Use of Computed Tomography for Cervical Spine Clearance in Trauma Patients

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The term *evidence-based medicine* was first described by Sackett and colleagues as "the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients."[1]

The key to practicing evidence-based medicine is applying the best current knowledge to decisions in individual patients. Medical knowledge is continually and rapidly expanding and it is impossible for an individual clinician to read all the medical literature. For clinicians to practice evidence-based medicine, they must have the skills to read and interpret the medical literature so that they can determine the validity, reliability, credibility, and use of individual articles. These skills are known as critical appraisal skills. Generally, critical appraisal requires that the clinician have some knowledge of biostatistics, clinical epidemiology, decision analysis, and economics, as well as clinical knowledge.

The Canadian Association of General Surgeons and the American College of Surgeons jointly sponsor a program entitled "Evidence-Based Reviews in Surgery," supported by an educational grant from Ethicon Inc. and Ethicon Endo Surgery Inc. The primary objective of this initiative is to help practicing surgeons improve their critical appraisal skills. During the academic year, 8 clinical articles are chosen for review and discussion. They are selected not only for their clinical relevance to general surgeons, but also because they cover a spectrum of issues important to surgeons; for example, causation or risk factors for disease, natural history or prognosis of disease, how to quantify disease (measurement issues), diagnostic tests and the diagnosis of disease, and the effectiveness of treatment. Both methodological and clinical reviews of the article are performed by experts in the relevant areas and posted on the Evidence-Based Reviews in Surgery Web site. A listserv discussion is held where participants can discuss the monthly article. Fellows and candidates of the College can access Evidence-Based Reviews in Surgery through the American College of Surgeons' Web site (www.facs.org). All journal articles and reviews are available electronically through the Web site. Currently, we have a library of 80 articles and reviews that can be accessed at any time. Beginning each year in October, a new set of articles will be available each month until May. Surgeons who participate in the current (modules) packages can receive Continuing Medical Education credits by completing a series of multiple-choice questions. Additional information about Evidence-Based Reviews in Surgery is on the American College of Surgeons' Web site or by email to the administrator, Marg McKenzie at mmckenzie@mtsinai.on.ca.

In addition to making the reviews available through the American College of Surgeons' and Canadian Association of General Surgeons' Web sites, 4 of the reviews are published in condensed versions in the *Canadian Journal of Surgery*, 4 will be published in the *Journal of the American College of Surgeons*, and 4 in the *Diseases of Colon and Rectum* each year.

REFERENCE

1. Evidence Based Medicine Working Group. Evidence-based medicine. JAMA 1992;268:2420–2425.

SELECTED ARTICLE

Computed Tomography Alone for Cervical Spine Clearance in the Unreliable Patient—Are We There Yet?

Menaker J, Philp A, Boswell S, Scalea TM. J Trauma 2008;64:898−904.

ABSTRACT

Question: Is an admission computed tomography (CT) without magnetic resonance (MR) imaging sufficient to diagnose cervical spine (CS) clearance in the unreliable patient?

Design: Retrospective chart review.

Setting: Trauma center at the University of Maryland.

Patients: Seven hundred thirty four patients were identified with blunt trauma that had CS imaging with CT and MR between August 2004 and December 2005. During this time a clinical guideline was in place where by patients who had persistently unreliable exam-

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inations had MRI despite a normal admission CT. Medical records were reviewed for demographics, Glasgow Coma Scale (GCS) at time of MRI and injury specific data.

Description of Test and Diagnostic Standard: Cervical spine CT scans were performed using various models of 16-slice Philips-Brilliance scanner using 2-mm slices with 1-mm overlap. The trauma protocol included axial as well as coronal and sagittal reconstruction views. The MR scans were performed using a standard trauma protocol for cervical spine injuries including short time inversion recovery, T1, T2 and proton-density sagittal images. In addition, axial images included gradient echo and T2-fast spin echo format.

Main Outcome Measures: Evaluate new generation CT technology and assess whether admission CS CT with no acute injury is sufficient for CS clearance in an unreliable patient.

Results: Of the 734 patients identified, 203 patients without obvious neurologic deficits but unreliable clinical examination, defined by GCS score of $\leq$14, had an initial cervical spine CT read by an attending trauma radiologist as having no acute injury. Mean age was 42.3 yrs ($\pm$20.4 yrs) and mean Injury Severity Score was 29.1 ($\pm$11.8). One hundred eighty four (90.6%) patients had negative MR and collars were subsequently removed. After collar removal, no patient developed new neurologic deficit. Eighteen (8.9%) patients had abnormal MR, 2 of which required operative repair, 14 required extended cervical collar use. Two patients had collars removed at the discretion of the attending surgeon. One patient had suboptimal MR and was discharged in a collar with scheduled follow-up. If the MRI is considered to be the "gold standard," then the costs of CT for diagnosing a cervical injury are: sensitivity (531/550 = 97%), specificity (184/184 = 100%), positive predictive value (530/530 = 100%), negative predictive value (184/203 = 91%). However, if so, then the question of the "added value" of MRI in diagnosing cervical spine in unreliable patients is not addressed.

Conclusions: MRI identified 18 (8.9%) abnormalities and changed the management in 7.9% of patients having an admission CT with no acute injury. However, it is not possible to ascertain the clinical significance of theses injuries.

COMMENTARY

The authors address an important and controversial clinical problem. Clearance of the cervical spine in the obtunded patient continues to be characterized by variations in practice and opinion. This issue is extremely important considering the population at risk, ie, obtunded trauma patients, who routinely have false-negative examinations, and the consequences associated with a "missed" cervical spine injury, including potential catastrophic secondary spinal cord injury. The study by Menaker and colleagues is a single-site, retrospective, registry-based observational study of 203 patients during a time period in which 8,902 trauma patients were admitted and 734 had both CT and MRI. The study group comprised those who underwent both CT and MRI, had a Glasgow Coma Scale $\leq$14, and had no obvious neurological deficits and a noninjured-appearing CT scan. Mean Injury Severity Score was 29.1, with a laudable mortality rate of only 7.9%. This group of severely injured patients who were two-thirds male and three-quarters brain-injured constitutes an appropriate cohort of blunt trauma patients to study, in terms of generalizing results to other trauma centers in the developed world.

The underlying question addressed in this study is whether MRI of the cervical spine in patients suffering traumatic injury with unreliable clinical examination, who previously had a CT scan of the cervical scan interpreted as showing no acute injury by attending trauma radiologists, detects other clinically significant findings. A critical question for any evaluation of a diagnostic test is whether there is an independent blinded comparison with a gold standard reference test. In this study, MRI was considered the reference standard test for detecting abnormalities in the cervical spine. The true test performance related to the addition of MRI cannot be answered because it presumes that all abnormal findings on MRI are clinically significant. If the investigators wanted to address whether the addition of MRI was useful, they would have to choose another gold standard or reference. Such a gold standard might be a clinical result, a result that might not be feasible (because it occurs so infrequently) and might possibly be unethical. Other limitations of this particular study are that there was no blinding of the CT results to the reviewing radiologists and there was no re-review of the CTs that were deemed false negative by MRI for quality. Also, because of the study design, there remains great ambiguity about the clinical relevance of MRI findings.

This study was purported to be an evaluation of "newer" CT technology and to evaluate the hypothesis that, despite newer technology, CT alone misses cervical spine injuries, warranting continued use of MRI for spinal clearance. (This is contradicted in the accompanying meeting discussion, however). The study was published after, but was apparently not a direct follow-up of, a larger study from the

same institution that concluded that CT was reliable, having not missed any clinically significant injuries. The current study did attempt to improve on the previous study by clarifying the description of "unreliable," providing Glasgow Coma Scale and Injury Severity Score data, and by providing some information about the disposition of injuries. CT and MRI scanning protocols were also well-described. Unfortunately, the most important information about what criteria were used to deem the findings of MRI to be significant was not reported.

By design, results of the test (CT) did not influence the results to perform the reference test (MRI), as all those with CT scans interpreted as normal underwent MRI by protocol. Although this methodology allows for detection of injuries missed by CT, it was not designed to perform a head-to-head comparison of MRI and CT scan. Therefore, likelihood ratios for the test results could not be obtained because the data necessary for their calculation were not collected. To have been able to comfortably report accurate test performance criteria, all CT scans, whether positive or negative, should have been followed with MRI, which would provide all test performance criteria, including both false-negative and false-positive rates, assuming an indisputable gold standard followed both of these modalities. In addition, the protocol as outlined in the article was not followed explicitly; and no effort was made to derive any results that can characterize the true population at risk for additional decision rule derivation. Another critical point is that, given the rapid progression of CT imaging and reformatting technology, use of the 16-slice CT in the study is not the newest technology and might not adequately reflect current tertiary trauma practice in many centers, where 64-, 128-, and 320-slice CTs are currently being used.

Another critical methodological question readers must ask is whether the reproducibility of the tests results and their interpretation will be satisfactory in their own practice setting. In this case, this is a "loaded" 2-part question. Any institution possessing a 16-slice CT scanner and a contemporary standards MRI machine would be expected to generate similar diagnostic images using the standardized protocols that have been adequately described in the article. The relevance of these results is extremely controversial and subject to interpretation. The majority of MRI findings that were not seen on CT imaging were subtle and required only prolonged treatment in a collar, and none were assessed in terms of mechanical stability using additional investigations, such as flexion-extension imaging. In addition, the actual indications and rationale for designating these findings as significant or for operative intervention are also not described. These uncertainties or even controversies limit the bedside translation of these study findings.

The implications of this study in clinical practice remain highly contentious. Although management was changed in 7.9% of patients based on positive findings of MRI after a negative CT, this management was seemingly arbitrary and essentially uncontrolled. Results of this study reveal that an MRI performed 10 days after serious blunt trauma will reveal radiological findings not suspected on a 16-slice CT scan of the neck, but the clinical significance of them is uncertain. The study does not provide additional guidance to practitioners about the importance of these new radiological findings or how to best manage patients. If MRI screening of all patients to clear the cervical spine was accepted, there are a number of considerations, including cost, logistics, and what to recommend for patients in whom MRI is contraindicated. In addition, delays in cervical spine clearance are associated with additional nursing support for log rolling, as well as potentially fatal complications related to prolonged immobilization, including increased risk of decubiti ulcers, ventilator-associated pneumonia, venous thromboembolism, and difficulty in managing the airway if these patients require reintubation. It is possible that routine use of MRI can be detrimental to the patient because of the infrequency of abnormal findings on MRI.

Overall, the authors' conclusions were 5-fold:

1. CT scan continues to miss both stable and unstable cervical spine injuries in unreliable patients;
2. Optimal cervical spine clearance algorithm remains unanswered;
3. MRI imaging continues to be necessary;
4. Any MRI abnormality requires neurosurgical or orthopaedic assessment, as neurological deficits should be presumed; and
5. Additional continued studies are required. As the primary clinical question posed was whether MRI would detect additional findings that were not detected on CT scan, they have addressed the initial question and have provided evidence to the effect that a 16-slice CT scanner will not detect all radiological findings after blunt trauma that will be detected by MRI. They leave clinicians uncertain as to 3 of their conclusions, however. The reader cannot further elucidate the meaning of stable versus unstable in this population. With this under-

standing, the uncertainty about optimal clearance protocol and the need for additional study are self-evident, and the need for neurosurgical and orthopaedic involvement in these findings, or the continued need for routine MRI scanning, remain conjecture. Although the article by Menaker and colleagues has identified a potential blind spot in our diagnostic imaging armamentarium, it has not resolved any of the controversies related to cervical spine clearance. In fact, the authors might have added more "fuel to the fire" in an area that requires precise test characteristic evaluation corroborated by comprehensive and long-term outcomes. To provide these data will require additional well-designed large studies.

THE EVIDENCE-BASED REVIEWS IN SURGERY GROUP COMPRISES: