

Evaluating the cervical spine in confused or unconscious adults after blunt trauma

Potential injury to the spinal column should be considered in all patients with suspected polytrauma irrespective of the presence of neurological symptoms. The cervical spine is the most commonly affected region, injured in approximately half of all cases of spinal injury (Advanced Trauma Life Support, 2018). Prompt diagnosis and treatment of cervical spine injury is of utmost importance in the trauma patient, because there is an increased risk of associated spinal cord injury if these injuries are missed at presentation. Clinical assessment of the cervical spine can be challenging in cases where the patient is confused or has a reduced level of consciousness, defined as a Glasgow Coma Scale (Teasdale and Jennett, 1974) score <13. The incidence of cervical spine injury following blunt trauma is approximately 1–3% (Roberge and Samuels, 1999; Milby et al, 2008), but in confused patients the incidence rises significantly to 7.7% (Milby et al, 2008). In 0.2% of these patients, an unstable injury is missed on initial assessment and results in damage to the spinal cord (Levi et al, 2006), with the potential for causing devastating morbidity.

While many guidelines have been published on cervical spine clearance in trauma patients generally, consensus regarding cervical spine management in unconscious patients is lacking. Developed from a combination of retrospective cases series, review articles and professional consensus, the British Orthopaedic Association published in 2008, and most recently updated in 2015, guidelines for spinal clearance in the trauma patient, including guidance on the management of the cervical spine in confused or unconscious patients (British Orthopaedic Association Standards for Trauma, 2015). Despite the existence of these guidelines, there are wide variations in practice between English hospitals (Craxford et al, 2016).

Initial management

On presentation to hospital, all major trauma patients should be managed using the Advanced Trauma Life Support (2018) algorithms. The initial management of patients with potential cervical spine injury is the same regardless of their consciousness level; the principal priority in all cases is to stabilize the cervical spine and limit movement, in order to reduce the risk of secondary injury. This is most commonly achieved in the pre-hospital environment, initially through manual in-line stabilization, followed by the subsequent application of a cervical collar, lateral blocks and tape over the forehead and chin. The subject of a Cochrane Review in 2001, there is some debate over the method of cervical immobilization in trauma

ABSTRACT

Potential injury to the cervical spine should be considered in all patients who have suffered blunt trauma. Early spinal immobilization is required to minimize the risk of secondary spinal cord injury. However, prolonged immobilization is associated with its own morbidity. Clinical evaluation of the cervical spine in confused or unconscious adult trauma patients is challenging, and imaging is required to safely 'clear' the cervical spine. Despite the existence of national guidelines, significant variations in practice exist. This article summarizes the evidence for the initial stabilization of the cervical spine in adult trauma patients. It reviews the imaging modalities available and the criteria for discontinuation of cervical spine immobilization.

patients (Kwan et al, 2001). This is particularly relevant for patients with a reduced Glasgow Coma Scale score, as the application of a rigid collar significantly increases intracranial pressure, potentially decreasing cerebral blood flow and worsening any concomitant head injury, in keeping with the Monro-Kellie hypothesis (Ho et al, 2002).

Two studies have reported a significant increase in optical nerve sheath diameter, a surrogate marker for intracranial pressure, in healthy volunteers following application of a rigid collar (Maissan et al, 2018; Woster et al, 2018). A small prospective study in 10 patients with severe head injury also found a significant increase in intracranial pressure (Mobbs et al, 2002). There is therefore insufficient evidence to recommend one form of immobilization over another.

Imaging

If not immediately obvious on presentation to hospital, clinical signs of neurological deficit should be elicited during the secondary survey. However, only 15% of patients with

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KEY POINTS

- Patients should be managed according to Advanced Trauma Life Support principles. Prompt immobilization of the cervical spine is paramount. Current practice is immobilization with a cervical collar, lateral blocks and tape.
- British Orthopaedic Association Standards for Trauma guidelines should be followed to clear the spine. In unconscious patients, a 2–3 mm thin-slice computed tomography scan should be performed and reported by a senior radiologist before withdrawal of cervical immobilization.
- Plain radiographs and flexion-extension fluoroscopy are no longer recommended for cervical spine clearance in unconscious patients and should not be performed.
- More work is needed to delineate the role of cervical magnetic resonance imaging in the evaluation of these patients.

cervical spine fractures have an associated neurological injury (Copley et al, 2016), therefore mandating further imaging. Widely used protocols such as the Canadian C-Spine Rule (Stiell et al, 2001) and the Royal College of Emergency Medicine (2010) guidelines are not applicable to the management of patients with reduced Glasgow Coma Scale score. The imaging modalities available are discussed below.

Plain film radiographs

Plain radiographs of the cervical spine were historically the first-line imaging modality for detecting cervical injuries. A three-view cervical spine series (lateral, anteroposterior and odontoid peg views) is commonly performed, accompanied, if required, by swimmer's views for the lower cervical spine and cervicothoracic junction, and computed tomography for areas inadequately visualized by plain radiographs. Indeed, plain films and directed computed tomography combined can exclude >99% of injuries (Morris and McCoy, 2004). Nevertheless, there is strong evidence that plain radiographs alone have poor sensitivity in the confused patient (Como et al, 2009), so these have been largely superseded by computed tomography in most centres in England (Craxford et al, 2016). In fully conscious patients, plain radiographs of the cervical spine continue to have a role for spinal clearance.

Flexion-extension views and dynamic fluoroscopy

Flexion-extension plain radiographs and flexion-extension fluoroscopy were used for clearing cervical spine injury. However, there is no evidence that these modalities can identify injuries that would not be found on computed tomography alone (Padayachee et al, 2006; McCracken et al, 2013). Dynamic imaging may be unsafe in unconscious patients who are unable to verbalise symptoms and lack protective muscle reflexes (Mirvis, 2001). They cannot be recommended for routine use in cervical spine clearance protocols.

Computed tomography

Computed tomography scanning of the cervical spine is both cost effective and time efficient (Daffner, 2001;

Grogan et al, 2005), and can be performed as part of a wider trauma scan from the head to pelvis in patients with polytrauma. For the cervical spine in particular, the British Orthopaedic Association Standards for Trauma (2015) guidelines specify that a thin slice (2–3 mm) helical computed tomography scan from the skull base to at least T1 should be performed, with both sagittal and coronal two-dimensional reconstructions. In confused or unconscious patients, this should be performed alongside the initial computed tomography scan of the brain. Current National Institute for Health and Care Excellence (2014) guidelines for head injury advise performing a computed tomography scan of the cervical spine within 1 hour in patients with a Glasgow Coma Scale score >13 on initial assessment. When properly performed, a cervical computed tomography scan has a negative predictive value of 99.7% for spinal injuries (Raza et al, 2013), and is thus the recommended initial imaging modality for confused or unconscious trauma patients.

Magnetic resonance imaging

While the role of magnetic resonance imaging in patients with obvious neurological deficit is well defined, its use is less clear in patients with no neurological symptoms or signs. Although adjuvant magnetic resonance imaging can detect soft tissue injuries not identified on computed tomography (Muchow et al, 2008; Lukins et al, 2015), purely ligamentous injuries with no associated cervical fracture are rare (Chiu et al, 2001). In patients with normal motor function and a negative computed tomography scan, adjuvant magnetic resonance imaging is most likely unnecessary (Schuster et al, 2005). Furthermore, organizing a magnetic resonance imaging scan for an unconscious, intubated and cervical spine-immobilized patient presents a logistical challenge, and puts the patient at risk of aspiration, secondary brain injury and raised intracranial pressure (Dunham et al, 2008). Current British Orthopaedic Association Standards for Trauma (2015) guidelines therefore only recommend magnetic resonance imaging in patients with suspected spinal cord injury.

Discontinuation of spine immobilization

The criteria required to remove spinal protection has been controversial in confused or unconscious patients. The British Orthopaedic Association Standards for Trauma (2015) guidelines state that unconscious patients require imaging if they are unlikely to regain consciousness within 48 hours. Spinal precautions can be discontinued if no injury is identified on a cervical computed tomography scan once it has been reviewed and reported as clear by a senior radiologist. While clinicians should be vigilant of cervical spine injury in trauma patients, unnecessary immobilization has its own morbidity. Cervical collars can be uncomfortable for the patient, and can lead to pressure ulcers from prolonged use (Ham et al, 2016), particularly in insensate patients.

Conclusions

Damage to the cervical spinal cord can result in disastrous injury. Previous work has shown a significant variation in practice in English hospitals despite the publication of national guidelines. All clinicians who deal with trauma patients should be aware of the current best practice standards for managing the cervical spine. Further research is required to determine the best method for cervical immobilization, and to define the role of magnetic resonance imaging in the management of these patients. **BJHM**

Conflicts of interest: none

- American College of Surgeons Committee on Trauma: Advanced Trauma Life Support. 2018. Spine and Spinal Cord Trauma. In: Merrick C, ed. ATLS, 10th edn. Chicago (IL): American College of Surgeons.
- British Orthopaedic Association Standards for Trauma. 2015. BOAST 2: spinal clearance in the trauma patient. (accessed 21 November 2018) <https://www.boa.ac.uk/uploads/assets/uploaded/530bc35f-1081-41a9-8d9b00a2172358ff.pdf>
- Chiu WC, Haan JM, Cushing BM, Kramer ME, Scalea TM. Ligamentous injuries of the cervical spine in unreliable blunt trauma patients: incidence, evaluation, and outcome. *J Trauma Inj Infect Crit Care*. 2001 Mar;50(3):457–464, discussion 464. <https://doi.org/10.1097/00005373-200103000-00009>
- Como JJ, Diaz JJ, Dunham CM et al. Practice management guidelines for identification of cervical spine injuries following trauma: update from the eastern association for the surgery of trauma practice management guidelines committee. *J Trauma Inj Infect Crit Care*. 2009 Sep;67(3):651–659. <https://doi.org/10.1097/TA.0b013e3181ae583b>
- Copley P, Tilliridou V, Jamjoom A. Traumatic cervical spine fractures in the adult. *Br J Hosp Med*. 2016 Sep 02;77(9):530–535. <https://doi.org/10.12968/hmed.2016.77.9.530>
- Craxford S, Bayley E, Walsh M, Clamp J, Boszczyk BM, Stokes OM. Missed cervical spine injuries. *Bone Joint J*. 2016 Jun;98-B(6):825–828. <https://doi.org/10.1302/0301-620X.98B6.37435>
- Daffner RH. Helical CT of the cervical spine for trauma patients: a time study. *AJR Am J Roentgenol*. 2001 Sep;177(3):677–679. <https://doi.org/10.2214/ajr.177.3.1770677>
- Dunham CM, Brocker BP, Collier BD, Gemmel DJ. Risks associated with magnetic resonance imaging and cervical collar in comatose, blunt trauma patients with negative comprehensive cervical spine computed tomography and no apparent spinal deficit. *Crit Care*. 2008;12(4):R89. <https://doi.org/10.1186/cc6957>
- Grogan EL, Morris JA Jr, Dittus RS, Moore DE, Poulouse BK, Diaz JJ, Speroff T. Cervical spine evaluation in urban trauma centers: lowering institutional costs and complications through helical CT scan1. *J Am Coll Surg*. 2005 Feb;200(2):160–165. <https://doi.org/10.1016/j.jamcollsurg.2004.10.019>
- Ham WHW, Schoonhoven L, Schuurmans MJ, Leenen LPH. Pressure ulcers, indentation marks and pain from cervical spine immobilization with extrication collars and headblocks: an observational study. *Injury*. 2016 Sep;47(9):1924–1931. <https://doi.org/10.1016/j.injury.2016.03.032>
- Ho AMH, Fung KY, Joynt GM, Karmakar MK, Peng Z. Rigid cervical collar and intracranial pressure of patients with severe head injury. *J Trauma Inj Infect Crit Care*. 2002 Dec;53(6):1185–1188. <https://doi.org/10.1097/00005373-200212000-00028>
- Kwan I, Bunn F, Roberts I. Spinal immobilisation for trauma patients. *Cochrane Database Syst Rev*. 2001;(2):CD002803. <https://doi.org/10.1002/14651858.CD002803>
- Levi AD, Hurlbert RJ, Anderson P et al. Neurologic deterioration secondary to unrecognized spinal instability following trauma—a multicenter study. *Spine*. 2006 Feb;31(4):451–458. <https://doi.org/10.1097/01.brs.0000199927.78531.b5>
- Lukins TR, Ferch R, Balogh ZJ, Hansen MA. Cervical spine immobilization following blunt trauma: a systematic review of recent literature and proposed treatment algorithm. *ANZ J Surg*. 2015 Dec;85(12):917–922. <https://doi.org/10.1111/ans.13221>
- Maissan IM, Ketelaars R, Vlottes B, Hoeks SE, den Hartog D, Stolker RJ. Increase in intracranial pressure by application of a rigid cervical collar: a pilot study in healthy volunteers. *Eur J Emerg Med*. 2018 Dec;25(6):e24–e28.
- McCracken B, Klineberg E, Pickard B, Wisner DH. Flexion and extension radiographic evaluation for the clearance of potential cervical spine injuries in trauma patients. *Eur Spine J*. 2013 Jul;22(7):1467–1473. <https://doi.org/10.1007/s00586-012-2598-z>
- Milby AH, Halpern CH, Guo W, Stein SC. Prevalence of cervical spinal injury in trauma. *Neurosurg Focus*. 2008 Nov;25(5):E10. <https://doi.org/10.3171/FOC.2008.25.11.E10>
- Mirvis SE. Fluoroscopically guided passive flexion–extension views of the cervical spine in the obtunded blunt trauma patient: a commentary. *Emerg Radiol*. 2001 Feb 26;8(1):3–5. <https://doi.org/10.1007/PL00011865>
- Mobbs RJ, Stoodley MA, Fuller J. Effect of cervical hard collar on intracranial pressure after head injury. *ANZ J Surg*. 2002 Jun;72(6):389–391. <https://doi.org/10.1046/j.1445-2197.2002.02462.x>
- Morris CGT, McCoy É. Clearing the cervical spine in unconscious polytrauma victims, balancing risks and effective screening. *Anaesthesia*. 2004 May;59(5):464–482. <https://doi.org/10.1111/j.1365-2044.2004.03666.x>
- Muchow RD, Resnick DK, Abdel MP, Munoz A, Anderson PA. Magnetic resonance imaging (MRI) in the clearance of the cervical spine in blunt trauma: a meta-analysis. *J Trauma Inj Infect Crit Care*. 2008 Jan;64(1):179–189. <https://doi.org/10.1097/01.ta.0000238664.74117.ac>
- National Institute for Health and Care Excellence. 2014. Investigating injuries to the cervical spine. In: Head injury: assessment and early management (CG176). (accessed 21 November 2018) <https://www.nice.org.uk/guidance/cg176>
- Padayachee L, Cooper DJ, Irons S, Ackland HM, Thomson K, Rosenfeld J, Kossmann T. Cervical spine clearance in unconscious traumatic brain injury patients: dynamic flexion–extension fluoroscopy versus computed tomography with three-dimensional reconstruction. *J Trauma Inj Infect Crit Care*. 2006 Feb;60(2):341–345. <https://doi.org/10.1097/01.ta.0000195716.73126.12>
- Raza M, Elkhodair S, Zaheer A, Yousef S. Safe cervical spine clearance in adult obtunded blunt trauma patients on the basis of a normal multidetector CT scan—A meta-analysis and cohort study. *Injury*. 2013 Nov;44(11):1589–1595. <https://doi.org/10.1016/j.injury.2013.06.005>
- Roberge RJ, Samuels JR. Cervical spine injury in low-impact blunt trauma. *Am J Emerg Med*. 1999 Mar;17(2):125–129. [https://doi.org/10.1016/S0735-6757\(99\)90042-6](https://doi.org/10.1016/S0735-6757(99)90042-6)
- Royal College of Emergency Medicine. 2010. Guideline on the management of alert, adult patients with potential cervical spine injury in the emergency department. (accessed 21 November 2018) <https://www.rcem.ac.uk/docs/College%20Guidelines/5z17.%20Cervical%20Spine%20Management%20of%20alert,%20adult%20patients%20with%20potential%20cervical%20spine%20injury%20in%20the%20ED.pdf>
- Schuster R, Waxman K, Sanchez B, Becerra S, Chung R, Conner S, Jones T. Magnetic resonance imaging is not needed to clear cervical spines in blunt trauma patients with normal computed tomographic results and no motor deficits. *Arch Surg*. 2005 Aug 01;140(8):762–766. <https://doi.org/10.1001/archsurg.140.8.762>
- Stiell IG, Wells GA, Vandemheen KL et al. The Canadian C-spine rule for radiography in alert and stable trauma patients. *JAMA*. 2001 Oct 17;286(15):1841–1848. <https://doi.org/10.1001/jama.286.15.1841>
- Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. *Lancet*. 1974 Jul;304(7872):81–84. [https://doi.org/10.1016/S0140-6736\(74\)91639-0](https://doi.org/10.1016/S0140-6736(74)91639-0)
- Woster CM, Zwank MD, Pasquarella JR, Wewerka SS, Anderson JP, Greupner JT, Moratib S. Placement of a cervical collar increases the optic nerve sheath diameter in healthy adults. *Am J Emerg Med*. 2018 Mar;36(3):430–434. <https://doi.org/10.1016/j.ajem.2017.08.051>