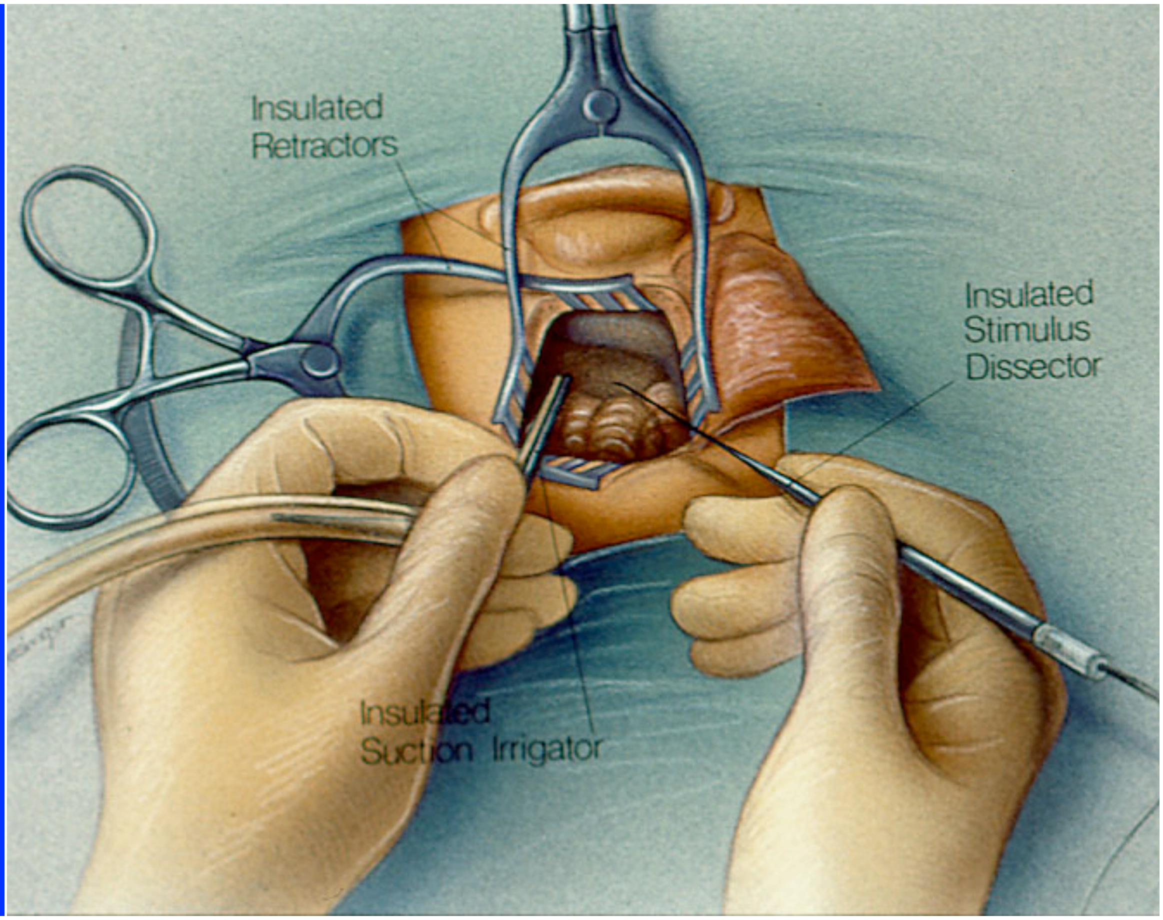
ACTIVE NEUROMONITORING

October 23, 2012



KSI
Kartush Stimulating Instruments during cerebellopontine angle surgery. Available from Neurosign.

The Imperative of 'Active' NeuroMonitoring

Jack M. Kartush, MD

As technology evolves, so should surgical techniques. Adoption of the operating microscope and illuminated endoscopes have markedly altered surgical approaches and techniques. Similarly, the adoption of intraoperative neurophysiologic monitoring lends itself to modifying surgical techniques that were once considered the "standard".

However, in this instance, many surgeons have only minimally altered their techniques - and only rarely taken the time to attend dedicated courses on IOM. Consequently, IOM is often not used to maximum benefit without an understanding of newer, optimized techniques.

A key point here is the difference between "Active" versus "Passive" monitoring.

Most surgeons place electrodes into the muscles and operate in, for lack of a better term, an out dated or "old-fashioned" way - modifying their technique only if they hear a response. The problem with this type of "Passive" monitoring is that a response is only heard if some trauma is inflicted upon the nerve. Thus, the information that they receive is that the nerve may have been traumatized - but it is post hoc or "after the fact" information.

If the trauma is mild then at least they have been alerted to the location and or sensitivity of the nerve. If the trauma is severe, then, unfortunately, the damage is done.

IOM is driving changes in surgical technique

In contrast, "Active" monitoring with continuous stimulation during high risk surgical maneuvers provides ongoing proactive information on:

1. Nerve location
2. Nerve proximity
3. Nerve responsiveness

Ongoing knowledge of each of these factors can positively affect the surgeon's dissection. If the surgeon modifies their technique and routinely uses stimulating instruments, then with active monitoring, they are continuously assessing both the location and the integrity of the nerve .

Furthermore, this technique leads to a desired behavior modification: when the surgeon is constantly aware of the location of the nerve, they will manipulate tissue more gently in areas in which the nerve has been identified, while appropriately operating more aggressively in areas in which the nerve has been shown not to be present.

With small tumors, for example, the location of the nerve is evident. But with large tumors, the nerve location may not become evident until significant amounts of tumor are debulked. But such blind debulking can place the nerve at risk - unless the nerve has been first located using electrical stimulation - i.e. "mapping".

There have never been any reports of neural injury from overstimulation using modern pulsed stimulators.

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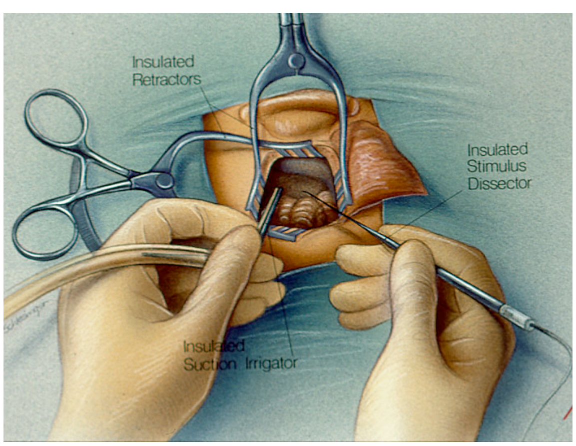
While such an active technique is possible without dedicated instruments such as the Kartush Stimulating Instruments (KSI), the nuisance and delays associated with constantly switching between conventional surgical instruments and stimulating probes means that, in practice, the surgeon will only rarely stimulate. KSI's remove the obstacles that prevent active monitoring throughout the entire risky portion of the procedure.

In addition, regular use of KSI's also assures that checking for proper current flow becomes a part of the surgeon's routine - and in so doing can avoid a common source of false negative errors.

KSI
Kartush Stimulating Instruments are insulated to minimize current shunting - except for the final 2mm of working surface.

They may be connected to any common nerve stimulator using pulsed constant current.

KSI's allow *simultaneous* stimulation with surgical dissection.



Safety checklists are becoming standard throughout medicine. They must similarly be applied to monitoring...

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Box 1
Facial nerve monitoring set up

1. Ensure that the anesthesiologist avoids the use of long-acting muscle relaxants
2. Be wary about local anesthesia (eg, lidocaine or marcaine), which can chemically induce a temporary facial paresis, rendering monitoring useless
3. Place electrodes carefully
4. After the electrodes are connected to the nerve monitor, check the impedances of the different electrode pairs
5. Perform a tap test to check the integrity from the electrode to the recording device
6. After incision and soft tissue exposure, check for current flow using a nerve stimulator
7. Stimulate the nerve at an early point in the surgery before any significant manipulation of the nerve is performed

Recommendations For Intraoperative Stimulus Levels

First, it is important to note that using modern pulsed, constant stimulation at routine settings, there have never been any reports of neural injury from overstimulation.

This clinical safety track record is reinforced by animal studies. Babin et al developed a cat facial nerve model to assess the safety of continuous facial nerve stimulation. They applied 3 stimulations per second to the cat facial nerve at 1 mA for 1 hour. Kelly & Leonetti demonstrated similar safety in a canine model.

Unnecessary fear of stimulus intensity might lead a surgeon to use too little current for the task at hand, which can in turn lead to false-negative errors.

Conversely, relatively high levels when working immediately adjacent to the nerve are unlikely to cause any harm - but will result in multiple frequent responses that provide little useful information and thus simply become a distraction.

Below are some practical suggestions I have collated specific to resecting acoustic and meningioma tumors at the cerebellopontine angle.

Typical Stim Levels
Intracranial

With small intracanalicular tumors, start at about 0.5mA when you are relatively distant from the nerve and then lower the current to as little as 0.05 to 0.1mA when dissecting directly along the nerve, usually with the curved stimulating needle.

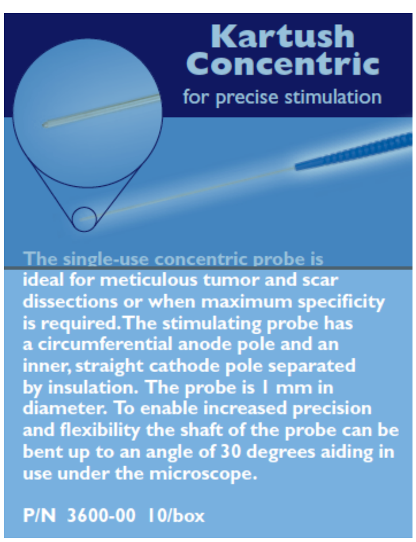
With a large 4 cm tumor, I set the stimulator as high as 1.2 mA just to map out roughly where the nerve is and where it isn't, with the stimulating elevator. As soon as the nerve is identified, stim levels are reduced in that area, as noted above. When performing intracapsular dissection in a 4 cm tumor, I use the stimulating ring curette to scoop out tumor set at approximately 1mA - until the capsule becomes thin.

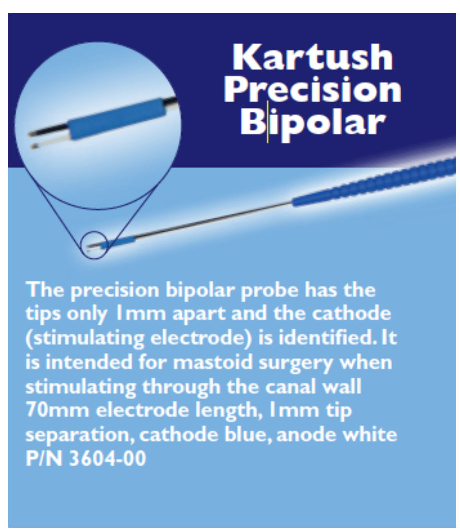
In such a way, one obtains ongoing feedback to know if the capsule is getting thin and if the dissection is getting close to the nerve despite not seeing it. This type of continuous stim dissection monitoring alerts you to nerve proximity - so the surgeon is not just relying on responding to trauma potentials (e.g. trains) once injury has already occurred.

Avoid high stim levels inferiorly at pars nervosa. I have never encountered adverse effects with stimulation of the vagus (eg bradycardia), but if the spinal accessory nerve is inadvertently stimulated, the sudden shoulder contraction can startle the surgeon.

When critical differentiation is required between two ill defined adjacent structures, consider using a bipolar stimulator. Neurosign produces both side-by-side as well as coaxial versions.

The precision of the Kartush bipolars have also been demonstrated to be effective during cervical spine, tethered cord and cerebral peduncle motor mapping.





Summary

These are lessons learned from my last 1,100 tumor operations but the concepts are easily extrapolated to other locations. As a rule, extracranial nerves (eg; recurrent laryngeal nerve) are much less sensitive and typically a) require more current for triggered EMG, and b) are far less sensitive to mechanical evoked potentials. Thus, during thyroid surgery, for example, the recurrent laryngeal nerve will have a stimulus threshold of approximately 1mA so it is preferable to begin mapping the nerve at 1.5 to 2 mA.

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