



Original Contribution

Femur fractures should not be considered distracting injuries for cervical spine assessment☆



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ARTICLE INFO

Article history:

Received 10 October 2014

Received in revised form 7 August 2015

Accepted 7 August 2015

ABSTRACT

Introduction: The National Emergency X-Radiography Utilization Study (NEXUS) clinical decision rule is extremely sensitive for clearance of cervical spine (C-spine) injury in blunt trauma patients with distracting injuries.

Objectives: We sought to determine whether the NEXUS criteria would maintain sensitivity for blunt trauma patients when femur fractures were not considered a distracting injury and an absolute indication for diagnostic imaging.

Methods: We retrospectively analyzed blunt trauma patients with at least 1 femur fracture who presented to our emergency department as trauma activations from 2009 to 2011 and underwent C-spine injury evaluation. Presence of C-spine injury requiring surgical intervention was evaluated.

Results: Of 566 trauma patients included, 77 (13.6%) were younger than 18 years. Cervical spine injury was diagnosed in 53 (9.4%) of 566. A total of 241 patients (42.6%) had positive NEXUS findings in addition to distracting injury; 51 (21.2%) of these had C-spine injuries. Of 325 patients (57.4%) with femur fractures who were otherwise NEXUS negative, only 2 (0.6%) had C-spine injuries (95% confidence interval [CI], 0.2%–2.2%); both were stable and required no operative intervention. Use of NEXUS criteria, excluding femur fracture as an indication for imaging, detected all significant injuries with a sensitivity for any C-spine injury of 96.2% (95% CI, 85.9%–99.3%) and negative predictive value of 99.4% (95% CI, 97.6%–99.9%).

Conclusions: In our patient population, all significant C-spine injuries were identified by NEXUS criteria without considering the femur fracture a distracting injury and indication for computed tomographic imaging. Reconsidering femur fracture in this context may decrease radiation exposure and health care expenditure with little risk of missed diagnoses.

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1. Introduction

Cervical spine (C-spine) injury after trauma carries great morbidity, with a subsequent lifetime cost of care often in excess of US \$1 000 000 per affected patient [1]. Furthermore, a missed or delayed diagnosis of C-spine injury results in up to 10 times the rate of neurologic injury, with 29.4% of these cases resulting in permanent neurologic deficit [2]. Missed or delayed diagnoses have been attributed commonly to inadequate or misinterpreted radiographic evaluation [3]. A 2006 review of 367 spinal injuries described a 4.9% incidence of delayed or missed diagnosis [4]. Ample literature highlights why C-spine injuries are addressed in a conservative manner.

The cost and radiation effect associated with computed tomographic (CT) imaging has called for a more judicious use of the technology.

A recent analysis noted a cost of greater than US \$50 000 per quality-adjusted life-year for populations with a fracture incidence of less than 2.8% and called into question the cost-effectiveness of “blanket” CT scanning [5]. In addition, recent studies have brought radiation consequences into consideration. Muchow et al [6] described in 2012 an estimated median excess relative risk of thyroid cancer after 1 CT scan of the C-spine in pediatric patients at 13% for men and 25% for women. Fortunately, a large body of literature suggests a high degree of utility of clinical examination for C-spine injury [7–10], mitigating the need for radiographic analysis.

The National Emergency X-Radiography Utilization Study (NEXUS) clinical decision rule (CDR) is widely used to exclude C-spine injury in blunt trauma patients and thereby avoid unnecessary imaging and the associated expense and radiation risk. As originally described, the NEXUS guidelines suggest cervical radiography for blunt trauma patients with any of the following high-risk criteria: (1) a focal neurologic deficit, (2) midline C-spine tenderness on examination, (3) altered level of consciousness, (4) intoxication, and (5) presence of distracting injury. According to the criteria, “distracting injury” includes any or all of the following: (1) a long bone fracture; (2) a visceral injury requiring surgical consultation; (3) a large laceration, degloving injury, or crush injury;

☆ The authors declare no source of funding for this study.

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(4) large burns; or (5) any other injury producing acute functional impairment or another injury determined based on clinician gestalt to be potentially distracting. Despite the vague elements of the distracting injury criteria, the interobserver reliability for the rule was acceptable in the trial (κ , 0.73), and the NEXUS CDR has subsequently grown into widespread use [11,12].

The distracting injury criteria, however, have been the subject of much debate. In the original series, these criteria were the indication for more than 30% of all cervical radiography tests. This CDR is based scientifically on the counterirritation phenomenon of pain, which suggests that the perception of pain can be altered by other noxious neurologic stimuli, if present simultaneously [13,14]. Studies have long shown that the counterirritation effect is correlated to the proximity as well as the amplitude of stimulus [15]. Recent published literature suggests that upper torso injuries may have a greater effect than lower extremity injuries on sensory inhibition of C-spine tenderness [11]; however, this effect has not been scientifically quantified nor fully explained, and studies have shown conflicting results, depending on the type of stimulus [14].

Research has been conducted to further qualify the need for imaging in the presence of distracting injury. Currently, conflicting data exist. A 2001 study that assessed the performance of each individual NEXUS criterion found that 39 patients with C-spine column injury met only the distracting injury criteria. This suggests an unacceptably low CDR sensitivity (93.5%) if the distracting injury criteria are removed [16]. In contrast, a 2005 investigation reviewing 4698 patients found that only 2.4% of patients with only distracting injury as an indication for imaging had spinal fractures, with only 1 injury being cervical and none requiring operative intervention. The investigators also evaluated the type of distracting injury and found only bony fractures (such as femur fracture) to impact the sensitivity of clinical screening [17]. Further evidence has mounted to suggest minimal impact of distracting injury on cervical examination, with Rose et al [18] demonstrating a sensitivity and negative predictive value greater than 99% for the NEXUS criteria in patients with distracting injuries.

Insufficient literature exists to evaluate the ability of the NEXUS criteria to safely evaluate C-spine injury in the scenario of a lower extremity fracture requiring operative intervention. In patients with a femur fracture, the rate of C-spine injury can be as high as 10%, and treatment of femur fractures generally requires endotracheal intubation and operative intervention [2]. Given the importance of bony fractures, in particular, on cervical neck examination, our objective was to determine whether the NEXUS criteria would maintain sensitivity for blunt trauma patients with femur fractures if the fracture is not considered a distracting injury and an absolute indication for diagnostic imaging.

2. Methods

2.1. Study population

This retrospective study was conducted for consecutive adult and pediatric patients presenting to the emergency department (ED) of a large, level I trauma center in the southeastern United States between 2009 and 2011. All patients included in the study were consecutive trauma activations after blunt trauma who were evaluated for C-spine injury with imaging and who also had at least 1 femur fracture. Patients with additional potentially distracting injuries were included in the study.

Patients were included only if a complete documented examination was performed sufficiently to include all of the NEXUS criteria before any imaging obtained. Patients were excluded upon (1) death before imaging, (2) transferal from another hospital without documented examinations before imaging, or (3) involvement in low-mechanism trauma (falls from standing or injuries sustained from contact sports) with no apparent clinical or radiographic evaluation for cervical injury. Pediatric patients were included in this study as in the original NEXUS

validation study. To date, the proportion of pediatric patients included in such studies are low (2.5% age 8 years or younger in NEXUS). In addition, spinal cord injury without radiographic abnormality can go undetected with CT or x-ray imaging alone. For this reason, although the NEXUS criteria can be assessed and used in this population, a conservative approach is taken at our institution that consists of C-spine immobilization and serial examinations as adjuncts to radiographic evaluation.

The primary end point was the presence of C-spine injury requiring operative intervention. The study population, methods, and protocol were reviewed and approved by the institutional review board of our institution. Because of the retrospective nature of the study and data handling and protections undertaken, patient consent was waived.

2.2. Evaluation

Patients arrived to the ED in spinal immobilization per prehospital provider protocols and subsequently underwent clinical evaluation. Patient evaluations were documented by either surgical or emergency medicine residents or attending physicians. Results of these evaluations were examined on review of the electronic medical record (CERNER PowerNote). Pertinent data reviewed included all of the NEXUS criteria: (1) any evidence of deficit on neurologic examination, (2) presence or absence of midline C-spine tenderness on examination, (3) evidence of altered level of consciousness, (4) evidence of drug or alcohol intoxication, and (5) presence of distracting injury. All subsequent radiographic images were also reviewed for each patient, with interpretations provided by board-certified radiologists.

2.3. Outcome measures

The primary outcome was any C-spine injury requiring operative intervention. For patients who did not require operative intervention, other interventions that were prescribed (eg, cervical collar) were gathered and recorded.

2.4. Data collection

Methodological strategies were used in accordance with the recommendations of Gilbert et al [19] to enhance validity, reproducibility, and overall quality of data collected from the ED medical records and the institution-based trauma database by 2 abstractors (HD and AR). The abstractors were trained in data collection and supervised by the primary investigator (RS) to ensure accuracy of data collection. Precisely defined variables were used to collect data; these included patient demographics, including age and sex; prehospital and ED Glasgow Coma Scale score; presence or absence of intoxication, including blood ethanol levels; ED vital signs; method of prehospital spine immobilization; result of physical examination that included the C-spine; type of radiography performed and results; ultimate disposition; and neurosurgical or orthopedic spine treatment (if applicable). Interrater reliability was 100% as determined by comparison of a subsample (10%) of charts abstracted by both researchers.

2.5. Statistical analysis

Data were compiled into a spreadsheet (Microsoft Office Excel 2003; Microsoft Corporation, Redmond, WA) and were subsequently analyzed using standard statistical methods; $P < .05$ was considered to be statistically significant. Descriptive statistics including mean \pm SDs, counts, and percentages were used to describe the study population on all variables, and 95% confidence intervals (CIs) were calculated to further describe sensitivities, specificities, and all predictive value calculations. Comparisons of statistical performance were made between our study and the original NEXUS validation trial using Fisher exact test. The SAS System version 8.02 (Cary, NC) was used to complete all statistical analyses.

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