Use of trans-cranial motor evoked potentials for lumbar plexus nerve monitoring during trans-psoas lateral lumbar interbody fusion

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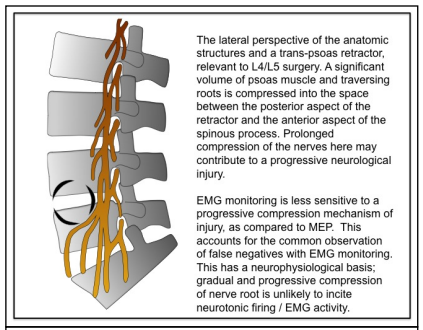
Introduction

This study assessed the potential utility of trans-cranial motor evoked potential (MEP) monitoring during trans-psoas lateral lumbar interbody fusion (LLIF). Trans-psoas LLIF is frequently associated with neurological complications, limiting its value as a less invasive procedure. The routine use of EMG neuromonitoring has been inadequate to detect iatrogenic injuries; significant postoperative thigh symptoms, including weakness, have gone undetected by EMG. An effective way to monitor for these intraoperative neurological events is not yet well established.

Methods

We introduce our modified intra-operative neuromonitoring (IONM) technique and review the clinical records of our first three patients (out of 58 consecutive patients) in whom MEP alerts were observed during L4-L5 LLIF. Postoperative neurological outcome was correlated with the IONM findings.



The lateral perspective of the anatomic structures and a trans-psoas retractor, relevant to L4/L5 surgery. A significant volume of psoas muscle and traversing roots is compressed into the space between the posterior aspect of the retractor and the anterior aspect of the spinous process. Prolonged compression of the nerves here may contribute to a progressive neurological injury.

EMG monitoring is less sensitive to a progressive compression mechanism of injury, as compared to MEP. This accounts for the common observation of false negatives with EMG monitoring. This has a neurophysiological basis; gradual and progressive compression of nerve root is unlikely to incite neurotonic firing / EMG activity.

Table

Table 1: Timing of tcMEP alerts, response to these alerts, and neurological outcome in three cases.

	Case 1	Case 2	Case 3
Elapsed time of retraction before tcMEP alert	27 minutes	32 minutes	61 minutes
Elapsed time from tcMEP alert to retractor removal	23 minutes	9 minutes	4 minutes
Immediate post-op motor	Quads 3/5	Quads 2/5	Quads 5/5
Immediate post-op sensory	Ant. thigh numbness	Ant. thigh numbness	Ant. thigh numbness
Deficits and (time to resolve)	Quad 5/5 (7d) Numbness (6m)	Quad 5/5 (4d) Numbness (6w)	Numbness (6w)

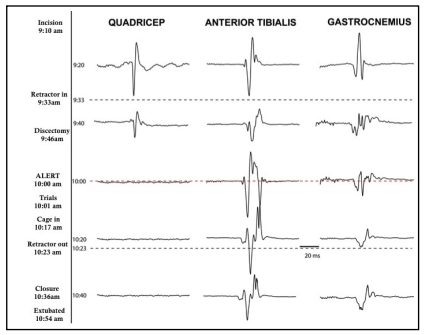
tcMEP – transcranial motor evoked potentials, Quads – quadriceps, Ant. – anterior, d – days, w – weeks, m – months

Results

In each case, loss of quadriceps MEP signals occurred during LLIF at L4/L5, and after prolonged retraction (27, 25 and 61 minutes respectively). The EMG, however, did not show any abnormal activity. Two patients had post-operative quadriceps weakness, concordant with MEP data. The third patient, in whom the MEP signals returned to normal after expeditious removal of the retractor, did not exhibit quadriceps weakness, also concordant with MEP data.

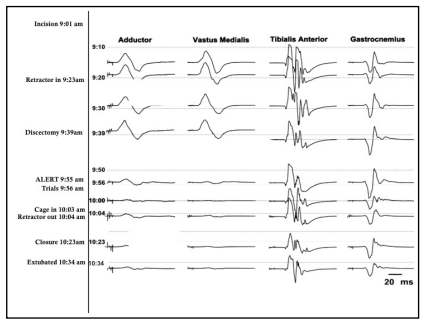
Case 1

The vastus medialis and vastus lateralis MEP signals were lost 27 minutes after retractor placement. EMG was quiet throughout the procedure. Retractor was removed 23 minutes after MEP alert. The MEP did not improve and the patient awoke with 3/5 quadriceps weakness.



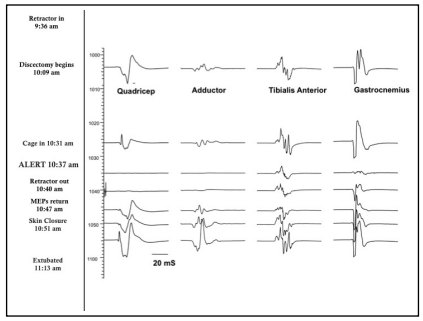
Case 2

MEP in vastus medialis, vastus lateralis and adductor was lost 32 minutes after retractor placement. sEMG was quiet, however, throughout the entire procedure. The retractor was removed 9 minutes after MEP alert. MEP did not recover, and the patient awoke with 2/5 quadriceps.



Case 3

The MEP signals in the right vastus medialis, vastus lateralis and adductors were lost 61 minutes after retractor placement, while sEMG remained quiet. The retractor was removed 3 minutes after the MEP alert. The signals returned to baseline amplitude 7 minutes after retractor removal, and the patient awoke with normal quadriceps strength.



Conclusions

We attribute these nerve inuries to prolonged compression of the nerve roots, between the retractor and the transverse process (figure). This type of progressive nerve inury cannot be reliably detected by EMG, while it can be detected by MEP. The addition of MEP may improve the sensitivity of IONM during trans-psoas surgery. Improved IONM may offer the opportunity to intervene on evolving iatrogenic nerve injuries, and may reduce the incidence of adverse postoperative findings.