

ORIGINAL ARTICLE

Cervical spine injuries to children under 11: should we use radiography more selectively in their initial assessment?

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Objectives: To assess the effectiveness of cervical spine radiography in injured children under 11 years old, and suggest improvements.

Methods: Retrospective survey of radiographs and accident and emergency records for children examined during a one year period in a large teaching hospital.

Results: No cervical spine fractures occurred in this age group during the year. The recorded clinical findings did not always justify radiography.

Conclusions: Clinical examination appears undervalued by those assessing injured children and is poorly recorded. Radiography can be used more selectively. Initial assessment using a single lateral projection can be followed in doubtful cases by cross sectional imaging.

Cervical spine fractures are rare in children, but can paralyse and kill. Considerable force is needed to fracture the cervical spine, and most fractures in this age group result from road accidents and falls. The great flexibility of the neck in children allows the spinal cord to be damaged without spinal fracture, in spinal cord injury without radiographic abnormality (SCIWORA). Children under 11 years old have been identified as a group in which cervical spine fractures are particularly rare, but in which subluxations and dislocations of the upper cervical spine are more common than in older children.¹

Guidelines on seriously injured patients prescribe a lateral radiograph of the cervical spine as part of the primary survey.² Other children with suspected cervical spine injury have traditionally been investigated with three initial radiographic projections (fig 1A–C), including anteroposterior (AP) and open mouth odontoid (peg) projections, and this has been the practice in our own hospital. There has long been concern that too many children are subjected to unnecessary radiography. There are conflicting opinions on how many radiographs are appropriate. Some authors continue to advocate that at least three projections are necessary.³ Others have suggested that the AP projection can be dropped from the initial imaging sequence,⁴ and that the peg projection is of little value in young children.^{5,6}

No cervical spine fractures were found in children under 11 presenting to our hospital in 1996. We therefore undertook a retrospective review of all the cervical spine radiography undertaken during 1997 in this age group. The aim was to identify whether any fractures had occurred, whether the radiographs had been justified by the clinical findings, and whether there was scope for reducing the amount of radiography in these patients without missing fractures.

METHODS

The study was based in a teaching hospital that is a tertiary referral centre for paediatric surgery and neurosurgery. Its children's accident and emergency (A&E) department saw 30 433 children under 11 years old in 1997. Its spinal unit



Figure 1 Three radiographic projections of the cervical spine: (A) lateral, (B) anteroposterior, and (C) open mouth odontoid (peg) projections.

Table 1 Mechanisms of injury in 76 children. Numbers (percentages) of children in each category

Road accidents	30 (39)
pedestrian	15 (20)
cyclist	9 (12)
rear seat passenger, restrained	4 (5)
rear seat passenger, unrestrained	2 (3)
Falls	28 (37)
under 2 metres	10 (13)
2 metres or more	7 (9)
unspecified height	11 (14)
Other causes	18 (24)
direct blow	6 (8)
sports injury	6 (8)
spontaneous neck pain	2 (3)
other	4 (5)

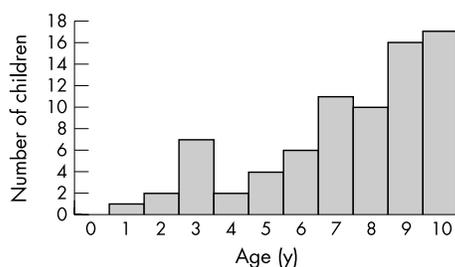
admits patients from all the health authorities in our region, which had a population of 717 928 children under 11 years old in 1997 (mid-year estimate). In a retrospective survey, all cervical spine radiographs requested for children under 11 during 1997 were identified from the radiology information system: 286 series of films had been requested for 169 boys (59%) and 117 girls. Of these, 242 (85%) were requests from A&E. Of the 286 film series, 211 were traced and reviewed for adequacy and the number of repeat attempts by a radiologist, together with the original reports. For a further 67 series we reviewed a radiologist's report only. In eight cases neither images nor report were available, and we checked for any subsequent hospital visits or admissions.

We also made inquiries of the spinal unit about whether any children in this age group had presented with spinal fractures during the study period, and inquired of the local pathologists whether any fractures had been detected at necropsy.

We analysed the A&E case notes for a sample of the same patients. Every third patient was sampled from an alphabetical list, 84 sets of notes were located, and adequate data were available in 76 of these. There were 49 boys (64%) and 27 girls. Details of the history and clinical examination of these children were extracted from the case notes by an A&E specialist registrar (PH). Points of interest from the history included the mechanism of injury, spinal immobilisation measures (either prehospital or on arrival in A&E), neck pain and stiffness, neurological symptoms, neck wounds, and any other injuries. Examination findings of interest included bony tenderness in the neck, spasm, wounds, bruising, neurological deficit, and any injuries elsewhere. We also noted whether each child had been admitted to hospital after assessment in A&E.

RESULTS

No cervical spine fractures were found in children under 11 years old seen at this centre in 1997. Of the 211 film series

**Figure 2** Ages of the 76 children whose A&E case notes were reviewed.**Table 2** Findings on clinical assessment before radiography in 76 children. Numbers (percentages) of children in each category

Glasgow Coma Score	
13–15	47 (62)
9–12	0 (0)
3–8	1 (1)
not recorded	28 (37)
Neck pain	
present	40 (53)
absent	8 (11)
not recorded	28 (37)
Neck tenderness	
present	18 (24)
absent	17 (22)
not recorded	41 (54)
Neurological deficit	
present	0 (0)
absent	53 (70)
not recorded	23 (30)

reviewed, 154 (73%) involved attempts at three or more projections. Of the retained films, 11% were repeat attempts at the same projections, with 57 children (27%) undergoing one or more repeat attempts and a mean of 2.9 films per series. Lateral projections were included in 206 of the reviewed series, and rated adequate in 180 (83%), with 143 (70%) adequate at the first attempt and a mean of 1.2 lateral films per adequate series. No instance of spinal cord injury without radiographic abnormality (SCIWORA) was detected.

Fifty eight (76%) of our sample of children examined in A&E had been injured in road accidents or falls (table 1). In two thirds of the road accidents there had been an associated head injury. The median age of the children in our sample was 8 years and the interquartile range 6 to 9 years (fig 2). There was no record of any symptoms in 27 children (36%), although 21 of these were over 5 years old, so their age would not have prevented them from localising pain and reporting it.

Only one child had impairment of consciousness recorded with a Glasgow Coma Score of less than 13 (table 2). Although the Glasgow Coma Score was only recorded in 48 of 76 children (63%), the remainder were all either discharged home or admitted to a general paediatric ward, implying a normal level of consciousness. In nine children (12%), all over 5 years old, there was no record of any neck examination or neurological assessment before or after radiography. A further 14 children (18%), of whom 11 were over 5 years old, had only "no neurological deficit" recorded, suggesting that no examination of the neck took place before radiography. There was no record of examination for neck tenderness in a total of 41 children (54%). There were 44 children (58%) with injuries elsewhere.

Documentation of spinal immobilisation proved difficult to interpret. Thirty one children (41%) arrived at A&E with a hard collar already in place, with or without sandbags and tape. A further 10 had some form of immobilisation placed on arrival, usually at the point of triage.

After assessment in A&E, 26 children (34%) were admitted to hospital, of whom three were taken to the paediatric intensive care unit, and 23 to other paediatric wards.

DISCUSSION

This study examines an age group known to have a particularly low incidence of cervical spine fracture, and it is not surprising that no fractures were found. A number of previous studies have been based on analysing cases of fracture arising over periods of 40 years or more.¹ We reviewed instead the clinical assessment of children with suspected injury who

had radiographs taken, and tried to determine whether radiography was justified in each case. We found that in some cases radiographs had been obtained in preference to clinical examination, without justification. We could not explain inadequate clinical assessment on the grounds of age or impairment of consciousness.

As with all retrospective studies based on review of case notes, we could not always determine the full circumstances leading to the request for cervical spine radiography. Our study sample included only those children who had radiographs taken, so did not allow us to compare them with children for whom radiographs had not been requested.

Assessment of very young children, who are not able to cooperate with examination including formal neurological testing, presents a challenge. In the conscious child, much of the required information may be obtained by observation, for example of their posture and limb movements. Any abnormality of head posture in this group of patients must prompt appropriate investigation.

Immobilisation may be impractical and inappropriate in a resisting child. Although it is vital that prehospital and hospital staff recognise the potential for a cervical spine injury and immobilise the neck appropriately, medical staff can then be reluctant to assess the neck clinically before requesting radiography. A major distracting injury may indicate that the cervical spine should be imaged whatever the outcome of the clinical examination, but this should not preclude examination taking place. Normal radiographs can give false reassurance, so that clinical assessment is also omitted after radiography.

There is evidence in both adults and children that clinical examination is an effective way of excluding cervical spine injury.⁷⁻⁸ These studies show that patients who are conscious and cooperative, and have no pain or tenderness in the neck, do not need cervical spine radiographs. Clinical examination can also detect SCIWORA, which plain radiography cannot.

One study of cervical spine injuries in patients up to 18 years old has, however, identified a minority of fractures (18%) where no neck symptoms or signs were detected.³ In all of these cases there was both a high risk mechanism of injury (a motor vehicle accident associated with head injury, fall from over 2.4 m, or collision involving the head and neck) and a painful injury elsewhere.

Combining the findings of previous studies might be expected to allow radiography to be used more selectively without missing injuries. We summarise a cautious application of published findings in box 1, in which even conscious and cooperative children without either neck pain or tenderness are imaged if there has been a high risk mechanism of injury, such as a road accident associated with head injury. We calculate that 68 rather than 76 (11% fewer) children in our sample would have required imaging if this approach had been followed. The NEXUS study⁹ in the United States has used similar clinical criteria prospectively in adults and children and reported a reduction by 12.6% in the number of patients requiring imaging.

We are planning to introduce a clinical care pathway for the initial assessment of children with potential neck injuries in the A&E department. Our intention is to improve the initial clinical assessment and improve its documentation. We plan to carry out imaging only in those cases with at least one of the clinical features summarised in box 1.

We are not persuaded that multiple radiographic projections are of benefit in the initial imaging of this age group, and propose to obtain a single lateral radiograph only. This can be obtained without moving a severely injured child. We are proposing to abandon the anteroposterior and odontoid peg projections, which require the patient to be held in position and entail additional radiation dose to both patient and helpers,

Box 1 Clinical features justifying imaging of the cervical spine

- Major trauma
- High risk mechanism of injury and painful injury elsewhere (see Discussion)
- Unconsciousness or lack of cooperation
- Neck pain
- Neck tenderness
- Abnormal neurological examination

especially when repeated attempts are made. In cases of doubt, cross sectional imaging with computed tomography or magnetic resonance imaging is more likely to be helpful than further radiographs.

In conclusion, clinical assessment should take place before radiography of the cervical spine, as it can exclude both fractures and spinal cord injury.

On clinical grounds we estimate that we can reduce the number of children having cervical spine radiographs in our hospital by about 10%. By obtaining an adequate lateral view alone in the first instance, there is scope to reduce the number of radiographs taken by about 60%. We intend to carry out a further prospective study to see whether these savings can be achieved in practice.

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Contributors

JS had the original idea for the study. DB and PS carried out a review of literature. DB reviewed the films, with additional contributions by PS and JS. PH carried out the review of case notes. PS drafted the paper. All the authors participated in revising the text. PS and PH will act as guarantors.

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