

## ADEQUACY OF CLINICAL AND RADIOLOGICAL EVALUATION IN PATIENTS WITH SUSPECTED CERVICAL SPINE INJURY IN MULAGO HOSPITAL

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### ABSTRACT

**Background:** Early diagnosis and prompt institution of treatment are of paramount importance for the best outcome in patients with Cervical Spine Injury (CSI). Early diagnosis depends on adequate clinical and radiological evaluation. Inadequate evaluation leads to missed injuries.

**Objective:** To evaluate the adequacy of the clinical and radiological evaluation of patients with suspected CSI and establish whether any injuries were missed as a result of inadequate evaluation.

**Design:** Cross-sectional descriptive study, carried out between December 2008 and March 2009.

**Setting:** Mulago National Referral and Teaching Hospital, Kampala, Uganda.

**Results:** Fifty four (62.8%) of patients were reviewed by a clinician within 30 minutes of arrival in Mulago Hospital. All 105 (100%) patients were assessed for head injury but only 35 (33.3%) were assessed for the presence of neck pain or cervical tenderness. Only 29 (27.6%) patients were evaluated radiologically with 17 (58.6%) of the X-rays taken being inadequate. Nine patients died before cervical spine clearance but more than 24 hours after arrival in Mulago Hospital. Of the remaining 67 uncleared patients, 5 (7.5%) had severe cervical spine injuries which had been missed.

**Conclusion:** This study concluded that the initial clinical and radiological evaluation of patients with suspected CSI in Mulago Hospital was inadequate with some injuries being missed altogether.

### INTRODUCTION

Cervical Spine Injury (CSI) occur in 2-5% of all trauma cases (1) and in 5-10% of all major trauma cases (2). Up to 40% of these patients develop neurological deficits. In the United States, 6000 deaths and 5000 new quadriplegias occur annually following CSI (1) earning CSI the ill repute of the most devastating musculoskeletal injury.

Early diagnosis and prompt institution of treatment are of paramount importance for the best outcome in patients with CSI. Delayed treatment often results in permanent (irreversible) injury to the spinal cord (3-7). Early diagnosis in turn depends on adequate clinical and radiological evaluation. Inadequate evaluation leads to missed injuries.

To help improve the outcome in patients with CSI in Mulago Hospital, this study sought to evaluate the adequacy of the clinical and radiological evaluation of patients with suspected CSI and establish whether any injuries were missed as a result of inadequate evaluation.

**Clinical evaluation:** All trauma patients should be evaluated clinically to establish whether or not they are likely to have CSI and therefore whether further/radiological evaluation is necessary. Clinical evaluation also aims at establishing the presence of any deficits

which indicates the likely level and pattern of injury and establishes a baseline for monitoring disease progression.

Many studies support the assertion that clinical criteria is predictive of CSI (8-12). The conscious patient with no neck pain, midline cervical tenderness or neurological deficits referable to the cervical spine is not likely to have CSI and need not be evaluated radiologically for the same (12,13). The presence of a distracting injury may however mask co-existing CSI. Patients with an altered level of consciousness for whatever reason cannot be readily evaluated for the above features. All trauma patients with altered level of consciousness (GCS < 15), disorientation (in person, place, or time), inability to remember three objects at 5 minutes or having delayed or inappropriate response to external stimuli should be considered to be having CSI until proven otherwise. (12-17).

**Radiological evaluation:** Many studies have been done to develop criteria for determining who requires X-ray evaluation and who does not so as to optimize the utility of X-rays. The largest such study involved 34,000 trauma patients and found that if the NEXUS criteria was applied, more than 99% of the patients requiring cervical spine X-rays would be picked (8). All but 8 out of the 818 patients requiring radiological evaluation were picked using the NEXUS criteria. All but two out of

the 578 patients with significant CSI were identified. Other studies support the use of the NEXUS criteria (18-20).

At least three views should be done (Open-mouth, AP, and lateral) (20). It is uncommon to miss CSI with adequate plain X-ray assessment from the occiput through to T1 (15,21). The lateral view alone can detect 60 to 80% of fractures. The AP and open mouth views improve sensitivity to 80 to 95% (22). The open mouth view, often not done, is the only view that gives an anterior view of the upper cervical spine that is obstructed by the jaw in the normal AP view. It also demonstrates the dens which is fractured in 11% of CSI patients (23).

In the lateral view, all the cervical vertebrae must be visualized as well as the upper border of the first thoracic vertebrae (20). This is important as a large proportion of cervical spine injuries occur in the lower cervical spine (23).

With adequate X-rays, the sensitivity of X-rays approximates that of CT scan. In a study in which all the three views were done, X-ray revealed 932 injuries in 498 patients but missed 564 injuries in 320 patients. However most missed injuries occurred in X-rays interpreted as abnormal or inadequate. Only 23 (2.8%) patients with 35 injuries were not visualized on adequate plain X-rays (24).

Other studies too support the high sensitivity of adequate cervical spine X-rays(22, 25). High pick-up rates are only attained with adequate X-rays. Studies done elsewhere have shown that up to 45% of initial X-rays are inadequate. In one such study up to 25% of X-rays had to be repeated (26).

## MATERIALS AND METHODS

This was a cross-sectional descriptive study conducted at Mulago National Teaching and Referral Hospital between December 2008 and March 2009. All consenting trauma patients with neck pain or midline cervical tenderness, neurological deficits referable to the cervical spine or an altered level of consciousness (GCS<15) or who were disoriented in time place and person as a result of head injury or intoxication were recruited into the study.

After the initial stabilization, resuscitation, evaluation and treatment, medical history was taken, a clinical examination performed and their medical records and X-ray films reviewed. Where X-rays had not been done, these were done and reviewed. The delay before review by a clinician was also established.

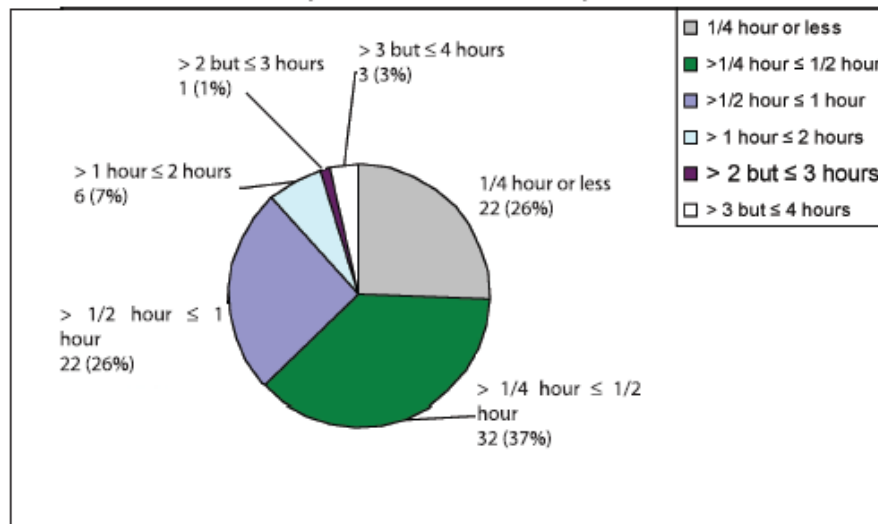
One hundred and five patients were recruited into the study. Ninety one (86.7%) were male while 14 (13.3%) were females. The youngest was 5 years old while the oldest was 69 years. The mean age was 30.14 years with a standard deviation of 13.07 years.

## RESULTS

*Delay before review by a clinician:* Eighty six patients could approximate the duration of the time taken from arrival in hospital to review by a clinician. Figure 1 summarizes our findings.

*Clinical evaluation:* Not all patients were assessed for features of CSI by the admitting clinician (Table 1).

**Figure 1**  
Delay in hours from arrival to review by a clinician



**Table 1**  
Patients evaluated for different features suggestive of CSI

Presentation	Frequency	Percentage
Head injury/altered consciousness	105	100.0
Neck pain	35	33.3
Cervical tenderness	35	33.3
Motor/sensory deficits (referable to cervical spine)	38	36.2
Distracting Injuries	101	96.2

An independent evaluation of all the patients by the principal investigator revealed that the above features were present in many patients (Table 2).

**Table 2**  
Frequency of features of CSI in the study population

Presentation	Frequency	Percentage
Head Injury/altered consciousness	81	77.1
Neck pain	53	50.5
Cervical tenderness	54	51.4
Motor/sensory deficits (referable to cervical spine)	15	14.3

*Radiological evaluation:* Only 29 (27.6%) patients were evaluated radiologically for CSI while 76 (72.4%) were not. All the 29 had both an AP and lateral view X-rays taken. Only one of the 29 patients had an open mouth view taken.

*Adequacy of the X-rays taken:* The adequacy of the lateral view X-ray films of the 29 patients was checked and 17 (58.6%) were considered inadequate. The lone open mouth view taken was considered inadequate as it did not show the entire area from the occipital condyles to the junction of C1 and C2.

*Diagnosis at 24 Hours after arrival in hospital:* Only 29 (27.6%) of patients had a diagnosis made as regards the cervical spine within the first 24 hours of arrival in Mulago Hospital. The bulk were not yet cleared (Table 3).

*Patients whose cervical spine was not cleared in the first 24 hours and Later found to have CSI:* After request of X-rays for the 76 uncleared patients, 9 (11.8%) died before the radiographs could be taken (but more than 24 hours after arrival in hospital). Of the remaining 67 patients, 5 (7.5%) were found to have cervical spine injuries (Table 4).

**Table 3**  
Diagnosis as regards the cervical spine at 24 hours

Diagnosis	Frequency	Percentage
Cervical spine not cleared in the first 24 hours	76	72.4
No fracture or dislocation, STI suspected	10	9.5
Wedge compression fracture	5	4.7
Unifacet dislocations	4	3.7
Hangman fracture	3	2.9
Flexion tear drop	2	1.9
Burst fractures	2	1.9
Bifacet dislocation	1	1.0
Odontoid fracture	1	1.0
Laminar fracture and bifacet dislocation	1	1.0
Total	105	100

**Table 4**  
Lesions initially missed owing to failure to evaluate patients radiologically within the first 24 hours

Diagnosis	Number
Wedge compression fracture C5	2
Hangman's fracture	1
Quadriplegia with normal X-rays (1 died of complications of CSI)	2

## DISCUSSION

*Delay before review by clinician:* It is commendable to note that most patients did not take very long before being seen by a clinician. Twenty one (25.6%) of the patients were seen by a clinician within 15 minutes of arrival in Mulago Hospital. Fifty five (62.85%) had been seen by a clinician within the first 30 minutes. This implies that most CSI could have been picked up early if adequate evaluation was done.

*Clinical and radiological evaluation:* It is commendable that all patients were assessed for head injury and altered level of consciousness, important predictors of CSI. This welcome trend was not replicated in the assessment of other features that are known to be predictive of cervical spine injury (7,9,10,13, 15, 20). As such, overall, the clinical evaluation of patients for cervical spine injury fell below the standards expected.

An independent assessment of the patients by the principal investigator revealed that many patients had features that should have been picked by the clinicians and warned them of the possibility of the patients having CSI. For instance midline cervical tenderness was present in 54(51.4%) patients yet the admitting clinicians checked for this in only a third of the patients (33.3%). Lack of expertise and overwork partially explain the failure to meet expectations.

Radiological evaluation did not meet expectations. In this study all the 105 patients recruited could not be cleared for CSI clinically and imaging was thus indicated for all of them(7,9,13,15,16). However, only 29 (27.6%) of the patients had radiological investigations done.

This low number is explained primarily by the poor clinical evaluation of patients. Because the patients' clinical evaluation was poor, the clinicians did not pick the features of CSI and thus did not see the need to investigate patients further. Only the few patients with overt signs of CSI were investigated.

Studies done elsewhere have shown that used appropriately, the pick up rate of bony lesions by X-ray can be as high as 90% (16,21,24,25). This all important tool was found to be under-utilized in this study as only 29 (27.6%) of the patients had X-rays of the cervical spine taken. This needs to be improved on as the diagnosis of the remaining 76 (72.4%) patients remained uncertain beyond the first 24 hours of arrival in hospital.

Of all the 29 (27.6%) patients who had had radiographs done, all had both an AP and lateral view. Only one (1%) patient had an open mouth view taken. This implies that only one(1%) was evaluated fully radiologically. While the lateral view is the most informative view followed by the AP view, it should be noted that the only view that demonstrates the upper 3 cervical spine from the front is the open mouth view (16,21,23). Proper CSI investigation using plain X-rays requires all three views.

Of the 29 lateral view X-rays taken, only 12 (41.4%) showed the entire cervical spine from C1 to the upper border of T1. The remaining 17(58.6%) could not be used to clear the cervical spine without doubt. This figure is higher than that of 45% reported by Moulton (26) in his study involving 120 patients in which he evaluated the adequacy of their cervical spine radiographs.

The reason for a high number of inadequate radiographs universally is the fear of moving these patients making proper positioning a challenge. However, all efforts should be made to ensure good radiographs are taken as the high number of inadequate films means that a high number of patients are not cleared on time not to mention that more resources are utilized as many of these patients end up having repeat radiographs taken.

The lone open mouth view X-ray taken did not cover the area from the occiput to the C1/C2 junction as recommended and was therefore considered inadequate (22,23). It is possible that the poor film may be because the patient could not follow instructions well. To get a good open mouth view, the patient's neck should be held in extension and mouth as wide open as possible.

*Cervical spine clearance and final diagnosis:* Seventy six (72.4%) patients, the bulk of the patients, did not have their cervical spine cleared within the first 24 hours. This meant that specific measures to treat CSI could not be instituted early in the majority of the patients compromising outcome.

Twenty nine (27.6%) patients had a diagnosis made with respect to the cervical spine in the first 24 hours. Nineteen (18.1%) of the patients were found to have fractures or dislocations of the cervical spine or both. Ten (9.5%) did not have any fracture or dislocation but had features suggestive of soft tissue injury to the supportive structures of the cervical spine.

*Missed Injuries:* Of the 76 patients not cleared within the first 24 hours, 9 (11.8%) died before the cervical spine was cleared but more than 24 hours after arrival in hospital. While they all had severe head injury as well as other accompanying injuries, whether CSI contributed to their death and whether this could have been changed had a diagnosis of CSI been made and treatment instituted will never be known.

Of the remaining 67 patients, 5 (7.5%) were later found to have injuries to the cervical spine. This is a significant proportion. Missed injury is a cause of increased morbidity and mortality. One of the patients in whom clearance was delayed died from complications of CSI while another was quadriplegic. These might have been prevented if a diagnosis had been made early and remedial measures taken. Two (3.0%) other patients had wedge compression fractures at the level of C5 and 1 (1.5%) had a hangman fracture. All these are serious injuries whose outcome would have been optimized by early diagnosis and timely intervention.

## CONCLUSION

This study revealed that the initial clinical and radiological evaluation of patients with suspected CSI in Mulago Hospital was inadequate. Most patients were not evaluated for features of CSI and only a small proportion of patients with indications for radiological evaluation got radiological evaluation with a large proportion of radiographs being inadequate.

This led to various serious cervical spine injuries being missed and several deaths and unfavourable outcomes for which the delay in diagnosis and treatment may have played a role.

Adherence to set standards of care and various other recommendations were made to the hospital to try to correct the inadequacies identified.

## REFERENCES

- Goodrich, J. and Riddle, T. Lower cervical spine fractures and dislocations. [www.emedicine.com/ortho/spine/LowerCervSpineFXDilocat](http://www.emedicine.com/ortho/spine/LowerCervSpineFXDilocat). Cited on 24/05/2008.
- Morris, C. G. and McCoy, E. Clearing spine in unconscious polytrauma victims, balancing risks and effective screening. *Anaesthesia*. 2004; **59**: 462-482.
- National Institute of Neurological Disorders and Stroke. Spinal Cord Injury: *Emerging Concepts*. NIH Publication. 1997; **62**.
- Reid, D. C., Henderson, R., Saboe, L., et al. Etiology and clinical course of missed spine fractures. *J. Trauma*. 1987; **27**: 980-986.
- Gerrelts, B. D., Petersen, E. U., Marbry, J., et al. Delayed diagnosis of cervical spine injuries. *J. Trauma*. 1991; **31**: 1622-1626.
- Unknown author. Cervical spine injury: Clinical Guidelines. RCS hospital Website. 2007; [www.rch.org.au/clinicalguide/cpg.cfm](http://www.rch.org.au/clinicalguide/cpg.cfm). Cited on 16/06/08.
- Bachulis, B. L., Long, W. B., Hynes, G. D., et al. Clinical indications for cervical spine radiographs in the traumatized patient. *Am. J. Surg*. 1987; **153**: 473-478.
- Panacek, E. A., Mowe, W. R. and Holmes, J. F. Test performance of the individual NEXUS low-risk clinical screening criteria for cervical spine injury. *Ann. Emerg. Med*. 2001; **38**(1): 22-25.
- Marion, D., Domeier, R., Dunham, C. M., et al. Practice management guidelines for identifying cervical spine injuries following trauma. *East Asso. Surg. Trauma* 1998; **1-14**.
- Domeier, R. M. The reliability of pre-hospital clinical evaluation for spine injury is not affected by the mechanism of injury. *Pre-Hospital Emergency Care*. 1999; **3**: 332-337.
- Forhna, J. W. Emergency department evaluation and treatment of the neck and cervical spine injuries. *Emerg. Med. Clinics of North Amer*. 1999; **17**: 739-791.
- Georges, D. Injuries to the cervical spine. *Trauma.org online journal*. 2008; [www.trauma.org/archive/anaesthesia/cspineanaes.html](http://www.trauma.org/archive/anaesthesia/cspineanaes.html). Cited on 17/07/08.
- Roberge, R., Wears, R., Evans, T., et al. Selective application of cervical spine radiography in alert victims of blunt trauma. *J. Trauma*. 1988; **28**: 784-788.
- Hoffman, J. R., Mower, W. R., Wolfson, A. B., et al. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. *N. England J. Med*. 2000; **343**: 94-99.
- Davis, J. and Park, S. Clearing the cervical spine in obtunded patients. *J. Trauma*. 1995; **39**: 435-438.
- Ajani, A., Cooper, D., Scheinkestel, C., et al. Optimal assessment of cervical spine in critically ill patients: a prospective evaluation. *Anaesthesia and Intensive Care*. 1998; **26**: 487-491.
- Ringenberg, B. J., Fisher, A. K., Udanete, L. F., et al. Rational ordering of cervical spine radiographs following trauma. *Ann Emerg. Med*. 1988; **17**: 792-796.
- Graber, M. A. and Kahtol, M. Cervical spine radiographs in trauma patients. *Amer. Fam. Phys*. 1999; **59**(2).
- Hadley, M. N. Radiographic assessment of the cervical spine in symptomatic trauma patients. *Neurosurgery*. 2002; **50**(3 suppl): 36-43.
- McDonald, R. L., Schwartz, M. L., Mirich, D., et al. Diagnosis of cervical spine injury in motor vehicle crash victims: How many X-rays are enough? *J. Trauma*. 1990; **30**: 392-397.
- Davis, J. and Hoyt, D. The aetiology of missed cervical spine injury. *J. Trauma*. 1993; **34**: 342-346.
- Stobbe, K. The occasional C-spine x-ray. *CJRM*. 2004; **9**(2): 38-42.
- Goldberg, W., Mueller, C., Panacek, E., et al. Distribution and patterns of blunt traumatic cervical spine injury. *Ann. Emerg. Med*. 2001; **38**(1): 17-21.
- Mower, W. R., Hoffman, J. R., Pollack, Jr, et al. Use of plain radiography to screen for cervical spine injuries. *Ann. Emerg. Med*. 2001; **38**(1): 1-7.
- Nguyen, G. K. and Clark, R. Adequacy of plain radiography in diagnosis of cervical spine injuries. *Emerg. Radiol*. 2005; **11**(3): 158-161.
- Moulton, C. The adequacy of cervical spine radiographs in the accident and emergency department. *J. Royal Soc. Med*. 1993; **86**: 141-144.