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Abbreviation:
EAST = Eastern Association for the Surgery of Trauma

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Exclusion of Unstable Cervical Spine Injury in Obtunded Patients with Blunt Trauma: Is MR Imaging Needed when Multi–Detector Row CT Findings Are Normal?[1]

PURPOSE: To retrospectively determine what information, if any, magnetic resonance (MR) imaging of the cervical spine in obtunded and/or "unreliable" patients with blunt trauma adds to multi–detector row computed tomography (CT) of the entire cervical spine (including routine multiplanar sagittal and coronal reformations) when the CT findings are normal.

MATERIALS AND METHODS: The study was HIPAA compliant and institutional review board approved. Informed consent was not required. From April 2001 to November 2003, 1400 trauma patients underwent MR imaging of the cervical spine to evaluate potential cervical spine injuries. Multi–detector row CT of the cervical spine was performed with a four– or 16–detector row scanner. MR imaging of the cervical spine was performed with transverse gradient-echo, sagittal intermediate-weighted, sagittal short inversion time inversion-recovery, and sagittal T1- and T2-weighted fast spin-echo sequences. Many MR examinations were performed to exclude soft-tissue injuries in the cervical spine of obtunded patients with blunt trauma in whom cervical spine injury could not be excluded with physical examination. Complete cervical spine MR studies were obtained to evaluate soft-tissue injuries in 366 obtunded patients with blunt trauma (281 male and 85 female patients; age range, 13–92 years; mean age, 42.1 years). The patients had previously undergone total cervical spine multi–detector row CT with normal findings. The results obtained with these two modalities were compared.

RESULTS: MR images were negative for acute injury in 354 of the 366 patients and negative for cervical spine ligamentous injury in 362. Seven of the 366 patients had cervical cord contusions, four patients had ligamentous injuries, three patients had intervertebral disk edema, and one patient had a cord contusion, a ligamentous injury, and an intervertebral disk injury. Four patients had ligamentous injuries; however, all of these patients had ligament injuries limited to only one of the three columns of cervical spine ligament support. Multi–detector row CT had negative predictive values of 98.9% (362 of 366 patients) for ligament injury and 100% (366 of 366 patients) for unstable cervical spine injury.

CONCLUSION: A normal multi–detector row CT scan of the total cervical spine in obtunded and/or "unreliable" patients with blunt trauma enabled the authors to exclude unstable injuries on the basis of findings at follow-up cervical spine MR imaging.

Historically, the exclusion of cervical spine injuries in patients with blunt trauma has been one of the major challenges facing traumatologists and emergency medicine physicians (1). Results of one study (2) indicated that 10% of patients develop neurologic deficits after entering medical care. To avoid this possibility, immediate immobilization, thorough clinical evaluation, and imaging assessment including radiography and, often, computed tomography (CT) for the evaluation of cervical spine injuries have become pillars of current clinical practice (3–5).

The best approach for excluding unstable cervical spine injury in patients with blunt trauma who are obtunded or otherwise unreliable for physical examination is yet to be determined (3–12). The cervical spine must be declared free of any potentially unstable injury (ie, "cleared") to permit removal of the cervical spine immobilization device before complications develop. The ideal diagnostic method(s) must be highly sensitive in the detection of any potentially unstable injury that could cause or exacerbate a neurologic deficit, cost-effective, and available within most emergency care facilities. A number of strategies have been promoted in this regard, but the high level of concern over missed injuries and possible attendant neurologic injury and the associated medicolegal ramifications have made consensus on an approach difficult to achieve.

The Eastern Association for the Surgery of Trauma (EAST) has clearly stated clinical practice management guidelines for evaluating the cervical spine in the obtunded patient with blunt trauma (13, 14). This organization recommends a three-view radiographic series (anteroposterior, lateral, and open-mouth odontoid), as well as cervical spine CT from the skull base through the C2 spinal level with sagittal reformations as an adequate approach for diagnosing cervical injury. Their guidelines also state that additional focused CT should be performed if there are any suspicious findings on the three-view series or if parts of the cervical spine are not well visualized radiologically.

In the case of ligament and other soft-tissue injuries, the most appropriate method of evaluation is unclear. No precise clinical algorithm for assessing the obtunded trauma patient, who is not likely to be able to participate in a reliable physical examination, has been agreed on. Some authors state that an attempt should be made to wait until the patient can cooperate for physical examination while maintaining cervical collar immobilization (3,11,15). Others have recommended passive cervical spine flexion and extension performed with fluoroscopy as a worthwhile procedure for assessing ligament integrity and stability (13,16,17). Dynamic fluoroscopy has been shown to be of low yield, potentially dangerous, and not cost-effective (18–20). Others recommend cervical MR imaging as the best method for ascertaining the integrity of the cervical spine ligaments for potential instability on the basis of the Denis three-column concept (14,16,21–23). Finally, others argue that magnetic resonance (MR) imaging is a tool for patients with neurologic findings and should not replace "functional studies" such as dynamic fluoroscopy (24).

The purpose of our study was to retrospectively determine what information, if any, cervical spine MR imaging of the obtunded or "unreliable" patient with blunt trauma adds to multi-detector row CT of the entire cervical spine, including routine multiplanar sagittal and coronal reformations, when those findings are normal.

MATERIALS AND METHODS

Our study was compliant with the Health Insurance Portability and Accountability Act, designed in a retrospective manner, and approved by our institutional review board. Informed consent was not required. All imaging examinations were performed for accepted clinical indications and in accordance with accepted imaging practices for standard patient care.

Evaluation of the Cervical Spine

In accordance with the EAST group guidelines, patients at our institution who are suspected of having cervical spine injury are initially evaluated with a three-view radiographic series. In uncooperative or unstable patients, one lateral view of the cervical spine is obtained, with the opened-mouth odontoid and anteroposterior views frequently omitted. If radiographs are judged as inadequate to clear the entire cervical spine for injury by the admitting fellow, attending traumatologist, attending radiologist, or on-call radiology resident, multi–detector row CT of the total cervical spine is performed. In accordance with the EAST guidelines, levels of concern are imaged with CT; however, at our institution this is fulfilled with complete cervical multi–detector row CT to include the skull base to at least the T1 vertebral body. Focused CT of the cervical spine is not performed at our institution. Most patients can be cleared with these imaging studies in combination with an adequate clinical examination.

The obtunded patient, who is unable to undergo clinical examination due to head injury, shock, alcohol or illicit drug use, intubation, pharmacologic sedation, and/or paralysis, remains in the cervical collar placed before admission until he or she is able to cooperate for a complete physical and neurologic examination. Dynamic fluoroscopy is not performed at our institution. MR imaging is performed to evaluate the cervical soft tissues in patients with prolonged (>72 hours) depressed or altered mental status and in those in whom surgery is required before they can become reliable for examination of the cervical spine.

TABLE 1
Mechanism of Injury

Mechanism of Injury	No. of Patients (*n* = 366)
Motor vehicle collision	168 (45.9)
Fall	75 (20.5)
Assault	37 (10.1)
Pedestrian struck by motor vehicle	36 (9.8)
Motorcycle collision	20 (5.5)
All-terrain vehicle accident	6 (1.6)
Other	24 (6.6)

Note.—Numbers in parentheses are percentages.

Injury Definitions

Findings of cervical spine injury at multi–detector row CT include cervical spine fracture, marked prevertebral edema, cervical spine malalignment (including the anterior spinal, posterior spinal, or spinolaminar line), widening of the normal interspinous or intervertebral disk spaces, and loss of normal facet coverage. At MR imaging of the cervical spine, visualization of ligament discontinuity, whether partial or complete, is considered indicative of ligament injury. Acuity was then based on the presence or absence of prevertebral, interspinous, or posterior neck soft-tissue edema; adjacent intervertebral disk edema or injury; and bone injury. Other cervical spine injuries involving the cervical spinal cord, intervertebral disks, and cervical spine were evaluated with cervical MR imaging.

Inclusion Criteria

From April 2001 to November 2003, 1400 patients admitted to R. Adams Cowley Shock Trauma Center at the University of Maryland Medical Center underwent cervical spine MR imaging to evaluate potential cervical spine injuries.

Figure 1. (**a–c**) Multi–detector row CT scans of the cervical spine in (**a**) coronal and (**b**, **c**) sagittal reconstructions. The image in **b** is a midline scan, and **c** was obtained in the lateral projection with facet joints visualized.

Only patients with acute injury secondary to blunt trauma were included in this study. Both patients with isolated cervical spine trauma and those with multiple injuries could be included. Of this subset, however, only obtunded patients who underwent MR imaging for the sole purpose of excluding a cervical spine soft-tissue injury and in whom the full physical examination, including neurologic testing, was inadequate were included in our study. The exact indication for MR imaging was determined from the MR study request and patient chart review, if necessary (G.J.H.). Obtunded patients with blunt trauma who underwent MR imaging and also had normal findings at multi–detector row CT of the entire cervical spine (occiput through T1) performed before MR imaging were included in our study.

Exclusion Criteria

Patients were excluded if they *(a)* had evidence of cervical spine malalignment at radiography or multi–detector row CT (similarly, patients with cervical spine fractures or those with marked prevertebral soft-tissue edema determined on the basis of the admission radiograph or multi–detector row CT interpretation were excluded), *(b)* were judged as neurologically reliable for cervical spine examination by the admitting team, *(c)* had neurologic evidence of spinal cord injury at physical examination, *(d)* could not cooperate for a complete cervical MR examination, and *(e)* had a distracting injury as their clinical indication for cervical MR imaging.

Study Group

Only 366 patients fulfilled the inclusion criteria of our study. This group consisted of 281 male and 85 female patients (male-female ratio, 3.3:1) with a mean age of 42.1 years (age range, 13–92 years). The female patients ranged in age from 13 to 90 years, with a mean age of 43.4 years. The male patients ranged in age from 14 to 92 years, with a mean age of 41.5 years. About 85% of the injuries in these patients were caused by motor vehicle collision, fall, assault, and pedestrian vehicle accidents (in descending order). The most common mechanism of injury was motor vehicle collision (168 of 366 patients [45.9%]) (Table 1).

On average, patients underwent MR imaging 9.0 days (maximum, 40 days) after their initial multi–detector row CT screening examination. MR imaging was often delayed owing to concurrent severe injury or illness that precluded transport or because of failure to obtain an adequate MR study at a prior attempt. Twenty-two patients underwent MR imaging on the same day as CT and represented a subgroup that required cervical spine clearance before surgery.

Multi–Detector Row CT

Cervical spine CT scans were obtained by using an MX8000 (four sections, 88 patients) or MX8000 IDT (16 sections, 278 patients) unit (Philips Medical Systems, Best, the Netherlands). As part of our routine cervical multi–detector row CT protocol, scanning was performed from the skull base to at least the T1 vertebral body. Four–detector row CT was performed by using 4 × 1.5-mm collimation with 3-mm-thick sections, 1.5-mm overlap, and a pitch of 0.875. Sixteen–detector row CT was performed by using 16 × 0.75-mm collimation with 2-mm-thick sections, 1-mm overlap, and

TABLE 2
Cervical Spine MR Imaging Protocol

Sequence	Repetition Time (msec)	Echo Time (msec)	Echo Train Length	Matrix	Other Parameter
Transverse gradient echo	1057	18	None	192 × 256	Flip angle of 40°
Sagittal intermediate weighted	2000	9	Eight	256 × 256	None
Sagittal short inversion time inversion recovery	2550	36	Eight	192 × 256	Inversion time of 110 msec
Sagittal T1-weighted fast spin echo	500	9	Two	256 × 256	None
Sagittal T2-weighted fast spin echo	4000	100	Eight	256 × 256	None

TABLE 3
Discrepancies between MR Imaging and CT Findings

Patient Information	Finding: CT	Finding: MR Imaging	Additional Injuries
77-Year-old man, s/p fall	Degenerative changes*	Old C3-4 ligamentum flavum tear	Fibular fracture
87-Year-old man, s/p fall	Degenerative changes†	Partial tear of anterior longitudinal ligament at C6-7 with disk edema or hemorrhage	None
23-Year-old woman, s/p high-speed motor vehicle collision	Normal†	Tear of ligamentum flavum and interspinous ligaments at C5-6	Facial bone fractures, lung contusions, rib fractures, bilateral pneumothoraces, radial-ulnar fracture, thoracic spine fracture
53-Year-old man, s/p fall	Normal*	Old partial tear of ligamentum flavum at C6-7	Pneumothorax, rib fractures, flank contusion, lumbar fractures

* Findings at retrospective review were not different from those at the initial evaluation.
† Subtle widening of the posterior elements at the injured level was found at retrospective review.

a pitch of 0.663. Transverse images were reconstructed at 1 mm, and three contiguous sections were fused for review and storage on a picture archiving and communication system workstation. Reformations in both the sagittal and coronal planes were obtained routinely from 1-mm transverse reconstructions (Fig 1). Multiplanar reformations were reformatted to 2-mm thickness every 2 mm through the entire spine. If needed, the 1-mm transverse images were available for review on the CT workstation.

MR Imaging

Complete cervical spine MR imaging was performed by using either a Signa 1.5-T system with 5.8 software and equipped with echo-planar gradients (GE Medical Systems, Milwaukee, Wis) or an Eclipse 1.5-T unit with 3.0 software and equipped with echo-planar gradients (Philips Medical Systems). Unenhanced MR imaging was performed in the transverse and sagittal planes by using standard fields of view, 3-mm-thick sections, and a 1-mm gap. The entire cervical spine was imaged by using a gradient-echo sequence in the transverse plane. The same protocol was used in all patients (Table 2). Transverse T2-weighted fast spin-echo imaging (repetition time msec/echo time msec, 4000/92; echo train length, 12; matrix, 192 × 256) was added to the MR imaging protocol and performed in 355 of the 366 patients.

Image Analysis and Data Collection

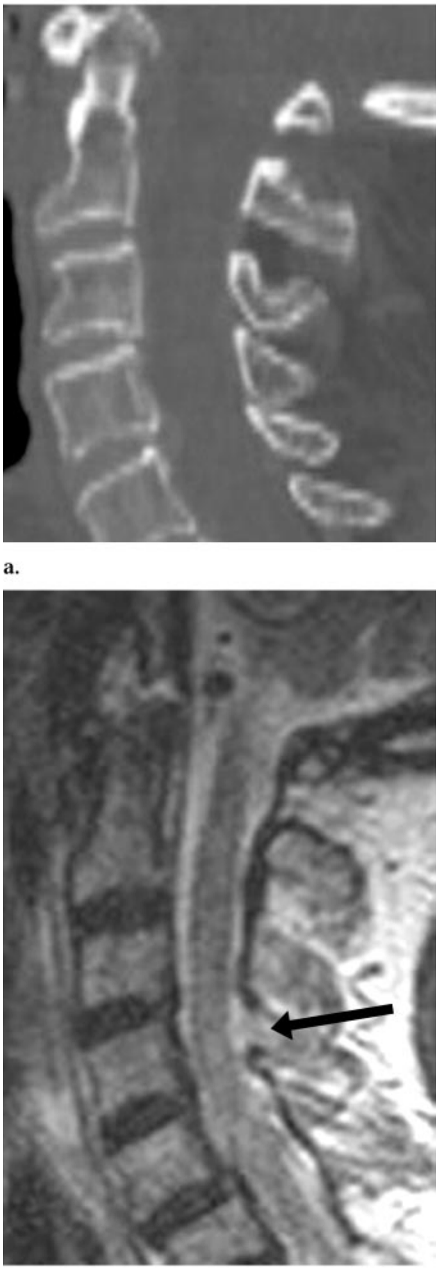
All CT and MR images were obtained for patient care and treatment and evaluated electronically; the results were then reported by one of five staff trauma radiologists with 1, 3, 3, 13 (K.S.), and 20 (S.E.M.) years of experience. All cervical spine MR reports were reviewed (G.J.H.) at a later date. MR study results that were reported as abnormal, including findings of cervical spine malalignment, ligament discontinuity, or increased T2-weighted signal intensity in the cord, disk, or vertebral body, were subsequently reviewed. In these cases, the CT and MR studies were reviewed separately by the two senior attending trauma radiologists (S.E.M., K.S.).

Review of the CT scans of the cervical spine was performed for any patient with positive MR imaging findings. Since the initial interpretation of each complete cervical spine multi–detector row CT scan was normal, CT abnormalities found at review did not exclude the patient. All positive MR imaging cases were reviewed independently of the multi–detector row CT findings. A consensus MR imaging case interpretation reached by the two reviewers (S.E.M., K.S.) was used as the final interpretation.

RESULTS

Of the 366 patients included in our study, 354 (96.7%) had MR images that were negative for acute injury. MR images were negative for cervical spine ligamentous injury in 362 of the 366 patients (98.9%). Seven of the 366 patients (1.9%) had cervical cord contusions, four patients (1.1%) had ligamentous injuries, three patients (0.8%) had intervertebral disk edema, and one patient (0.3%) had a cord contusion, a ligamentous injury, and an intervertebral disk injury.

Four patients had ligamentous injuries involving only one cervical column. The MR studies for these patients were obtained 1–8 days (mean, 4.75 days) after



a.

b.

Figure 2. **(a)** Sagittal multi–detector row CT and **(b)** sagittal T2-weighted MR (4000/87, 32.0 × 32.0-cm field of view, 512 × 512 matrix) images of the cervical spine show normal alignment and anatomy. The MR image shows discontinuity of the ligamentum flavum at C3-4 (arrow), with no associated soft-tissue edema.

trauma. In two of the four patients (50%), the injuries appeared to have occurred before the admitting trauma event (6 and 8 days earlier) on the basis of a complete lack of associated soft-tissue edema. Table 3 shows the pertinent information about these four patients. A normal multi–detector row CT scan of the cervical spine in obtunded patients with blunt trauma enabled us to exclude unstable injury, contiguous two- or three-column injury, or injury necessitating surgical fixation. Multi–detector row CT had a negative predictive value of 98.9% (362 of 366 patients) for ligament injury and a negative predictive value of 100% (366 of 366 patients) for unstable cervical spine injury.

Of the four patients with ligamentous injuries, three (75%) had injuries that involved the posterior ligaments, including the ligamentum flavum and interspinous ligaments. On the basis of MR imaging, the injuries appeared to have resulted from hyperflexion in three patients (75%) and from hyperextension in one patient (25%) (Figs 2–4). In two of these four patients, the findings at retrospective evaluation of the cervical multi–detector row CT scan were discordant with those from the initial readings, with subtle abnormalities suggestive of the ligamentous injuries eventually diagnosed on MR images (Table 3; Figs 3, 4).

Seven of the 366 patients (1.9%) had cord contusions. These were seen in patients with narrowed spinal canals due to pre-existing, degenerative disk–osteophyte complexes. One of these patients had an anterior longitudinal ligament injury at C6-7 and a cord contusion at C2-3 (Fig 3). No patient with a cord contusion at MR imaging had a corresponding neurologic deficit diagnosed during or after his or her admission. These areas of increased signal intensity may have been secondary to chronic myelomalacia associated with degenerative spinal stenosis.

Degenerative changes noted at multi–detector row CT, including neural foramina narrowing and spinal canal stenosis, were verified with MR imaging. Many patients had degenerative disk disease with mild cervical disk protrusion or broad disk bulge. No disk herniations necessitating surgical treatment were diagnosed. Three patients had intervertebral disk edema, but no disk rupture or injury required a change in management.

DISCUSSION

Acute spine injury is reported in 2%–3% of major trauma admissions, with blunt trauma as the mechanism in 85% of cases (1). The obtunded patient, who cannot cooperate for physical and neurologic examinations, is at high risk for spinal injury and delayed diagnosis (10,25,26).

Cervical Spine Radiography versus Cervical Spine CT for Evaluating Cervical Spine Injuries

In the evaluation of cervical spine injury, the diagnostic accuracy of a standard three-view (anteroposterior, lateral, and open-mouth odontoid) radiographic series is superior to that of lateral radiography (3,24,27–31). Studies have shown that, compared with helical CT, three-view radiography "misses" cervical spine fractures at rates of 40%–53% (24,27–31). Up to one-third of potentially unstable injuries are missed at radiography (28,29,32,33). Most of these missed fractures occur at the cervicocranial junction, including the occipital condyles to C2, or at the cervicothoracic junction (3,24,27,28,30,34). Link et al (35) showed that 89% of occipital condyle fractures and 39% of upper cervical spine fractures are missed with radiography.

Screening Multi–Detector Row CT of the Complete Cervical Spine

Many investigators believe that it is necessary to perform cervical CT from the skull base to C2 in the obtunded or unreliable patient with blunt trauma (5,8,11,17,36). Others mandate additional focused CT of cervical levels that are poorly visualized at radiography or suspicious for injury (5,11,36). Others suggest complete cervical spine CT for screening high-risk patients (29,30,37, 38).

Berne et al (28) have shown that focused CT, as recommended by the EAST group protocol, would fail to depict 12.5% of unstable injuries that would be diagnosed with complete cervical spine CT. In another study (29), no unstable cervical spine fractures were missed with complete cervical CT. It has been stated that performing complete cervical spine CT would eliminate 28%–40% of the false-positive diagnoses and 20% of the false-negative diagnoses that are based on radiographic findings (13,39).

Missed spinal injuries and delayed diagnoses are due primarily to inadequate radiographic evaluation (25,26). Among missed cervical spine injuries, 71% are unstable and 29% lead to permanent neurologic deficits (25). In studies of delayed diagnoses, in which radiography and focused CT were used, 20%–60% of injuries occurred below C2 (15,40).

Blackmore et al (38) showed that complete cervical spine CT is cost-effective in patients considered to have moderate to high risk of injury. The use of complete screening cervical spine CT in the high-risk population, as compared with the use of screening radiography, could save society $3.4 million per 100 000 patients. Moreover, complete cervical spine CT can be performed concurrently with head CT, which is already required in obtunded trauma patients (37,38). These observations indicate that it is prudent to perform total cervical spine CT, preferably multi–detector row CT, in symptomatic and obtunded patients with blunt trauma.

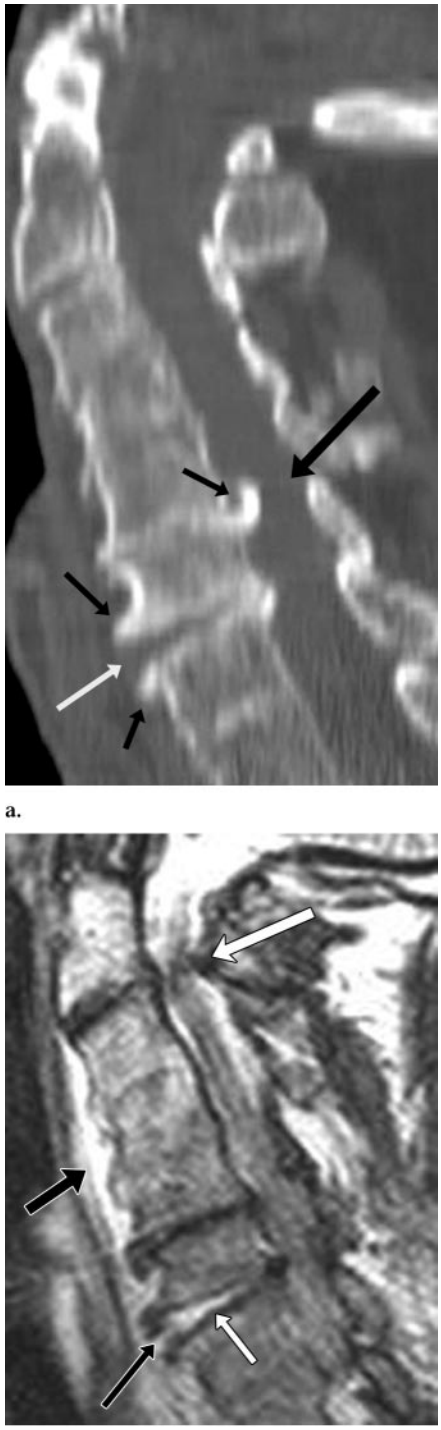


Figure 3. **(a)** Sagittal multi–detector row CT scan of the cervical spine. This image was initially interpreted as showing normal alignment with the exception of degenerative changes including anterior and posterior osteophytes (small black arrows) and associated spinal canal narrowing at C5-6 (large black arrow). At retrospective evaluation of the image, widening of the interspace was detected anteriorly at the C6-7 level (white arrow). **(b)** Sagittal T2-weighted MR image (4000/87, 32.0 × 32.0-cm field of view, 512 × 512 matrix) shows anterior widening of the C6-7 level with disruption of the anterior longitudinal ligament (thin black arrow), prevertebral edema (thick black arrow), and increased T2-weighted signal intensity in the C6-7 intervertebral disk (thin white arrow), a finding that is consistent with a diskoligamentous injury. In addition, the image also demonstrates a disk bulge at C2-3 with a cord contusion (thick white arrow).

Ligamentous Injury and the Obtunded Patient

Clinical examination.—Once initial radiographic and CT examinations have been performed and normal results have been obtained, ligament injuries must be excluded. It is agreed that patients should be maintained in cervical immobilization until these injuries can be excluded with clinical examination (4,5,7,8,11,36,41). For the obtunded patient, the clinical team usually waits until mental acuity is improved enough to perform a reliable clinical evaluation. This approach, however, is not without potential morbidity because long-term collar use limits central venous access and causes discomfort, skin maceration, and ulceration (44%), especially after 72 hours (19). Consequently, there is a clinical need to clear the cervical spine of the obtunded patient relatively quickly without placing the patient at risk for a neurologic deficit.

Dynamic fluoroscopy.—There are several proponents of dynamic flexion and extension views with fluoroscopy as a functional study that can help accurately exclude cervical spine instability (8,19,32, 36,42). Many of the reported "positive" findings at dynamic fluoroscopy, however, are fractures that radiographs did not reveal and subluxations of questionable importance. These include subluxation that does not satisfy White and Panjabi's (43) agreed-on limits of at least 3 mm of intervertebral body displacement and/or more than 11° of relative altered angulation between adjacent vertebral levels. Moreover, these studies compare dynamic fluoroscopy with radiography rather than cervical CT.

With use of the proper technique, dynamic fluoroscopy has been shown to be a safe technique (19,32,42). However, there has been one case of quadriplegia that resulted from a protocol violation that led to the inappropriate clearance of a cervical spine based on dynamic fluoroscopic findings (44). Dynamic fluoroscopy has been reported as inadequate in 17%–33% of patients, necessitating repeat studies (18,41,45). Findings at dynamic fluoroscopy can be false-negative owing to postinjury muscle spasm (45, 46). Bolinger et al (47) showed that dynamic fluoroscopy was almost always inadequate for visualizing the lower cervical spine in obtunded patients and recommended that it not be a consideration for clearance in this population. With the relative paucity of reported true-positive cases, there are substantial potential limitations of dynamic fluoroscopy and its incorporation into routine practice.

MR imaging.—Cervical spine MR imaging has been shown to be an excellent technique for evaluating soft-tissue injuries and is considered the reference standard in this regard (14,16,21,22,48,49). Traumatologists have agreed on the use of MR imaging in patients with a neurologic deficit (8,29,36,50,51). Benzel et al (21) have shown that cervical MR imaging performed after conventional radiography did not miss a ligament injury or permit any delayed diagnoses. In most cases, however, cervical spine MR images obtained for trauma have been compared with radiographs principally, dynamic fluoroscopic images rarely, and complete cervical spine CT scans almost never (16,21,22,49).

MR Imaging versus Complete Cervical Spine CT in the Obtunded Trauma Patient

To our knowledge, only the National Emergency X-Radiography Utilization Study (51) has compared CT and MR imaging in the evaluation of ligament injuries. In that study, investigators reported that only 12% (three of 25) of ligament injuries found with MR imaging were diagnosed with CT. Important details are omitted from the article, however, including what injuries were missed (ie, acute, chronic, stable, or unstable). Although the accuracy of MR imaging in

Figure 4. **(a)** Sagittal multi–detector row CT scan of the cervical spine. Although this image was initially interpreted as showing normal alignment and anatomy, there is subtle posterior element-facet widening (arrow) at the C5-6 level, a finding that is suggestive of a posterior ligamentous injury. **(b)** Sagittal T2-weighted MR image (4000/100, 24.0 × 24.0-cm field of view, 256 × 256 matrix) shows this posterior ligamentous injury, a ligamentum flavum tear (arrow). There is no associated posterior neck edema.

the detection of ligament injury would be expected to exceed that of multi–detector row CT, the question of greater import is whether multi–detector row CT can depict unstable ligament injuries, that is, injuries involving two adjacent ligament support columns as defined by Denis (23).

Current four– and 16–detector row CT systems achieve excellent spatial resolution in all axes. Routine analysis of multiplanar reformations should reveal known patterns of injury and subtle disturbances in alignment that suggest potential ligament injury. In addition, if findings at multi–detector row CT are equivocal, MR imaging is still an option for assessing ligaments directly. Our results indicate that unstable cervical spine injuries are very unlikely to be present in obtunded patients with blunt trauma and completely normal findings at cervical spine multi–detector row CT. Only four of 366 patients (1.1%) with negative findings at multi–detector row CT of the cervical spine had ligament injury detected at MR imaging; none of the injuries was judged to be or treated as unstable.

Chiu et al (50) stated that there is a low percentage of isolated ligament injuries in trauma and reaffirmed the use of the EAST protocol in the obtunded patient. In an accompanying editorial to this article, however, Marion et al asked if an unstable cervical spine injury could be present concurrently with normal anatomic alignment. Although multi–detector row CT cannot directly depict torn ligaments, we attempted to answer this question in this study.

Our results raise a question as to the medical necessity of routinely performing either cervical spine MR imaging or dynamic fluoroscopy in obtunded patients with blunt trauma who are unlikely to recover enough for a reliable clinical examination within 72 hours. Multi–detector row CT scans of the entire cervical spine that showed no acute osseous injury and anatomic alignment had a negative predictive value of 98.9% (362 of 366 patients) for ligament injury and a negative predictive value of 100% (366 of 366 patients) for unstable cervical spine injury on the basis of subsequent MR images.

There were some limitations to our study. First, because this was a retrospective study, some images were evaluated by the same reader who performed the initial evaluation. To reduce potential recall bias, the readers were blinded to patient information and no study was reevaluated by the same reader within 6 months of the initial reading. In addition, there was a delay in the performance of cervical spine MR imaging in some patients, which caused a delay in modality comparison. Unfortunately, this is the reality when dealing with severely injured patients, many of whom require urgent surgery, require constant intensive care observation, or are too ill to be transported. Earlier MR imaging (<24 hours) is preferred whenever possible if one requires cervical MR imaging as the reference standard.

On the basis of our findings, we suggest for consideration a cervical spine protocol for the obtunded trauma patient that includes routine complete cervical spine multi–detector row CT screening without the need for MR imaging or dynamic fluoroscopy if findings at multi–detector row CT are negative. Given the substantial medical, medicolegal, social, and cost issues associated with this approach, we acknowledge that further investigation and a larger prospective multi-institutional study are needed to verify our results and this suggested protocol.

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