DEM Journal Club

Article Appraisal

Article: Defining the cervical spine clearance algorithm
T. M. Duane, A. J. Young, P. Vanguri, L. G. Wolfe, J. Katzen, J. Han, J. Mayglothling, J. F. Whelan, M. B. Aboutanos, R. R. Ivatury, and A. K. Malhotra, "Defining the cervical spine clearance algorithm," J. Trauma Acute Care Surg., vol. 81, no. 3, pp. 541–547, June 2016.

Date of Journal Club: May 4, 2017

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Background and Study Objective(s):

The intent of this study was to create an evidence-based, easily adoptable algorithm for clearance of the cervical spine (c-spine) after significant blunt trauma, specifically with regards to ligamentous injury of the c-spine. For adult patients with blunt trauma qualifying for Trauma Team Alert (TTA), which patients are low risk for ligamentous injury? The authors set out to identify a short list of risk factors and incorporate these into a suggested algorithm for c-spine collar removal for clinicians.

As a baseline, the authors accept CT of the c-spine as the gold standard for identification of a fracture. This is the first step for every patient in their cohort. The question that follows is: "Of major trauma patients without a significant cervical spine fracture or evidence of ligamentous injury on high quality CT scan, who requires an MRI?"

Study Design:

Over a 6-year period (2008-2014), patients over 18 years of age who qualified for TTA by the 2012 CDC Field Triage recommendations for a blunt trauma presenting to Virginia Commonwealth University (VCU) Medical Center were prospectively recruited. All patients underwent a cervical CT scan as standard of care. In total, 9,227 prospectively recruited TTA patients were included. A review of the trauma registry between 2009 and 2013 showed that of patients eligible for recruitment 3,083 were missed on initial study recruitment, and the populations were retrospectively compared to assess for differences and sources of bias.

The prospective cohort data was collected on the following variables: midline tenderness, GCS, intoxication, age, paresthesias, focal deficits, head load mechanism, type of motor vehicle collision (MVC), if ever sitting up in the ED, if non-ambulatory.

The studied population was 64% male, with an average age of 39, presenting after predominately MVC's, falls, motorcycle collisions, or pedestrian-struck events. The average GCS was reported as 14.3, SBP 140, HR 90 and RR 18.

The authors defined a negative CT as high quality images, without motion artefact, with no fracture and no ligament injury identified by an attending radiologist, and a positive CT as identification of a fracture or injury, or the inability to exclude a fracture or injury. A logistic regression was performed by stepwise selection and a preliminary data analysis took place. The CT results were subsequently forced into the model during the logistic regression and a final data analysis was performed.

Patient variables for those with any c-spine injury, fracture and ligament injury, and ligament injury alone were compared. Follow up was attempted for all patients within 4 weeks of discharge, using telephonic follow-up, scanning of electronic records, and contact with other physicians.

Results:

A key finding, taking into account a large number lost to follow-up, is that the incidence of unstable ligamentous injury in patients with a negative CT c-spine was nil. The sensitivity of CT for any c-spine injury, whether fracture and/or ligamentous, was 100%, with a specificity of 99.93%, a PPV of 98.93, and a NPV of 100, allowing for the conclusion that CT c-spine is an excellent modality for picking up injury as a first step in the algorithm. Of the variables on which data was collected no independent risk factors of ligamentous injury alone were identified in initial logistic regression. When the study's CT findings were forced into their logistic regression model the five greatest predictors of ligament injury were found to be: (1) CT evidence of ligament injury, (2) fracture pattern other than "isolated transverse process/spinous process," (3) neurologic symptoms, (4) midline tenderness, and (5) GCS < 15.

Using a 95% confidence interval these predictors were reported with an area under the receiver operating characteristic curve (AUROC) of 0.98 for ligament injury in the entire study population, 0.86 for those with positive CT findings, and 0.68 for those with isolated TP/SP and CT negative. Given these findings, the authors propose the "Evidence-based c-spine clearance algorithm after blunt trauma to rule out injury," as depicted in Figure 1.

Validity of Results:

The use of prospective cohort methodology and large number of recruited patients makes this study likely as valid as possible for trauma research on this topic. Nonetheless, there are some concerns with regards to missing patients, patients lost to follow-up, and potential areas of bias. The authors did not report the number patients who did not meet criteria of "high quality image with no motion artifact." Furthermore, no comment was made regarding the experience of the attending radiologist, whether a trainee read the images first, or if any patients had multiple attending radiologist reads, with any injuries that were missed initially. Of note, GCS is commonly considered an ordinal data set and thus a mean should not be calculated. The reported average GCS of 14.3 is difficult to interpret as level of consciousness impacts the ability to assess the other risk factors. Here, it may have been more meaningful if reported as the number of patients with GCS < 13 or >14, a median, or as interquartile ranges.

Approximately 3000 patients were missed in prospective recruitment and found on retrospective review of the trauma registry. While the authors comment that this missed population was largely the same in demographics and outcomes, they in fact were not included in the statistical analysis used to derive the final algorithm. There may have been undetected injuries that were lost to follow up as the follow up protocol used in this study (reference 12) reveals some follow up concerns. However, the authors felt that their follow up was good, and the authors further state that all patients who had persistent tenderness at 2 weeks or a GCS <15 went on to receive a follow up MRI.

Generalizability of Results:

Despite having a strong recruitment strategy, the use of a single institution inherently limits the generalizability of the study's findings. The VCU Medical Center sees a largely uninsured, young, African American population and a high level of trauma. This differs from the settings in Vancouver. Furthermore, the suggested algorithm hinges on the CT result, and as such, the experience level of the radiologists is paramount. The VCU medical centre had radiologists with extensive experience in trauma radiology, and these results may not be generalizable to preliminary, or resident level radiology reports.

The Bottom Line:

Based on all of the above, the authors propose that the collar be removed in all patients with a negative CT because the incidence of a meaningful ligamentous injury is so low. There seems to be robust evidence to support that this is safe, assuming confidence in the CT report. In patients with an isolated TP/SP fracture pattern and a negative CT the authors suggest moving forward with a C-spine MRI in patients with GCS persistently less than 15, or focal deficits/paresthesias. Patients with persistent midline tenderness can be followed clinically with a collar, and re-assessed for collar removal after two weeks, and those without mid-line tenderness or neurological findings can simply have their collar removed in the ED. All patients with any fracture pattern other than isolated TP/SP should have a C-spine MRI to further assess ligamentous injury. Effectively, sustaining a clinically significant or unstable ligament injury without having any abnormality on a CT is exceedingly rare, and thus even in the context of a TTA-level blunt trauma, this study provides good evidence that if the CT is normal, take the collar off.