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A pediatric cervical spine clearance protocol to reduce radiation exposure in children

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ABSTRACT

Background: To minimize radiation exposure in children and reduce resource use, we implemented an age-specific algorithm to evaluate cervical spine injuries at a Level 1 trauma center. The effects of protocol implementation on computed tomography (CT) use in children (≤ 10 y) were determined.

Methods: With institutional review board approval, we conducted a retrospective review using the institutional trauma registry. All pediatric patients (≤ 10 y) ($n = 324$) between January 2007 and present were reviewed. We excluded cases in which no imaging or outside imaging was performed. Patients were evaluated by physical exam alone, with the aid of plain radiograms or with cervical spine CT. All patients who required head CT also had CT of cervical spine to C3. We analyzed demographic, injury, and outcome data using STATA to perform chi-square and *t*-test, and to determine *P* value. $P < 0.05$ was defined as significant. We used the WinDose program to calculate the radiation-effective dose used in cervical spine CT.

Results: There were 123 and 124 patients in the pre-protocol and post-protocol groups, respectively. Demographics, GCS, and injury analysis, specifically head–neck and face Injury Severity Scores showed no significant difference between groups. There was a 60% ($P < 0.001$) decrease in the use of full CTs after protocol implementation. We estimated that the protocol reduced the exposed area by 50% and decreased the radiation dose to the thyroid by > 80%. We extrapolated the combined effect results in a threefold reduction in radiation exposure.

Conclusions: Implementation of a cervical spine protocol led to a significant reduction in radiation exposure among children.

1. Introduction

Pediatric cervical spine injuries are less common than adult cervical spine injuries and differ in the level of injury, type of injury, and outcomes [1–7]. Despite the differences, children are usually subjected to the same trauma workup as adult patients for pediatric spine clearance, which involves a complete cervical and upper thoracic spine computed tomography (CT) image. Computed tomography of the cervical spine exposes children to radiation. Studies have shown that this type of radiation exposure carries a higher relative risk for developing malignancy in the future [8–12].

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There has been increased awareness of the excessive and unnecessary use of CT imaging in the pediatric population group. However, many trauma centers continue to image the entire spine of children as part of the initial trauma workup. Although there is a need for standardized care to improve patient outcomes, many institutions do not use a protocol for clearing the cervical spine in the pediatric trauma patient [13]. Our goal was to minimize radiation exposure in children and reduce resource use by implementing an age-specific protocol to evaluate cervical spine injuries at our Level 1 trauma center. We determined the effects of this protocol implementation on CT use in children ($\leq$ 10 y).

2. Methods

We conducted an institutional review board–approved retrospective review using the University of Iowa Hospitals and Clinics trauma registry. We reviewed all pediatric trauma patients age 10 y and under, seen by the trauma service from January 2007 to August 2008 (pre-protocol) and from January 2009 to April 2011 (post-protocol). Patients seen between August 2008 and January of 2009 were excluded from the study because this was during the implementation phase of the protocol. We also excluded patients whose imaging was performed at other hospitals before transfer to our hospital. We enrolled into this study 157 patients in the pre-implementation protocol group and 167 patients in the post-implementation protocol group (n = 324). Chart review was performed to determine mode of cervical spine clearance; type of imaging used, if any; and patient specific demographic data. Data collected included age, sex, Pediatric Glasgow Coma Score (GCS), Injury Severity Score (ISS), and Abbreviated Injury Score of the head–neck and face. We excluded 74 cases in which no imaging or outside imaging was performed, and three cases in which magnetic resonance imaging was ordered after plain film. We used the STATA program (StataCorp LP; TX) to perform chi-square and t-test, and P value to determine significance. P values < 0.05 were defined as significant. We used the WinDose program (Institute of Medical Physics; Erlangen, Germany) to calculate the radiation effective dose used in cervical spine CT.

The pediatric cervical spine clearance protocol (Fig. 1) begins with assessing the patient's GCS and ability to communicate at a developmentally appropriate level. It also assesses the presence of neck pain, neurologic deficit, intoxication, and distracting injuries. If the GCS is 15 and none of the above findings are present, a patient can be cleared clinically. If the patient has GCS of $\leq$ 14 and positive findings in the initial survey, imaging is required. Anteroposterior and lateral plain films of the cervical spine are the imaging modalities of choice in age $\leq$ 10 y pediatric patients. Any patient who requires head CT could also obtain a CT of cervical spine from occiput to the C3 level in addition to plain films. A full cervical CT is not recommended for screening of any pediatric patient unless concern exists on plain film for an injury at multiple levels, or if the spine specialist teams requests one. In the event a patient has normal radiologic findings but continues to be symptomatic with cervical spine tenderness or decreased range of motion, magnetic resonance imaging could be ordered. If any abnormalities are found on imaging, the spine service is consulted. The Orthopedic, Neurosurgery, Radiology, and Surgery Departments at the University of Iowa Hospitals and Clinics approved this protocol.

2.1. *WinDose methods*

The expected dose reduction from decreasing the area of scanned was determined from radiation dose calculations

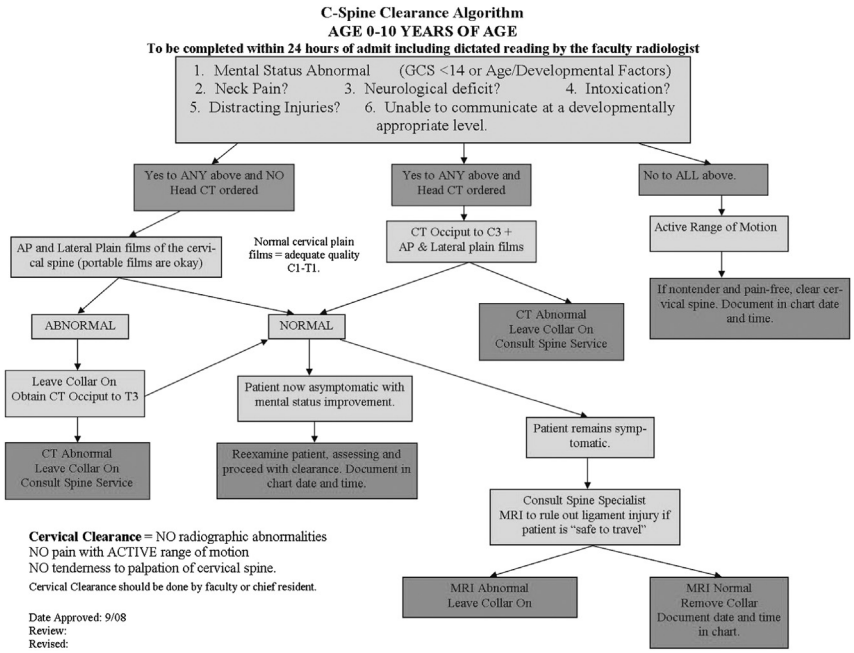

Fig. 1 – Cervical spine clearance algorithm for pediatric patients < 10 y of age.