evoked Potentials (MEPs)

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Introduction and Objectives

The value of intraoperative neuromonitoring (IONM) depends both on its accuracy in diagnosing evolving neurologic compromise and the effectiveness of interventions implemented to reverse the compromise.

The purpose of this study was to

- Compare the incidence and accuracy of IONM alerts during surgery in different regions of the spine when MEPs are included in a multimodality monitoring protocol.

- Assess the impact of the resolution of IONM alerts on neurologic outcomes.

Hypothesis

Accuracy- Prediction of New Deficits

Unresolved IONM alerts should be associated with increased odds of a new deficit (relative to cases with no IONM Alerts)

Impact- Prevention of New Deficits

Successful resolution of IONM alerts should be associated with decreased odds of a new postoperative neurologic deficit (relative to cases with unresolved IONM alerts)

Methods

- We conducted a retrospective review of a multi-institutional IONM database of adult extradural spine surgeries monitored between 2016 and 2019. Cases involving tumors and trauma were excluded.
- Monitoring consisted of MEPs in all surgeries, complemented by somatosensory evoked potentials and electromyography in the majority of procedures.
- Incidence and resolution of IONM alerts were calculated separately for surgeries addressing the cervical (C), cervicothoracic (CT), thoracic (T), thoracolumbar (TL) and lumbosacral (LS) regions of the spine.
- Neuromonitoring diagnostic accuracy was estimated by calculating sensitivity, specificity, and likelihood ratios for new onset motor deficits identified by neurologic examination in the immediate postoperative period.
- The therapeutic impact of alert resolution was calculated using odds ratios (OR) for new onset motor deficits for cohorts of patients with full, partial, or non-resolution of IONM alerts.

Methods – *Diagnostic Accuracy Calculations*

- *True Positives (TP):* Cases with a positive diagnostic result (i.e. unresolved IONM alert at closure) and presence of a new motor deficit postoperatively
- *False Positives (FP):* Cases with a positive diagnostic result and no new motor deficit postoperatively
- *True Negatives (TN):* Cases with a negative diagnostic result (i.e. no alerts or fully resolved alerts at closure) and no new motor deficit postoperatively
- *False Negatives (FN):* Cases with a negative diagnostic result and presence of a new motor deficit postoperatively

Sensitivity = TP/(TP+FN)

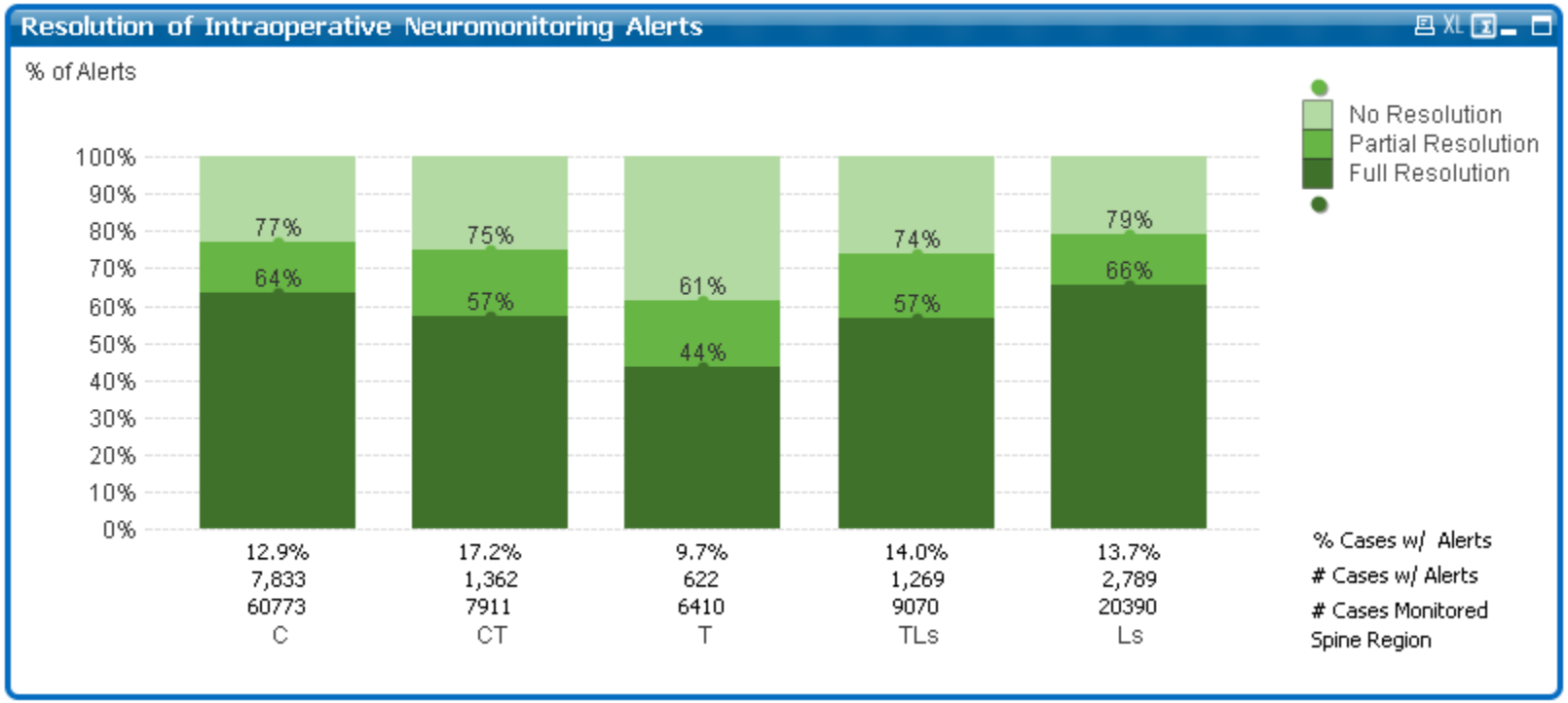
Specificity = TN/(TN+FP)

Positive Likelihood Ratio (LR+) = Sensitivity/(1-Specificity)

Negative Likelihood Ratio (LR-) = (1-Sensitivity)/Specificity

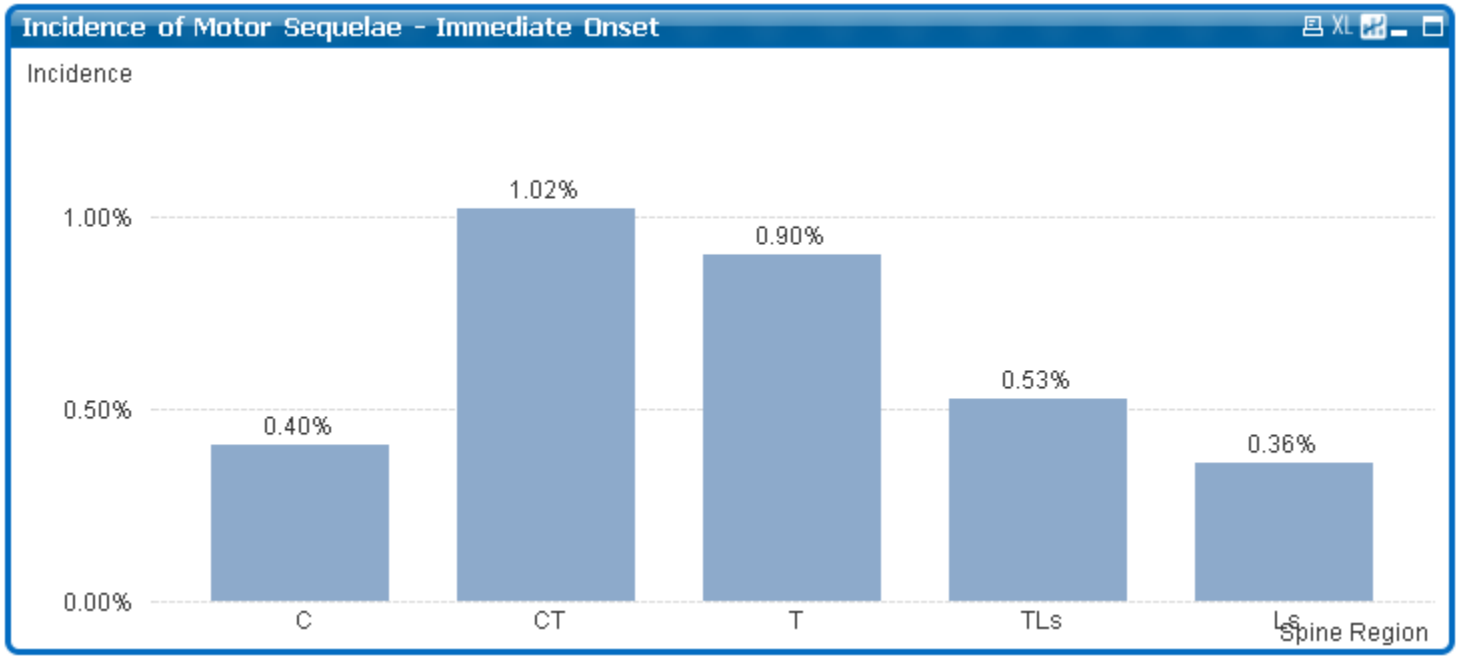
Results – *IONM Alert Rates and Resolution*

- 104,554 procedures met inclusion criteria
- The overall IONM alert rate during surgeries across different regions of the spine was 13.3% [range= 9.7%(T)-17.2%(CT)].
- Alert resolution rates varied by spine region, as summarized below. The lowest rates of resolution (44%) were noted during surgeries in the thoracic region.



Results – *Incidence of Postop Motor Deficits*

The overall rate of new onset motor deficits noted in the immediate postoperative period was 0.48% [range= 0.36%(Ls)-1.02%(CT)].



Results – *IONM Diagnostic Accuracy*

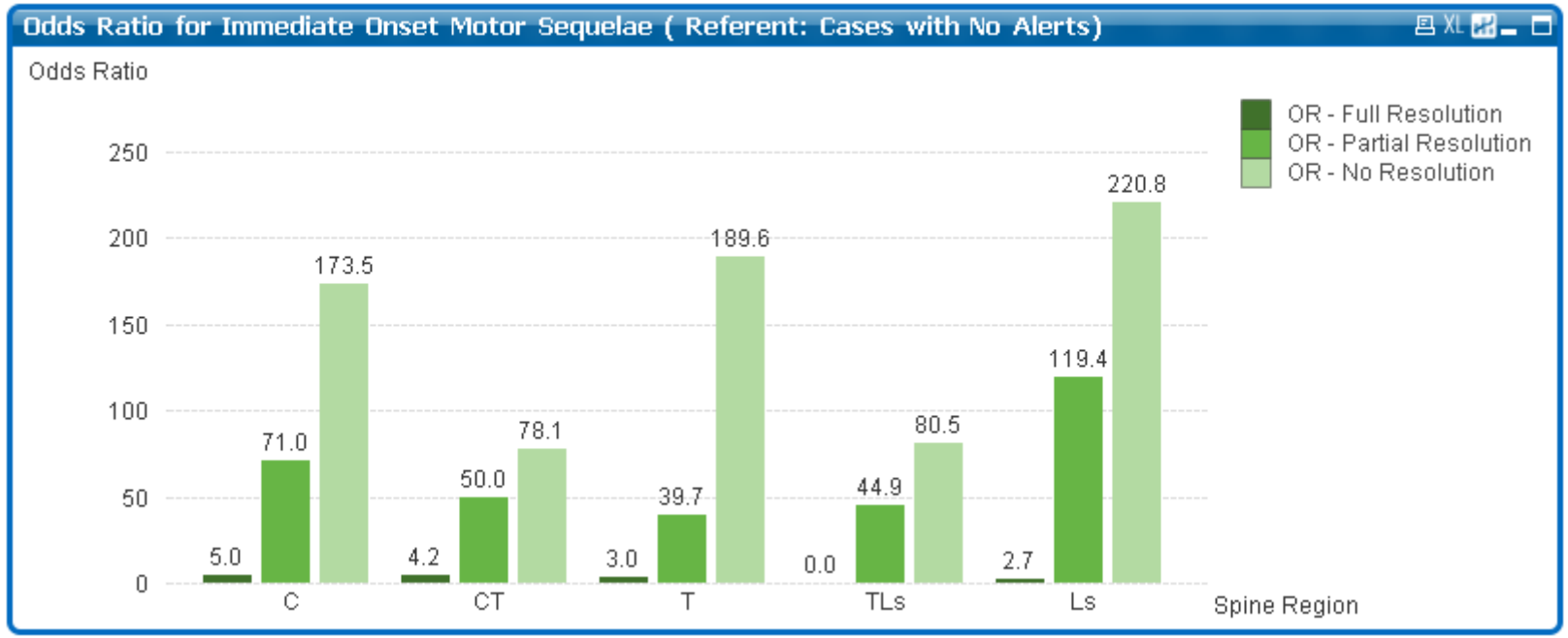
- Sensitivity was 82.6% [range = 77.8% (CT) – 87.7% (LS)].
- Specificity was 95.3% [range = 93.4% (CT) – 95.6% (C)].
- Positive likelihood ratio was 17.6 [range = 11.8 (CT) – 19.9 (LS)].
- Negative likelihood ratio was 0.18 [range = 0.13 (LS) – 0.24 (CT)].

Diagnostic Accuracy for Immediate Onset Motor Sequelae

Spine Region	Case Count	TP	FN	FP	TN	Sensitivity	Specificity	LR+	LR-
	104554								
C	60773	202	44	2,655	57,872	82.1%	95.6%	18.72	0.19
CT	7911	63	18	518	7,312	77.8%	93.4%	11.76	0.24
T	6410	50	8	300	6,052	86.2%	95.3%	18.25	0.14
TLs	9070	39	9	513	8,509	81.3%	94.3%	14.29	0.20
Ls	20390	64	9	893	19,424	87.7%	95.6%	19.95	0.13

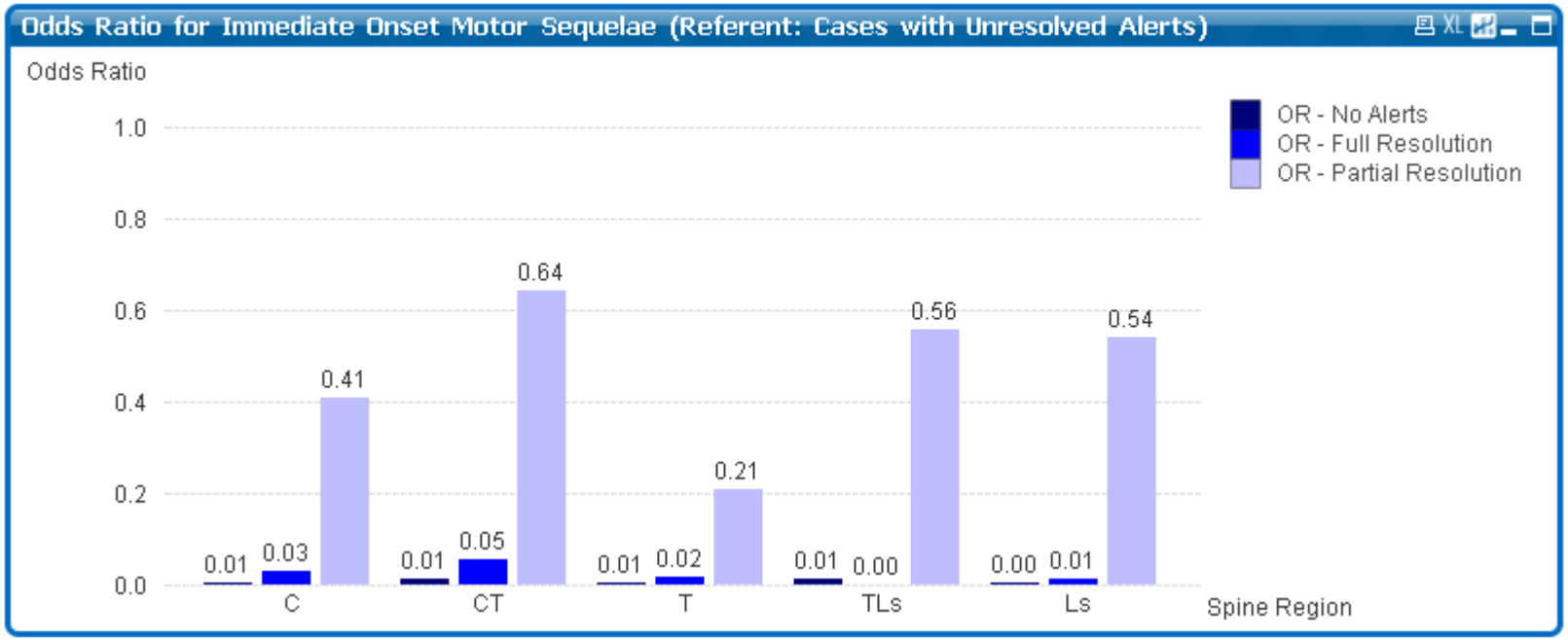
Results – *Risk of Neurologic Sequelae*

- Relative to patients with no IONM changes, the odds of a new motor deficit for patients with **unresolved IONM alerts** were significantly elevated [overall OR=152.1,range=78.1(CT)-220.8(LS), all p<0.0001)].
- These odds were lower but still significantly elevated for patients with **partially resolved alerts** [overall OR=68.6, range=39.7(T)–119.4(LS), all p<0.0001)].
- Odds of a new motor deficit were lowest for patients with **fully resolved alerts** [overall OR=3.7, range=0.0(TL)-5.0(C)]. In thoracic, thoracolumbar and lumbosacral procedures with fully resolved alerts , odds of a new deficit were statistically indistinguishable from odds for patients with no alerts.



Results – *Therapeutic Impact of Alert Resolution*

Relative to patients with non-resolution of alerts, odds of a new deficit in patients with full resolution of alerts following intervention by the surgical team were significantly decreased [overall OR=0.025, range=0.000(TL)–0.054(CT), all p<0.0006)].



Conclusion

- Multimodality monitoring with MEPs has high diagnostic accuracy for evolving neurologic compromise during spine surgery.

- Effective interventions implemented by the surgical team in response to IONM alerts are associated with improved neurologic outcomes following surgery in all spine regions.