

Missed upper cervical spine fracture: clinical and radiological considerations

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Objective: This report presents a case of missed upper cervical spine fracture following a motor vehicle accident and illustrates various clinical and radiographic considerations necessary in the evaluation of post traumatic cervical spine injuries. Specific clinical signs and symptoms, as well as radiographic clues should prompt the astute clinician to suspect a fracture even when plain film radiographs have been reported as normal.

Clinical features: A 44-year-old male was referred for an orthopaedic consultation for assessment of headaches following a high speed head-on motor vehicle accident eleven weeks prior to his presentation. Cervical spine radiographs taken at an emergency ward the day of the collision were reported as essentially normal.

Subsequent radiographs taken eleven weeks later revealed a fracture through the body of axis with anterior displacement of atlas. A review of the initial radiographs clearly demonstrated signs suggesting an upper cervical fracture.

Intervention and outcome: Initially the patient was prescribed a soft collar which he wore daily until an orthopaedic consultation eleven weeks later. Fifteen weeks following trauma, the patient was considered for surgical intervention, due to persistent headaches associated with the development of neurological signs suggestive of early onset of cervical myelopathy.

Conclusion: Cervical spine fractures can have disastrous consequences if not detected early. A thorough clinical and radiological evaluation is essential in any patient presenting with a history of neck or head trauma. Repeated plain film radiographs are imperative in the event of inadequate visualization of the

Objectif : Ce rapport présente un cas de fracture non diagnostiquée de la colonne cervicale supérieure découlant d'un accident d'automobile et illustre divers facteurs cliniques et radiologiques nécessaires à l'évaluation de blessures cervicales post-traumatiques. Des signes cliniques et radiographiques, de même que des symptômes spécifiques devraient inciter un clinicien à soupçonner la présence d'une fracture même lorsque les radiographies ne montrent rien d'anormal.

Caractéristiques cliniques : Un homme de 44 ans, se plaignant de céphalée et ayant été impliqué dans un accident automobile onze semaines plus tôt, a été référé pour consultation orthopédique. Des radiographies de la colonne cervicale prises au service des urgences le jour de l'accident n'ont rien signalé d'anormal. Des radiographies ultérieures prises onze semaines plus tard ont révélé la présence d'une fracture du corps de l'axis accompagnée d'un glissement antérieur de l'atlas. Le réexamen des radiographies initiales a clairement démontré des signes évoquant une fracture de la colonne cervicale supérieure.

Intervention et résultat : À priori, on a prescrit au patient un collier cervical souple qu'il devait porter tous les jours jusqu'à une consultation orthopédique onze semaines plus tard. Quinze semaines après le traumatisme, on a envisagé une intervention chirurgicale en raison de céphalées persistantes accompagnées de signes neurologiques évoquant l'apparition d'une myélopathie cervicale.

Conclusion : Une fracture de la colonne cervicale peut avoir des conséquences néfastes si elle n'est pas détectée très tôt. Une évaluation clinique et radiologique exhaustive s'avère essentielle chez tout patient ayant des

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cervical vertebrae. When in doubt, further imaging studies such as computed tomography or magnetic resonance imaging are required to rule out a fracture. (JCCA 1997; 41(2):77-85)

KEY WORDS: upper cervical fracture, odontoid fracture, cervical spine trauma, chiropractic.

antécédents de traumatismes cervicaux ou crâniens. Des radiographies répétées s'imposent dans le cas d'une visualisation insuffisante des vertèbres cervicales. En cas de doute, des méthodes d'imagerie plus poussées, telles que la tomographie par ordinateur ou l'imagerie par résonance magnétique, sont nécessaires pour éliminer la possibilité d'une fracture. (JCCA 1997; 41(2):77-85)

MOTS CLÉS : fracture cervicale supérieure, fracture de l'odontoïde, traumatisme cervical, chiropratique.

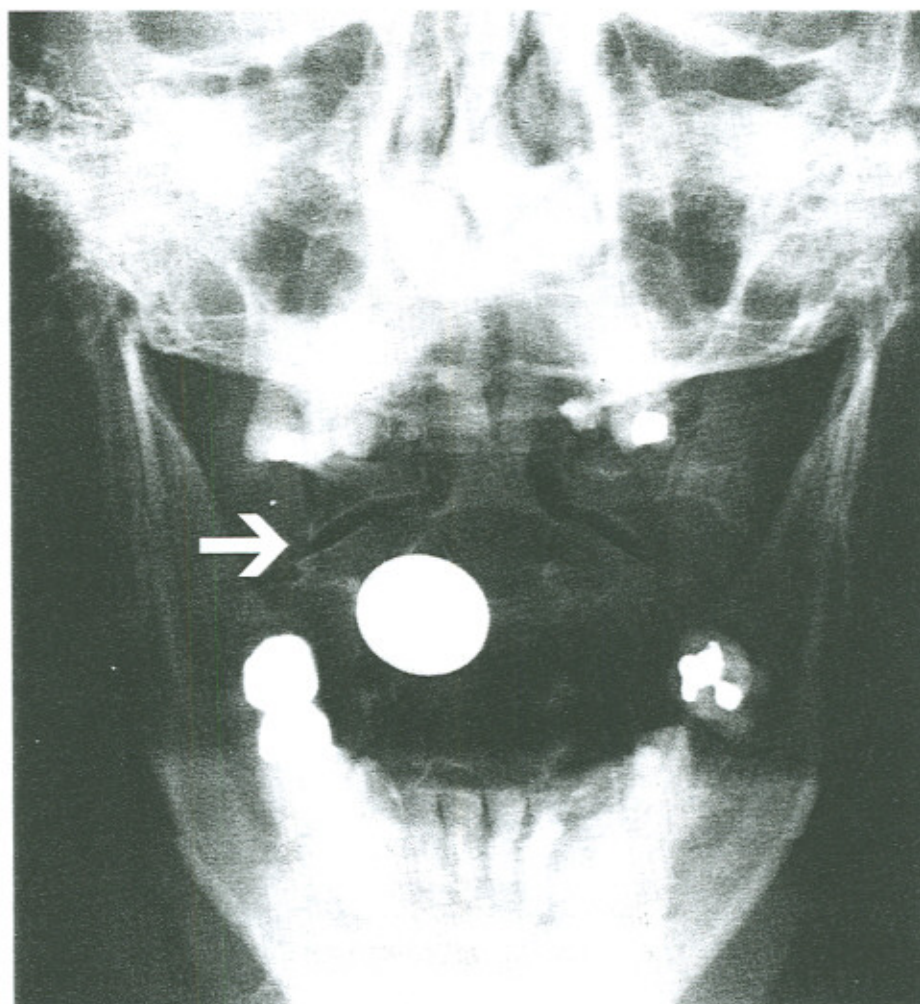


Figure 1 Cervical spine radiographs (same day of accident)

A. Antero-posterior view showing a round artifact (likely a metal snap from a cervical collar) directly in view of the body of axis. In spite of this artifact, a lack of congruency is evident between the cortical margins of the lateral mass of atlas and the lateral aspect of axis (arrow) when compared to the opposite side.

Introduction

High mortality and morbidity associated with cervical spine injuries has resulted in a widespread interest in clinical and radiological evaluation of patients with cervical spine trauma. There is extensive literature on protocols for radiographic investigation of the cervical spine following trauma; however, many areas of controversy still exist. Some question its value in light of evidence of poor quality and inaccurate interpretation.¹ This may be of concern to chiropractors owing to the devastating nature of possible sequelae following cervical spine manipulation in the presence of a missed upper cervical spine fracture.

Despite concerns with the increasing costs involved in plain film radiographs,^{2,3,4,5} fear of litigation and the increasing number of reported asymptomatic cervical spine fractures have led to its indiscriminate use following trauma.⁶ After revisiting the issue of asymptomatic cervical spine fractures, many authors have concluded that all of these cases presented with specific indications for cervical spine radiography or other imaging studies.^{1,6,7,8} A case report is used to emphasize some of the clinical and radiological signs that should prompt the astute clinician to suspect a cervical spine fracture in a patient presenting with a history of a neck injury or blow to the head.



B. Lateral view showing a discontinuity of the spinolaminar junction line at the atlantoaxial junction (dotted line), an increase in the retropharyngeal soft tissue space (straight line) and a loss of cortical integrity at the anterior aspect of the body of axis (arrow). Of incidental note is a well defined radiodensity posterior to the C6 spinous process which may represent subligamentous calcification.

Case report

A 44-year-old male was referred for an orthopaedic consultation with a chief complaint of headaches which began immediately following a head-on motor vehicle accident 11 weeks prior to his presentation. The patient reported wearing a seat belt and travelling at 100 km/hr at the time of the collision. On impact, his chest struck the steering wheel while the right side of his head struck the rear-view mirror, causing a deep laceration. There was no loss of consciousness. The patient was transported by ambulance to an emergency ward where cervical spine (see Figure 1) and skull radiographs were taken. All films were inter-

preted as normal by a junior radiologist and the patient was discharged after receiving 21 sutures for his laceration. He was given a soft collar.

Eleven weeks after the motor vehicle accident, he presented to an orthopaedic clinic wearing a soft collar that he had been wearing 24 hours per day since his injury. He reported having constant left-sided throbbing headaches since the time of the accident, reaching their greatest intensity 4 weeks later. His headaches were particularly worse upon awakening. He denied any associated symptoms such as dizziness, nausea, vision disturbances, difficulty hearing, loss of balance or any abnormalities with his

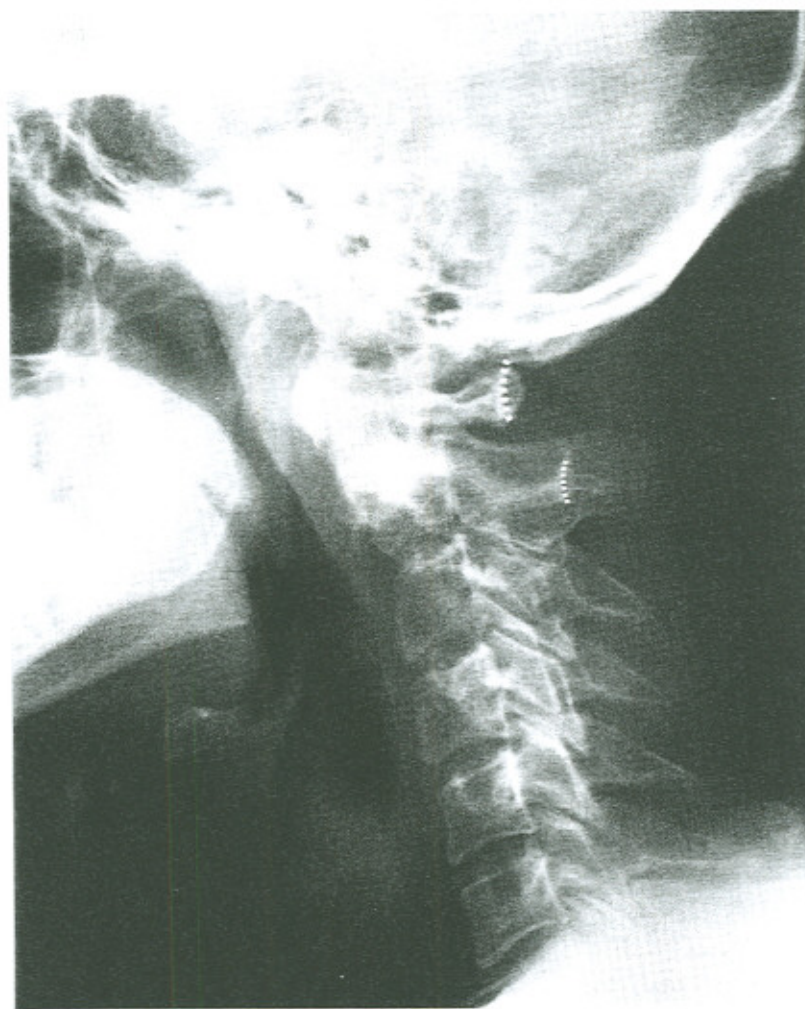


Figure 2 Lateral cervical spine radiograph (11 weeks after the accident)

When compared to figure 1B, this view demonstrates a normal retropharyngeal soft tissue space, indicating the subsidence of initial inflammation. Also, there is a greater amount of atlantoaxial displacement as evidenced by the significant disruption in the spinolaminar junction line (dotted line). Increased radiodensity over the body of axis suggests the fracture is healing.

short or long term memory. When questioned about neck pain he recalled a significant amount of neck pain while receiving sutures for his laceration. Minimal pain relief was obtained through acetaminophen with codeine at high dosage (8 tylenol #3 per day).

Physical assessment revealed a normal neurological examination of the upper and lower extremities. Active range of movement of the cervical spine was painfully limited by 25 per cent in left and right rotation. There was tenderness on palpation over the upper cervical spine area.

Due to persistence of his headaches, plain film radiographs of the cervical spine, including flexion-extension

views, were repeated (see Figure 2). These films showed a united fracture through the body of axis with anterior displacement of atlas. Initial plain film radiographs were obtained and reviewed (see Figure 1). A careful examination of the lateral view of the cervical spine revealed a loss of cortical integrity at the anterior aspect of the body of axis. Also, there was a disruption in the spinolaminar junction line of the atlas, suggesting anterior displacement of the atlas relative to the axis. The antero-posterior view showed an artifact (most likely a metal snap from a cervical collar) inadvertently placed directly in view of the body of axis. Flexion-extension views revealed no instability.

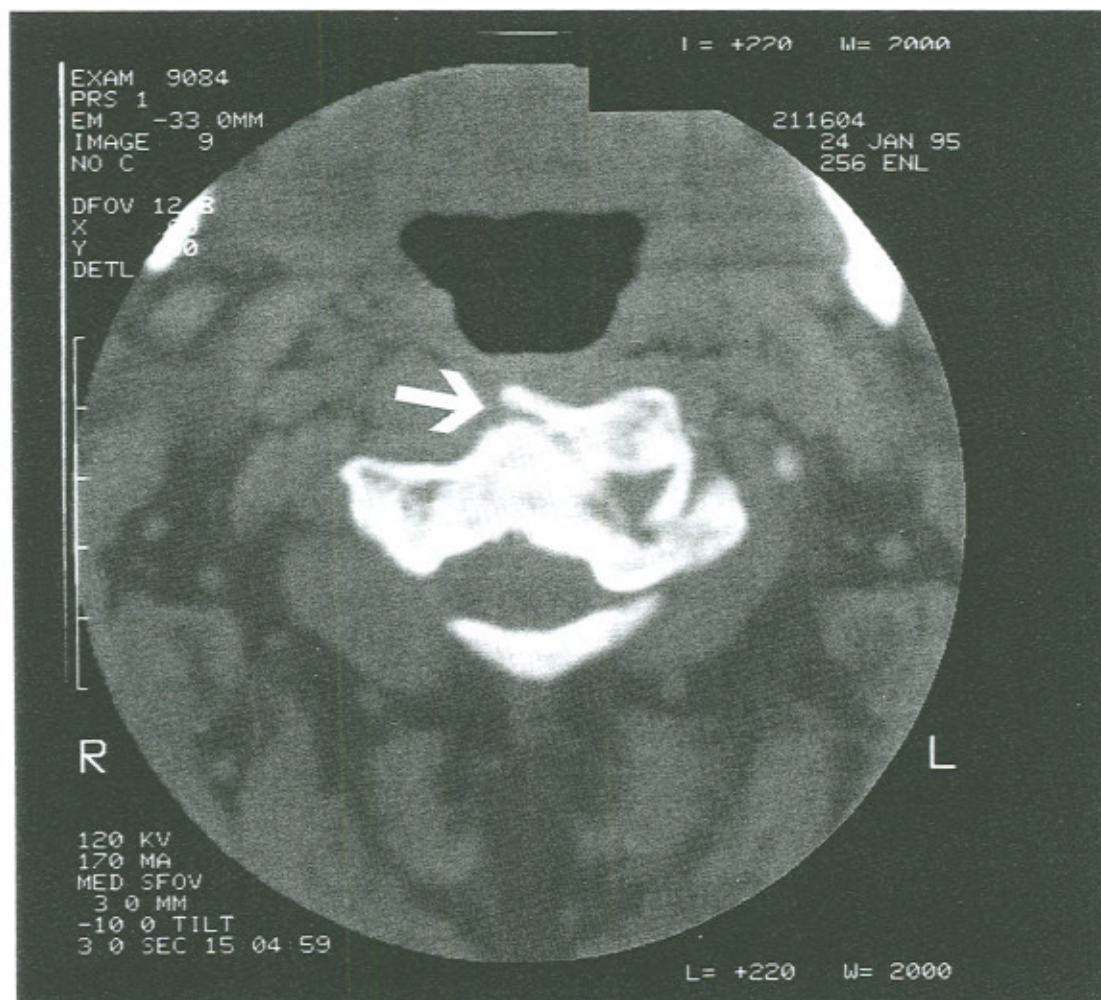


Figure 3 CT Scan (11 weeks after the accident)

This CT scan confirms a fracture through the body of axis, extending anteriorly. The discontinuity in the anterior cortex (arrow) corresponds to that seen on the lateral radiograph taken at the time of the injury (figure 1B).

A computed tomography scan was ordered to ascertain the possibility of bony fragmentation or extension of the fracture segment within the spinal canal. These films showed a fracture extending through the body of C2 (see Figure 3).

Since the fracture appeared to be stable, the patient was not considered a candidate for operative management at that time. The patient was advised to discontinue the use of his soft collar.

At follow-up evaluation one month later, the patient reported a significant decrease in the intensity of his headaches. However, he complained of neck pain upon turning his head to either side. Also, he reported experiencing a "shock like sensation" in both arms on forward flexion of his neck (L'hermitte's phenomenon). These new symptoms were believed to be suggestive of early onset of cervical myelopathy. There were no other neurological signs or symptoms. The patient was considered for operative management, pending the results of an MRI study.

Discussion

Epidemiology and etiology

The incidence of radiographic signs of cervical spine injury in cervical trauma patients has been reported as 2–4%.^{2,3,7,9,10} The observation that a significant number of patients with cervical spine injuries will have more than one fracture of the cervical spine, or unsuspected fractures of the thoracic or lumbar spine is well documented.^{1,11,12} The predominance of cervical injuries (such as fractures or fracture-dislocations) occur at C-2, C-5 and C-6 vertebrae.^{1,11,13,14} Most studies report motor vehicle accidents as the most common mechanism of cervical spine trauma, with falls being second.^{7,14,15,16} However, falls are associated with a higher incidence of cervical spine fractures,⁶ and a significant increase in instability.¹⁷

Clinical presentation

Several studies have attempted to identify characteristics of patients requiring plain film radiographs of the cervical spine following blunt head or neck trauma^{1,6,8} (see Table 1). In these studies, cervical spine fractures or dislocations were found in patients who were not alert or awake, clinically intoxicated, had complaints of central neck pain or tenderness over the cervical spine, focal neurological findings, or other painful or distracting injuries. Cadoux et

Table 1
Indications for radiographic examination following cervical spine trauma

Central neck pain or tenderness
Not fully awake or alert following trauma
Altered mental status
Clinically intoxicated
Presence of other painful or distracting injuries
Presence of focal neurological findings

al.¹⁹ reported that only cervical spine tenderness, direct cervical injury and loss of consciousness were statistically associated with cervical spine fractures. Furthermore, Kriepke et al.² reported a statistical association between cervical spine fractures and respiratory irregularity, motor dysfunction, and altered sensorium (non-communicative).

According to Fischer,⁸ in the absence of head injury, substance abuse or other causes of decreased level of consciousness, clinical suspicion reliably selects patients at risk for cervical spine injury based on the patient's complaints and the physical examination. Others consider patients at risk for cervical fracture and requiring radiographic assessment of the cervical spine if involved in a high-speed motor vehicle accident, serious fall or diving accident, or who have other injuries, especially facial injuries.²⁰

There are several features in the case presented that strongly indicated the possibility of a cervical fracture. Although the patient did not lose consciousness after a high speed motor vehicle accident, the presence of a distracting head injury following a blunt head trauma associated with neck pain should have raised the suspicion of a cervical fracture.

Radiological evaluation

According to Kaye and Nance,²⁰ routine radiographs remain the single best initial examination for cervical spine trauma. Traditionally, patients presenting with cervical spine trauma underwent a three-view series including a cross-table lateral, antero-posterior and open-mouth odontoid views. Several authors have recognized the controversy surrounding the need for additional or fewer views.^{4,20,21,22} Many believe that the first study that should

Table 2
Radiographic signs of cervical trauma

Abnormal Curvatures
Loss of cervical lordosis
Acute kyphotic angulation
Abnormal Alignments
Tracheal deviation
Laryngeal dislocation
Widened interspinous space
Atlantodental interspace (>4mm)
Widened apophyseal joint space
Axial rotation of vertebrae
Abnormal Soft Tissue Planes
Retropharyngeal space greater than 7mm at C2
Retrolaryngeal space greater than 21mm at C6
Displaced prevertebral fat stripe

(after: White AA, Panjabi M. Clinical biomechanics of the spine. Second edition. JB Lippincott Co. 1990)

be obtained is a lateral view.^{20,23,24} Additional views should be ordered based on the findings of this view,²⁰ which often best demonstrates subtle radiographic findings suggestive of cervical spine trauma (see Table 2).

Conversely, the lateral view has been reported to have a false negative rate of 14–26 per cent.^{7,8,25} This has led to criticism of its sole use in screening trauma victims for cervical spine injury. Shaffer and Doris²⁵ reported the antero-posterior and open mouth views to increase the diagnostic yield to 100% in a study of 35 patients with cervical spine fracture. Freemyer et al.²¹ compared the traditional three-view with five-view (including supine oblique views) series in patients at high risk for cervical fractures, locked facets, subluxation, or dislocation. Using conventional tomography as the gold standard, they concluded that supine oblique views did not improve detection but did, in certain cases, allow more specific diagnosis of injuries. Holliman et al.⁴ looked at the usefulness of the antero-posterior view, as part of the three-view series in 148 patients diagnosed with cervical spine injury. They concluded that there were no cases of cervical spine injury

evident on the antero-posterior view without obvious corresponding abnormality on the lateral or open mouth views.

Lewis et al.¹⁷ conducted a retrospective study to determine if flexion-extension views provided supplementary information to the routine three-view series. These views demonstrated cervical spine instability in less than 8 per cent among the 141 patients assessed. Furthermore, flexion-extension views have been reported to increase the sensitivity of the three view series in the detection of fracture from 71% to 99% and its specificity from 89% to 93%.¹⁷

While many researchers are in pursuit of the ideal radiographic series following cervical spine trauma, and its indications, others argue that the lack of understanding in the interpretation of these investigations is a greater obstacle. It has been reported that 7 to 10 per cent of patients with cervical fracture are missed.^{1,15} while 14 per cent of patients with acute cervical spine injury are falsely diagnosed with traumatic fracture or dislocation.²⁶ False positive interpretations were attributed to the unfamiliarity with the various conditions that may mimic acute traumatic injury.²⁶ In a study of 897 patients, Annis et al.²⁷ reported a large discrepancy in the radiological interpretations of casualty officers and junior radiologists (residents), when compared to clinical radiologists. The difficulty in radiographic interpretation was attributed partially to incorrect positioning and exposure factors. Failure of clinicians to consult with clinical radiologists is seen as a frequent source of error in diagnostic imaging.²⁸ The need for careful assessment of cervical spine radiographs by experienced radiologists is illustrated by the case presented in this report.

Many patients will undergo computed tomography (CT scan) of the cervical spine following equivocal or positive plain film radiographs. CT scanning is indicated when there is persistent neck pain or tenderness; neurological signs or symptoms; the antero-posterior projection is obscured by tubes inserted in resuscitation; poor visualization of the upper or lower cervical spine on the open mouth, lateral or swimmer's lateral views; abnormal prevertebral soft tissue swelling greater than 7mm at C2 and 22 mm at C6 vertebrae;^{12,16,29,30} and in the presence of normal cervical spine radiographs when cervical spine fracture is suspected clinically.³⁰ One study suggests the routine CT imaging of the cervical spine in all patients

with a known mechanism of cervical injury regardless of symptomatology, in light of a 5% rate of asymptomatic fractures.¹²

The patient presented in this report demonstrated various clinical and radiographic features, indicating the need for cervical tomography at the time of the accident. The patient reported neck pain, in the presence of a distracting head injury. An artifact, thought to be a metal snap from a cervical collar, did not allow adequate visualization of the body of C2, one of the most common areas of cervical spine injury following trauma. The initial lateral film demonstrated prevertebral soft tissue swelling, a disruption in the spinolaminar junction of atlas in relation to axis, and loss of cortical integrity in the body of axis anteriorly. This latter sign was confirmed by CT scan to be a fracture extending through the anterior aspect of the body of axis (see Figure 3).

Recently, Woodring and Lee¹² compared cervical films and CT scans of 216 patients with cervical injuries in the detection of fractures and dislocations. They concluded that the lateral views grossly underdetected the number of fractures and dislocations, even when the results of the lateral views were considered abnormal. Nonetheless, an abnormal radiograph provides valuable information in its indication of the need for advanced imaging, even without proper estimation of the extent or severity of injury.

Acheson et al.²⁹ recognised this value in their comparison of CT scan with plain film radiographs. They noted that although plain films only detected 47% of fractures, all undetected fractures had corresponding abnormalities identifiable on plain film radiographs. In the case presented, although the initial lateral radiograph did not clearly depict a fracture through the body of axis, the presence of abnormalities in soft tissues and osseous structures makes its value irrefutable in assessment of cervical spine trauma.

Conclusion

A comprehensive evaluation of cervical trauma victims, including presenting complaints, mental status, palpatory findings, and neurological status should provide the necessary information to indicate if cervical spine radiographs are warranted. Furthermore, any patients with complaints of neck pain present a high index of suspicion for cervical spine fracture when the mechanism of injury includes a high speed motor vehicle accident or a fall.

Clinicians should be wary when radiographs are interpreted as normal in the presence of persistent signs and symptoms. It is essential that the attending clinician order and review any previous radiographs for proper management of patients with a history of cervical trauma. The acceptance of poor quality radiographs may have catastrophic consequences.

Acknowledgments

We wish to thank the Chiropractors' Association of Saskatchewan and the Canadian Memorial Chiropractic College for financial assistance in preparing this manuscript, and the Department of Medical Photography at the Royal University Hospital of Saskatoon for assistance with photography. Special thank you to Dr. André Cardin, professor in radiology at the Canadian Memorial Chiropractic College, for his valuable comments in the interpretation of the radiographs.

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