Diagnostic Accuracy of Plain X-Ray in Diagnosis of Cervical Spine Fracture, Keeping CT as Gold Standard

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¹Conception, Synthesis and Planning of the research, literature review
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Abstract
Objective: Determine the diagnostic accuracy of plain x-ray in diagnosing cervical spine injury in patients of blunt trauma.

Study Design: Cross sectional validation study.

Place and Duration of the Study: PIMS hospital Islamabad from July-December 2015.

Materials & Methods: A total of 70 patients of 20-60 years of age of either gender with blunt trauma to cervical spine were included in the study. Patients with previous cervical surgery, GSC <15, hemodynamically unstable patients, acute paralysis, penetrating trauma, known vertebral disease (rheumatoid arthritis, ankyllosing spondylitis) and pregnant females were excluded. First, all the patients underwent plain x-ray (AP & Lateral views) and then computed tomographic scanning. X-ray and CT results were correlated.

Results: Mean age was 36.58 ± 8.22 years. Out of 70 patients, 59 (84.29%) were males and 11 (15.71%) were females with male to female ratio of 5.3:1. Plain x-ray cervical spine supported the diagnosis of cervical spine fracture in 31 (44.29%) patients. CT has shown cervical spine fracture in 29 (41.43%) cases. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of x-ray cervical spine in diagnosing cervical spine fracture in blunt trauma patients are 89.66%, 87.80%, 92.31% and 88.57% respectively.

Conclusion: This study concluded that x-ray cervical spine is a low costs, widely available and low dose ionizing radiation imaging modality for immediate assessment of cervical spine in blunt trauma patients.

Keywords: cervical, injury, imaging, radiation.

Introduction
Cervical spine radiographs are relatively inexpensive and are easy to obtain. All initial evaluations of cervical spine injuries should begin with plain radiographs. A variety of other imaging modalities may also be used, such as conventional tomography, CT, and MRI. The prevalence of cervical spine injury following blunt trauma from 65 published studies¹ is 2.8% overall and ~2% in less selective, prospective studies of consecutive patients.² Less than 1% of patients will suffer a cord injury but for those that do it can be devastating to both the individual and their family. Failure to diagnose unstable fractures or ligamentous injuries in the cervical spine can result in...
irreversible devastating neurologic consequences. All patients with CSI, 5–10% will show a deterioration of their neurological functions during their Emergency Department (ED) admission because of a delay in diagnosis or inadequate spinal immobilisation. A missed cervical spine injury can result in devastating neurological injury. For this reason, radiographic assessment of the cervical spine is liberally employed in patients following acute trauma. Cervical spine radiographs are relatively inexpensive and are easy to obtain. Cervical spine injuries should initially be evaluated with plain radiographs. Other imaging modalities that can be also be used are conventional tomography, CT and MRI. A quick and appropriate choice has to be made quickly for diagnosing cervical trauma. Trauma may be at multiple levels so imaging should include the upper and lower cervical hinges. The standard radiographs vary greatly in their quality so their negative quality and predictive value decreases as the severity of the injury increases. Conventional radiography has been for decades the standard method of evaluation for cervical spine trauma patients. However, currently available helical multidetector CT scanners allow multiplanar reconstruction of images, leading to increased diagnostic accuracy. Universal cervical spine radiography has yielded a positive test rate of less than 3% in most trauma series. We had planned this study to determine the diagnostic accuracy of plain x-ray in diagnosing cervical spine injury in patients of blunt trauma, keeping CT as gold standard. Hence, we could provide these particular patients with an imaging modality of low dose radiations for accurate assessment of the condition which would help the clinicians for selection of proper treatment option in order to reduce the morbidity and mortality of these patients.

Materials and Methods

This cross sectional validation study was done on 70 patients with blunt trauma to cervical spine and age between 20-60 years of both genders, who were referred by clinician to the radiology department of PIMS Hospital, Islamabad for X-ray cervical spine. Sample size was calculated by taking 95% confidence level and 5% desired precision. Patients with previous cervical surgery, GSC <15, hemodynamically unstable patients, acute paralysis, penetrating trauma, known vertebral disease (rheumatoid arthritis, ankylosing spondylitis) and pregnant females were excluded from the study. After taking informed consent and relevant history, all the subjects were undergone plain radiographs (AP & Lateral views) with and without flexion and extension views. The patient's neck was remained immobilized until a full cervical spine series could be obtained, although initial films were taken through the cervical collar. After this, computed tomography (CT) scan was performed in each patient. All the results were interpreted by a consultant radiologist (with at least 5 years post-fellowship experience). Plain X-ray results were correlated with CT scan results. The collected data was analyzed through computer software SPSS 20.0. Mean and standard deviation was calculated for quantitative variables. Frequency and percentage was calculated for qualitative variables. 2×2 contingency table was used to calculate sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of x-ray cervical spine in blunt trauma patients.

Results

Age range in this study was from 20 to 60 years with mean age of 36.58 ± 8.22 years. Majority of the patients 36 (51.43%) were between 30 to 40 years of age. Out of 70 patients, 59 (84.29%) were males and 11 (15.71%) were females with male to female ratio of 5.3:1. All the patients were subjected to plain x-ray cervical spine (AP & Lateral view) and computed tomography scanning. Plain x-ray cervical spine supported the diagnosis of cervical spine fracture in 31 (44.29%) patients. CT has shown cervical spine fracture in 29 (41.43%) cases. In x-ray positive patients, 26 (True Positive) had cervical spine fracture and 05 (False Positive) had no fracture on CT. Among 39 x-ray negative patients, 03 (False Negative) had cervical spine fracture on CT where as 36 (True Negative) had no fracture. So, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of x-ray cervical spine in diagnosing cervical spine fracture in blunt trauma patients are 89.66%, 87.80%, 83.87%, 92.31% and 88.57% respectively (Figure I).

<table>
<thead>
<tr>
<th>Table I: Findings of X-ray and CT</th>
<th>CT</th>
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<tbody>
<tr>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Positive result on x-ray</td>
<td>26 (TP)</td>
</tr>
<tr>
<td>Negative result on x-ray</td>
<td>03 (FN)</td>
</tr>
</tbody>
</table>

*-TP=True positive **FP=False positive ***FN=False negative ****TN=True negative
Specificity - 15%

Sensitivity was 99% and NPV - 7% respectively.

Although, its sensitivity approximately 20%. By proceeding to accuracy -

Specificity was 100% for CT and ranged for radiography ranged from 98% to 93%.

In a meta-proven for the high injuries are missed by X-ray imaging that are detected by CT scanning. In 35–72% of the patients injuries are missed by X-ray imaging that are detected by CT scanning.11–13 This higher sensitivity is especially proven for the high-risk patients.11–13

In a meta-analysis, sensitivity for CT ranged from 98% to 99% and for radiography ranged from 25% to 93%. Specificity was 100% for CT and ranged for radiography from 99% to 100%. Pooled sensitivity was 99% and pooled specificity was 100% for CT. Pooled sensitivity was 42.8% and pooled specificity was 99% for radiography.14 In another meta-analysis, the sensitivity of plain radiographs at identifying cervical spine injuries has been reported to be only 58% and 98% for CT.15 A recently published systematic review 72 derived similar sensitivities for plain films and CT.7

The highest reported sensitivity for identification of clinically important cervical spine fractures with adequate, good quality 3-series radiographs is 93%16 while the most reliable estimate of sensitivity of plain films (89.4%) comes from the NEXUS group.17 Mohd N et al18 in his study has shown the sensitivity, specificity, positive predictive value and negative predictive value of x-ray cervical spine in diagnosing cervical spine fracture in blunt trauma patients as 45.4%, 98.2%, 55.5% and 97.3% respectively.

Cervical spine injuries are evident in approximately 85-90% of cases in lateral view radiographs. The sensitivity of lateral cervical spine radiograph is 82%, which rises to 93%.19 when combined with AP and odontoid views. To rule out a fracture, conventional radiographs are generally considered adequate but there are significant false-negative rates of approximately 20%. By proceeding to CT, these false negative rates could be countered, when the plain radiographs are negative in a patient who has neck pain disproportionate to the findings on plain radiographs. A CT scan is a sensitive in identifying cervical fractures but it has a limited ability to identify ligamentous injuries. With the advent of multidetector CT (MDCT), the need for conventional tomography is also limited but conventional tomography may be an indication if a type II dens fracture is suspected.20

**Discussion**

X-ray images are currently the primary choice for radiography in the low-risk group. The advantages of X-ray imaging are the relative low costs, wide availability and the broad experience with this method. It has gained wide acceptance that X-ray imaging of the cervical spine should at least exist of three images, respectively the ‘3-view series; a lateral view (from skull base to the upper limit of the vertebral body of Th1), an open-mouth odontoid and an anteroposterior view.4

When injuries are diagnosed with X-ray imaging additional radiography is advised for optimal planning of treatment (i.e. CT scan or magnetic resonance imaging (MRI)). If the 3-view series are inadequate for assessment a CT scan of the cervical spine is indicated.10

In our study, all the patients were subjected to plain x-ray cervical spine (AP & Lateral view) and computed tomography scanning. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of x-ray cervical spine in diagnosing cervical spine fracture in blunt trauma patients are 89.66%, 87.80%, 83.87%, 92.31% and 88.57% respectively. Several studies evaluated the value of X-ray imaging in high- and/or low-risk patients and compared this with a CT scan of the cervical spine. In 35–72% of the patients injuries are missed by X-ray imaging that are detected by CT scanning.11–13 This higher sensitivity is especially proven for the high-risk patients.11–13

In a meta-analysis, sensitivity for CT ranged from 98% to 99% and for radiography ranged from 25% to 93%. Specificity was 100% for CT and ranged for radiography from 99% to 100%. Pooled sensitivity was 99% and

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**Figure 1: Diagnostic accuracy of X-ray in cervical spine injury**

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**Conclusion**

This study concluded that x-ray cervical spine is relative low costs, wide availability and low dose ionizing radiation imaging modality for immediate assessment of cervical spine in blunt trauma patients. Although, its accuracy is low compared to CT scan but due to its easy availability at all setups, we recommend that it should be used as primary imaging modality for cervical spine injuries in these patients for selection of proper treatment in order to reduce the morbidity of our community.

**References**


