



## Adherence to the guidelines of paediatric cervical spine clearance in a level I trauma centre: A single centre experience



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### ABSTRACT

**Introduction:** International guidelines define if and what type of radiography is advised in children to clear the cervical spine (C-spine). However, adherence to these guidelines has never been evaluated in a paediatric population. Therefore, we wanted to assess the adherence to the guidelines for C-spine clearance in a level-one trauma centre.

**Methods:** We retrospectively included all children, presented at the ED between January 2006 and December 2013, in whom radiographic imaging of the C-spine was obtained following blunt trauma. Primary outcome was the adherence to the international guidelines with regard to (1) if the indication for radiographic imaging was correct and (2) if the type of radiographic imaging was correct.

**Results:** Included were 573 patients; 336 boys (58.7%). Median age was 11 years (IQR 5.25–15). The indication for radiographic imaging was correct in all cases. The type of primary imaging modality was concordant with the guidelines in 99.7%. In 41% of the cases supplementary radiographs were made. The most common supplementary view was the odontoid. In 15% an incomplete set of radiographs was obtained.

**Conclusion:** The adherence to the international guidelines when to obtain radiographic imaging was 100%. However, in a large proportion of patients (56%), not the recommended number of radiographs was obtained.

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### 1. Introduction

The prevalence of cervical spine injury (CSI) in children following blunt trauma is approximately 1–2% [1,2]. Accurate diagnosis is of utmost importance since missed CSI may lead to morbidity and mortality [1,3]. Therefore international guidelines have been developed that describe when radiographic imaging is mandatory in children following blunt trauma, what type of radiographic imaging is necessary, and what number of radiographs is indicated [4–7].

International guidelines advise to obtain radiography in children that have midline cervical tenderness; focal neurological deficits; altered level of consciousness; evidence of intoxication; or if they have distracting injuries [4–7]. Additionally, some guidelines recommend radiographic imaging if patients had undergone a dangerous trauma mechanism or were not able actively to rotate the neck >45° [4,5,7]. The abovementioned items are included as high-risk criteria in the NEXUS-criteria and Canadian C-Spine Rules (CCR), which are clinical decision rules recommending when to obtain radiographic imaging in patients following blunt trauma [8,9]. Although these clinical decision rules have been developed for and validated in a predominantly adult population a combination of both clinical decisions rules is also used in children [4,5]. However, caution is advised in the employment of these decision rules in children under the age of 3 since there is no evidence about the accuracy of both clinical decision rules in this population [2,4].

In the international guidelines plain radiography of the cervical spine (C-spine) is recommended as primary imaging modality

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in almost all patients [4,5,7,10]. A lateral and an antero-posterior view is recommended for all age groups, whereas an odontoid view is indicated (open-mouth view) only for children of 8 years of age and older [4,5,7,11]. A CT-scan of the C-spine is recommended in case of inadequate conventional imaging, a fracture on plain radiography, or a clinical suspicion of CSI despite normal radiography [4–7]. A CT scan of the C-spine is mandatory when the patient either has neurological symptoms, is intubated, or has a Glasgow Coma Scale less than 13 at initial assessment [4–7]. However, a CT-scan of the C-spine in children should be performed with caution due to the increased excessive relative risk of thyroid cancer in children varying from 13 to 25% when compared to plain radiographs [12–15].

A MRI of the C-spine is recommended in children in whom plain radiography or CT-scans are equivocal, or when neurological or ligamentous injury is suspected [4,5,7]. Our hospital guideline is based on abovementioned guidelines.

Previous studies showed that adherence to the NEXUS criteria and CCR in adults varies widely [16–19]. However, there are no studies that describe the adherence to the cervical spine clearance protocol in children.

We hypothesized that in our hospital the adherence to the guidelines for clearance of the C-spine in children was not optimal and more imaging was obtained than necessary. Therefore, the aim of this study was to evaluate the adherence to the guidelines in a level-one trauma centre.

Primary outcome was the adherence to the international guidelines with regard to (1) if the indication for radiographic imaging was correct and (2) if the type of radiographic imaging was correct. Also the associated effective dose and the number of radiographs will be taken in consideration.

## 2. Materials & methods

### 2.1. Study population

A retrospective cohort study was performed in a combined adult and pediatric level-one university trauma centre with a paediatric surgery department. Included were all paediatric patients that presented at the ED between January 2006 and December 2013 in which radiographic imaging of the C-spine was obtained following blunt trauma. Patients older than 18 years of age, and patients suspected of CSI not caused by blunt accidental trauma (e.g., suffocation trauma, penetrating trauma, non-accidental trauma) were excluded. Patients who were transferred to our hospital after initial CSI clearance at another hospital were also excluded. Patients revisiting the ED during the study interval, with renewed blunt trauma, were regarded as separate cases. The electronic patient database was used to detect if patients were readmitted within 3 months after they were presented following blunt trauma. In our hospital retrospective patient record studies are part of a waiver from the Internal Review Board. Permission was therefore not requested.

### 2.2. Imaging guidelines

The guideline for CSI in children in our hospital is based on the international guidelines, and established through collaboration between the trauma- and radiology department. Radiographic imaging was obtained if patients meet one- or more high-risk criteria of the NEXUS criteria. Or if patients had undergone a dangerous trauma mechanism according to the CCR. The preferred primary imaging modality is plain radiography. A CT-scan of the C-spine was obtained in case of inadequate conventional imaging, a fracture on plain radiography, or a clinical suspicion of CSI despite normal radiography. A CT-scan of the C-spine was obtained as

primary imaging modality if patients had neurological symptoms, were intubated, or had a Glasgow Coma Scale less than 13 at initial assessment. MRI of the cervical spine was obtained if patients had a high suspicion for ligamentous injury. A flowchart of our guideline is shown in Fig. 1.

All CT-scans of the C-spine were obtained with a sliding gantry Siemens Sensation 64 multislice CT-scanner (Siemens Medical Systems, Erlangen, Germany).

MRI examinations were obtained on a 1.5-T MR imager (Magnetom Avanto 1.5T, Siemens Medical Systems, Forchheim, Germany).

Patients were divided in two groups; children younger than 8 years and children from 8 years and older. The reason for this categorization is that children between 8 and 18 years display different patterns of injury than children younger than 8 years of age [2].

### 2.3. Definitions

CSI was defined as any fracture or dislocation of the C-spine. A fracture was defined as a disruption/bulging of at least one of the cortices or an osseous avulsion.

A complete set of plain radiographs of the C-spine was defined of two- or three images (depending on age; lateral, antero-posterior in all patients, and in children above the age of 8 an additional odontoid view) [4,5,7]. Consequently, we regarded any additional image as superfluous. A complete set of plain radiography was considered as incomplete if less than 3 views were obtained in children older than 8 years of age. Consequently, when an odontoid view was obtained in children younger than 8 years this was judged as unnecessary imaging.

Plain radiography was scored inadequate if the complete area of interest was not visualized properly, e.g. if the lateral view did not display the top of Th1, or if the odontoid view did not visualize the lateral processes of C1 and C2 [20,21].

A dangerous trauma mechanism was, conform the CCR, considered to be a fall from height ( $\geq 3$  feet or  $\geq 5$  stair threads); an axial load to the head; a motor vehicle collision at high speed ( $> 100$  km/hr), or with rollover or ejection; a collision involving a motorized recreational vehicle; or a bicycle collision [9].

### 2.4. Outcome

Primary outcome was the adherence to the international guidelines with regard to (1) if the indication for radiographic imaging was correct and (2) if the type of radiographic imaging (plain radiography, CT, MRI) and the amount of radiographs used to assess the patient was correct.

Adherence to the guidelines with regard to the indication for radiographic imaging was defined positive if:

- Patients met one of the high-risk criteria from the NEXUS criteria before radiographic imaging was obtained or if patients had undergone a dangerous trauma mechanism.

Adherence to the guidelines with regard to the type of radiographic imaging (plain radiography, CT, MRI) and the amount of radiographs used to assess the patient, was defined positive if:

- The choice of primary imaging modality was plain radiography, or a CT scan if patients had neurological symptoms, were intubated, or had a Glasgow Coma Scale less than 13 at initial assessment. And if:
- The complete set of radiographs consisted of two- or three images depending on age (lateral, antero-posterior in all patients, and in children above the age of 8 also an odontoid view).

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