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Editorial

Preventing nerve injury with pedicle screw testing

See Article, pages 573–581

Troni and colleagues in this issue of *Clinical Neurophysiology* report on electrodiagnostic testing of pedicle drilled holes prior to screw placement (Troni et al., 2019). They remind neuromonitoring teams and surgeons that this initial step of testing holes could reduce neurologic postoperative deficits. They encourage testing each hole with a probe as an early warning of possible pedicle wall breech before insertion of larger, more dangerous, threaded pedicle screws.

Pedicle screw placement techniques and knowledge continue to evolve. The typical risky situation is when a screw is placed in contact with a nerve root. Penetration of screws into the spinal cord or through a nerve root is a rare, feared risk.

Electrical and imaging measurement after screw placement is the common surgical practice. Screws can be removed if a low threshold or intraoperative imaging suggests malplacement. If the nerve root or spinal cord already has been injured during placement, screw removal is insufficient to prevent postoperative deficits. Traditional electrodiagnostic testing with triggered EMG has an 80% chance to detect a malpositioned screw (Balzer et al., 2008, Mikula et al., 2016, Holdefer et al., 2013). Surgeons need to be aware of that 20% false negative risk.

Calancie et al. (1994) originally described use of an electrically active probe to test holes before screw placement. Others have tested the drill bit as holes are placed (Maguire et al., 1995). That initial phase of testing is too often skipped to save time. It is skipped at the risk of damaging nervous structures during placement. Troni and colleagues (Troni et al., 2019) remind us that testing during or after hole drilling is available as a method to reduce risk.

There are many technical and clinical problems with pedicle screw electrodiagnostic testing. Fluid around the screw or stimulation site can short circuit or shunt the testing current resulting in erroneous results. Chronically damaged nerves may respond poorly to electrical stimulation, resulting in false negative tests. Osteoporosis or damaged vertebrae can leak current too easily, resulting in false positive tests. Anodized screws or a hydroxyapatite coating can prevent current flow out of the screw, causing a false negative test. Multiaxial screw constructs also can impede current flow between pieces of the screw. Train of Four testing can assess that previously used neuromuscular junction blocking agents are no longer impeding synaptic transmission. The monitoring team needs to test the muscles relevant to the level tested, and poor placement or choice of wrong muscles can result in missing the clinically relevant responses. There may not be good muscles to test for upper to mid-thoracic levels, so testing is most often used at cervical and lumbar levels. Finally, testing assesses motor pathways, so damage to sensory roots may be missed.

The surgeon has options to determine proper placement. Checking the hole before screw placement should reduce nervous system risk. The monitoring team conducting hole testing needs to avoid many of the same problems encountered with screw testing: fluids shunting, an anodized or poorly conducting probe, unresponsive chronically damaged nerve roots, testing muscles at the wrong levels, residual neuromuscular blockade. Using both imaging and electrodiagnostic testing should reduce nervous system risk. Finding spinal fluid in the hole suggests a too medial placement. Skipping hole testing or too cursory a probe test saves time while increasing nerve injury risk. Testing holes as well as screws is quick and simple, and reduces risk.

Conflict of interest

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