

Variable Results in Motor Mapping of the Lumbar Plexus: A Comparison of 3 Different L2-L3 Far Lateral Lumbar Discectomy & Fusion Procedures

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There has been a major trend in surgery towards less invasive procedures performed through smaller surgical apertures. Smaller surgical openings are associated with decreased visualization, and surgeons must rely more on intraoperative tools including fluoroscopic imaging and motor nerve mapping techniques to assess their relative anatomical position and proximity to neural structures respectively. In retroperitoneal lateral lumbar interbody fusion (LLIF) procedures, the surgeon must establish a safe surgical corridor to access the disc space by traversing through the substance of the psoas muscle while avoiding damage to the lumbar plexus. Surgeons utilize Triggered EMG (T-EMG) using a monopolar electrical probe to detect the presence and proximity of lumbar plexus elements in the surgical field. A detailed understanding of the functional anatomy of the lumbar plexus and an appreciation of anatomical variants is essential to understanding how to effectively map the lumbar plexus. Anloague and Huijbregts (2009) describe a prevalence of anatomical variation ranging between 8.8-47.1% in the individual nerves of the lumbar plexus with a mean prevalence of 20.1%.

No clear guidelines for muscle selection in LLIF procedures have been established. In this article, the authors describe their personal experience and rationale for selection of essential muscle recordings for LLIF procedures at the L2-3 level. We present 3 separate L2-3 LLIF procedures that illustrate the variability of lumbar plexus elements that may be encountered at the same surgical level in different patients. At the L2-L3 Level, we recommend the following essential T-EMG muscle recordings to assist in the navigation of the lumbar plexus:

Abdominal Muscles

The major elements of the upper lumbar plexus include multiple nerves that innervate the abdominal muscles including the Subcostal (T12), Iliohypogastric (T12, L1) and Ilioinguinal (L1) nerves. Gaining access to the retroperitoneal space and traversing the abdominal wall poses a risk of injury to these major nervous structures and abdominal wall paresis is an associated complication of the LLIF procedure. (Ahmadian, Deukmedjian, Abel, Dakwar, & Uribe, 2013; Dakwar et al, 2011). The authors have often observed T-EMG responses from abdominal muscle recordings that have been useful in alerting the surgeon of the presence of neural elements in the surgical field. (Figure 1).

Adductors

The Obturator nerve is formed by the L2, L3, & L4 roots and descends through the Psoas muscle to innervate the major muscle group for leg adduction. Figure 2 illustrates an example where motor mapping at the L2-3 level resulted in T-EMG responses limited to the adductor muscle recording channel suggesting proximity to the Obturator nerve.

Quadriceps

The femoral nerve (L2, L3, & L4) innervates the quadriceps muscles. Anterior thigh pain, paresthesia and diminished knee extension are complications associated with a femoral nerve injury in LLIFs. (Ahmadian, Deukmedjian, Abel, Dakwar, & Uribe, 2013). We recommend using multiple quadriceps muscle recordings (i.e. rectus femoris & vastus medialis). Figure

3 illustrates an example where motor mapping at the L2-3 level resulted in T-EMG responses from multiple quadriceps muscles in addition to adductor muscle responses suggesting proximity to both the Femoral and Obturator nerves.

Although more study is needed, the authors recommend the utilization of abdominal, adductor and quadriceps muscle recordings when mapping the lumbar plexus in L2-3 LLIF procedures.

Figures:

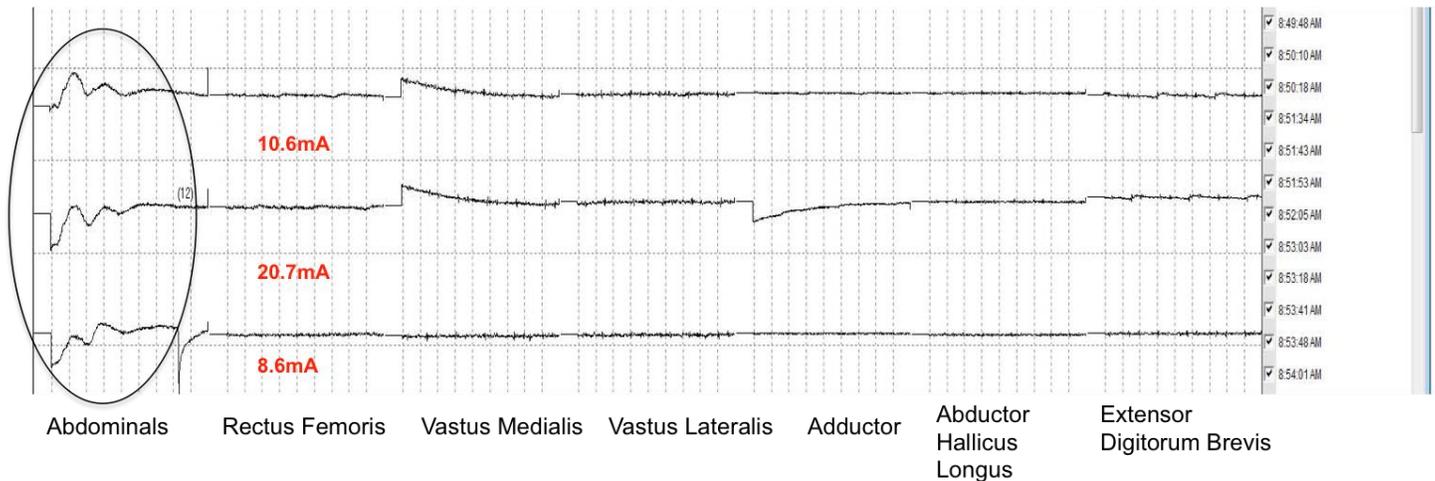


Figure 1: Waterfall of Manual TEMG conducted at the L2-L3 level. Note the isolated abdominal CMAPs recorded with no other muscle activation. Muscles used: Abdominals (Peripheral nerve innervation: Subcostal n., ilioinguinal n., iliohypogastric n.), Rectus Femoris (Peripheral nerve innervation: Femoral n.), Vastus Medialis (Peripheral nerve innervation: Femoral n.), Vastus Lateralis (Peripheral nerve innervation: Femoral n.), Adductor (Peripheral nerve innervation: Obturator n.), Abductor Hallicus Longus (Peripheral nerve innervation: Sciatic n./Posterior tibial n./medial plantar n.), & Extensor digitorum brevis (Peripheral nerve innervation: Sciatic n./Common peroneal n./Deep peroneal n.). Relative activation thresholds are noted in mA.

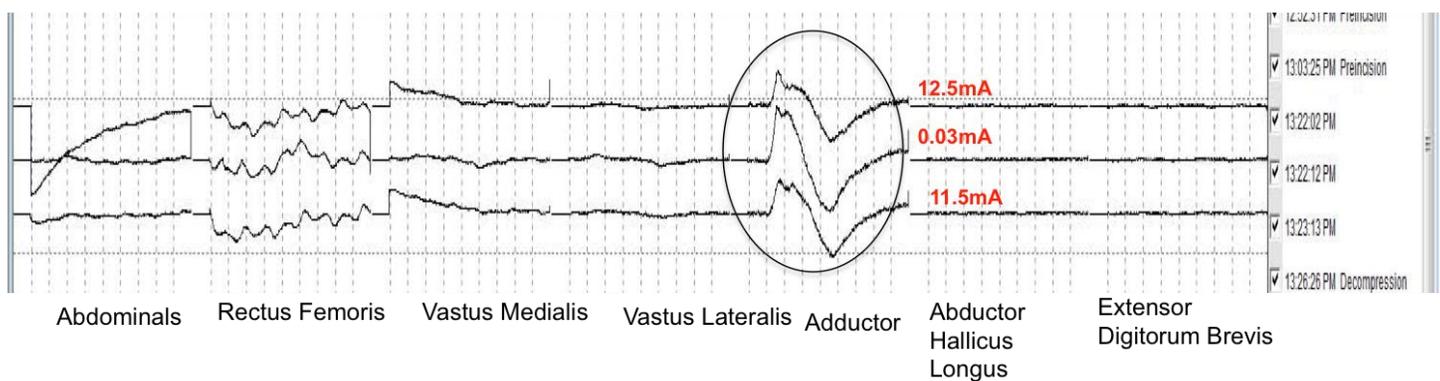


Figure 2: Waterfall of Manual TEMG conducted at the L2-L3 level. Note the isolated adductor CMAPs recorded with no other muscle activation. Muscles used: Abdominals (Peripheral nerve innervation: Subcostal n., ilioinguinal n., iliohypogastric n.), Rectus Femoris (Peripheral nerve innervation: Femoral n.), Vastus Medialis (Peripheral nerve innervation: Femoral n.), Vastus Lateralis (Peripheral nerve innervation: Femoral n.), Adductor (Peripheral nerve innervation: Obturator n.), Abductor Hallicus Longus (Peripheral nerve innervation: Sciatic n./Posterior tibial n./medial plantar n.), & Extensor digitorum brevis (Peripheral nerve innervation: Sciatic n./Common peroneal n./Deep peroneal n.). Relative activation thresholds are noted in mA.

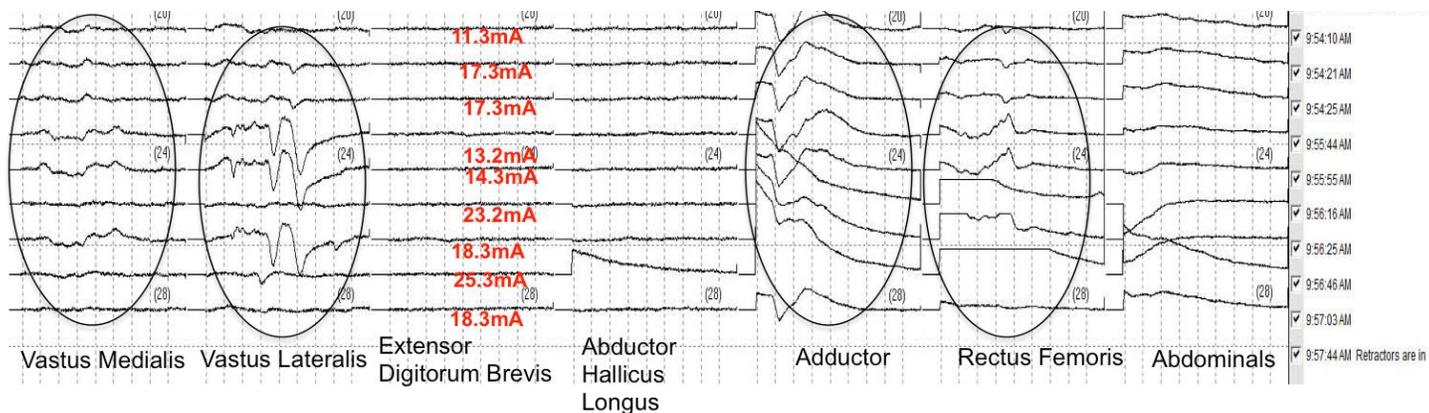


Figure 3: Waterfall of Manual TEMG conducted at the L2-L3 level. Note the multiple quadriceps and adductor CMAPs recorded with no other muscle activation. Muscles used: Abdominals (Peripheral nerve innervation: Subcostal n., ilioinguinal n., iliohypogastric n.), Rectus Femoris (Peripheral nerve innervation: Femoral n.), Vastus Medialis (Peripheral nerve innervation: Femoral n.), Vastus Lateralis (Peripheral nerve innervation: Femoral n.), Adductor (Peripheral nerve innervation: Obturator n.), Abductor Hallicis Longus (Peripheral nerve innervation: Sciatic n./Posterior tibial n./medial plantar n.), & Extensor digitorum brevis (Peripheral nerve innervation: Sciatic n./Common peroneal n./Deep peroneal n.). Relative activation thresholds are noted in mA.

References

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