Implementation of neuromonitoring in TAAA

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SCI & Mortality After TAAA Repair

OPEN

Endo

Authors	Year	SCI	Operative Mortality
Crawford	1986	11%	18%
Murana	2016	5.9%	8.5%
Coselli	2016	5.3%	7.5%
Latz	2019	7.0 %	7.7%
Chiesa	2023	7.8%	8.1%
UTHealth	Last 10 years	6.2%	8.2%
Heslin (VQI)	2023	4.2%	6.7%
Heslin (US ARC)	2023	2.3%	2.2%

Spinal Cord Injury

Two-Hit Theory

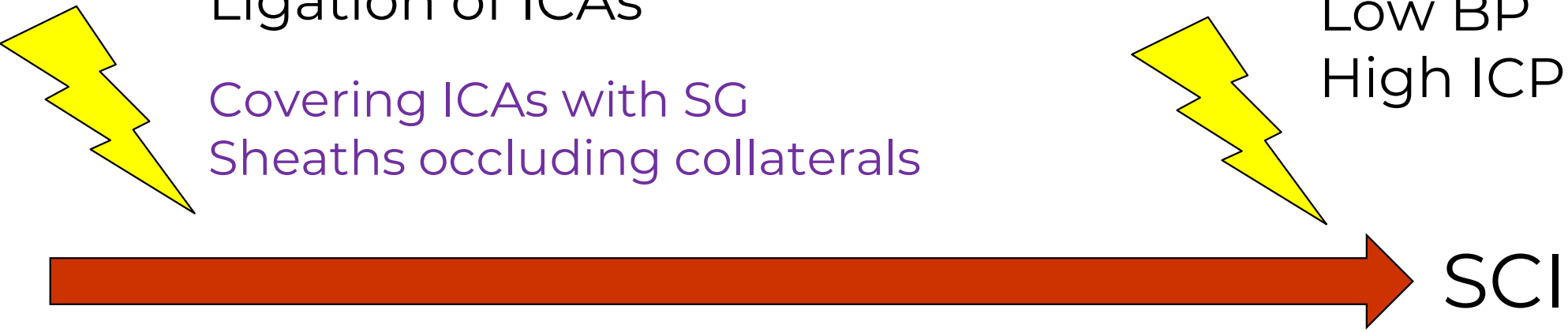
First hit

Aortic Clamping
Ligation of ICAs

Covering ICAs with SG
Sheaths occluding collaterals

Second hit

Low BP
High ICP

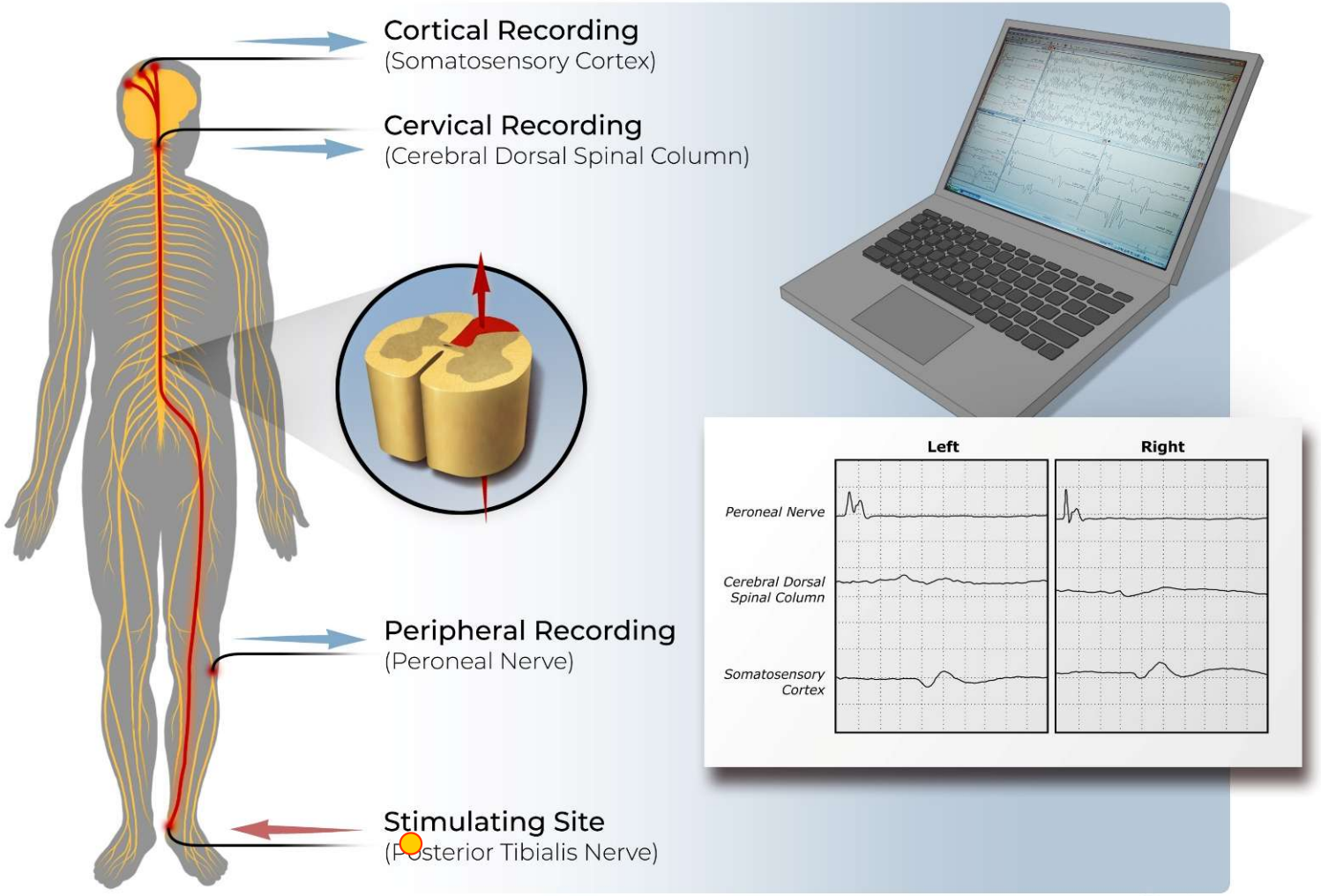


Intraop

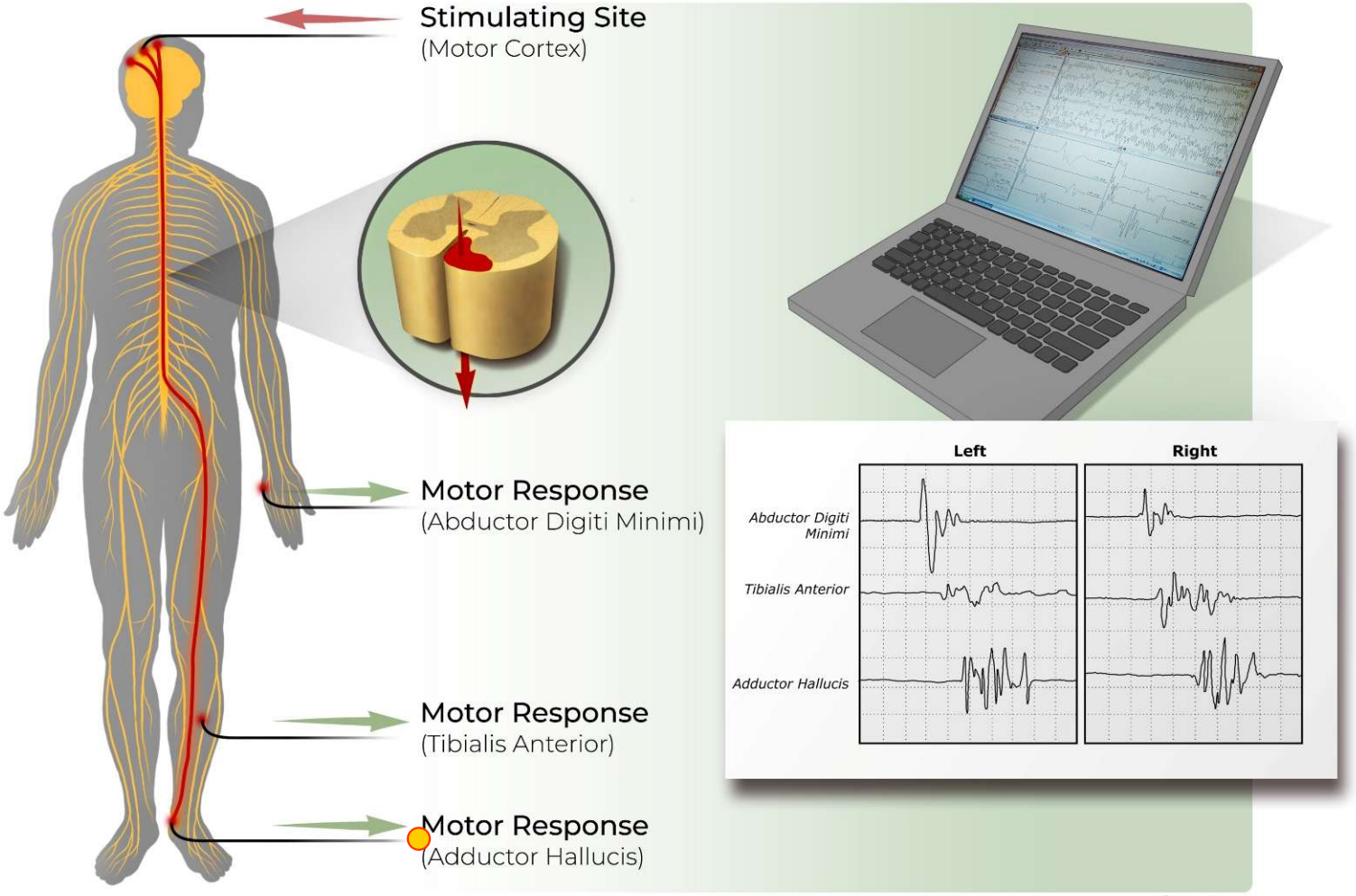
Postop

Evoked Potentials

Sensory


Cortical Recording
(Somatosensory Cortex)
Cervical Recording
(Cerebral Dorsal Spinal Column)
Peripheral Recording
(Peroneal Nerve)
Stimulating Site
(Posterior Tibialis Nerve)
Left
Right
Peroneal Nerve
Cerebral Dorsal Spinal Column
Somatosensory Cortex
Chris Akers

Motor


Stimulating Site
(Motor Cortex)
Motor Response
(Abductor Digiti Minimi)
Motor Response
(Tibialis Anterior)
Motor Response
(Adductor Hallucis)
Left
Right
Abductor Digiti Minimi
Tibialis Anterior
Adductor Hallucis
Chris Akers

UTHealth Experience with MEP/SSEP

ADULT: AORTA

Reappraisal of the role of motor and somatosensory evoked potentials during open distal aortic repair

Check for updates

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ADULT

ABSTRACT

Objective: Intraoperative motor and somatosensory evoked potentials have been applied to monitor spinal cord ischemia during repair. However, their predictive values remain controversial. The purpose of this study was to evaluate the impact of motor evoked potentials and somatosensory evoked potentials on spinal cord ischemia during open distal aortic repair.

Methods: Our group began routine use of both somatosensory evoked potentials and motor evoked potentials at the end of 2004. This study used a historical cohort design, using risk factor and outcome data from our department's prospective registry. Univariate and multivariable statistics for risk-adjusted effects of motor evoked potentials and somatosensory evoked potentials on neurologic outcome and model discrimination were assessed with receiver operating characteristic curves.

Results: Both somatosensory evoked potentials and motor evoked potentials were measured in 822 patients undergoing open distal aortic repair between December 2004 and December 2019. Both motor evoked potentials and somatosensory evoked potentials were intact for the duration of surgery in 348 patients (42%). Isolated motor evoked potential loss was observed in 283 patients (34%). Isolated somatosensory evoked potential loss were observed in 173 patients (21%), and both motor evoked potential and somatosensory evoked potential loss were observed in 18 patients (3%). No spinal cord ischemia occurred in the 18 cases with isolated somatosensory evoked potential loss. When both signals were lost, signal loss happened in the order of motor evoked potentials and then somatosensory evoked potentials. Immediate spinal cord ischemia occurred in none of those without signal loss, 4 of 283 (1%) with isolated motor evoked potential loss, and 15 of 173 (9%) with motor evoked potential plus somatosensory evoked potential loss. Delayed spinal cord ischemia occurred in 12 of 348 patients (3%) with intact evoked potentials, 24 of 283 patients (8%) with isolated motor evoked potentials loss, and 27 of 173 patients (15%) with motor evoked potentials + somatosensory evoked potentials loss ($P < .001$). Motor evoked potentials and somatosensory evoked potentials loss were each independently associated with spinal cord ischemia. For immediate spinal cord ischemia, no return of motor evoked potential signals at the conclusion of the surgery had the highest odds ratio of 15.87, with a receiver operating characteristic area under the curve of 0.936, whereas motor evoked potential loss had the highest odds ratio of 3.72 with an area under the curve of 0.638 for delayed spinal cord ischemia.

Conclusions: Somatosensory evoked potentials and motor evoked potentials are both important monitoring measures to predict and prevent spinal cord ischemia during and after open distal aortic repairs. Intraoperative motor evoked potential loss is a risk for immediate and delayed spinal cord ischemia after open distal aortic repair, and somatosensory evoked potential loss further adds predictive value to the motor evoked potential. (J Thorac Cardiovasc Surg 2023;165:944-53)

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Read at the 100th Annual Meeting of The American Association for Thoracic Surgery: A Virtual Learning Experience, May 22-25, 2020.

Received for publication July 14, 2020; revisions received July 14, 2021; accepted for publication Aug 9, 2021; available ahead of print Aug 20, 2021.

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0022-5223/$36.00

https://doi.org/10.1016/j.jtcvs.2021.08.033

Impact of intraoperative MEP and SSEP loss on SCI during open distal aortic repair.

CENTRAL MESSAGE

MEP loss was a risk for any SCI after distal aortic repair, and SSEP loss further added predictive value.

PERSPECTIVE

MEP and SSEP are important monitoring measures to predict and prevent SCI during and after open distal aortic repairs.

See Commentaries on pages 954 and 956.

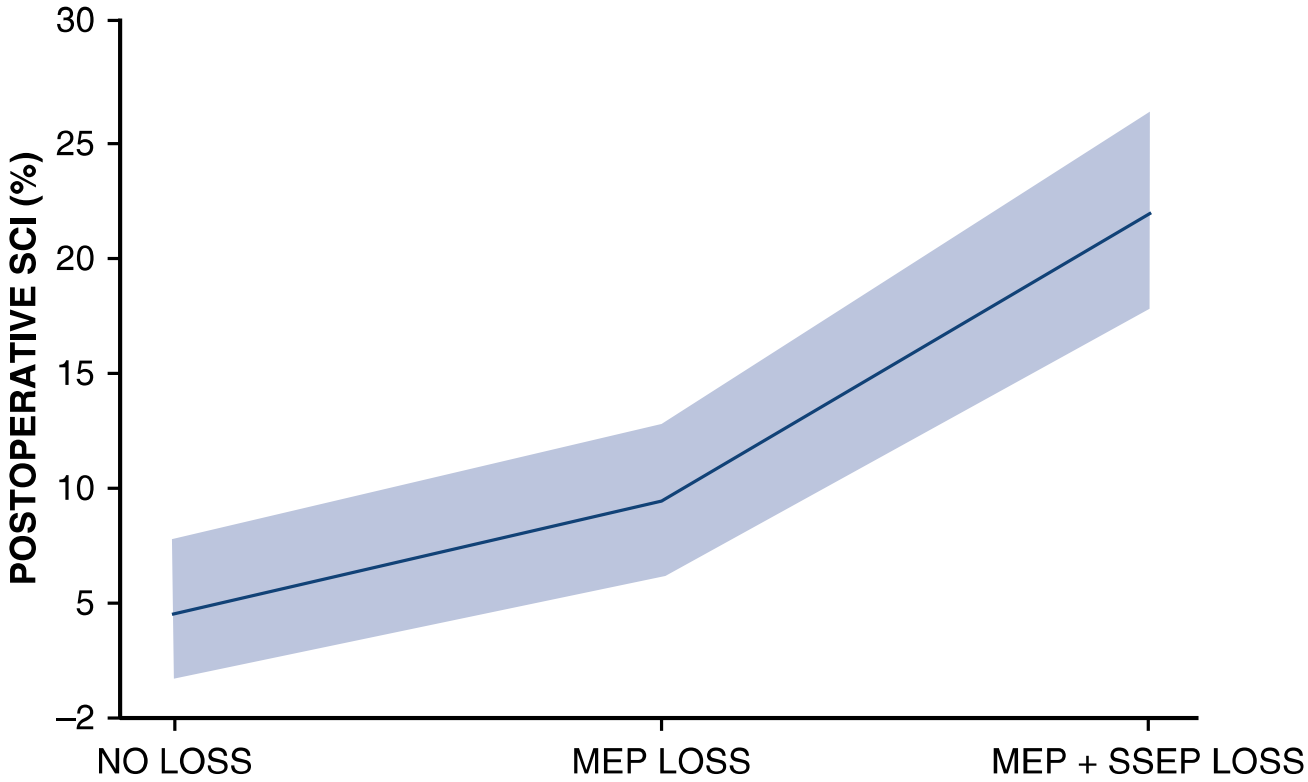
Descending/TAAA
Recorded MEP &SSEP
2004-2019
N=822

64-year-old (IQR: 52-72)

65% ♂ 35% ♀

Tanaka A. J Thorac Cardiovasc Surg 2023;165:944-53

Any SCI vs. MEP/SSEP Loss



MEP/SSEP in Endovascuar TAAA repair (Systematic Review)

ELSEVIER

Neuromonitoring during Endovascular Thoracoabdominal Aortic Aneurysm Repair: A Systematic Review

Myat Soe Thet,[1] Mario D'Oria,[2] Daverin Sef,[3] Tomislav Klokovovnik,[4] Aung Ye Oo,[5] and Sandro Lepidi,[6] Southampton and London, United Kingdom; Trieste, TS, Italy; and Celje, Slovenia

Background: Spinal cord ischemia (SCI) is a potentially devastating complication of thoracic endovascular aortic repair (TEVAR) and fenestrated-branched endovascular aortic repair (F-BEVAR). The aim of this systematic review was to evaluate the efficacy of neuromonitoring modalities to mitigate the risk of SCI during TEVAR and F-BEVAR procedures.

Methods: Following the PRISMA guidelines, we conducted a detailed literature search of databases including PubMed, MEDLINE via Ovid, Embase, Scopus, and Cochrane CENTRAL, from 1998 to the present. Inclusion criteria were original research articles examining neuromonitoring during TEVAR and F-BEVAR. The primary outcome was the incidence of SCI, while the secondary outcome included early mortality. The quality of studies was assessed using the Newcastle–Ottawa Scale.

Results: From 1,450 identified articles, 11 met inclusion criteria, encompassing data from 1,069 patients. Neuromonitoring modalities included motor-evoked potentials (MEPs), somatosensory evoked potentials (SSEPs), and near-infrared spectroscopy. The combination of MEPs and SSEPs was most commonly used, with 93% sensitivity and 96% specificity for detecting SCI risks. SCI incidence ranged from 3.8 to 17.3%, with permanent deficits occurring in 2.7–5.8% of cases. In-hospital mortality ranged from 0.4 to 8%. Risk factors for SCI were identified, including operation duration and extent of aortic coverage.

Conclusions: Neuromonitoring with MEPs and SSEPs appears to be effective in detecting perioperative SCI risk during TEVAR and F-BEVAR. However, discrepancies between neuromonitoring changes and actual SCI outcomes suggest the need for cautious interpretation. While the incidence of SCI remains variable, identified risk factors may guide clinical decisions, particularly in high-risk procedures. Future research should focus on prospective studies and randomized controlled trials to validate these findings and improve SCI prevention strategies in TEVAR and F-BEVAR.

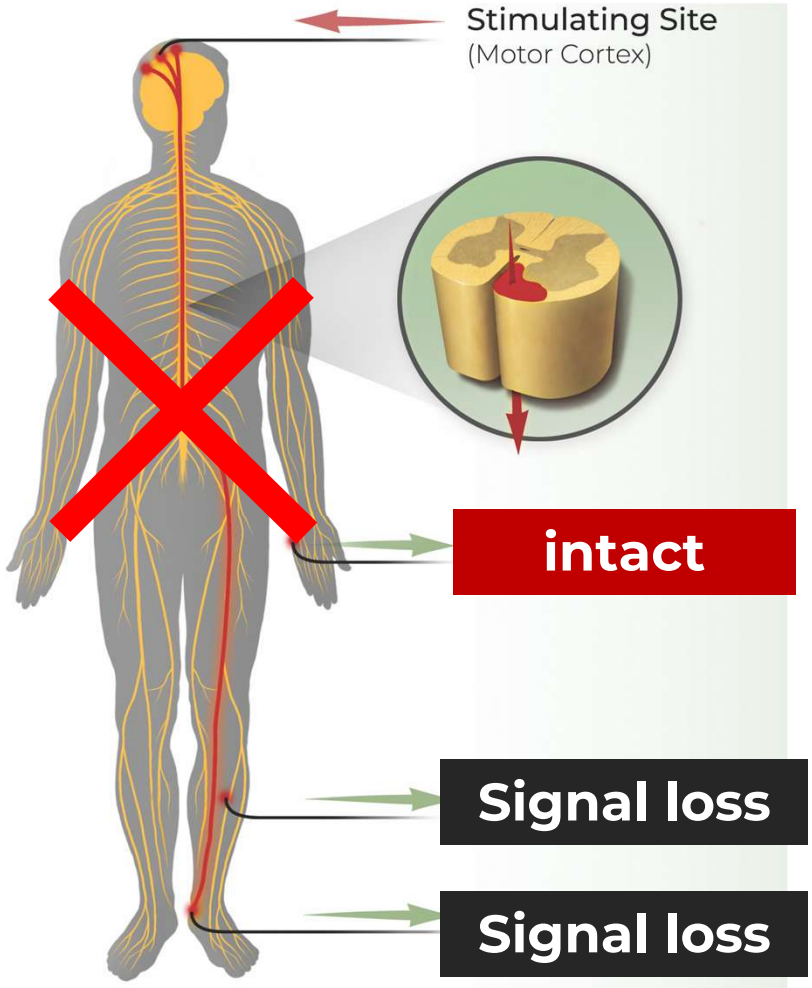
1998-2023
11 Studies
1069 Patients

SCI: 3.8-17.3%
MEP+SSEP signal loss
Sn 93% Sp 96%

Author (Year)	N	ICA Reconstruction	Neuromonitor	SCI	Mortality
Davidovic (2011)	118	Routine		9%	25%
Okita (2012)	156	Adamkiewicz	MEP	10%	13%
Pillai (2013)	131	SSEP guided	SSEP	3%	NR
Tanaka (2015)	100	Adamkiewicz	MEP	2%	5%
Coselli (2016)	3309	NR		5%	7%
Murana (2016)	542	Routine	MEP & SSEP	6%	11%
Shimamura (2019)	393	Routine		11%	6%
Harky (2021)	273	Routine	MEP	9%	18%
Gombert (2022)	255	MEP guided	MEP	7%	20%
Chiesa (2023)	652	Routine	MEP & SSEP	8%	8%

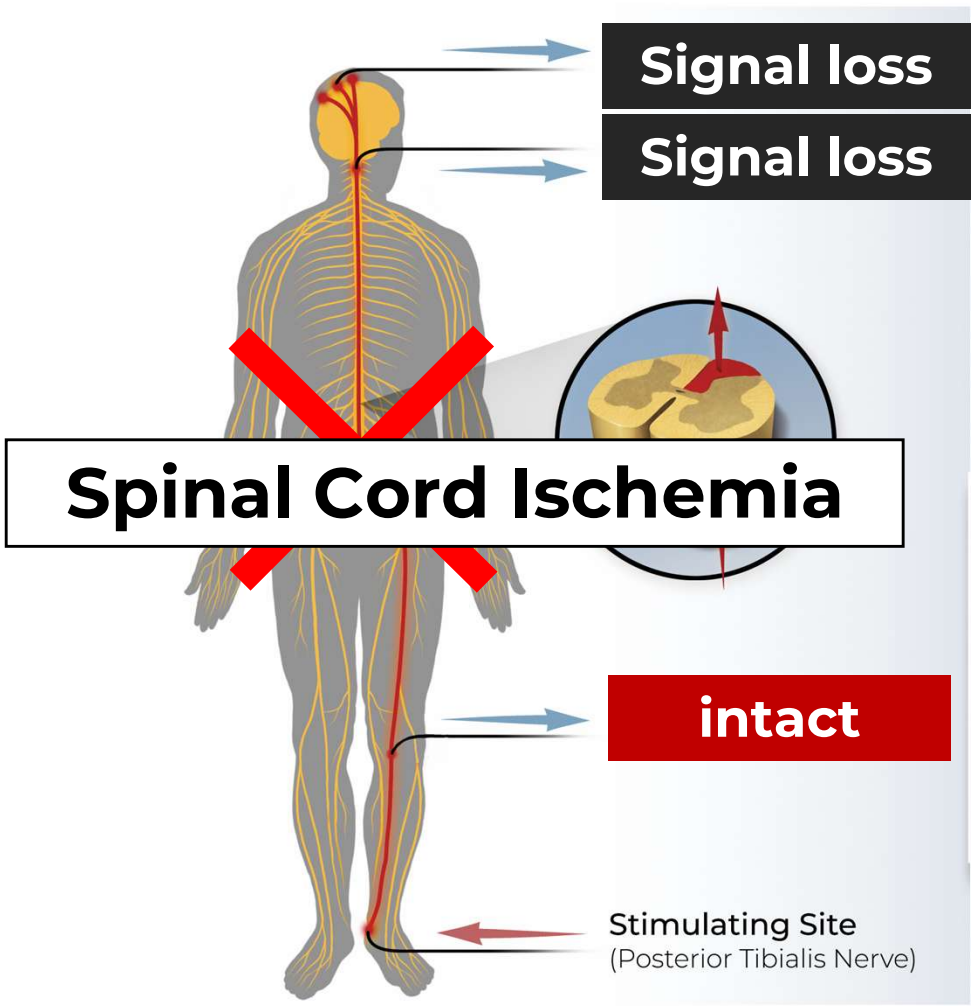
Benefit of Using Both MEP/SSEP?

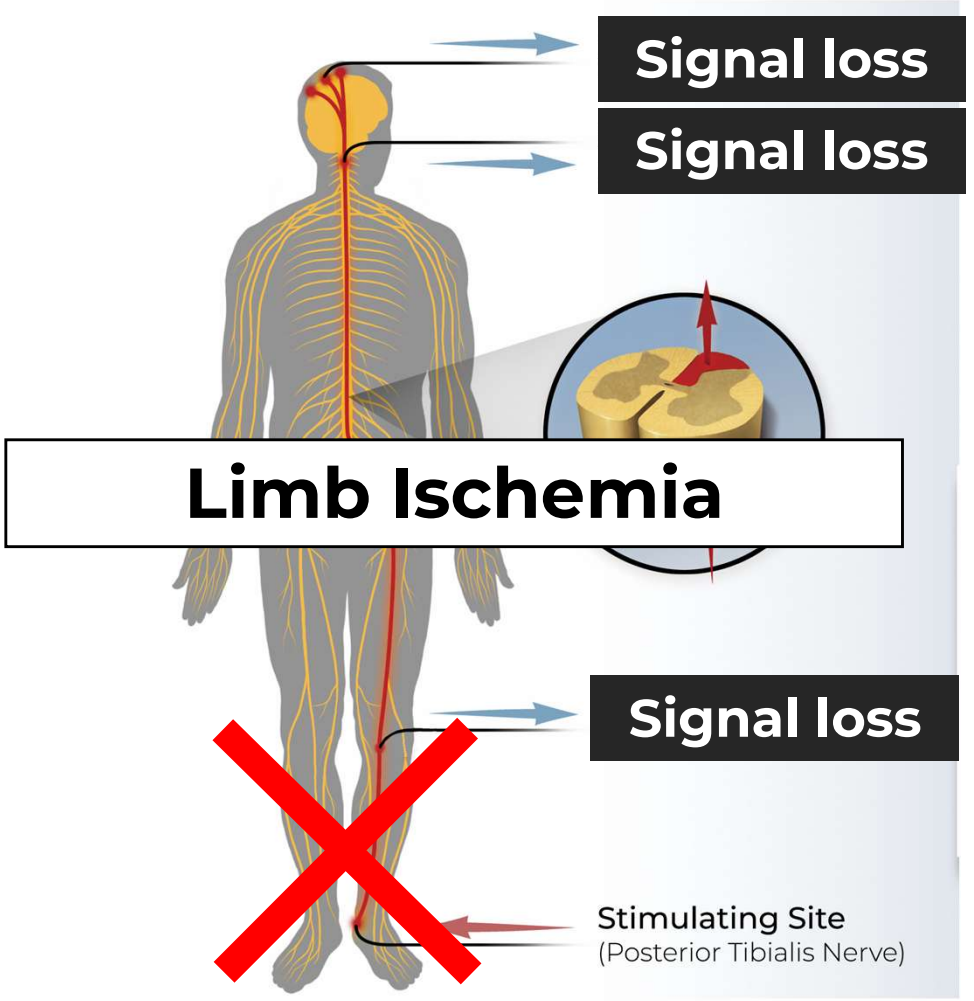
MEP



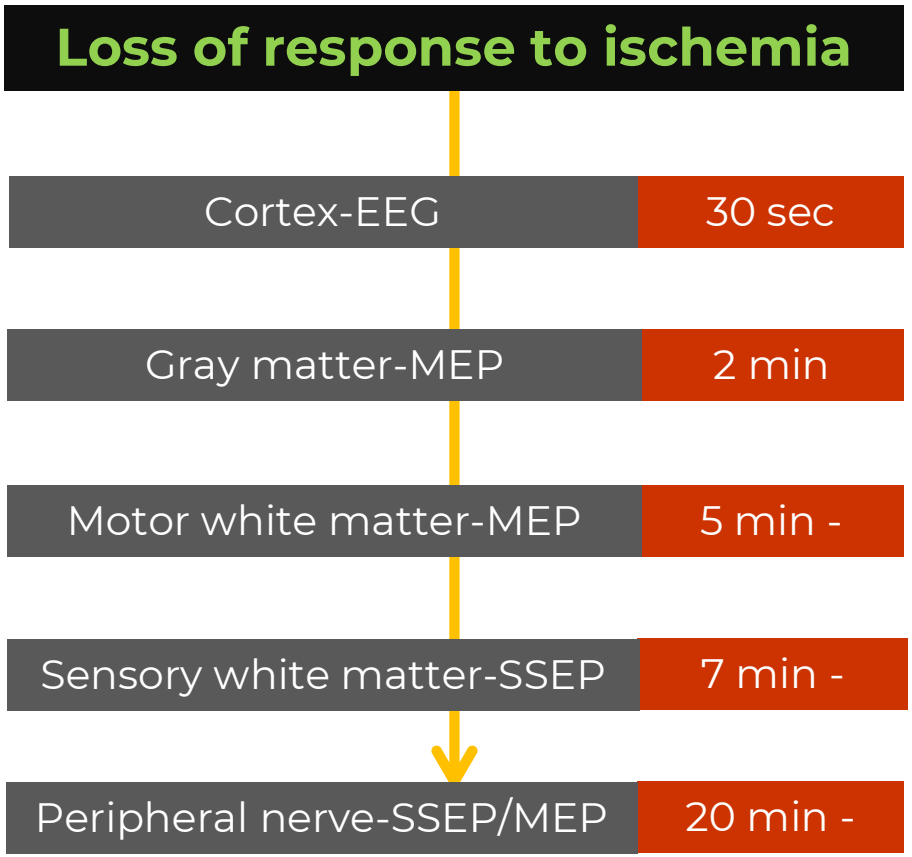
Spinal Cord Ischemia?
Leg Ischemia??

SSEP


Signal loss
Signal loss
Spinal Cord Ischemia
intact
Stimulating Site
(Posterior Tibialis Nerve)


Signal loss
Signal loss
Limb Ischemia
Signal loss
Stimulating Site
(Posterior Tibialis Nerve)

MEP vs. SSEP Signal Loss Timeline



MEP loss:

Gray matter penumbra

no infarct yet

SSEP loss:

Gray matter **penlucida**

beginning of infarct

White matter **penumbra**

MEP - / SSEP +

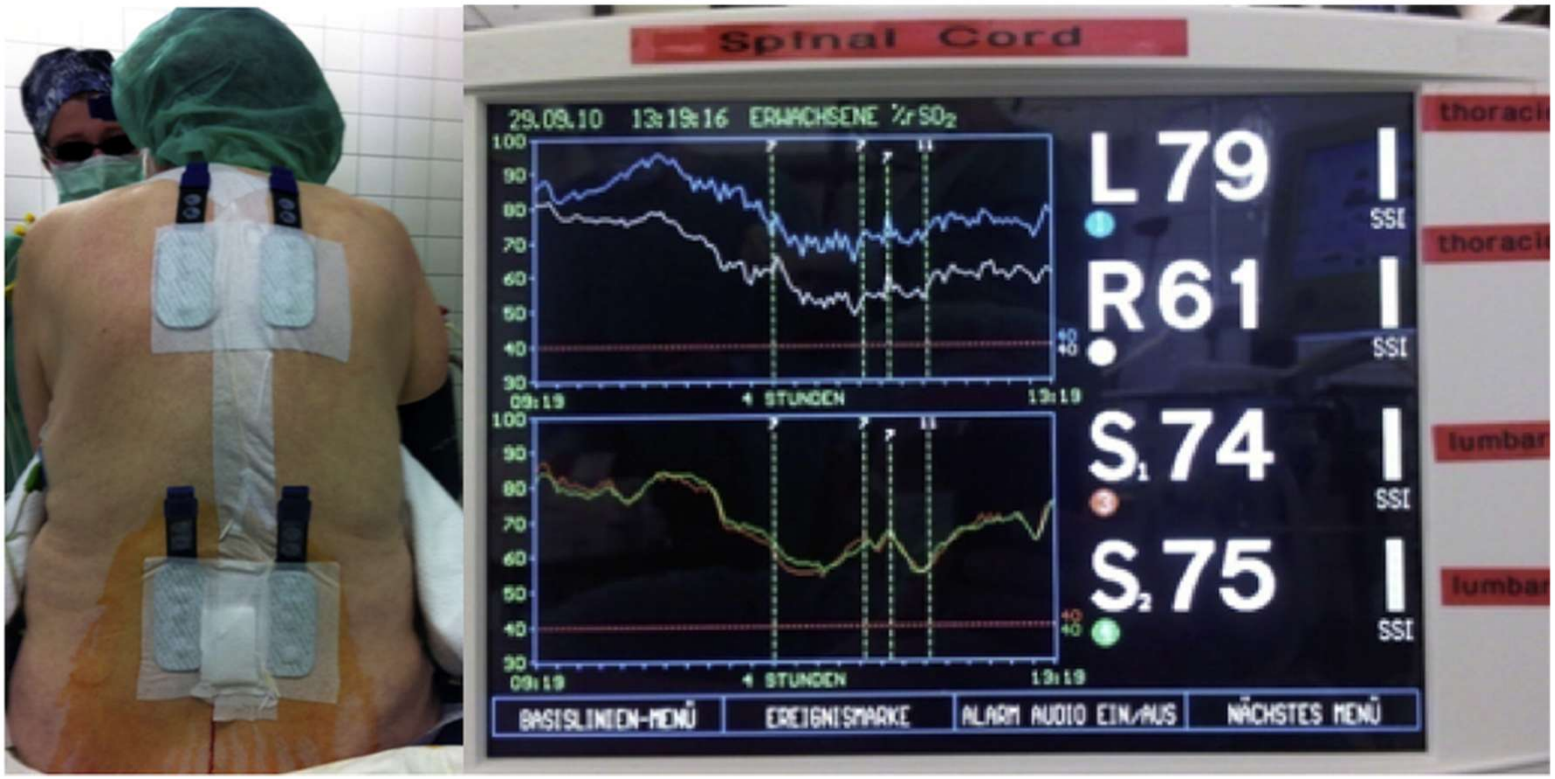
Early ischemia
Reversible

MEP - / SSEP -

Advanced ischemia
Irreversible

Other Neuromonitoring Options?

NIRS Monitoring of the Collateral Network



Clinical Use of NIRS?

e30 Abstracts

Journal of Vascular Surgery
Volume 70, Number 2

Journal of Vascular Surgery
August 2019

Detection of Spinal Cord Ischemia During Endovascular Thoracoabdominal Aneurysm Repair Using Near-Infrared Spectroscopy Monitoring

Hemodynamic Consequences of Eversion Versus Patch Angioplasty Carotid Endarterectomy

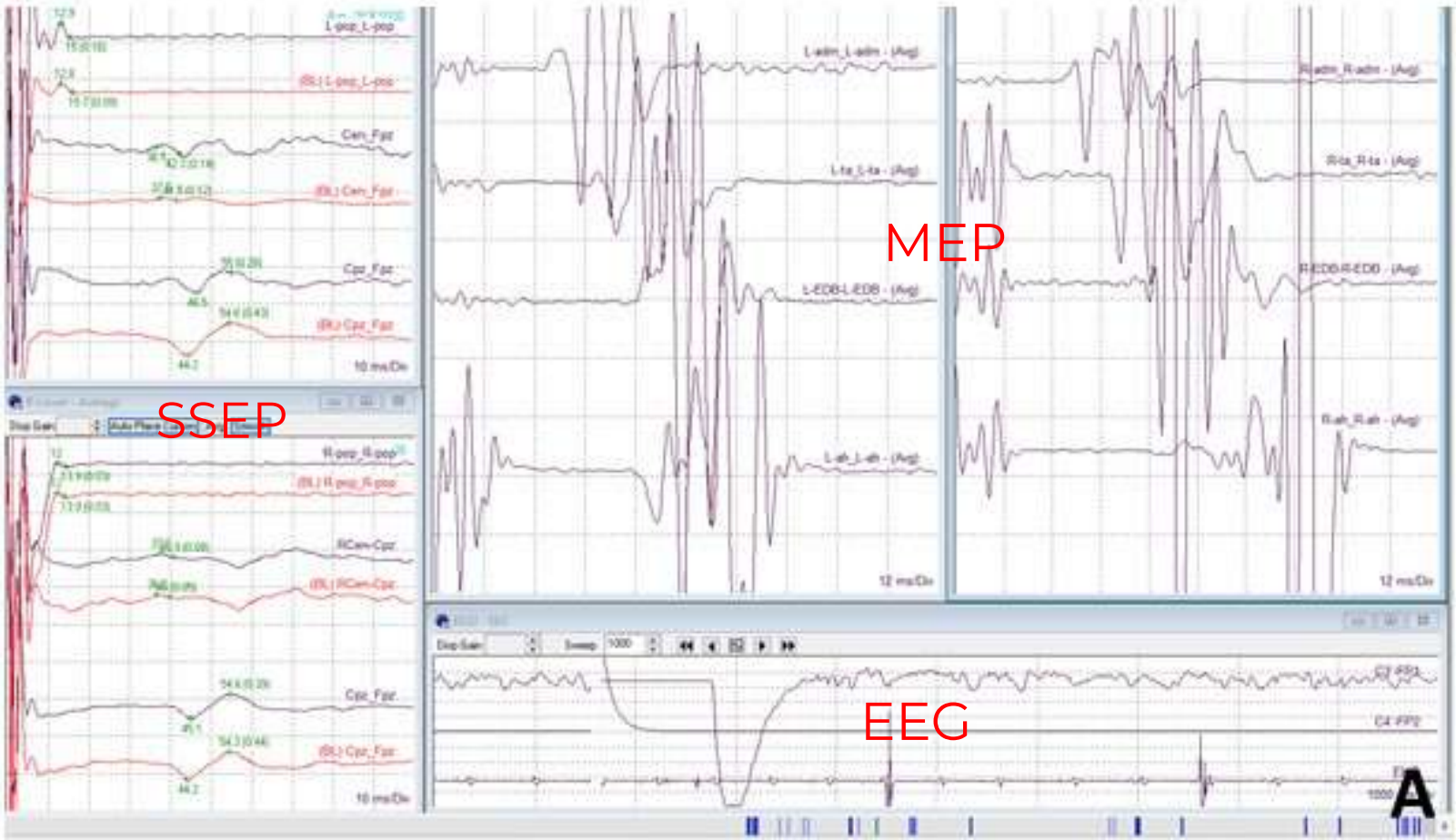
- Multicenter, N=109
- detecting SCI
  - Sn NIRS 33%
  - Sp NIRS 99%

Ok to use muscle relaxant
Ok to use in ICU

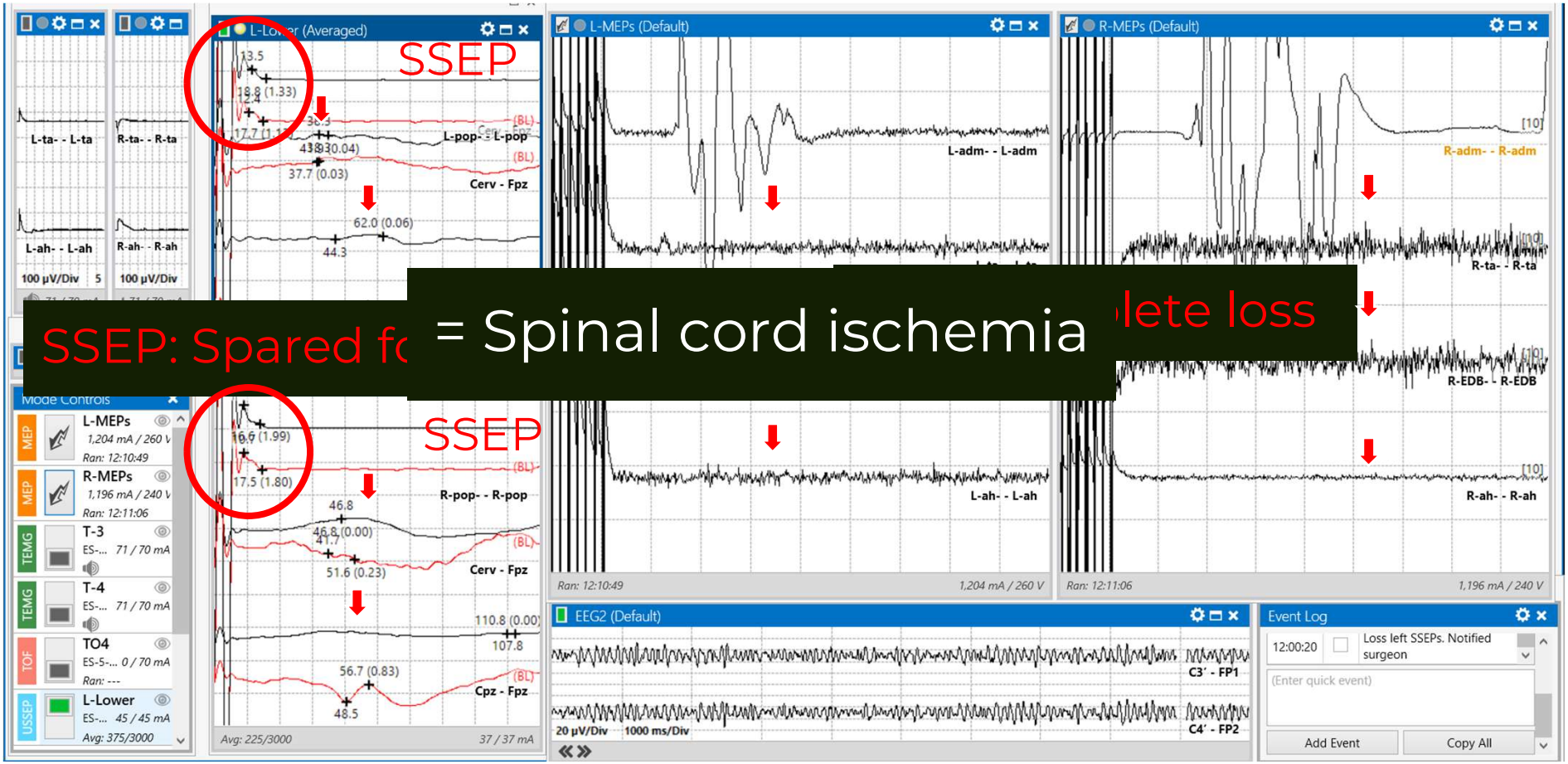
Lewis CT. J Vasc Surg 2019; 70: e30-e31

Open Repair:
Extent IV TAAA+Previous TEVAR

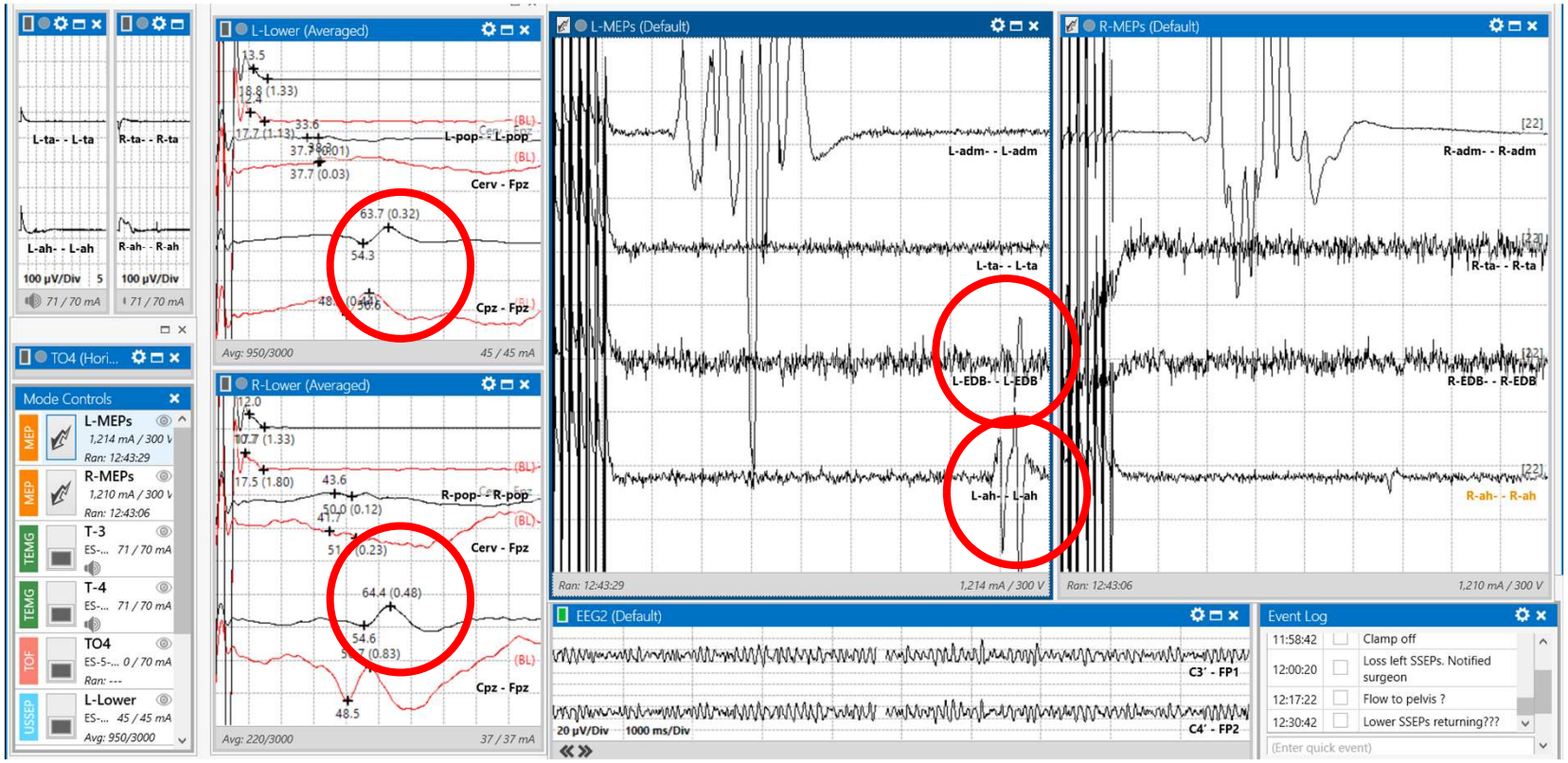
Baseline



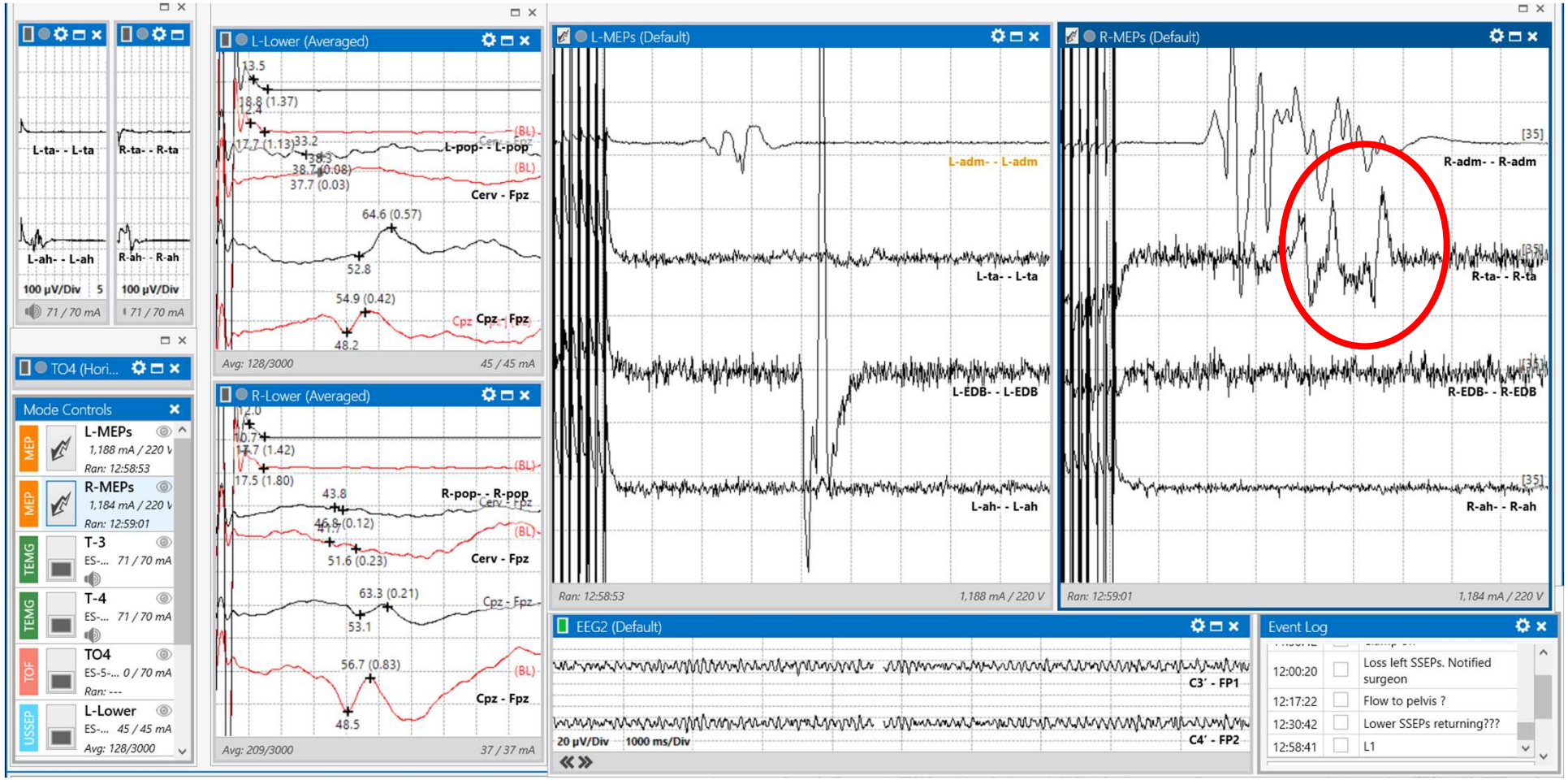
Immediate MEP Loss After T12 Clamp



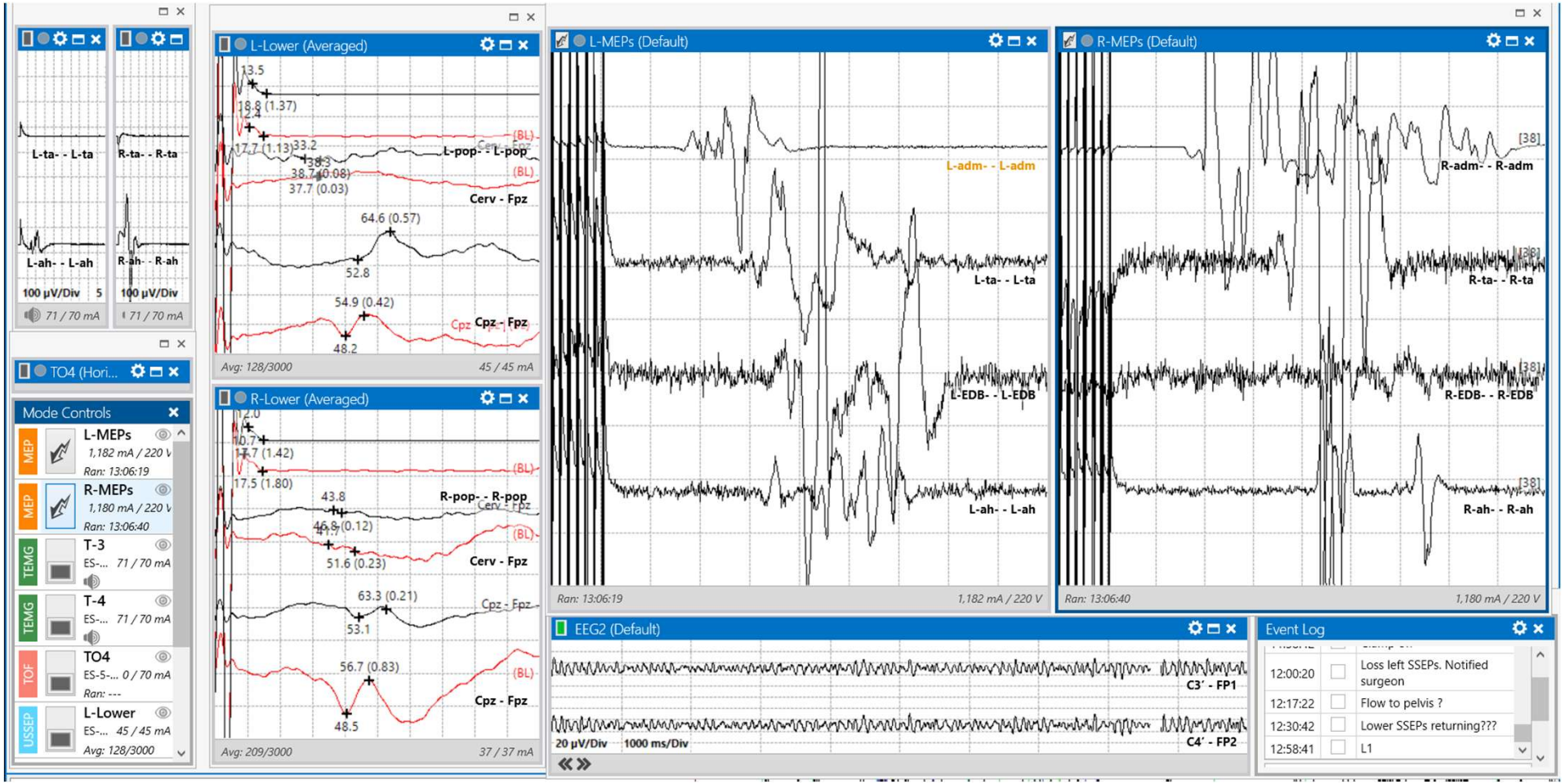
SSEP + partial MEP recovery with BP>160mmHg/CSFD

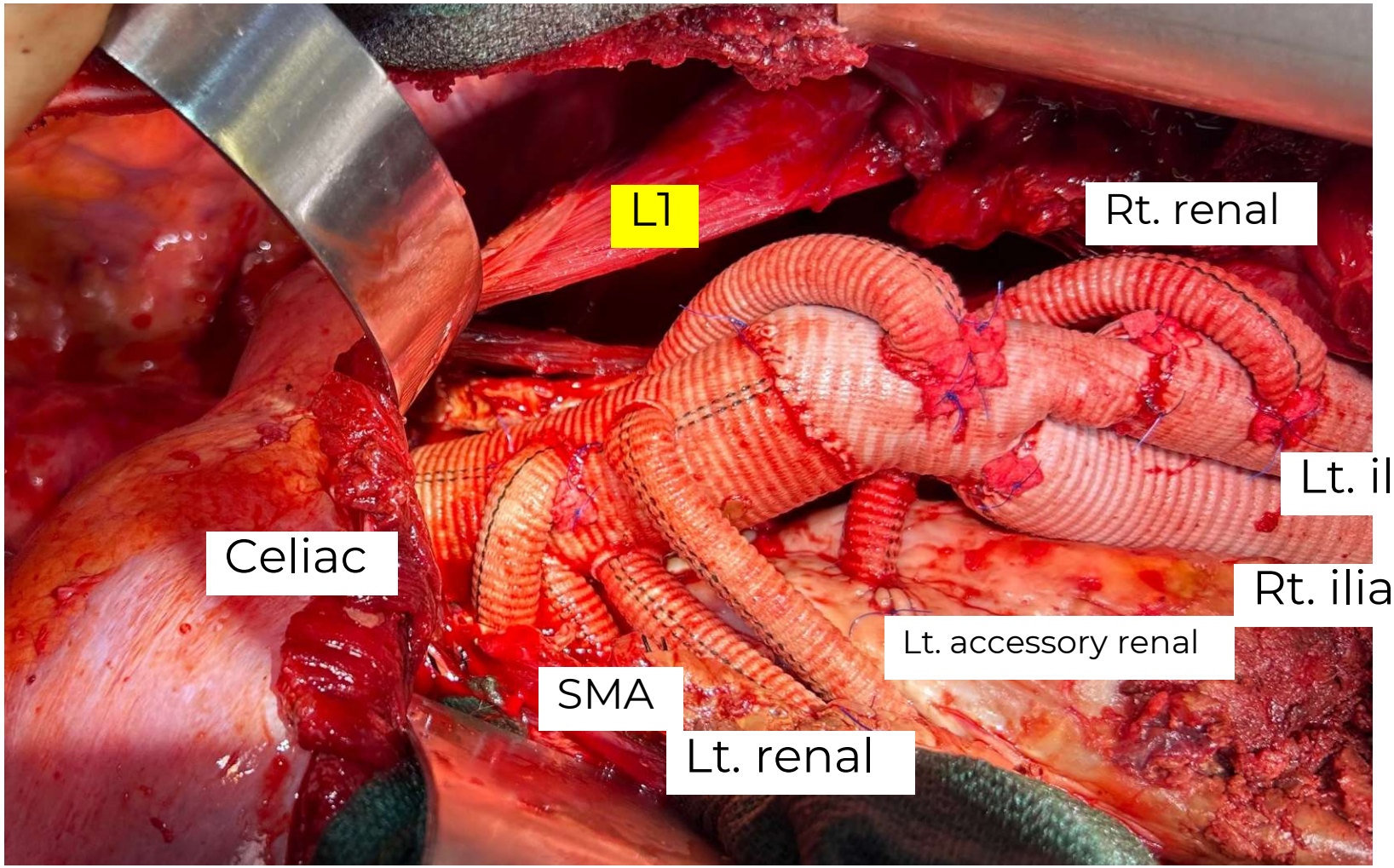


More MEP Signals with Pulsatile Flow to the Pelvis



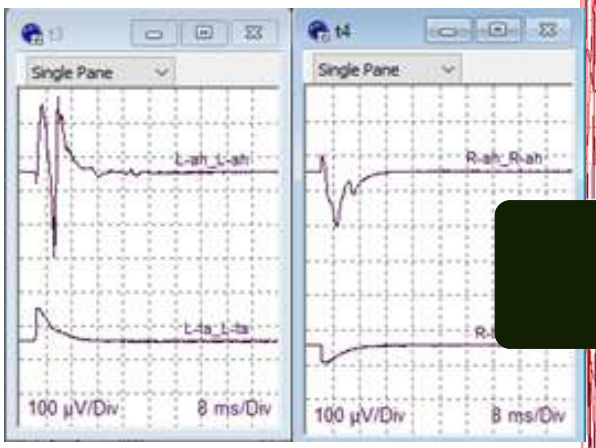
Full Recovery After L1 Reconstruction



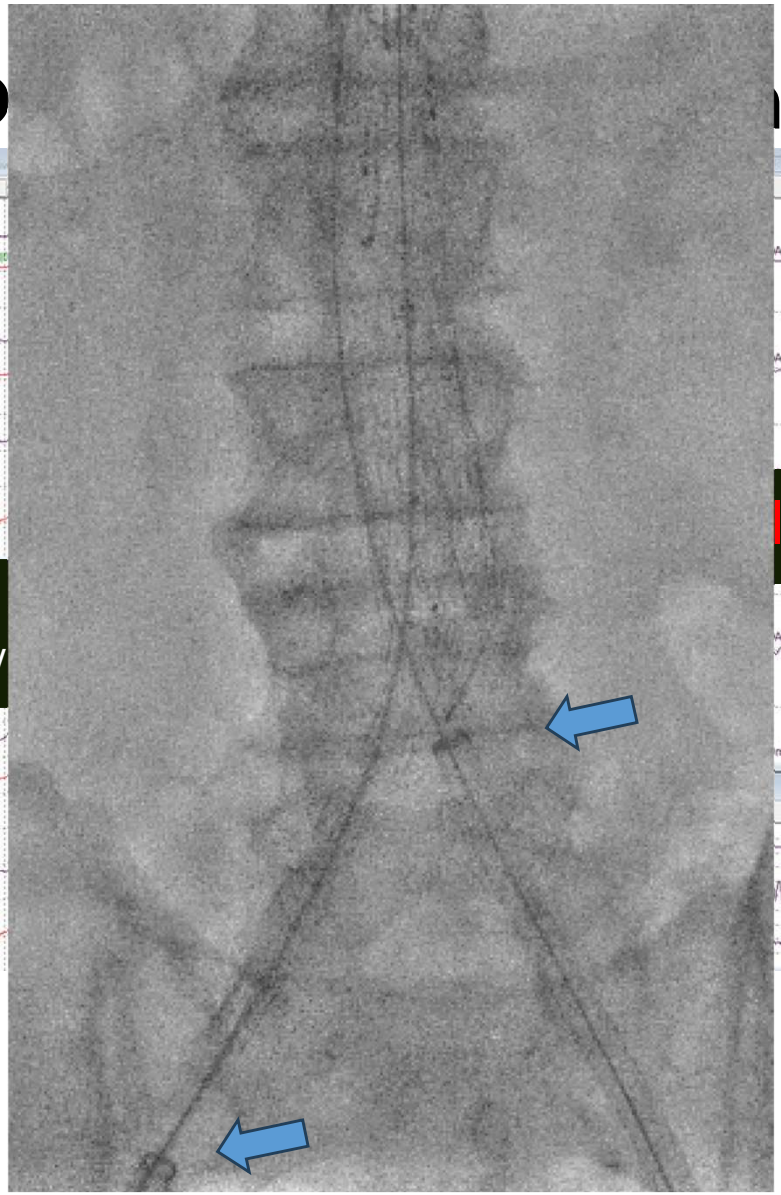

L1
Rt. renal
Lt. iliac
Celiac
Rt. iliac
Lt. accessory renal
SMA
Lt. renal

Endo TAAA: Extent IV TAAA

Signal Loss D nulation



Right foot SSEPLoss



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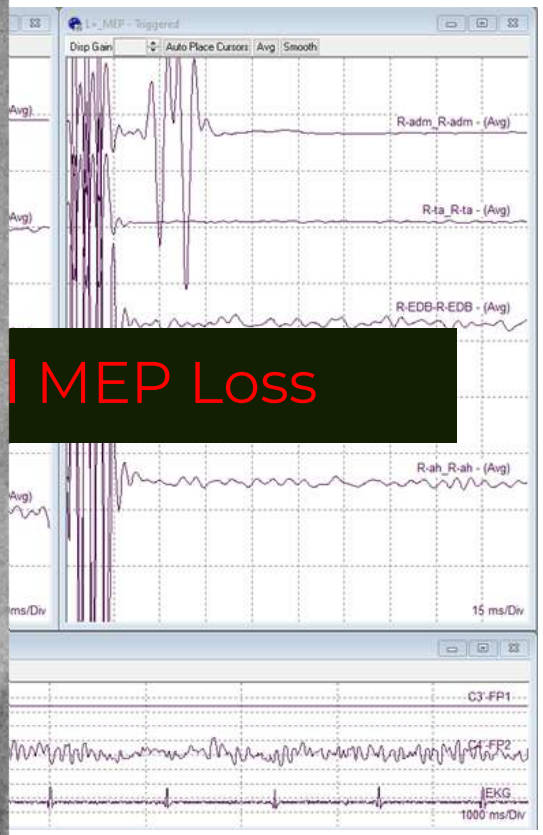
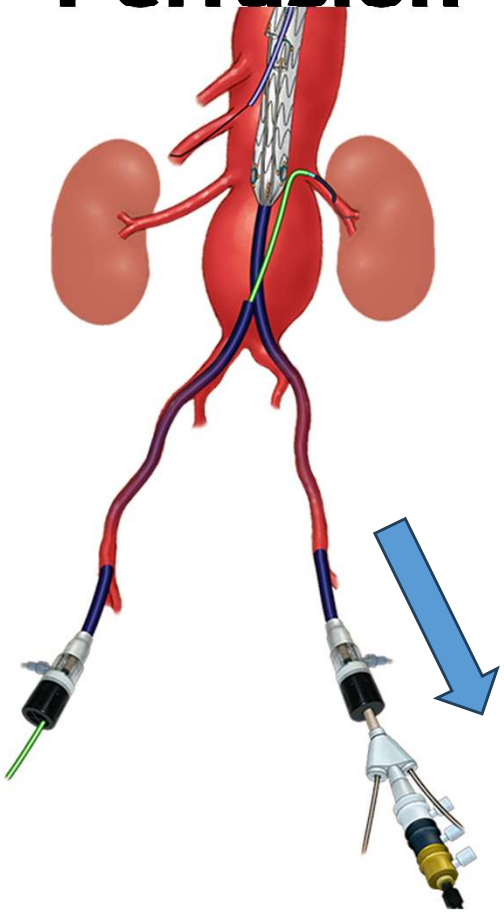
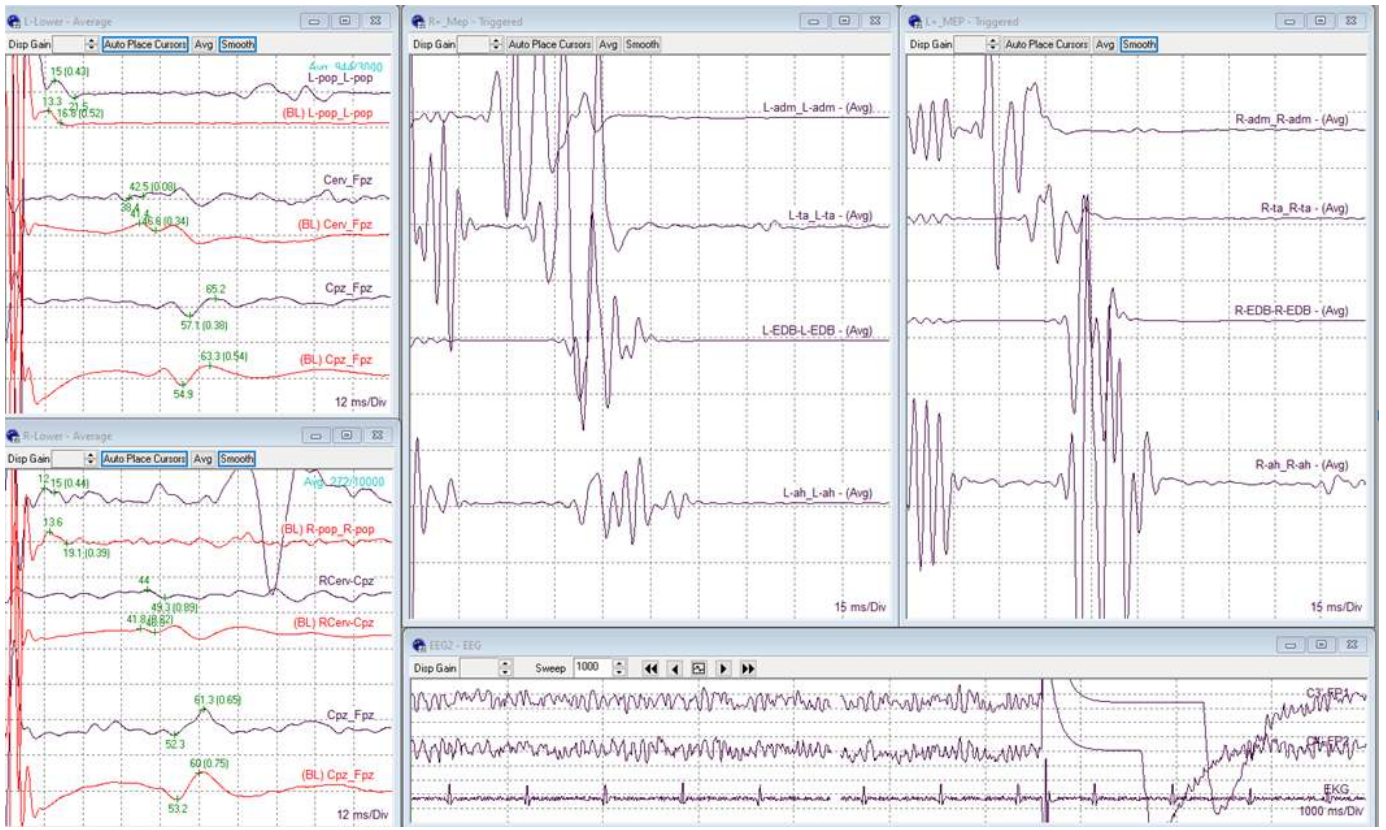


l MEP Loss

All Recovered With Left Internal Iliac Artery Perfusion+SBP>160mmHg





If MEP/SSEP signals are lost...

Anesthesiologists/Perfusionists

Increase blood pressure (>140mmHg)
Optimize hematocrit
Drain CSF <5-10cmH_2O

Open Repair

Surgeons

Re-establish pulsatile flow to the pelvis
= Unclamp the aorta
Increase ICA perfusion
=Reattach ICAs (T8-T12)

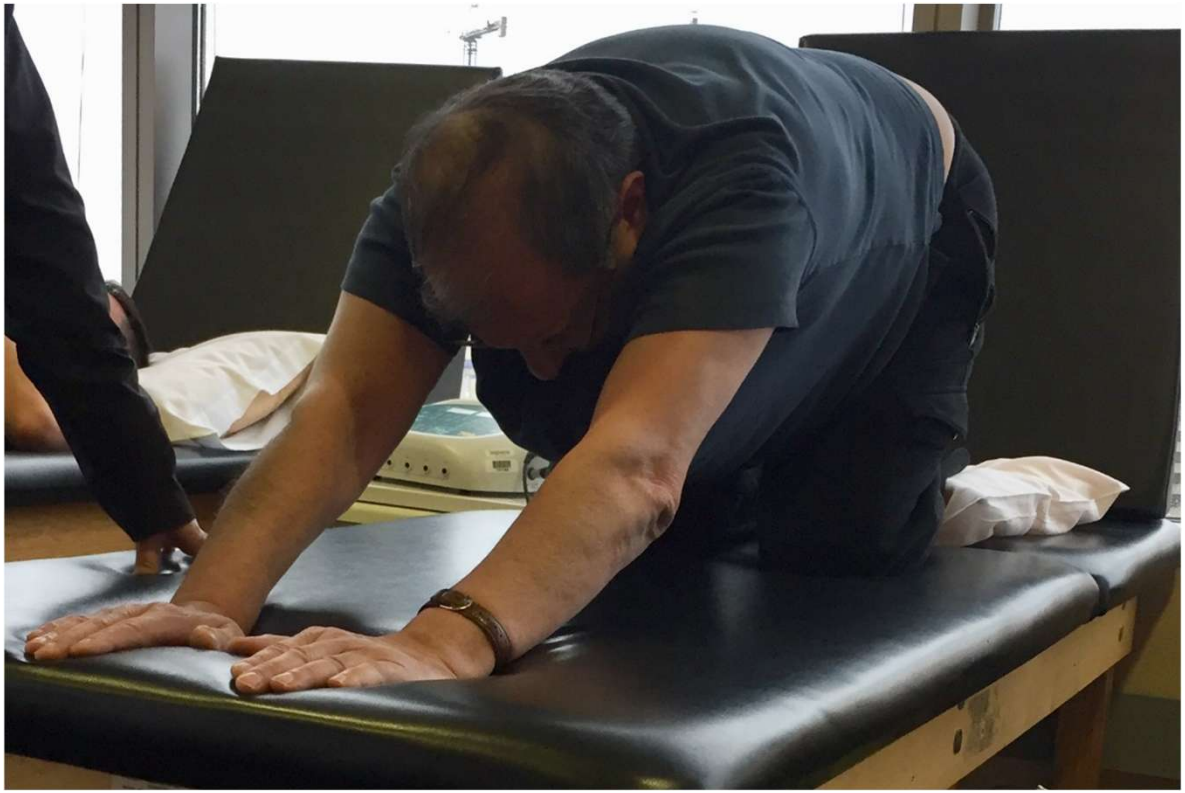
Endovascular

Surgeons

Re-establish pulsatile flow to the pelvis
= Downsize/pull back sheath
Constrain device
Increase ICA Perfusion
=Keep the aneurysm sac open

Summary

Just PRAY for the best?



Or have actionable data?

Thank You!

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Vascular Surgery

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UTH_CVSurgery
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https://med.uth.edu/cvs/