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Original Article

Diagnostic accuracy of Lateral X-Ray of Cervical Spine in detection of fracture in hospitalized patients.

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Abstract

Background: Lateral X-ray of the cervical spine (LCSX) is a common diagnostic tool to detect fractures in hospitalized patients. Its non-invasive nature and cost-effectiveness make it a preferred imaging technique for rapid identification of cervical spine fractures. However, its diagnostic accuracy is still a subject of debate and further research is needed to establish its reliability and validity. This study aimed to determine the diagnostic accuracy of LCSX in detecting fractures in hospitalized patients, using multi-detector computed tomography (MDCT) as the gold standard.

Methodology: This cross-sectional retrospective study was conducted at a tertiary care hospital in Karachi. The study included 431 male and female patients aged between 18 to 60 years referred by the primary medical team to the Radiology Department for both LCSX and MDCT to detect cervical spine fractures. Patients with known cases of cervical spine fractures determined by history, examination, and previous radiological modalities like LCSX, MDCT, or MRI at the time of imaging were included.

Results: LCSX identified 63 cases (14.6%) as having cervical spine fractures, while 368 cases (85.3%) were reported as not having cervical spine fractures. However, on MDCT, 116 cases (26.9%) out of the 431 cases were found to have cervical spine fractures, while 315 cases (73.08%) were reported as not having cervical spine fractures. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of LCSX were calculated. The sensitivity of LCSX was found to be 58.35%, specificity was 100%, positive predictive value was 100%, negative predictive value was 85.59%, and diagnostic accuracy was 87.70%.

Conclusion: LCSX has low sensitivity as a diagnostic tool in detecting cervical spine fractures in trauma patients, resulting in missed diagnoses of critical cervical spine fractures and compromised patient care, which can lead to increased morbidity and mortality.

Keywords

Cervical Spine, Trauma, Fracture, Vertebral Injury, CT Cervical Spine, X-Ray Cervical Spine.

Introduction

Head and cervical spine injuries are common occurrences resulting from blunt trauma, such as motor vehicle accidents, sports injuries, falls from height, or fights, which can cause damage to the spine and its surrounding structures[1,2]. The level of injury in the cervical spine is a significant factor in determining the morbidity and mortality of trauma patients[3]. While the exact statistics for cervical spine fractures due to trauma are not available in Pakistan, they are relatively common in the country.

Cervical spine fractures can have serious consequences, and failure to accurately identify and manage these fractures can lead to severe morbidity or even mortality for patients. Therefore, an evaluation of the cervical spine is an essential part of assessing individuals who have experienced trauma[4]. Traditionally, a LCSX has been used to evaluate the cervical spine for fractures. However, in Western literature, its sensitivity and specificity in detecting fractures are reported to be 45.5% and 71.4%, respectively[5].

In recent years, in Western countries, MDCT has gained popularity as an imaging modality for traumatic spine injuries. This is due to its superior resolution and ability to provide coronal, sagittal, and axial reformation images, and MDCT also produces 3D reconstruction images when needed[5]. As a result, MDCT is increasingly replacing LCSX as the preferred imaging technique for detecting cervical spine fractures in Western countries[6-11].

However, due to limited resources and the unavailability of MDCT in every hospital, particularly in rural Pakistan, LCSX remains the most commonly used modality for evaluating cervical spine fractures. Therefore, this study aims to evaluate the diagnostic accuracy of LCSX in assessing posttraumatic cervical fractures in correlation with MDCT in a tertiary care center in Pakistan.

Methodology

Study design & Setting

This retrospective cross-sectional study was conducted at a tertiary care hospital in Karachi, Pakistan, from January 2022 to August 2022, after obtaining approval from the ethical review committee. Patients who were clinically suspected of having cervical spine injuries and were referred to the Radiology department by the primary physician within 24 hours of the trauma incident for both LCSX and MDCT were included in the study.

Participants

Exclusion criteria comprised patients with a known history of cervical spine fracture confirmed by history, examination, and previous radiological modalities, patients who had undergone only one imaging modality for detecting cervical spine fractures, and pregnant women determined by a positive pregnancy test.

Table 1: Sensitivity, specificity, positive and negative predictive value, and diagnostic accuracy.

LCSX findings	MDCT findings	
	Fracture (+ve)	**Fracture (-ve)**
Fracture (+ve)	True Positive (a)	False Positive (b)
Fracture (-ve)	False Negative (c)	True Negative (d)

Parameters were calculated as follows:

- Sensitivity = True Positive/False Negative + True Positive x 100
- Specificity = True Negative/False Positive + True Negative x 100
- Positive predictive value = True Positive/False Positive + True Positive x 100
- Negative predictive value = True Negative/False Negative + True Negative x 100

- Diagnostic accuracy = True Positive + True Negative/True Positive + False Positive + False Negative + True Negative x 100

Data sources/measurement

LCSX was performed using a Shimadzu 800 MA machine with automatic exposure control settings of 65-70 Kvp and 200 mAs. MDCT of the cervical spine was performed using a Toshiba Alexion 16-slice CT scanner with automatic exposure control settings of 120 KVp and 200 mAs. Volume data with a slice thickness of 0.8mm and a slice interval of 1.0mm were acquired, followed by reconstruction in axial, coronal, and sagittal planes with volume-rendering images.

Variables

Demographic information, including age, gender, and mechanism of injury, was collected for all patients using a standardized Performa by the primary investigator. The diagnostic accuracy of LCSX in detecting cervical spine fractures was calculated against MDCT, which served as the reference standard. Stratification was performed for age, gender, and mechanism of injury to control for potential effect modifiers.

Statistical methods

Data was collected and analyzed using SPSS version 20. Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy of LCSX were calculated using a 2 x 2 table (Table 1). Frequencies and percentages were computed for categorical variables such as sex, mechanism of injury, LCSX, and MDCT findings. Means were calculated for quantitative variables such as age. Effect modifiers were addressed through stratification of age and gender to assess their effects on outcomes.

Results

The study included 431 patients, 370 of whom were men (85.84%) and 61 were women (14.15%). The age range of the patients was 18 to 60 years, with a mean age of 37.4 ± 11.1 years. Among the patients, 347 had a history of roadside accidents, 55 had a history of falls, and 29 had sports-related injuries.

Table 2: Findings of LCSX and MDCT.

LCSX	MDCT		Total
	Positive	Negative	
Positive	63	0	63
Negative	53	315	363
Total	116	315	431

Cervical spine fractures were detected in 63 cases (14.6%) using LCSX, while 368 cases (85.3%) were negative for cervical spine fractures. Subsequently, MDCT detected cervical spine fractures in 116 cases (26.9%) out of the total 431 cases, while 315 cases (73.08%) were negative for cervical spine fracture. LCSX had 63 true positives, 0 false positives, 315 true negatives, and 53 false negatives, with MDCT as the gold standard for diagnosing cervical spine fractures (Table 2). The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of LCSX in diagnosing cervical spine fractures in trauma patients are shown in Figure 1.

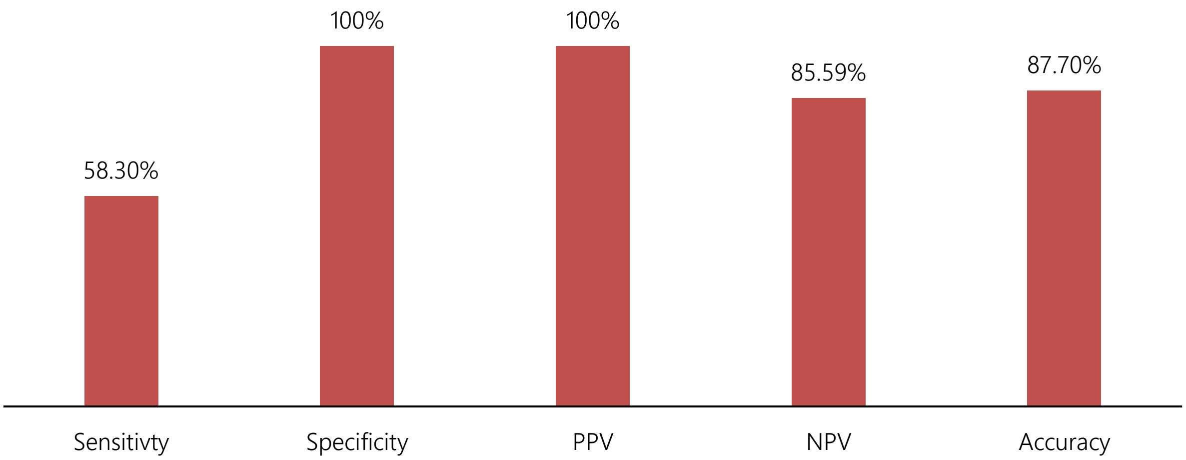

Figure 1: Diagnostic Accuracy of LCSX Compared to MDCT.

Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were also calculated for age, gender, and mechanism of injury (Table 3). The results showed a higher incidence of cervical fractures in males aged 28 to 42. Road traffic accidents were found to be the most common mechanism of injury.

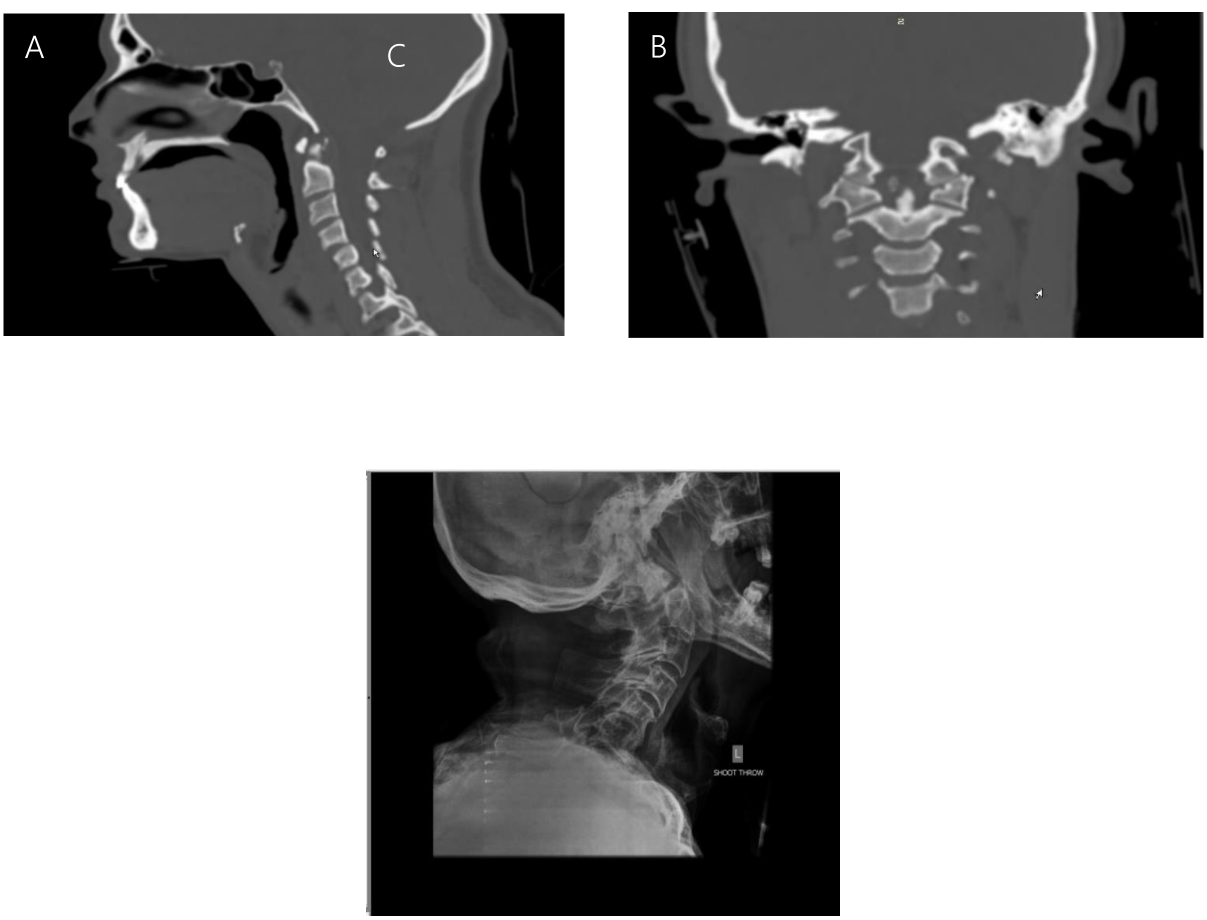

Figure 2: This lateral view plane cervical X-ray image depicts the cervical spine.

Table 3: Sensitivity, specificity, PPV, NVP, and DA for patient characteristics.

Variables		LCSX	MDCT Fracture	MDCT No Fracture	Sensitivity	Specificity	PPV value	NPV value	DA
Age group	18-22	Fracture	3	0	60	100	100	93.7	94.2
		No fracture	2	30					
	23-27	Fracture	6	0	46.1	100	100	85.7	87.3
		No fracture	7	42					
	28-32	Fracture	15	0	71.4	100	100	89.4	91.6
		No fracture	6	51					
	33-37	Fracture	11	0	57.8	100	100	87.5	89.3
		No fracture	8	56					
	38-42	Fracture	12	0	63.1	100	100	84.4	87.7
		No fracture	7	38					
	43-47	Fracture	3	0	27.27	100	100	80	81.3
		No fracture	8	32					
	48-52	Fracture	4	0	33.33	100	100	78.9	80.9
		No fracture	8	30					
	53-57	Fracture	5	0	62.5	100	100	86.3	88.8
		No fracture	3	19					
	58-62	Fracture	2	0	25	100	100	73.9	76
		No fracture	6	17					
Gender	Male	Fracture	49	0	25.6	100	100	86.2	88.1
		No fracture	44	277					
	Female	Fracture	12	0	52.1	100	100	77.5	82
		No fracture	11	38					
Sports-related		Fracture	2	0	33.3	100	100	85.18	86.2
		No fracture	4	23					
History of Fall		Fracture	10	0	55.5	100	100	82.2	85.5
		No fracture	8	37					
Road traffic accident		Fracture	61	0	52.5	100	100	85.1	87.2
		No fracture	55	315					

Discussion

Our study evaluated the sensitivity of plain radiography (LCSX) and CT scanning for detecting cervical spine injuries in trauma patients. Cervical spine fractures account for approximately 2-3% of all trauma cases and are rising[12]. Radiographic screening is essential in patients with severe trauma and suspected head and neck injuries to rule out cervical spine injuries. Clinicians should know the different radiological imaging modalities required for this purpose. Although plain radiography is cost-effective, quick, and has minimal radiation exposure, its effectiveness compared to MDCT scan in trauma patients with suspected cervical spine injuries is limited[13].

Detecting cervical spine injuries using plain radiography films in severely injured or unconscious patients is challenging and problematic[14]. With the increasing availability of multiple CT units in recent years, plain cervical radiographs' diagnostic efficacy and accuracy in detecting or excluding spinal injuries have been under scrutiny[15,16]. Several studies have highlighted the limitations of conventional radiography, particularly in spinal trauma patients. Fractures clearly visible on CT scans are not always apparent on plain radiographs. Moreover, established guidelines indicate that the optimal imaging modality for the detection of cervical spine injury is CT imaging, which is now readily available in most centers and has high sensitivity and specificity for fracture identification compared to plain film radiograph[15,16].

Our study findings are consistent with various other studies that have reported higher sensitivity and specificity of CT scanning in evaluating cervical spine injuries compared to plain film radiographs. In our study, all enrolled patients underwent plain cervical spine radiography, specifically the lateral view, followed by multi-detector CT scanning. The sensitivity, positive predictive value, specificity, negative predictive value, and diagnostic accuracy of X-ray cervical spine in diagnosing cervical spine fractures were 58.3%, 100%, 100%, 85.59%, and 87.70% respectively.

A meta-analysis conducted by Holmes et al.[11] reported a pooled sensitivity of 52% for cervical spine plain radiography and 98% for CT, which is consistent with our study. A study by Majeed et al.[17] conducted in 2015 assessed the diagnostic performance of X-ray cervical spine in detecting cervical spine fractures in blunt trauma patients. The study reported a sensitivity of 45.4%, specificity of 98.2%, positive predictive value of 55.5%, and negative predictive value of 97.3%. These results suggest that while X-ray cervical spine has high specificity and negative predictive value, it has low sensitivity and positive predictive value in diagnosing cervical spine fractures in blunt trauma patients. Our study data demonstrate that most cervical spine injury victims were in the age group of 33 to 42 years[18]. Yadollah et al.[18] also showed the highest frequency of cervical injuries among individuals aged 16 to 40.

Conclusion

In conclusion, our study highlights the need to replace LCSX with MDCT to accurately detect cervical spine fractures in patients with trauma-related neck injuries. Radiological investigation plays a crucial role in diagnosing and managing spinal trauma and can greatly impact patients' morbidity and mortality. Our study demonstrated that MDCT is the preferred imaging modality for moderate to high-risk spinal trauma patients with potential neurological deficits. It can identify subtle fractures and detect retropulsion bony fragments. We found that multi-detector CT scans are superior to conventional X-rays in detecting fractures and unstable injuries, with a sensitivity of up to 100%. Rapid assessment and acquisition of MDCT should be integral to trauma protocols and have rendered plain radiographs nearly obsolete, especially in the cervical spine.

Conflicts of Interest

The authors declare no conflicts of interest related to this study.

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