CERVICAL SPINE CLEARANCE

SUMMARY

Cervical spine clearance following traumatic injury is an area of significant controversy. Patients often fall into one of two categories: those who are awake, alert, and able to participate in a clearance protocol and those who are obtunded and unable to facilitate clearance of their cervical spine. A missed cervical spine injury can be devastating and may lead to chronic neck pain or even paralysis. Chronic use of cervical collars, however, is associated with the development of skin breakdown and ulceration.

RECOMMENDATIONS

- **Level 1**
  - **Awake and alert patients may be cleared by history and physical examination alone.**
- **Level 2**
  - **Computed tomography of the cervical spine from the occiput to T1 including axial, sagittal, and coronal images, should be utilized for cervical clearance.**
  - **Due to the significant incidence of cervical collar-induced decubitus ulcers and other complications, cervical spine clearance should be performed within 72 hours of injury.**
- **Level 3**
  - **In the obtunded patient, computed tomography of the cervical spine is sufficient to allow clearance of the cervical spine.**

INTRODUCTION

Cervical spine injuries have been reported to occur in up to 3% of patients with major trauma and up to 10% of patients with serious head injury (1). The neurologic deficits that are a common consequence of these injuries can result in devastating disability for the patient as well as considerable economic and social burden for society. A missed injury can result in delayed treatment, instability, and possible quadriplegia; therefore, it is critical that physicians responsible for the initial evaluation and treatment of trauma patients be knowledgeable with regard to the methods for diagnosis of cervical spine injury.

Patients who are awake and alert can reliably be cleared of cervical spine pathology by painless clinical examination alone; patients who are obtunded, however, are much more difficult to assess and ultimately clear of cervical spine injury. Clearance of the cervical spine should be based upon a thorough elucidation of the patient's history in addition to a complete physical examination. Many imaging modalities have been evaluated for the diagnosis of cervical spine injury. Plain radiographs (PR), static flexion & extension radiographs (F&E), computed tomography (CT), dynamic fluoroscopy (DF) and magnetic resonance imaging (MRI) have all been evaluated to determine their accuracy and usefulness in the diagnosis of cervical spine injury. The choice of imaging modality to use initially is dependent upon the patient's history and physical examination as well as an assessment of the patient's risk for cervical spine injury.

EVIDENCE DEFINITIONS

- **Class I:** Prospective randomized controlled trial.
- **Class II:** Prospective clinical study or retrospective analysis of reliable data. Includes observational, cohort, prevalence, or case control studies.
- **Class III:** Retrospective study. Includes database or registry reviews, large series of case reports, expert opinion.
- **Technology assessment:** A technology study which does not lend itself to classification in the above-mentioned format. Devices are evaluated in terms of their accuracy, reliability, therapeutic potential, or cost effectiveness.

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Convincingly justifiable based on available scientific information alone. Usually based on Class I data or strong Class II evidence if randomized testing is inappropriate. Conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation.
- **Level 2:** Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion. Usually supported by Class II data or a preponderance of Class III evidence.
- **Level 3:** Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.

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LITERATURE REVIEW

Clinical Examination vs. Plain Radiographs (PR)

The National Emergency X-Radiography Utilization Study (NEXUS) was a prospective, observational study involving 21 centers across the United States that evaluated 34,069 stable patients with blunt trauma who were at risk for cervical spine injury (2). All patients were assessed using a straightforward, logical and easy to remember decision instrument that consisted of five clinical findings from the history and physical examination. The presence of any one of these findings was considered to be evidence that the patient was at increased risk for a cervical spine injury and required radiographic evaluation.

The NEXUS Clinical Criteria

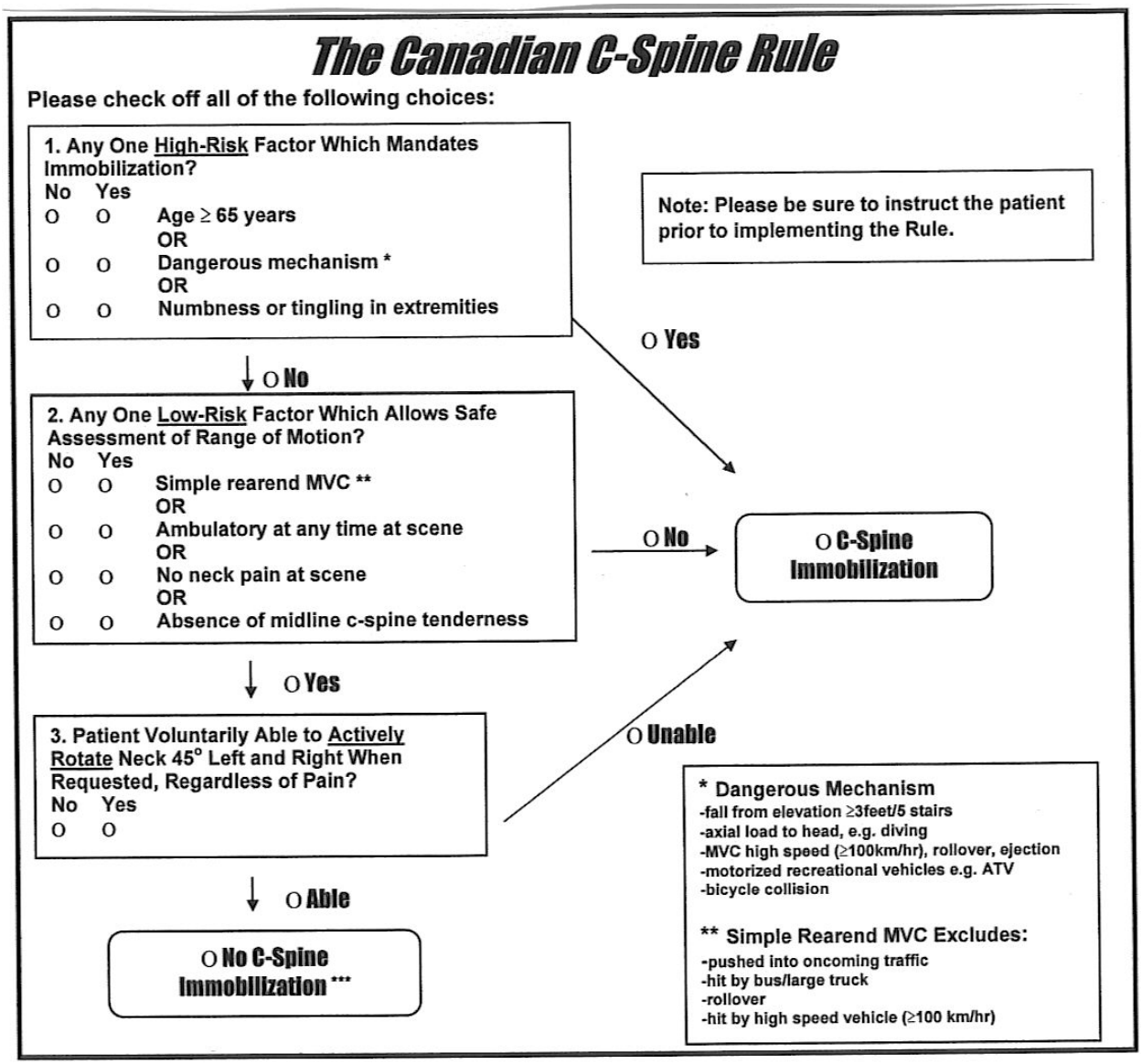
1. Tenderness at the posterior midline of the cervical spine
2. Focal neurologic deficit
3. Decreased level of alertness
4. Evidence of intoxication
5. Clinically apparent pain that might distract the patient from the pain of a cervical spine injury

The presence of any one of the above findings is considered to be clinical evidence that a patient is at increased risk for cervical spine injury and requires radiographic evaluation.

A standard series of PR of the cervical spine (cross-table lateral view, anteroposterior view and open-mouth view of the odontoid) was obtained in all patients, unless CT or MRI of the entire cervical spine was performed because PR was impractical or impossible. Other imaging studies could be ordered in addition to the standard series at the discretion of the treating physician. Diagnosis of cervical spine injury and determination of the type of injury was made according to the final interpretation of all the imaging studies. The decision instrument had a sensitivity of 99.6%, a NPV of 99.9%, a specificity of 12.9%, and a PPV of 2.7% for the identification of clinically significant cervical spine injuries.

The Canadian C-Spine Rule was derived from a prospective, observational study involving 10 centers across Canada that evaluated 8,924 alert and stable patients with blunt trauma who were at risk for cervical spine injury (3). All patients were assessed for potential predictor variables of cervical spine injury. These variables consisted of 20 standardized clinical findings and 5 demographic variables from the patient's history and physical examination. Radiographic evaluation consisted of a standard series of PR of the cervical spine (cross-table lateral view, anteroposterior view and open-mouth view of the odontoid). Other imaging studies could be ordered at the discretion of the treating physician. Diagnosis of cervical spine injury and determination of the type of injury was made according to the final interpretation of all the imaging studies. Patients who did not undergo any radiographic evaluation underwent a structured 14-day proxy outcome measure by telephone. Recursive-partitioning analysis was then applied to the collected data to create a decision instrument, the "Canadian C-Spine Rule" (see below). When retrospectively applied to the population from which it was derived, the decision instrument had a sensitivity of 100%, a NPV of 100%, a specificity of 42.5% and a PPV of 2.9% for the identification of clinically significant cervical spine injuries. When prospectively applied to a separate population of 7,438 alert and stable patients, the decision instrument had a sensitivity of 99.4%, NPV of 99.97%, a specificity of 45.1%, a PPV of 3.9% for the identification of clinically significant cervical spine injuries (4). The results of these three large prospective, observational studies, clearly demonstrate that cervical spine injury may be safely ruled out in the awake and alert patient based upon clinical examination alone.

The Canadian C-Spine Rule



Plain Radiographs (PR) vs. Computed Tomography (CT)

PR of the cervical spine has long been utilized for the diagnosis of cervical spine injury. Woodring and colleagues, however, have illustrated many of the limitations of PR as the sole imaging modality for clearance of the cervical spine (5). Since the mid 1990's, there has been a steady increase in the utilization of CT of the cervical spine for the diagnosis of cervical spine injury. The Eastern Association for the Surgery of Trauma (EAST) in both their 1998 and 2000 guidelines for cervical spine clearance following trauma recommended a standard series of PR of the cervical spine (cross-table lateral view, anteroposterior view and open-mouth view of the odontoid) and CT with sagittal reconstruction for any suspicious or poorly visualized area (6,7). EAST revisited their guidelines for CS evaluation in 2009. Based on the evaluation of 78 studies, they found that "computed tomography has supplanted plain radiography as the primary screening modality in those who require imaging." (8)

Clearance in the obtunded patient

Clearance of the cervical spine in the obtunded trauma patient remains an area of significant controversy. Accepted management regimens for this type of patient include CT alone, CT + MRI or DF, and CT with

continued cervical spine immobilization until the return of a normal neurologic exam and a negative clinical exam of the cervical spine. Unfortunately, there is no preponderance of clinical data to support one particular approach as superior. Demetriades and colleagues retrospectively reviewed a 5 year sample of all blunt trauma patients injured in motor vehicle crashes or falls (14,755 patients) (9). Cervical spine injuries were categorized into three groups (fractures, subluxations without fracture and spinal cord injuries without any evidence of associated fractures or subluxations). The incidence of cervical spine injuries in this population was 2%. 0.2% of all blunt trauma admissions or 11% of all cervical spine injuries had subluxations without fracture. The combination of PR and CT diagnosed or highly suspected all of these injuries. 0.07% of all blunt trauma admissions or 4% of all cervical spine injuries had spinal cord injuries without evidence of associated fractures or subluxations. The combination of PR and CT diagnosed 46% of these injuries. However; 82% of these patients had an abnormal neurologic exam at or within hours of admission suggestive of a cervical spine injury. The authors concluded that all severe blunt trauma patients with multiple injuries should be evaluated by a combination of PR and CT of the cervical spine. If these studies are normal, then the cervical collar may be removed if the patient is expected to remain unevaluable for many days. Chiu and colleagues retrospectively reviewed a 3 year sample of all blunt trauma admissions (14,577 patients) and came to a similar conclusion (10). Widder and colleagues prospectively evaluated 102 obtunded blunt trauma patients with a PR and CT of the cervical spine (11). All patients had an ISS ≥ 16, a GCS < 9 or were intubated with a motor score ≤ 4. Patients were excluded based upon the presence of an obvious cervical spine injury at the time of admission. The incidence of cervical spine injuries in this population was 17%. CT of the cervical spine identified all of the cervical spine injuries. All patients with negative PR and CT of the cervical spine were liberated from cervical spine immobilization, and none of these patients subsequently developed neurologic symptoms secondary to a missed cervical spine injury. The authors concluded that a protocol of PR and CT may be a safe and effective approach to clear the cervical spine in obtunded trauma patients, but cautioned that a large prospective trial comparing CT scanning to additional studies is required to confirm its safety

The 2009 EAST review found that F/E radiography should not be performed in obtunded patients. A paper by Bolinger and colleagues found bedside DF to be adequate in only 4% of patients (12), and another by Davis et al found identification of ligamentous injury at 0.7% (13). The general consensus is that DF should no longer be an option for CS clearance in the unconscious trauma patient (8).

The incidence of ligamentous injury in the setting of a negative CT is very low (<5%), but the incidence of clinically-significant injury is unknown according to the EAST review. Current recommendations include continued cervical spine immobilization until a clinical exam can be performed, simply removing the cervical collar, or obtaining a MR study. The largest such study to date was done by Hogan et al who performed complete MR of the cervical spine in 366 obtunded patients with a negative CT of the cervical spine (14). This study showed 354 (96.7%) being negative for injury, 7 (1.9%) with cord contusion, 4 (1.1%) were positive for ligamentous injury and 3 (0.8%) showed intervertebral disk edema. One patient (0.3%) had a cord contusion, ligamentous injury and intervertebral disk injury. The main conclusions drawn were CT of the cervical spine had a negative predictive value of 98.9% (362 of 366 patients) for ligamentous injury and 100% for unstable cervical spine injury. (14) A clear and definitive recommendation regarding the need for MR imaging after a negative CT study of the cervical spine in obtunded patients cannot be made at this time.

Magnetic Resonance Imaging (MRI) and Dynamic Fluoroscopy (DF)

Benzel and colleagues prospectively evaluated 174 patients at high risk for cervical spine injury using PR and MRI (15). All patients had significant neck pain, an impaired ability to communicate or equivocal findings on PR. Patients were excluded based upon the presence of an abnormal neurologic exam suggestive of a cervical spine injury or an obvious abnormality seen on PR. The incidence of cervical soft-tissue injury in this patient population was 36%. The incidence of operative intervention in this patient population was 3% (2 patients). Both of these patients had fractures identified by CT of the cervical spine. D'Alise and colleagues prospectively evaluated 121 blunt trauma patients at risk for cervical spine injury using PR followed by MRI (16). All patients were intubated and, therefore, clinically unevaluable. Patients were excluded based upon the presence of an abnormal neurologic exam suggestive of a cervical spine injury or an obvious abnormality seen on PR. The incidence of cervical

soft-tissue injury in this patient population was 26%; however, only 15% had significant soft-tissue injuries of the cervical spine without associated fractures. The incidence of operative intervention in this patient population was 7%, and all but one of these patients had fractures identified by CT of the cervical spine. Davis and colleagues prospectively evaluated 300 obtunded trauma patients, all of whom had a normal PR and CT of the cervical spine, with bedside DF (17). The incidence of cervical spine injury in this patient population was 0.7% (2 patients). Both patients were successfully treated with semirigid collars. During the study period, cervical spine injury without evidence of fracture accounted for 0.45% of all cervical spine injuries. The 2009 EAST review recommended that DF should no longer be an option for cervical spine clearance in the obtunded patient based on the low percentage of actually indentifying a cervical spine injury and the fact that it actually may be dangerous (8). In the absence of any compelling evidence to suggest that MRI identifies a clinically significant cervical spine injury that is not identified by a cervical CT, it is recommended that the cervical spine be cleared in the obtunded patient based upon a normal cervical spine CT.

Prolonged Use of Cervical Immobilization

The prolonged use of a semi-rigid cervical collar has an attendant morbidity that must not be taken lightly, as illustrated by several thorough reviews of this subject (18,19). Cutaneous pressure ulceration is quite common, and many patients will ultimately require an operation for treatment of this lesion. Davis et al demonstrated a 55% incidence of decubitus ulcers and skin breakdown in patients wearing a cervical collar for over 5 days while Sees reported a 15% incidence of skin breakdown in patients with collars in place over 8 days (20,21). Cervical venous obstruction and elevated intracranial pressure can be problematic for patients with an associated head injury. Airway maintenance is made more difficult by the presence of a cervical collar and the limitation of neck movement. Central venous access is more difficult in the neck and upper chest and is associated with a higher incidence of infectious complications. The nursing staff's ability to provide optimal oral care is inhibited. Finally, restrictions in physical therapy regimens result in an increased risk of ventilator-associated pneumonia and thromboembolism. It has been argued that in the presence of appropriate imaging of the cervical spine, the cumulative risks and clinical significance of the above complications associated with prolonged immobilization and semi-rigid cervical collar use may approach and even exceed the risk and clinical significance of an undetected, unstable ligamentous injury (22). Therefore, with the goal of minimizing the complications associated with prolonged cervical spine mobilization, it is recommended that clearance of the cervical spine be pursued expeditiously and obtained within 72 hours of admission.

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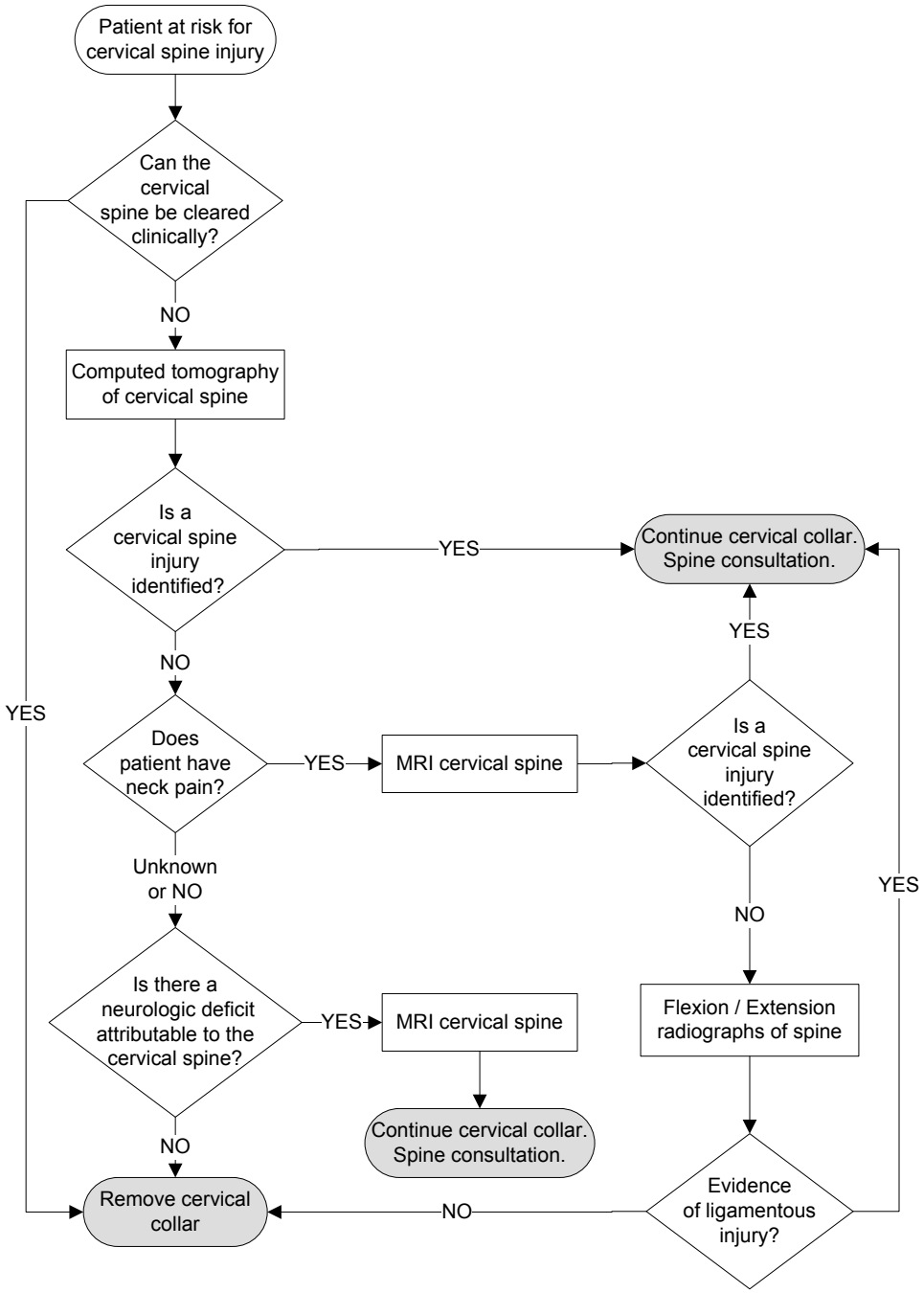
Cervical Spine Clearance Algorithm



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