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C6-C7 SUBLUXATION IN AN ELDERLY PATIENT AFTER A NORMAL INITIAL CERVICAL COMPUTED TOMOGRAPHY SCAN

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ABSTRACT

Reports of neurologic injury as a result of undiagnosed cervical spine injuries in a patient with a normal computed tomography (CT) scan is a feared phenomenon not well described in the medical literature. Reported is a case of an elderly woman who was involved in a motor vehicle accident who was appropriately immobilized by the emergency medical services (EMS) and had a normal CT scan of the cervical spine who subsequently developed a few hours later neurologic deficits. This is the first documented report of neurologic deterioration occurring in an emergency department after a normal CT scan of the cervical spine in a patient with an occult cervical spine injury.

INTRODUCTION

Trauma to the head and neck can cause a vertebral spinal column injury, a spinal cord injury, or both. Reports of neurologic injury as a result of undiagnosed cervical spine injuries in a patient with a normal computed tomography (CT) scan is a feared phenomenon not well described in the medical literature. Missed or delayed diagnosis of cervical spine injuries may lead to extension of those injuries and subsequent preventable mortality or morbidity. This reports a case of an elderly woman who was involved in a motor vehicle accident who was appropriately immobilized by the emergency medical services (EMS) and had a normal CT scan of the cervical spine who subsequently developed a few hours later neurologic deficits.

CASE REPORT

A 77 year-old female presented to the emergency department (ED) after a motor vehicle accident. She was brought in by the EMS immobilized on a long spinal board with a cervical collar. She was a driver and the exact mechanism of the accident was unknown, but there was significant damage to the front of her car. It was unknown if she was retrained. She did lose consciousness and did not recall the events. She complained of pain all over. Her past medical history included hypertension and an unspecified heart disease. Her medications were Plavix and she had no allergies. She did not drink alcohol, smoke, or use illicit drugs.

She had a temperature of 36.2°C, blood pressure of 119/66 mm Hg, heart rate of 64 beats per minute, and a respiratory rate of 22 per minute. Her pulse oximeter reading was 100% without supplemental oxygen. She was easily aroused but confused. Her neck examination revealed no tenderness or deformity. Her chest wall illustrated a contusion over the left anterior portion with no deformities or crepitus. Her lungs were clear to auscultation and her heart examination was normal. Her abdominal wall showed ecchymosis over the right upper quadrant with mild tenderness. Her Glasgow Coma Scale (GCS) score was 14. Her motor and sensory neurologic examinations and deep tendon reflexeswere normal. Her right elbow showed ecchymosis with no deformity and her left knee had a 26 cm complex laceration with no deformity.

Her complete blood cell (CBC) count, basic metabolic profile, prothrombin time (PT), and activated thromboplastin time (aPTT) were normal. Her chest and pelvic radiograph showed no acute abnormalities. Her head CT scan was normal. Her cervical spine CT scan showed no acute fracture, dislocation, subluxation, or soft tissue swelling;but did reveal mild degenerative changesof the vertebral bodies [Figure 1]. Her abdominopelvic CT scan showed soft tissue swelling consistent with contusions of the abdominal wall with no internal organ injury.

During a routine reassessment, the patient was found with an acute decrease in her level of consciousness and weakness of all her extremities. Her motor exam strength included 0/5 in the upper extremities and 2/5 in the lower extremities. Her sensory examination was difficult to assess due to confusion, but it seemed to have a loss from T4 dermatome down. Apparently she tried to get out of the stretcher, but was not successful. It was noted in the nursing notes that she removed her C-collar but it was immediately replaced. The repeat CT scan of the cervical spine revealed a C6-C7dislocation [Figure 2]. Orthopedics was consulted and she was placed in Halo traction. She was hospitalized and slowly regained some of her motor function and was transferred to a rehabilitation hospital.

DISCUSSION

Spinal cord injury causes significant morbidity and mortality. The reported incidence of cervical spine injury in the setting of major trauma is 1.5% to 4% [1, 2]. Most common causes of injury are falls followed by motor vehicle accidents (MVA).Patients with proven cervical spine injuries are initially asymptomatic in up to 13% of cases [3]. Occult spinal cord injury is very difficult to diagnose. Missed or delayed diagnosis of cervical spine injuries may lead to extension of those injuries and subsequent preventable mortality or long-term morbidity. It has been postulated that 3% to 25% of patients with cervical spine injury may suffer injury extension as a consequence of delays in diagnosis or inappropriate handling of their injury [4-6]. Factors shown to contribute to the delay in the diagnosis of cervical spine injuries include intoxication, fluctuating level of consciousness, the presenceof distracting injuries, and failure to obtain adequate plain radiographs [4, 7]. Davis et al in a review of 740 patients with cervical spine injuries, the diagnosis was delayed or missed in 34 patients (4.6%) [8]. Ten of the 34 patients (29%) developed permanent sequelae as a result of these delays. The single most common error was the failure to obtain an adequate series of C-spine roentgenograms. Delayed diagnosis could have been avoided in at least 31 of 34 injuries by the appropriate use of a standard three-view C-spine series and careful interpretation of those roentgenograms. In our patient, confusion probably attributed to not having a reliable neurologic examination, which may have aided in detecting a potential cervical spine injury. A low level of suspicion, possibly due to inadequate elucidation of the mechanism of injury, is often the reason for failure to diagnose a cervical spinal injury [4].

The mechanism of injury in blunt cervical spine injury (CSI) involves two forces[9].An acceleration-deceleration force or change in velocity causes significant head and neck movement resulting in a flexion-extension injury pattern. A direct force to the head or face against an immovable object with the force transmitted down the cervical spine.

Bilateral interfacetal dislocation (i.e., locked facets) occurs when the articular massesof one vertebra dislocate anteriorly and superiorly from the articular surfaces of the adjacent vertebra below. All ligamentous structures are severely disrupted. On radiographs, the vertebral body is dislocated anteriorly ≥50% of its width. These injuries usually present with neurologic deficits due to compromise of the intervertebral foramen unless the dislocation is only partial. In our patient extreme hyperextension from the MVA resulted in acomplete tear of the anterior longitudinal ligament, a complete tear of the intervertebral disk, and adisruption of the posterior ligamentous complex. On the lateral radiographic view, the vertebrae may appear normal if the dislocation spontaneously reducesor if the injury is masked by a cervical immobilization collar. Prevertebral soft tissue swelling may be the only radiographic finding present. Anterior disk space widening or fracture of the anteroinferior end plate of the vertebral body may occur.

Patients usually present with a central cord syndrome. This is commonly seen in older patients with preexisting cervical spondylosis from degeneration of the spine or spinal osteoarthritis who sustain a hyperextension injury. This injury preferentially involves the central portion of the cord more than the peripheral. The centrally located fibers of the corticospinal and spinothalamic tracts are affected. The neural tracts that provide functions to the upper extremities are most medial in position compared with the thoracic, lower extremity, and sacral fibers that have a more lateral distribution. Clinically, the patient presents with decreased strength, decreased pain, and decreased temperature sensation effecting more of the upper than the lower extremities. Vibration and position sensation are usually preserved. Spastic paraparesis or spastic quadriparesis can also be seen. The majority will have bowel and bladder control, although this may be impaired in the more severe cases.

Radiographic clearance for injury must be provided efficiently and accurately. High levels of variation and inefficiency exist in current clinical practice regarding use of cervical spine (C-spine) radiography in alert and stable trauma patients. Patients with head or neck trauma who are not fully alert or a GCS<15 should undergo imaging of their cervical spine because the frequency of cervical spine injury in association with traumatic brain injury ranges from 1.7% to 8%[10].

Despite the use of plain radiographs to exclude cervical spine injury, they are inherently associated with difficulty in proper interpretation and an unacceptably prominent rate of diagnostic error [4]. It has been reported 4.3% to 22.9% of cervical spine injuries are missed initially, with half of these misses attributed to misinterpretation of the plain radiograph [4, 11, 12]. Of the patients with missed fractures, two-third of them had deterioration of their neurologic status [11].

In alert, stable adult trauma patients who have no neurologic deficits (i.e., low-risk trauma patients), two major clinical decision rules have been defined to reduce practice variation and inefficiency in the ED use of plain cervical spine radiography and decrease unnecessary radiography. The first decision rule was derived by the National Emergency X-Radiography Utilization Study (NEXUS), which determined that plain cervical spine imaging is unnecessary in patients who lack all five clinical criteria: absence of midline cervical tenderness, normal level of alertness and consciousness, no evidence of intoxication, absence of focal neurologic deficit and absence of painful distracting injury [2, 13]. In their prospective study, 34,069patients were included and the NEXUS criteria were 99.6% sensitive (95% confidence interval [CI], 98.6% to 100%) for detecting clinically significant cervical spine injuries, but only 12.9% specific (95% CI, 12.8%to 13.0%), with a negative predictive value of 99.9% (95% CI, 99.8% to100%). The original NEXUS trial excluded patients >60 years old, but the criteria were subsequently reported to be 100% sensitive (95% CI, 97.1% to100%) and 14.7% specific (95% CI, 14.6% to 14.7%) for clinically significant injuries in 2,943 patients ≥65 years of age[14]. In a subsequent prospectivetrial of 2,785 patients ≥65 years of age, the NEXUS's criteria was only 65.9% sensitive (vs 84.2% in younger patients) for cervical spine injuries detected on CT[14]. However, this trialcontained several sources of bias, use of a convenience sample, a very highincidence of cervical spine injuries in the elderly group (12.8% vs 4.6% inthe previous trial), and every elderly patient included activated a trauma teamevaluation. This latter study did not clarify whether the fractures detectedon CT were clinically important or if any intervention was required.

The second clinical decision rule was the Canadian C-spine rule (CCR) study[16]. There were 8,924 patients with blunt trauma to the head/neck, stable vital signs, and a GCS score of 15 that were evaluated by plain radiography, computed tomography, and a structured follow-up telephone interview [17]. In the study, 151 (1.7%) had significant C-spine injury. The Canadian rule consists of three assessments which are asked in sequential order. First, there are no high-risk factors that mandate radiography (i.e., age 65 ≥years, a dangerous mechanism of injury [fall from a height of >3 feet; an axial loading injury; high-speed motor vehicle crash, rollover, or ejection; motorized recreational vehicle or bicycle collision], or presence of paresthesias in the extremities). Second, there are low-risk factors that allow a safe assessment of range of motion (i.e., simple rear-end motor vehicle crashes, patient able to sit up in the ED, patient ambulatory at any time, delayed onset of neck pain, absence of midline cervical tenderness). Third, the patient is able to actively rotate their neck regardless of pain. To proceed to the next assessment, the answerto the previous assessment must be “Yes.” If the answer to any assessmentsis “No,” then imaging is immediately performed. By cross-validation, CCR was 100% sensitive (95% CI, 98% to100%) and 42.5% specific (95% CI, 40% to 44%) for identifying 151 patientswith significant cervical spine injuries [17].The potential radiography ordering rate would be 58.2%.

The CCR has alsobeen validated in both larger hospital-based studies and prehospital studies, but has been criticized for its complexity when compared to the NEXUS[17-19]. There is one published direct prospective comparison of NEXUS versus CCR (n = 8,283) that reported that CCR was more accurate for detecting cervical spine injury compared to NEXUS, with greater sensitivity(99% vs 91%), specificity (45% vs 37%), positive likelihood ratio (1.81 vs1.44), and negative likelihood ratio (0.01 vs 0.25)[20]. However, some havequestioned the methodology of this comparison as being biased in favor of the CCR [21, 22]. A meta-analysis of 15 studies included 79,526 patients and concluded that the CCR appeared to have better diagnostic accuracy than NEXUS. However, these studies had modest methodologic quality and further studies need to follow rigorous methodologic procedures to ensure that the findings are as free of bias as possible [23].

With the more liberal use of CT scans in the evaluation for C-spine injuries, studies have been done to compare both decisionrules using CT scan as the gold standard. In a 2011 study of 2,606 blunttrauma patients, NEXUS was found to only be 82.8% sensitive and 45.7%specific for spine injury[24]. Of the 26 missed injuries, 19 patients requiredfurther intervention, including 2 who went to the operating room and 1needing a Halo. The same group compared CCR to CT scan (3,201 blunttrauma patients), finding excellent sensitivity of 100% but only 0.60%specificity [25]. Nevertheless, the use of NEXUS has been recommended foruse in several national guidelines and trauma societies [26, 27].

Spinal cord injury occurring after normal cervical spine radiographic studies is always a feared phenomenon that is extremely rare. Imaging is used in instances of trauma to the cervical spine to detect and assess the extent of osseous, ligamentous, neural, soft-tissue injuries, and to help evaluate instability of the cervical column. In cases of acute trauma, these objectives must be met expeditiously, affordably, and with the smallest amount of diagnostic error. Conventional radiography remains agood screening examination when the probability of injury is high and the consequences of missing a fracture could be disastrous.

There are numerous choices for clearance that have been used in clinical practice. These include the lateral radiograph only, the 3-view C-spine series (i.e., the lateral, anterior-posterior, and odontoid views) or 5-view C-spine series (i.e., add oblique views to the 3-view), flexion-extension radiographs, CT with multiplanar reformations, and magnetic resonance imaging (MRI) [28]. Using only a cross-table lateral cervical radiograph to detect cervical spine injuries may miss up to 67% of cervical spine injuries [3, 4, 29]. All seven cervical vertebrae and the upper section of the first thoracic vertebrae should bevisualized on the radiograph to not miss hidden injuries[30]. A "swimmers view" may be necessary to visualize the junction of C7-T1 clearly. This often requires an assistant to pull down the shoulders during the radiograph. The main advantages of plain radiography are that it can be done at the bedside, exposes the patient to only small amounts of ionizing radiation, and has a relatively low cost. One of the main disadvantages of plain films is that they are poor for imaging C1 and C2. In addition, visualization of the entire cervical spine by plain films is often problematic in obese, elderly, or extremely muscular patients. This is especially true with a cervical collar in place. Most centers utilize a three-view screen. Even if these radiographs are normal, as many as 7% to 10% of cervical injuries may be missed. Some have recommended right and left oblique views as a routine part of the radiographic evaluation of the cervical spine [31-33]. Studies have shown that, compared with helical CT, 3-view radiography "misses" cervical spine fractures at rate of 40% to 55% [34-37].

If radiographs are not satisfactory, patients with continued unexplained neck pain despite normal radiographs, CT or MRI are indicated [31, 38]. However, in most trauma center's CT scan has become the quintessential imaging technique as the initial imaging modality for assessing injuries to the cervical spine [39]. The multidetector CT scan provides better visualization of the soft-tissues, osseous structures, and potential impingement of the spinal cord than conventional radiography. It is more sensitive and specific than plain radiography for evaluating the cervical spine in trauma patients and can be performed quickly [40, 41]. CT scan of the whole cervical spine in obtunded patients with normal osseous structures and anatomic alignment has been shown to have a negative predictive value of 98.9% for ligamentous injury and a negative predictive value of 100% for unstable cervical injury when compared to subsequent MRI [42]. In addition, a 3-year retrospective review found that plain radiography did not add any clinically useful information to a cervical spine CT [43]. Furthermore, a cost analysis showed CT to be cost-effective to screen for cervical spine injuries in moderate-to high-risk patients [43]. The Eastern Association for the Surgery of Trauma recommends CT as the primary diagnostic tool for suspected cervical spine injury[25]. In addition, if plain radiography is chosen as the primary imaging modality, a CT should be ordered if an injury is detected, suspected, or if the initial plain radiographsare inadequate. CT can be used to visualize the entire cervical spine and is particularly useful at the craniocervical and cervicothoracic regions, where the sensitivity of plain films is most limited.

In patients with pure ligamentous injuries, the spine can spontaneously reduce to a normal position. The resulting instability risks subsequent neurologic injury if the bony spine moves. Signs and symptoms include persistent neck pain, midline tenderness, extremity paresthesias, or focal neurologic findings despite normal plain radiographs and/or CT. Although flexion and extension radiographs have been traditionally used to try to detect ligamentous instability, numerous studies have demonstrated their lack of sensitivity and inefficiency [44-48]. It has been shown that 30% to 80% of flexion and extension radiographs are inadequate and provide no further information beyond a CT [44-48]. Therefore, flexion and extension radiographs should not be ordered when more advanced imaging is available.

MRI is the imaging modality of choice if a ligamentous injury is strongly suspected as it has excellent sensitivity for soft tissue injuries[49, 50]. However, there are practical limitations on its use. This includes the requirement for the patient to be stable, MRI availability, MRI cost, and patient tolerance for the procedure. If emergent MRI is not feasible, reliable patients with persistent pain but normal CT can be discharged in a firm foam collar with outpatient follow-up in 3 to 5 days. Most patients' symptoms will resolve over a few days. A patient with persistent pain at follow-up will likely require additional imaging. Unreliable patients with severe persistent pain and normal CT images should be considered for an MRI study, although this is rarely indicated as part of the initial investigation. Some data have suggested that newer generation CT scanners are sufficient to detect significant injuries in obtunded patients [51, 52]. The results of these studies cannot currently be externally generalized to awake, symptomatic patients. In a review of 11 studies comparing CT versus MRI of the cervical spine in obtunded patients, MRI detected 96 (5.8%) more traumatic injuries with the majority requiring continued collar immobilization with 1.25% required surgical stabilization [53]. Therefore, MRI is reserved for patients with suspected injuries to the spinal cord, intervertebral disks, and ligaments. MRI is far superior to other modalities for patients with neurologic deficits [54, 55].

Fig 1. CT scan of the cervical spine showing degenerative changes of the vertebral bodies.

Fig 2. CT scan of the cervical spine demonstrating a C6-C7 dislocation.

CONCLUSION

This is the first documented report of neurologic deterioration occurring in an emergency department after a normal CT scan of the cervical spine in a patient with an occult cervical spine injury. Patients who have a mechanism with a high clinical suspicion for cervical spine injury but have decreased mentation or the presence of distracting injuries should have cervical spine precautions maintained until the proper radiographic assessment is performed or the confounding factors resolve allowing for a reliable neurologic examination. Reliance solely on a normal CT scan of the cervical spine to “clear” these patients from cervical injuries may actually miss injuries.

CONFLICT OF INTEREST

The author declares that he has no conflicts of interest.

STATEMENT OF HUMAN & ANIMAL RIGHTS

All procedures performed in human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by the author. This report meets the institutional review board exemption policy.

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