Is magnetic resonance imaging in addition to a computed tomographic scan necessary to identify clinically significant cervical spine injuries in obtunded blunt trauma patients?

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KEYWORDS:
Cervical spine injury; Obtunded; Blunt trauma patient; Cervical spine magnetic resonance imaging; Cervical spine computed tomography

Abstract

BACKGROUND: Guidelines are in place directing the clearance of the cervical spine in patients who are awake, alert, and oriented, but a gold standard has not been recognized for patients who are obtunded. Our study is designed to determine if magnetic resonance imaging (MRI) detects clinically significant injuries not seen on computed tomographic (CT) scans.

METHODS: The trauma registry was used to identify and retrospectively review medical records of blunt trauma patients from January 1, 2005, to March 30, 2012. Only obtunded patients with a CT scan and MRI of the cervical spine were included.

RESULTS: The study cohort consisted of 277 patients. In 13 (5%) patients, MRI detected clinically significant cervical spine injuries that were missed by CT scans, and in 7 (3%) these injuries required intervention. The number needed to screen with MRI to prevent 1 missed injury was 21.

CONCLUSIONS: The findings suggest that the routine use of MRI in clearing the cervical spine in the obtunded blunt trauma patient.

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It is estimated that cervical spine (CS) injuries occur in 2% to 6% of patients suffering blunt trauma.1,2 Because of the potentially devastating consequences of missed CS injury including paraplegia, quadriplegia, and death,3 all patients with significant injury mechanism are considered to have CS injuries until proven otherwise and must be maintained with spinal precautions and the use of a rigid protective collar. However, cervical collars are cumbersome; hinder access to the head and neck for intubation, intravenous access, and procedures; and if used for prolonged periods can result in decubitus ulcers.4 Therefore, thorough but expeditious measures to rule out CS injury, the so-called “clearing the C-spine,” are a standard part of trauma patient management.3,5

The equipment and methods used for clearing the CS have changed dramatically over time. Clinical decision rules have been developed to identify patients who require radiographic imaging in addition to clinical evaluation.6–8

The authors declare no conflict of interest.

Presented at the South Western Surgical Congress, Santa Barbara, CA, March 24–27, 2013.

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Manuscript received March 9, 2013; revised manuscript August 28, 2013

0002-9610/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.amjsurg.2013.08.021
Plain radiographs were originally used for imaging but have been shown to miss significant injuries, many of which required operative therapy. Therefore, the standard for accurate imaging was raised to a computed tomographic (CT) scan, and current recommendations from the Eastern Association for the Surgery of Trauma now omit radiographs entirely in favor of an initial CT scan.

In an obtunded patient in whom no reliable clinical evaluation is possible, there is a question whether a CT scan alone gives enough certainty to clear the CS or if further imaging in the form of magnetic resonance imaging (MRI) is necessary. Given the high severity of consequences of delayed or missed CS injury, many centers recommend that the use of MRI be standard in obtunded blunt trauma patients. However, arguments against performing routine MRIs are the risks involved with transport of critically ill patients to the radiologic suite, lack of adequate monitoring capacity and nursing care during the imaging process itself, potential delays in removing the cervical collar, and increased health care costs. This study examined the results of both CT scans and MRI imaging of the CS in obtunded blunt trauma patients admitted to a level 1 trauma center in order to identify the proportion of cases in which MRI identified a clinically significant CS injury that would have been missed using CT alone.

Methods

This retrospective study was approved by the Texas Tech University Health Sciences Center Institutional Review Board.

Subject selection

Subjects were identified using the trauma registry at the University Medical Center, a level 1 academic trauma center in Lubbock, TX. Inclusion criteria were blunt trauma patients with a Glasgow Coma Scale (GCS) score of less than or equal to 14 admitted between January 1, 2005, and March 30, 2012. Only patients who were administered both a CT scan and MRI were selected for the study. Data were collected on sex; age; the mechanism of injury; discharge location; the injury detected on CT, MRI, or both; and any CS treatment administered.

Imaging details

All CT scans were performed with either a General Electric (Little Chalfont, Buckinghamshire, UK) “Lightspeed” 64-slice scanner or with a General Electric “Lightspeed” 16-slice scanner. The MRI scans were performed using a General Electric HDX scanner.

Determination of clinical significance

CT scans and MRI were considered clinically significant if they detected one of the following: ligamentous injury in two adjacent spinal columns, subluxations, cord injury, nerve root injury, disc herniations, and fractures except the following types as specified by the National Emergency Radiography Utilization Study (NEXUS): spinous process fracture without involvement of the lamina, transverse process fracture without involvement of the facet joint, osteophyte fracture not including corner or teardrop fracture, isolated avulsion without associated ligamentous injury, simple wedge-compression fracture without loss of greater than or equal to 25% of vertebral body height, endplate fracture, type 1 odontoid fracture, and injury to the trabecular bone.

Statistical analysis

Sensitivities for CT scans and MRI and the number needed to treat were calculated manually using standard equations with “diagnosis of clinically significant cervical spine injury by any modality” as the denominator because of the lack of an external gold standard. This definition precluded analysis of specificity.

Results

Study population

One thousand three hundred fifty-four blunt trauma patients were admitted between January 1, 2005, and March 30, 2012. During that time period, 277 (21%) had both a CT scan and MRI performed; these patients comprise our study population. This study population had a
mean age of 35.2 years (range 0 to 93 years), a mean Injury Severity Score of 22 (range 0 to 75), and a mean GCS score of 6 (range 3 to 14). There were 195 (70%) men and 82 (30%) women. Thirty-nine (14%) were children under the age of 18 years, with 18 (7%) under the age of 12 years. The mechanism of injury included motor vehicle collisions (70%), falls (9%), assaults (8%), pedestrian/bike accidents (3%), and other (10%).

MRI was obtained an average of 3.3 days (range 0 to 39 days) after admission. The mean length of stay for the cohort was 15.3 days (range 1 to 66 days). Upon discharge, 42% of patients went home, 50% went to a nursing/rehabilitation facility, 7% died, and 2% were unclassified.

Radiographic findings

One hundred fifty (54%) patients had a negative CT scan and negative MRI. Seventy (25%) patients had both a positive CT scan and positive MRI. Thirty-four (12%) patients had a negative CT scan and MRI with a different but clinically insignificant injury. An overview of patient details stratified by radiographic findings is given in Table 1.

Eleven (4%) patients had a positive CT scan and negative MRI. All 11 of these patients had fractures detected by a CT scan that were not identified on MRI. This is to be expected because CT imaging is more sensitive than MRI at detecting fractures. Of these patients, 5 were maintained in a cervical collar, and none were managed surgically.

One patient had a clinically insignificant finding on CT imaging but MRI showed a clinically significant injury. This patient was a 49-year-old man admitted after a motor vehicle collision with a GCS score of 3, an Injury Severity Score of 14, and a length of stay of 3 days. His MRI was performed 1 day after admission and showed a ligamentous injury, disc herniation, and spinal canal stenosis. His CT scan results reported only the spinal canal stenosis.

Twelve (4%) patients had a negative CT scan followed by MRI, which detected a clinically significant injury. Two of the patients had MRI that showed fractures, 2 revealed a ligamentous and disc herniation, and 2 showed disc herniation alone. There was 1 patient with a fracture and subluxation and 1 with a subluxation alone. MRI also revealed a ligamentous injury for 1 patient, a cord injury and spinal canal stenosis in another, and the diagnosis of a nerve root injury and spinal canal stenosis was given to 1 other patient. One patient had an injury that did not fit into our classification.

Overall, 13 (5%) patients had clinically significant CS injuries detected on MRI that were not identified on CT imaging. Of these, 7 (3%) patients required further treatment to stabilize the CS; 5 were placed in a longer-term
cervical collar, and 2 had surgical repair and a cervical collar (Figs. 1 and 2). The remaining 4 patients, although MRI detected clinically significant injuries, were not maintained on a specific treatment identified in our review. Further details of these patients are given in Table 2.

Based on these results, the sensitivity of CT imaging for CS injury is 83%, whereas the sensitivity of MRI for CS injury is 89%. However, it is important to note that this study was not designed to determine whether CT imaging or MRI is better at detecting injury as a solo modality. Rather, the aim of the study was to determine whether MRI is useful as an adjuvant imaging modality to more safely clear the CS. The number needed to treat (NNT) with an MRI to prevent 1 clinically significant missed CS injury is 21.

Table 2 Clinically significant MRI findings, treatment, and disposition

<table>
<thead>
<tr>
<th>Patient age/sex</th>
<th>MOI</th>
<th>GCS</th>
<th>ISS</th>
<th>LOS</th>
<th>MRI DAA</th>
<th>MRI results</th>
<th>Treatment</th>
<th>Disposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 mo/female</td>
<td>Assault</td>
<td>7</td>
<td>17</td>
<td>12</td>
<td>4</td>
<td>Odontoid ligament damage with stretching of the ligaments of the posterior margin of the posterior arch</td>
<td>Cervical collar</td>
<td>Home</td>
</tr>
<tr>
<td>22 y/female</td>
<td>MVA</td>
<td>3</td>
<td>36</td>
<td>66</td>
<td>2</td>
<td>Nuchal ligament rupture at C1-2, increased distance between odontoid and clivus suggesting atlanto-occipital dislocation (Fig. 1)</td>
<td>Posterior cervical fusion, occipit to C5, cervical collar</td>
<td>Rehabilitation facility</td>
</tr>
<tr>
<td>47 y/male</td>
<td>MVA</td>
<td>3</td>
<td>24</td>
<td>5</td>
<td>0</td>
<td>C2-3 PLL rupture, C2-T1 ALL injury, C1-3 interspinous ligament rupture, C1-T6 nuchal ligament rupture, C2-3 disc herniation</td>
<td>None</td>
<td>Death</td>
</tr>
<tr>
<td>46 y/female</td>
<td>MVA</td>
<td>11</td>
<td>22</td>
<td>41</td>
<td>2</td>
<td>C5-6 disc herniation</td>
<td>None</td>
<td>Home</td>
</tr>
<tr>
<td>47 y/male</td>
<td>Assault</td>
<td>3</td>
<td>13</td>
<td>9</td>
<td>2</td>
<td>C3 pedicle fracture, C3-T2 interspinous ligament rupture, C1-5 ALL rupture</td>
<td>None</td>
<td>Rehabilitation facility</td>
</tr>
<tr>
<td>54 y/female</td>
<td>Fall</td>
<td>3</td>
<td>9</td>
<td>10</td>
<td>1</td>
<td>Large syrinx from C4-7, occipital ligament injury, C5-6 herniated disc,</td>
<td>None</td>
<td>Home</td>
</tr>
<tr>
<td>29 y/male</td>
<td>MVA</td>
<td>14</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>C5-6 herniated disc, C2-4 interspinous and nuchal ligament injuries (ci)</td>
<td>Cervical collar</td>
<td>Home</td>
</tr>
<tr>
<td>17 y/female</td>
<td>MVA</td>
<td>6</td>
<td>34</td>
<td>12</td>
<td>6</td>
<td>C2 fracture of left sup, articular facet, anterior subluxation of C2 with respect to C1</td>
<td>None</td>
<td>Rehabilitation facility</td>
</tr>
<tr>
<td>60 y/male</td>
<td>Ped vs auto</td>
<td>14</td>
<td>9</td>
<td>10</td>
<td>7</td>
<td>C4-5 cord contusion</td>
<td>None</td>
<td>Home</td>
</tr>
<tr>
<td>52 y/male</td>
<td>Assault</td>
<td>3</td>
<td>50</td>
<td>9</td>
<td>1</td>
<td>C6-C7 disc herniation with cord compression (Fig. 2)</td>
<td>C6 corpectomy and cervical collar</td>
<td>Home</td>
</tr>
<tr>
<td>25 y/male</td>
<td>MVA</td>
<td>6</td>
<td>27</td>
<td>22</td>
<td>2</td>
<td>C3 pedicle/pars interarticularis fracture, C2 spinous process fracture, C7 transverse process fracture, C2-3 interspinous/ supraspinous/ligamentum flavum rupture</td>
<td>Cervical thoracic orthosis brace</td>
<td>Rehabilitation facility</td>
</tr>
<tr>
<td>28 y/male</td>
<td>MVA</td>
<td>14</td>
<td>22</td>
<td>13</td>
<td>3</td>
<td>C6-7 disc protrusion impinging C7 nerve root</td>
<td>Cervical collar</td>
<td>Home</td>
</tr>
<tr>
<td>49 y/male</td>
<td>MVA</td>
<td>3</td>
<td>14</td>
<td>3</td>
<td>1</td>
<td>C4-5 disc herniation, occiput-C6 interspinous ligament rupture</td>
<td>Cervical collar</td>
<td>Home</td>
</tr>
</tbody>
</table>

ALL = anterior longitudinal ligament; ci = clinically significant; DAA = days after admission; GCS = Glasgow Coma Scale; ISS = Injury Severity Score; LOS = length of stay; MOI = mechanism of injury; MRI = magnetic resonance imaging; MVA = motor vehicle accident; PLL = posterior longitudinal ligament.
Comments

The findings of this study suggest that CT scan alone is inadequate to rule out CS injury in obtunded blunt trauma patients. The overall incidence of significant CS injury that would have been missed without MRI was low at 5%, and the incidence of injuries requiring specific treatment was lower still at 3%. Nevertheless, given the potential for devastating injury in a population that is often young and otherwise healthy, the authors believe that this incidence is enough to justify the routine use of MRI in these patients.

It has been well documented that CT imaging is excellent at identifying osseous injuries of the cervical spine. However, it is insensitive for diagnosing cord injury, disc herniation, or subluxation. Furthermore, it does not specifically evaluate ligamentous injuries; only 12% of CS ligament injuries identified on MRI are observed on a CT scan. MRI is considered to be the reference modality for evaluating injuries to the soft tissues such as ligaments, discs, and capsules. In the past, MRI has been compared with flexion-extension radiographs and dynamic fluoroscopy but has been found to be more accurate and safe than these modalities. Some may argue that the incidence of ligamentous injury without fracture is too low to be considered. The Eastern Association for the Surgery of Trauma guidelines state that the incidence of ligamentous injury after a negative CT scan is less than 5%, but we found in our study that the rate is 13% although not all of the injuries represented are clinically significant.

Despite the publication of numerous guidelines on clearing the CS in trauma, there is still clinical equipoise on the role of MRI, especially regarding which populations might benefit most from the additional imaging detail this modality provides. Numerous studies have looked specifically at this issue; however, there is some difficulty in comparing the results of these studies with one another because of varying definitions of what constitutes a clinically unstable or significant injury. Dunham et al., Khanna et al., and Steigelman et al. defined clinical significance by the need for surgery or continued collar immobilization. Stassen et al. and Menaker et al. defined any injury identified as being clinically significant. In the current study, we used anatomic guidelines in determining if an injury was significant based on the NEXUS definitions and also the 3-column model proposed by Denis.

Several authors have proposed that MRI is not justified in the setting of a negative CT scan in blunt trauma. In 2005, Hogan et al. found that only 1.1% of patients with negative findings on a CT scan were subsequently found to have ligamentous injury on MRI, and none of these were clinically significant. Como et al. reported that although 5.2% of patients with a negative CT scan had a positive MRI with findings of ligamentous injury, microtrabecular damage, and an epidural hematoma, none of these findings changed patient management. After removing MRI from their treatment algorithm, this group subsequently published a 2-year follow-up reporting no cases of new-onset neurologic deficit. Tomyucz et al. in a study published in 2008 reported that 21.1% of patients (38/180) had acute traumatic CS defects detected on MRI that were not observed on CT imaging. Sixteen of the 38 patients had ligamentous injury all of which were deemed clinically insignificant; however, the other 22 patients had injuries such as disc herniation, spinal hematomas, and spinal cord edema. Steigelman et al. produced similar results with 5% (7/120) of patients having injuries identified on MRI that were missed on CT scans. Two of these injuries were treated with continued cervical collar immobilization, but none of these injuries were surgically treated and were thus deemed insignificant. Khanna et al. also reported that 49% of those patients with a negative CT scan had injuries identified on MRI, but all were deemed insignificant. The opponents of using MRI acknowledge that it does identify and delineate ligamentous and soft-tissue injuries but argue that these injuries are not clinically significant and do not warrant treatment, thus eliminating the need for MRI.

Conversely, there is also evidence for continuing the use of MRI. Menaker et al., reporting from the same institution as Hogan et al., found that 9% (18/203) of patients had abnormal MRI after an initial CT scan showing no acute CS injury of whom 2 had surgery and 14 were prescribed a cervical collar for 6 weeks. Sarani et al. found that MRI detected an injury in 26% (42/164) of patients with a negative CT scan. The findings of the MRI resulted in surgery in 9 patients (6%) and maintenance of the rigid cervical collar in 22 patients (13%). The current study adds to the literature supporting the use of MRI.

Several authors also chose different cutoffs for what obtunded was defined as. All of the prospective studies did not use a GCS cutoff but rather defined obtunded by an inability to give a reliable CS physical examination as determined by the examining physician. Dunham et al. and Schuster et al. define obtunded as less than 9. Tomyucz et al. defines obtunded as less than or equal to 13, and Menaker et al. and Sliker et al. both defined obtunded as less than or equal to 14. We defined obtunded in our study as a GCS less than or equal to 14 because we felt that any loss in consciousness may impair a patient’s ability to give a reliable physical examination.

It has been shown that MRI performed within 72 hours identifies acute edema to the soft tissues, which is diagnostic of injury to the tissues. After this brief window, edema in the soft tissue gradually subsides, and injury will no longer be detected on MRI, thus producing a false negative. In our study, the average time after admission until MRI was 3.3 days, which is just 8 hours over the recommended time. Many of the previously mentioned studies had MRI performed much later (ie, on days 7.5 [Hogan et al.], 9.0 [Como et al.], 9.9 [Menaker et al.], 8.3 [Steigelman et al.], and 4 [Tomyucz et al.]). Thus, many of these studies may have suffered from reduced sensitivity, resulting in missed injury.

There are certainly risks and disadvantages associated with using MRI, especially in unstable, severely injured patients. Many of these revolve around the inherent dangers...
of transport from an intensive care environment to a less monitored environment, especially when a nurse cannot be in the same room while the imaging is performed. There are also risks from supine positioning in the MRI scanner, which can result in increased intracerebral pressures, aspiration, and hypoxemia. Furthermore, the nature of MRI disallows the use of ferric compounds, eliminating its use in patients with certain implants. Finally, MRI is an expensive imaging modality. At our institution, MRI of the CS results in charges of $4,000 when billed to insurance, which typically results in an out-of-pocket expense to the patient of approximately $800.

In view of these conflicting reports in the literature, it is important to take into account the devastating and irreversible nature of missed CS injury. A recent case was published by Gebauer et al of an alert man who presented with head and neck pain after falling down 4 steps. His CS was cleared by a CT scan, and within 24 hours he developed weakness that progressed to tetraplegia. It was discovered by MRI that there was injury to the posterior ligamentous complex and facet subluxation at C5-6 with spinal cord compression. This case highlights the potential danger in relying solely on a CT scan to clear the CS. It is evident that the cost of MRI is far outweighed by the cost of caring for a quadriplegic. It has recently been estimated (in 2012 US dollars) that the average cost to care for a patient with high tetraplegia (C1-4 injuries) in the first year is $1.02 million, and for each subsequent year, it costs $177,808; for low tetraplegia (C5-8 injuries), it costs $739,874 in the first year and subsequently $109,077 each year after. This adds up to be a lifetime cost of approximately $3.3 to 4.5 million dollars for a patient who is approximately age 25 at the time of the injury and $2.0 to 2.5 million dollars for patients approximately 50 years old at the time of the injury. Therefore, although the cost of MRI is substantial, over 5,000 MRIs on obtunded patients would be required to match the cost of providing care for 1 quadriplegic patient, which is far more than the NNT of 21 described in this study.

As mentioned previously, the definition of clinical significance varies from study to study and between individual surgeons. A prevalent opinion among many practitioners is that the defining factor of a significant injury is the need for surgical stabilization. With this definition in mind, the rate of clinically significant injury undetected by CT scans but detected by MRI in our study would be 9%. This would in turn expand the NNT with an MRI to prevent 1 clinically significant missed CS injury to 111. Although this modified NNT is much larger than our original NNT, it is still significantly smaller than the 5,000 MRIs that would need to be performed to balance the cost of a missed cervical spine injury. Because of this difference, we would still recommend treating obtunded blunt trauma patients with both a CT scan and MRI to accurately identify unstable CS injuries to avoid the risk of tetraplegia.

This study has several limitations in addition to those inherent in a retrospective review. The study cohort included both adult and pediatric patients who have differing incidences of CS injury in the literature as well as patients with differing mechanisms of trauma. The low number of significant injuries precluded any meaningful statistical analysis of risk factors that predispose to such injuries; therefore, we are unable to determine which patient subgroups, if any, would most benefit from MRI. We used official radiologist reports in determining the presence and significance of CS injuries; it is possible that interpretations of the same images by the treating surgeons may have differed. It is also important to realize that medical complications that are unstable patients are transferred to and as they are in the MRI suite. These may be minor and reversible; yet, some may result in irreversible damage or death. In this study, we did not discover any mortal complications while doing our chart reviews; however, these are not commonly reported in electronic medical records. Thus, a weakness in our study is the lack of knowledge of complication rates, which may outweigh the rate of a missed clinically significant injury by CT scan. Finally, long-term, postdischarge follow-up was not available, so there is the possibility of late presentation of a missed injury in this cohort.

Conclusions

We studied victims of blunt trauma with a GCS less than or equal to 14 who received both a CT scan and MRI of their CS and found that 3% of patients had treatment altered because of the detection of an injury on MRI that was not seen on the CT scan. The number needed to be screened with MRI to identify 1 clinically significant injury is 21. Therefore, we strongly recommend the continued use of MRI in the routine evaluation of the CS in obtunded blunt trauma patients.

Acknowledgments

The authors would like to acknowledge the Clinical Research Institute of the Texas Tech University Health Sciences Center and the Trauma and Burn Services Office of the University Medical Center, Lubbock, TX, for their assistance with this study.

References


Discussion

Herbert Phelan, M.D. (Dallas, TX): In an era of limited resources, Dr Fisher and colleagues have revisited the issue of MRI for the clearance of the C-spine of obtunded patients, finding a rate of clinically significant missed injury of 5% and thus recommending that MRI be used on all these patients. Although I congratulate your use of an a priori definition of clinically significant injury, I think it is overly broad. Only 2 patients, or .9%, required an operation they would not have had if not for their MRI. This was over the 7 years of the study. Because I suspect that I am not alone in using that definition of a clinically significant injury, I have the following 2 questions. Would using this definition of a missed clinically significant injury and its rate of .9% change your thoughts on this recommendation? If your answer is no, is there some missed injury rate that you would find acceptable or do you contend that this should be a “never” event? Did you look at complication rates from the road trip to MRI and its attendant prolonged loss of bedside care in patients who are in the first few days after serious injury? A serious complication rate of .9% seems realistic in that setting and may actually negate the benefits of missed injury detection. I would like to
commend the authors for their study and thank the association for the privilege of reviewing this interesting article.

Brian Fisher, B.S. (Lubbock, TX): Thank you for those questions. The first of your questions is very interesting because the definition of what constitutes a clinically significant injury has differed from study to study. Some studies define clinical significance by surgically stabilized, whereas others suggest that any sort of additional treatment including cervical collar could also be recommended as a distinction that the CS was unstable. However, if we were just to use the surgical definition, I would still have to stay with our recommendation to obtain MRI at least from a financial perspective. Although the NNT would rise, it still would not be close to the 5,000 needed to match the cost to care for a tetraplegic patient. For the second question, we did not particularly look at complications that occurred in these patients on the way to or in the MRI suite in our retrospective review. Although the complication rate of .9% may be a possibility, the only safe alternative in my mind is to leave the patient in a cervical collar and wait for them to become unobtunded to obtain a reliable physical examination. Of course, there are complications involved with this as well. This may be an area for a future research project.

Fred Pierraci, M.D. (Denver, CO): That was a nice talk. Thanks. I am interested to know if you have neurologic examination data available on any of your patients. I am thinking of the person with a disc herniation and say a GCS of 14, which would technically be qualified as obtunded, may not be opening his eyes spontaneously but certainly is going to have some weakness, maybe even paralysis from such a significant spine injury. Therefore, I am wondering if you can further stratify these patients into those who are really obtunded (ie, they are not moving anything or no one has ever seen them move anything) versus someone who is a little intoxicated and if they have a serious injury that is going to require surgery, it could be picked up by the physical examination.

Dr Fisher: In this study, we did not particularly include that portion of it. That would be an important aspect of future research, maybe not necessarily changing the definition of obtunded but maybe further stratifying between really obtunded and just a little incoherent. This may be best accomplished with a prospective study.

Michael Truitt, M.D. (Dallas, TX): Your NNT was significantly lower than that reported in the literature. Can you comment on why you think that is?

Dr Fisher: Yes, absolutely. I believe there are 2 reasons that our number to treat is significantly lower. First, our definition of clinically significant contributed because we defined it much more broadly. We did this because as surgeons we get these radiologists’ reports, if you will, and it is based off of what they or we see and also our physical examination that clinical decisions are made. Also, I believe that our NNT was lower because we had an increased sensitivity of MRI. It has been shown in studies that MRI is most sensitive in detecting soft-tissue injury if obtained within 72 hours. Many previous studies had days after admission when MRI were obtained as 7, 8, 9; some of them were upward of 10 days on average to obtain an MRI. So, at that point, there is obviously a reduced number of injuries that would be detected by MRI because of the reduced sensitivity if the length of time is that long.