Perspective

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

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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-

sician education in the diagnosis of spine trauma, and the ever-present fear of misdiagnosis or mismanagement of these injuries. These trends only partly explain the increased number of cervical spine examinations requested today.

Perhaps the primary source of these examinations is the widespread use of spinal immobilization protocols by emergency medical service personnel at the accident scene. Without question, these prehospital care protocols have prevented or minimized many serious spinal injuries. Nonetheless, as a consequence of this universal practice, the presence of a cervical spine collar carries little, if any, predictive value for the presence of a spinal injury. The index of suspicion for cervical spine injury has become so high that virtually all patients with blunt trauma or injuries above shoulder level will undergo CSR. From the treating physician's perspective, liberal indications for CSR seem justified by the costly medical and legal consequences of a missed spinal injury.

One problem faced by the referring physician is that the majority of patients immobilized in a cervical collar, whether injured or not, volunteer some degree of neck discomfort, pain, or tenderness on physical examination. Once such symptoms are elicited, it becomes difficult to omit the radiographs because posttraumatic neck pain is the most widely accepted indication for CSR. Paradoxically, prolonged immobilization in a collar sometimes produces symptoms of neck pain that were not present when the collar was applied. The examining physician in this situation may be confused about the need for CSR, given the concomitant history of trauma and the patient's complaint of neck discomfort. Logically, one would assume that, in the neurologically normal patient, a careful physical examination of the neck might eliminate the need for radiographs. This incorrect assumption is an extrapolation from the observation that many extremity fractures can be anticipated by careful physical examination before obtaining radiographs. Unfortunately, physical examination of the neck differs from that of the extremities in several important ways. First, the vertebral column is a well-protected structure, deep within the neck. Except for the neurologically insignificant spinous processes, it is not readily accessible to palpation. Second, unlike physical examination of a limb, motion of the neck during the examination is prohibited. Despite these drawbacks, physical examination of the neck should still be performed but has limited value in determining the need for CSR. These limitations were highlighted in a recent study that demonstrated that the ability of some referring physicians to predict spinal injury on the basis of history or physical examination is poor, with only half of cervical injuries identified prospectively [1]. Acknowledging these problems, many physicians omit this important part of the trauma evaluation and rely almost exclusively on the radiologic examination instead.

Another reality of emergency department practice, which often goes unrecognized, is the pressure from patients themselves to have radiographs taken. The patient may be merely seeking reassurance that their "X-rays are normal." Sometimes, however, the treating physician is coerced into ordering these radiographs by patients whose litigious nature surfaces during the emergency department evaluation.

Whether radiographs are indicated or not, the likelihood of patients eventually undergoing CSR is high, as noted by McNamara et al. [2] in a study of posttraumatic neck pain. These authors note that of patients who did not undergo CSR at their initial emergency department visit, 52% subsequently had radiographs taken within 6 months of their injury. In addition, 66% of patients were pursuing litigation. Undoubtedly, some trauma patients legitimately suffer from chronic posttraumatic cervical pain, accounting for a portion of the delayed examinations. Recognizing these clinical and behavioral factors, some experienced referring physicians feel that a baseline cervical spine series is justified.

As if there were not enough reasons for the clinician to request a cervical spine series, there is also the myth of the "painless" or asymptomatic cervical spine fracture, fostered in the literature by several disputed case reports [3–5]. The thoroughness or validity of the clinical examination has been challenged in most of these cases [6]. Typically, the patient's pain symptoms are not elicited or are ignored in the haste of resuscitation, blunted by altered mental status or masked by other, more painful, injuries [7]. Significant cervical spine injuries can be "occult," escaping initial clinical and radiologic screening, but a truly painless injury in a mentally unimpaired patient has not been reported [8]. Despite doubts cast on these reports, the myth of the painless cervical spine injury still persists in some quarters as a justification for CSR.

On the basis of these clinical and social factors, frequent use of CSR is unavoidable. A liberal approach to CSR should not, however, be construed as tolerance for indiscriminate use of the examination. CSR should be recognized as a necessary but low-yield examination, with less than 2% of cervical spine series in trauma patients revealing a potentially significant finding or definite abnormality. The impact of unnecessary or overly exhaustive cervical spine examinations on patient throughput in the emergency department should not be trivialized, and indiscriminate ordering practices must be prevented. Unfortunately, it is not unusual for some physicians to adopt a "protocol" approach to trauma in which every patient, regardless of symptoms or mechanism of injury, undergoes CSR [9].

Another common source of unnecessary CSR occurs when inexperienced clinicians misconstrue the relationship between head injury and cervical spine injury. Although it is well documented that patients with significant head injuries can have associated cervical spine injuries, this is not true in patients with normal mental status and minor head injury. In the majority of these patients, CSR, at least on clinical grounds, is not indicated. Experienced clinicians recognize this as a "no-risk" patient and do not order radiographs.

Selective use of CSR in patients with head injuries is supported in the literature [10]. Even among trauma patients whose clinical history suggests a genuine possibility of cervical spine injury, it has been shown that CSR is usually unnecessary when an alert, mentally unimpaired, neurologically intact patient denies neck pain [8, 11, 12]. Normal mental status implies absence of drug, alcohol, intoxicants, or psychiatric disturbance. Clearly, certain trauma patients do not require CSR, and protocol ordering should be discouraged.

Occasionally, such practices are detrimental to care of the patient when the treating physician's attention becomes fixed on the cervical spine evaluation rather than on life-threatening injuries, which are statistically more common in these patients.

Managing the Demand for CSR: A Risk-Tailored Approach

Our approach to these complicated issues is based on an open dialogue with our referring physicians. Requesting physicians are motivated to stratify each cervical spine trauma case by the perceived risk of significant cervical spine injury. We consider patients to fall into four possible risk categories for cervical spine injury: category 1, no risk; category 2, low risk; category 3, medium risk; category 4, high risk.

General guidelines for assessment of a patient's risk and the characteristics of the high-risk patient are noted in Tables 1 and 2. Appropriately trained and experienced physicians usually have little difficulty in estimating a patient's risk. In addition, knowledge of the physician's assessment of injury risk is very helpful to the radiologist reviewing the case and often alters his recommendation for additional or follow-up studies. Assessment of risk can facilitate CSR because the clinician is prospectively challenged to justify the allocation of radiology resources required for the examination. Patients classified into low-, medium-, and high-risk groups undergo

TABLE 1: Clinical Risk Categories in Cervical Trauma

Clinical Risk	Description
None	Collar placed owing to protocol; no historical or physical findings to suggest a neck injury
Low	Mechanism/history of injury unlikely to have exceeded physiologic range of motion
Medium	Mechanism/history of injury sufficient to have exceeded physiologic range of motion
High	Mechanism/history of injury very likely to have exceeded physiologic range of motion

TABLE 2: Clinical and Historical Characteristics of the High-Risk Patient

1. High-velocity blunt trauma
2. Significant motor vehicle accident
3. Direct cervical region injury
4. Altered mental status at the time of trauma and/or during emergency department evaluation (includes alcohol, drugs, intoxicants, loss of consciousness, and mental illness)
5. Falls/diving injuries
6. Significant head/facial injury
7. Abnormal neurologic examination
8. Prominent neck pain or tenderness
9. Thoracic or lumbar spine fracture
10. Rigid spine (ankylosing spondylitis, etc.)

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.

different radiologic examinations requiring different time commitments.

As shown in Table 3, patients categorized in the low-risk group undergo a brief, erect, three-view examination, which takes approximately 10 min. Occasionally, the examination is performed with the patient supine when, for example, another injury prevents radiographs from being obtained with the patient sitting or standing. Placement of a cervical spine collar in the emergency department is discouraged in this group until the radiographs have been completed and reviewed. This improves the quality of radiographs, which are unaffected by collar-engendered artifacts. Even if a patient with medium or high risk were inadvertently classified as a low-risk patient, we consider a high-quality, three-view cervical spine series sufficient for a primary cervical spine evaluation.

Patients with medium risk for cervical spine injury are generally classified by exclusion from either the low-risk or high-risk categories. Patients in the medium-risk category have a trauma history that suggests sufficient force to produce a spine injury but high-risk features are absent. The advantage of placement in the medium-risk group is that these examinations, which begin with the patient supine, can be terminated with the patient sitting or erect. This decreases examination time and improves the diagnostic quality of the oblique radiographs, which, when obtained with the patient supine, show inherent geometric distortion. Again, even if a high-risk patient were inadvertently categorized into the medium-risk group, a review of the supine lateral radiographs by a physician, as noted in Table 3, should allow detection of significant cervical spine injury before any erect views are obtained.

Common Sources of Miscommunication

The interpretation of the radiographs can lead to several areas of miscommunication between the radiologist and referring physician. These problems involve the interrelated issues of accuracy, speed of diagnosis, and structural stability of the traumatized cervical spine.

"Sensitivity" of CSR

When CSRs are considered, two misconceptions are shared by many radiologists and referring physicians concerning the presumed high sensitivity of CSR for detection of injury. Both groups tend to forget the two major components of the examination that contribute to its capacity to detect injury: quality of radiographs and experience of the interpreter.

With a complete trauma series of well-positioned and optimally exposed radiographs of the cervical spine, recognition of significant injuries is quite high, with a sensitivity of 95% under ideal conditions. Unfortunately, a complete, high-quality examination is frequently impractical or impossible to obtain because of time constraints imposed by other trauma priorities, lack of cooperation from patients, and physical limitations imposed by supine positioning of the patients. Significantly, those patients at highest risk of injury are most likely to have a technically compromised cervical spine examination. Inadequate radiographs are a common source of misdiagnosis in cervical spine trauma, especially with regard to visualization of the cervicothoracic and atlantoaxial regions [13]. Single lateral portable radiographs of the spine have been shown to be inadequate in up to 25% of examinations [14]. Clearly then, compromised examinations, particularly in the high-risk groups, should be anticipated. Increasingly, CT has been used to overcome these problems and has improved fracture detection. Acheson et al. [15] note that approximately 53% of cervical spine fractures were missed on the initial trauma radiographs, but subsequently were detected on CT scans. Despite this observation, the authors support a near-perfect sensitivity for CSR in the detection of cervical spine injuries, because all patients in their series with fractures proved with CT had initially abnormal or suspicious trauma radiographs. Nevertheless, the retrospective nature of the study, a 63% false-positive rate, and a high degree of interpretive experience are factors that generally do not prevail in the acute trauma setting. Missed cervical spine injury rates of 10–20% are probably more representative of the typical trauma setting, in which reliance on incomplete or technically compromised examinations is not uncommon. The propensity for certain cervical spine fractures to escape detection on radiographs was recently reported by Clark et al. [16], who found delayed radiologic diagnosis in 23% of odontoid, 16% of teardrop, 14% of facet, and 10% of hangman's fractures. Decreased "sensitivity" of the initial trauma series should be expected when radiographs are suboptimal, with provisions made for repeated radiographs or additional studies when the patient's condition permits.

Precisely how many films constitute a complete examination varies widely. The three-view series is the minimum complete examination. Five views are desirable in medium-

and high-risk patients, although the value of supine oblique radiographs has recently been questioned [17]. As it is often difficult to obtain high-quality films, and the experience of the interpreter may be limited, the number of radiographs should not be overly restricted.

The second component of sensitivity is the quality of the interpretation of radiographs. Many articles discussing sensitivity of CSR fail to clarify who has interpreted the cervical spine radiographs. Studies advocating a high sensitivity for this examination have used attending radiologists or experienced traumatologists. This high degree of interpretive experience rarely exists in the majority of hospitals, especially during peaks in trauma caseloads. This may explain the experience of Reid et al. [18], who noted that 8% of cervical spine injuries were missed on initial review of adequate radiographs. Notably, one third of injuries missed because of inadequate clinical evaluation or misinterpretation of radiographs occurred in a tertiary care hospital. The majority of reviewing physicians probably do not have sufficient training or experience with these injuries to attain a desirable 95% sensitivity. Furthermore, the emergency department is a traditional training ground for most physicians, including radiologists, emergency physicians, and general surgeons. Under such circumstances, caution is advised in attributing high sensitivity to examinations interpreted at this level of experience. Less than ideal circumstances may explain Bohlman's observation that fully one third of 300 cervical spine injuries escaped initial clinical and/or radiologic detection [19]. Close supervision of house officers in training, regardless of specialty, and review of all trauma cases by a radiologist is essential in maximizing sensitivity.

Clearing the C-Spine

Probably the most frustrating aspect of cervical spine trauma for both the treating physician and the radiologist is the differing expectations these physicians may have concerning the role of the radiographs in the management of the patient.

Perhaps the most detrimental concept to have evolved is the imperative to radiologically "clear the c-spine." The radiologist is often uncomfortable responding to this directive with a "yes" or "no" response. This concern is justified, because most physicians lack a firm understanding of the term. In its most common (but incorrect) usage, "clearing the spine" is taken to mean that if no abnormality is identified on the radiographs then the patient is free of cervical spine injury. In this syntax, "cleared c-spine" means a "normal c-spine." This definition is seriously flawed by its presumption of 100% sensitivity for CSR in the detection of injury. Reliance on a perfect sensitivity for any screening examination is unwise. In addition, even if we assume an optimistic 95% sensitivity, most physicians would not be comfortable with a missed injury (false-negative) rate of 5%. Therefore, CSR cannot be considered the gold standard for cervical spine injury.

Physicians who function under the illusion that a normal cervical spine series has eliminated cervical region injury are likely to miss significant injuries. As shown in Figure 1, patients can have serious cervical region injuries without obvious

evidence of fracture or subluxation on the cervical spine radiographs. In addition to soft-tissue injuries, frequently inapparent on the radiographs, some fractures and destabilizing ligamentous injuries can elude detection on a routine trauma survey. Delayed detection of spinal injuries is not uncommon and should not be surprising [19]. Cervical spine examinations that are precipitously "cleared" may later turn up significant injuries that were either overlooked or incompletely visualized in the initial trauma survey. Figures 2 and 3 show two unstable injuries that might have been erroneously cleared on the basis of a single lateral radiograph.

A minority of experienced trauma physicians use the expression "clear the c-spine" in a more limited and cautious context. In this definition, the cervical spine radiographs are
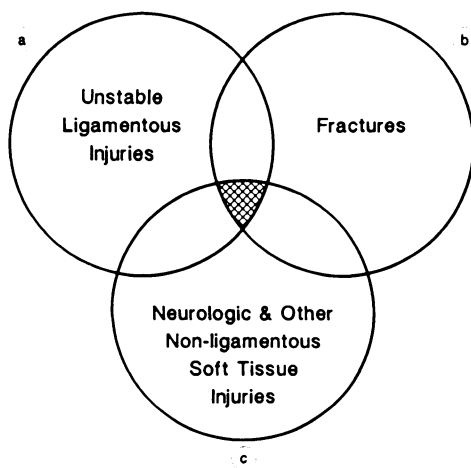

Fig. 1.—Spectrum of cervical spine injuries: any cervical injury can be ascribed to one or more injury subsets a, b, or c. Cross-hatched zone is exemplified by a fracture-dislocation with quadriplegia. Radiographs are sensitive to detection of most injuries in subset b, many in a, but few in c (e.g., traumatic disk herniation or anterior and central spinal cord syndromes).

evaluated primarily for the purpose of detecting unstable cervical spine injury. Careful examination of one lateral cervical spine radiograph alone can eliminate the presence of unstable cervical spine injuries in a high percentage of cases. It should be emphasized that in this context, a spine could be classified as stable but any number of soft-tissue or bone injuries could be present.

Rapid evaluation of the trauma radiographs for obvious signs of unstable injury is important to the trauma physician for patient management. Should neck motion be necessitated by endotracheal intubation, no neurologic sequelae would be expected in the patient with a stable cervical spine. In the initial trauma resuscitation, this limited goal of CSR is usually sufficient for patient management. Prudence dictates that even when a spine is thought to be stable on the basis of the initial radiologic evaluation, unnecessary manipulation of the neck should be avoided. The exclusion of injuries that would be considered stable is a low priority and can be postponed until the patient's condition allows a more definitive clinical and radiologic examination of the spine. Although clearing the c-spine in this more limited context is a valid approach, the use of the term "clear" as a verb inappropriately promotes the concept that the initial trauma radiographs can be expected to eliminate all unstable and stable cervical spine injuries. To avoid miscommunication, radiologists and trauma physicians in each institution should come to a common understanding of the usage of these terms.

Reliable communication of CSR results is vital because tracheal/esophageal intubation and many routine aspects of patient care can involve motion of the neck. Physicians, nurses, technologists, and other care providers must have an unambiguous report of the status of the trauma patient's spine, which encompasses the results of CSR and clinical findings or concerns. An incomplete series of radiographs is especially problematic for care providers and is not unusual in medium- and high-risk patients when other pressing trauma priorities do not allow sufficient time for a definitive evaluation.


A   B   C
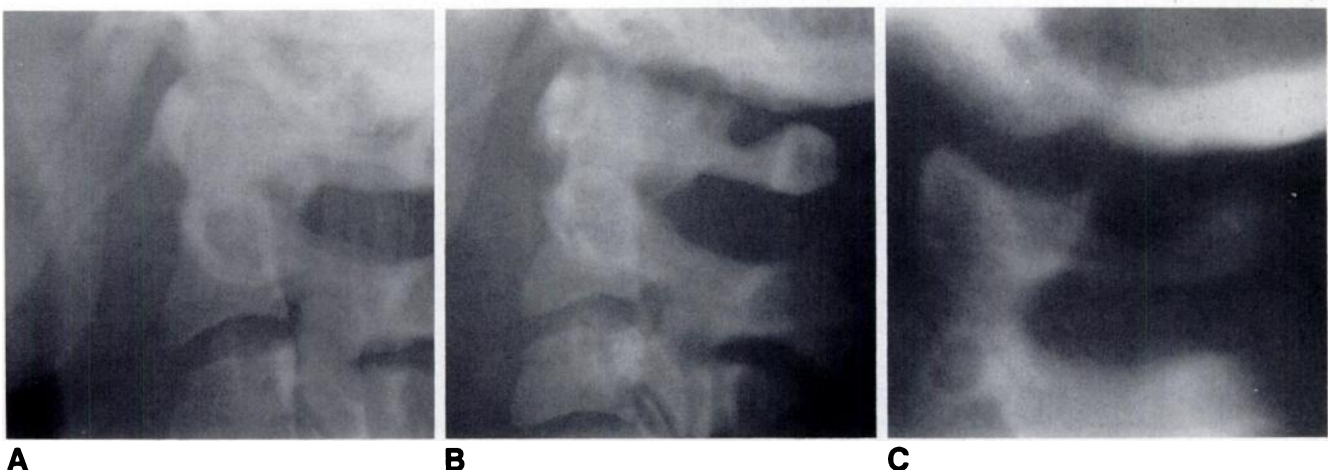
Fig. 2.—Case 1. 45-year-old man with neck pain after a motor vehicle accident.
A, Initial lateral radiograph, in a neurologically normal trauma patient, shows prevertebral soft-tissue swelling only.
B, A second exposure with improved positioning of patient shows unusual lucency through craniocervical junction but no fracture.
C, Lateral tomogram verified an unstable ligamentous injury; vertical atlantooccipital dislocation.
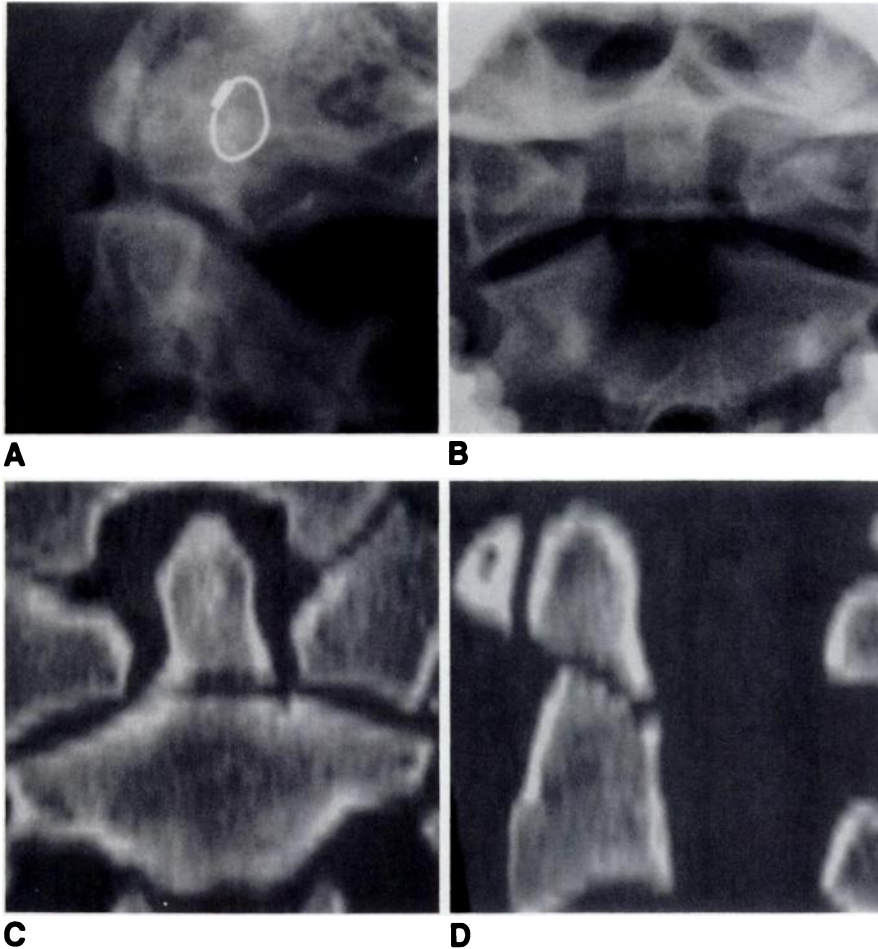
Fig. 3.—Neurologically intact 18-year-old man with neck pain after a motorcycle accident.

A, Single lateral radiograph shows prevertebral soft-tissue swelling but no unstable injury.

B, Odontoid view from complete five-view supine series is deceptively normal with exception of a vague zone of lucency at base of dens.

C and D, Anteroposterior and sagittal reformatted CT scans show an oblique undisplaced odontoid fracture.

This may require secondary radiologic examinations such as conventional tomography or CT, flexion-extension views, CT-myelography, or MR imaging. A rating system that plainly communicates the status of the cervical spine evaluation based on initial CSR is suggested. CSR "A" is an adequate examination with no evidence of instability, fracture, or soft-tissue injury. CSR "B" is a bothersome finding on radiographs that requires repeated CSR, flexion-extension views, or a secondary examination. CSR "C" is a compromised or technically inadequate examination that must be repeated. CSR "D" is a definite injury with fracture and/or instability detected by CSR. The rating of radiographs is sometimes overruled by clinical concerns or findings. For example, a patient could have a CSR rating of "A" and yet have a neurologic finding that requires further evaluation. Another patient with suspicious findings on radiographs (CSR "B") might be clinically asymptomatic. Likewise, patients with high-risk characteristics may require secondary examinations despite apparently normal findings on initial CSR. The importance of clinical parameters in the interpretation of initial CSR should not be underestimated.

Stability/Instability

Referring physicians often expect the radiologist to render an opinion about the stability of a detected injury on the basis of his examination of the trauma radiographs. The radiologist is sometimes appropriately uncomfortable in rendering this opinion on the basis of routine trauma radiographs alone. As no universally accepted definition of cervical spine stability exists, misunderstanding and miscommunication often result.

White et al. [20] have proposed a definition of cervical spine instability. Their approach is by no means complete or entirely satisfactory for the radiologic analysis of instability. However, it is based on sound biomechanical research and provides a starting place for this analysis. According to these authors, a clinically unstable spine, subjected to physiologic loads, is unable to maintain normal anatomic relations between spinal segments so that current (or subsequent) spinal cord, nerve root, or painful spine deformity results [20]. For practical purposes, an unstable cervical spine injury is considered present if critical aspects of structural integrity of the spine have been compromised, so that a neurologic injury could

occur if the cervical spine moved through a normal range of motion.

As there is no universally accepted definition of instability, designation of a particular injury as unstable can vary among different authors. Harris [21] has presented a concise, but nonexclusive list of injuries that can be recognized as unstable on routine CSR. Injuries defined as unstable include: bilateral interfacetal dislocation, flexion teardrop fracture, extension teardrop fracture (unstable in extension), hangman's fracture,
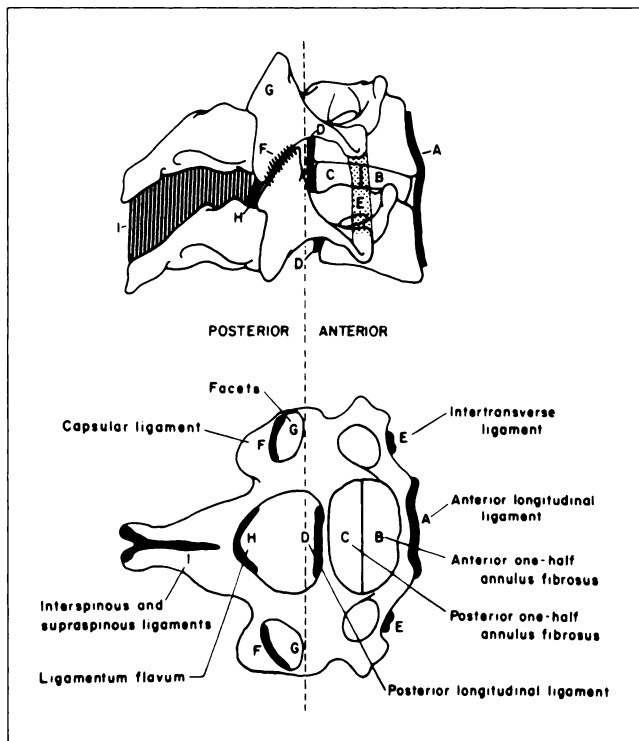

Fig. 4.—Bone and soft-tissue structures responsible for spinal stability. White et al. [20] suggest that for a margin of clinical safety, an unstable injury is considered present when there is structural failure of either anterior or posterior spinal elements.

Jefferson fracture, and hyperextension fracture-dislocation. When such patterns are not obvious, White et al. [20] have identified several findings on radiographs that, in combination, strongly suggest instability: loss of anterior structural integrity, loss of posterior structural integrity, subluxation greater than 3.5 mm, kyphosis greater than 11 degrees, and traumatic disk space widening or narrowing. The anterior and posterior structures responsible for stability of the cervical spine are depicted in Figure 4. Although kyphosis and subluxation are usually obvious, traumatic loss of anterior or posterior binding elements may be difficult to assess on radiographs. Nevertheless, this approach is valuable when no obvious instability pattern is recognized on radiographs. Although less specific, when the findings on cervical spine radiographs are apparently normal, the presence of a neurologic deficit, unusual degree of neck pain, or marked prevertebral soft-tissue swelling should alert the radiologist to the possibility of an occult, unstable injury. Caution is advised in these patients until a thorough evaluation of the cervical spine can be accomplished.

Stating with confidence that a structure such as the cervical spine is stable often requires a two-phase analysis with both static and dynamic testing. Sometimes the initial supine trauma examination will detect obvious signs of unstable cervical spine injury. For practical use and patients' safety, we would consider identification of any of the criteria noted above as suspicious for unstable cervical spine injury, so that spinal consultation is obtained. Based on this consultation, further imaging, including flexion-extension views, can be performed to make a final determination.

Occasionally, when the findings on supine cervical examination appear normal, it may be necessary in high-risk or symptomatic patients to proceed to a dynamic flexion-extension series for a definitive assessment of stability. In our institution, the need for and timing of flexion-extension examinations are based on consultation between the spine consultant and the radiologist. For patients who are being discharged from the emergency department with a cervical collar, we favor a delayed flexion-extension examination in 10 to 14 days, because of the inability of many patients with
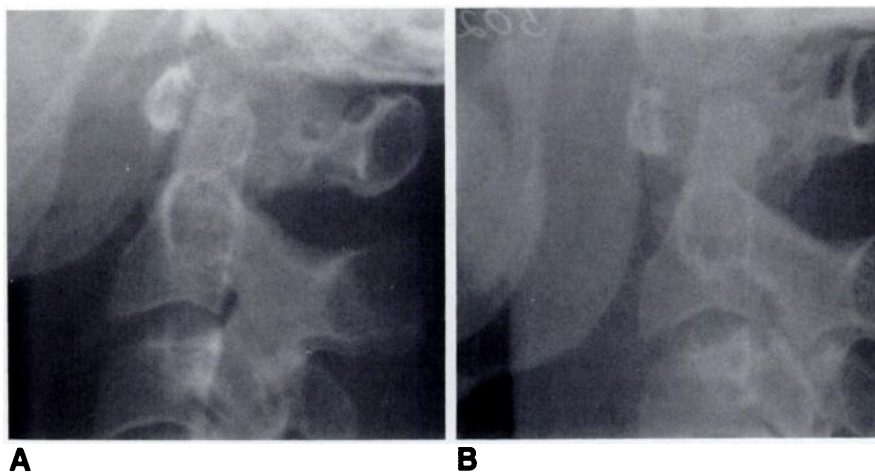
Fig. 5.—Neurologically intact 45-year-old man after a motor vehicle accident.

A, Radiograph of supine patient shows marked prevertebral soft-tissue swelling but no unstable injury. Predental space is 3 mm, upper limit of normal.

B, A subsequent flexion maneuver revealed an unstable, traumatic atlantoaxial subluxation.

A   B

acute symptoms to perform flexion-extension maneuvers satisfactorily. For high-risk patients, an erect flexion-extension series is almost always impossible or impractical to perform in multisystem trauma patients. Under rare circumstances, the spinal consultant and radiologist may jointly perform a fluoroscopically monitored flexion-extension examination of the cervical spine.

Clearly, certain unstable injury patterns can be recognized on static supine radiographs, whereas others may not become apparent until repeated radiographs are obtained with physiologic loading, as in erect flexion-extension films. Figure 5 demonstrates this principle.

Physicians must appreciate the limitations of a purely static supine cervical spine evaluation in trauma. The expectation that the radiologist can exclude unstable cervical spine injury in all cases, without benefit of a dynamic examination, is erroneous.

Conclusions

Radiologists must be knowledgeable in the complex medical and social issues that surround the subject of cervical spine trauma. Referring physicians are subject to multiple forces that favor liberal use of cervical spine radiographs and heavy reliance on the interpretation of radiographs. It is unlikely that this trend will be reversed in the near future; therefore, steps must be taken to accommodate the increased demand for these studies. A risk-tailored approach to CSR, which can improve efficiency in performance of these studies by expediting the examination of medium- and low-risk patients and encouraging the elimination of radiographs in no-risk patients, is suggested. The role of CSR in the clinical management of medium- and high-risk trauma patients is particularly liable to lead to misunderstandings. Improved communication and insight into the limitation of the initial trauma radiographs in these patients will ameliorate much of the problem. In patients with significant risk of injury, a staged evaluation, which may include repeated radiographs or secondary examinations, is appropriate and will minimize delayed detection or misdiagnosis of these injuries. Finally, clinical parameters are extremely important in guiding our evaluation of cervical spine trauma and highlight the need for frequent consultation between radiologist and spine injury consultant. A team approach, which involves radiology and the clinical services in a periodic review of these complex issues, is the best approach in caring for patients with suspected cervical spine injury.

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