Delayed or Missed Diagnosis of Cervical Spine Injuries

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**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.

**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
sports activities in 8%, scuffles in 1%, and from other mechanisms in 9%. Fifty-three patients (14%) came in walking, 138 patients (38%) were brought in by ambulance, 66 patients (18%) by emergency car or emergency helicopter, and 110 patients (30%) were transferred from other hospitals.

Forty-nine percent of the cervical spine injuries occurred isolated or combined with insignificant concomitant injuries (e.g., grazes, bruises, etc.) and 51% in combination with other severe injuries. In all, 222 patients (60%) were fully conscious during primary evaluation and examined both clinically and neurologically. Also, 145 patients (40%) had an alteration of their mental status so that clinical and neurologic evaluation was not reliable.

The overall incidence of neurologic deficits was 38% (n = 140). One patient showed motor deficits, 14 patients incurred sensory deficits, and 58 patients had motor and sensory deficits. Sixty-seven patients (18%) showed a complete tetraplegia.

In all, 185 patients (50%) were treated conservatively, 182 patients (50%) submitted to an operation, 325 patients (89%) were admitted to the ward, and 42 patients (11%) remained outpatients. One hundred twenty-four patients (34%) required intensive care treatment. The average duration at ICU was 15.3 days.

Forty-nine patients (13%) died: 16 because of the cervical spine injury, nine as a result of multiple injuries, nine because of a severe brain injury trauma, and 15 patients because of other reasons.

The analysis of clinical records revealed that 18 patients (4.9%) had delayed or missed diagnosis of their cervical spine injuries. The 18 diagnostic failures concerned 7 female and 11 male patients with an average age of 46.6 years (3.6–88.9 years). Seven delayed diagnoses occurred at the upper cervical spine, nine at the lower cervical spine, and two occurred in combined injuries of the upper and lower cervical spine (Fig. 1).

The missed injuries of the upper cervical spine consisted of five fractures of the odontoid process, one Jefferson fracture, and a slightly displaced fracture of C2. The missed injuries of the lower cervical spine comprised a fracture of C4, two displaced fractures of C5, two fractures of C6, one displaced fracture of C7, and three discoligamentous instabilities. In the two patients with combined injuries of the upper and lower cervical spine level, once a fracture of C2 and C3 was missed and once a fracture of the atlas and C5 was failed to diagnose.

In eight cases (44%), delayed diagnosis was found to be the result of a misinterpretation of the standard radiographs (Fig. 2). Junior staff responsible for initial radiologic examination failed to diagnose the injuries. In six cases, correct diagnosis was made later on from the standard radiographs by more experienced senior surgeons following the control mechanism of the unit. Experienced staff evaluated all plain radiographs secondarily within 24 hours. In two cases, the injury was diagnosed after performing a CT scan because of continuous neck pain.

In five cases (28%), incomplete sets of radiographs were responsible for delayed diagnosis (Fig. 2). Three discoligamentous injuries were missed because no functional flexion/extension views were performed. One of the patients had an isolated discoligamentous injury. He was polytraumatized and unconscious as a result of a severe brain injury during primary examination. Clearing the cervical spine with complete sets of standard radiographs and CT scan did not show the extent of the injury. After regaining consciousness, the patient had a complete tetraplegia. Functional flexion/extension views and MRI were ordered showing the discoligamentous injury. The other two patients sustained discoligamentous injuries combined with fractures at the lower cervical spine. The fractures were diagnosed during primary radiologic examination, but the discoligamentous instabilities were missed. Finally, in both cases the discoligamentous injuries were identified by functional flexion-extension views after the spinal precautions were discontinued. In the other two cases with incomplete sets of radiographs, fractures were missed because only a lateral view of the cervical spine was performed during initial evaluation. Both patients were poly-

**Fig. 1.** Delayed diagnosis: distribution.

**Fig. 2.** Diagnostic failures: causes.
traumatized and primary examination focused on other severe injuries. Correct diagnosis was made after performing complete sets of standard radiographs in one case and by autopsy in the other case.

In four cases (22%), the injury was missed because inadequate radiographs did not show the level of the injury (Fig. 2). All four delayed diagnosis occurred at the lower cervical spine level. Performing proper x-ray views was difficult because of degenerative spine disease, severe neck pain, or altered mental state. In two cases, correct diagnosis was made by a CT scan, in one case by tomography, and in another case after repeating standard radiographs.

In one case (6%) of delayed diagnosis, the injury was missed because the treating surgeon did not see the radiographs (Fig. 2). The patient returned later on with increasing neck pain. Correct diagnosis could then be made by another surgeon who checked the initial radiographs.

An appropriate clinical and neurologic evaluation of the patients was not possible in eight cases (44%). Five patients suffered from an altered mental state because of other severe injuries, two patients because of alcohol or drug usage. Six patients (33%) had other severe injuries that were focused on during initial evaluation. Immediate lifesaving measures for other injuries were necessary in three patients.

Correct diagnosis was made by senior surgeons following the control mechanism of the unit in seven cases. In four cases, the injury was diagnosed by a CT scan, in three cases by performing functional flexion/extension views, and in two cases after repeating standard radiographs. Once the injury was diagnosed by a conventional tomography and once by an autopsy (Fig. 3).

Seven (39%) of the 18 patients with delayed diagnosis remained outpatients after primary trauma evaluation. In four of them, correct diagnosis was made within 24 hours following the control mechanism of the unit. All four patients were informed to come in immediately. In the other three cases, correct diagnosis was made within a week after trauma, after patients had returned because of increasing neck pain and/or neurologic deficits.

Eleven patients (61%) with delayed diagnosis of their cervical spine injuries were admitted to the ward because of other injuries. In eight cases, correct diagnosis was made during stationary treatment after patients had complained about increasing neck pain or after developed neurologic deficits. In five of them, correct diagnosis was made within a week after trauma; in three of them, correct diagnosis was made after 10 to 15 days. In three cases, correct diagnosis was made after patients had been discharged. All of them returned with increasing neck pain or neurologic symptoms. In two of them, correct diagnosis was made within a week after trauma; in one of them, it was made after three weeks.

Complications attributed to delayed or missed diagnosis occurred in eight patients (44%), ranging from motor and/or sensory neurologic deficits to complete tetraplegia. Six patients had neurologic deficits during primary evaluation and developed progressive deficits subsequently. One patient returned with incipient neurologic deficits after being discharged. In one case, a polytraumatized and initially unconscious patient showed a complete tetraplegia after regaining consciousness. Finally, in six of those eight patients, we saw a complete recovery of neurologic function after change of treatment. In two patients, neurologic deficits resolved incompletely.

A change of treatment was necessary in 15 patients (83%). Seven patients underwent operative treatment after correct diagnosis had been made. In two patients, anterior cervical fusion was performed; posterior cervical fusion was performed in five patients. Eight patients were treated conservatively either by a halo brace (n = 3) or a cervical collar (n = 5).

Two patients (11%) died, but neither because of the cervical spine injury.

DISCUSSION

The incidence of delayed or missed diagnosis of cervical spine injuries is between 5 and 20%. 1-3 Previous works have shown that common reasons for delays in diagnosis are radiologic misinterpretation, incomplete sets of radiographs, or inadequate radiographs. 1,2 An inappropriate clinical and neurologic evaluation of the patients is another common problem for diagnostic pitfalls. This problem mainly appears in patients with an altered mental state or in patients with other severe injuries. 4,5

The results of this retrospective study show an incidence of delayed diagnosis of 4.9%. Comparing to previous studies, the incidence rate at this trauma unit was relatively low, but the causes for delays in diagnosis appear not to have changed in the last 10 to 15 years.

An analysis of causes demonstrate that we had three main reasons for delayed or missed diagnosis at the cervical spine: (1) lack of experience in evaluating the radiographs leading to misinterpretation, (2) inadequate radiographs, and (3) incomplete sets of radiographs.
The most common cause of missed cervical spine injuries was a misinterpretation of the standard radiographs. In eight cases (44%), injuries were not detected because inexperienced junior staff responsible for initial radiologic examination failed to make the correct diagnosis. This requires establishing a policy for the department. More experienced senior surgeons are expected to evaluate all radiographs secondarily. In our patients, this helped to detect six primarily missed cervical spine injuries within 24 hours.

Incomplete sets of radiographs ranked as the second most common cause of missed cervical spine injuries. This error was responsible for five (28%) of 18 delayed diagnosis. In three cases, discoligamentous injuries were missed because no functional flexion/extension views were performed during initial examination. The functional flexion/extension views were made delayed (after spinal precautions were discontinued) because the patients had complained about continuous neck pain or neurologic deficits. In all three patients, the functional flexion/extension views showed discoligamentous instability of the cervical spine that was missed primarily. We recommend performing functional flexion/extension views as obligate completion to a three-view cervical-spine series (anteroposterior, lateral, and open mouth) in awake patients after excluding unstable bony injuries in the standard series. In comatose patients, flexion-extension studies are potentially dangerous to the unprotected spinal cord. If functional flexion/extension views are performed, strict adherence to an established guideline, including repeated review of the cervical spine radiographs by an experienced reviewer as well as complete visualization of the entire cervical spine, is necessary to ensure safety of the patients. If this protocol is obtained and patient safety can be ensured, flexion-extension studies appear to be an effective method to detect occult discoligamentous injuries. In patients with a suspected injury in the standard series, flexion/extension views should be avoided until the extent of the injury can be measured by cervical CT scan.

In two cases, bony injuries were missed because only a lateral view was made during initial examination in the trauma room. Both patients were severely injured and lifesaving measures were focused on initially. Following several studies reporting that a lateral cervical spine view alone is associated with delays in diagnosis in 15% of patients with cervical spine injuries, we also recommend performing further standard radiographs to a complete three-view cervical-spine series after treatment of life-threatening injuries to improve sensitivity in detecting cervical spine injuries in these patients before they leave the trauma room.1,2,6–9

In four cases (22%), inadequate radiographs were responsible for delays in diagnosis. Injuries were missed either because the x-ray field did not show the level of the injury or because of the poor technical quality of the radiographs. All four delayed diagnosis occurred at the lower cervical spine, where it might be difficult to perform proper x-ray views. Particularly in patients with preexisting degenerative spine disease or severe neck pain, as we found it in this study, further radiologic examination (CT scan, tomography) might become necessary for complete visualization of the cervical spine. This helped in our cases to detect all four cervical spine injuries that were missed primarily.

Severely injured patients as well as patients with an altered mental status pose a further diagnostic problem because clinical and neurologic evaluation is often not reliable.2,4,5

In eight cases (44%), an appropriate clinical and neurologic evaluation of the patients was not possible at all. Five patients had an altered mental status because of other serious injuries, three patients because of alcohol or drug abuse. Finally, we had four patients with neurologic deficits that were missed primarily. We recommend that patients with altered mental status should remain in cervical spine precautions until they are awake and alert.1 A cervical collar might be indicated until a careful clinical and neurologic evaluation of these patients is completed.

Six patients (33%) had other serious injuries that were focused on during initial examination. Immediate lifesaving measures were necessary in three cases. Two patients only got a lateral view of the cervical spine and the injury was missed. In these cases, we recommend complete sets of cervical-spine radiographs before initial examination is completed and patients can leave the trauma room.

As our results show, most errors leading to delayed or missed diagnosis of cervical spine injuries were fundamental and did not require advanced diagnostic technology. For optimal examination of patients with suspected cervical spine injuries, we recommend establishing a specific diagnostic algorithm including physical examination, standard radiographs, and further radiologic evaluation (CT scan, MRI) as indicated (Figs. 4 and 5).

For standard radiologic evaluation of the cervical spine, we recommend a three-view cervical spine series (anteroposterior, lateral, and open-mouth) followed by functional flexion-extension views. Some studies suggest that three-view cervical-spine series are limited and that improved sensitivity would be obtained with a five-view series (oblique views added) as “golden standard.”2,8 However, those reports were disapproved by other studies indicating that most “false-negative” three-view cervical spine series were interpreted retrospectively by other surgeons or radiologists as being abnormal.1,10 McDonald et al., for example, stated that a complete three-view cervical-spine series would miss significant fractures in less than 1% of patients.2

In patients with clinically suspected cervical spine injuries or significant trauma history, cervical spine precautions should be maintained until the radiographs are evaluated by experienced reviewers.1 Correct interpretations of cervical spine radiographs can be difficult, particularly for junior staff with lack of experience in evaluating those radiographs. Only experienced trauma surgeons should decide on a removal or a continuation of the spinal precautions.
After excluding significant injuries in the three-view cervical-spine series, flexion-extension views might be obtained to detect suspected discoligamentous injuries. In responsive and awake patients, those studies should be considered as obligatory completion to a three-view cervical-spine series, but in comatose or anesthetized trauma patients, passive flexion/extension views are not without risk for the spinal cord. In addition, previous studies report that flexion/extension studies are not routinely necessary to clear the cervical spine in unconscious patients because isolated discoligamentous injuries without fractures are

**Fig. 4.** Diagnostic algorithm in alert patients.

**Fig. 5.** Diagnostic algorithm in patients with altered mental status.
a rare occurrence. However, other studies have introduced those views as a safe and effective method for detecting discoligamentous injuries after excluding significant bony injuries or an instability pattern in the standard radiographs. If functional flexion/extension views are to be obtained in unresponsive patients, strict adherence to established guidelines, including review of the cervical spine radiographs by a skilled reviewer as well as complete visualization of the entire cervical spine, is mandatory to ensure patient safety.

To avoid delays in diagnosis by misinterpretation of the radiographs, experienced surgeons are required to evaluate all x-ray studies secondarily as soon as possible. This control mechanism is a certain policy of the department to detect suspected cervical spine injuries that were missed primarily.

A careful physical examination should be obtained in alert patients. Severe neck pain, tenderness on palpation, spasm on active motion, or neurologic deficits are clinical signs referring to a suspected cervical spine injury. A meticulous physical examination of those patients is certainly helpful in determining the risk of a cervical spine injury, although it might not result in better compliance from the x-ray technicians in getting all the necessary views.

Patients with altered mental state and significant history of trauma should remain in cervical spine precautions until they are awake and appropriate evaluation is possible.

Further radiologic examination becomes necessary when indicated by the standard radiographs or by clinical suspicion. Computed tomography has become the most important area for improvement in cervical spine clearance using newer technology. We recommend the use of cervical CT scan by suggestion of an injury on the standard cervical-spine series or an incomplete visualization of the entire cervical spine in patients with significant history of trauma. A CT scan of the cervical spine is also obligate in patients with neurologic deficits and should be used more liberally in patients with preexisting cervical pathologic conditions and in patients with persistent symptoms.

In patients with neurologic deficits but negative radiographs and CT scans, we perform MRI to detect suspected discoligamentous injuries. MRI poses as a further area using newer technology in cervical spine clearance and will become definitely more important by increased availability and decreased costs.

**SUMMARY**

In conclusion, most errors leading to delayed or missed diagnosis of cervical-spine injuries were fundamental (misinterpretation of radiographs, incomplete or inadequate cervical spine series). A three-view cervical-spine series including functional flexion/extension views should be obtained for radiologic evaluation. In patients with significant symptoms or trauma history, cervical spine precautions should be maintained until evaluation of the patients is completed and radiographs have been interpreted by skilled reviewers. Patients with altered mental status should also remain in cervical spine precautions until they are awake to complete evaluation. Further radiologic examination using cervical CT scan becomes necessary when indicated by the cervical spine series or by clinical suspicion.

Combining a more meticulous physical examination, standard cervical spine series, and the more liberal use of cervical CT scan should improve the detection of cervical spine injuries. Regarding the fact that most errors leading to delayed or missed diagnosis were fundamental and did not require advanced diagnostic technology, an error rate of 4.9% appears to be improvable if a specific diagnostic algorithm with standard and supplemental diagnostic tools for cervical spine clearance is accepted and obtained.

**REFERENCES**