Radiographic Cervical Spine Evaluation in the Alert Asymptomatic Blunt Trauma Victim: Much Ado about Nothing?

Velmahos, George C. MD, PhD; Theodorou, Demetrios MD; Tatevosian, Raymond; Belzberg, Howard MD; Cornwell, Edward E. III, MD; Berne, Thomas V. MD; Asensio, Juan A. MD; Demetriades, Demetrios MD, PhD

Author Information
From the Department of Surgery, University of Southern California and the Los Angeles County/USC Medical Center, Los Angeles, California.
Address for reprints: George C. Velmahos, MD, PhD, Department of Surgery, LAC/USC Medical Center, 1200 N. State St., Room 9900, Los Angeles, CA 90033-4525.

Abstract

Objective: To evaluate the hypothesis that alert nonintoxicated trauma patients with negative clinical examinations are at no risk of cervical spine injury and do not need any radiographic investigation.

Design: Prospective study.

Setting: A university-affiliated teaching county hospital.

Patients: Five hundred and forty-nine consecutive alert, oriented, and clinically nonintoxicated blunt trauma victims with no neck symptoms.

Results: All patients had negative clinical neck examinations. After radiographic assessment, no cervical spine injuries were identified. Less than half the patients could be evaluated adequately with the three standard initial views (anteroposterior, lateral, and odontoid). All the rest needed more radiographs and/or computed tomographic scans. A total of 2,272 cervical spine radiographs, 78 computed tomographic scans and magnetic resonance imagings were performed. Seventeen patients stayed one day in the hospital for no other reason but radiographic clearance of an asymptomatic neck. The total cost for x-rays and extra hospital days was $242,000. These patients stayed in the collar for an average of 3.3 hours (range, 0.5-72 hours). There was never an injury missed.

Conclusions: Clinical examination alone can reliably assess all blunt trauma patients who are alert, nonintoxicated, and report no neck symptoms. In the absence of any palpation or motion neck tenderness during examination, the patient may be released from cervical spine precautions without any radiographic investigations.

The incidence of cervical spine injuries among blunt trauma survivors is between 1 and 3%. [1] Yet the sequelae are serious, with a 6.7% direct mortality [2] and 10 to 39% morbidity due to devastating neurologic damage. [3,4] Despite these alarming figures, a high rate of missed cervical spine injuries ranging from 15 to 30% has been reported. [5,6] In order to avoid the tragic consequences of a missed injury, Advanced Trauma Life Support protocol recommends that all blunt trauma victims should be kept in a collar until full clinical and radiographic evaluation of the cervical spine has been conducted. [7] These guidelines, combined with the ethical, legal, and financial concerns of a delayed diagnosis, have generated defensive practices in emergency room physicians and trauma surgeons who seek radiographic “clearance” exhaustively.

There is little doubt that patients with neck symptoms or patients that are not fully alert should undergo radiographic examination before spinal immobilization is removed. On the other hand, a significant number of blunt trauma victims are completely alert and can respond precisely to questions and physical examination. No clear guidelines are provided for this group. Some authors hold that clinical examination is adequate only in cases where no other major painful injuries exist. [8,9] Others caution about the risk of asymptomatic cervical spine trauma even in the absence of distracting injuries and, therefore, recommend routine radiographic investigation. [10,11] The purpose of this prospective study was to evaluate the hypothesis that alert nonintoxicated trauma patients with negative clinical examinations are at no risk of cervical spine injury and do not need any radiographic investigation.

PATIENTS AND METHODS

All alert, oriented, and nonintoxicated blunt trauma victims who, despite the absence of any neck pain,
Arrived in a collar at LAC/USC Medical Center from July 1994 to June 1995 entered the study. Because alcohol blood levels were not drawn from all patients and, even if they were, we did not have the results immediately, we relied on questioning and on the patient's breath to determine intoxication. Therefore, all alert and oriented patients, responding immediately to questions and capable of following complex commands, who denied alcohol and drug use and who did not have any alcohol smell on their breath were included. However, patients who, despite satisfying the previous criteria, were not cooperative with the examiner were excluded. Excluded also was one patient who, in the absence of neck pain, reported retropharyngeal pain. Eventually, he had a negative radiographic examination. No specific age limits were set. A patient was included regardless of age if it was felt that he or she could provide a reliable clinical response. The presence of other significant injuries was not an exclusion criterion.

We classified the injuries as minor (lacerations, contusions, small hematomas) and major (fractures, degloving injuries, hemopneumothoraces, acute peritonitis). Among major injuries, we defined as "distracting" the following: long bone fractures, sternal and rib fractures, thoracic and lumbar spinal fractures, pelvic fractures, severe soft tissue injuries, and peritonitis. The clinical evaluation consisted of three simple steps:

1. The patient was asked to focus his attention on his neck and to report the presence of any pain. A positive response prompted the cessation of any further neck manipulation and the initiation of radiologic investigation.

2. In the absence of neck pain, the collar was loosened and careful palpation of the entire neck area was conducted while the neck was manually stabilized. Again, the uncovering of even minimal tenderness resulted in immediate collar placement and radiographic evaluation.

3. In the absence of any palpation tenderness, the patient was asked to move his neck actively ("chin on shoulder, chin on chest"). If no active pain was elicited, the clinical examination was recorded as negative. At this point the collar was put back on and the patient underwent cervical spine radiography (CSR).

The initial standard radiographic set (ISRS) consisted of three views (lateral, anteroposterior and odontoid), unless the patient was unstable, in which case only a cross-table lateral was obtained. In the unusual situation of the alert blunt trauma victim with frank hemodynamic instability that did not allow time for any radiographs, the collar was simply left in place until all priorities were successfully managed. If all cervical vertebrae were not properly visualized, the standard views were repeated or additional radiographic tests (swimmer's view, flexion-extension, computed tomographic (CT) scan, magnetic resonance imaging (MRI)) were ordered as needed. All patients were examined after admission on a daily basis by the initial admitting team as well as by an observer independent from the team.

We classified the patients into the following groups: distracting injuries group (DIG), head or face injuries group (HFG), operated patients group (OG), and pregnant patients group (PG). All patients with no or minor injuries that were not in the head or face were included in the minimal risk group (MRG).

We recorded the mode of the accident, the type of injuries, all diagnostic and therapeutic interventions, the number and type of cervical spine radiographic investigations, the time to collar removal, and the length of hospital stay for all patients.

RESULTS

Demographics

During the period of July 1994 to June 1995, 549 alert and clinically nonintoxicated blunt trauma victims with no neck symptoms arrived in cervical spine protection at LAC/USC Medical Center. Two-thirds (366) were male and one-third (183) was female. The mean age was 33 years (range, 6 to 84 years). There were 18 patients younger than 10 and 8 patients older than 70 years of age. Twelve pregnant women were also included. Motor vehicle crashes accounted for 370 cases, pedestrians were struck by a car in 113 cases, falls were the cause in 54 cases, and assault in 3 (Figure 1).
Four hundred and nine patients suffered at least one injury with 159 (38.8%) having only minor ones. Major injuries were recorded in 250 (61.2%) patients and in 212 cases they were classified as distracting. Diagnostic work-up independent of the cervical spine was pursued in 227 patients who underwent 275 radiologic tests in total (201 head CT scans, 49 abdominal or chest CT scans, 8 arteriograms, 10 intravenous pyelograms or cystograms, 3 thoracolumbar radiographic series, and 4 diagnostic peritoneal lavages). Twenty-five operations (16 celiotomies, 1 thoracotomy, 3 vascular repair, 1 amputation, 4 orthopedic fixations) were performed in 24 patients on an urgent basis. One patient died.

Cervical Spine Assessment

 Adequate visualization of the entire length of the cervical spine with the three standard initial views (anteroposterior lateral, odontoid) was achieved in 227 (41.3%) cases (Figure 2). The remaining 322 (58.6%) patients needed additional cervical spine radiographs due to inability to clearly visualize C-1 in 37 cases, below C-6 in 169, below C-5 in 73, below in C-4 in 14, below C-3 in 5, and a combination of C-1 and lower vertebrae in 24 cases (Figure 3).
On average, 4.1 CSRs per person were needed (4.9 CSRs per person not cleared by the ISRS) for a total number of 2,272 CRSs, 1,647 of which were done initially and 625 later (Figure 4). Also 78 CT scans and 1 MRI were performed to evaluate questionable areas. In 30 of these patients cervical spine clearance was the sole reason for the transportation to the CT scanner. Therefore, only 9.6% (31 out of 322) of patients not needing any other type of CT scan received a CT scan of the cervical spine, as opposed to 21.1% (48 out of 227) of those who needed CT scanning of another area of their body also (p = 0.0016). This fact demonstrates that the need for any kind of CT scan lowered significantly our threshold for requesting a CT scan of the cervical spine.
No acute cervical spine pathology was found in any of the clinically asymptomatic patients. None of them complained of neck pain during the rest of their hospital stay.

In-Collar Delays

The average time that these asymptomatic patients remained in the collar was 3.4 hours (range, 0.5 to 72 hours; Figure 5). Patients assessed adequately by the ISRS spent a mean 1.1 hours in spinal protection versus 5 hours for those who needed additional cervical spine investigations. Seventeen patients remained one day each in the hospital for no other reason than a time-consuming cervical spine assessment.

Cervical Spine Assessment Costs

The total expenses for 2,272 simple CSRs, 78 CT scans, 1 MRI, and 17 hospital days were $242,000. These costs do not include professional fees and are expected to be higher in private institutions.

Subgroups

There were 212 patients in the DIG, 193 patients in the HFG, and 206 patients in the MRG (Table 1). There were also 24 patients who received an operation and 12 pregnant women. Differences in numbers of cervical spine radiographs and in-collars delays between high and low risk group patients are shown in Table 2.
DISCUSSION

The desire for optimal patient care combined with malpractice issues have caused serious concerns surrounding missed cervical spine injuries. [12] Therefore, mandatory radiographic evaluation of the cervical spine in all blunt trauma victims is an established policy for many trauma centers. [1,2,13] On the other hand recent emphasis on cost restriction and rational use of medical resources create the impression that routine "blind" policies are not the most efficient way of treating patients in an era of limited resources. Therefore, "high yield" criteria for the use of CSR have been proposed with the goal of saving time and money without jeopardizing the patient's health. [14,15] Unfortunately, most of the existing studies suffer from the following problems: retrospective study, [15,16] small sample size, [17,18] and inclusion of mixed groups of blunt trauma patients. [11,12,19] Therefore, we feel that a prospective study focused on a relatively large number of patients who are most likely to benefit from the omission of CSR (that is, alert nonintoxicated blunt trauma patients with no neck complaints) may contribute to the resolution of the controversy.

In a prospective study of 233 blunt trauma patients Jacobs and Schwartz [11] found that 20% of cervical spine injuries would have been missed if physicians had used physical examination and mechanism of injury as criteria to predict the injury. However, there is no information on the level of consciousness of all these patients. Inability to reliably evaluate patients who are confused or intoxicated is to be expected. Furthermore, in this study even radiologic investigation had a very low sensitivity of only 46% in detecting cervical spine injuries. Cohn et al. [17] suggest in a prospective study of 60 consecutive trauma admissions that all patients should be presumed to have an unstable cervical spine injury until clinical examination with radiography excludes it. Multiple radiographs or reluctance to move unstable patients to the radiology department resulted in a median time of 15 hours for radiologic clearance. Again, no data are given on the sensitivity of clinical examination in the fully conscious patient and thus, the inclusion of "all patients" in the final conclusion may be an overstatement.

The issue of asymptomatic cervical fracture in the alert patient is a rather confusing one. Occasional case reports provide the only published data. Mace reported twice [10,20] on "occult" cervical spine fractures. Unfortunately, the patients that she referred to either had pain (even if minimal) or were intoxicated and, thus, her data have been emphatically debated. [21] Maul and Sachatello [13] support the necessity of subjecting all asymptomatic conscious patients to radiologic clearance based "on recent personal experience" but they never reveal the actual facts that led them to this conclusion. The only well documented case report of an asymptomatic cervical spine fracture is published by McKee et al., [22] referring to an 83-year-old patient with an odontoid fracture and no pain. This patient had loss of consciousness, was amnestic to the event, and did not report minimal pain even for multiple rib fractures with an associated hemopneumothorax.

On the other hand a number of authors believe that in selected cases cervical spine injury can be reliably ruled out on the basis of clinical examination alone. [9,14-16,18,19,23] However, they feel that other major injuries may distract the patient's attention away from the neck. Therefore, even in the absence of mental changes, intoxication, and neck symptoms, they feel that the mere presence of distracting injuries renders clinical neck evaluation unreliable and suggest radiologic clearance.

In our study we selected a specific subgroup from all our trauma admissions: blunt trauma patients who are fully alert, oriented, clinically nonintoxicated, and complain of no neck pain and are capable of following complex commands. Intoxication due to alcohol or illicit drug use is common in our population. Approximately two-thirds of critically injured patients are under the influence of drugs or alcohol on admission. [24] Because toxicologic screening for all patients is not cost effective nor necessary, and because results are routinely not readily available, we tried to create a more realistic situation by detecting intoxication through questioning the patient and breath odor. We are obviously dealing with a modification of Ransohoff's [25] class I category; that is, patients alert, responding immediately to questions, and able to follow complex commands.

None of the 549 patients whom we prospectively evaluated reported neck pain. A simple, quick, focused neck examination, like the one we standardized in three steps, fits perfectly the acute situation in a busy trauma
center. It can be easily performed as soon as any other life-saving priorities are settled.

The presence of even minimal symptoms should prompt radiographic investigation. We were particularly worried about the rare occasion of retropharyngeal pain in the absence of any neck tenderness, because it was associated in a case report with an anterior odontoid fracture. [10] This is why we excluded the single patient who was having pharyngeal pain. His radiographic evaluation was negative and pharyngitis incidental to the traumatic event was established as the cause of the pain.

The presence of distracting injuries did not affect the reliability of our clinical examination. We believe that once the patient is asked to focus his attention on his neck, pain or palpation tenderness will be unmasked. Distracting injuries were recognized in 212 patients (38.6% of our study population) and were associated with longer in-collar time and more radiographs. Larger studies will be necessary to confirm the safety of excluding radiographs in these patients.

Head and face injuries are frequently postulated to be associated with cervical fractures. [26,27] Although such studies reported patients with cervical fractures to also have craniofacial injuries, [28] the opposite assumption has never been validated. That is, patients with craniofacial trauma are not found to be at increased risk of cervical spine injury than those without craniofacial trauma. [29,30] Out of 193 patients with head and facial injuries but asymptomatic cervical spines, we did not detect any "missed" cervical fracture. Many of these patients underwent unnecessary scanning of their spine, presumably because the transportation or a head CT scan lowered our threshold for requesting a C-spine CT scan.

Time spent for unnecessary radiographs is another major issue. Proper radiographic clearance of the cervical spine may not be a simple task and if the patient is to be kept properly immobilized until this is achieved, diagnostic studies and possibly treatment may be affected. [15] In general, patients in the OG stayed significantly longer in the collar than nonoperated patients, because many of these patients were rushed to the operating room before cervical spine radiographic clearance was achieved.

Undue delays in an overloaded emergency room like ours should not be taken lightly. Pooling of patients there or in the radiology department for superfluous radiographic work-up slows down expeditious evaluation and treatment and wastes valuable resources in terms of equipment and personnel.

The risk also from multiple radiographs may be small but real and the long-term results have not yet been fully assessed. [31,32] The persistence of assessing asymptomatic necks in pregnant women with multiple x-ray films due to strict adherence to protocol rules is definitely striking. Although the majority of the 12 pregnant women who entered our study had trivial injuries, they all underwent meticulous radiologic cervical spine clearance. Five of them needed more x-rays than the initial three views (4 to 12) to clear their asymptomatic C-spine.

Finally, although no price tag can be affixed to the disastrous complications of a missed injury, concerns about cost are realistic in our society. CSRs are the most frequently ordered radiographs in the emergency room [31] and a significant percentage of them are deemed to be inadequate or unnecessary. [15,18] The total cost for radiographic evaluation of the asymptomatic cervical spine of our 549 patients escalated to $190,000. Also, 17 patients stayed in the hospital suffering no significant injuries, only because they needed multiple and lengthy radiographic procedures to assess their C-spine or because they waited for unloading of the radiology department from more urgent cases on a busy night. If this extra hospitalization cost is added the total unnecessary expenses are estimated to be $240,000.

Because the incidence of cervical spine injuries is low and a really adequate sample size has been calculated to be in the range of 10,000 to 30,000 patients, the definitive answer can only be given by a nationwide multicenter study. [12,19] But, as the significant diversity of opinions among the various trauma centers might prevent the initiation of such a project, smaller studies with well-controlled material should serve the purpose of partially resolving the debate and make such a study a realistic goal. Although we believe that there is no dogma without exceptions, we feel that the "no pain-no injury" concept was reliably reproduced in our study. We strongly believe that "missed" cervical spine injuries in asymptomatic, alert, nonintoxicated, communicative patients are most probably due to superficial and unfocused clinical examinations rather than secret mysteries in the pathophysiology of the disease.

EDITORIAL COMMENT

Dr. Velmahos and colleagues have identified an important aspect in the management of the trauma patient: a
In this section, the emphasis is on cervical spine assessment. While this report’s emphasis is on cervical spine assessment, the principle should be liberally applied. The cervical spine examination or an examination done in a distracted patient or one who is in an altered mental state will not yield the same results and could yield disastrous results when the cervical spine is the focus of the examination. The use of adjunctive tests in alert non-tender patients is certainly a form of defensive medicine that we should not condone. The authors suggest that the Advanced Trauma Life Support (ATLS) course sponsored by the American College of Surgeons Committee on Trauma (ACSCOT) indicates that all patients with blunt trauma should have their cervical spine radiologically assessed. This statement certainly sounds like it supports defensive medicine. This statement best reflected the information available at the time the current ATLS manual was written. This statement also represents why the ATLS course is dynamic and needs revisions on a regular basis.

The ATLS course is revised approximately every 4 years by the ATLS Subcommittee of the ACSCOT. Additions, deletions, and corrections are made that represent the Committee’s best effort to define a care approach that approximates best clinical practice. An attempt is made not to hold onto dogma too long, nor to embrace novelty too soon. Using our clinical assessment capabilities has always been a part of the ATLS curriculum. Diagnostic tests are adjuncts to our physical examination performed during the primary and secondary surveys. The latest edition of the ATLS manual, which is just now being completed, does address the topic identified by Dr. Velmahos and his colleagues. We agree that radiologic studies of the cervical spine are not necessary in patients who are awake, alert, sober, and neurologically normal and who do not have neck pain. We recommend that the C-collar be removed, spine immobilization maintained, and the cervical spine palpated. If no pain is elicited then the patient is asked to move his or her neck first to the side and then to voluntary flex and extend the neck. If these maneuvers are done with no pain, the C-collar is removed. If pain is noticed, the patient has the C-collar replaced and radiographic studies of the cervical spine are obtained.

I believe this study adds to the body of literature that supports this selective approach for radiographic studies of the cervical spine in alert patients. A practical point which neither the ATLS manual nor this article addresses is the use of pain control in these patients. As more emphasis is placed on early pain control and more patients are seen as transfers from an initial stabilization facility, the evaluation of alert patients who have received narcotics or other pain relief is required. Where do these patients fit in our decision tree for cervical spine evaluation? Dr. Velmahos and colleagues do not address these patients and the ATLS manual acknowledges that pain relief may mask injuries. As usual our information evolution simply identifies another question that will need to be asked. I believe it also identifies why the knowledgeable physician must still be actively involved in the clinical assessment of the injured patient: Our profession remains part science and part art! We need to use both to provide our patients optimal care!

John A. Weigelt, MD, FACS

Chairperson, American College of Surgeons Committee on Trauma

Department of Surgery

St. Paul-Ramsey Medical Center

St. Paul, Minnesota

REFERENCES


