



Yield of computed tomography of the cervical spine in cases of simple assault



Matthew L. Uriell^{a,b}, Jason W. Allen^{a,b,c}, Brendan P. Lovasik^{a,d}, Marc D. Benayoun^{a,b}, Robert M. Spandorfer^a, Chad A. Holder^{a,b,*}

^a Emory University School of Medicine, Atlanta, GA, United States

^b Department of Radiology and Imaging Sciences, Emory University, Atlanta, GA, United States

^c Department of Neurology, Emory University, Atlanta, GA, United States

^d Department of Surgery, Emory University, Atlanta, GA, United States

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ABSTRACT

Background: Computed tomography (CT) of the cervical spine (C-spine) is routinely ordered for low-impact, non-penetrating or “simple” assault at our institution and others. Common clinical decision tools for C-spine imaging in the setting of trauma include the National Emergency X-Radiography Utilization Study (NEXUS) and the Canadian Cervical Spine Rule for Radiography (CCR). While NEXUS and CCR have served to decrease the amount of unnecessary imaging of the C-spine, overutilization of CT is still of concern.

Methods: A retrospective, cross-sectional study was performed of the electronic medical record (EMR) database at an urban, Level I Trauma Center over a 6-month period for patients receiving a C-spine CT. The primary outcome of interest was prevalence of cervical spine fracture. Secondary outcomes of interest included appropriateness of C-spine imaging after retrospective application of NEXUS and CCR. The hypothesis was that fracture rates within this patient population would be extremely low.

Results: No C-spine fractures were identified in the 460 patients who met inclusion criteria. Approximately 29% of patients did not warrant imaging by CCR, and 25% by NEXUS. Of note, approximately 44% of patients were indeterminate for whether imaging was warranted by CCR, with the most common reason being lack of assessment for active neck rotation.

Conclusions: Cervical spine CT is overutilized in the setting of simple assault, despite established clinical decision rules. With no fractures identified regardless of other factors, the likelihood that a CT of the cervical spine will identify clinically significant findings in the setting of “simple” assault is extremely low, approaching zero. At minimum, adherence to CCR and NEXUS within this patient population would serve to reduce both imaging costs and population radiation dose exposure.

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Introduction

It has been estimated that over 819,000 patients per year are evaluated for potential cervical spine injury in emergency departments (ED) across the United States [1]. The overall ED visit volume has also been projected to increase approximately 2% per year, making efficient evaluation of this population essential

[2–4]. The use of medical imaging to evaluate patients in an ED setting is additionally increasing at a disproportionately higher rate than imaging in other settings [5,6], in particular computed tomography (CT) and magnetic resonance imaging (MRI), which have increased more than 330% between 1998 and 2007 [7–10]. Although C-spine radiographs are still utilized in certain circumstances, CT has been demonstrated to be a more efficient and accurate modality than plain radiography for identifying cervical spine fractures [11,12] and thus has emerged as the imaging modality of choice in the ED for cervical spine evaluation following trauma.

Despite the potential clinical importance of identifying cervical spine injuries, the actual incidence of cervical spine fractures has been reported to be extremely low, up to 0.6%, in the setting of low impact “simple” assault [13–15], yet determination of the

* Corresponding author at: Department of Radiology and Imaging Sciences, Emory University Hospital, 1364 Clifton Road NE, BG22, Atlanta, GA 30322, United States.

E-mail addresses: muriell@emory.edu (M.L. Uriell), jason.w.allen@emory.edu (J.W. Allen), brendan.p.lovasik@emory.edu (B.P. Lovasik), marc.benayoun@emory.edu (M.D. Benayoun), robert.spandorfer@emory.edu (R.M. Spandorfer), cholder@emory.edu (C.A. Holder).

circumstances under which these patients should be evaluated further with CT imaging remains unclear, and these patients continue to be imaged. Multiple approaches have been suggested to reduce or eliminate unwarranted imaging for this patient population subset. Some suggest that victims of blunt assault be evaluated only using plain radiographs [16]. Others have found that assault only resulted in cervical spine fractures if there was a direct blow to the neck [14] or if the assault involved a ground level fall [13]. While these all represent important efforts toward better allocation of hospital imaging resources and more targeted patient-care, a more comprehensive analysis of the clinical circumstances under which C-spine CT studies are indicated in this demographic subset is needed.

The National Emergency X-Radiography Utilization Study (NEXUS) [17] and the Canadian Cervical Spine Prediction Rule (CCR) [18] are clinical guidelines developed to provide a specific set of criteria to define when cervical spine imaging is required in the setting of trauma, although not specifically in the setting of simple assault. While both clinical rules have high sensitivity in the detection of cervical spine fracture (NEXUS 99.6%, CCR 100%), CCR has been proposed by some to be the superior model [19]. Since the widespread implementation of these rules, there have been reports of decreases in the number of unnecessary CT scans, including in trauma and ED settings [20,21] resulting in increased per-scan effectiveness [22]; however, anecdotal experience suggests that CT of the cervical spine is still overutilized in this setting.

While the development of NEXUS and CCR has helped to decrease the number of unnecessary C-spine CT scans, it has been estimated that up to 73% of alert, stable adults presenting with possible spinal injury still undergo C-spine CT imaging [23]. Thus, it can be inferred that consistent full application of these clinical decision-making rules has not yet occurred. In addition, questions have been raised about whether these rules can be applied to patients suffering blunt trauma [24,25], and there is a relative lack of information specifically regarding the application of NEXUS and CCR to patients following “simple” non-penetrating assault. Since assaults account for approximately 15% of patients assessed for spinal cord injuries annually [26], these patients represent an important demographic to test the applicability of these guidelines. Furthermore, given the low reported fracture rate and high volume of patients screened for injury, there is potential for overuse of imaging resources and excess radiation exposure. Thus, a more comprehensive analysis of when CT studies are indicated in this specific patient subset is necessary, as this could be easily applied to everyday practice in the ED, resulting in savings of time, financial costs, and radiation exposure.

Within the context of simple assault, the presence of a cervical spine fracture was the primary outcome of interest. We hypothesized that the incidence of cervical spine fracture would be extremely low in cases of simple assault. Secondary outcomes of interest were appropriateness of radiological imaging based on the retrospective application of NEXUS and CCR clinical decision rules.

Patients and methods

Study design

With institutional review board (IRB) approval, a retrospective, cross-sectional review was undertaken of the electronic medical record (EMR) database at a large, high-volume, urban Level I Trauma Center over a 6-month period from March 1, 2014 through August 31, 2014 for patients who had undergone cervical spine CT imaging for the clinical indications of trauma, assault, and/or fall. Imaging studies were performed at the discretion of the ED and/or Trauma team.

Study population

Patient consent was waived for all included patients at the time of IRB approval. Inclusion criteria were ED patients with a documented history of assault with non-penetrating weaponry (such as hands, fists, feet, sticks/clubs, and/or bottles) by one or more individuals, hereafter defined as “simple” assault, and age greater than or equal to 16 years. The age of greater than or equal to 16 years was used as an inclusion criterion based on CCR guidelines [18]. Clinical circumstances including axial loading to spine (defined as high impact force to the vertex with axial transmission of force through the cervical spine, such as a diving type injury or injury associated with a “pile-driver” wrestling maneuver), fall/push from height greater than 3 ft/5 steps, motor vehicle collision, pedestrian versus automobile, and bicycle accident were excluded as these were considered high-risk mechanisms for cervical spine injury by CCR [18], as well as not fitting our definition for simple assault. Penetrating wounds (gun shot or stab) were also excluded, given the potential for high-risk mechanism depending on the location of injury, and also did not fit our definition of simple assault. Lastly, being “found down” at the scene with unknown etiology was excluded given that any mechanism of injury could have preceded this circumstance.

Study protocol/measurements

The EMR of each of the 3753 patients was reviewed by one of 4 independent coders that adhered to an agreed upon search pattern with measurements of interest predominantly taken from the original ED encounter; however, subsequent notes, including surgical consult notes, were reviewed if the original ED encounter was incomplete. All data for patients not meeting the above mentioned inclusion criteria was excluded. Demographic factors (age and gender), clinical factors (presence of ground level fall, neck pain, delayed onset neck pain, tenderness to cervical spine palpation, ambulatory status, patient upright in emergency department, focal neurologic deficit including weakness and paresthesias, distracting injury, intoxication, and altered mental status), known pre-existing vertebral risk factors that would predispose the patient to fractures (ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis, osteopenia, and prior cervical spine surgery), and radiologic features (any cervical spine fracture, isolated spinous process fracture, isolated transverse process fracture, maxillofacial fracture, and associated intracranial trauma) were coded as either absent, present, or unknown.

CT studies were performed on GE VCT 64 slice and Phillips Brilliance 16 slice helical CT scanners in the Emergency Department including thin section axial (spiral/helical acquisition) images and multiplanar (sagittal and coronal) reformatted images. All studies were interpreted by board-certified radiologists at the time of the imaging study.

Data analysis

Analysis of data was performed using MATLAB 2015a with statistics and Machine Learning Toolbox (Mathworks, Mass.).

Results

Characteristics of study subjects

During the six-month study period, 3753 patients underwent CT evaluation for cervical spine injury of any cause. Of these patients, 460 patients met the inclusion criteria, with a mean age of 38.8 years old (range 16–76 years) with 80.2% (n = 369) males and

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