



Martin-Gruber Anastomosis Explains Bizarre Intraoperative Neuromonitoring Data: A Case Report

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Abstract

Background and Importance: Intraoperative Neuromonitoring (IONM) plays a pivotal role in surgeries involving the brain, spinal cord, or peripheral nerves. The monitoring of Somatosensory Evoked Potentials (SSEPs) and Motor Evoked Potentials (MEPs) facilitates the assessment of sensory and motor pathways, respectively.

Clinical Report: In this case study, the absence of Motor Evoked Potentials in the left Abductor Pollicis Brevis (APB) and left Abductor Hallucis (AHAL) can be attributed to the presence of Martin-Gruber anastomosis between the Ulnar nerve and Median nerve. While such anatomical variations are rare, they can elucidate seemingly unrelated loss of neuromonitoring signals.

Conclusion: Being mindful of such exceptions is crucial for neurologists, surgeons, and neuromonitoring technicians, as it provides valuable insights into the interpretation of signals and aids in the explanation of potentially perilous signal losses during surgical procedures.

Keywords: Intraoperative Neuromonitoring (IONM); Somatosensory Evoked Potentials (SSEPs); Motor Evoked Potentials (MEPs); Martin-Gruber anastomosis

Background and Importance

This is a 60-year-old male diagnosed with cervical stenosis accompanied by myelopathy, neck pain, myelomalacia of the cervical cord, and foraminal stenosis of the cervical region. Patient underwent a C3-C7 cervical posterior fusion involving laminectomy and discectomy.

Towards the conclusion of the surgical procedure, an uncommon bilateral loss of lower extremity Posterior Tibial Nerve (PTN) Somatosensory Evoked Potentials (SSEP) was observed. Additionally, Motor Evoked Potentials (MEPs) recorded a loss in the left Abductor Pollicis Brevis (APB) and left Abductor Hallucis (AHAL). Concurrently, Electromyography (EMG) detected baseline activity in the right Bicep Brachii, which became increased in intensity during screw placement and persisted through closure.

Case Presentation

A 60-year-old male right-handed, laborer in trade complains of Symptoms: Very minimal symptoms that quickly progressed over 1 month; progressive weakness in bilateral UE and LE - patient describes feeling "wobbly" in his legs. Medical, family, genetic and psycho-social information is not provided in this case. MRI findings consistent with multilevel degenerative changes with significant stenosis from C3-C7 with the concluding diagnosis of cervical stenosis with myelopathy, neck pain, myelomalacia of cervical cord, foraminal stenosis of cervical region.

Intraoperative findings are described below

SSEP: Increase in stim intensity, adjustment of Pulse Width (PW), decrease Rep Rate (RR) to 1.41 hZ, and movement of headset posteriorly. L UE: 40 mA, PW 400, R UE: 40 mA, PW 400, L LE: 90 mA, PW 500, R LE: 90 mA, PW 500. TcMEP: Quadripolar montage, increase in stim intensity, increase in PW, PC, and ISI. L: 300V, 75, 9, 1.5 respectively. R: 350V, 75, 9, 1.5 respectively.

Baseline Anesthetic

MAP 77, MAC 0.29 ET SEVO, prop: 150 mcg/kg/min, Remi: 0.05 mcg/kg/min. For Somatosensory

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Figure 1: Intermittent EMG activity was observed in the right side of the Bicep Brachii muscle at baseline. However, during the placement of screws, the EMG activity transitioned to a continuous pattern, exhibiting an increase in both amplitude and frequency, which persisted throughout the closure phase.



Figure 2: 13:54 shows the last SSEP trace at baseline.



Figure 3: Shows complete loss of B PTN SSEP.

Evoked Potentials (SSEP), a 10/20 system was employed to position the SSEP headset, with electrode placements at Fpz, Cz, C3, C4, CV, and a ground reference point. Recordings were conducted within

muscle bellies to capture Electromyography (EMG) and Transcranial Motor Evoked Potentials (TcMEP) across various muscle groups: Deltoid (delt), biceps brachii (bi), Extensor Digitorum Communis



Figure 4: Loss of L ADM and L AHAL at 14.



Figure 5: S-EMG showed slight EMG activity.

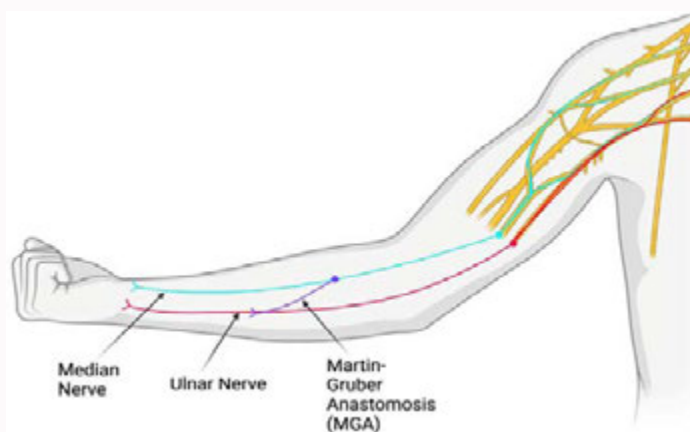


Figure 6: MGA (Created with Biorender.com), showing the proximal Median Nerve branching to join the Ulnar Nerve more distally.

(EDC), Flexor Carpi Radialis (FCR), and Abductor Digiti Minimi (ADM). Baseline data showed SSEP x4, TcMEP x3 (absent right hand), quiet EMG except for minimal intermittent R BI activity, TOF 4/4, and limited EEG continuous and symmetrical showing a constant state anesthesia. Alert: Intermittent EMG activity was observed in the

right side of the Bicep Brachii muscle at baseline. However, during the placement of screws, the EMG activity transitioned to a continuous pattern, exhibiting an increase in both amplitude and frequency, which persisted throughout the closure phase (Figure 1). O-Arm spin to confirm placement: 13:39 Decompression began: 13:48. Alert:

Loss of B PTN SSEP. Began trending down at 13:58 and flatlined the very next trace. 13:54 shows the last SSEP trace at baseline (Figure 2). Alert: 13:59 shows complete loss of B PTN SSEP (Figure 3). The surgeon informed and acknowledged the loss of Bilateral PTN SSEP and requested to run new TcMEP after the tech completed troubleshooting measures. Loss of L ADM and L AHAL at 14:06 (Figure 4) Anesthetic during the time of alerts: 13:57: MAP 89, MAC 0.0, temp: 36.2°C, prop 175 mcg/kg/min, Remi: 0.08 mcg/kg/min. At closure: Starting 14:28: At 14:30 R PTN SSEP began to show signs of returning to baseline. TcMEP was stable to baseline except for L ADM and L AHAL loss as mentioned above. Final trace: (Figure 5).

The patient reported experiencing transient weakness in the upper extremities and sensory issues in the lower extremities lasting for 24 h post-surgery. After these 24 h, the patient indicated an improvement, noting a better overall condition than that observed preoperatively.

Discussion

Intraoperative Neuromonitoring (IONM) is necessary in brain, spinal cord and peripheral nerve surgeries evaluating Somatosensory Evoked Potentials SSEPs and Motor Evoked Potentials MEPs [1-3]. The difficulties lie in localizing the changes anatomically [4]. SSEP changes lessened below but not above suggest lesions. Absent Transcranial MEP in hand muscles corresponds to (C6-8) lesions, while EMG of right biceps suggests the involvement of C5-7 [5].

The surprising preservation of upper SSEP can be attributed to Martin-Gruber anastomosis that involves Ulnar and Median nerves [6,7], despite association between ulnar nerve with C8-T1. This anatomical variation allows SSEP stimulation to bypass the lesioned area of the cord, indicating either C7 level or below injury. EMG in the right biceps can be localizing the lesion between C6-7, but weakly because of possible previous injury (Figure 6).

A 2019 study [8] revealed that SSEPs have sensitivity and specificity of 100% while MEPs had 50% of Its sensitivity with the 95.5% of its specificity. Patient-reported postoperative sensory deficiency is consistent with high SSEP sensitivity and specificity. This introduces false positives and enforces a necessity for anatomical variations.

Conclusion

Conflicting SSEP, EMG, and MEP results can be explained by rare anatomical variations such as Martin-Gruber anastomosis

and especially at the cervical level without any specific spinal cord localization. Knowledge of such anatomical intricacies is important for correct diagnostics and informed decision-making in cases related to cervical-level dysfunction.

Performing EMG for median nerve and the muscles like Flexor Carpi Ulnaris innervated by ulnar nerve would confirm that the Martin-Gruber anastomosis is influencing this. Alternatively, the specificity may be boosted by evaluating ulnar and median nerve fibers in the medial cord of the brachial plexus to validate MGA hypothesis needed for accurate lesion localization.

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