“Why can’t we get good baseline motor evoked potentials in this patient?”

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Case Presentation

• 29 year old woman presents for suboccipital craniotomy for a cerebellar vermis hematoma evacuation and treatment of a suspected neurovascular lesion. She presents with headache and vertigo, but motor strength is intact throughout. She has no significant past medical or surgical history.

• Planned neuromonitoring modalities are transcranial motor evoked potentials (tcMEPs), somatosensory evoked potentials (SSEPs), and brainstem auditory evoked potentials (BAEPs).
After an uneventful anesthetic induction and intubation and patient positioning, baseline evoked potentials are obtained. Baseline tcMEPs are as follows.

The tracings (labeled “L Hemis” for left hemisphere stimulation) appear adequate with responses from the right upper extremity and right lower extremity. (The right upper extremity is labeled “Rapb” for right abductor pollicis brevis and the right lower extremity is labeled “Rah” for right abductor hallucis. These are where responses are being recorded from each extremity.)
Contralateral baseline tcMEPs are as follows.

The tracings (labeled “R Hemis” for right hemisphere stimulation) show a response from the left lower extremity but no response from the left upper extremity. (The left upper extremity is labeled “Lapb” for left abductor pollicis brevis and the left lower extremity is labeled “Lah” for left abductor hallucis.)
The surgeon prefers to not make incision until baseline signals are obtained in the left upper extremity. Help the neuromonitoring team find the problem to ensure patient safety, optimize neuromonitoring, and so surgery can commence. What could be the cause of the failure to obtain a MEP baseline response from left upper extremity?

- A) residual neuromuscular blockade post intubation
- B) surgical trespass on motor system
- C) malpositioning of the upper extremity
- D) technical problem with signal acquisition
- E) hypotension post induction
- F) C or D are both possibilities
Why do we likely not have good pre-incision MEP baseline responses from the left upper extremity?

Choice A. residual neuromuscular blockade post intubation

Answer: Try again. Residual neuromuscular blockade should result in globally depressed or absent motor evoked potentials from all extremities and not just one focal area.
Why do we likely not have good pre-incision MEP baseline responses from the left upper extremity?

Choice B. surgical trespass on motor system

Answer: Try again. Surgical etiology unlikely since incision has not yet been made.
Why do we likely not have good pre-incision MEP baseline responses from the left upper extremity?

Choice C. malpositioning of the upper extremity

Answer: Yes, malpositioning of an extremity could result in loss of signal or inability to obtain signal response. For this case, the patient has been positioned in a Concorde position. Inspection of the affected extremity reveals neutral positioning and padding and no other problems (e.g. IVs functioning, no tourniquet inadvertently left in place, etc.) so it is unlikely the problem in this patient. There is a more correct answer...
Why do we likely not have good pre-incision MEP baseline responses from the left upper extremity?

Choice D. technical problem with signal acquisition

Answer: Yes, a technical problem could result in loss of signal or inability to obtain signal response. More discussion will follow in next slides and there is a more correct answer...
Why do we likely not have good pre-incision MEP baseline responses from the left upper extremity?

Choice E. hypotension post induction

Answer: Try again. Hypotension should result in globally depressed or absent motor evoked potentials from all extremities and not just one focal area.
Why do we likely not have good pre-incision MEP baseline responses from the left upper extremity?

Choice F. C or D are both possibilities

Answer: Yes! Both malpositioning of the brachial plexus or extremity and a technical problem(s) could be responsible for the lack of baseline response from the left upper extremity.
Troubleshooting-Positional Etiology? Check:

• Position?
  – Concorde (prone with head flexed and fixed in head pins, slight reverse Trendelenburg, arms tucked at sides, and knees slightly flexed).

• For our patient, inspection reveals the arm to be in neutral position and well padded, and there is no apparent tension on the brachial plexus.
Troubleshooting-Positional Etiology? Check:

• “Accessories”?¹
  – Ensure there is no ischemia being caused to the extremity, such as by a malfunctioning blood pressure cuff, a tourniquet for intravenous line place inadvertently left in place, or by an infiltrating intravenous line.

• For our patient, intravenous lines on the extremity are functioning well, and there is no blood pressure cuff in place on this arm.

Troubleshooting-Positional Etiology? Check:

• Temperature?
  – In positions where one extremity may be less covered than the others, there can be a local temperature difference which could impact MEPs. However, this would be more expected to cause a latency change rather than an amplitude change. In general, reproducible MEP signals should be obtainable with mild hypothermia (31-34°C). Latencies begin to increase below 32°C as nerve conduction velocity is impacted.¹

  • In our patient, both extremities are equally covered and intravenous fluids are being warmed, so a local temperature difference would be unlikely.

• SSEPs?
  – see next slide

Troubleshooting-Positional Etiology?

Lack of a positioning problem is also supported by unchanging SSEPs

Baseline SSEPs – left upper extremity

@11:19am  @11:37am  @11:59am
Troubleshooting-Patient Etiology?

• Our patient is neurologically motor intact. However, if a motor deficit had been present, it could contribute to the lack of MEP response in the affected extremity.
  – Preoperative motor deficits are associated with lower tcMEP monitoring success.¹

Troubleshooting-Technical Etiology? Check:

• Reproducible?
  – Multiple runs have been performed without signal response from left upper extremity.

• Check electrode impedences and stimulation parameters? Optimal stimulation intensity, number, pulse duration, and interstimulus interval to overcome impediments to propagation?
  – Machine setup seems okay, as we are getting MEP signals from other extremities, stimulation on the contralateral hemisphere resulted in excellent baseline, and SSEP baselines are fine.

• Correct electrode placement in affected extremity?
  – Verify recording electrode position. If surface electrodes, consider changing to needle electrodes. (Recording needles instead of stickers might be especially helpful if extremity had been edematous or obese.)
True/False: The problem can not be with scalp electrodes, since tcMEPs are okay in other extremities

• A) True
• B) False
True/False: The problem can not be with scalp electrodes, since tcMEPs are okay from the other extremities.

Choice A. True

Answer: False – Try again. The position might be fine for some of the scalp electrodes but not all of them, and this could still impact monitoring for an individual extremity.
True/False: The problem can not be with scalp electrodes, since tcMEPs are okay in other extremities.

Choice B. False

Answer: Yes! See the next slide.
Stimulating scalp electrodes are placed over the motor cortex based on a naming system called the international 10-20 system which is traditionally used for electroencephalogram (EEG) electrode placement.
• A common stimulating array would be approximately as highlighted in blue in the diagram. Specifically, this is the C3, C1, C2, C4, Cz -1 and Cz + 6 array.
• Some groups prefer to use a slightly more anterior array.¹
• Both stimulating locations are considered acceptable.²

• Inspection and measurement of the scalp stimulating needle locations reveals that the needles are not in their optimal positions. This is likely due to confusion in placing them with the patient turned prone and head flexed.

  – It is recommended that scalp stimulating electrode sites be measured to minimize risk of this problem.¹

Needle electrodes are placed in appropriate measured locations, and this baseline is obtained.

With baseline evoked potentials obtained, surgery begins.