# SCI CDE Imaging Guidelines

There are several imaging techniques in common clinical use in the evaluation of spinal trauma and spinal cord injury (SCI) including radiography, computed tomography (CT) and magnetic resonance imaging (MRI). Radiography and CT provide a comprehensive assessment of the complexity of the bony injury as well as structural changes associated with vertebral translation and angulation. MRI provides the most comprehensive assessment of the soft tissue component of the injury and is the only imaging method that reveals the intrinsic features of spinal cord injury (i.e., edema, hemorrhage, transection, compression, swelling). Because MRI possesses the unique capability to non-invasively depict the damaged substructure of the spinal cord, the SCI working group advocates that the CDE imaging features for SCI described herein be derived only from MRI datasets. The CDE SCI essential imaging features represent anatomic findings that are routinely discernible on commercial MRI platforms. We include diffusion tensor imaging (DTI) as part of the essential imaging features as this technology has matured sufficiently that it is available and feasible to utilize on most modern clinical systems at or about 1.5 Tesla.

In addition to the common imaging methods, there are several imaging techniques that are highly experimental or under development, such as computed tomography angiography (CTA), magnetic resonance angiogram (MRA), magnetization transfer (MT), functional magnetic resonance imaging (fMRI), perfusion, spectroscopy, myelin water fraction imaging, and other diffusion methods such as diffusional kurtosis imaging (DKI). Since these recommendations have not yet been standardized or validated for this general population, no recommendations regarding these techniques are made at this time.

## Specific MR imaging guidelines with respect to SCI for consideration:

* Injury to Imaging Time: The injury to imaging time interval is a factor in the assessment of the length of spinal cord injury on MRI. Spinal cord edema is a dynamic process after injury. The longitudinal extent of edema may increase by as much the height of one vertebral body per day. Therefore the length of the lesion may increase over a period of days without an associated change in clinical status. An important corollary to this observation is that two lesions of different lengths may produce the same neurologic deficit when imaged at different times after injury (Leypold, et al. 2008).(Leypold, Flanders, & Burns, 2008)
* Methylprednisolone: While the therapeutic benefits of methylprednisolone in the setting of acute SCI are controversial, there is some evidence that early administration of MPS in the doses advocated by Bracken et al. (Bracken et al., 1997; Bracken et al., 1998) after SCI can have an effect on the MRI appearance of SCI. Steroid does not seem to have an effect on overall lesion length, however, it does diminish the probability of frank hemorrhage at the lesion center (Leypold, et al. 2007)(Leypold, Flanders, Schwartz, & Burns, 2007). This observation has been replicated in animal studies.
* Acute vs chronic injury: There are MRI features that can help differentiate acute and chronic SCI. Swelling and edema are typical MRI changes associated with acute SCI with or without frank areas of intrinsic intramedullary hemorrhage whereas spinal cord atrophy, tethering and syrinx formation are more characteristic of chronic SCI. In the subacute period, spinal cord edema will tend to contract around the geographic center of the injury. Chronic hemorrhagic by-products may persist indefinitely in the lesion center. In the subacute period, a sudden progression in neurologic deficit or an ascending neurologic level may be indicative of subacute progressive ascending myelopathy (SPAM). There is an MRI correlate to SPAM which demonstrates a dramatic increase in length of the lesion from the initial MRI. In the chronic phase of injury a sudden neurologic decline after a long period of stability is known as post-traumatic progressive myelopathy (PTPM). This clinical entity may be associated with MRI changes of syrinx formation/enlargement, spinal cord tethering or progressive spinal cord atrophy.
* Instrumentation: All forms of metallic instrumentation produce local or regional artifacts on MRI which may obscure portions of the spine and the contents of the spinal canal. Stainless steel devices in prior use (e.g., sublaminar wiring, Luque and Harrington rods) are highly ferromagnetic and generally will produce severe distortion of the regional anatomy resulting in a non-diagnostic MRI study. The modern metal alloys used in current instrumentation are more “MRI friendly” resulting in a vastly improved depiction of the contents of the spinal canal on MRI. However, local artifacts are still apparent which do negate useable signals from the adjacent soft tissues. In general, the more extensive and complex the hardware geometry, the greater the local artifact. As a general rule, cervical anterior fixation plates and lateral mass rods/screws produce little local artifact and do not affect visualization of the spinal canal (and spinal cord) presumably due to the smaller caliber and mass of these implants, although lateral mass instrumentation does diminish the quality of evaluation of the neural foramina. Pedicle screws and posterior fixation rods frequently result in the largest areas of local artifact that can extend into the spinal canal and obliterate useable signal from the spinal cord. Cross-link stabilizers on posterior fixation rods are particularly problematic and can produce large areas of signal dropout that preclude any reliable assessment of the spinal cord. There are several ways to mitigate the instrumentation artifact on MRI: (1) counseling the spine surgeon prior to placement of instrumentation and avoiding use of cross-links and wiring over the injured areas whenever possible, (2) adjustment of the MR acquisition protocol to minimize artifact from instrumentation. This includes avoidance of active fast suppression and gradient echo family of pulse sequences. Wide receiver bandwidth should be employed in all fast spin-echo techniques. Advanced imaging (e.g., spectroscopy, DTI, and MT imaging) should be avoided in the instrumented patients as even the mild perturbations introduced to the magnetic homogeneity will have deleterious consequences on the results.
* Pediatric: There are risks, benefits and needs for imaging studies in children under 7 who require sedation.

While the clinical assessment and grading of individual patients is performed using standard instruments at the point-of-care, the NINDS SCI Imaging WG recommends that assessment of individual patient MR imaging studies be performed in a centralized manner by imaging experts who are versed in the SCI Imaging CDEs. This is to minimize variability in imaging assessment and maximize the potential value of the NINDS Imaging CDE instrument. There are tools available (both commercially and in the open-source market) that will facilitate secure transmission of medical images to a single repository for central review.

References

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