

X-Ray, CT and MRI: Trauma Cases May Require All Three Tests

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I recently was involved in a legal case and reviewed medical records on a patient who was in a car crash.

Mary was taken to the hospital and had X-rays, MRI and CT all on the same day. Each of these was read by a different radiologist and each test revealed completely different results.

The bottom line is that Mary had 12 spine fractures, three herniated discs and a transected spinal cord. However, the cervical and thoracic plain films were both read as normal by the radiologist. A different radiologist read the CT films and found four cervical and eight thoracic spine fractures, no disc herniations nor the transected spinal cord. A third radiologist read the MRI films and did not find any of the four cervical fractures and found only four thoracic fractures. However, he did see the three cervical disc herniations and the transected thoracic spinal cord.

All three radiologists were competent and none missed anything on the films. This case illustrates the limitations and strengths of each of these imaging modalities. It also means that the prudent clinician should consider doing both CT and MRI in trauma cases if clinical symptoms and/or plain film X-rays indicate spine injury but initial tests fail to document the injury.

Let's look at the specifics of the different test results. Looking just at the cervical spine, plain films were read as normal despite the existence of four fractures. The CT study did visualize the cervical fractures but missed seeing the three cervical disc herniations. Finally, the MRI study was not able to identify any of the cervical fractures but visualized the three disc herniations.

Specifically, the cervical MRI missed a C1 posterior-arch fracture, C4-5 left-facet fracture, C5 left-pedicle and lamina fracture, and a C6 spinous-process fracture. The CT study completely missed disc herniations at C3-4, C4-5 and C5-6. The plain film X-rays missed everything.

If your patient has severe or persistent neck pain and plain films are normal, this case illustrates that the patient could have disc herniations or fractures completely invisible on plain X-ray films. If you think it could be a soft-tissue injury, such as disc herniation, it appears that MRI is the best test. However, a negative MRI study may be insufficient to adequately assess the patient's true injuries. When a patient with a negative MRI has persistent or severe pain, it's wise to order the CT to rule out fracture.

CT	MRI
C1 Arch Fx	C3-4 Disc Bulge
C4-5 Facet Fx	C4-5 Disc Bulge
Cervical C5 Pedicle Fx	C5-6 Disc Bulge
C6 SP Fx	No Fx
No Disc Bulges	

T8 Body Fx	
T7 Lamina Fx	
Thoracic T4-7 SP Fx	Fx/Dislocation T7-8
T6-8 TP Fx	Total Transection of Spinal Cord
9mm Anterior Subluxation T7 on T8	

Table 1: Summary of Findings

Looking at just the thoracic-spine radiology reports, the plain films report stated, "normal vertebra body alignment, well-maintained disc spaces and no evidence of bony injury." The thoracic CT report described a comminuted fracture through the body of T8, a comminuted fracture through the posterior elements and facet joints of T7, spinous process fractures of T4, T6 and T7, and left transverse process fractures at T6, T7 and T8. The radiologist also noted a 9mm anterior subluxation of T7 on T8 - the location of the posterior elements fractures.

Surely, the MRI also saw these eight thoracic fractures, right? No, only four of the fractures were visible on MRI films. Interestingly, the MRI radiologist described a "total transection of the thoracic spinal cord." Obviously, Mary never walked again, but that is not the lesson to be learned from this case.

The lesson here is that the prudent clinician must consider the possibility that a thorough examination of a trauma patient may indicate the need to evaluate for both disc herniations and spine fractures with separate tests. This case teaches us that neither MRI nor CT alone will completely or accurately visualize fractures and disc herniations. Both tests may need to be done to accurately assess the patient's injuries. Faced with a trauma patient, the prudent doctor should consider ordering all three of these tests.

See the Table for a summary of the findings from plain films, CT and MRI tests. Despite the severity of the trauma, this case is an excellent teaching tool on the subtle distinctions between the three most common imaging techniques.

There are three lessons to learn. The first lesson is that the MRI test completely missed eight out of 12 spine fractures. The second lesson is that the CT test completely missed three disc herniations and a transected spinal cord. The third lesson is that the plain film X-rays missed everything.

While plain film X-rays remain a useful and cost-effective first test, the case illustrates the need to carefully consider using both CT and MRI on a patient with spine trauma. The use of only two out of three imaging techniques may completely miss the patient's true injury and leave the doctor wondering why the patient is not recovering at a normal pace.

This unusual case is like a triple-blind study of the three imaging techniques. Three different radiologists read the three different tests. There appears to be far less overlap between the imaging capabilities of MRI and CT than I had previously believed. Clinicians would be wise to consider the patient's clinical symptoms and do whatever tests are necessary to evaluate the condition. Do not think a negative MRI is the final answer in trauma patients with persistent or significant pain.

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