



## Review

## Cervical spine evaluation in the bluntly injured patient

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## H I G H L I G H T S

- Not all cervical spine injuries require imaging.
- Clinical guidelines exist for clearance.
- In patients who are obtunded, CT scan is adequate to clear the cervical spine in blunt trauma.

## A R T I C L E I N F O

## Article history:

Received 6 July 2015

Received in revised form

29 December 2015

Accepted 24 January 2016

Available online 28 January 2016

## Keywords:

Blunt

Cervical spine

Clearance

Trauma

## A B S T R A C T

**Background:** Cervical spine injuries causing spinal cord trauma are rare in blunt trauma yet lead to devastating morbidity and mortality when they occur. There exists considerable debate in the literature about the best way for clinicians to proceed in ruling out cervical spine injuries in alert or obtunded blunt trauma patients.

**Methods:** We reviewed the current literature and practice management guidelines to generate clinical recommendations for the detection and clearance of cervical spine injuries in the blunt trauma patient. **Results:** The NEXUS and Canadian C-Spine Rules are clinical tools to guide in the clearance of the cervical spine of patients who have sustained low risk trauma and who are pain free, with the Canadian C-Spine Rules having superior sensitivity and specificity. In the alert, high risk patient with pain (or without, if over the age of 65 years), follow up imaging is required. The best imaging modality to use is Computerized Tomography (CT) of the cervical spine. In the obtunded trauma patient, CT clearance of c-spine injury is adequate, unless there is soft tissue injury or any non-bony abnormalities detected. At such point, definitive clearance may be obtained with Magnetic Resonance Imaging (MRI).

**Conclusions:** It is imperative to assume cervical spine injury in the blunt trauma patient. Clinical decision rules for cervical clearance may be used in low risk patients, avoiding imaging. High risk patients require imaging in the form of CT scan of the cervical spine.

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Injury to the cervical spine occurs frequently in trauma. Over 13 million patients are assessed each year in Emergency Departments (ED) across the United States for cervical spine injuries. Of these, 30 000 (0.2%) will have cervical spine injuries and of this group, only 10 000 (0.08% overall) will have spinal cord injuries [1]. The principles of the Advanced Trauma Life Support course from the American College of Surgeons [2] advocate assuming a cervical spine injury until proven otherwise in all trauma patients who present after blunt trauma. Emergency Medical Technicians have

been trained to apply rigid cervical collars early in the pre-hospital course of patient care, although the effectiveness of this is currently being debated in the medical literature [3]. The early role of the clinician caring for injured patients is thus to protect the cervical spine while concomitant treatment and assessments continue. This is to prevent further harm by manipulating an unstable cervical spine injury, which can render an incomplete injury into a complete spinal cord injury. Assessment of the cervical spine is also important in the primary survey as spinal injury may contribute to life threatening hemodynamic instability due to neurogenic shock. This is a diagnosis of exclusion and only accepted once all potential sources of bleeding have been ruled out [4]. Once life-threatening issues in the primary survey have been addressed, the traumatologist can proceed with a secondary survey to identify non-life

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threatening injuries. At that point she or he can decide if indeed a cervical spine injury is present, in the absence of overt neurological disability identified in the primary survey. The most important factor in deciding this is to assess if your patient is examinable or not, and to assess if the cervical spine may be cleared on clinical grounds alone. The typical trauma patient that is not examinable is considered “obtunded”. This may be due to a variety of factors including traumatic brain injury, acute intoxication, intubation/sedation or other reasons. In this review we will discuss the approach to the evaluation of the cervical spine in the trauma patient who has sustained blunt or penetrating injury. We have divided this approach into evaluation of the cervical spine in the alert, non-obtunded and obtunded patient. This includes the use of appropriate imaging, when possible, largely but not exclusively in the context of blunt trauma.

### 1. The alert, non-obtunded patient after blunt trauma

In the alert, examinable patient, a variety of clinical decision rules have been developed to assist with deciding which patients require cervical spine imaging and which do not. Imaging constitutes a significant expenditure for hospitals and health care systems, and thus validated tools to reliably exclude patients from needing imaging are worthwhile [5]. Typical criteria for clinical clearance require that the patient is awake and alert without drugs, alcohol or other sensorium-altering substances in the patient's bloodstream. Additionally, neurological deficits cannot be present in order to clinically clear the spine, as assessed by neuromotor exam of both upper and lower extremities. Additionally, no ‘distracting’ injury can be present. This means an injury that causes significant enough pain to distract the patient from the pain of a cervical spine injury. How much of an injury constitutes as truly distracting injury still remains to be clearly defined [6]. The main clinical tools that traumatologists have used to clear the cervical spine clinically, without the need for imaging, include the National Emergency X Radiography Utilization Study (NEXUS) [7] and Canadian C-spine Rules (CCR) [8]. Both represent clinical decision-making tools used by clinicians in the ED to clinically assess the cervical spine, without the need for imaging.

The NEXUS tool was developed in 1992 and was predicated on five elements: no cervical spine tenderness, no signs of intoxication or altered mental status, no significant and painful distracting injuries, and no focal neurological deficits (Fig. 1). The sensitivity and specificity of NEXUS in detecting a c-spine injury is 99.6% and 12.9%, respectively, indicating that it is a helpful screening tool in ruling out injury [9,10]. A similar sensitivity was also found in elderly patients, over the age of 80 years, when using NEXUS criteria to clear the c-spine, however this is being currently disputed in updated trials [11]. The CCR were similarly developed in parallel with a focus on high and low risk mechanism of injury (Fig. 2). Age alone (>65 years) was considered high risk, together with significant mechanism of injury (fall > 3 feet/5 stairs; axial loading; high speed motor vehicle collision (>100 km/h); collision with a recreational vehicle or bicycle) and paresthesias in the extremities [8]. If any of these factors are present, imaging is required. If they are absent, low risk factors are assessed including simple rear-end collision, sitting in the ED or ambulatory at the scene with no or delayed onset neck pain. In the absence of high risk criteria, and with the presence of at least one low risk criteria, the patient is then assessed for any pain with a 45° active range of motion assessment. In a direct comparison of NEXUS and the CCR involving 8283 trauma patients across Canada, the CCR were found to have better sensitivity and specificity, reducing costs related to unnecessary imaging of the c-spine [12]. Trauma surgeons or trauma team leaders working in specialized Level I or II trauma centers

rarely employ these tools, as patients have already been triaged by Emergency Medical Services to be high risk and thus transported directly to a trauma center, bypassing local hospitals and EDs. Thus the CCR is a helpful tool for clinicians working with trauma patients that are low risk in the absence of significant mechanisms of injury.

Trauma surgeons have devised their own practice management guidelines for the identification of cervical spine injuries following trauma. Several recommendations incorporate the above CCR and were based on a thorough review of the trauma literature. In particular, the Eastern Association for the Surgery of Trauma (EAST) has highlighted the clinical conundrums surrounding c-spine injuries in trauma [13]: who needs imaging; what imaging should be obtained; when should computed tomography (CT), magnetic resonance imaging (MRI), or flexion/extension (F/E) radiographs be obtained; and how is significant ligamentous injury excluded in the comatose patient? In focusing on the non-obtunded patient, the recommendations regarding the use of cervical collars include early removal as soon as feasible and non-use for isolated penetrating trauma to the head (Level 3 recommendations). Interestingly, the EAST guidelines also recommend c-spine clearance in patients who are awake, alert, no distracting injury with no neck pain to palpation or on range of motion (Level 2). They have combined elements of both NEXUS and CCR while eliminating others, such as age >65 years as being an absolute contraindication to clearance based on clinical grounds alone. If the patient requires imaging, computerized tomography (CT) is recommended from the occiput to T1, with no additional information gained from the use of plain films (Level 2). It remains difficult to make specific recommendations on the appropriate level of resolution of CT scan (4–64 multidetector row CT or greater) due to heterogeneity in the literature. If there is an injury present on CT, a prompt spinal consultation is recommended. If there is a spinal cord injury in addition to bony c-spine injury, MRI should be obtained urgently. In the presence of spinal cord injury, close attention should be paid to limiting secondary central nervous system injury (in particular avoidance of hypotension and hypoxia) [14]. If the trauma patient with neck pain has a negative CT scan, the cervical collar should be kept in place while an MRI is obtained to rule out the presence of ligamentous injury. If an MRI is unobtainable, flexion/extension plain films may be obtained in lieu of this. If either MRI or flexion/extension films are negative, the cervical collar may be removed. This is despite the occasional false positive reads on MRI, when abnormalities may be detected but these do not warrant any change in clinical management. To date, detecting these false positive reads on MRI has proven to be difficult. There is one meta-analysis (which is methodologically flawed) that states that an accurate assessment of the number of false positive MRIs in the setting of blunt cervical spine trauma cannot be accurately determined [15].

### 2. The obtunded patient after blunt trauma

In contrast to the alert patient, cervical spine clearance in the unexaminable patient is an ongoing area of controversy derived primarily from two issues. First, what is the definition of an “obtunded” patient? Second, is CT alone sufficient to evaluate for clinically significant spinal column injury? CT is considered too insensitive to detect non-bony injuries, such as ligamentous, that may still progress to permanent disability if missed [16]. The primary outcome of concern is conversion of a stable spinal column injury into an unstable injury with permanent paraplegia or quadriplegia.

The term “obtunded” has been broadly interpreted in the literature leading to confusion amongst practitioners as to which patients can be safely considered for cervical collar removal. It has been defined to mean any abnormal GCS, intoxication, intubation,

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