SERVİKAL VERTEBRA
SCAN OR NOT TO SCAN????

Dr. Müge Günalp
AÜTF İbni Sina Hastanesi
Acil Tıp AD

Servikal Görüntüleme

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Gözden kaçırdığımız ne var???

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The Journal of TRAUMA® Injury, Infection, and Critical Care

Delayed or Missed Diagnosis of Cervical Spine Injuries

Patrick Platzer, MD, Nicole Hauswirth, MD, Manuela Jaindl, MD, Sheila Chatwani, MD, Vilmos Vecsei, MD, and Christian Gaebler, MD

Background: Correct diagnosis of cervical spine injuries is still a common problem in traumatology. The incidence of delayed diagnosis ranges from 5 to 20%. The aim of this study was to analyze the frequency and reasons for delayed or missed diagnosis at this Level I trauma unit and to provide recommendations for optimal examination of patients with suspected cervical spine injuries.

Methods: Analysis of clinical records showed 367 patients with cervical spine injuries who were admitted to this trauma department between 1980 and 2000. In all, 140 patients had an injury of the upper cervical spine (C1/C2), 212 patients had an injury of the lower cervical spine (C3–C7), and 15 patients had a combined injury of the upper and lower cervical spine.

Results: The diagnostic failure rate was 4.9% (n = 18). Results showed several profound reasons for missed or delayed diagnosis. In eight patients (44%), radiologic misinterpretation was responsible for delay in diagnosis; in five patients (28%), incomplete sets of radiographs were responsible. In four cases (22%), the injury was missed because inadequate radiographs did not show the level of the injury; in one case (6%), the treating surgeon did not see the radiographs.

Conclusion: For optimal examination of patients with suspected cervical spine injuries, we recommend establishing specific diagnostic algorithms including complete sets of proper radiographs with functional flexion/extension views, secondary evaluation of the radiographs by experienced staff, and further radiologic examinations (computed tomography, magnetic resonance imaging) if evaluation of standard views is difficult.

Key Words: Cervical spine injuries, Delays in diagnosis, Common reasons, Diagnostic algorithm.

J Trauma. 2006;61:150–155.

Failure to diagnose cervical spine injuries occurs with a frequency of 5 to 20%.[1–3] The incidence of delayed or missed diagnosis at the cervical spine has been reduced in the last years by increased availability and accuracy of radiologic examination (computed tomography [CT] scan, magnetic resonance imaging [MRI]) as well as improved diagnostic algorithms at trauma departments. Nevertheless, incomplete sets of radiographs, radiologic misinterpretation, and trauma patients with multiple injuries are still common reasons for delays in correct diagnosis.[1,2] However, the early detection of cervical spine injuries is essential because false or delayed diagnosis might lead to tragic consequences for the patients, ranging from neurologic deficits to complete tetraplegia.[4,5]

The aim of this study was to analyze the frequency of delayed or missed diagnosis of cervical spine injuries and the factors involved in these diagnostic failures, and to develop recommendations for appropriate clinical and radiologic examination of patients with suspected cervical spine injuries to avoid delays in diagnosis.

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From the University of Vienna Medical School, Department for Traumatology, Vienna, Austria.
Address for reprints: Patrick Platzer, MD, University of Vienna Medical School, Department for Traumatology, Wachringer Gurtel 18-20, A-1090 Vienna, Austria; email: patrick.platzer@gmx.at.
DOI: 10.1097/01.ta.0000196673.58429.2a

PATIENTS AND METHODS

This study retrospectively analyzed the clinical records of 367 patients with fractures and/or dislocations of the cervical spine that were admitted to the Level I trauma center at Vienna General Hospital, University of Vienna Medical School between January 1980 and December 2000. Collected data included parameters such as age, sex, mechanism of injury, level of injury, treatment, neurologic state, significant concomitant injuries, and alteration of mental state during initial examination. Delayed or missed diagnosis was defined as any injury identified after primary trauma evaluation.

The patients were evaluated for cervical spine injuries corresponding to the diagnostic algorithm of this unit with physical examination and standard set of radiographs. The standard set of radiographs included an anteroposterior view, a lateral view, and an open-mouth view of the odontoid. Other series like oblique views, flexion-extension views, or swimmer's views were not used routinely. CT scan or MRI was ordered at the discretion of the trauma surgeon as indicated by the standard views (incomplete or inadequate radiographs) or by clinical suspicion because of persistent symptoms or neurologic deficits.

RESULTS

In all, 140 patients (38%) sustained an injury of the upper cervical spine (C1/C2), 212 patients (58%) an injury of the lower cervical spine (C3–C7), and 15 patients (4%) suffered from a combined injury of the upper and lower cervical spine.

Clinical records showed several mechanisms of injury. The injuries resulted from car or motorcycle accidents in 44%, falls in 22%, jumps into shallow water in 15%, various

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Cervical Spine Injury: A Clinical Decision Rule to Identify High-Risk Patients for Helical CT Screening

Julian A. Hanson[1]
C. Craig Blackmore[1,2]
Frederick A. Mann[1]
Anthony J. Wilson[1]

OBJECTIVE. We aimed to validate the routine use of a clinical decision rule to direct diagnostic imaging of adult blunt trauma patients at high risk for cervical spine injury.

MATERIALS AND METHODS. We previously developed and have since routinely used a prediction rule based on six clinical parameters to identify patients at greater than 5% risk of cervical spine injury to undergo screening helical CT of the cervical spine. During a 6-month period, 4285 screening imaging studies of the cervical spine were performed in adult blunt trauma patients. Six hundred one patients (398 males, 203 females; age range, 16–100 years; median age, 38 years) underwent helical CT, and the remainder underwent 3684 conventional radiographic examinations. Clinical and report data were extracted from the radiology department database, medical records, and the hospital trauma registry. Abnormal findings were independently confirmed by additional imaging studies, autopsy results, or clinical outcome.

RESULTS. The true-positive cervical spine injury rates in helical CT– and conventional radiography-screened patients who presented directly to our trauma center were 40 (8.7%) of 462 and seven (0.2%) of 3684, respectively. The cervical spine injury rate in patients who were transferred from outside institutions to our trauma center and who underwent helical CT was 37 (26.6%) of 139. This figure included 20 patients already known to have cervical spine fracture.

CONCLUSION. The clinical decision rule can distinguish patients at high and low risk of cervical spine injury, thus supporting its validity.

Spinal cord injury and paralysis are important health burdens in the United States, with an annual incidence of 40 per 1 million population. Most cases are caused by blunt force cervical spine trauma [1, 2]. Radiography, despite its recognized limitations [3], is the standard imaging technique for screening patients for suspected neck injury that may be clinically occult. A minimum standard examination comprises a lateral radiograph that completely shows C7 and anteroposterior and open-mouth odontoid views [4]. Recent interest has been shown in the technique of helical CT to screen for cervical spine injury [5]. Advantages of helical CT over radiography may include improved accuracy and faster diagnosis [6]. However, helical CT of the cervical spine is more expensive than conventional radiography, carries a higher radiation dose, and may be warranted only in high-risk patients. Recent work from our institution, using decision-tree analysis modeling and considering all long-term costs and outcomes, has shown that screening helical CT can be more cost-effective than conventional radiography, provided that contemporaneous head CT is performed and that the probability of cervical spine fracture in the screened population exceeds approximately 5% [7]. Thus, the optimal imaging strategy for a particular patient will depend on that individual's probability of injury.

Unfortunately, reliable predictors of cervical spine injury have proven difficult to identify, although several authors have proposed methods for stratifying patients into broad categories of risk [3, 8, 9]. We developed a clinical decision rule (Appendix), based on published and retrospective local institutional data, that was designed to select adult patients with blunt trauma who are at greater than 5% risk for cervical spine fracture to undergo screening helical CT [10]. Guidelines

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[1]Department of Radiology, Harborview Medical Center, University of Washington School of Medicine, 325 Ninth Ave., Seattle, WA 98104. Address correspondence to C. C. Blackmore.

[2]Department of Radiology, University of North Carolina, Manning Dr., Chapel Hill, NC 27599.

AJR 2000;174:713–717

0361–803X/00/1743–713

NEXUS

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VALIDITY OF A SET OF CLINICAL CRITERIA TO RULE OUT INJURY TO THE CERVICAL SPINE IN PATIENTS WITH BLUNT TRAUMA

JEROME R. HOFFMAN, M.D., WILLIAM R. MOWER, M.D., PH.D., ALLAN B. WOLFSON, M.D., KNOX H. TODD, M.D., M.P.H., AND MICHAEL I. ZUCKER, M.D., FOR THE NATIONAL EMERGENCY X-RADIOGRAPHY UTILIZATION STUDY GROUP*

ABSTRACT

Background Because clinicians fear missing occult cervical-spine injuries, they obtain cervical radiographs for nearly all patients who present with blunt trauma. Previous research suggests that a set of clinical criteria (decision instrument) can identify patients who have an extremely low probability of injury and who consequently have no need for imaging studies.

Methods We conducted a prospective, observational study of such a decision instrument at 21 centers across the United States. The decision instrument re-

results of assessment with the decision instrument, radiographic imaging could have been avoided in the cases of 4309 (12.6 percent) of the 34,069 evaluated patients.

Conclusions A simple decision instrument based on clinical criteria can help physicians to identify reliably the patients who need radiography of the cervical spine after blunt trauma. Application of this instrument could reduce the use of imaging in such patients. (N Engl J Med 2000;343:94-9.)

BECAUSE unrecognized injury to the cervical spine can produce catastrophic neurologic disability, clinicians liberally order radiographs of the cervical spine, and as a result the majority of the radiographs are normal.[1-8] Eliminating even a small proportion of the approximately 800,000 cervical-spine radiographs ordered annually in the United States for patients with blunt trauma could lead to substantial savings and decrease patients' exposure to ionizing radiation.[9-11]

1. Servikal hassasiyet yok
2. İntoksikasyon göstergesi yok
3. Mental durumu uyanık
4. Fokal nörolojik defisit yok
5. Ağrılı yaralanma yok

Participating Centers

Twenty-one centers across the United States participated in this prospective, observational study. Among them were university and community hospitals, hospitals with and without residency programs, and public and private hospitals; they varied in size, in the level of activity in the emergency department, and in the level of trauma care they provided. The study was designed to assess the validity of the following five criteria (the decision instrument)

From the Emergency Medicine Center and the Departments of Medicine (J.R.H., W.R.M., M.I.Z.) and Radiology (M.I.Z.), University of California, Los Angeles, School of Medicine, Los Angeles; the Department of Emergency Medicine, University of Pittsburgh School of Medicine, Pittsburgh (A.B.W.); and the Division of Emergency Medicine, Department of Surgery, Emory University School of Medicine, Atlanta (K.H.T.). Address reprint requests to Dr. Mower at the UCLA Emergency Medicine Center, 924 Westwood Blvd., Suite 300, Los Angeles, CA 90024, or at nexusgrp@ucla.edu.

*The centers and investigators participating in the National Emergency X-Radiography Utilization Study (NEXUS) are listed in the Appendix.

NEXUS

Kanada Spinal Kord Kuralları(KSKK)

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Ian G. Stiell, MD, MS…
George A. Wells, PhD…
Katherine L. Vanden…
Catherine M. Clement…
Howard Lesiuk, MD
Valerie J. De Maio, M…
Andreas Laupacis, M…
Michael Schull, MD, …
R. Douglas McKnight…
Richard Verbeek, M…
Robert Brison, MD, …
Daniel Cass, MD
Jonathan Dreyer, MD…
Mary A. Eisenhauer, …
Gary H. Greenberg, …
Iain MacPhail, MD, …
Laurie Morrison, MD…
Mark Reardon, MD
James Worthington, …

MORE TH… tients w… and po… spine (C… treated each year in U… partments (EDs).[1,2] A… tients presenting with … cal status (arriving eit… ambulance), the incid… ture or spinal injury … Due to concerns abou… abling spinal injuries… make liberal use of C… phy.[3-9] Nevertheless, s… efficient—more than 9… diographs are negativ…

See also p 1893 and …

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…ril 1999, in which …r to radiography. …ver assessments. …pitals. …s) who presented …a Glasgow Coma …valuated by plain …telephone inter- …ogistic regression …ine injury. The re- …stions: (1) is there …5 years, danger- …-risk factor pres- …nd motor vehicle …delayed onset of …e patient able to …s rule had 100% … specificity (95% …es. The potential …ly sensitive deci- … patients. If pro- …gnificantly reduce …

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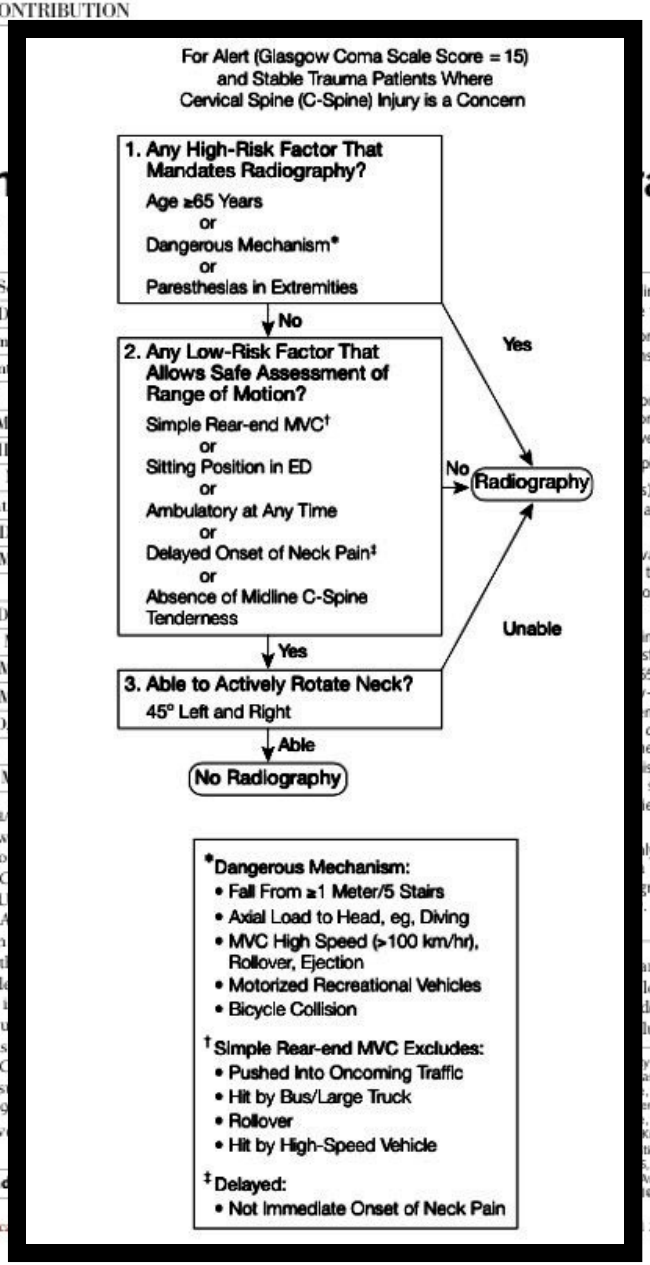
…y of Toronto, Toronto, …ass, and Morrison); Di- …, University of West- …er and Eisenhauer); Di- …, University of British …Knight and MacPhail). …tiell, MD, MSc, FRCPC, …5, Ottawa Health Re- …we, Ottawa, Ontario, …@ohri.ca).



Kanada Spinal Kord Kuralları(KSKK)

BMJ

RESEARCH

Implementation of the Canadian C-Spine Rule: prospective 12 centre cluster randomised trial

Ian G Stiell, professor and chair,[1] senior scientist,[4] Catherine M Clement, research program manager,[4] Jeremy Grimshaw, full professor,[4] Robert J Brison, professor,[6] Brian H Rowe, professor and research director,[5] Michael J Schull, associate professor,[7] Jacques S Lee, assistant professor,[7] Jamie Brehaut, assistant professor,[2] scientist,[4] R Douglas McKnight, clinical associate professor,[9] Mary A Eisenhauer, associate professor,[8] Jonathan Dreyer, research director and professor,[8] Eric Letovsky, associate professor,[7] Tim Rutledge, associate professor,[7] Iain MacPhail, emergency medicine physician,[9] Scott Ross, emergency medicine physician,[5] Amit Shah, assistant professor,[8] Jeffrey J Perry, associate professor,[1] scientist,[4] Brian R Holroyd, professor and department head,[5] Urbain Ip, emergency medicine physician,[9] Howard Lesiuk, associate professor,[3] George A Wells, professor[2,4]

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Kanada Spinal Kord Kuralları(KSKK)

EMERGENCY MEDICAL SERVICES/ORIGINAL RESEARCH

The Out-of-Hospital Validation of the Canadian C-Spine Rule by Paramedics

Christian Vaillancourt, MD, MSc
Ian G. Stiell, MD, MSc
Tammy Beaudoin, CHIM
Justin Maloney, MD
Andrew R. Anton, MD
Paul Bradford, MD
Ed Cain, MD
Andrew Travers, MD, MSc
Matt Stempien, MD
Martin Lees, MD
Doug Munkley, MD
Erica Battram, RN
Jane Banek, CHIM
George A. Wells, PhD

From the Department of Emergency Medicine (Vaillancourt, Stiell, Maloney) and the Department of Medicine (Wells), the Ottawa Health Research Institute (Vaillancourt, Stiell, Wells, Beaudoin, Battram, Banek), University of Ottawa, Ottawa, Ontario, Canada; the City of Calgary Emergency Medical Services, Calgary, Alberta, Canada (Anton); the Essex-Kent Base Hospital, Hotel Dieu Grace Hospital, Windsor, Ontario, Canada (Bradford); the Department of Emergency Medicine, Dalhousie University, Halifax, Nova Scotia, Canada (Cain); Emergency Health Services, Halifax, Nova Scotia, Canada (Travers); the Department of Emergency Medicine, Joseph Brant Hospital, Burlington, Ontario, Canada (Stempien); the Department of Emergency Medicine, Bluewater Health, Samia, Ontario, Canada (Lees); and the Niagara Base Hospital, Niagara Falls, Ontario, Canada (Munkley).

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Kanada Spinal Kord Kuralları(KSKK)

CMAJ RESEARCH

Multicentre prospective validation of use of the Canadian C-Spine Rule by triage nurses in the emergency department

Ian G. Stiell MD MSc, Catherine M. Clement RN, Annette O'Connor RN PhD, Barbara Davies RN PhD, Christine Leclair BScN, Pamela Sheehan RN, Tamara Clavet RN, Christine Beland RN MScN, Taryn MacKenzie BScN, George A. Wells PhD

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KSKK vs NEXUS

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

The Canadian C-Spine Rule versus the NEXUS Low-Risk Criteria in Patients with Trauma

Ian G. Stiell, M.D., M.Sc., Catherine M. Clement, R.N., R. Douglas McKnight, M.D., Robert Brison, M.D., M.P.H., Michael J. Schull, M.D., M.Sc., Brian H. Rowe, M.D., M.Sc., James R. Worthington, M.B., B.S., Mary A. Eisenhauer, M.D., Daniel Cass, M.D., Gary Greenberg, M.D., Iain MacPhail, M.D., M.H.Sc., Jonathan Dreyer, M.D., Jacques S. Lee, M.D., Glen Bandiera, M.D., Mark Reardon, M.D., Brian Holroyd, M.D., Howard Lesiuk, M.D., and George A. Wells, Ph.D.

Table 4. Sensitivity, Specificity, and Negative Predictive Value of the Two Rules for 162 Cases of "Clinically Important" Injury among 7438 Patients.*

Result of Assessment	Canadian C-Spine Rule		NEXUS Criteria	
	Injury	No Injury	Injury	No Injury
Positive (no.)	161	3995	147	4599
Negative (no.)	1	3281	15	2677
Sensitivity (%)	99.4 (95% CI, 96–100)†		90.7 (95% CI, 85–94)†	
Specificity (%)	45.1 (95% CI, 44–46)†		36.8 (95% CI, 36–38)†	
Negative predictive value (%)	100		99.4	

* A total of 845 cases were classified as indeterminate and are therefore omitted from this analysis.
† P<0.001. CI denotes confidence interval.

KSKK vs NEXUS

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Comparison of the Canadian C-Spine Rule and NEXUS Decision Instrument in Evaluating Blunt Trauma Patients for Cervical Spine Injury

William R. Mower, MD, PhD
Jerome Hoffman, MD, MA

From the University of California–Los Angeles Emergency Medicine Center, Los Angeles, CA.

See related article, p. 507, and editorial, p. 518.

[*Ann Emerg Med.* 2004;43:515-517.]

Concerned about missing potentially catastrophic neurologic injury, emergency physicians have typically made liberal use of radiographic imaging to evaluate blunt trauma patients for cervical spine injuries. This practice subjects large numbers of patients to imaging, with its associated cost, time expenditure, and radiation exposure, in order to detect injury in a small minority. Consequently, decision instruments that allow clinicians to safely reduce cervical spine imaging have the potential to be of significant value.

One existing instrument, the National Emergency X-Radiography Utilization Study (NEXUS) low-risk criteria, has been shown in prospective application to more than 34,000 patients to have a sensitivity of 99.6% for detecting clinically important cervical spine injury.[1] However, in this issue of *Annals*, Canadian researchers, seeking to develop their own decision instrument, report the NEXUS instrument to have a sensitivity of less than 93% when retrospectively applied to their patient population.[2] These results are inconsistent with the voluminous data collected during the development and validation of the NEXUS instrument and are in conflict with the large body of literature that investigated similar criteria before the performance of the NEXUS trial. Furthermore, the reported 7% miss rate with the NEXUS criteria is inconsistent with clinical experience and existing medical literature, which, except for the rare cases presented in the original NEXUS report, is virtually devoid of reports of missed injury.

The discrepancy between these 2 studies reflects, in part, a natural asymmetry between the processes of "validating" and "invalidating" a decision instrument. Validation studies are quite vulnerable to misclassification errors, and when such errors occur, an instrument can easily appear to have been "invalidated." For example, failure to detect important clinical findings because of inadequate evaluations or the use of surrogate variables can cause high-risk patients to be misclassified as low risk. If injured high-risk patients are misclassified in this manner, the reported sensitivity and negative predictive value will decrease. In contrast, if uninjured patients who exhibit high-risk criteria are misclassified, the reported specificity may be falsely increased. Misclassification can also decrease the instrument's interrater reliability, as reflected by measures such as the κ statistic.

Compared with the performance of the NEXUS decision instrument documented in the NEXUS report, the Canadian study reports a large decrease in sensitivity, a small but real decrease in negative predictive value, and an increase in the measured specificity.[1,2] This pattern suggests the presence of misclassification errors in the Canadian study, and likely results from the study's retrospective methodology and use of surrogate variables. Consequently, the Canadian article tells us little about the true performance of the NEXUS instrument, but does serve as an important warning regarding the use of decision instruments in general. Clinicians who wish to use a given instrument must understand the definitions used by the instrument, and they must perform careful assessments in determining the classification of individual patients. Failure to use a decision instrument properly can produce inadequate and misleading assessments, can produce misclassification of risk status, and can have potentially devastating consequences.

Bearing these concerns in mind, clinicians should retain confidence in the reliability of the NEXUS cervical spine criteria. This instrument has already undergone validation in a large prospective study involving a wide range of institutions, clinical settings, and clini-

0196-0644/$30.00

doi:10.1016/j.annemergmed.2003.12.005

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Grafiler (3 vs 5 vs 10)

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Grafiler (3 vs 5 vs 10)

TABLE 3: Risk-Tailored Cervical Spine Radiologic Examination in Trauma Patients

Category	Clinical Risk	Radiologic Examination	Approx. Duration
1	None	Radiographs unnecessary	—
2	Low	Erect three-view series[a] Lateral Anteroposterior Odontoid	10 min
3	Medium	Five-view supine-erect series Supine lateral (± swimmers) Supine odontoid Supine anteroposterior Radiologist/clinician must approve Erect obliques	20 min
4	High	Five-view supine-only series Lateral (± swimmers) Anteroposterior Odontoid Supine trauma obliques	≥30 min

[a] The three-view examination can be performed with the patient supine when necessary.

Radiology of the Cervical Spine in Trauma Patients: Practice Pitfalls and Recommendations for Improving Efficiency and Communication

Robert M. Vandemark[1]

Trauma constitutes a significant portion of emergency department practice. Such patients often have suspected cervical spine injury necessitating cervical spine radiographs. The importance of detecting cervical spine injury is obvious because failure to do so can lead to tragic consequences for patient and physician alike. Although most cervical spine radiographs are justified, poorly indicated and unnecessary examinations are unfortunately commonplace. Indiscriminate ordering of cervical spine examinations can easily exceed radiology resources assigned to the emergency department. Rational ordering practices are therefore essential for efficient patient management. A risk-tailored approach to performing these examinations, which can improve efficiency, is presented. Once obtained, cervical spine radiographs are presumed to detect injury with consistently high sensitivity. Prevailing conditions of emergency department practice that may lower the "sensitivity" of cervical spine radiographs are reviewed. Overreliance on the initial radiologic examination may lead to inappropriate haste in the evaluation of suspected cervical region injury as exemplified by the commonly voiced mandate to "clear the cervical spine" of injury. This approach is discouraged in patients with significant trauma in favor of a careful, progressive evaluation of the potentially injured cervical spine. Periodic review of these complex issues and close cooperation between clinical services are emphasized.

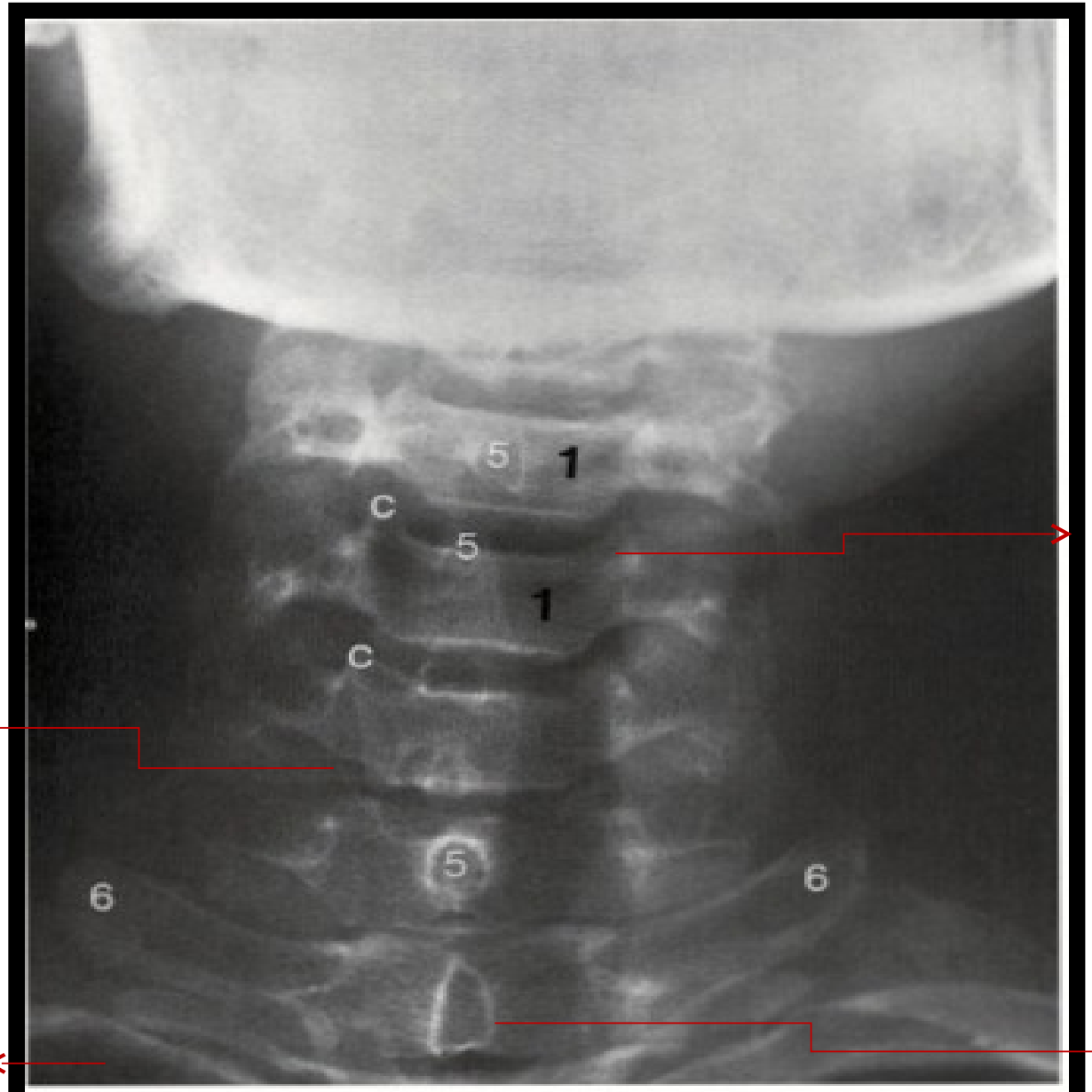
Evaluation of the patient with suspected cervical spine injury remains a constant challenge for radiologists and emergency physicians alike. No single component of the trauma evaluation so consistently produces frustration, anxiety, and miscommunication. These problems are accentuated in cervical spine trauma because of the common association with permanent, severely disabling spinal cord injuries. Implicit in the trauma resuscitation is the need to protect the spinal cord from iatrogenic injury.

In addressing these concerns, referring physicians rely heavily on cervical spine radiographs (CSR). This approach can lead to indiscriminate ordering practices, especially when radiographs are requested by protocol rather than with regard to the actual risk of injury in a particular patient. Unselective ordering practices can severely strain radiology resources allocated to the emergency department. Even when these examinations are successfully performed, problems of communication between radiologist and referring physician often emerge because of discordant expectations of the role of CSR in trauma.

The Flood of Cervical Spine Requests: Cause and Effect

In the past decade, the number of patients with suspected cervical spine injury has increased steadily, paralleled by a surge in demand for CSR. Factors fueling these trends include the increased frequency of traumatic injuries, improved phy-

Received February 23, 1990; accepted after revision May 3, 1990.
[1] Department of Radiology, Box 3808, Duke University Medical Center, Durham, NC 27710. Address reprint requests to R. M. Vandemark.
AJR 155:465–472, September 1990 0361–803X/90/1553–0465



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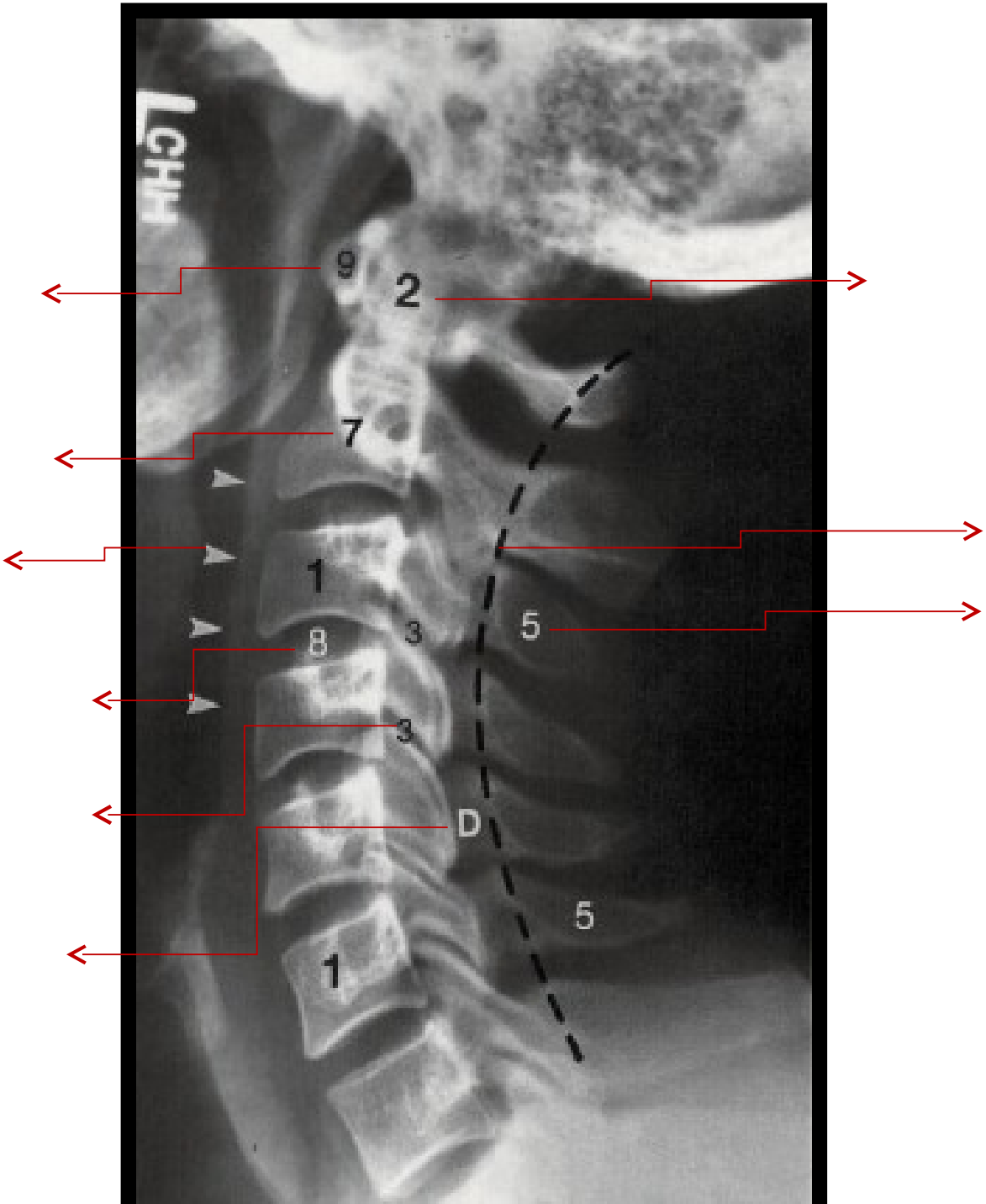
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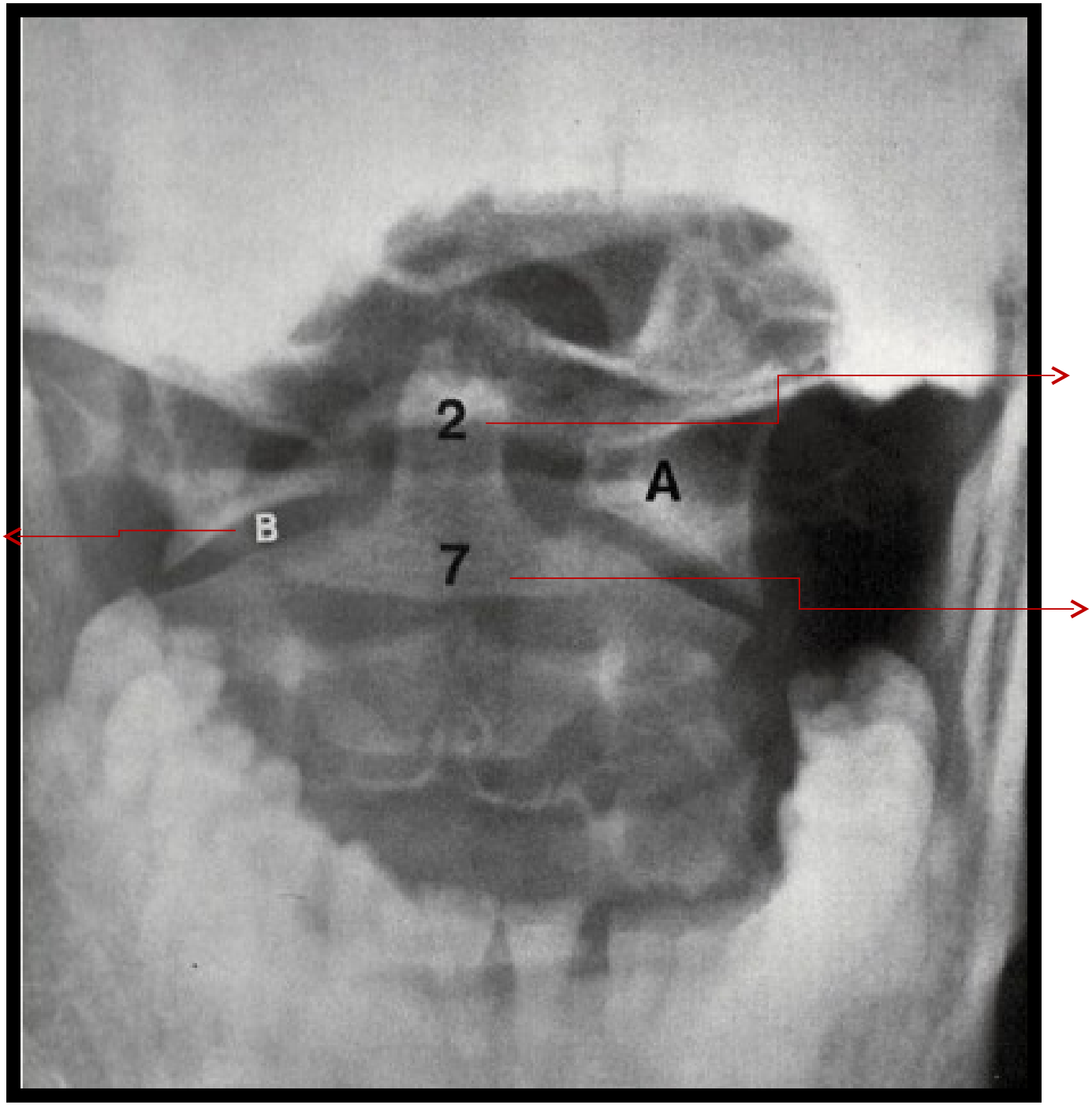
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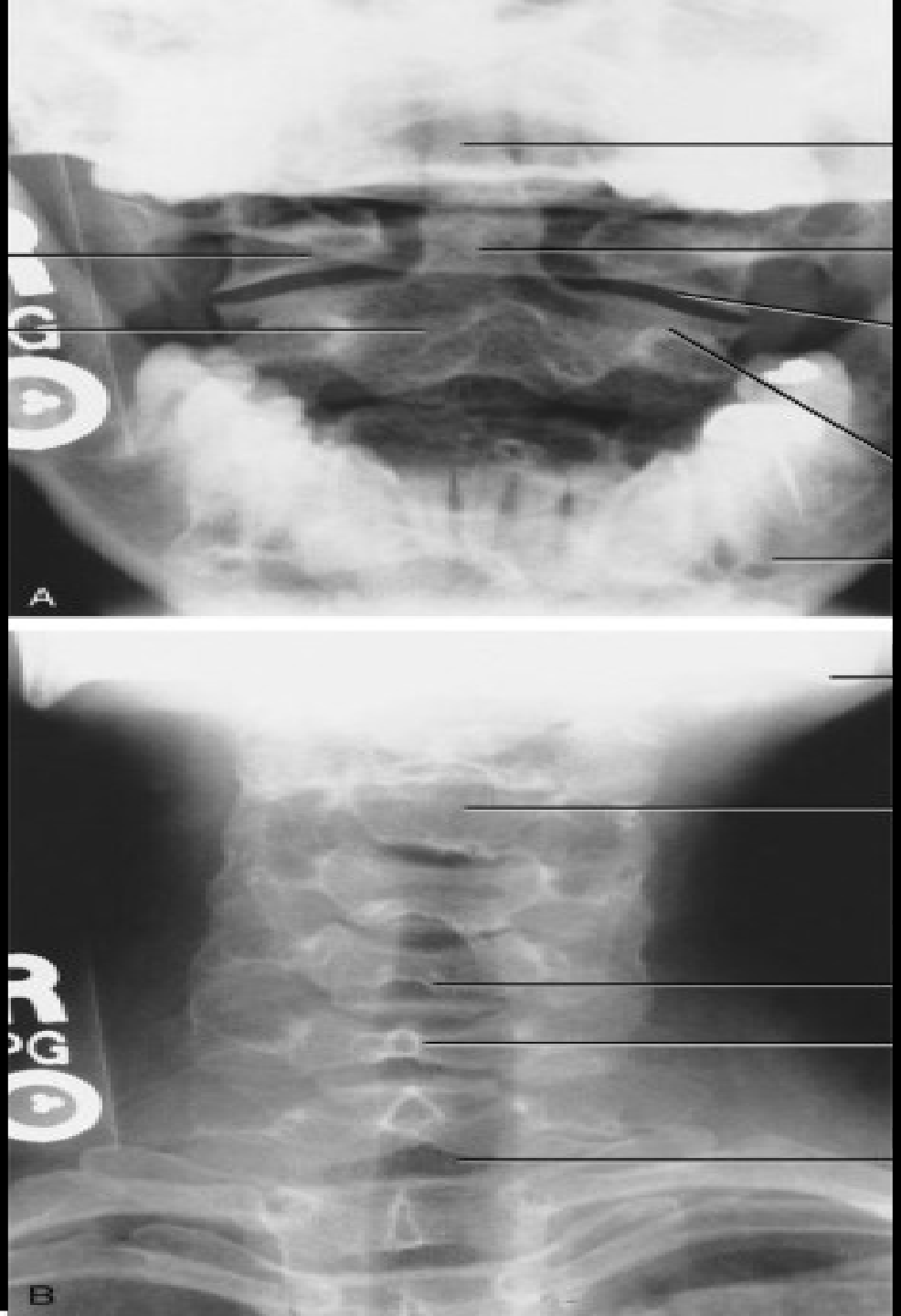


Ön dişlerin üstü

Odontoid

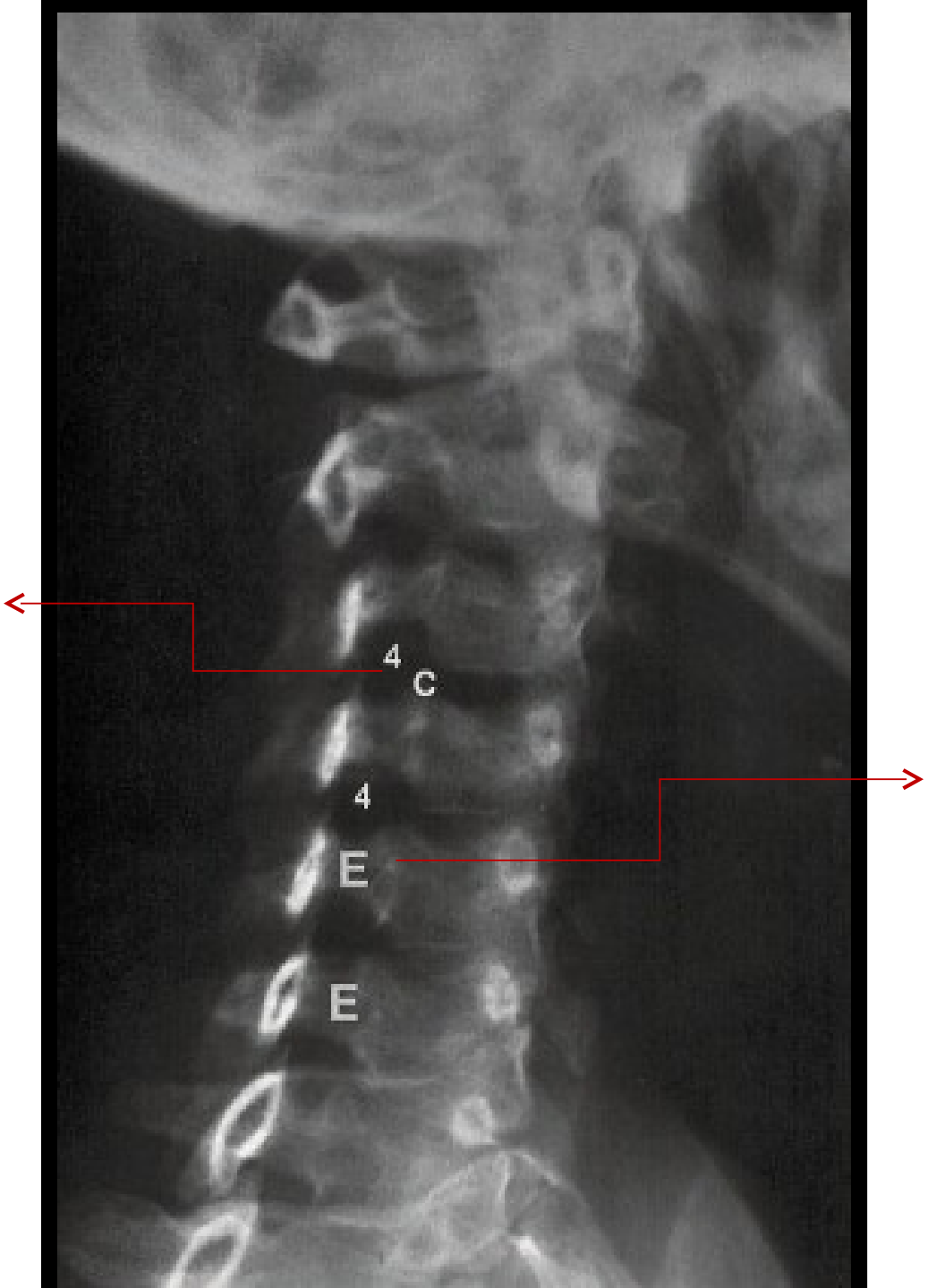
C1 lateral gövde

C2 gövde

C1 inferior articuler proces

C2 superior articuler proces

Mandibula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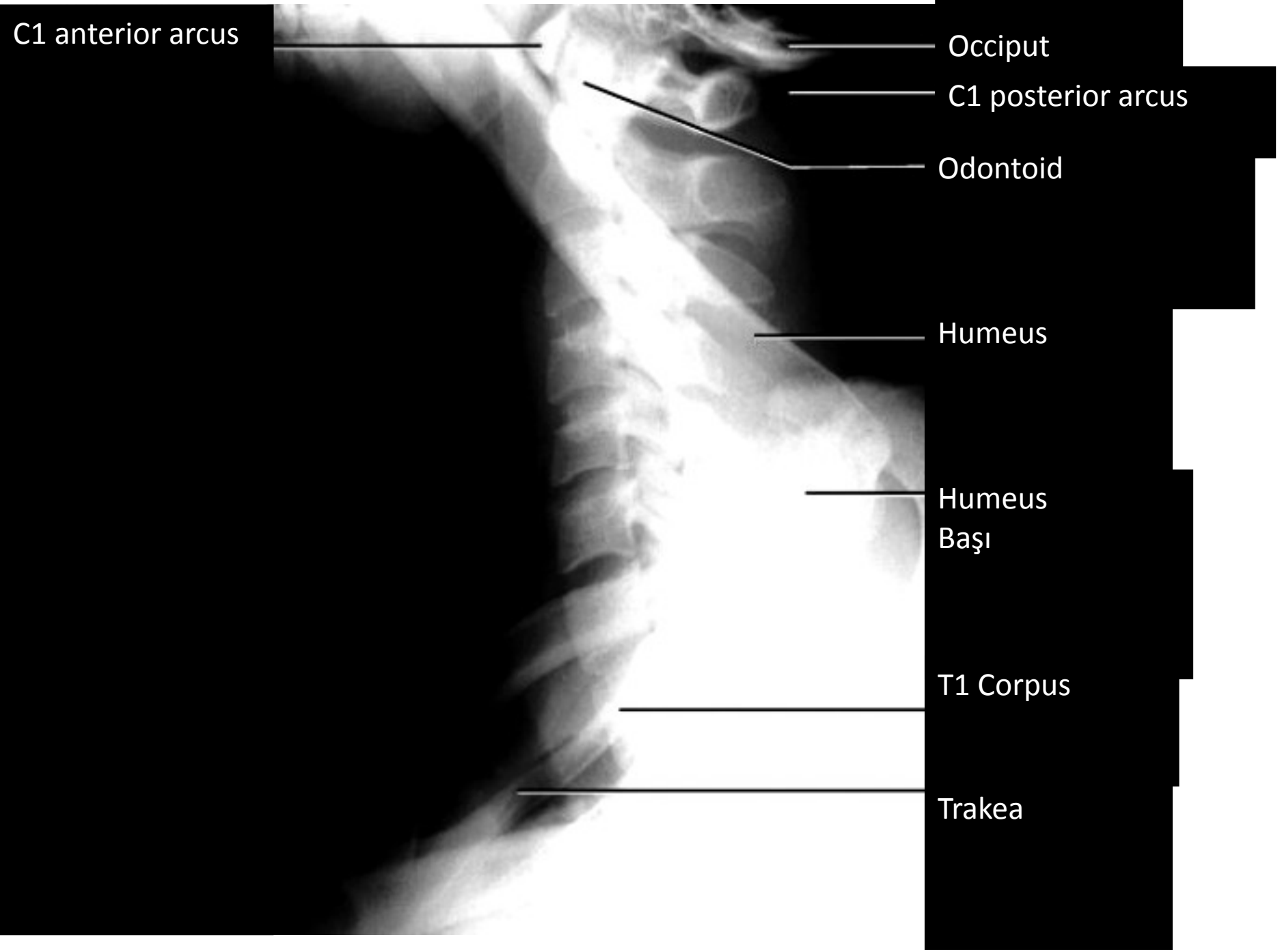
C1 anterior arcus
Occiput
C1 posterior arcus
Odontoid
Humeus
Humeus
Başı
T1 Corpus
Trakea

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Radiology of the Cervical Spine in Trauma Patients: Practice Pitfalls and Recommendations for Improving Efficiency and Communication

Robert M. Vandemark[1]

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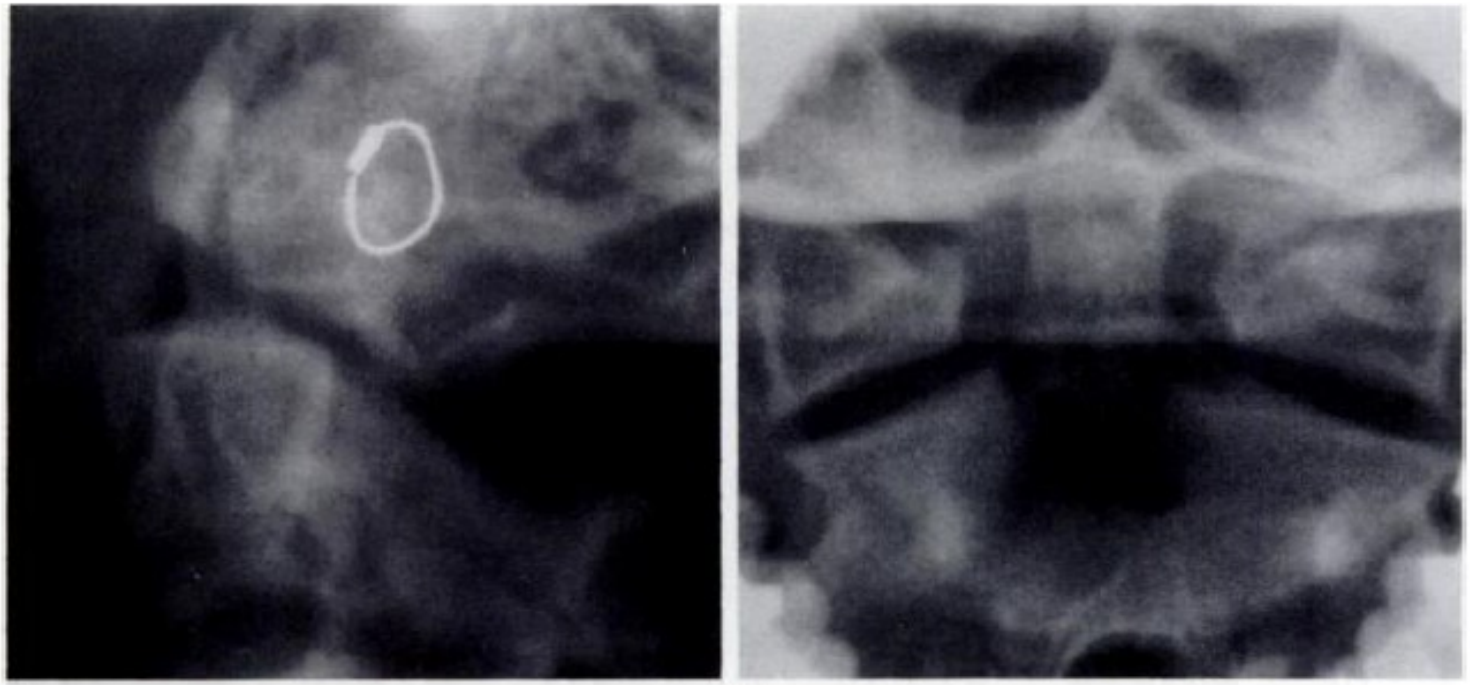

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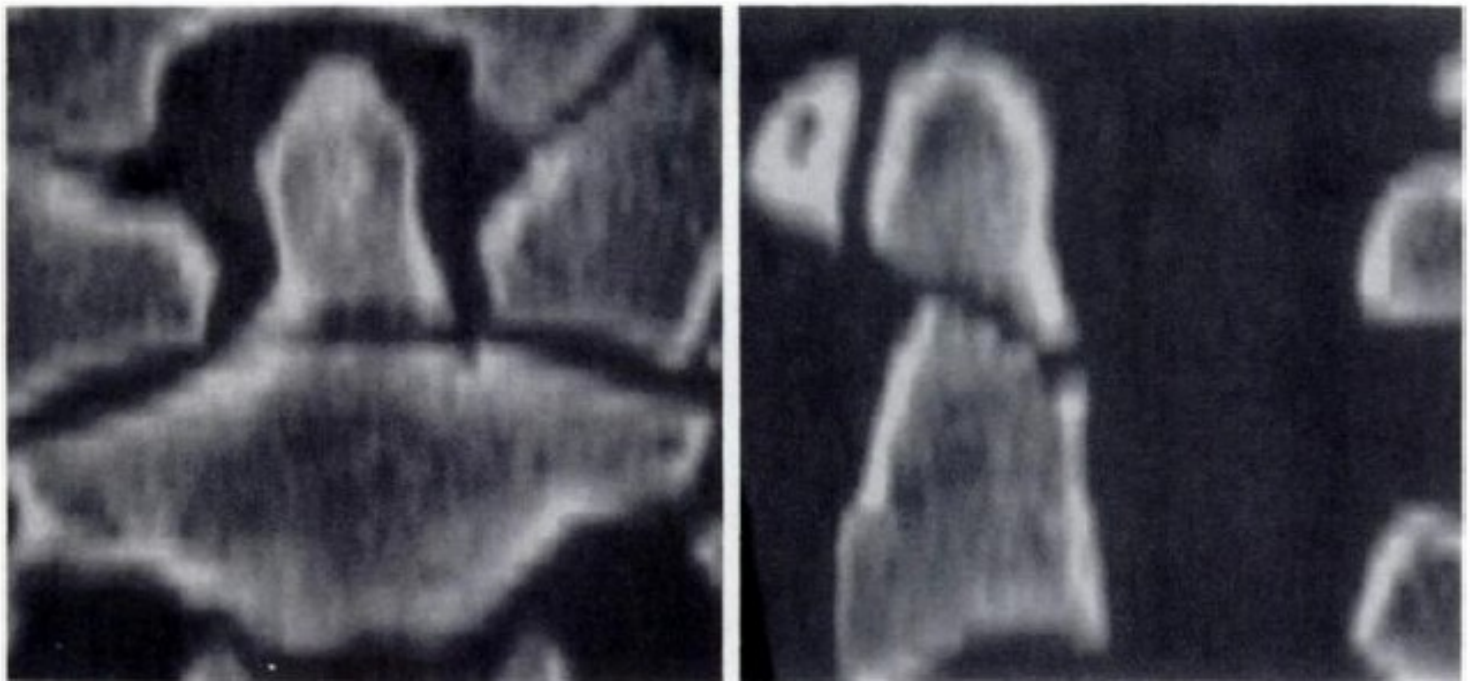

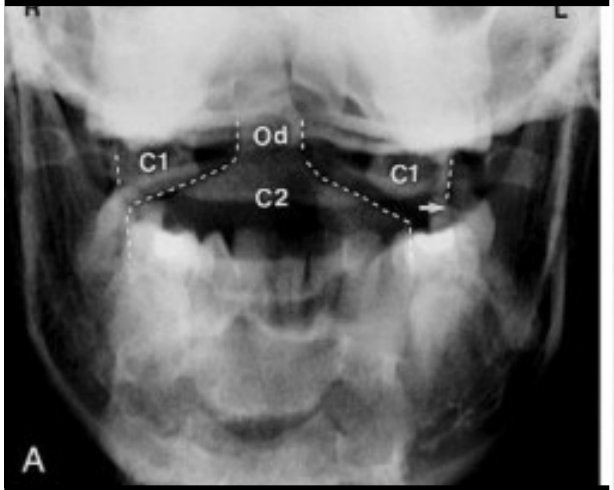
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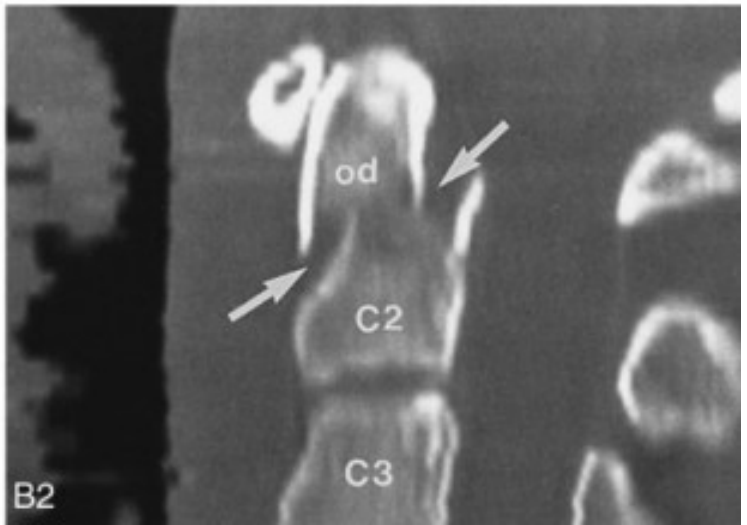
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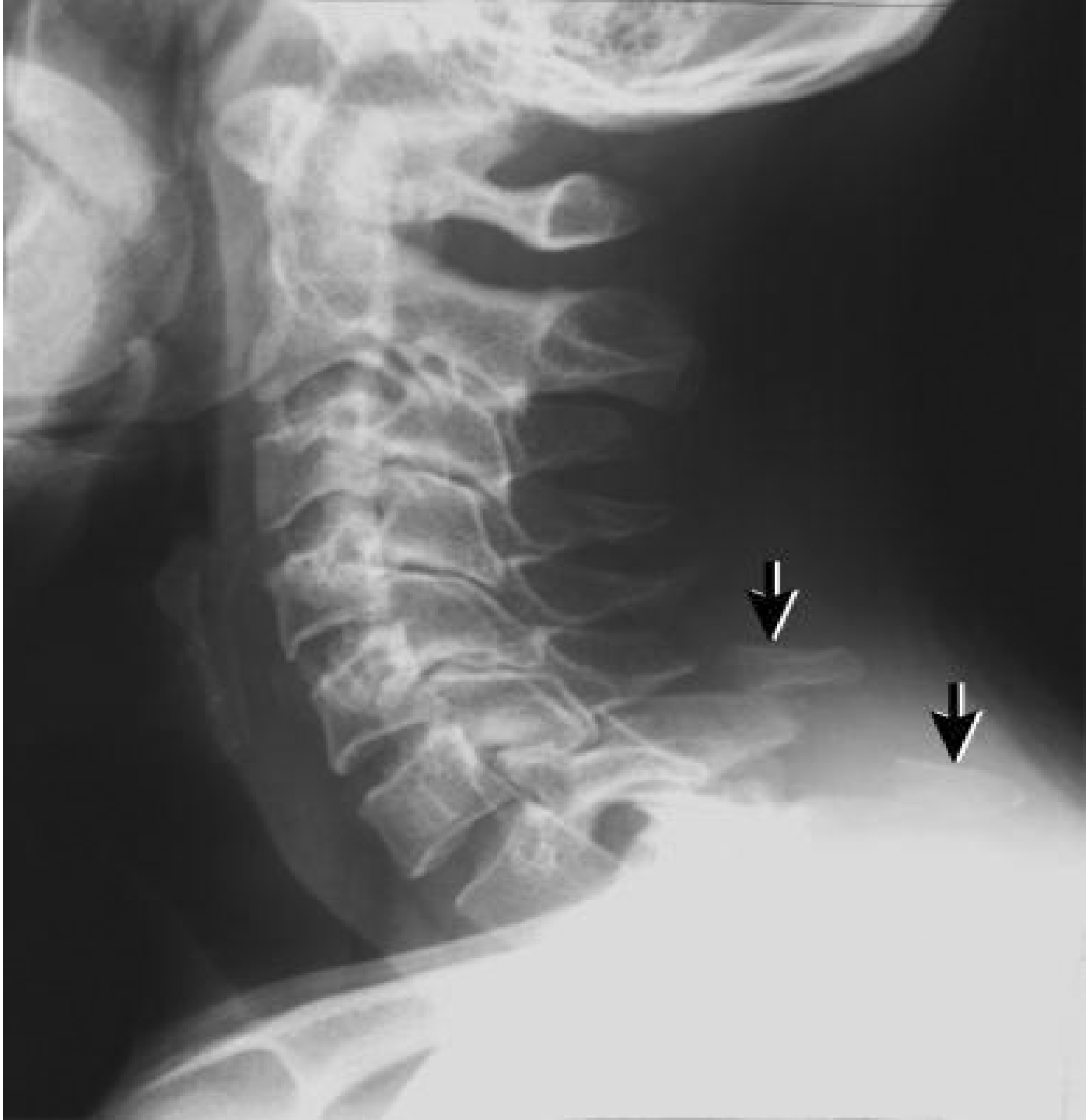

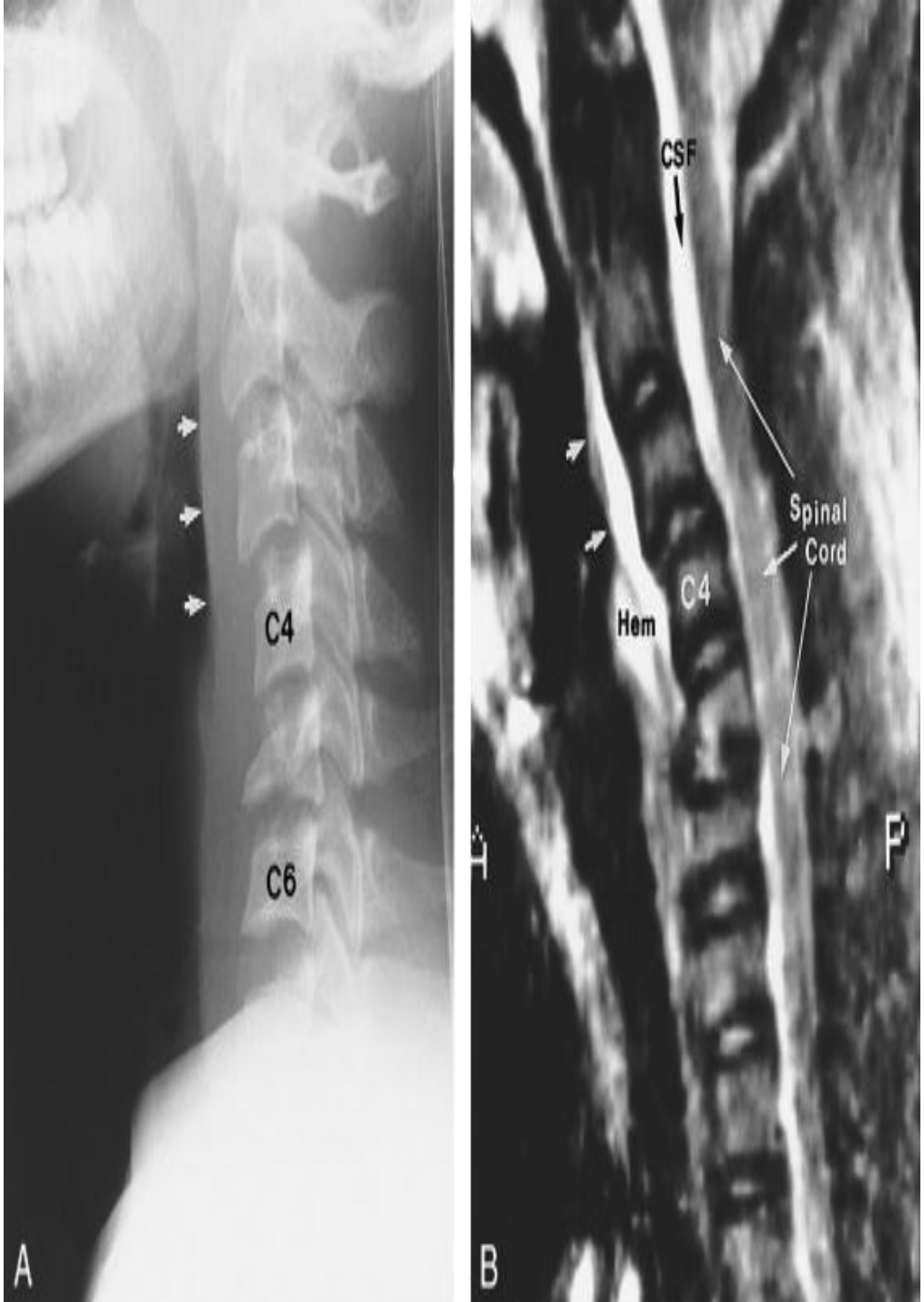
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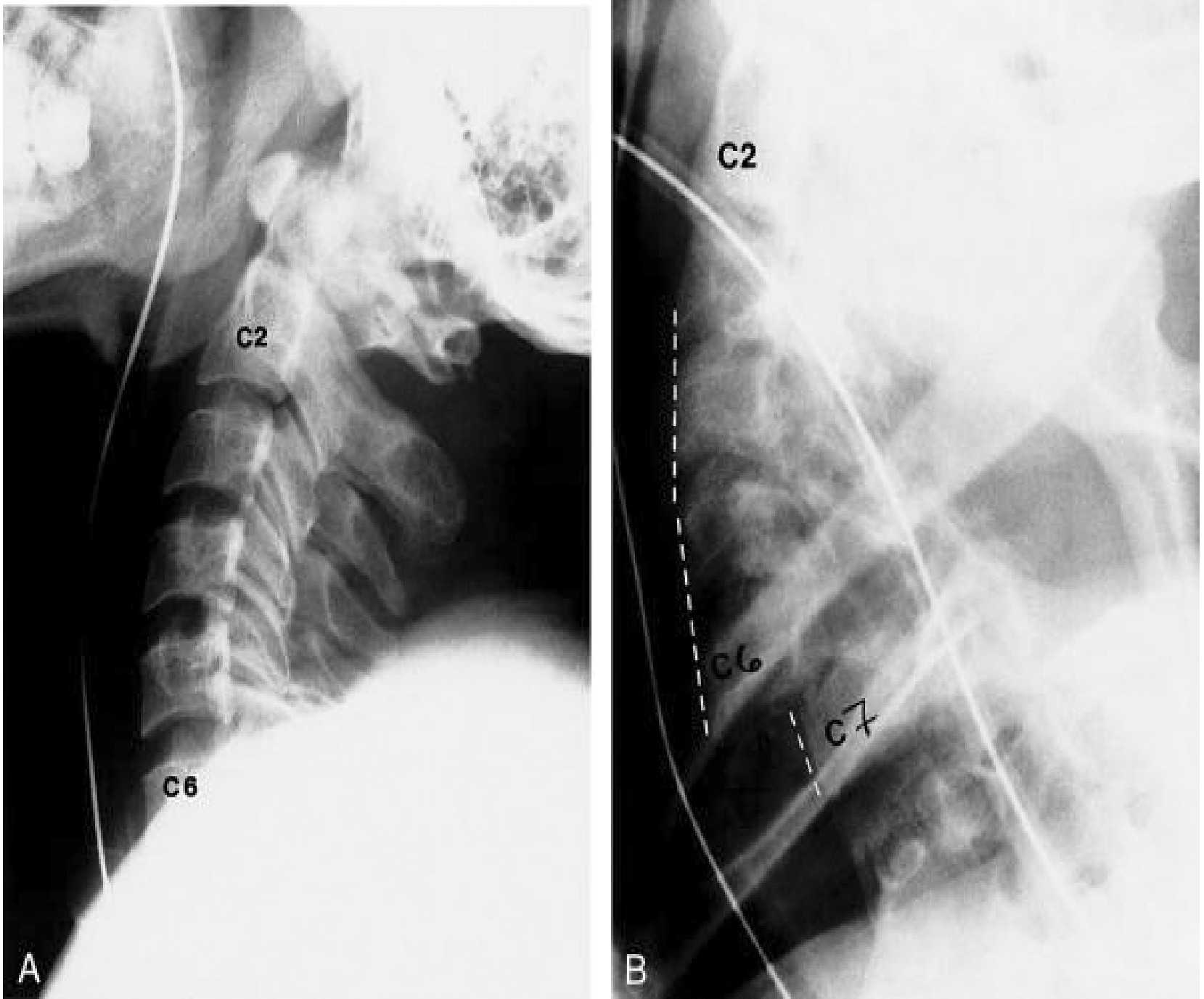
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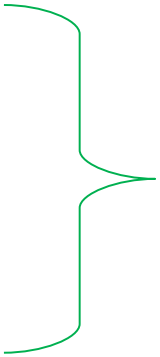

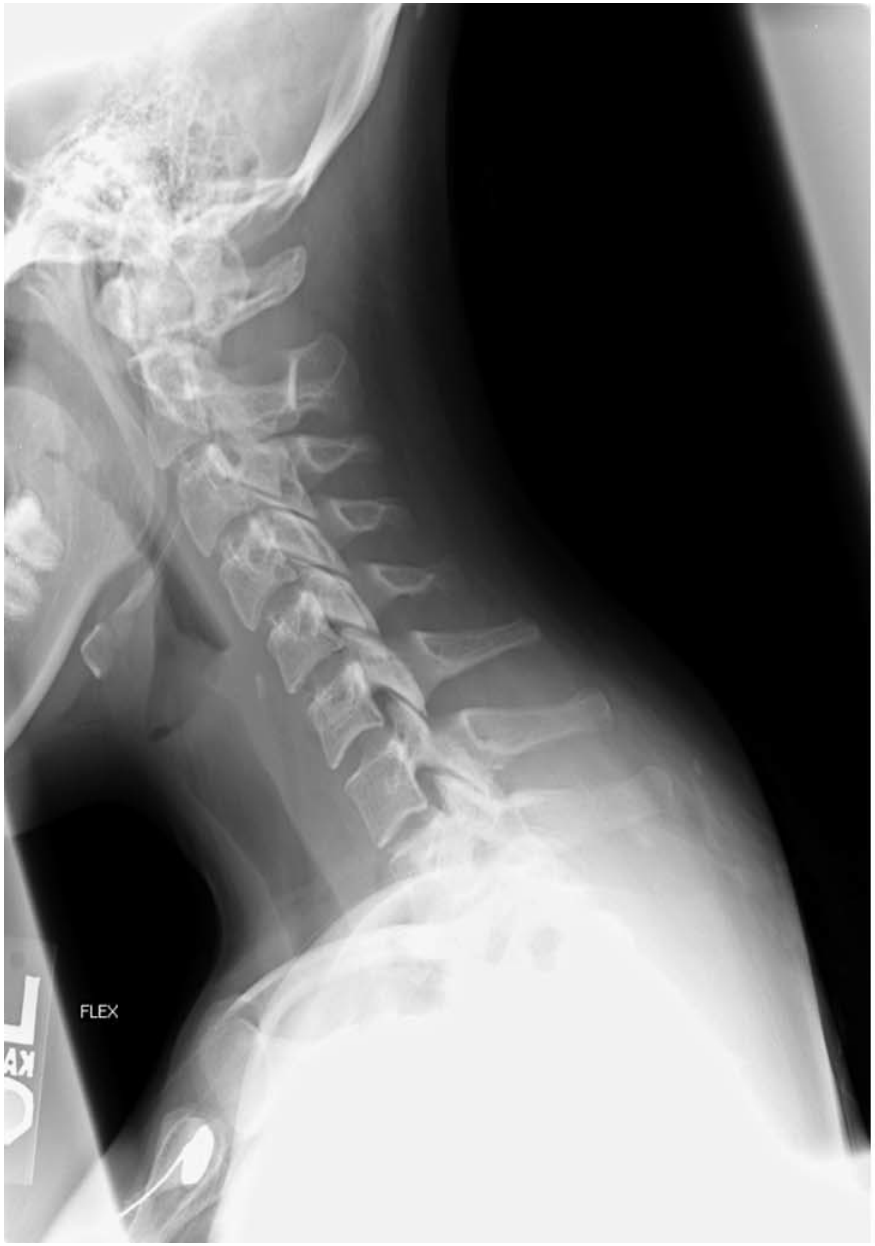
FLEX


EXT


A
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Use of Flexion-Extension Radiographs of the Cervical Spine in Blunt Trauma

From the Department of Emergency Medicine, Maricopa Medical Center, Phoenix, AZ*; the Department of Emergency Medicine, UCSF-Fresno, University Medical Center, Fresno, CA†; the Ohio State University Medical Center, Columbus, OH§; and the UCLA Emergency Medicine Center, Los Angeles, CA.‖

Author contributions are provided at the end of this article.

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Charles V. Pollack, Jr., MA, MD*
Gregory W. Hendey, MD‡
Daniel R. Martin, MD§
Jerome R. Hoffman, MA, MD‖
William R. Mower, MD, PhD‖
For the NEXUS Group

See related articles, p. 1, p. 12, p. 17, and p. 22.

Study objective: Flexion-extension (F/E) radiographs of the cervical spine are often used in patients with blunt trauma when the evaluating physician remains concerned about bony or ligamentous injuries despite negative or nondiagnostic standard radiographs. The use of this approach has never been addressed in a large prospective study. We sought to determine the clinical factors associated with ordering F/E views and the incidence of diagnostic F/E films in patients with a normal 3-view cervical spine series.

Methods: Patients with blunt trauma selected for radiographic cervical spine imaging at 21 participating institutions in the National Emergency X-Radiography Utilization Study project under-

Conclusion: F/E imaging adds little to the acute evaluation of patients with blunt trauma. Other approaches, including magnetic resonance imaging, computed tomography, or delayed F/E, in the presence of specific clinical concerns would seem to provide a more reasonable approach to adjunctive imaging.

[Pollack CV Jr, Hendey GW, Martin DR, Hoffman JR, Mower WR, for the NEXUS Group. Use of flexion-extension radiographs of the cervical spine in blunt trauma. *Ann Emerg Med.* July 2001;38:8-11.]

Role of flexion/extension radiography in neck injuries in adults

Report by Elspeth Pitt, *Specialist Registrar*
Checked by Shobhan Thakore, *Consultant*

doi: 10.1136/emj.2004.017947

Abstract

A short cut revie
flexion-extension
tion of a neurologi
tenderness and n
Altogether 101 pa
of which five pre
clinical question. T
patient group stud
and study weaknesses of these best papers are tabulated. A clinical bottom line is stated.

► **CLINICAL BOTTOM LINE**

In the acute setting FECSR adds little if CT/MR can be used to seek fractures or ligamentous instability.

Clinical scenario

A man attends the emergency department having been involved in a high speed road traffic accident. He complains of neck pain and midline neck spinal tenderness but has no neurological signs or symptoms. Standard 3-view cervical spine radiology (lateral, anteroposterior, and odontoid views) shows no abnormality. You wonder if a flexion/extension radiograph would show any significant injury/instability.

Three part question

In [a neurologically intact adult patient with neck pain following trauma but normal plain radiographs] do [flexion/extension xrays] aid [diagnosis of ligamentous or soft tissue injury with instability]?

Search strategy

Medline 1966-05/04 and Embase 1980-05/04 using the Ovid interface. [exp neck injuries/OR neck trauma.mp OR cervical
OR exp spinal cord
actures/OR cervical
exp cervical verte-
p OR exp spinal
ion.ti OR dynamic
flexion-extension
rvical spine radio-
np] AND [exp joint
ligament injury.mp
s/OR ligamentous
instability.mp OR exp soft tissue injuries/OR soft tissue injury.mp] LIMIT to human AND English.

Search outcome

Altogether 101 papers from Medline and 79 from Embase were found of which five were relevant (see table 2).

Comment(s)

Most studies are retrospective so the evidence base is limited. Flexion-extension cervical spine radiography (FECSR) is safe in the properly selected patient. If the patient has adequate

The Journal of TRAUMA® Injury, Infection, and Critical Care

Utility of Flexion and Extension Radiographs of the Cervical Spine in the Acute Evaluation of Blunt Trauma

Erik K. Inaba, MD, PhD, Vicente H. Graciaa, MD, Rajan Gupta, MD, Claudia E. Goettler, MD, David F. Gaieski, MD, and Murray K. Dalinka, MD

Background: The purpose of this study is to investigate the usefulness of flexion and extension radiographs of the cervical spine for the acute evaluation of ligamentous injury in cases of awake blunt trauma.

Methods: A review of 106 consecutive cases of blunt trauma evaluated with flexion and extension radiographs of the cervical spine obtained in the acute setting at a Level I trauma center was performed. The data compiled included the age, sex, mechanism of injury, type of radiographic evaluations, interpretation of all radiographic studies, and clinical outcome on follow-up.

Results: Sixty-six of the patients (62%) were involved in motor vehicle crashes. Other injuries included 15 falls (14%), 9 blunt assaults (8.5%), and 16 other types of blunt trauma (15%). Thirteen cervical spine injuries were diagnosed in 9 of 106 patients (8.5%). Injuries included two fractures, eight acute disc herniations, two ligamentous injuries, and one cord contusion diagnosed on the basis of all radiologic evaluation and clinical follow-up. Seventy-four patients (70%) had a range of flexion and extension motion interpreted as adequate for diagnostic purposes. Five of the 74 patients (6.75%) with an adequate range of motion had cervical spine injuries. No ligamentous injuries were misdiagnosed in this group. Thirty-two of the flexion and extension examinations (30%) were interpreted as inadequate because of limited motion. Four of the 32 patients (12.5%) with inadequate flexion and extension examinations had injuries subsequently detected on cross-sectional imaging (computed tomographic scanning or magnetic resonance imaging) including severe ligamentous injury.

Conclusion: When adequate motion was present on flexion and extension radiographs, the false-negative rate was zero in this study. However, in the acute setting, 30% of the examinations were limited by inadequate motion. A higher percentage of injury (12.5%) was detected by subsequent cross-sectional imaging in these patients. Limited flexion and extension motion on physical examination should preclude the use of flexion and extension radiographs, as they are of limited diagnostic utility. Cross-sectional imaging may be warranted in this high-risk group of patients.

Key Words: Flexion and extension, Radiographs, Cervical spine.

Use of Flexion and Extension Radiographs of the Cervical Spine to Rule Out Acute Instability in Patients With Negative Computed Tomography Scans

Safdar N. Khan, MD, Gregory Erickson, MD,* Matthew J. Sena, MD,† and Munish C. Gupta, MD**

Objectives: To investigate the usefulness of flexion and extension

specificity 99%, positive predictive value 0%, and negative predictive value 31%.

Sonuç: CT negatif olan hastalarda instabiliteyi değerlendirmede yararlı değil

plate of the first thoracic vertebra; 2) adequate range of flexion and extension was defined as motion greater than 30° from the neutral position; 3) supplementation with a swimmer's view if the cervicothoracic junction was poorly visualized; and 4) no evidence of rotational deformity on neutral, flexion, or extension views. Radiographs were thus deemed either "adequate" or "inadequate." Acute instability was defined as listhesis of greater than 3.5 mm or 11° of relative angulation. Radiologists' interpretation of all studies was noted and any clinical or radiographic evidence of instability on follow-up within 3 months of discharge was also recorded.

Results: A total of 311 patients were included in the study. The intraobserver reliability for the four fixed criteria for adequacy of flexion and extension radiographs was excellent. Only 97 (31%) flexion and extension radiographs were deemed adequate. Two hundred fourteen (69%) patient radiographs were deemed inadequate but were interpreted as normal by the radiologists. Not a single radiograph was identified with evidence of acute instability (true-positive = 0). One hundred seventy-one (55%) of patients had follow-up within 3 months of discharge from the hospital of which one (0.5%) patient developed signs of instability necessitating surgery. The sensitivity was 0%,

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From the Departments of *Orthopaedic Surgery; and †General Surgery, University of California, Davis, Sacramento, CA.
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Reprints: Safdar N. Khan, MD, Department of Orthopaedic Surgery, 4860 Y Street, Sacramento, CA 95817 (e-mail: safdarkhan@ucdmc.ucdavis.edu).

is critically important because the consequences of a missed cervical spine injury can be devastating. Clinical evaluation is the first step and patients with neck tenderness are followed with bony imaging of the cervical spine. Multiview plain radiographs and, more recently, computerized tomography (CT) are the next step in the evaluation of persistent neck tenderness.

Despite the high sensitivity of CT in detecting bony injuries (vertebral body fractures, facet dislocations, facet fractures, lamina fractures, and so on), patients with persistent neck pain and negative bone imaging present a continued diagnostic challenge. Purely ligamentous injury, although rare, may have devastating sequelae if unrecognized. Magnetic resonance imaging has a high diagnostic accuracy but is resource-intensive and costly. Alternatively, using cervical spine flexion-extension radiographs to evaluate ligamentous stability has been advocated by some in the setting of persistent neck pain and negative bone imaging.[3,4] To the best of our knowledge, the evidence in support of this technique originates from case reports describing posttraumatic instability in patients with normal plain radiographic evaluations of the cervical spine.[5–7] The purpose of this study was to examine the contribution of cervical flexion–extension radiographs in the evaluation of persistent cervical spine tenderness in awake adults with a negative screening CT scan.

PATIENTS AND METHODS

We identified all patients admitted to an academic, Level I trauma center over 12 months (2004–2005) who sustained

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Cervical Spine Imaging in Patients with Trauma: Determination of Fracture Risk to Optimize Use[1]

C. Craig Blackmore, MD, MPH
Scott S. Emerson, MD, PhD
Frederick A. Mann, MD
Thomas D. Koepsell, MD, MPH

Index terms:
Receiver operating characteristic curve (ROC)
Spine, fractures, 31.11, 31.12, 31.41
Spine, injuries, 31.11, 31.12, 31.41
Trauma, 31.41

Radiology 1999; 211:759–765

Abbreviations:
OR = odds ratio
ROC = receiver operating characteristic

[1] From the Department of Radiology, CB 7510, School of Medicine, University of North Carolina–Chapel Hill, Chapel Hill, NC 27599–7510 (C.C.B.); and the Department of Radiology, Harborview Medical Center (C.C.B., F.A.M.), the Departments of Biostatistics (S.S.E.) and Epidemiology (T.D.K.), and the Robert Wood Johnson Clinical Scholars Program (C.C.B., T.D.K.), University of Washington, Seattle. From the 1997 RSNA scientific assembly. Received October 28, 1997; revision requested January 20, 1998; final revision received September 1; accepted December 15. C.C.B. supported by the Seattle Veterans Affairs–Robert Wood Johnson Clinical Scholars Program. **Address reprint requests to** C.C.B.

The views expressed are those of the authors and are not necessarily those of the Robert Wood Johnson Foundation or the Veterans Administration.

Author contributions:
Guarantors of integrity of entire study, C.C.B.; study concepts, C.C.B., F.A.M., T.D.K.; study design, C.C.B., S.S.E., F.A.M., T.D.K.; definition of intellectual content, C.C.B., S.S.E., F.A.M., T.D.K.; literature research, C.C.B.; data acquisition, C.C.B.; data analysis, C.C.B., S.S.E., T.D.K.; statistical analysis, C.C.B., S.S.E., T.D.K.; manuscript preparation, C.C.B., S.S.E.; manuscript editing and review, C.C.B., S.S.E., F.A.M., T.D.K.

PURPOSE: To develop a method to use clinically apparent factors to determine cervical spine fracture risk to guide selection of optimal imaging strategies.

MATERIALS AND METHODS: Records from 472 patients with trauma (168 with fractures, 304 control patients) who visited the emergency department in 1994 and 1995 were reviewed for 20 potential predictors of cervical spine fracture in this retrospective case-control study. Simple logistic regression was used to determine predictors of cervical spine fracture. Prediction rules were formulated by using multiple logistic regression and recursive partitioning with bootstrap validation. Posttest fracture probabilities were calculated from base prevalence and likelihood ratios derived for predictors by using Bayes theorem.

RESULTS: Predictors of cervical spine fracture included severe head injury (adjusted odds ratio [OR] = 8.5, 95% CI: 4.0, 17.0), high-energy cause (OR = 11.6, 95% CI: 5.4, 25.0), and focal neurologic deficit (OR = 58, 95% CI: 12, 283). The prediction rule was used to stratify patients into groups with fracture probabilities of 0.04%–19.70%. After adjusting for overfitting, the area under the receiver operating characteristic curve was 0.87.

CONCLUSION: Clinically apparent factors, including cause of injury, associated injuries, and age, can be used to determine the probability of cervical spine fracture. Development of evidence-based imaging guidelines should incorporate knowledge of fracture probability.

Spinal cord injuries are a major source of morbidity and mortality in the United States, particularly among young persons. Occurring at a rate of approximately 30 injuries per million person-years (1), spinal cord injuries cost society an estimated $3.4 billion in 1993 (2). The majority of these cord injuries are related to cervical spine fractures. However, such fractures may not be clinically apparent, and, if not diagnosed rapidly, they may lead to subsequent neurologic deficits, including paralysis (3–5). Accordingly, trauma care, including the American College of Surgeons Advanced Trauma Life Support program, has emphasized imaging of the cervical spine (commonly referred to as "screening" imaging) for all patients whose injuries raise the possibility of cervical spine fracture (6).

Screening radiography of the cervical spine is expensive, costing society as much as $140 million annually (7), and usually has a low yield, with only 1%–5% of screening studies showing a fracture (8–10). In addition, depending on the clinical situation, from 4% to 28% of such screening radiographic examinations may lead to further imaging, without a fracture being present (11). Accordingly, considerable attention has been focused on developing optimal guidelines for cervical spine imaging. However, the same imaging strategy may not be appropriate for all patients. Patients with a very low probability of fracture may not need any imaging (12,13), whereas those with a modest probability of injury may require radiography. In addition, several authors (14–16) have suggested that patients with a high probability of fracture may benefit from screening computed tomography (CT). The key to determining who should undergo screening and to selecting the ideal imaging modality is the probability of fracture.

Servikal spinal fraktürleri öngörme

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Cervical Spine Injury: A Clinical Decision Rule to Identify High-Risk Patients for Helical CT Screening

Julian A. Hanson[1]
C. Craig Blackmore[1,2]
Frederick A. Mann[1]
Anthony J. Wilson[1]

OBJECTIVE. We aimed to validate the routine use of a clinical decision rule to direct diagnostic imaging of adult blunt trauma patients at high risk for cervical spine injury.

MATERIALS AND METHODS. We previously developed and have since routinely used a prediction rule based on six clinical parameters to identify patients at greater than 5% risk of cervical spine injury to undergo screening helical CT of the cervical spine. During a 6-month period, 4285 screening imaging studies of the cervical spine were performed in adult blunt trauma patients. Six hundred one patients (398 males, 203 females; age range, 16–100 years; median age, 38 years) underwent helical CT, and the remainder underwent 3684 conventional radiographic examinations. Clinical and report data were extracted from the radiology department database, medical records, and the hospital trauma registry. Abnormal findings were independently confirmed by additional imaging studies, autopsy results, or clinical outcome.

RESULTS. The true-positive cervical spine injury rates in helical CT– and conventional radiography-screened patients who presented directly to our trauma center were 40 (8.7%) of 462 and seven (0.2%) of 3684, respectively. The cervical spine injury rate in patients who were transferred from outside institutions to our trauma center and who underwent helical CT was 37 (26.6%) of 139. This figure included 20 patients already known to have cervical spine fracture.

CONCLUSION. The clinical decision rule can distinguish patients at high and low risk of cervical spine injury, thus supporting its validity.

Spinal cord injury and paralysis are important health burdens in the United States, with an annual incidence of 40 per 1 million population. Most cases are caused by blunt force cervical spine trauma [1, 2]. Radiography, despite its recognized limitations [3], is the standard imaging technique for screening patients for suspected neck injury that may be clinically occult. A minimum standard examination comprises a lateral radiograph that completely shows C7 and anteroposterior and open-mouth odontoid views [4]. Recent interest has been shown in the technique of helical CT to screen for cervical spine injury [5]. Advantages of helical CT over radiography may include improved accuracy and faster diagnosis [6]. However, helical CT of the cervical spine is more expensive than conventional radiography, carries a higher radiation dose, and may be warranted only in high-risk patients. Recent work from our institution, using decision-tree analysis modeling and considering all long-term costs and outcomes, has shown that screening helical CT can be more cost-effective than conventional radiography, provided that contemporaneous head CT is performed and that the probability of cervical spine fracture in the screened population exceeds approximately 5% [7]. Thus, the optimal imaging strategy for a particular patient will depend on that individual's probability of injury.

Unfortunately, reliable predictors of cervical spine injury have proven difficult to identify, although several authors have proposed methods for stratifying patients into broad categories of risk [3, 8, 9]. We developed a clinical decision rule (Appendix), based on published and retrospective local institutional data, that was designed to select adult patients with blunt trauma who are at greater than 5% risk for cervical spine fracture to undergo screening helical CT [10]. Guidelines

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[1]Department of Radiology, Harborview Medical Center, University of Washington School of Medicine, 325 Ninth Ave, Seattle, WA 98104. Address correspondence to C. C. Blackmore.

[2]Department of Radiology, University of North Carolina, Manning Dr., Chapel Hill, NC 27599.

AJR 2000;174:713–717

0361–803X/00/1743–713

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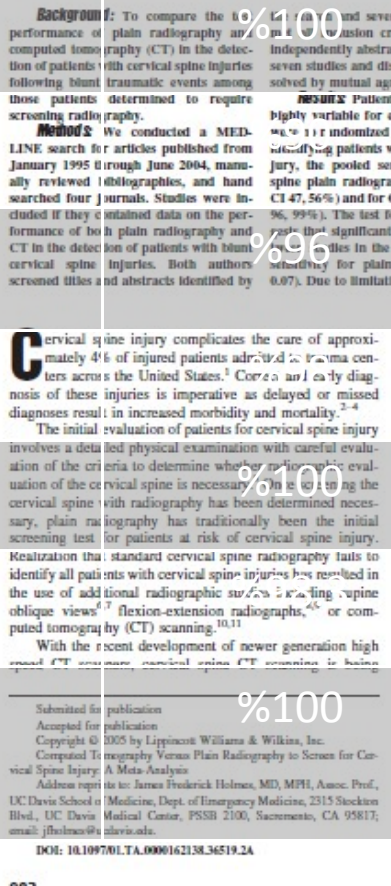
Çalışma	Hasta sayısı	Grafide saptanan hasar(%)	Tomografide saptanan hasar (%)	Gold Standard test
Nunez, 1996	88	%37.5	%100	CT
Schenarts, 2001	1356	%54	%96	Radyolog
Griffen, 2002	1199	%65	%100	CT
Widder,2004	102	%39	%100	Klinik kayıtlar



Background: To compare the t… performance o… plain radiography an… computed tomo… raphy (CT) in the detection of patients … ith cervical spine injuries following blunt traumatic events among those patients determined to require screening radi… raphy.

Method… We conducted a MEDLINE search for articles published from January 1995 t… hrough June 2004, manually reviewed … ibliographies, and hand searched four … ournals. Studies were included if they c… ntained data on the performance of both … plain radiography and CT in the detec… tion of patients with blunt cervical spine … injuries. Both authors screened titles a… nd abstracts identified by … nd seven of the 712 a… rticles … clusion criteria. Both a… uthors independently abstracted data from these seven studies and disagreements w… re resolved by mutual agreement.

Results: Patient entry criteria were highly variable for each study and there were … r randomized controlled trials. Fo… identifying patients with cervical spine injury, the pooled sensitivity for … ervical spine plain radiography was 52% (95% CI 47, 56%) and for CT was 98% (9…% CI 96, 99%). The test for heterogeneity sug… gests significant differences exist between studies in the measurement of the sensitivity for plain radiography (p = 0.07). Due to limitations of the gold stan… dard tests in each study, calculation of a combined specificity was not possible.

Conclusion: Despite the absence of a randomized controlled trial, ample evidence exists that CT significantly outperforms plain radiography as a screening test for patients at very high risk of cervical spine injury. … CT should be … the initial screening … n those patients with a significantly depressed mental status. There is insufficient evidence to suggest that cervical spine CT should replace plain radiography as the initial screening test for … ss injured patients who are at low risk … still require … … … graphic examination.

J Trauma. 2005;58:902–905.

Cervical spine injury complicates the care of approximately 4… of injured patients admitted … trauma centers across the United States.[1] Correct and early diagnosis of these injuries is imperative as delayed or missed diagnoses result in increased morbidity and mortality.[2–4]

The initial evaluation of patients for cervical spine injury involves a detailed physical examination with careful evaluation of the criteria to determine whether radiographic evaluation of the cervical spine is necessary. Imaging the cervical spine with radiography has been determined necessary, plain radiography has traditionally been the initial screening test for patients at risk of cervical spine injury. Realization that standard cervical spine radiography fails to identify all patients with cervical spine injuries has resulted in the use of additional radiographic studies including supine oblique views,[5,6] flexion-extension radiographs,[4,5] or computed tomography (CT) scanning.[10,11]

With the recent development of newer generation high speed CT scanners, cervical spine CT scanning is being …

utilized with increasing frequency as a screening test for patients with potential cervical spine injury. However, the appropriate screening test to rule out cervical spine injury in the blunt trauma patient is unclear. The goal of this meta-analysis is to compare the test performance of plain radiography and CT for identifying patients with cervical spine injuries after blunt traumatic events.

METHODS

We queried the English-language medical literature to examine the test performance of plain radiography and computed tomography for identifying patients with cervical spine injuries. We searched MEDLINE for articles published from January 1995 to June 2004. Search terms included *cervical spine trauma* and *computed tomography*. The MEDLINE search was supplemented with a manual search of the bibliographies of all selected articles and a hand search of the four journals: *The Journal of Trauma, Injury, Infection, and Critical Care*, *…pine*, *Annals of Emergency Medicine*, and *Academic Emergency Medicine*.

All selected abstracts … reviewed independently by both authors to determine whether the study met the inclusion or exclusion criteria. We included studies if they were either a randomized controlled trial comparing plain radiography with CT for the detection of blunt cervical spine injury or a cohort study consisting of patients undergoing both plain radiography and helical CT of the cervical spine for the detection of blunt cervical spine injury. Articles were excluded for any of the following: 1) the plain

Submitted for publication
Accepted for publication

Computed Tomography Versus Plain Radiography to Screen for Cervical Spine Injury: A Meta-Analysis
Address reprints to: James Frederick Holmes, MD, MPH, Assoc. Prof., UC Davis School of Medicine, Dept. of Emergency Medicine, 2315 Stockton Blvd., UC Davis Medical Center, PSSB 2100, Sacramento, CA 95817; email: jfholmes@ucdavis.edu.
DOI: 10.1097/01.TA.0000162138.36519.2A

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The Journal of TRAUMA® Injury, Infection, and Critical Care

CT Should Replace Three-View Radiographs as the Initial Screening Test In Patients at High, Moderate, and Low Risk for Blunt Cervical Spine Injury: A Prospective Comparison

John Bailitz, MD, Frederic Starr, MD, Matthew Beecroft, MD, Jon Bankoff, MD, Roxanne Roberts, MD, Faran Bokhari, MD, Kimberly Joseph, MD, Dorian Wiley, MD, Andrew Dennis, MD, Susan Gilkey, MD, Paul Erickson, MD, Patricia Raksin, MD, and Kimberly Nagy, MD

Background: An estimated 10,000 Americans suffer cervical spine injuries each year. More than 800,000 cervical spine radiographs (CSR) are ordered annually. The human and healthcare costs associated with these injuries are enormous especially when diagnosis is delayed. Controversy exists in the literature concerning the diagnostic accuracy of CSR, with reported sensitivity ranging from 32% to 89%. We sought to compare prospectively the sensitivity of cervical CT (CCT) to CSR in the initial diagnosis of blunt cervical spine injury for patients meeting one or more of the NEXUS criteria.

Methods: The study prospectively compared the diagnostic accuracy of CSR to CCT in consecutive patients evaluated for blunt trauma during 23 months at an urban, public teaching hospital and Level I Trauma Center. Inclusion criteria were adult patient, evaluated for blunt cervical spine injury, meeting one or more of the NEXUS criteria. All patients received both three-view CSR and CCT as part of a standard diagnostic protocol. Each CSR and CCT study was interpreted independently by a different radiology attending who was blinded to the results of the other study. Clinically significant injuries were defined as those requiring one or more of the following interventions: operative procedure, halo application, and/or rigid cervical collar.

Results: Of 1,583 consecutive patients evaluated for blunt cervical spine trauma, 78 (4.9%) patients received only CCT or CSR and were excluded from the study. Of the remaining 1,505 patients, 78 (4.9%) had evidence of a radiographic injury by CSR or CCT. Of these 78 patients with radiographic injury, 50 (3.3%) patients had clinically significant injuries. CCT detected all patients with clinically significant injuries (100% sensitive), whereas CSR detected only 18 (36% sensitive). Of the 50 patients, 15 were at high risk, 19 at moderate risk, and 16 at low risk for cervical spine injury according to previously published risk stratification. CSR detected clinically significant injury in 7 high risk (46% sensitive), 7 moderate risk (37% sensitive), and 4 low risk patients (25% sensitive).

Conclusion: Our results demonstrate the superiority of CCT compared with CSR for the detection of clinically significant cervical spine injury. The improved ability to exclude injury rapidly provides further evidence that CCT should replace CSR for the initial evaluation of blunt cervical spine injury in patients at any risk for injury.

Key Words: Blunt cervical spine injury, Cervical spine radiographs, Cervical spine CT, Prospective comparison, Blinded radiologists.

J Trauma. 2009;66:1605–1609.

Cervical spine injury (CSI) occurs in 2% to 10% of all patients with blunt cervical trauma (BCT), resulting in 10,000 new victims per year. The human and healthcare costs associated with these injuries are enormous. Since publication in 2000, the NEXUS clinical criteria have become the standard practice for deciding which patients require cervical spine imaging.[1] Although five-view cervical spine radiography has been endorsed by the American College of Emergency Physicians, a three-view series (AP, lateral, open mouth) remains the current practice in most institutions.[2] Abnormal cervical spine radiographs (CSR), an inadequate CSR study, a high suspicion for injury, or the need for multiple CT scans often prompts physicians to order limited or complete cervical CT scans (CCT). In many trauma centers, physicians follow the Eastern Association for the Surgery of Trauma (EAST) guidelines which recommend three-view radiographs of the cervical spine, supplemented with CCT scan of any suspicious or inadequately visualized areas and CCT of C1/C2 in all patients expected to be obtunded for greater than 48 hours.

Recent studies have called into question the sensitivity of CSR as an initial screening test for the diagnosis of CSI. Although the NEXUS study reported a sensitivity of 89%, Griffen et al.[3] later reported a sensitivity of only 65% versus 100% for CCT. This and other studies demonstrating the poor performance of CSR[4–8] have prompted many physicians to ask the question—should CCT replace CSR as the initial screening test for CSI? Our study prospectively compared the

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From the Departments of Trauma (F.S., R.R., F.B., K.J., D.W., A.D., K.N.), Emergency Medicine (M.B., J.Bailitz, J.Bankoff), Radiology (S.G., P.E.), and Neurosurgery (P.R.), John H. Stroger, Jr. Hospital of Cook County, Chicago, Illinois.
Presented at American College of Emergency Physicians National Conference, Seattle, Washington, October 2008.
Address for reprints: John Bailitz, MD, 1900 West Polk, 10th Floor, Department of Emergency Medicine, Chicago, IL 60305; email: jbailitz@cchh.org.

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Plain Radiography Does Not Add Any Clinically Significant Advantage to Multidetector Row Computed Tomography In Diagnosing Cervical Spine Injuries In Blunt Trauma Patients

Raed Hashem, MD, Christopher C. Evans, MD, Forough Farrokhyar, PhD, and Kamyar Kahnamoui, MD

Background: Cervical spine (c-spine) injuries (CSI) in trauma patients are common and potentially catastrophic. Numerous guidelines involving clinical and radiologic criteria have been devised to diagnose such injuries. It is not clear whether using plain X-ray films in addition to helical computed tomography (CT) provides any additional benefit in trauma patients who require radiologic clearance of their c-spine. We hypothesized that three standard X-ray views (anteroposterior, lateral, and odontoid) of the c-spine do not provide clinically significant advantage to Multidetector row CT in diagnosing CSI in trauma patients.

Methods: We reviewed the charts of consecutive adult patients with CSI who were admitted to the Trauma Service at a Level I Trauma Center between January 2001 and December 2004. Patients who had CT plus X-ray at admission were entered into the study. Exclusion criteria were age ≤16 years, incomplete radiology reports, inadequate plain films, or no CSI identified.

Results: A total of 121 patients with diagnosed CSI were included in the study. CT picked up 100% of patients who had a CSI diagnosed on plain films and also detected 47 additional CSI that were missed by plain films. The sensitivity for CT was 100%, whereas that of plain films was 61%. Nine patients with CSI (19.1%) who had false-negative plain films required operative intervention.

Conclusions: Three standard X-ray views of the c-spine provided no clinically significant advantage to Multidetector row CT in diagnosing CSI. Revision of current clinical guidelines on c-spine clearance is recommended.

Key Words: Cervical spine, Computed tomography, Plain X-ray, Retrospective, Database.

J Trauma. 2009;66:423–428.

Cervical spine (c-spine) injuries (CSI) are common in trauma patients. On an annual basis in the United States, these injuries complicate the care of approximately 4% of patients admitted to trauma centers,[1] contribute to approximately 6,000 deaths and result in an additional 3,500 to 5,000 cases of quadraplegia.[2,3] At least some of this burden of morbidity and mortality seems preventable, as about 5% to 10% of patients who have sustained a CSI suffer a worsening of their function as a result of delays in the diagnosis and management of their injury.[4,5] Thus, it is critically important that all patients with potential CSI undergo a comprehensive clinical, and in many cases, radiologic examination to exclude these potentially catastrophic injuries.

Over the past decade, there have been significant efforts devoted to creating evidence-based guidelines to assist clinicians in their decision as to when to remove universal c-spine precautions. This is a critically important decision as inappropriate removal of c-spine protection can result in serious neurologic disability or death,[4] whereas prolonged immobilization can lead to pressure ulcers,[6,7] difficulties in airway management,[8] and vascular access issues. For obtunded trauma patients, the most widely accepted and clinically implanted guidelines to date have been those released by the Eastern Association for the Surgery of Trauma (EAST).[9,10] The first version of these guidelines[9] is the model upon which the protocol for "clearing" the c-spine at our institution (Hamilton Health Sciences) is based.

In accordance with the EAST guidelines, our category I patients (alert, awake, nonintoxicated patients without neck pain or tenderness throughout full range of motion) are cleared by clinical examination alone. Category II patients (alert and awake patients with neck pain or midline tenderness, or age >65 years, or having a dangerous mechanism of injury, or paresthesias) are initially imaged with three views of the c-spine (anteroposterior, lateral, and odontoid), followed with computed tomography (CT) for poorly visualized or suspicious areas. Flexion extension views or magnetic resonance imaging (MRI) may be used to rule out ligamentous injury where indicated, and Swimmers views are used to demonstrate the lower c-spine when necessary. Category III patients are those with an altered mental status and in whom a return to full consciousness is not anticipated within 48 hours. These patients receive three views with plain radiography (if intubated the odontoid view is not performed) in addition to CT of the c-spine and Swimmers views if appropriate. Patients expected to regain consciousness within 48 hours remain in universal precautions until extubated and a clinical examination is performed, whereas those expected to remain unconscious >48 hours have their cervical collar removed after radiologic clearance by a neuroradiologist. If any radiologic abnormality is detected, cervical immobilization is maintained and the spine service is consulted.

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From the Division of Trauma, Hamilton Health Sciences; Department of Surgery, McMaster University, Hamilton, Ontario, Canada.

Address for reprints: Kamyar Kahnamoui, MD, 237 Barton Street East, 6 North, Room 607, Hamilton, Ontario L8L 2X2, Canada; Email: kahnam@mcmaster.ca.

DOI: 10.1097/TA.0b013e3181589fe5

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Practice Management Guidelines for Identification of Cervical Spine Injuries Following Trauma: Update From the Eastern Association for the Surgery of Trauma Practice Management Guidelines Committee

John J. Como, MD, Jose J. Diaz, MD, C. Michael Dunham, MD, William C. Chiu, MD, Therese M. Duane, MD, Jeannette M. Capella, MD, Michele R. Holevar, MD, Kosar A. Khwaja, MD, Julie A. Mayglothling, MD, Michael B. Shapiro, MD, and Eleanor S. Winston, MD

Background: Injury to the cervical spine (CS) is common after major trauma. The Eastern Association for the Surgery of Trauma first published its Practice Management Guidelines for the evaluation of CS injury in 1998. A subsequent revision was published in 2000. Since that time a large volume of literature has been published. As a result, the Practice Management Guidelines Committee set out to develop updated guidelines for the identification of CS injury.

Methods: A search of the National Library of Medicine and the National Institutes of Health MEDLINE database was performed using PubMed (www.pubmed.gov). The search retrieved English language articles regarding the identification of CS injury from 1998 to 2007. The questions posed were: who needs CS imaging; what imaging should be obtained; when should computed tomography, magnetic resonance imaging, or flexion/extension radiographs be used; and how is significant ligamentous injury excluded in the comatose patient?

Results: Seventy-eight articles were identified. From this group, 52 articles were selected to construct the guidelines.

Conclusion: There have been significant changes in practice since the previous CS injury guidelines. Most significantly, computed tomography has supplanted plain radiography as the primary screening modality in those who require imaging. Clinical clearance remains the standard in awake, alert patients with trauma without neurologic deficit or distracting injury who have no neck pain or tenderness with full range of motion. Cervical collars should be removed as soon as feasible. Controversy persists regarding CS clearance in the obtunded patient without gross neurologic deficit.

(*J Trauma.* 2009;67: 651–659)

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Accepted for publication April 5, 2009.

From the Division of Trauma, Critical Care, and Burns (J.J.C), Department of Surgery, MetroHealth Medical Center, Cleveland, Ohio; Department of Surgery (J.J.D.), Vanderbilt University Medical Center, Nashville, Tennessee; Department of Surgery (C.M.D.), St. Elizabeth Health Center, Youngstown, Ohio; Department of Surgery (W.C.C.), R. Adams Cowley Shock Trauma Center, University of Maryland Medical Center, Baltimore, Maryland; Department of Surgery (T.M.D., J.A.M.), Virginia Commonwealth University Medical Center, Richmond, Virginia; Department of Surgery (J.M.C.), Virginia Tech Carilion School of Medicine, Roanoke, Virginia; Department of Surgery (M.R.H.), Mount Sinai Hospital, Chicago, Illinois; Department of Surgery (K.A.K.), Montreal General Hospital, Montreal, Quebec; Department of Surgery (M.B.S.), Northwestern Memorial Hospital, Chicago, Illinois; and Department of Surgery (E.S.W.), Baystate Medical Center, Springfield, Massachusetts.

Address for reprints: John J. Como, MD, Dr, 2500 MetroHealth Dr., Suite H045, Cleveland, OH, 44109-1998; email: jcomo@metrohealth.org.

DOI: 10.1097/TA.0b013e3181aa583b

Injury to the cervical spine (CS) occurs frequently after major trauma. Determination of CS stability is thus a common problem encountered by those charged with the acute care of patients with trauma. In this setting, several issues are of particular concern: who needs CS imaging; what imaging should be obtained; when should computed tomography (CT), magnetic resonance imaging (MRI), or flexion/extension (F/E) radiographs be obtained; and how is significant ligamentous injury excluded in the comatose patient?

These issues were first addressed by the Eastern Association for the Surgery of Trauma (EAST) in the Practice Management Guidelines for Identifying Cervical Spine Injuries Following Trauma published in 1998.[1] A subsequent revision was published in 2000.[2] Since that time a large volume of literature has been published. As a result, the Practice Management Guidelines Committee set out to develop updated guidelines for the identification of CS injury.

Process

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Quality of the References

Articles were classified as Class I, II, or III as described in the EAST primer on evidence based medicine as follows:[3]

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Address for reprints: John J. Como, MD, Dr, 2500 MetroHealth Dr., Suite H945, Cleveland, OH, 44109-1998; email: jcomo@metrohealth.org.

DOI: 10.1097/TA.0b013e3181aac83b

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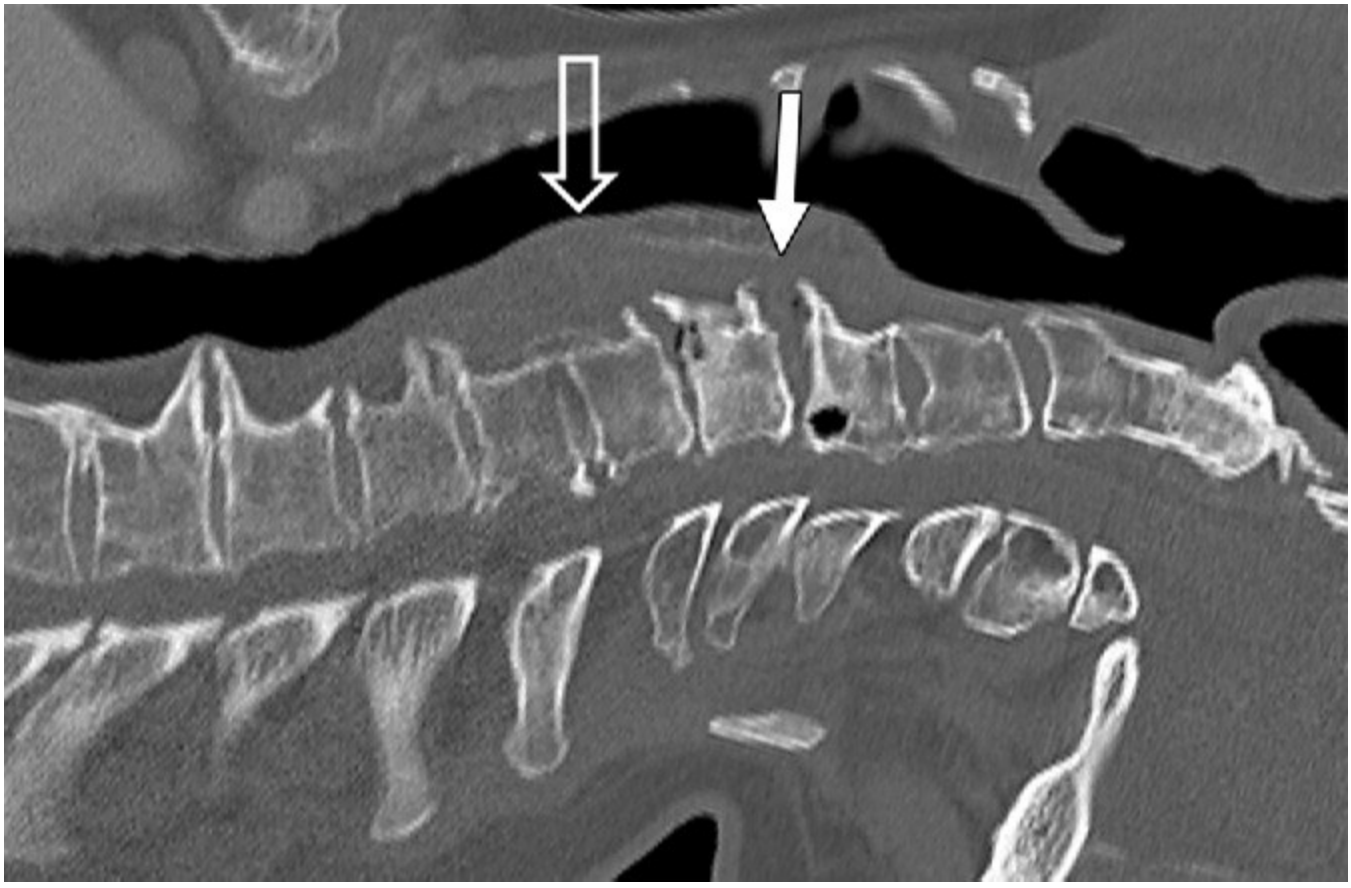

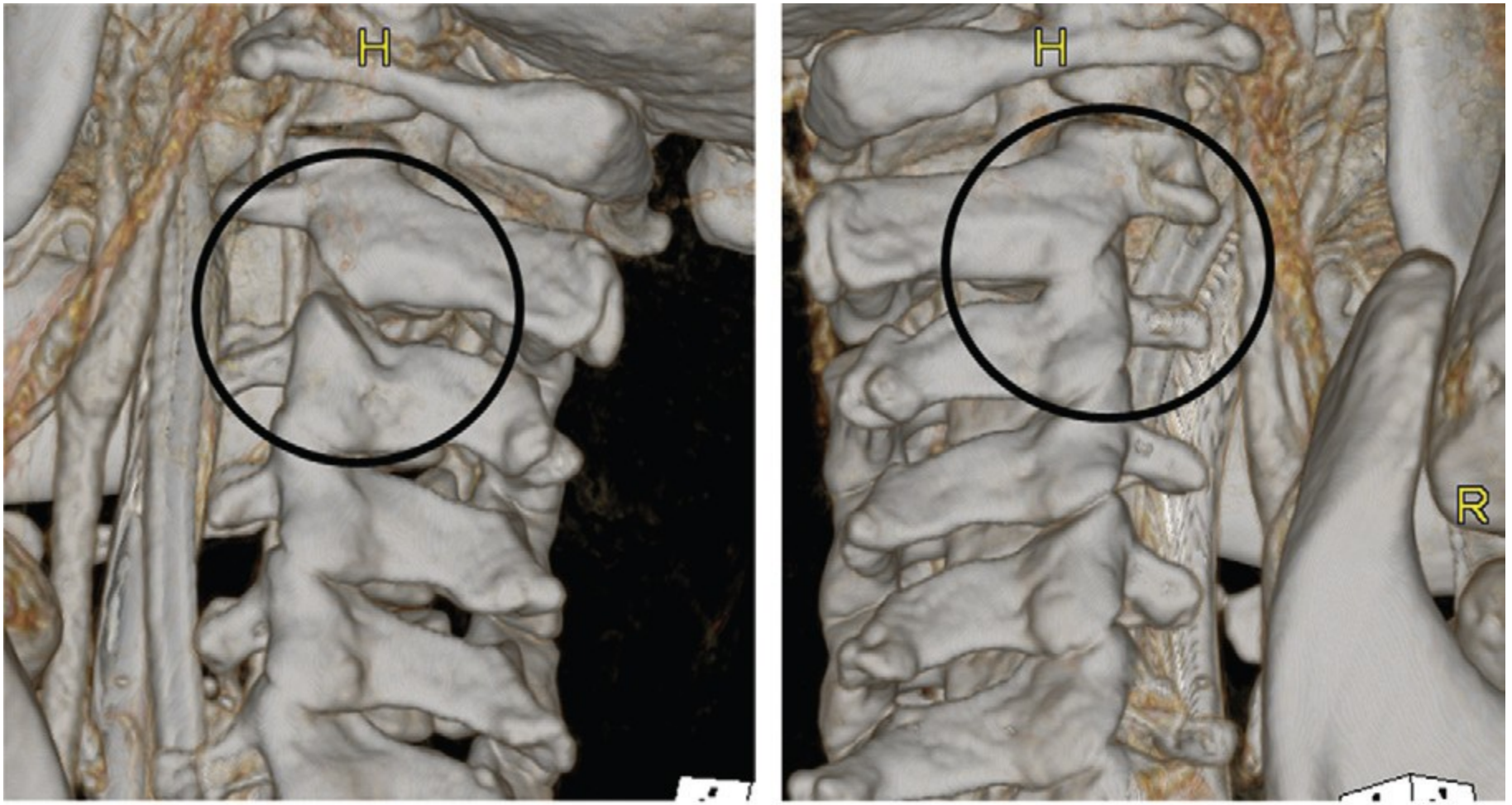

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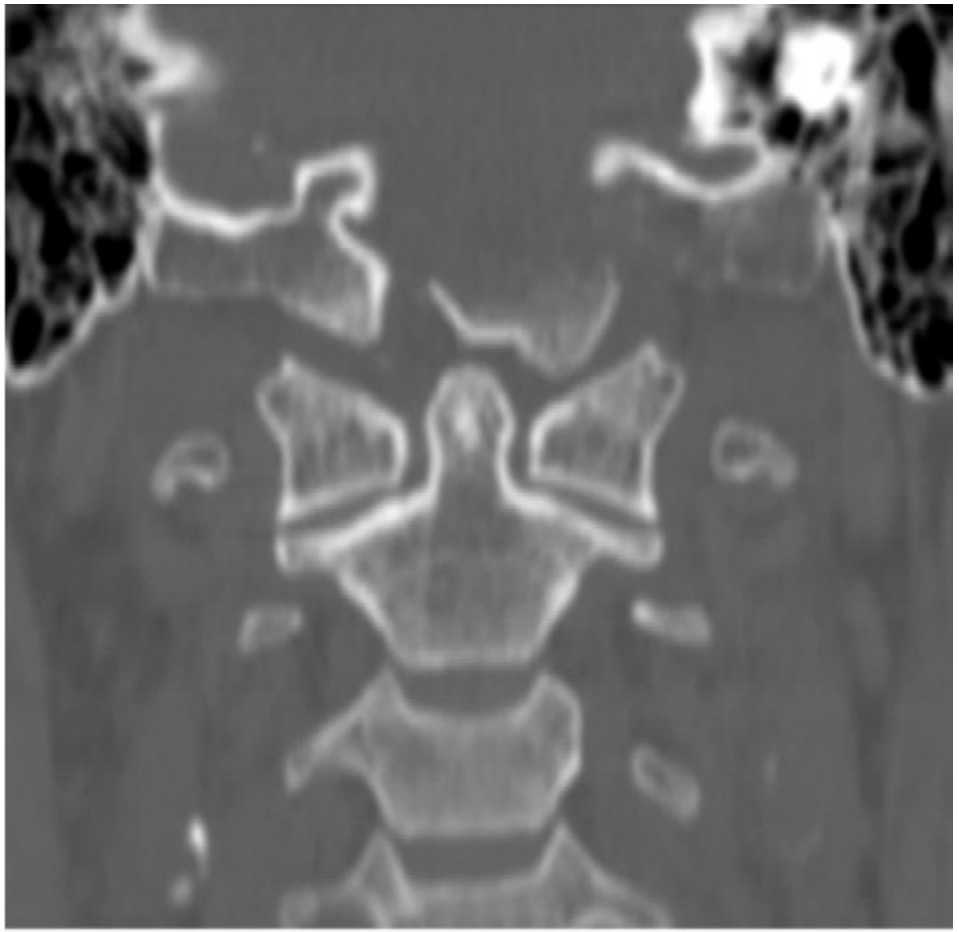

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Comparative effectiveness of using computed tomography alone to exclude cervical spine injuries in obtunded or intubated patients: meta-analysis of 14,327 patients with blunt trauma

A review

David M. Panczykowski, M.D., Nestor D. Tomycz, M.D., and David O. Okonkwo, M.D., Ph.D.

Department of Neurological Surgery, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania

Object. The current standard of practice for clearance of the cervical spine in obtunded patients suffering blunt trauma is to use CT and an adjuvant imaging modality (such as MR imaging). The objective of this study was to determine the comparative effectiveness of multislice helical CT alone to diagnose acute unstable cervical spine injury following blunt trauma.

Methods. The authors performed a meta-analysis of studies comparing modern CT with adjunctive imaging modalities and required that studies present acute traumatic findings as well as treatment for unstable injuries. Study quality, population characteristics, diagnostic protocols, and outcome data were extracted. Positive disease status included all injuries necessitating surgical or orthotic stabilization identified on imaging and/or clinical follow-up.

Results. Seventeen studies encompassing 14,327 patients met the inclusion criteria. Overall, the sensitivity and specificity for modern CT were both > 99.9% (95% CI 0.99–1.00 and 0.99–1.00, respectively). The negative likelihood ratio of an unstable cervical injury after a CT scan negative for acute injury was < 0.001 (95% CI 0.00–0.01), while the negative predictive value of a normal CT scan was 100% (95% CI 0.96–1.00). Global severity of injury, CT slice thickness, and study quality did not significantly affect accuracy estimates.

Conclusions. Modern CT alone is sufficient to detect unstable cervical spine injuries in trauma patients. Adjuvant imaging is unnecessary when the CT scan is negative for acute injury. Results of this meta-analysis strongly show that the cervical collar may be removed from obtunded or intubated trauma patients if a modern CT scan is negative for acute injury. *(DOI: 10.3171/2011.4.JNS101672)*

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The Journal of TRAUMA® Injury, Infection, and Critical Care

Computed Tomography Alone for Cervical Spine Clearance in the Unreliable Patient—Are We There Yet?

Jay Menaker, MD, Allan Philp, MD, Sharon Boswell, ACNP, and Thomas M. Scalea, MD

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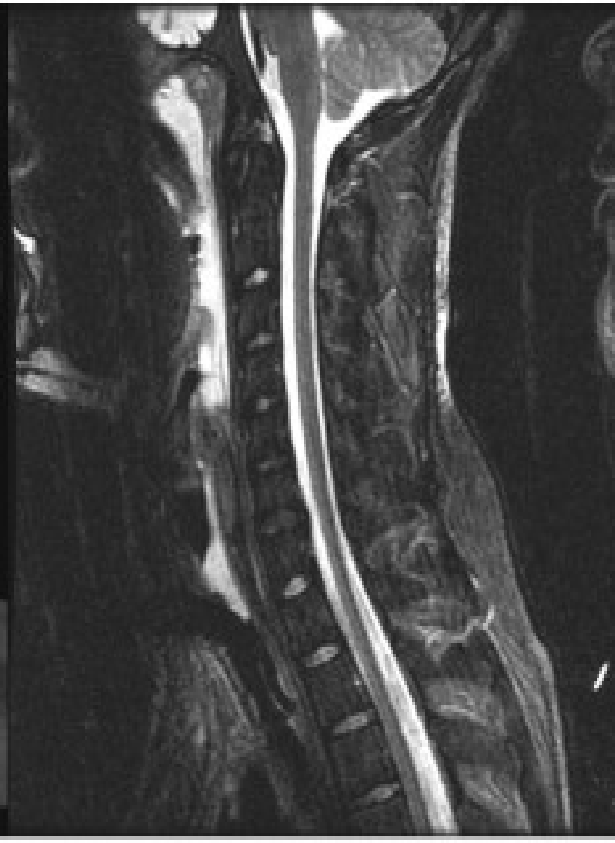
The Journal of TRAUMA® Injury, Infection, and Critical Care

MRI Is Unnecessary to Clear the Cervical Spine in Obtunded/Comatose Trauma Patients: The Four-Year Experience of a Level I Trauma Center

Nestor D. Tomycz, MD, Brandon G. Chew, BS, Yue-Fang Chang, PhD, Joseph M. Darby, MD, Scott R. Gunn, MD, Dederia H. Nicholas, RN, Juan B. Ochoa, MD, Andrew B. Peitzman, MD, Eric Schwartz, MD, Hans-Christoph Pape, MD, Richard M. Spiro, MD, and David O. Okonkwo, MD, PhD





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Computed Tomography Alone Versus Computed Tomography and Magnetic Resonance Imaging in the Identification of Occult Injuries to the Cervical Spine: A Meta-Analysis

Andrew J. Schoenfeld, MD, Christopher M. Bono, MD, Kevin J. McGuire, MD, Natalie Warholic, MA, and Mitchel B. Harris, MD, FACS

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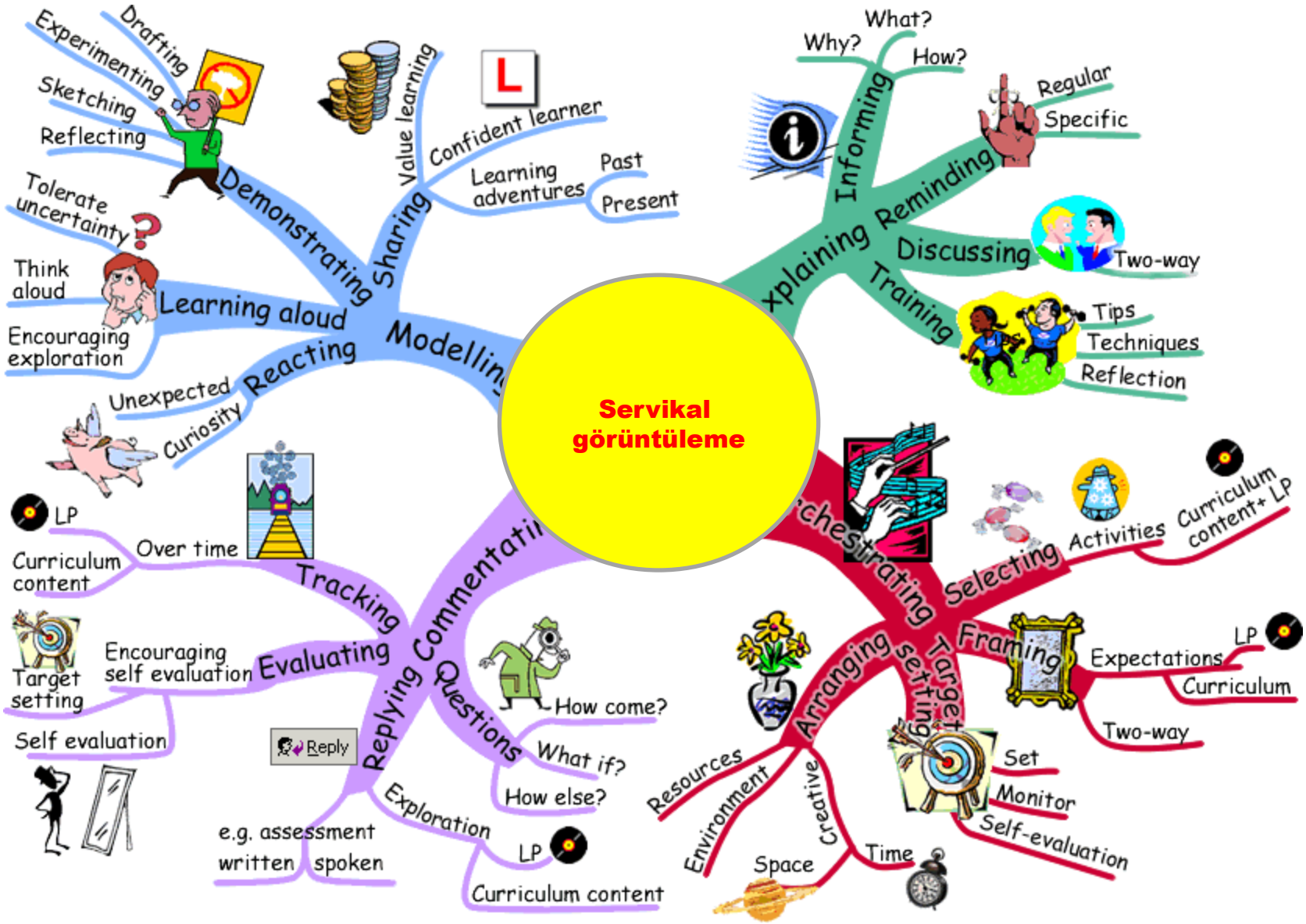
Intensive Care Med (2012) 38:752–771
DOI 10.1007/s00134-012-2485-4

REVIEW

James O. M. Plumb
C. G. Morris

Clinical review: spinal imaging for the adult obtunded blunt trauma patient: update from 2004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Curriculum content

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The Journal of TRAUMA® Injury, Infection, and Critical Care

Spinal Cord Injury without Radiographic Abnormality: Results of the National Emergency X-Radiography Utilization Study in Blunt Cervical Trauma

Gregory W. Hendey, MD, Allan B. Wolfson, MD, William R. Mower, MD, PhD, and Jerome R. Hoffman, MA, MD for the National Emergency X-Radiography Utilization Study Group

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Eur Spine J (2012) 21:165–171
DOI 10.1007/s00586-011-2041-x

CHINESE SECTION

Epidemiological characteristics of adult SCIWORA in Tianjin, China: a preliminary study

Honggang Guo · Jing Liu · Xiuying Qi · Guangzhi Ning · Huafeng Zhang · Xiaomian Li · Xinlong Ma

ORIGINAL ARTICLE

The misapplication of the term spinal cord injury without radiographic abnormality (SCIWORA) in adults

John J. Como, MD, MPH, Hoda Samia, MD, Gregory A. Nemunaitis, MD, Vikas Jain, MD, James S. Anderson, MD, Mark A. Malangoni, MD, *and* **Jeffrey A. Claridge, MD, MS,** *Cleveland, Ohio*

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