



## CERVICAL INJURY IN HEAD TRAUMA

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**□ Abstract**—Criteria for excluding cervical spine injury in patients who have sustained blunt head or neck trauma were prospectively studied at four hospitals in the Chicago area. The authors attempted to define a subset of these adult patients who, based on clinical criteria, could reliably be excluded from cervical spine radiography, thus avoiding unnecessary radiation and saving considerable time and money in their evaluation.

Patients fell into four groups: (1) patients who were awake, alert, and had no complaint of neck pain or tenderness on physical examination; (2) patients who were awake, alert, but had complaint of neck pain or tenderness on physical examination laterally over the trapezius muscle only; (3) patients who were awake, alert, but had complaint of central neck pain or tenderness on physical examination over the cervical spine or center of the neck; and (4) patients who were not fully awake or alert, were clinically intoxicated, had other painful or distracting injuries, or had focal neurologic findings. Patients in group 4 had significantly more fractures (21/387) when compared with all other patients (7/478). Patients with central neck pain or tenderness (group 3) had significantly more fractures (7/237) than patients without pain or tenderness or with these findings limited to the trapezius area (0/236).

It is clear that patients who have altered mental status, abnormal examination findings, distracting injury, or pain or tenderness over the cervical spine must have cervical spine radiographs. In a patient who is awake, alert, has normal physical examination findings, is undistracted by other painful injuries, and has no pain or tenderness in the neck or these findings are limited to the trapezius area, there is less than 1% chance of a cervical spine fracture, with a 90% confidence limit. Our data strongly suggest we can modify our use of cervical spine radiographs in patients sustaining blunt head trauma without subjecting patients to undue risk.

**□ Keywords**—head trauma; cervical spine trauma; cervical spine radiographs; trauma assessment; injury prediction

### INTRODUCTION

An enormous number of patients are seen in emergency departments each year with blunt head or neck trauma. Controversy exists over the use of cervical spine radiography for evaluation of occult cervical spine injury. Patients with decreased mental status from trauma, alcohol, or drugs may have an unreliable history and physical examination, making radiographic evaluation of the cervical spine essential.<sup>1,2</sup> In patients with other painful injuries cervical symptoms may go unnoticed, making radiographs necessary.<sup>2,3</sup> A cervical spine radiographic study is clearly warranted in patients manifesting focal neurologic signs.<sup>1,3</sup> The real difficulty exists in patients who are awake, alert, have normal physical examination findings, and have minimal or no symptoms.

A recent study attempted to address this issue, but fell short having had only five fractures and failing to take radiographs in a third of the patients.<sup>4</sup> There are also a number of reports in the literature citing painless cervical fractures<sup>5-8</sup>; however, none were in patients who were completely awake, alert, unimpaired by alcohol or drugs, with normal neurologic examination findings, and undistracted by other painful injuries. This multicenter study was designed to determine if clinical criteria could reliably differentiate those patients sustaining blunt head or neck trauma who would not require cervical spine radiography.

## METHODS

All patients who were evaluated for blunt head or neck trauma and had cervical spine radiographs in the emergency departments of the University of Chicago Medical Center; Lutheran General Hospital, Park Ridge, Illinois; the University of Illinois Hospital, Chicago; and Saint Francis Hospital, Peoria, Illinois, during the 9-month period April 1, 1985, through December 31, 1985, were entered into the study. (All above hospitals had trauma-center designation at the time of the study.) Patients with blunt head and neck trauma that was, in the clinical opinion of the physician, so trivial as not to warrant an x-ray study were not included in the research population. Emergency physicians at the resident or attending level completed a short data sheet that included (1) historical data pertaining to type of injury, loss of consciousness, complaint of neck pain and specific location of the pain (over cervical spine, ie, the center of the neck, or over trapezius muscle), complaint of neurologic symptoms; (2) physical examination data pertaining to level of consciousness, clinical intoxication, painful injuries other than the neck injury, neck tenderness and specific location (over cervical spine, over trapezius muscle, both, or neither); and (3) cervical spine radiographic series result. Only patients aged 14 or older with fully completed data sheets were entered into the study. All patients received a full five-view cervical spine radiographic series that included lateral, anteroposterior (AP), odontoid, and two oblique views, unless a fracture or dislocation was clearly evident on the lateral view and the patient's condition prohibited completion of the full series. Radiographs were interpreted by the emergency physician and a radiologist. Radiographs were considered positive if a cervical spine fracture or dislocation was present.

Based on the completed data sheet, patients were placed in one of four groups:

1. Patients without exclusion criteria who had no neck pain both on history and physical examination.
2. Patients without exclusion criteria who had pain confined laterally to the trapezius muscle only, on history or physical examination.
3. Patients without exclusion criteria who had central neck pain over the cervical spine (center of the neck) on either history or physical examination.
4. Patients with exclusion criteria defined as any of the following: (a) not fully alert or oriented, (b) clinically intoxicated, (c) other painful or distracting injuries, (d) focal neurologic signs or findings.

The data were statistically compared using the two-sided Fisher Exact Test.

## RESULTS

Complete data consisting of history, physical examination, and cervical spine radiograph results were collected on 886 patients who were entered into the study. Thirty patients were excluded because of either uncompleted data sheets, penetrating trauma, or age less than 14 years. No significant differences were found between study sites; pooled data from participating institutions are depicted in Table 1.

As is shown in Table 1, no patient in group 1 or 2, (patient with no neck pain or pain localized to the trapezius muscle) had a cervical spine fracture or dislocation, compared with seven patients in group 3 (pain over cervical spine). This difference is significant,  $P=0.014$  using the two-sided Fisher Exact Test.

When probability of fracture or dislocation was compared between patients with no neck pain (group 1) to those with central or cervical neck pain (group 3), the result approached, but did not reach, statistical significance ( $P=0.18$ ).

Comparison of the probability of fracture or dislocation in patients without exclusion criteria (groups 1 to 3) to patients with exclusion criteria (group 4) revealed a significantly higher likelihood of fracture in patients with exclusion criteria ( $P=0.003$ ).

There were 28 total fractures or dislocations in our sample of 886 patients, or 3.16% (Table 2). Injury was more common in males than in females (23 to 5). Motor-vehicle accidents accounted for 14 (50%) fractures, with falls being next most common, followed by sports injuries, battery, and diving accidents. Twenty-one (75%) patients sustaining fractures fell into the exclusion category, and only seven patients were fully alert, not intoxicated, and had no other painful injuries or focal neurologic signs or findings. All seven of these patients had either complaints of pain in the center of the neck, or clinical findings of central neck pain on physical examination, or both.

## DISCUSSION

Based on our experience, several conclusions can be drawn. Our data reaffirm the recommendations of earlier studies that showed that certain patients suffering blunt head or neck trauma must have cervical spine radiographic examination regardless of absence of neck pain.<sup>1-3,5-9</sup> This subset consists of those patients with exclusion criteria (group 4) and included

**Table 1. Cervical Spine Radiograph Results**

	Group 1	Group 2	Group 3	Group 4	Totals
No fracture	96	145	230	387	858
Fracture or dislocation	0	0	7	21	28
Totals	96	145	237	408	886

Group 1: Patients without exclusion criteria with no neck pain on history or physical examination; group 2: patients without exclusion criteria who had lateral neck pain over the trapezius muscle on history or physical examination; group 3: patients without exclusion criteria who had central neck pain over the cervical spine; group 4: patients with exclusion criteria that were any of the following: (a) not fully alert or oriented, (b) clinically intoxicated, (c) other painful or distracting injuries, (d) focal neurologic signs or findings.

those not fully alert or oriented, those with focal neurologic signs or findings, clinical intoxication, or other distracting painful injuries. We found the highest incidence of fracture (21 fractures in 408 patients) in this group, a result significantly different from patients without any of these criteria. It is in this group that clinical history and physical examination may be unreliable and patients with significant injury to their cervical spine may lack neck pain or have pain localized laterally to the trapezius muscle (Table 2, patients 14, 15, 17, and 20). A recent prospective study of 233 patients identified ten variables that statistically correlated with cervical spine injury.<sup>10</sup> Of these, all but two (history of fall less than 10 feet, and presence of neck spasm) fell into the exclusion category in our study, thus lending further support to the necessity of cervical spine x-ray study in these patients.

Our data support the necessity of cervical spine radiographic evaluation in patients suffering blunt head or neck trauma who have central neck pain on history or physical examination. We found seven fractures in 237 patients with central neck pain, a significant difference from the sum of patients without neck pain and with lateral trapezius neck pain only, on history or physical examination. Others have not found neck pain correlating with cervical injury, but did not subdivide neck pain as to location in the neck, trapezius or cervical, as in this study. Also, their definition of cervical injury included entities other than fracture or subluxation, such as cervical straightening.<sup>10</sup>

The primary purpose of this study was to try to identify a subgroup of patients who, after suffering blunt head or neck trauma, could reliably be excluded from cervical spine radiographic evaluation without fear of missing a fracture or subluxation. Stated another way, we prospectively sought to determine the incidence of fracture in patients with pain localized to the trapezius muscle and in patients without neck pain who have no exclusion criteria.

Because of potential patient morbidity and practitioner liability of missing a cervical fracture, to con-

clude that cervical spine radiographic examination is unnecessary in these groups, the incidence of fracture needs to be so small that it approaches zero. In our experience of 241 patients with no neck pain or pain limited to the trapezius muscle, none had a cervical fracture, compared with seven fractures in 237 patients with central neck pain on history or physical examination. Although this difference is significant at the 0.01 level, it does not tell us the likelihood of fracture in the former group. Given our sample size of 241 patients, the 90% upper confidence bound for the probability of fracture in this group is .0095. This means that if the actual fracture rate among all cases with no neck pain or pain limited to the trapezius was as large as 1% (0.0095), then more than 90% of all samples of size 241 would contain at least one fracture (which our sample did not). In order to raise this confidence bound to 99%, close to 30,000 radiographic examinations would need to be done on patients with trapezius or no neck pain, clearly a large task. The authors of a recent review of this topic mention preliminary data of their retrospective study that attempted to identify high-yield criteria for cervical spine radiographic evaluation.<sup>11</sup> They note that of 27 parameters assessed to distinguish patients with normal versus abnormal cervical spine films, there appears to be a significant statistical difference with respect to two parameters, local tenderness and pain. They, too, affirm that an enormous data base is needed to define fully specific screening criteria for cervical spine radiographic studies in the traumatized patient.

Some emergency physicians, including those who collected data in this study, are selective in ordering cervical spine radiographic series on patients sustaining blunt head or neck trauma whom they suspect have a low probability of injury. Therefore, in this study alert patients sustaining trivial injuries who did not have neck pain often did not receive cervical spine radiographic studies. Other physicians automatically perform radiographic studies in all patients, regardless of lack of symptoms, to document absence of

**Table 2. Clinical Findings in Patients with Cervical Spine Fracture or Dislocation**

Patient	Age	Sex	Mechanism of Injury	Exclusion Criteria	Neck Pain on History			On Examination			Injury
					Over C-Spine	Over Trapezius	None	Over C-Spine	Over Trapezius	None	
1	39	F	MVA	None	X			X			Avulsion Fx ant. body C-6
2	17	M	Football injury	None	X			X			Comminuted Fx C-4 5mm sublux C4 on C5
3	14	M	Hit in neck	None	X			X			Fx spinous process C-6
4	53	M	Fall (3 days prior)	Multiple injuries Quadriplegia	X			X			Comminuted Fx C-4 & C-5
5	30	F	MVA	None	Stiff	Stiff		X	X		Chip Fx C-5
6	61	M	MVA	Other injuries	X	X		X	X		Hangman's Fx C-2
7	30	M	MVA	Intoxicated Other injuries	X			X			Chip Fx ant body C-3
8	18	M	Diving accident	Other injuries	X	X		X	X		Comminuted Fx body C-7
9	27	M	MVA	None	X	X		X	X		Fx body C-5
10	21	M	MVA	None	X			X			C-1 Fx
11	50	M	Fall	Obtunded intoxicated Other injuries	Unable to adequately assess						C-2 Fx
12	32	M	Fall	None	X			X	X		Chip fx ant body C-5
13	49	M	MVA	Other injuries		X		X	X		Fx Spinous Process C-5
14	63	M	MVA	Focal neuro findings		X		X	X		5 mm sublux C-5 on C-6
15*	30	M	Pistol whipped	Intoxicated			X			X	3 mm sublux C-4 on C-5
16	34	M	Fall	Unconscious	Unable to adequately assess						60% sublux C-6 on C-7
17	46	M	MVA	Other injuries	Unable to adequately assess		X			X	C-4 Fx
18	22	M	MVA	Obtunded intoxicated Other injuries	X	X		X	X		Chip Fx C-2
19	31	M	Fall	Other injuries	X	X		X	X		Hangman's Fx C-2
20	40's	M	Fall	Obtunded intoxicated			X			X	Fx C-2 transverse process
21	21	M	Diving accident	Focal neuro findings	X	X		X	X		Fx C-2, C-4
22	32	F	MVA	Unconscious Other injuries	Unable to adequately assess						Fx C-2 sublux C-3 on C-4 15mm
23	41	F	MVA	None	X			X			Fx C-4 lateral mass
24	17	M	MVA	Unconscious Other injuries	Unable to adequately assess						C-2 Fx of odontoid
25	22	M	Football injury	Other injuries	X			X			C-5 Fx
26	49	M	Fall	Obtunded intoxicated Other injuries	Unable to adequately assess						Teardrop Fx C-3 50% sublux C-3 on C-4
27	61	F	MVA	Other injuries	X	X		X	X		Fx C-2 Body
28	56	M	Fall	Intoxicated Other injuries	X	X		X	X		Fx C-2, C-3

\* Patient was discharged home from emergency department.  
MVA = motor vehicle accident, Fx = fracture, sublux = subluxation, ant = anterior, C = cervical

injury in patients believed to have no injury. Had we obtained cervical spine radiographs on all patients with head or neck trauma, regardless of degree of injury and absence of pain, the number of patients in our sample group would have been much larger, and therefore our upper confidence bound for the probability of fracture would have been higher.

We believe that our data lend support to selectivity in cervical spine radiographic evaluation. In the alert, nonintoxicated patient without focal neurologic signs, or associated painful injury, who on history denies central neck pain and has no neck pain or pain localized to the trapezius muscle only on physical examination, we have demonstrated that the likelihood of fracture is very low. Based on this finding, we have modified our approach to this subset of patients by excluding them from cervical radiographic examination. This should reduce by approximately 25% the

number of radiographs we order, without undue patient risk.

### CONCLUSION

Our data support obtaining cervical spine radiographic examination for (1) all traumatized patients who have complaints of central neck pain or tenderness centrally in the neck on physical examination and for (2) all patients, regardless of neck pain or tenderness, who are not fully alert, are clinically intoxicated, or have other painful and possibly distracting injuries, or focal neurologic signs or findings.

Alert traumatized patients without any of the above findings who have no neck pain or tenderness, or pain or tenderness localized only to the trapezius muscle can be reliably excluded from cervical spine radiographic examination without undue patient risk.

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