

# Comparative Imaging of the Cervical Spine

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Imaging of the cervical spine has undergone substantial evolution in the past fifteen years. The most common indications for imaging of the cervical spine include degenerative disease and trauma. In contrast to the lumbar spine, imaging of the cervical spine is more difficult due to the relatively smaller volume occupied by the intervertebral disks, intervertebral canals, and vertebra. This discussion explores the relative usefulness of various imaging modalities for the evaluation of cervical spine degenerative disease and trauma. Cost considerations will also be reviewed (Table 1).

## DEGENERATIVE DISEASE

The clinical presentation of cervical degenerative disease includes musculoskeletal pain, radiculopathy, or myelopathy; however, many patients with significant degenerative disease are asymptomatic. Proper patient management requires the accurate correlation of clinical and imaging findings. Compression and/or irritation of the spinal nerve roots (radiculopathy) or spinal cord itself (myelopathy) are common accounting for 1-2% of admissions to large community hospitals.

There are several pathologic entities associated with degenerative disease of the cervical spine. They include: 1) disk degeneration, 2) disk herniation, 3) spondylosis, and 4) facet osteoarthritis. The goal of imaging in the context of degenerative disease is to establish the diagnosis and etiology of cervical spinal stenosis, neural foraminal stenosis, and myelomalacia.

Myelomalacia is typically due to chronic compression of the spinal cord. This may have an ischemic basis. Pathologic features include the presence of gliosis, necrosis, or demyelination. CT, myelography, and CT myelography are insensitive for the diagnosis of myelomalacia. MR imaging accurately assesses for the presence of myelomalacia which typically appears as an ill-defined focus of increased signal intensity on T2-weighted or T2\*-weighted images which is unaccompanied by mass effect. The presence of myelomalacia generally portends a poorer prognosis following decompressive surgery, however, surgery may prevent further progression of this disease process.

MR imaging is now widely accepted as the most accurate imaging modality for the screening of patients with suspected cervical radiculopathy and/or myelopathy associated with either disk herniation or cervical spondylosis. Brown et al compared MRI to CT, plain myelography, and CT myelography in 34 patients who were operated on for cervical radiculopathy and myelopathy. MRI correctly predicted 88% of all surgically proven lesions. The corresponding rates were 81% for CT myelography, 58% for plain myelography, and 50% for CT. It was concluded that MRI, in combination with plain films, provides the best imaging pathway for the pre-operative evaluation of cervical radiculopathy and myelopathy. If consistent, high quality MR imaging is not available, then CT myelography is the examination of choice. Other indications for CT myelography include: 1) negative MR study in the context of a strong clinical suspicion, 2) severe spinal deformity, 3) extensive surgical hardware, and 4) "sucker" artifact versus residual or recurrent disk herniation. Shafaie et al established concordance rates between interpretations of CT myelography and MRI in patients with degenerative cervical spine disease. For most parameters of interpretation, the degree of concordance between CT myelography and MRI was found to be only moderately good, with discrepancies noted especially in the differentiation of disc and bony pathology. It was concluded that these methods should be viewed as complementary studies in the patient diagnosed clinically with cervical spondylotic radiculopathy, myelopathy, or both. Kinematic MR imaging has also been shown to add additional information when compared to flexion and extension radiographs, myelography, CT myelography and static MR imaging in patients with advanced stages of degenerative disease of the cervical spine.

In summary, MR imaging is less costly, less invasive, and more accurate than CT myelography for the evaluation of cervical spine degenerative disease. CT myelography should be utilized for problem solving. Finally, clinical and imaging findings must be carefully correlated. While CT myelography and MR imaging are both very sensitive for demonstrating anatomic abnormalities, they cannot reliably differentiate symptomatic from incidental degenerative changes in the cervical spine.

## CERVICAL SPINE TRAUMA

Trauma involving the spine is a common cause of disability. There are approximately 12,000 new quadriplegics or paraplegics each year and 250,000 existing victims in the United States alone. A recent national survey of Trauma Centers published by Grossman et al demonstrated an overall incidence of all types of cervical spine injury of 4.3%. The incidence of cervical spine injury without spinal cord injury was 3.0%, spinal cord injury without fracture was 0.70%, and delayed diagnosis of all types of cervical spine injury was 0.01%. Approximately 60% of spinal cord injuries involve the cervical region. Cervical spine trauma occurs primarily in adolescents and young adults with the majority occurring between the ages of 15 and 35 years. Males predominate with a 4:1 ratio over females. The most common causes of cervical spine injury include motor vehicle accidents, falls, water sport injuries, and penetrating trauma.

The goals of imaging the patient with cervical spine trauma include detection of fractures, cord injury, or compression and determining the potential for instability. Clinical instability is defined as the inability to maintain normal associations between vertebral segments while under physiologic load. Cervical spine injuries due to trauma can be classified by anatomic location (Table 2).

**Table 1: Cervical Spine Imaging: 2002 Medicare Fee Schedule**

Plain film series	\$ 59.00
CT w/ 3D recons	\$406.52
Myelogram	\$362.35
MRI	\$483.62
CT Myelogram	\$633.48

Compared to conventional radiography, CT is the preferred initial screening examination in trauma patients at high and moderate risk for cervical spine fracture. This strategy prevents cases of paralysis and saves money for society. MRI and CT are often complementary. The major indications for CT include: 1) detection and assessment of fractures; 2) evaluation of hemodynamically unstable patients; 3) to "clear the C-spine" in the context of suboptimal plain films; and 4) evaluation of traumatic rotatory atlantoaxial dislocation. The main indications for

**Table 2: Cervical Spine Trauma**

**Intradural/Extradural Lesions**

- Concussion
- Contusion
- Hematomyelia
- Transection
- Myelomalacia
- Syringomyelia

**Intradural/Extradural Lesions**

- Nerve Root Avulsion

**Extradural Lesions**

- Acute Traumatic Disk Herniation
- Traumatic Epidural Hematoma
- Displaced Fracture Fragments
- Subluxation/Dislocation

MR imaging include: 1) assessment of the cord in the context of a focal neurologic deficit; 2) negative plain films and/or CT in the context of positive clinical findings; 3) assessment of stability (ligament integrity); 4) to rule out disk herniation or epidural hematoma; 5) to rule out nerve root avulsion; and 6) to rule out vertebral artery injury. The development of mid-field, open-design MR units has helped solve many of the historical problems associated with utilizing MRI in the context of acute trauma.

Flanders et al compared MRI and CT for the evaluation of acute cervical spine trauma. The positive predictive value of MRI for the presence of a vertebral body fracture was 88 percent and 100 percent for posterior element fracture. CT fared poorly in detection of soft tissue injuries. The sensitivity of CT in the detection of disk protrusion was 44 percent, cord swelling 33 percent, cord compression 77 percent, and pre-vertebral edema 35 percent. Goldberg et al concluded that little correlation exists between neurologic status and radiographic findings (CT and plain films) and that these studies are of no prognostic value. MRI, however, can reliably detect cord contusion, compression, and transection while providing additional prognostic information. The presence of blood products associated with a cord contusion on MR imaging correlates with a poor prognosis for recovery of function. It is clear that evaluation of spinal cord injury by MRI is unparalleled. CT, on the other hand, has recently been shown by Klein et al to be superior to MRI in the diagnosis and classification of cervical spine fractures.

In summary, CT and MRI are often complementary techniques for the evaluation of cervical spine trauma. CT remains better for fracture fragment assessment, however, significant cervical spine injuries may be present in the absence of a fracture or subluxation. MR imaging offers the advantages of direct assessment of the cervical spinal cord, and accurately assesses for the presence of associated traumatic disk herniation, and ligamentous injury that may contribute to instability.

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