SNACC
Neuromonitoring Interactive Case

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83 yo woman with h/o HTN, prior CVA without residual deficit, and right breast CA s/p resection and chemotherapy presents for L3-L5 posterior spinal fusion by orthopedic spine surgery.

Neuromonitoring with SSEPs and EMG is planned by the surgeon.

For SSEPs, what extremities should be monitored for this surgery?

A. Right and left lower extremities only
B. Right and left upper extremities only
C. Right and left upper and lower extremities

A. Right and left lower extremities

The lower extremities should be monitored, since, for lumbar surgery, these are the extremities most at risk for neurological trespass. However, there is a more complete answer…

Try again

B. Right and left upper extremities

Perhaps the bilateral upper extremities should be monitored, but these are not the primary extremities at risk from this surgery. There is a better answer.

[Try again]

C. Right and left upper and lower extremities

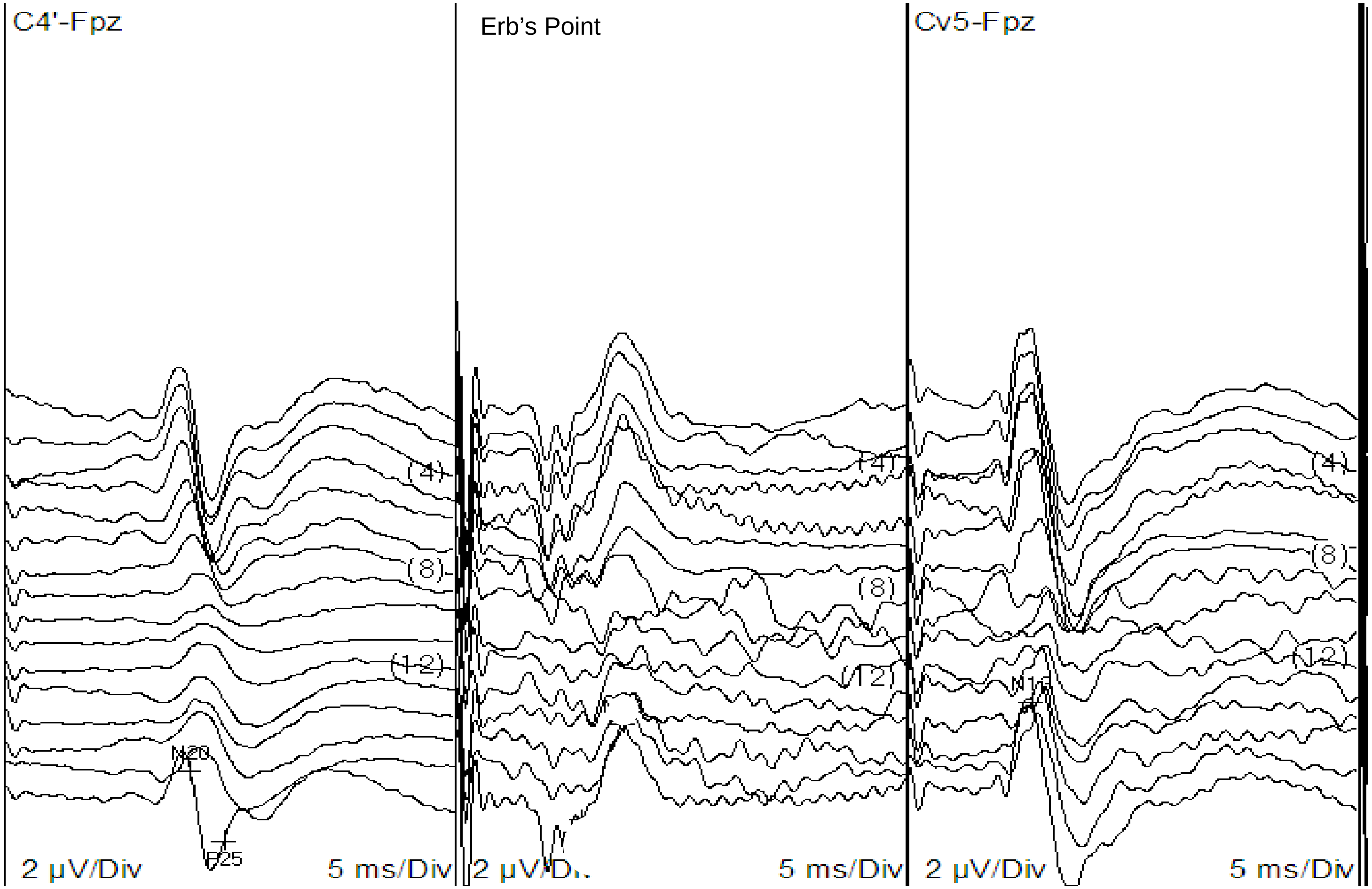
Yes! Intraoperative neurophysiologic monitoring helps to prevent permanent neurological injury by alerting the surgeon & anesthesiologist of the need to modify surgical strategy &/or patient management.[1] This applies not only to potential injury from the surgical procedure itself, but also to detecting problems unrelated to the surgical procedure.[2,3] For example, IONM (especially SSEPs) have been shown to be a reliable intraoperative tool to monitor position related peripheral nerve injuries in spine, cardiac, orthopedic, and intracranial surgeries.[4] Furthermore, monitoring both upper and lower extremities helps detect systemic causes of neuromonitoring changes, such as physiologic or pharmacologic effects, and helps with the differential diagnosis when a change occurs. Hence, there is value in monitoring "globally", or, for this case, including the upper extremities in neuromonitoring.

1. *Neurosurg Rev.* 2007;30:109-16.
2. *J Clin Monit Comput* 2006;20:437-44.
3. *J Clin Anesth*. 2011;23:134-6.
4. *Otolaryngol Head Neck Surg*.2013;149(1):168-73.

The patient is positioned prone with arms in the cephalad position (<90 degrees angle) after an uneventful anesthetic induction and intubation and placement of arterial line and additional peripheral IVs.

After baseline SSEP signals are obtained, surgical incision is made.

As surgery progresses, the SSEPs are as follows from one extremity.



What signals are we seeing on this slide?

A. SSEPs from one set of signal acquisitions/ one "run".

B. SSEPs from a lower extremity.

C. SSEPs from an upper extremity.

D. From left to right, signals are recorded from cortical, Erb's Point, and subcortical areas.

E. Both C and D are correct.

A. SSEPs from one set of signal acquisitions/one “run”.

No. This is in in the “waterfall” format, where multiple runs over time are shown. In this case, the oldest signals are on top (earliest in case) and the newest (most recent during case) are on the bottom. This can be confirmed by checking the run number (i.e. run # 4, then #8, then #12) noted on the right. Of note, the time format in ascending or descending order is simply set by user preference. In addition, each SSEP signal is really an average of hundreds of repeated stimuli performed to improve signal-to-noise ratio (i.e. it is never just really one signal acquisition we are seeing.)

Try again

B. SSEPs from a lower extremity.

No. Lower extremity SSEPs are usually monitored by stimulating the posterior tibial nerve at the ankle (or, less often, the common peroneal nerve at the knee). Activation of the sensory component of these large mixed nerves sends responses along the sensory pathway all the way to the sensory cortical strip in the brain. Cortical SSEPs for a lower extremity are expected to occur later than for an upper extremity (because the signal has further to travel), and this occurs at about 37 msec (which may be called P37 or N37 by convention) in neurologically intact individuals. The upper extremity cortical signal occurs at about 20 msec in neurologically intact individuals (marked N20 on the left column of signals in this example). This is also the “latency” of the signal response.

Try again

C. SSEPs from an upper extremity.

These SSEPs are from an upper extremity. Upper extremity SSEPs are usually monitored by stimulating the median or ulnar nerve at the wrist. Activation of the sensory component of one of these large mixed nerves sends responses along the sensory pathway to the brain all the way to the sensory cortical strip. Cortical SSEPs for an upper extremity are expected to occur at about 20 msec (compared to about 37 msec for the lower extremity) and are traditionally called “N20” as labeled in this case on the left column of signals. This is also the “latency” of the signal response. However, there is a more complete answer…

maybe - Try again

D. From left to right, signals are recorded from cortical, Erb's Point, and subcortical areas.

The labels at the top of each column mark the "recording montage". This is the electrode pair of two recording sites (an active electrode and a reference electrode) between which voltage is measured. The 10-20 International System of EEG electrode placement is used to describe scalp placement of electrodes for cortical recordings. Just as the cortical recording can be identified by the approximate msec time of the signal, subcortical can be identified as occurring at about 14 msec from an upper extremity in a neurologically intact patient. Erb's point has a signal latency of about 10 msec from an upper extremity in a neurologically intact
However, there is a more complete response…

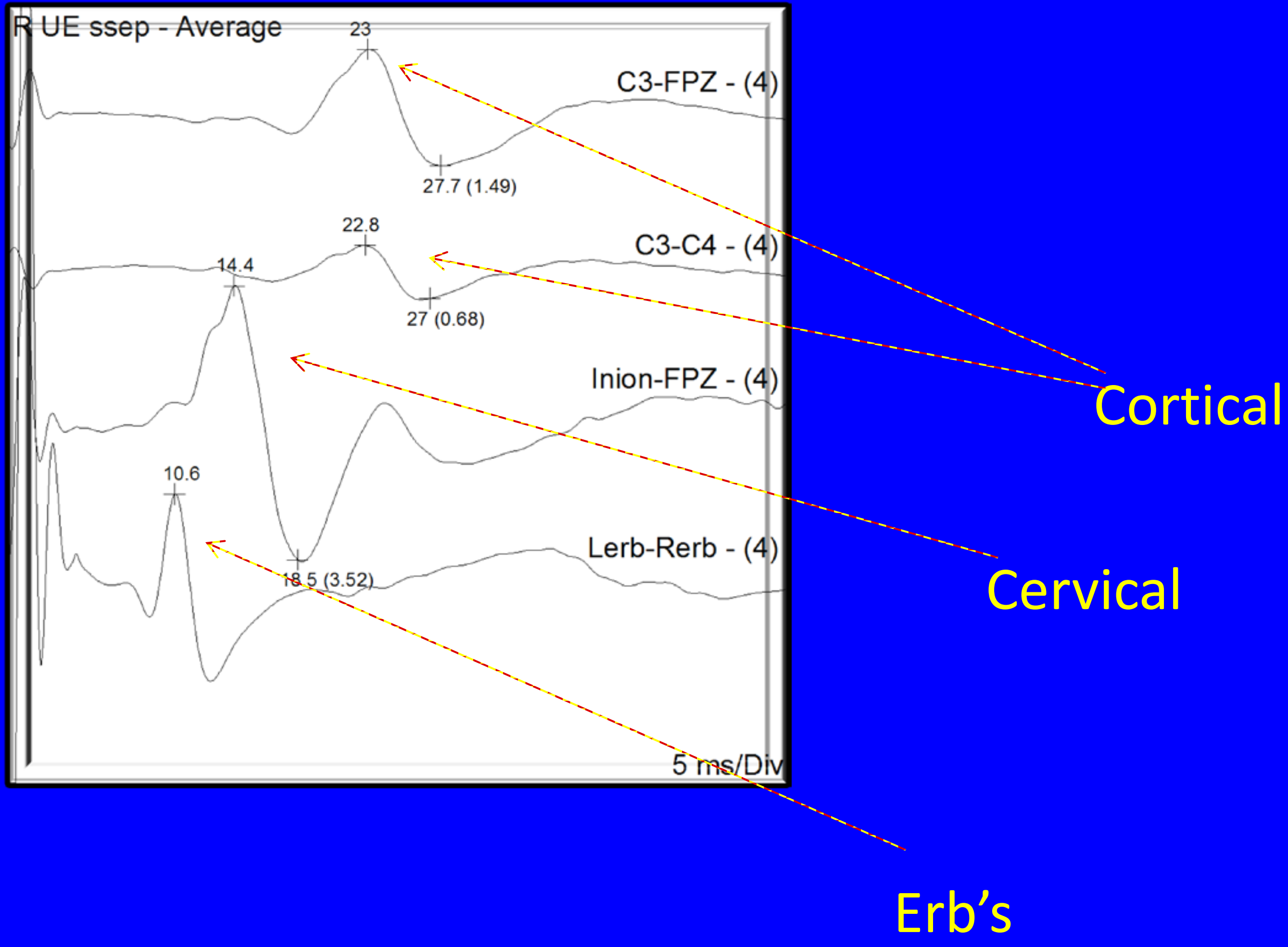
maybe - Try again

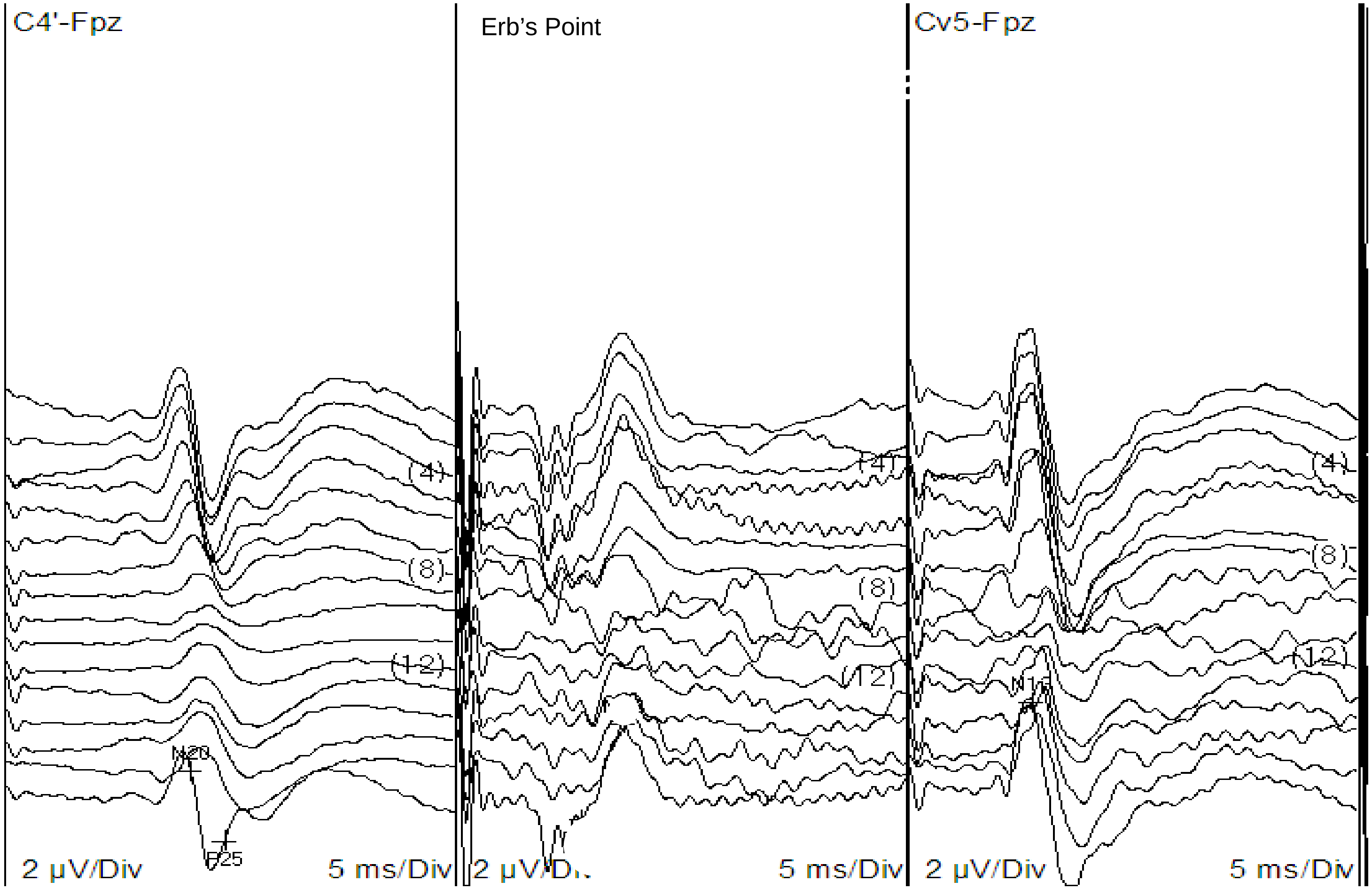
E. Both C and D are correct.

Yes! These SSEPs are from an upper extremity. Upper extremity SSEPs are usually monitored by stimulating the median or ulnar nerve at the wrist. Activation of the sensory component of one of these large mixed nerves sends responses along the sensory pathway to the brain all the way to the sensory cortical strip. Cortical SSEPs for an upper extremity are expected to occur at about 20 msec (compared to about 37 msec for the lower extremity) and are traditionally called “N20” as labeled in this case on the left column of signals.). This is also the “latency” of the signal response. The labels at the top of each column mark the “recording montage”. This is the electrode pair of two recording sites (an active electrode and a reference electrode) between which voltage is measured. The 10-20 International System of EEG electrode placement is used to describe scalp placement of electrodes for cortical recordings. Just as the cortical recording can be identified by the approximate msec time of the signal, subcortical can be identified as occurring at about 14 msec from an upper extremity in a neurologically intact patient. Erb’s point has a signal latency of about 10 msec from an upper extremity in a neurologically intact patient.

SSEPs

This slide further demonstrates SSEP signals from Erb's Point, subcortical (cervical), and cortical areas.





As shown in this waterfall, the SSEP signal decreases in amplitude and then recovers with time. Assuming SSEPs from other extremities are stable, what could be the cause of this left upper extremity SSEP signal change?

A. A cortical bony breech by a pedical screw that could lead to radiculopathy.

B. An increase in anesthetic depth.

C. Addition of neuromuscular blockade.

D. Insult to the brachial plexus from positioning or some other insult to the left upper extremity.

E. Neck malposition.

A. A cortical bony breech by a pedical screw that could lead to radiculopathy.

No. The lower extremities and not the uppers would be at neurological risk from this lumbar spine surgery, and triggered EMG would better identify impending radiculopathy from a cortical breech by a pedicle screw.

Try again

B. Increase in anesthetic depth.

No. Anesthetic depth will impact cortical SSEPs more than SSEPs from lower level areas due to the increasing number of synaptic connections at the cortical level. The changes seen in these SSEPs are consistent throughout recording sites. Also, pharmacological effects should have a global impact, and no changes are seen in this case to other extremities.

[Try again]

C. Addition of neuromuscular blockade.

No. Neuromuscular blockade actually can make it easier to see SSEP signals because it reduces artifact. Also, pharmacological effects should have a global impact, and no changes are seen in this case to other extremities. Of course with EMG monitoring, neuromuscular blockade past the time of surgical exposure is contraindicated for this case.

Try again

E. Neck malposition

No. If neck malposition was the etiology of the SSEP change, the ipsilateral Erb's point signal should be preserved, since it is located at the upper trunk of the brachial plexus (just above the clavicle), so neurologic transmission through the cervical spine has not yet occurred at this recording site. Hence Erb's point can be valuable in helping pinpoint the cause of a neuromonitoring change.

Try again

D. Insult to brachial plexus from positioning or some other insult to the left upper extremity.

Yes! Intraoperative neuromonitoring can detect problems unrelated to the surgical procedure itself, such as a positioning problem. In this case, the affected arm was inspected by the anesthesiologist and it was found that an IV had infiltrated. The IV was immediately discontinued, and the extremity was examined for signs of good perfusion. In order to allow continued monitoring of signals (since amplitude was greatly diminished and surgery was ongoing), the adhesive pads that had been placed for stimulating that extremity were changed to subdermal needles. This likely allowed closer proximity of stimulation to the nerve (as the pads were now further away from the nerve due to fluid infiltration), and signals returned to allow continued monitoring. This case helps demonstrate how intraoperative neuromonitoring input is important to us too as anesthesiologists besides us maybe needing to modify patient management (e.g. raise the blood pressure), neuromonitoring can even alert us to problems caused by us! Each time there is a signal change in an individual extremity, the anesthesiologist should inspect the affected extremity and confirm appropriate positioning.