TECHNOLOGY SPOTLIGHT:

Advancing Minimally Invasive Surgery with Transabdominal Muscle Action Potential (TMAP™)

What is TMAP™?

TMAP™ is a lumbar motor evoked potential (MEP) modality on NVM5™ that actively monitors the motor function of the cauda equina and related nerve roots throughout a lumbar procedure.

Proactive Diagnostic

- TMAP™ stimulates and monitors the functional integrity of the complete lumbosacral motor pathway

More Information than Electromyography (EMG) Alone

- EMG helps to identify nerve location and integrity in the surgical field while TMAP™ monitors bilateral lower extremity motor function

Simplified Anesthesia

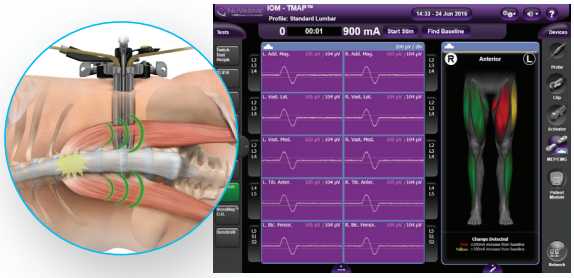
- Unlike transcranial MEPs (TcMEPs), TMAP™ does not require total intravenous anesthesia (TIVA), which helps to simplify patient care

Advanced Neuromonitoring Features

- Automated and surgeon driven
- No neurophysiologist required

Adjunctive Monitoring

- TMAP™ can be used in addition to traditional neuromonitoring modalities, including Free-Run EMG, Directional EMG, TcMEP, and SSEP



How TMAP™ Works

TMAP™ utilizes transabdominal stimulation to induce a complete, bilateral depolarization of the peripheral nerves below the point of stimulation. The minimum stimulation required to elicit a compound muscle action potential (CMAP) from each myotome is identified and tracked throughout the procedure. Increasing stimulation levels suggest decreasing peripheral nerve motor function and may serve as an early intraoperative warning of potential neuropraxia.

Efficacy of TMAP™: Abstract Highlight

In a study by Patel, et al., TMAP™ showed high (as much as 100%) utility in identifying postoperative neuropraxias.[1]

Background Context: Postoperative femoral nerve palsy is an uncommon but severe complication that can occur following lateral lumbar interbody fusion (LLIF). Various neuromonitoring modalities have been explored to identify nerve injuries; however, EMG, traditional SSEP, and TcMEPs are limited by either a low sensitivity and/or specificity. TMAP™ is a promising complement to conventional neuromonitoring as it can test the integrity of the lumbosacral motor pathway by assessing the stimulation required for an individual muscle contraction. By comparing stimulation level changes and corresponding muscle amplitudes, TMAP™ allows for real-time assessment of nerve function.

Purpose: The purpose of the study by Patel, et al., was to examine the utility of TMAP™ in predicting postoperative femoral nerve palsy.[1]

Methods: A retrospective study of the initial 107 prone LLIF patients with TMAP™ neuromonitoring at a single center was conducted. TMAP™ was run systematically according to an event protocol to identify if and when nerve injuries occurred. Stimulation increases from baseline were recorded and analyzed to examine potential correlation between stimulation increases and postoperative femoral nerve palsy (3 out of 5 knee extension strength postoperatively).

Results: Prone lateral LLIF was performed on 107 consecutive patients, of which 71.0% were single-level cases. There were 145 total levels treated, with 79.4% of patients having a fusion at L4-5. The average TMAP™ maximum change from baseline was 224 ±207mA (range 0-1000mA). Five patients developed an immediate postoperative femoral nerve palsy. The mean TMAP™ change from baseline was significantly higher for the patients with postoperative injury (600 ±70mA, range 550-700) compared to those without a postoperative deficit (203 ±90mA, range 0-1000, p <0.0001). A TMAP™ change was present in every injured patient, with no false negatives identified. At a change-from-baseline threshold of 150mA, TMAP™ demonstrated a sensitivity of 100% and a specificity of 47.1%. At a 400mA change-from-baseline threshold, sensitivity was 100% and specificity was 85.3% for identifying postoperative femoral nerve palsy.

Conclusions: TMAP™ is a sensitive neuromonitoring modality that can provide real-time assessment of nerve integrity, complementing triggered EMG in LLIF. This study suggests the potential for TMAP™ to also have applicability in other lumbosacral spine surgeries where such neuromonitoring could be utilized.[1]

Reference

1. Patel A, McDermott M, Rogers M, et al. Transabdominal Muscle Action Potentials (TMAP) show 100% sensitivity for predicting postoperative neuropraxia in initial 107 prone LLIF cases. *T Spine J.* 2024;24(9):S79-80.

Surgeon Perspective

Ashish Patel, MD
Chairman of Spine Surgery
The Spine Center, Duly Health and Care

Dr. Ashish Patel has over 15 years of experience in orthopaedics and spine surgery. He has studied TMAP™ and developed workflows that incorporate the modality into his lumbar interbody fusion procedures. He discusses his experience below.

Q: What unmet clinical need does TMAP™ address and how were you first introduced to TMAP™?

A: For spinal deformity cases, we have several modalities of patient monitoring such as EMG for testing screw placement, SSEP to monitor the dorsal column, and TcMEPs. In lateral cases, we have leveraged SSEP monitoring and EMG nerve mapping modalities, but we were missing that critical motor monitoring component that was not as impacted by anesthesia.

My trusted neuromonitoring tech first introduced me to TMAP™ as an adjunct to SSEP and EMG monitoring. I saw the screen layout was very easy to interpret and provided options for how to display the information. I like numbers over waveforms so I can have a clear understanding of the change in response relative to the baseline stimulation threshold to elicit a CMAP. The setup was easy, and I can now monitor the motor health of the lumbar nerve roots in real time with a modality developed specifically for lumbosacral spine surgery procedures.

Q: How have you incorporated TMAP™ into your lateral procedural workflow?

A: TMAP™ is a vital piece of my lateral workflow. We have identified seven major steps at which point we run a TMAP™ to assess the health of the nerves. Our four steps during the docking phase are:

1. After dilator/wire placement
2. After retractor placement
3. After disc shim placement
4. After the retractor is maximally opened just prior to cutting the disc

If the change in TMAP™ is less than 400mA from baseline in each lead, we move on to preparing the disc space. We then run TMAP™ three times during the interbody phase:

5. After removing the disc
6. After trialing
7. After the implant is placed

We have found this workflow to be efficient and aligned to the most critical steps of the lateral procedure.

Q: From your research, what are the most compelling findings and what could it mean for lateral procedures and outcomes moving forward?

A: Very simply, TMAP™ is a reliable motor monitoring modality we have available in lateral surgery that has promising results in being a key neuromonitoring modality alongside SSEP, TcMEP, and EMG. There's nothing more disconcerting for a spine surgeon than a false negative. In my experience with TMAP™, we have had a 0% false negative rate.[1] This detail is the most significant part of our findings to me as a surgeon. Mistakes can happen in the operating room. We need the right tools to tell us when that is happening as close to 100% of the time as possible. If we can understand the timing of the error, we can learn from this and avoid the same issue again. Ultimately, this feedback leads to surgeon learning, surgeon learning leads to better technique, and better technique may lead to better outcomes.

Q: In your experience, how does TMAP™ differ from other methods used to help reduce the risk of neural complications in lateral procedures (SSEP, MEP, and retractor time)?

A: Retractor time alone is a rudimentary measure to avoid nerve injury. We need real-time data to make intraoperative decisions to reduce or avoid the likelihood of a nerve injury during lateral surgery. In ALIF surgery we avoid the nerve and during PSO and deformity surgery we use TcMEPs to understand the health of the lower extremity nerves. Similarly, during lateral surgery, we can use a motor monitoring modality to understand the health of the lower extremity nerves. TMAP™ is that modality.

Q: How has the use of the TMAP™ modality impacted your practice?

A: TMAP™ allows me to not feel like I am on a timer anymore. I use specific data that I get from TMAP™ to judge what I am doing so that I am not rushed and can take my time especially with difficult lateral cases. For example, when I was implementing prone lateral into my practice, TMAP™ provided me with time and data so that I could focus on developing and refining my technique, while having confidence in the nerve health of the patient.

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