Rational Ordering of Cervical Spine Radiographs Following Trauma

A retrospective review of 312 hospitalized patients with cervical spine injuries was conducted to identify presenting signs, symptoms, and coexisting conditions, and to determine if any injuries were not diagnosed in the emergency department. Of the 257 (82%) patients who were alert on ED evaluation, 215 (84%) complained of neck pain or tenderness. Of the remaining 42 alert patients without neck pain, 34 had sensory or motor symptoms or signs suggestive of cervical spine injury, and eight had significantly painful other injuries. Of the 284 patients presenting within the first 48 hours after injury, 23 were not diagnosed initially, 21 because radiographs were initially read as negative and two because no radiographs were taken. A significant number of patients had more than one fracture of the spinal column. A stepwise approach to rational ordering of cervical spine radiographs in blunt trauma is proposed. [Ringenberg BJ, Fisher AK, Urdaneta LE, Midthun MA: Rational ordering of cervical spine radiographs following trauma. Ann Emerg Med August 1988;17:792-796.]

INTRODUCTION

In 1979 Bohlman1 published a retrospective review of 300 patients with cervical spine injuries. One-third of the patients with injuries were not diagnosed initially in the emergency department. This study clearly demonstrated a need for emergency physicians to heighten their index of suspicion and make cervical radiography a routine part of the evaluation of trauma patients, especially those with an altered level of consciousness due to head injury, intoxication, or multiple injuries. Other authors have reported “occult” injuries,2, 3 “personal experience” with painless cervical spine fractures,4 and cervical spine injuries in patients with “minimal or no symptoms.”5

Undoubtedly the safest approach to the problem of missed neck injuries, as promoted by the American College of Surgeons in their advanced trauma life support guidelines,6 is to make cervical spine radiography a routine part of the evaluation of every trauma patient. However, the high percentage of negative studies7,8 and an increased awareness of the need to consider cost containment have encouraged recent investigators to propose guidelines for cervical radiographic evaluation of trauma patients9,10 and to develop high-yield criteria for cervical radiography.8,10-12

Fischer reported that in 333 fully alert head injury patients, all five patients with cervical spine injuries had symptoms or signs referable to the cervical spine.13 Similarly, Bachulis found that all 65 alert trauma patients with positive cervical radiograph findings had symptoms of neck injury.7 The remaining 29 patients with cervical spine injuries had a decreased level of consciousness secondary to brain injury, alcohol, shock, or mental handicap. These reports lend credence to Gatrell’s suggestion that “the asymptomatic cervical injury may be a myth.”14

Our retrospective review of hospitalized patients was conducted to address the question of the asymptomatic cervical spine injury. Guidelines for rational ordering of cervical spine radiographs were developed based on our findings as well as suggestions of earlier authors.

METHODS

The University of Iowa Hospitals and Clinics is a 1,020-bed tertiary care hospital.
facility that serves as the major referral center for the state of Iowa. Using the main frame hospital computer and the ICD-9 coding system, a list of all patients discharged from the University Hospitals with a diagnosis of cervical spine injury between January 1979 and April 1985 was obtained.

Detailed analyses of the ED records, consultants' statements, radiographic reports, discharge summaries, and transfer records, if available, were completed. Age, sex, time of presentation, mechanism of injury, type and location of all spinal injuries, evidence of alcohol or other drug intoxication, and concurrent injuries were recorded. Documentation of the presence or absence of neck pain or tenderness as well as subjective or objective sensory or motor findings were noted. If any of these signs or symptoms were mentioned by any examiner they were to be positive findings. Any delays in diagnosis of the cervical spine injury and circumstances surrounding these delays were analyzed.

RESULTS

Three hundred twelve cases were studied retrospectively after the deletion of duplicate records (three); cases without clear evidence of trauma, those with the diagnosis of cervical strain, old fracture, or congenital abnormality (109); and those unavailable for review (52).

Two hundred forty-nine (77%) of these 312 patients were men, with a mean age of 31 ± 16.4 years. The mean age of the 72 women was 36.5 ± 23.4 years. Mechanisms of injury are shown (Table 1). There were no patients with penetrating trauma in this series. The distribution of cervical spine injuries is shown (Table 2). Concomitant spinal injuries included 4% of patients with one or more thoracic spine fractures, 4% with one or more lumbar spine fractures, and 1% with fractures of the cervical, thoracic, and lumbar spines.

Two hundred fifty-seven patients (82%) were conscious and alert at the time of initial evaluation, the remaining 55 (18%) had evidence of decreased mentation. Ninety-five of these 55 patients had decreased mentation due to alcohol or drugs alone.

Of the 257 alert patients, 215 (84%) complained of neck pain or tenderness on initial ED evaluation. The remaining 42 (16%) alert patients had no neck pain or tenderness documented. Of these 42 patients, 25 had both subjective symptoms and sensory or motor signs, four had subjective complaints only, four had objective findings only, and one had isolated radicular pain. Of the remaining eight patients without documented neck pain or tenderness, all had significantly painful other injuries. Six of these patients were involved in automobile accidents, two were involved in motorcycle accidents, and two appeared intoxicated. The other painful injuries are listed [Figure 1]. Although the charts reflected that 54 (21%) of these patients appeared intoxicated, all of them were capable of cooperating sufficiently to obtain historical or physical information suggestive of cervical spine injury.

Two hundred eighty-four of the 312 patients presented for evaluation within 48 hours of injury. Of these, 261 (92%) had cervical spine injuries diagnosed on initial ED evaluation. In the remaining 23 (8%), diagnosis was delayed. In 21 of these 23 patients, radiographs were taken but were read initially by the emergency physician, specialty consultant, or on-duty radiologist. Nine patients had complete cervical spine radiographs (ie, anterior-posterior, lateral, odontoid, supine oblique). In five of these cases, the diagnosis was suspected on review by the staff radiologist and confirmed with polytomography. One was diagnosed by the staff radiologist on the plain films alone, and three were not diagnosed until the patients returned and were reevaluated because of persistent symptoms (68-year-old man with a unilateral C6-7 facet dislocation, 83-year-old woman with C-6 body fracture, and 24-year-old woman with C-4 and C-5 facet fractures).

Two patients did not have adequate studies. One had a complete series, but only the superior end plate of the seventh vertebra was visualized (diagnosed as a superior facet fracture of C-7 20 days later when the patient returned complaining of persistent pain). The other had a poor-quality series because of patient motion and lack of cooperation. The diagnosis was suspected by the staff radiologist on re-
Subluxation or dislocation

C-4 2
C-3 2
C-2 8
C-1 1

confirmed as stable fracture of the right
view of films the next day and con-
C-7 3
C-6 1
C-5 3

on initial review of the radiograph is
articular facet C-4 by polytomography.

*Twenty-three abnormalities missed on 21

The distribution of fractures missed
articular facet C-4 by polytomography.

\[ \text{TABLE 3. Distribution of fractures missed on initial radiograph interpretation} \]

<table>
<thead>
<tr>
<th>Level</th>
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<tbody>
<tr>
<td>C-1</td>
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<td>C-7</td>
<td>3</td>
</tr>
<tr>
<td>Subluxation or dislocation without fracture</td>
<td>3</td>
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</tbody>
</table>

*Twenty-three abnormalities missed on 21

The remaining two patients with
delayed diagnoses had no cervical
spine radiographs taken as part of
their ED evaluation. One of these
patients was a 55-year-old man who ap-
parently sustained a cervical spine
fracture when he fell from a standing
position at the time of a cardiac arrest.
Despite motor and sensory deficits at
the time of transfer to this facility, a
neck fracture was not suspected until
the next day. The second patient was
an 83-year-old woman with organic
brain syndrome who was found lying
next to her bed. In this case, the diag-
nosis was made three days after ad-
mision when she complained of neck
pain.

Fourteen of the 21 patients who
were not diagnosed at the time of ini-
tial ED presentation required halo
traction (12) and/or surgery (two),
while the other seven were treated
with neck collars only.

Twenty-eight of the 312 patients
(9%) presented for initial evaluation
more than 48 hours after injury. Forty-
four percent of these patients present-
et between 48 hours and one week,
37% between one and four weeks, and
19% between one and ten months. It
was not possible to determine the in-
cidence of missed diagnoses in this
group because the majority of these
patients did not present to our facility
initially, and a careful review of the
available records did not fully explain
the circumstances leading to delay in
presentation or details of initial radi-
ographic evaluation.

DISCUSSION

The age/sex distribution and mech-
anisms of injury in our study were
similar to those seen in other stud-
ies.7,13,15 The predominance of inju-
ries at the C-2, C-5, and C-6 levels
was also consistent with previous re-
ports.16-18

Because patients with cervical spine
injuries may not present with dramat-
ic signs and symptoms, a high index
of suspicion is required to prevent a
missed diagnosis and possible cord in-
jury. However, our study demonstrated
that in our series of 312 patients, no
conscious, alert patient had a cervical
spine injury without signs or symp-
toms consistent with neck injury or
other significantly painful injuries
that may have distracted the attention
of the patient and/or examining physi-
cian. These findings concur with
those of other authors who recently
questioned the existence of truly
"asymptomatic" cervical spine injuries
in alert trauma patients.7,13,14

The limitations of a retrospective
study such as ours must be consid-
ered. Because our review was based
on discharge diagnoses of hospitalized pa-
tients at a single institution, any pa-
tient who was not admitted or who
may have decided to go to another fa-
cility following initial evaluation in
our ED would have been missed. In
addition, although every effort was
made to locate all charts, and it is un-
likely that the inability to locate "lost
charts" would have biased the data
base, this limitation must be consid-
ered.

Understanding the limitations of a
retrospective study, it is clear that any
recommendations made from our re-
view for rational ordering of cervical
spine radiographs should be validated
in a large prospective multicenter
study. An algorithm for rational or-
dering of cervical spine radiographs
would start with the decision to ob-
tain films on any patient who has sus-
tained blunt trauma and is incapable
of giving a good history or cooperating
with a physical examination. This
would include all cases in which the
clinician judges the patient's mental
status impaired for any reason, includ-
ing head injury, anoxia, organic brain
syndrome, or mental retardation. In
the absence of decreased mentation,
the next step would be to ascertain
whether neck pain or tenderness is
present. Alert patients with neck pain
would be radiographed, as would alert
patients without neck pain or tender-
ness if complete history and physical
examination demonstrated any sub-
jective or objective findings consistent
with cervical spine injury.

![FIGURE 1. Eight alert patients with cervical spine fractures did not have signs or symptoms referable to the cervical spine but had other more painful injuries.](image-url)
Finally, any blunt trauma patient with other significantly painful injuries should receive radiographic evaluation of the cervical spine. Blunt trauma patients without an altered level of consciousness, neck pain or tenderness, numbness, weakness or radicular pain, or other more painful injuries probably do not need radiographs. Our recommendations are outlined in Figure 2.

Head or facial trauma or preceding loss of consciousness without impaired mentation at the time of ED evaluation is not part of the decision tree described in Figure 2. Some authors consider these factors alone to be criteria for radiographic evaluation of the cervical spine.5,6,9,11,19,20 Other investigators have questioned the usefulness of these criteria.8,11,15,16,21 No attempt was made to evaluate these correlations in our study.

The observation that a significant number of patients with cervical spine injuries will have more than one fracture of the cervical spine or have unsuspected fractures involving the thoracic or lumbar spine has been made by other authors as well.17,18,22,23 Documentation of fracture at one spinal level should prompt a radiographic investigation of the entire spine in any patient with pain or the inability to complain of pain in the thoracic or lumbar areas. While severe deficit from injury at the cervical level may seem to make treatment of lower spinal fractures less urgent, the possibility of recovery of function with rapid treatment of the cervical spine injury requires the recognition of other unstable spinal injuries.

Seven percent of the patients in our series had cervical spine radiographs initially read as negative by the radiologist and/or emergency physician. Although 11 of 21 (52%) of these were diagnosed or suspected on review of films by the staff radiologist, it is imperative that the clinician maintain a high index of suspicion and that there be a timely mechanism for review of films that initially appear to be negative. As shown clearly by the 14 of 21 patients in our series who required neurosurgical stabilization, difficulty in diagnosing a fracture or dislocation may not mean the injury is insignificant or stable.

**CONCLUSION**

In our retrospective study of 312 patients with cervical spine fracture or dislocation, there were no conscious and alert patients without neck pain or tenderness, signs or symptoms of cervical spine pathology or other more painful injuries. In 7% of patients the diagnosis of cervical spine injury was missed on ED evaluation because initial radiographs were read as negative. Half of these patients were suspected or diagnosed after further review of the plain films, although most required additional studies to confirm the diagnosis. Associated fractures of the thoracic and lumbar spine are not uncommon in patients with cervical spine injuries.

The following recommendations thus can be made but must be substantiated by a prospective study before accepted as valid. All blunt trauma patients with neck pain, tenderness, signs or symptoms of cervical spine injury decreased mentation, or other painful injuries secondary to blunt trauma should receive radiographic evaluation of their cervical spine. Patients with none of these findings after thorough history and physical examination may not require radiographic evaluation of the cervical spine.

All radiographs should be reviewed as soon as possible by a staff radiologist, and patients with persistent complaints should be carefully reevaluated. A full series of spinal radiographs should be completed on all patients with documented cervical spine fracture who complain of pain in other areas of the spine or who have altered mentation or neurologic impairment.

**REFERENCES**


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### Approach to rational ordering of cervical spine radiographs in blunt trauma patients

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Action</th>
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</thead>
<tbody>
<tr>
<td>Abnormal mentation?</td>
<td>Yes → Radiograph</td>
</tr>
<tr>
<td>Neck pain or tenderness?</td>
<td>Yes → Radiograph</td>
</tr>
<tr>
<td>Sensory or motor signs or symptoms?</td>
<td>Yes → Radiograph</td>
</tr>
<tr>
<td>Other more painful injury?</td>
<td>Yes → Radiograph</td>
</tr>
</tbody>
</table>

Radiographs may not be necessary.

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**FIGURE 2.** Proposed algorithm for rational ordering of cervical spine radiographs.


