Review Article

Clearing the Cervical Spine in the Blunt Trauma Patient

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Abstract

The goal of cervical spine clearance is to establish that injuries are not present. Patients are classified into four groups: asymptomatic, temporarily nonassessable secondary to distracting injuries or intoxication, symptomatic, and obtunded. Level I evidence supports that the asymptomatic patient can be cleared on clinical grounds and does not require imaging. The temporarily nonassessable patient may have short-term mental status changes (eg, intoxication, painful distracting injuries) and can be evaluated by two methods. When there is urgency, the evaluation is similar to that for the obtunded patient. Alternatively, the patient can be reevaluated within 24 to 48 hours, after return of mentation or following treatment of painful injuries. The patient then can be assessed as the asymptomatic patient is. The symptomatic patient requires advanced imaging. The obtunded patient should undergo, at minimum, a multidetector CT scan. Two methods are advocated. One uses only multidetector CT; a normal result is sufficient to clear the obtunded patient. The alternative method is obtaining a magnetic resonance image subsequent to a negative multidetector CT scan. Because at present information is insufficient to determine whether MRI is indicated, this is an area of controversy.

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The assessment of the cervical spine is a priority in the treatment of the more than 10 million patients who annually present for emergency center evaluation.[1] Cervical spine injury occurs in only 1% to 3% of these patients but is a major cause of long-term disability.[2,3] Historically, nearly one third of cervical spine–injured patients, if inappropriately assessed, are at risk of delay in diagnosis or treatment.[4] Early recognition of these injuries may prevent or limit neurologic compromise and optimize eventual functional restoration.[5]

Although most blunt trauma patients do not have a cervical spine injury, a reliable method to clear the cervical spine of these persons is challenging. The emergency setting presents a host of confounding and distracting impediments to the clearance process. These obstacles notwithstanding, the timely clearance of these patients is essential. Protracted cervical spine evaluation may prolong bed rest immobilization, inhibit or restrict the thorough assessment of other organ systems, and complicate or delay general patient recovery. A haphazard approach to cervical spine clearance can generate needless costs and inefficiently use medical resources.

The Advanced Trauma Life Support (ATLS) protocol for the initial management of the trauma patient can be used in the process of cervical spine clearance in four recognized

groups of adult blunt trauma patients who require cervical spine clearance. Here, we discuss the process applying to the adult trauma patient; pediatric evaluation has been recently reviewed.[6]

Clearance: Definition and Rationale

Cervical spine clearance after blunt trauma is defined as accurately confirming the absence of a cervical spine injury. Contrary to a common perception, cervical spine clearance does not entail injury detection or classification or the determination of optimal treatment. The objective of cervical spine clearance is to establish that an injury does not exist.

ATLS Protocol

The ATLS protocol was developed by the American College of Surgeons with the intent of creating a reproducible approach to rapidly identify injuries and initiate intervention for limb- and life-threatening injuries.[7] In addition, ATLS guidelines seek to reduce the incidence of missed injuries and delayed diagnosis. The protocol should be applied to any patient in any trauma situation. The initial vital steps in the ATLS evaluation include assessment of the airway, breathing, and circulation while maintaining strict vigilance of spinal precautions.

Immobilization in a cervical collar should be initiated at the scene of injury and maintained until a directed examination is performed during the secondary evaluation.[7] The ATLS protocol mandates that all patients be presumed to have a cervical spine injury until proved otherwise. Therefore, all trauma patients are initially immobilized with a cervical collar, sandbags, and/or a backboard as if they have an unstable injury to the cervical spine. The ATLS system is not intended to diagnose all cervical spine injuries but rather to establish a high level of suspicion for cervical spine injury, avoid missed injuries, and prevent neurologic deterioration in the patient with a potentially unstable cervical spine. All blunt trauma patients must undergo a standardized cervical clearing process.

Current ATLS recommendations advocate immediate collar removal in the awake, alert, sober, and neurologically normal patient who has no tenderness to palpation in the cervical spine and who exhibits full, pain-free range of motion (ROM). These guidelines were based on well-designed prospective level I studies and consensus among experts. However, when a patient exhibits midline cervical tenderness with palpation or neck pain with active ROM, a screening cervical spine CT scan performed with a multidetector CT (MDCT) scanner is indicated.[8] A similar protocol is initiated in the patient who exhibits altered levels of consciousness or who has distracting injuries.

The major exception to this more contemporary algorithm is the patient who is in extremis and therefore unable to undergo a CT scan. In this situation, a lateral cervical plain radiograph is warranted to provide initial information on the status of the cervical spine. In the event of significant malalignment, cranial tongs may be placed and traction applied during the resuscitation period. Further definitive radiographs can be obtained once the patient is stabilized.

When the cervical spine cannot be cleared clinically, the patient's status reverts to the ATLS category of "suspected unstable cervical injury," and the collar is left in place. The American College of Surgeons recommends that, in most instances, "doctors who are skilled in the evaluation and management of the spine-injured patient should be consulted ... where a spine injury is detected or suspected."[7] The criteria that the consultant should use are not specified.

Clinical Assessment

The clinical examination is an essential component of the clearance process. This assessment includes a review of the history of trauma, identification of pain or tenderness in the head, neck, or thoracolumbar spine, and any neurologic changes of sensation or muscle strength in the trunk and extremities. Any patient history of transient motor or sensory changes, such as parasthesias or paralysis, may indicate significant spinal pathology, and, when noted, requires radiographic assessment. Physical examination includes palpation from the occiput to the sacrum and identification of areas of tenderness, crepitus, or other abnormality,

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such as a hematoma, step-off, or gap between the spinous processes. ROM can be tested only in the asymptomatic patient, as described below. This is performed first by asking the patient to turn her or his head 45° to each side. If no symptoms are elicited by head rotation, the patient is then asked to actively flex and extend the head. A detailed neurologic examination according to American Spinal Injury Association protocol should be performed.[9]

The clinical examination has been shown to have low sensitivity, ranging from 79% to 93%, even in the awake, alert patient.[2,10,11] However, in the studies cited, most injuries not identified by clinical examination were minor, with none requiring surgery or resulting in neurologic deficits. Thus, although the clinical assessment may miss minor injuries to the cervical spine, the clinical examination appears to identify significant unstable injuries in the awake, alert, cooperative patient.

Classification

Several basic principles are applied to all blunt trauma patients undergoing the cervical spine clearance process. First, a meaningful clinical examination of the cervical spine is an essential component of the process. The principal requirement is a lucid patient. Therefore, the initial step is to determine the patient's level of alertness. Although all patients should be thoroughly evaluated, only patients with an unimpaired level of consciousness can be conclusively cleared. Secondarily, the alert, oriented patient should be assessed for the presence or absence of signs and symptoms that can either be attributed to or possibly mask cervical spine injury. These include intoxication and distracting injuries.

Based on these principles, all blunt trauma patients can be acutely categorized into four fundamental patient groups (Table 1): asymptomatic (group 1), temporarily nonassessable (group 2), symptomatic (group 3), or obtunded (group 4). A treatment algorithm for each group may be used to guide the treatment of these patients (Figures 1-4).

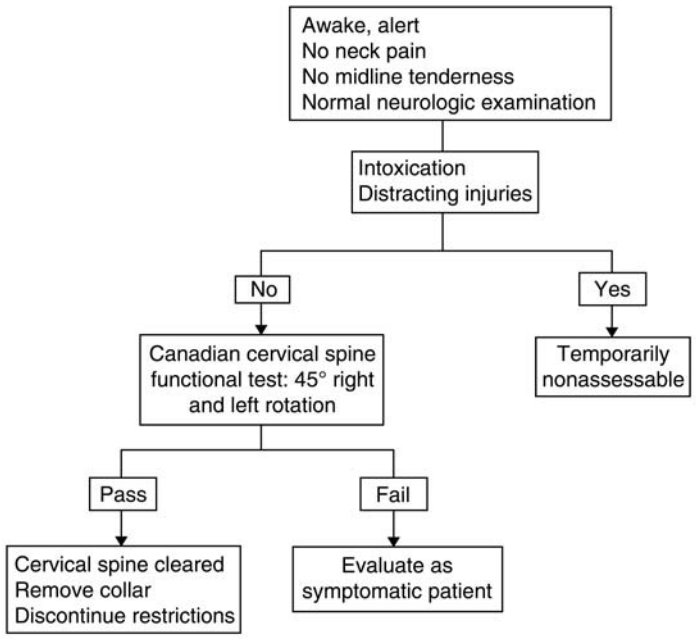
The asymptomatic patient (group 1) can be reliably cleared by clinical examination alone without imaging (ie, no plain radiography, CT, MRI, other modality). The patient must exhibit no evidence of intoxication or distracting injury, which may in-

Table 1

Classification and Characteristics of Blunt Trauma Patients Requiring Clearance

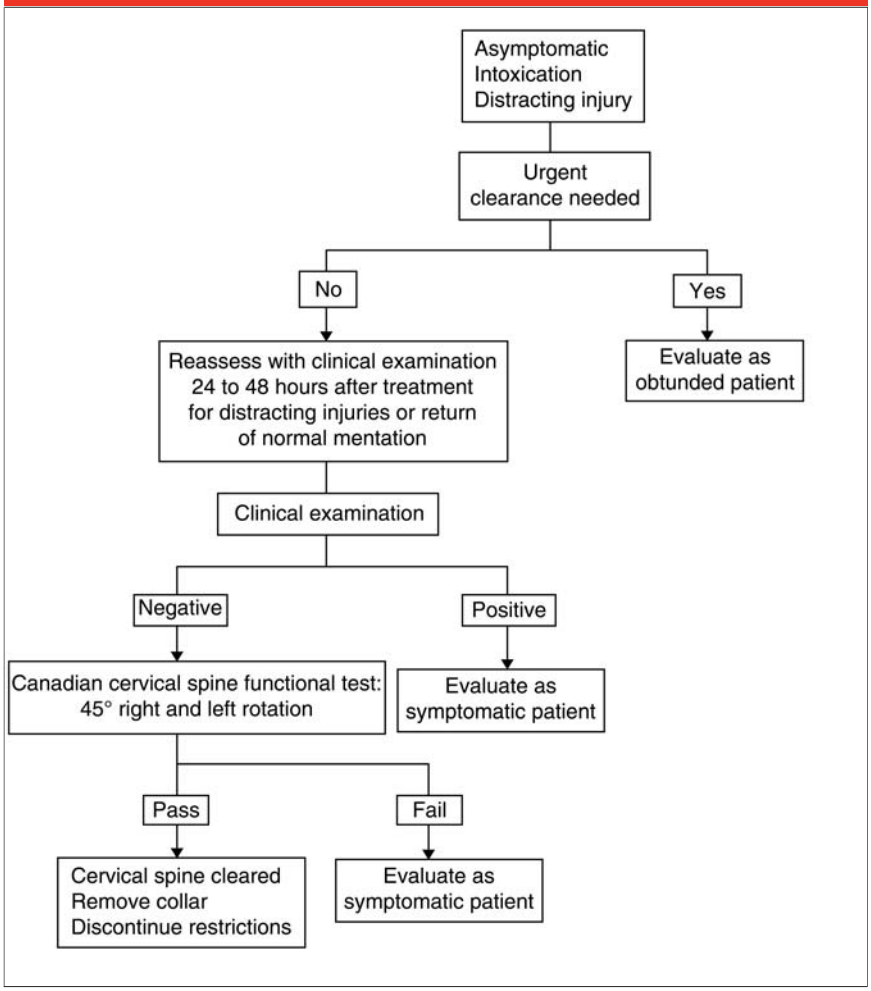
Group	Classification	Important Characteristics
1	Asymptomatic	Awake, alert No neck pain/tenderness Normal neurologic function No intoxication No distracting injuries
2	Temporarily nonassessable	Asymptomatic Intoxicated or has distracting injuries Expect resolution in 24-48 h
3	Symptomatic	Cervical pain or tenderness Neurologic deficits
4	Obtunded	Abnormal cognitive function that interferes with clinical examination

Figure 1



Algorithm for the evaluation of the asymptomatic blunt trauma patient.

Figure 2



Algorithm for the evaluation of the temporarily nonassessable blunt trauma patient.

terfere with the patient's ability both to feel pain associated with cervical spine injury and to cooperate with the examination, as well as impair communication.[1,12]

Patients in group 2, or those who are temporarily nonassessable, are asymptomatic but have evidence of intoxication or distracting injuries that invalidate their examination. The expectation that these temporary conditions will resolve in 24 to 48 hours makes this group unique. Symptomatic patients (group 3) require diagnostic imaging in addition to a clinical examination to be reliably cleared. These patients are fully alert and have neck pain, tenderness, or a neurologic deficit. Patients in group 4 are obtunded, intubated, and/or pharmacologically compromised such that they cannot submit to a meaningful clinical examination.

Group 1: Asymptomatic

Large clinical studies, systematic reviews, meta-analyses, and expert panels have concluded that asymptomatic patients can receive cervical spine clearance based on clinical examination without imaging studies.[1,13-16] The National Emergency X-Radiography Utilization Study (NEXUS) validated a clinical protocol that cleared the cervical spine in asymptomatic patients.[1] The NEXUS method uses specific criteria to identify the low-risk patient who can be cleared clinically without imaging. All of the following criteria must be met for a patient to be considered low-risk: an awake, alert patient; no history, signs, or laboratory evidence of intoxication or distracting injury (ie, major injury above the shoulder, pelvic fracture, long bone or periarticular fracture, thoracolumbar spine injury, severe soft-tissue injury, major visceral cavity injury); no cervical spine pain or midline tenderness; and no neurologic signs or symptoms.

Twenty-one centers prospectively screened 34,069 patients using the NEXUS criteria.[1] Two weeks later, patients were reassessed by nurses to confirm the presence or absence of cervical spine injury. Overall, 2.8% of patients had cervical injuries. The overall sensitivity of the screening method was excellent—99.0% for patients with all cervical injuries and 99.6% for those with significant cervical injuries. Eight cases of cervical spine fractures had false-negative screening tests. Six were deemed not significant (minor process fractures). Two significant injuries occurred without neurologic sequelae. The negative predictive value was excellent at 99.8%, indicating that a patient who does not meet criteria for radiographs is extremely unlikely to have a significant cervical injury. However, because of very low specificity (12.9%), many potentially unnecessary radiographs were taken when the NEXUS criteria were used.

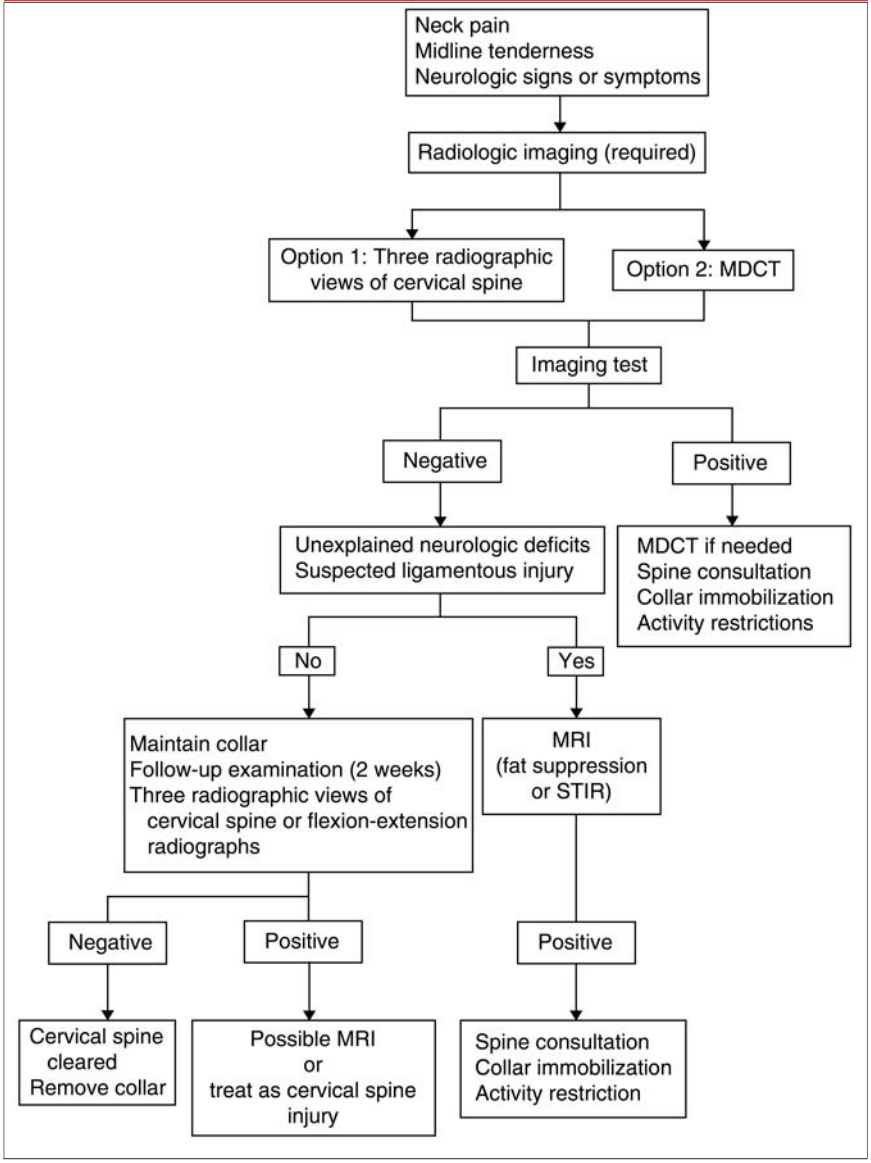
The NEXUS criteria have also been validated in geriatric populations. Touger et al[17] reported that the incidence of injury was twofold greater in the geriatric population and that odontoid fractures occurred in 20% of cases. The NEXUS criteria had equally high sensitivity and negative predictive value, with only 2 of 2,943 patients having cervical spine

injuries despite negative screenings. Both injuries were insignificant fractures and did not result in neurologic deterioration.

An alternative to the NEXUS protocol is the Canadian C-Spine Rule.[13] This rule applies to awake, nonintoxicated patients with a Glasgow Coma Scale (GCS) score of 15 and identifies those who require radiographs by answering three questions. First, is the patient high-risk enough that radiographs are required? These risk factors include age >65 years, reports of paresthesia, and a dangerous mechanism of injury (ie, fall from a height >1 m or five stairs, axial load to the head, high-speed [>100 km/h] automobile, motorcycle, recreational vehicle, or bicycle accident). Second, is there a low risk factor that would allow safe assessment of ROM? Examples of such a factor are a simple rear-end motor vehicle crash, a patient who has already sat upright in the emergency department or was ambulatory at any time, a delay of onset of pain, and absence of tenderness. Third, can the patient actively rotate the head 45° to the right and left without pain? A patient who is not at high risk and can safely perform the rotation test can be cleared clinically without radiographs.

Stiell et al[13] reported the sensitivity and specificity of the Canadian C-Spine Rule after enrolling 8,924 patients from eight centers. The sensitivity of this protocol was 100% and specificity was 42.5%, which were a significant improvement over the NEXUS protocol measures. By use of these results, a 25% to 50% reduction in radiographs can be achieved. In a separate study, Stiell et al[18] found that, compared with the NEXUS Low-Risk Criteria, the Canadian C-Spine Rule had significantly higher sensitivity and greater specificity. In applying the Canadian C-Spine Rule compared with the NEXUS criteria, 10% fewer cases would have required radiographs.

Figure 3



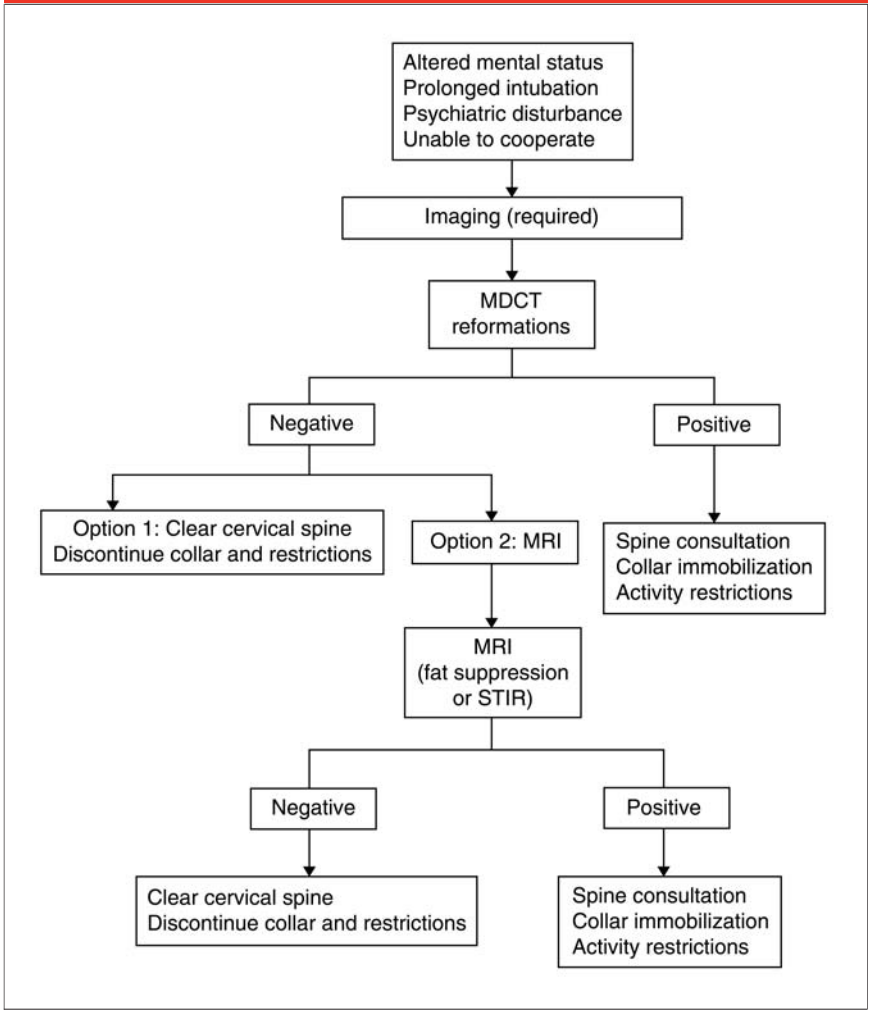
Algorithm for the evaluation of the symptomatic blunt trauma patient.
MDCT = multidetector CT, STIR = short tau inversion recovery

Hadley[16] reported a systematic review of the evaluation of the cervical spine in asymptomatic patients. Based on nine studies, many of which used NEXUS criteria or the Canadian C-Spine Rule, this study concluded that there was level I evidence that asymptomatic patients do not require radiographic evaluation. Tontz et al[14] performed a meta-analysis totaling >63,000 patients, including three NEXUS, two Canadian C-Spine Rule, and nine institutional protocols. The overall sensitivity based on a random effects model was 98.1%, and specificity was 35.0%. Of 28 missed injuries, only 2 were deemed significant; none was associated with neurologic deterioration.

Recommendation

Based on level I evidence, our recommendation is that asymptomatic patients be clinically evaluated by

Figure 4



Algorithm for the evaluation of the obtunded blunt trauma patient.
MDCT = multidetector CT, STIR = short tau inversion recovery

NEXUS or Canadian C-Spine Rule criteria. If negative, their cervical spines may be cleared without radiographs.

Group 2: Temporarily Nonassessable

Temporarily nonassessable patients have short-term cognitive dysfunction, usually from intoxication, or have distracting injuries that preclude a valid clinical examination. Group 2 patients are expected to have resolution of pain from distracting injuries and recovery of cognitive dysfunction within 24 to 48 hours, at which time they can reliably participate in the clinical examination.[8,19] This group has not been adequately defined, nor has the reliability of clearance methods been determined in the literature. The recommendations below are opinions of the authors.

Recommendation

Collar immobilization should be maintained and the clinical examination repeated 24 to 48 hours after initial presentation, following management of distracting injuries and after the return of normal cognitive function. At that time, if the patient is "asymptomatic," she or he should be cleared on clinical grounds without radiographs. Alternatively, or if urgency is required for treatment of other injuries, the patient is evaluated as if she or he were obtunded.

Group 3: Symptomatic

A patient who has neck pain, tenderness, or neurologic symptoms requires radiographic imaging as an adjunct to physical examination to evaluate the cervical spine. Imaging options include plain radiography, flexion-extension radiography, CT, and MRI.

Plain Radiography

In the acute setting, plain radiography is often the first screening modality employed. It is readily available, inexpensive, quick, and specific for cervical spine injury; however, there are currently no validated guidelines for its use in blunt trauma patients. Sensitivity of plain radiography is low, ranging from 52% to 85%, although many missed injuries have little significance.[20,21] The major limitation is inability to delineate injuries at the occipitocervical and cervicothoracic junctions in many patients.

The standard set of cervical radiographs usually consists of lateral, odontoid, and AP views. The inclusion of oblique and swimmer's views only slightly improves the sensitivity and, therefore, has been deemed cost-inefficient.[22-24] If further imaging is required, CT is recommended.

The efficacy of cervical radiographs is dependent on the quality of the views obtained. Davis et al[25] demonstrated that 94% of the errors leading to missed or delayed diagnosis of cervical spine injuries resulted from the inability to obtain adequate radiographs. This problem has been addressed by the widespread use of CT and MRI, which display areas often inadequately revealed by plain radiography.

Flexion-extension Radiography

Cervical spine radiographs may fail to detect an unstable cervical spine injury in 15% of cases.[26] To identify these injuries, lateral flexion-extension radiographs have been recommended. These would be appropriate only for the alert patient with negative cervical radiographs and persistent symptoms who can voluntarily undergo the study and whose entire cervical spine can be visualized on the standard views. The efficacy of lateral flexion-extension views in the acute setting is controversial.[27] The NEXUS study reported that flexion-extension radiographs obtained acutely added little to the screening process considering the risk involved.[28,29] Furthermore, flexion-extension radiographs for acute cervical spine clearance are not cost-effective and are reserved for the subacute setting.[15,30]

Computed Tomography

CT with reformations has gradually replaced plain radiography for cervical spine clearance. Helical MDCT offers volume imaging, providing quick and efficient imaging in all planes, and is becoming the primary method for the detection of spinal injury in many trauma centers. MDCT has equal sensitivity in all planes, so there is less risk of missing nondisplaced transverse fractures such as a type II dens fracture. CT alone identifies 99.3% of all cervical spine fractures; in one study, the missed fractures required minimal or no treatment.[31] Recent studies have recognized the cost-effectiveness of helical CT to complement its superior sensitivity.[32] The cost-effectiveness of cervical spine CT is even greater when applied as an extension of a primary CT of other organs (eg, head, thorax, abdomen). Some authors advocate CT as the preferred initial imaging modality for patients with moderate to high risk for cervical spine injury.[33] The disadvantages of CT include its greater expense, increased radiation exposure, and limited availability (compared with plain radiography).[34]

Magnetic Resonance Imaging

MRI is an effective noninvasive imaging tool for the detection of neural, ligamentous, or disk injury. MRI is primarily indicated for the patient who presents with neurologic deficit. In this setting, MRI is an effective and safe method for evaluating the spinal cord because it can depict epidural hematoma, spinal cord edema, and spinal cord compression. Additional MRI is indicated when ligamentous injury is suspected. This includes when focal tenderness or gaps are present between spinous processes on examination or when kyphosis or interspinous widening is seen on CT or plain radiographs.

MRI is not indicated for the primary cervical spine clearance imaging procedures. MRI requires extensive time to perform, interferes with the patient's monitoring equipment, and is expensive. MRI is most useful in the patient for whom other imaging modalities are not consistent with the neurologic presentation. In one study, 25% of patients with cervicothoracic injuries and a neurologic deficit on presentation had their preliminary treatment plan altered after MRI, whereas imaging had no effect on neurologically intact patients.[35] Although MRI can have negative predictive value approaching 100%, its positive predictive value has been less impressive.[36]

Unlike flexion-extension radiography, MRI provides valuable information regarding cervical ligaments, disks, and joint capsules without placing the spinal cord or neural elements at risk. However, no consensus exists on the imaging criteria for establishing a significant ligamentous injury. Fat suppression sequences, including T2-weighted and short tau inversion recovery MRI, are most sensitive to fluid and hemorrhage, whereas T1-weighted sagittal images can depict the anterior and posterior longitudinal as well as the supraspinous ligaments. A disruption of the black stripe on T1-weighted images and increased signal that extends through normal ligamentous structures on fat-suppressed images can be indicative of ligamentous injury. Delays that allow resolution of edema and hemorrhage can decrease MRI sensitivity in cervical spine clearance. Although 48 to 72 hours has been suggested as an optimal time interval, no data exist to substantiate this notion.[36]

Recommendation

Symptomatic patients require imaging of the cervical spine. Current practice and evidence support two options: three-view plain radiography with adjunctive CT if needed for inadequate radiographs, or MDCT. In the symptomatic patient undergoing CT scanning of other locations, the addition of cervical MDCT is recommended. Flexion-extension radiography for cervical clearance is not recommended but is appropriate in the subacute setting (ie, 2 weeks) if symptoms persist.[15] MRI is not indicated for screening; however, it may be warranted for evaluation of the patient with spinal cord injury, suspected ligamentous injury, or neurologic deterioration.

Group 4: Obtunded

Clearance of the cervical spine in the patient with cognitive dysfunction is controversial and unresolved. The decision to discontinue the cervical collar for such a patient is not synonymous with determining that the cervical spine has been cleared, as in groups 1 and 3. In a group 4 patient, the risks of an occult cervical spine injury must be weighed against the potential morbidities of continued cervical immobilization. The

concern is that cervical injuries resulting from high-energy trauma might include soft-tissue damage that may not be readily identifiable on plain radiographs or CT. Chiu et al[37] estimated a 0.6% incidence of isolated ligamentous cervical spine injuries in all blunt trauma patients. These isolated soft-tissue injuries are difficult to detect and may result in neural injury, ranging from minor sensory deficits to complete tetraplegia.[5,38-40] Neurologic sequelae associated with a spinal injury are 10 times more likely to occur in the event of a missed injury.[41]

There is consensus that the patient who has altered mentation requires imaging of the cervical spine.[7,15,42-44] A variety of methods has been recommended, but no definitive standard currently exists. Numerous algorithms have been advocated and incorporate clinical examination (often unreliable), plain radiographs, dynamic fluoroscopy, CT, and MRI. In the past decade, CT and MRI have largely replaced these other imaging modalities; the current debate revolves around the extent to which MDCT can direct clearance of the cervical spine.

Computed Tomography

Several recent investigations have advocated CT as a single modality capable of detecting all clinically significant cervical spine injuries.[42,44-49] Harris et al[42] analyzed 367 obtunded trauma patients using CT and reported that all clinically significant cervical spine injuries were identified. Furthermore, CT failed to detect minor injury in only one patient. Tomycz et al[49] analyzed 180 obtunded blunt trauma patients with no neurologic deficits and Glasgow Coma Scale scores ≤13 by CT, and then, if the result was normal, by MRI. MRI identified acute abnormalities in 21% of patients with a negative CT result; however, none of the injuries identified by MRI was deemed clinically significant. This led the authors to conclude that the use of MRI is obviated by a negative MDCT. Similar results were reported by Como et al[45] and Schuster et al.[48]

Hogan et al[46] published results of 366 obtunded blunt trauma patients evaluated with both MDCT and MRI. These authors found that MDCT had a 98.9% negative predictive value for ligament injury and a 100% negative predictive value for cervical instability. In this investigation, 4 of the 366 patients with negative MDCT results had isolated ligamentous injuries on MRI, none of which was felt to be unstable. Stelfox et al[47] compared the results of a clinical examination with helical CT reconstruction with those of MRI. CT alone had sensitivity equal to that of MRI but was faster and resulted in 67% fewer adverse events, such as decubiti, delirium, and hospital-acquired pneumonia while awaiting imaging.

Magnetic Resonance Imaging

Although CT is sensitive in the identification of osseous abnormalities, it has not been shown to have the same level of accuracy as MRI in detecting an isolated ligamentous injury. Menaker et al[50] analyzed 203 obtunded trauma patients who had normal CT results and found an 8.9% incidence of abnormality identified by MRI. In this study, 2 patients found to have a normal cervical spine by CT interpretation required surgical intervention for ligamentous injury, and 14 others required immobilization in an orthosis. These researchers concluded that CT cannot reliably detect all clinically significant cervical injuries and that MRI remains a necessary adjunct in the evaluation of the obtunded patient with suspected cervical trauma.

Similarly, Diaz et al[41] reported a 32% sensitivity for helical CT for cervical spine ligamentous injuries. The authors found that the negative predictive value of CT for ligamentous injury was only 78%. Based on these findings, the authors concluded that CT is not effective in evaluating ligamentous injuries and recommended that obtunded patients undergo MRI.

Recently, Muchow et al[36] published a meta-analysis involving five level I studies, representing 464 trauma patients evaluated using MRI and plain radiographs or CT. Comparable to other published reports, these authors found a 20.9% incidence of abnormalities on MRI that were not detected by plain radiographs or CT. They found that MRI demonstrated a sensitivity of 97.2%, a specificity of 98.5%, and a negative predictive value of 100%. Based on these findings, Muchow et al[36] concluded that a negative MRI study is the definitive standard for cervical spine clearance in the obtunded patient. However, the high rate of false negatives makes the usefulness of MRI as a screening tool questionable.

Stassen et al[39] advocated an algorithm in which the obtunded trauma patient undergoes both a helical CT and MRI procedure to facilitate cervical spine clearance. In the authors' investigation, 30% of the patients with normal CT findings demonstrated abnormal findings on MRI ($P < 0.01$). Furthermore, MRI identified all abnormalities that were indicated by CT. These authors suggested that both helical CT and MRI be employed in the evaluation of the cervical spine in obtunded trauma patients.

Such a recommendation is in accord with the American College of Radiology (ACR) Appropriateness Criteria on suspected spine trauma.[15] The ACR has stated that CT and MRI are the most appropriate modalities for cervical spine evaluation in the obtunded trauma patient.

Moreover, the ACR advocates that "... MRI be used to evaluate the cervical spine in patients whose neurologic status cannot be fully evaluated within 48 hours of injury, including those in whom computed tomographic results are normal."[15]

Dynamic Radiography

Dynamic radiography in the obtunded patient has been obtained under physician's supervision and with the use of bedside fluoroscopy, traction, and general anesthesia.[27] Studies have shown that approximately 1% of patients may demonstrate an undiagnosed ligamentous injury and that most such applications are inadequate because they do not visualize the cervicothoracic junction.[51] Further cases of neurologic deterioration from flexion-extension radiographs have been noted.[52] We therefore do not recommend their use in the obtunded patient.[15,27,52]

Upright Radiograph

An alternative to dynamic radiographs is an upright lateral radiograph as a potentially functional test. This is often used as an initial assessment of stability in the nonsurgical treatment of a patient with spinal fracture. Harris et al[42] recently evaluated the efficacy of this in evaluating obtunded patients. They could not find a single case in which the upright radiograph identified an injury after a negative CT finding and, thus, did not believe this was an effective screening tool.

Recommendation

Despite voluminous research, no unequivocal standard has emerged for clearing the cervical spine in the obtunded trauma patient, although any such patient should have radiographic evaluation. Such patients should be expeditiously evaluated so that appropriate collars can be removed and restrictions eliminated. The initial screening should be MDCT. When the CT result is normal, two options are available to ultimately clear the cervical spine. The first is to accept a negative CT scan as clearing the spine and to discontinue collar and restrictions. Alternatively, cervical MRI should be obtained to ultimately clear the cervical spine. Both of these options are supported in the current literature and by consensus panels as discussed above. The authors recommend the use of the first method: MDCT alone for clearing the cervical spine in obtunded patients.

Summary

Clearance of the cervical spine in the adult trauma patient is a critical assessment. The objective of this process is to efficiently exclude the presence of a significant injury. This should occur in all blunt trauma patients in an orderly and timely manner. Patients can be classified into four groups: asymptomatic, temporarily nonassessable, symptomatic, and obtunded. Clearance of the asymptomatic patient (group 1) on clinical assessment without radiography has been established by level I evidence. The asymptomatic but temporarily nonassessable patient (group 2) has been described only recently and requires further investigation. The authors recommend that a group 2 patient be immobilized for 24 to 48 hours until mentation becomes normal and distracting injuries are treated; at this time, the patient can be reassessed as asymptomatic. If cognitive function does not normalize by this time, then the patient should be assessed and treated according to obtunded protocols. Level I evidence mandates that the symptomatic patient (group 3) be initially evaluated by CT or plain radiographs. A consensus on how to optimally clear the obtunded patient (group 4) does not currently exist. The authors propose the use of MDCT or a combination of CT and MRI. Creation and implementation of clearance protocols such as those described here, based on the best available medical evidence, are recommended at each institution.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 1, 13, 17, 18, 29, 32, 33, 38, 42, 49, and 50 are level I studies. References 23, 24, and 47 are level II studies. References 2, 3, 10-12, 14, 16, 20, 28, 36, 41, 45, 51, and 52 are level III studies. References 4, 5, 21, 25, 30, 31, 35, 37, 39, 40, 44, 46, and 48 are level IV studies. References 6-8, 15, 19, 22, 27, 34, and 43 are level V expert opinion.

Citation numbers printed in **bold type** indicate references published within the past 5 years.

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