The Benefits of Neuromonitoring

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Neuromonitoring (IOM) Basics

Brief Synopsis of IOM

What is Neuromonitoring?

- Multi-modality approach to safeguard patients during several surgical procedures

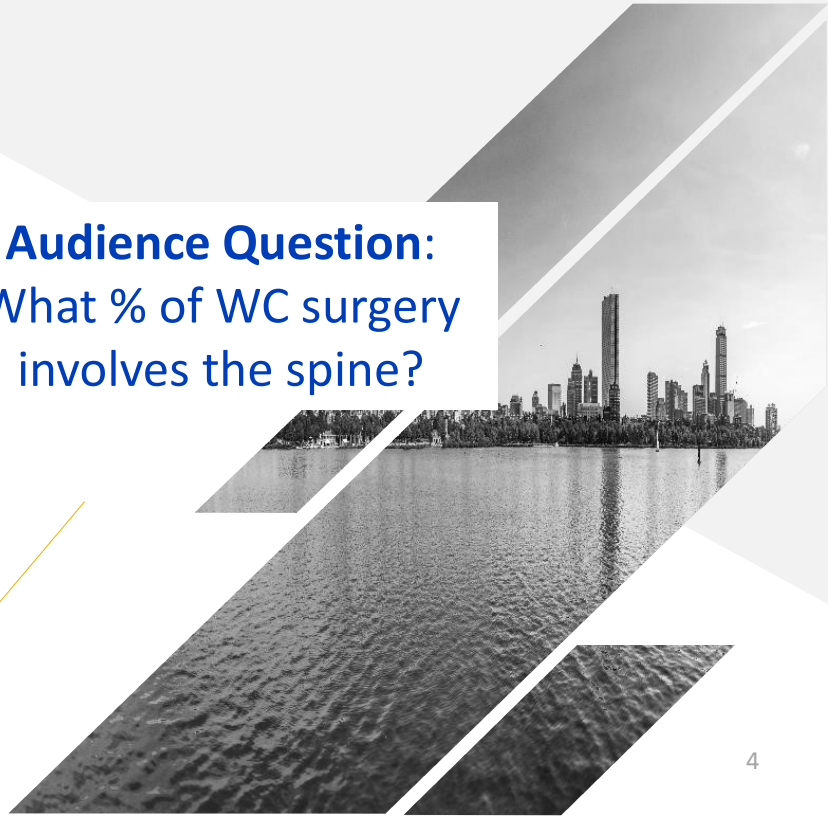
- Overall goal is to:
  - Increase patient safety and positive outcome
  - Limit post-operative complications
  - Reduce overall cost of patient treatment

Procedures Benefitting from IOM

IOM usage is determined by surgeon

- Spine/Neurologic Surgery
  - **ACDF** – Anterior Cervical Discectomy and Fusion
  - **Lumbar Fusions**
    - PLIFs, TLIFs, ALIFs, lateral approaches etc.
  - **Thoracolumbar Fusions**
    - Scoliosis Correction
    - Burst/compression fractures
  - **Spinal Cord Stimulator (SCS) placement**

Audience Question:
What % of WC surgery involves the spine?



How Does It Work?

Oversimplified Introduction

- **SSEP** – Somatosensory Evoked Potentials
- **TcMEP** – Transcranial Motor Evoked Potentials
- **sEMG** – Spontaneous Electromyography
- **TrEMG** – Triggered EMG (screw stimulation, direct nerve stimulation, lateral access stimulation, etc.)
- **EEG** – Electroencephalogram (aiding anesthesia in ensuring patient depth)

Benefits of IOM w/Case Presentation

1. Patient Positioning/ Safe Access
2. Hardware Verification
3. Prognostic Value

Patient Positioning/Safe “Access”

Hypothetical Case Presentation

- 35ish YO male fell at work, presented with neurologic symptoms (shooting arm pain, weakness, numbness in right arm)
- Surgeon determines C6-7 ACDF is necessary treatment and requests IOM
- Surgical Steps:
  - Pt on bed > Intubation > IOM set up/baselines > Shoulder traction/taping for access

Patient Positioning/Safe "Access" cont.

Hypothetical Case Presentation ACDF

- IOM changes after taping, during surgical site prep
  - What does it look like?
  - What is the corrective move?
  - If it's not from the tape, what could it be?
    - Blood Pressure?
    - Anesthesia?
    - Overextension of neck?

Real Case Presentation

What IOM Changes Look Like and Corrective Action

Green = Baselines

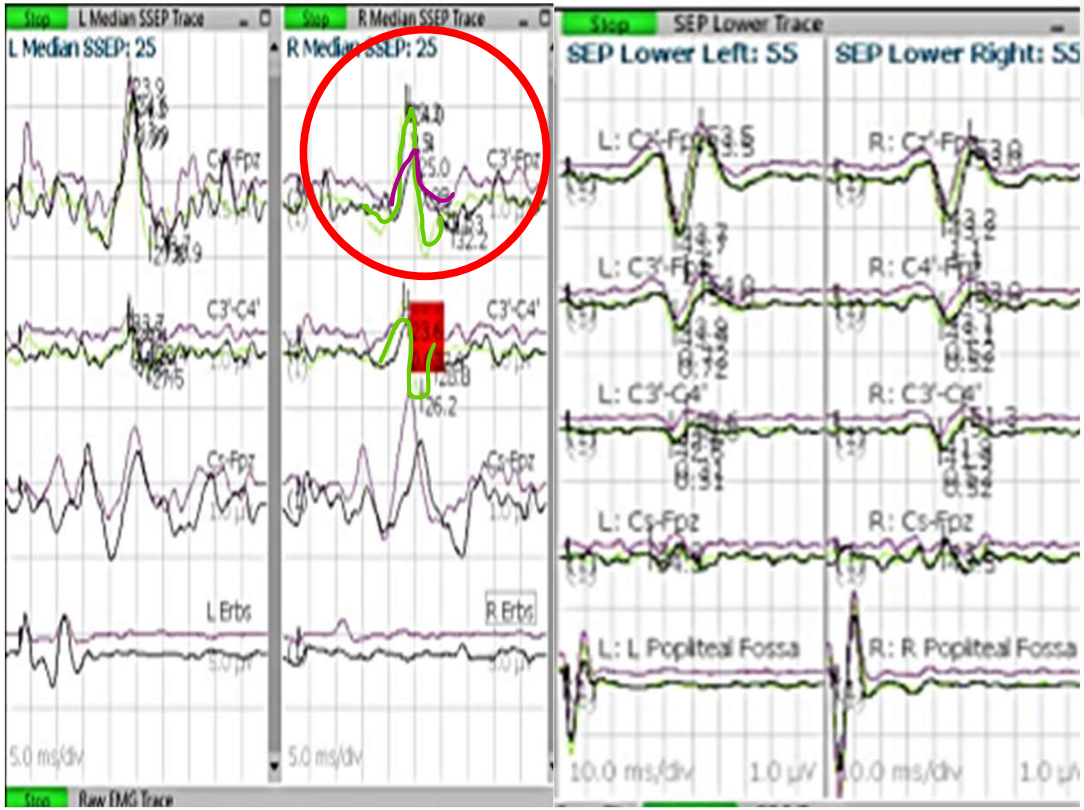
Purple = Last Average

Black = Current Data

1223 Baselines

1257 Right Median Nv. Alert

1258 Released Shoulder Tape



Real Case Presentation

What IOM Changes Look Like and Corrective Action

Green = Baselines

Purple = Last Average

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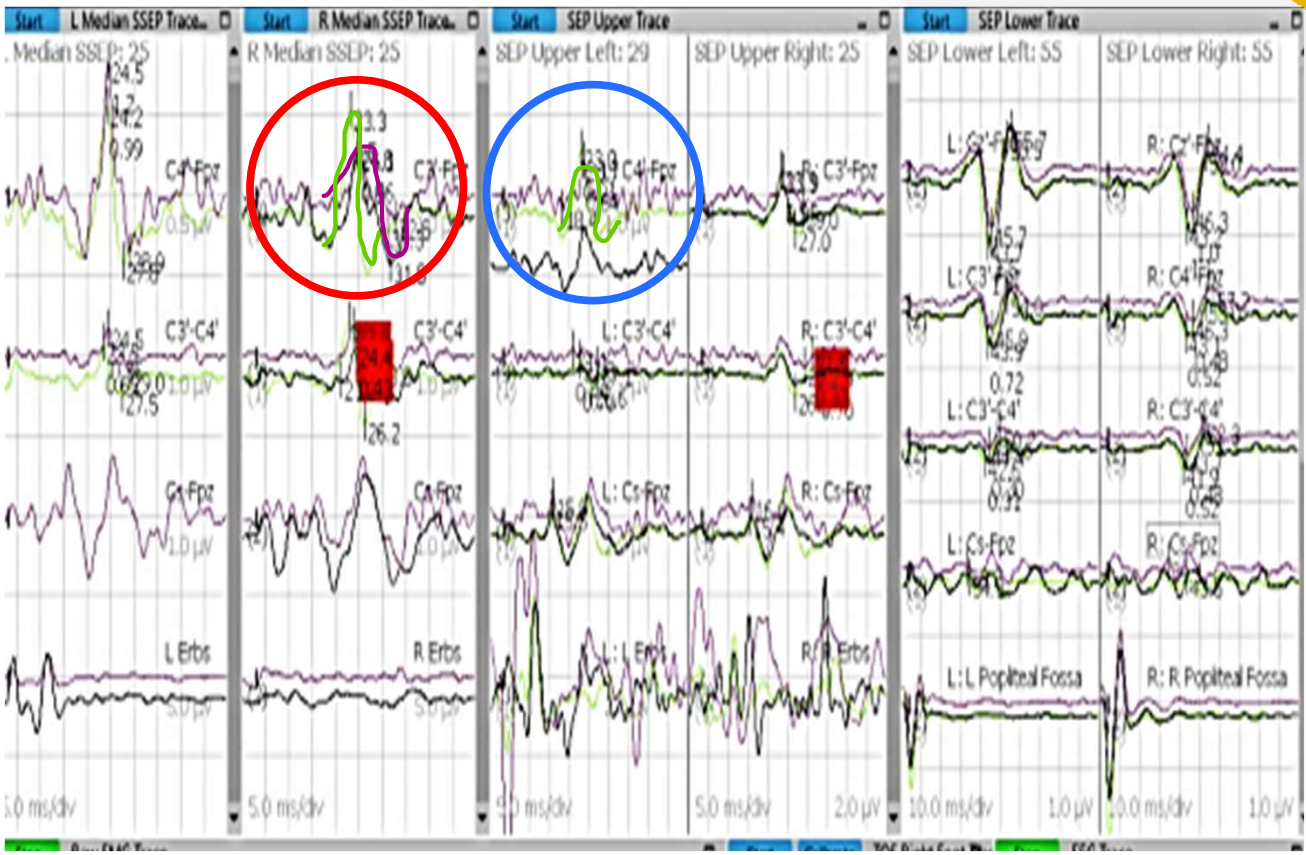
1258 Bilateral Tape Release

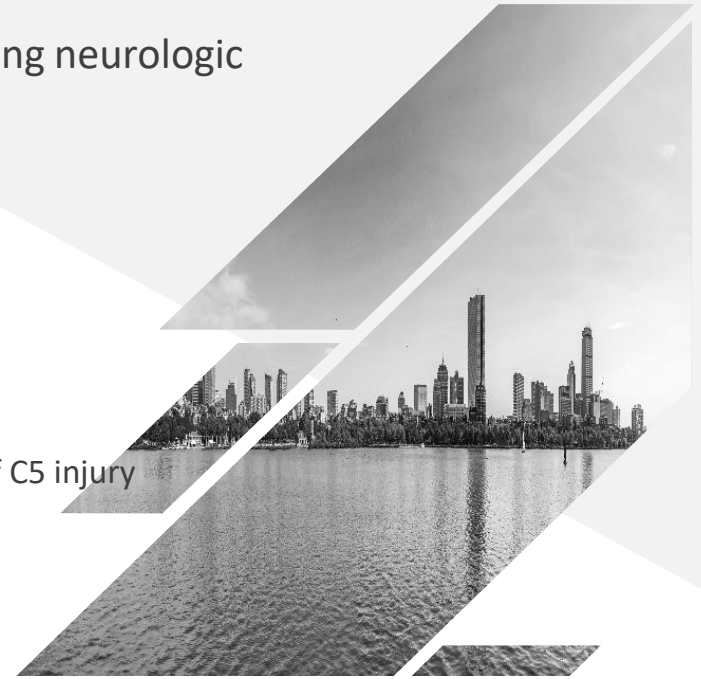
1310 Recovery of Right Median

Improvement of left ulnar



Patient Positioning Overview

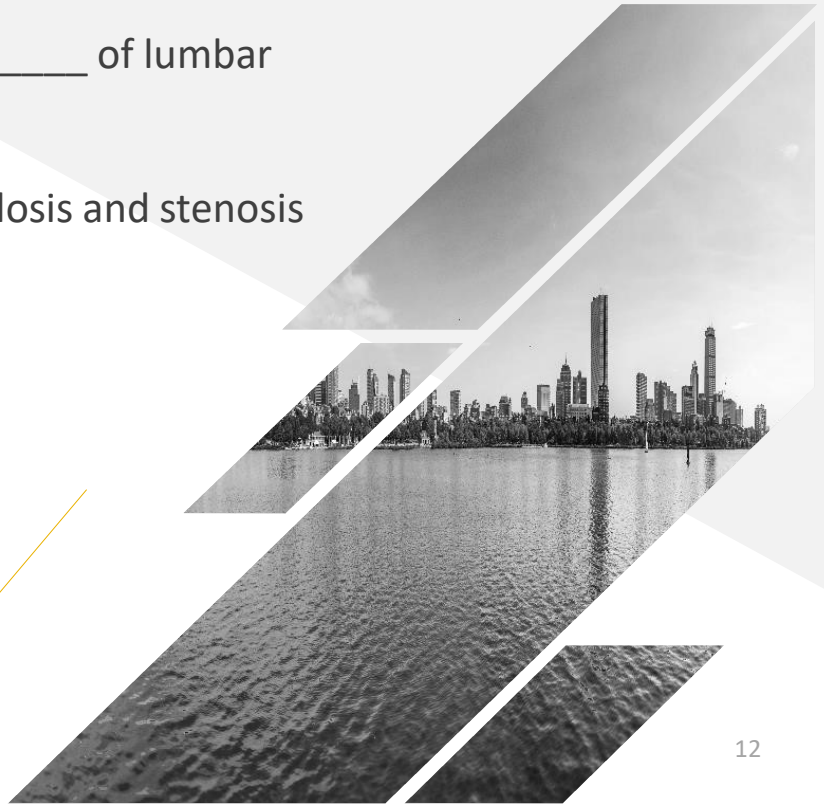
- For ACDFs:
  - 69/3806 patients (1.8%) showed IOM evidence (alerts) of impending neurologic injury[1]
    - 65% of 'alerts' from brachial plexopathy (taping/traction)
    - 16% of 'alerts' from ulnar nerve traction
    - 19% of 'alerts' from neck overextension, spinal cord issues
  - IOM reduces the rate of C5 palsy[2]
    - 4.56% of patients without IOM had C5 injury v. 0.84% with IOM
      - Some studies estimate 30% of cervical procedures have some degree of C5 injury
    - Long C5 Palsy and Short C5 palsy



- 1 Schwartz et. Al, "Neurophysiological Identification of Position-Induced Neurologic Injury During Anterior Spine Surgery" Journal of clinical Monitoring and Computing 2006
- 2 Bose B., et Al., Neurophysiological Monitoring of Spinal Cord Function during instrumented anterior cervical fusion," Spine Journal, 2004

Patient Positioning Overview

- For Lumbar Fusion:
  - Brachial plexus impending neurologic issues occur in _____ of lumbar procedures
  - Anecdotal Utility of detecting undiagnosed cervical spondylosis and stenosis during prone positioning



Hardware Verification

- IOM can be utilized to verify safe placement of hardware
  - Pedicle screws (TrEMG, EMG, SSEP, MEP)
  - Interbody cages in Cervical, Thoracic and Lumbar Spine (SSEP, MEP, EMG)
  - Rod Placement (MEP, SSEP, EMG)
  - Anterior cage placement (MEPs)
  - Spinal Cord Stimulator Placement (EMG, SSEP, MEPs)

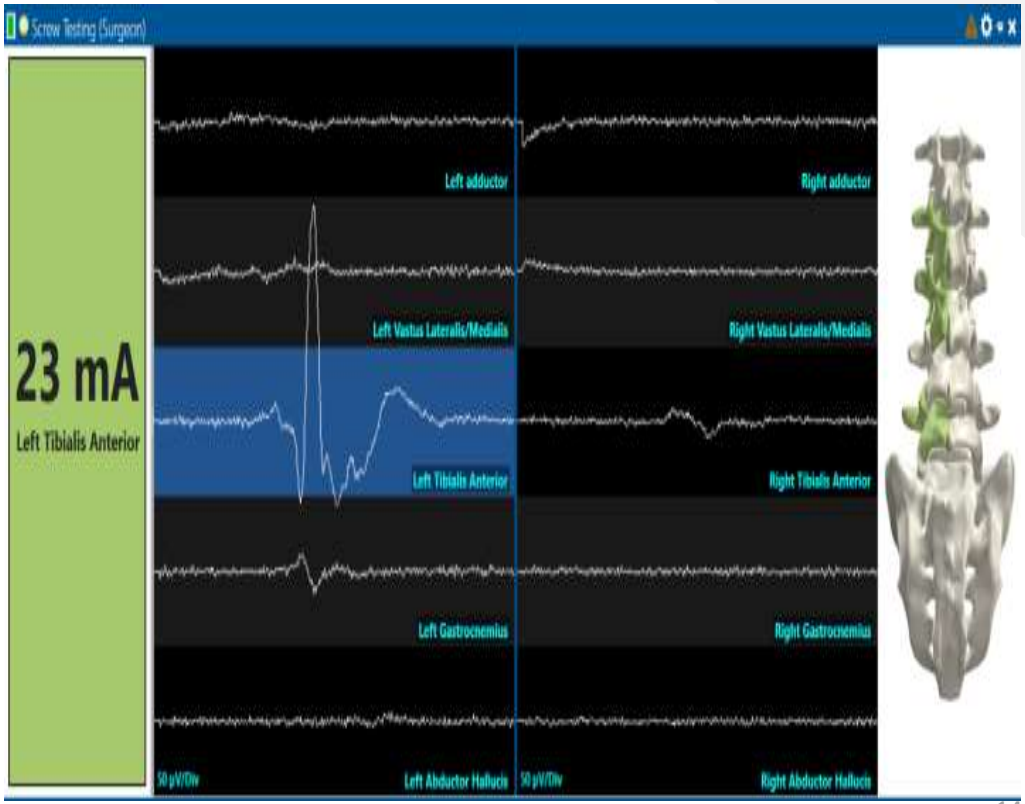
Real Case Presentation # 2

What IOM Changes Look Like and Corrective Action

L2-5 TLIF w/decompression

- Screws placed and placement verified with x-ray and TrEMG

- Example of screw with ‘safe’ testing
  - Below 10mA is an ‘alert’
  - Left L5 screw at 23mA



Real Case Presentation # 2

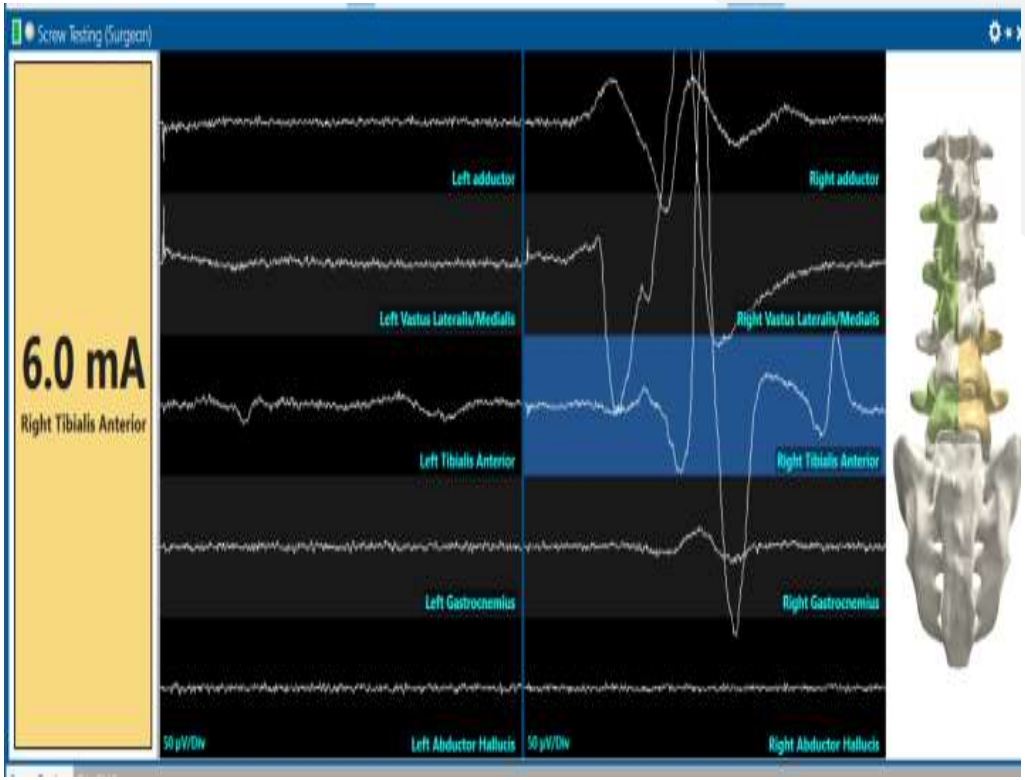
What IOM Changes Look Like and Corrective Action

L2-5 TLIF w/decompression

- Right L5 screw appeared safe via x-ray but TrEMG results indicated possible breach
  - 6mA
  - Massive muscle responses
  - What is the corrective action here?

- This surgeon elected to keep screw as is and patient had to come back 2 days later

Audience Question:
Does anyone know the costs associated with revision surgery?

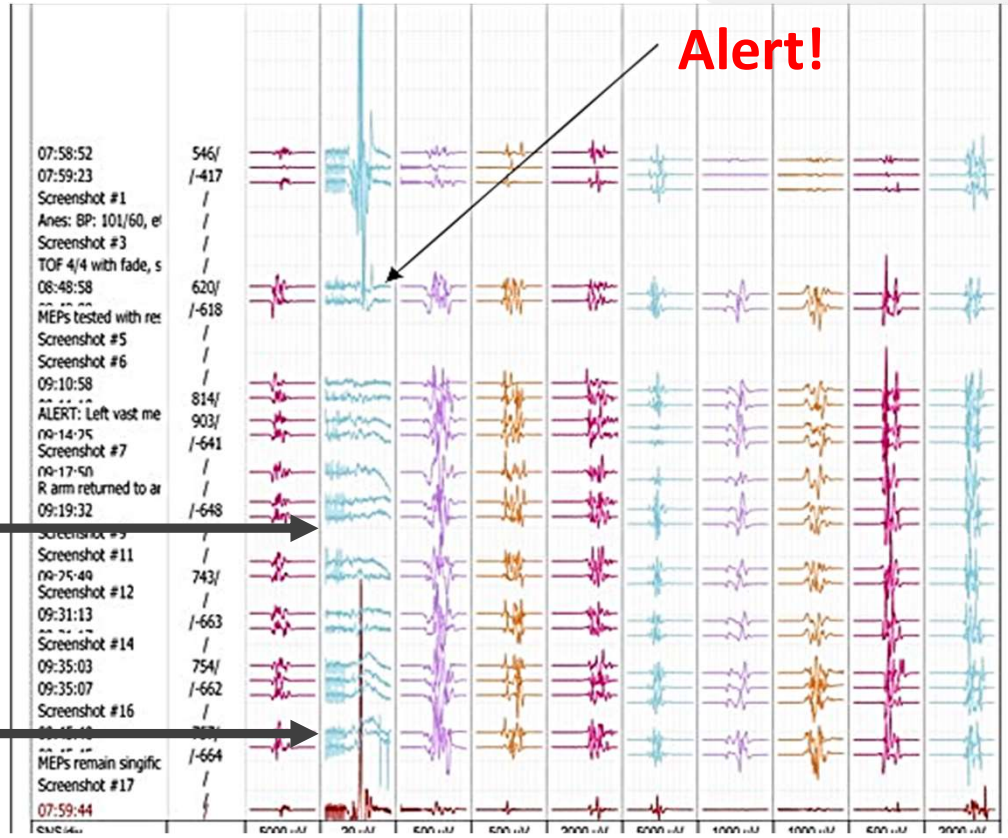


Real Case Presentation # 3

What IOM Changes Look Like and Corrective Action

L4-S1 ALIF (Anterior Lumbar)

- What is the surgical steps?
- During trialing of the disc space at L4-5:
  - **TcMEP** Alert seen in left quadriceps (80% reduction)
- Intervention
  - Removal of cage
- Minor Recovery



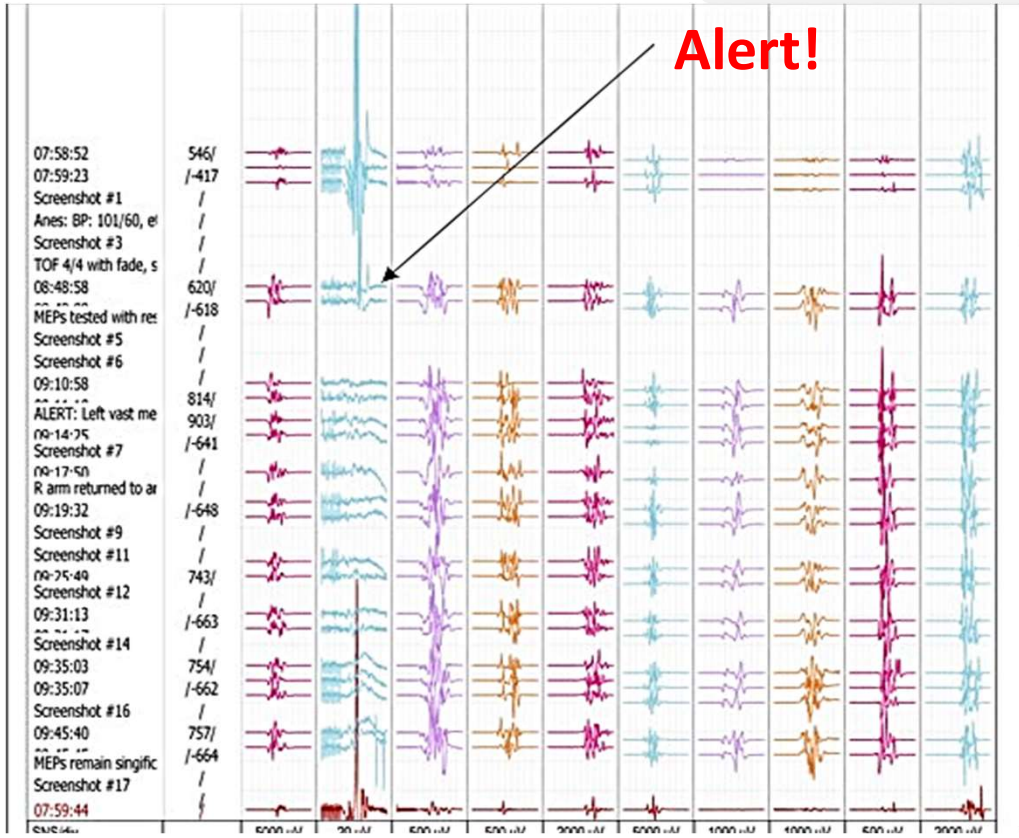
Real Case Presentation # 3

What IOM Changes Look Like and Corrective Action

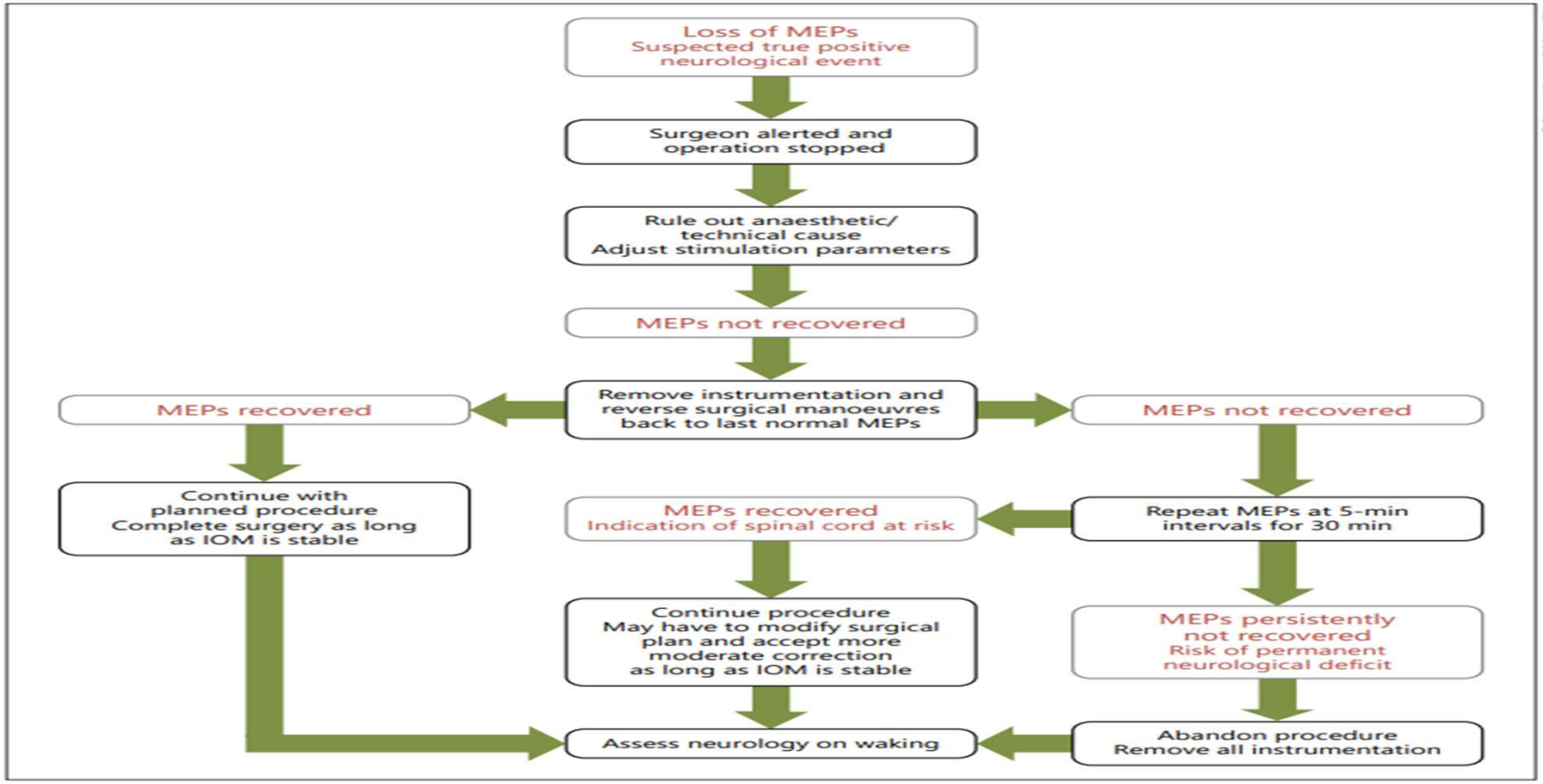
L4-S1 ALIF (Anterior Lumbar)

- What happened?
  - Pt woke up with 3+ strength in quad
  - Further exams found undiagnosed conjoined nerve roots at L3 and L4

- IOM Mitigated potential quadricep palsy



TcMEP Change and Corrective Action



Prognostic Value

Good and Bad News

- IOM is useful in forecasting post-operative results
  - Sustained sEMG over 5 minutes correlates with post-op radiculopathy
    - Corrective Action here?
  - Unresolved SSEP alerts indicate post-op dermatomal issues in _____ of patients

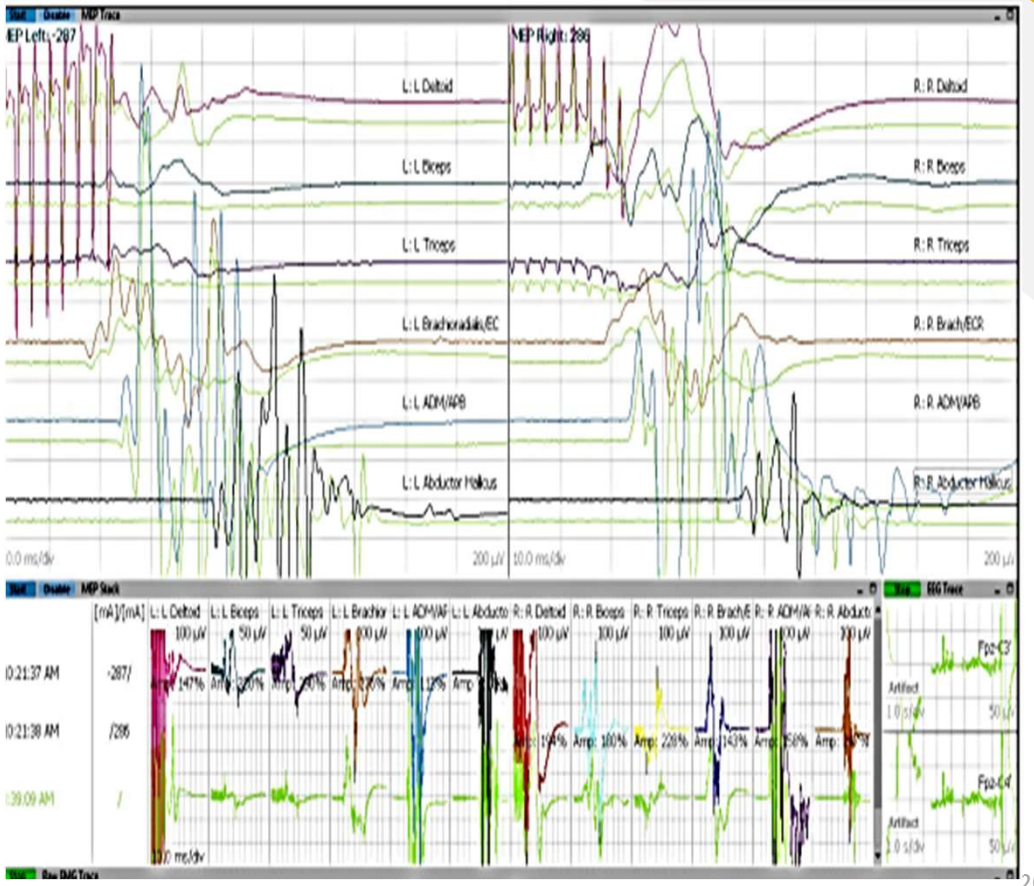
Real Case Presentation # 4

Good Job Doc!

C3-4 ACDF

- MVA w/ neural deficits
  - Weakness in left biceps and triceps

- After instrumentation/decompression
  - Surgeon informed of improvement in left biceps and triceps



Cost-Effectiveness of IOM

- Neurologic deficits were greater in non-IOM group (4.1% v. 0.3%)[1]
  - IOM Group had greater QALY of 0.010
  - Lower post-operative costs including
    - Revisions
    - Readmissions
    - Narcotic Use

1 Jared D. Ament MD, MPH , Alyssa Leon BS , Kee D. Kim MD , J. Patrick Johnson MD , Amir Vokshoor MD , Intraoperative Neuromonitoring in Spine Surgery: Large Database Analysis of Cost-Effectiveness, North American Spine Society Journal (NASSJ) (2023)

Cost-Effectiveness of IOM

- Dr. Thomas and Susan, please elaborate

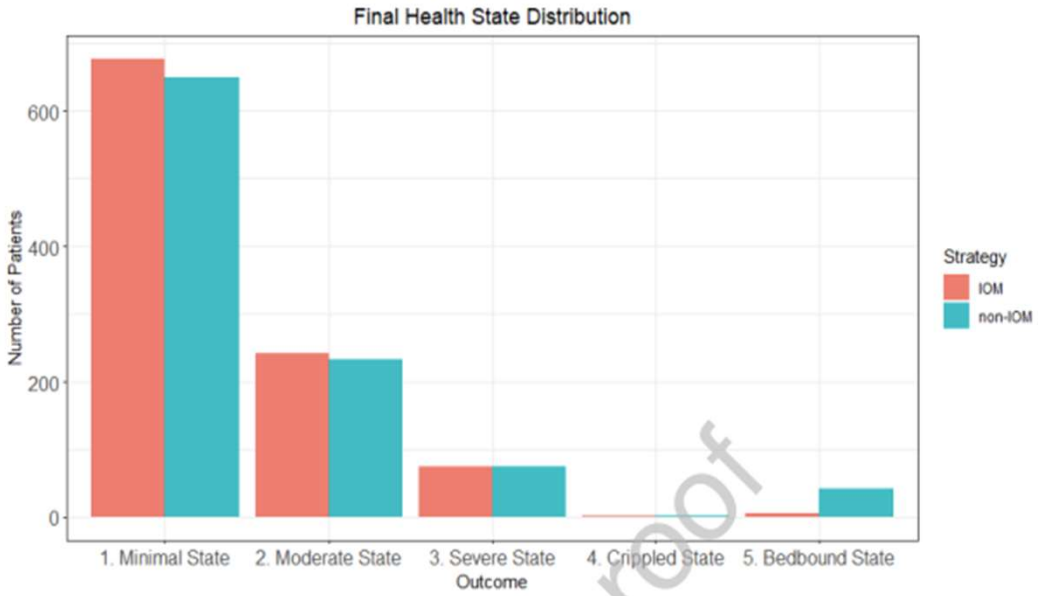


Fig. 2. Final Health State Distribution