

DIAGNOSING THE UNSTABLE CERVICAL SPINE

Stuart E. Mirvis, MD, FACR

INTRODUCTION

One of the most challenging and stressful aspects of emergency radiology is the accurate diagnosis and characterization of cervical spine injuries. Usually the mistake leading to the missed injury is failure to recognize the injury on screening radiographs or improper imaging work-up of the patient based on clinical circumstances. These injuries can be missed for a variety of reasons that I have seen over the years in our practice and in malpractice cases including:

- 1) abnormal study buried in a large stack of normal studies – lack of attention
- 2) subtle positive imaging findings – lack of perception, experience
- 3) technically poor or incomplete examination – inability to observe injury
- 4) misidentification of injury as variant, remote injury, degenerative change, etc. – experience & training
- 5) failure to perceive obvious injury – care of search & experience
- 6) satisfaction of search error – see one injury and stop looking
- 7) recognition of injury, but lack of appreciation of instability
- 8) failure to communicate from both the clinical and imaging sides – poor or no symptom description and lack of notification of suspicious findings. While there are many potential ways these important injuries can be missed, there are clearly certain injuries that are the *most frequently overlooked* mainly because they are either rare or often very subtle. The lecture will review an overall approach to cervical spine imaging based upon *patient clinical presentation* and on the imaging appearances of these injuries along with management issues. The focus of the lecture is on the radiographic and CT appearances of selected injuries. The use of ancillary radiographic views, flexion-extension views, and MRI is considered as appropriate.

RECOMMENDED IMAGING PROTOCOL FOR POTENTIAL CERVICAL SPINAL INJURY IN BLUNT TRAUMA – BASED ON CLINICAL PRESENTATION

- I. Patient is awake and alert with negative clinical examination of the cervical spine and no major distracting injury (Nexus Criteria met)- No imaging assessment needed.
- II. Clinically apparent neurologic deficit attributable to cervical cord injury. Maintain stabilization – rigid. Work-up based on specialist recommendations.
- III. Neck pain or otherwise positive physical examination of the cervical spine.
 AP/horizontal lateral/OMO radiographs: If positive for injury maintain rigid stabilization and continue imaging as per specialist consultation. If negative, obtain full cervical spine CT (MDCT slice helical 1-2 mm sections from occipital condyles to bottom of T2. Reformations @ every 2-3mm (Reconstruct images for MPR at axial slice thickness or thinner).
 If axial and MPR images negative – C- spine cleared. Maintain soft collar immobilization. If symptoms persist consider flex-ext views or MRI.
 (flexion-extension views are occasionally useful if patient is *fully cooperative* and able to perform flexion and extension maneuver under clinical supervision prior to attempting radiographs. Radiographs must cover to C7-T1 and be of acceptable technical quality to radiologist – about 60% are inadequate).
- IV. Unconscious, unreliable, obtunded, not likely to be reliable for examination within 72 hours. Total cervical CT as above. If positive, maintain stabilization and image as per consultant. If negative MRI, sagittal T1,T2 spin echo, axial gradient echo, axial T2 fast spin echo, sagittal proton and inversion recovery. If negative- cleared.
 (Recent data from our center, unpublished, indicates that a negative MDCT of the cervical spine in an obtunded patient has an extremely high negative predictive value for injury – with corresponding MRI showing only stable injuries. MRI may not be necessary with after a negative high quality MDCT of the cervical spine)

STABILITY VS. INSTABILITY

Stable injuries resist movement to physiologic loads and do not create or worsen neurologic deficits. Unstable injuries (involve two contiguous columns of spine permit abnormal movement against physiologic loads, usually leading to creation or worsening of a neurologic deficit.

Potentially treacherous unstable c-spine injuries:

- 1- Atlanto-occipital distractions: rare, the 12 mm rule of Harris, anatomic landmarks to check, need for CT or MRI to verify.
- 2- Atypical Jefferson fracture (14% -unstable with torn transverse atlantal ligament).
- 3- C1-C2 rotatory subluxation: rare, role of CT stress rotation views, asymmetry of rotation of articular masses, use of volume images.
- 4- Type 2 and 3 odontoid fractures: need for high-resolution imaging, spinolaminar line offset, pre-vertebral soft tissue contour, posterior axial line interruption, Harris's cortical composite shadow – ring sign, tilted dens sign.
- 5- Hangman's and atypical Hangman's fractures: low-grade vs. high-grade, Harris's ring sign, spinolaminar offset sign, foramen transversarium involvement, disc space variation at C2-3.
- 6- Rotational facet fracture-subluxation: More common than pure dislocation, ligamentous injury, difficult reduction, subtle CT findings.
- 7- Isolated articular pillar fracture (lamino-pedicular separation): Hyperflexion mechanism, unstable, may appear in alignment and can have subtle fractures.
- 8- Re-aligned hyperextension dislocation – uncommon, usually obvious secondary to neurologic deficit, incidence increased in fused spines.
- 9- Re-aligned bifacetal flexion dislocation – usually obvious by deficit
- 10- Association of vertebral artery injury with certain injury patterns.

Selected References

1. D'Alise MD, Benzel EC, Hart BL. Magnetic resonance imaging evaluation of the cervical spine in the comatose or obtunded trauma patient. *J Neurosurg* 1999 Jul 91:54-9.
2. Barba CA, Taggart J, Morgan AS, et al. A new cervical spine clearance protocol using computed tomography. *J Trauma* 2001 Oct 51:652-6; discussion 656-7.
3. Dwek JR, Chung CB. Radiography of cervical spine injury in children: are flexion-extension radiographs useful for acute trauma? *AJR Am J Roentgenol* 2000 Jun 174:1617-9.
4. Veras LM, Pedraza-Gutiérrez S, Castellanos J, Capellades J, Casamitjana J, Rovira-Cañellas A. Vertebral artery occlusion after acute cervical spine trauma. *Spine* 2000 May 25:1171-7.
5. Crim JR, Moore K, Brodke D. Clearance of the cervical spine in multitrauma patients: the role of advanced imaging. *Semin Ultrasound CT MR* 2001 Aug 22:283-305.
6. Griffen MM, Frykberg ER, Kerwin AJ, et al. Radiographic clearance of blunt cervical spine injury: plain radiograph or computed tomography scan? *J Trauma* 2003 Aug 55:2 222-6; discussion 226-7.
7. Berne JD, Velmahos GC, El Tawil Q, Demetriades D et al. Value of complete cervical helical computed tomographic scanning in identifying cervical spine injury in the unevaluable blunt trauma patient with multiple injuries: a prospective study. *J Trauma* 1999 Nov 47:5 896-902; discussion 902-3.
8. Holmes JF, Mirvis SE, Panacek EA, Hoffman JR, Mower WR, Velmahos GC, Collective Name For the NEXUS Group. Variability in computed tomography and magnetic resonance imaging in patients with cervical spine injuries. *J Trauma* 2002 Sep 53:3 524-9; discussion 530.
9. Hanson JA, Blackmore CC, Mann FA, Wilson AJ. Cervical spine injury: a clinical decision rule to identify high-risk patients for helical CT screening. *AJR Am J Roentgenol* 2000 Mar 174:3 713-7.
10. Grossman MD, Reilly PM, Gillett T, Gillett D. National survey of the incidence of cervical spine injury and approach to cervical spine clearance in U.S. trauma centers. *J Trauma* 1999; Oct 47:4 684-90.