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UTILITY OF CHEST X-RAY IN BLUNT TRAUMA CHEST IN A TERTIARY CARE TRAUMA CENTER

Surgery

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ABSTRACT

Introduction: Chest X-Ray (CXR) is routinely employed as the first diagnostic modality in chest trauma but some potentially life-threatening injuries are frequently missed on CXR. Non contrast computed tomography (NCCT) scan is a better diagnostic tool in blunt trauma chest. We studied the diagnostic accuracy of CXR in blunt trauma chest patients.

Methodology: 100 patients of blunt trauma chest were included. All underwent CXR and NCCT chest. Findings of NCCT chest were considered as standard for CXR findings. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), likelihood ratio positive (positive LR), likelihood ratio negative (negative LR) and accuracy were calculated for CXR.

Results: CXR had 100% sensitivity, PPV and accuracy in detecting rib fractures. The sensitivity for hemothorax, pneumothorax and other injuries (lung contusion, thoracolumbar vertebra fractures, diaphragmatic injuries, surgical emphysema and pneumomediastinum) were 68.75%, 71.64% and 15.38%. For hemothorax it had specificity and PPV of 100%, negative LR of 0.31, NPV of 11.76% and accuracy of 70%. For detecting pneumothorax, CXR had sensitivity of 71.64%%, specificity and PPV of 100%, negative LR of 0.28, NPV of 63.46% and accuracy of 81.00%. For other lung injuries CXR had specificity and PPV of 100%, negative LR of 0.85, NPV of 77.08% and accuracy of 78.00%. In 71% patients, NCCT identified significant chest injury intricacies that were missed on CXR.

Conclusion: CXR performed alone during primary survey is not a reliable tool for evaluation of blunt trauma chest. NCCT chest should be performed and included as a protocol in all hemodynamically stable cases of blunt trauma chest.

KEYWORDS

Blunt trauma chest, diagnostic accuracy, NCCT chest, X-ray Chest

INTRODUCTION

Of all the deaths occurring due to road traffic accidents (RTA), 48% are between 15 and 44 years (1). In India, there are 360 deaths every day due to RTA of which 16 victims are children (2). Chest trauma constitutes 10-15% of all injuries and is a significant cause of mortality in trauma patients (25% of all fatalities due to trauma) (3). Blunt chest trauma accounts for approximately 80% of thoracic injuries in children and elderly (3). Chest X-Ray (CXR) is the first steps in diagnosis and treatment of clinically apparent injuries like rib fractures, severe pneumothorax, or large hemothorax. But some potentially life-threatening injuries such as pulmonary contusion, occult pneumothorax, small to moderate hemothorax, mediastinal injuries and diaphragmatic injuries, thoracolumbar vertebral fractures may be missed on chest radiography during primary survey (3).

Non contrast computed tomography (NCCT) scan is the gold standard diagnostic tool in chest trauma, which can diagnose pulmonary contusion, hemothorax, pneumothorax, rib fracture and thoracic spinal injuries with high sensitivity (4–10). Rapid diagnosis of these injuries in patients with blunt trauma chest has led to significant improvement in patient management (4). Still, CXR is considered a useful bedside and cost-effective modality providing valuable information in the initial evaluation of trauma patients.

With this background we designed a study to evaluate whether CXR when performed alone during primary survey is a reliable diagnostic tool and whether additional information obtained with NCCT chest influences subsequent therapeutic decisions for early management of blunt trauma chest patients.

METH ODOLOGY

A study of diagnostic accuracy was conducted in a tertiary care teaching hospital and trauma care center, with prior ethical clearance from the Institutional ethical committee.

Study design: Diagnostic accuracy study

Study period: Dec 2017- Nov 2018

Sample size: 100 patients admitted to acute surgical wards and intensive care unit

Inclusion Criteria:

1. All blunt trauma chest victims with dangerous mechanism of injury
2. All hemodynamically stable patients after primary survey

Exclusion Criteria:

1. Age < 12 years
2. Pregnant women
3. Female of child bearing age (age: 15-45 years)

All patients were subjected to primary and secondary survey including a brief relevant history at the trauma center. They underwent CXR and NCCT chest after being stabilized hemodynamically. Once stabilization and necessary intervention, the findings of CXR and NCCT were noted using written report from radiologist. The results were recorded and analyzed. Follow up period was 03 months from the date of injury.

SPSS software Version 24.0 was used for statistical analysis. Detailed diagnostic test evaluation was performed for CXR with respect to NCCT chest according to findings. Results of the NCCT chest findings were considered as the gold standard for CXR findings. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), likelihood ratio positive (positive LR), likelihood ratio negative (negative LR) and accuracy were calculated by standard methods for CXR. P value < 0.05 was considered statistically significant.

RESULTS

A total of 100 patients with a mean age of 38.9 ± 18.1 years with history of blunt trauma chest were included. There were 63 males and 37

females. Leading cause of blunt trauma chest was road traffic accidents and 42 % of the cases were seen in the age group 21-40 years. During primary survey of the patients, all had a positive chest compression test and 24% had a respiratory rate of >16/minute. 68% had decreased breath sounds. 24 patients who had a respiratory rate of >16/minute also had flail segments and decreased breath sounds on clinical examination. Of these 24 patients, 5 were found to have an oxygen saturation of <90% and the remaining 19 had saturation between 90-93%. 26% had a hemoglobin of <10g/dl and a packed cell volume of <37%. Arterial blood gas analysis revealed that 22% had acidosis (pH <7.35).

Trauma scoring as per Injury Severity Score (ISS) and New Injury Severity Score (NISS) was done for all the patients. 24% patients had an ISS of >15 (ISS 16-49: 14%, ISS 50-74: 10%). These patients had a longer duration of hospital stay (>30 days). 10% patients who had an ISS≥50 had poor outcome and did not survive. 22% patients who had an ISS > 15 and NISS > 32 together with acidosis, Hb <10g/dl and PCV <37% required intubation. All hemodynamically stable patients after primary survey underwent X-ray chest-AP view and NCCT chest. Table 1 shows the findings that were picked up by CXR and NCCT chest. CXR had 100% sensitivity in detecting rib fractures with PPV of 100% and accuracy of 100% (95% CI: 96.38% to 100.00%). The sensitivity of CXR for hemothorax, pneumothorax and other injuries (lung contusion, thoracolumbar vertebra fractures, diaphragmatic injuries, surgical emphysema and pneumomediastinum) were 68.75%, 71.64% and 15.38%, respectively as shown in Table 2.

Table 1: Comparison of findings on CXR and NCCT chest

Findings	CXR	NCCT Chest	p-value
Rib Fractures	100	100	0.32
Haemothorax	66	96	0.004
Pneumothorax	48	67	0.0001
Other injuries: Lung contusion, thoracolumbar vertebral injuries, surgical emphysema, diaphragmatic injuries	4	26	0.016

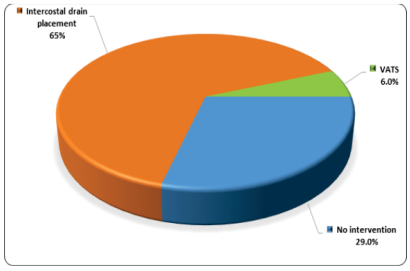
Table 2 Diagnostic evaluation of CXR with respect to NCCT chest (Gold Standard) for various chest trauma findings

	Rib fracture		Hemothorax		Pneumothorax		Other thoracic injuries	
	Value	95% CI	Value	95% CI	Value	95% CI	Value	95% CI
Sensitivity	100.00 %	96.38 % to 100.00 %	68.75 %	58.48 % to 77.82%	71.64 %	59.31 % to 81.99%	15.38 %	4.36% to 34.87%
Specificity	-	-	100.00 %	39.76 % to 100.00 %	100.00 %	89.42 % to 100.00 %	100.00 %	95.14 % to 100.00 %
PPV	100.00 %	-	100.00 %	-	100.00 %	-	100.00 %	-
NPV	-	-	11.76 %	9.02% to 15.21 %	63.46 %	54.28 % to 71.76 %	77.08 %	74.06 % to 79.85 %
Accuracy	100.00 %	96.38 % to 100.00 %	70.00 %	60.02 % to 78.76 %	81.00 %	71.93 % to 88.16 %	78.00 %	68.61 % to 85.67 %

CXR had a specificity and a PPV of 100%, negative LR of 0.31 (95% CI: 0.23 to 0.42), NPV of 11.76% (95% CI: 9.02% to 15.21%) and accuracy of 70% (95%CI: 60.02% to 78.76%) for hemothorax. For detecting pneumothorax, CXR had a sensitivity of 71.64%%, specificity and a PPV of 100%, a negative LR of 0.28 (95% CI: 0.91 to 0.41), NPV of 63.46% (95% CI: 54.28% to 71.76%), and accuracy of 81.00% (95%CI: 71.93% to 88.16%). CXR had specificity and PPV of 100%, negative LR of 0.85 (95% CI: 0.72 to 1.00), NPV of 77.08 % (95% CI: 74.06% to 79.85%), and accuracy of 78.00% (95% CI: 68.61% to 85.67%) in detecting other injuries like lung contusion, thoracolumbar vertebral injuries, surgical emphysema and diaphragmatic injuries.

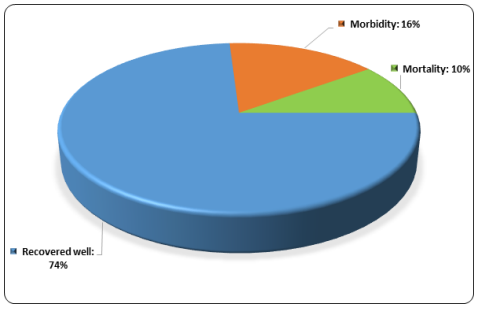
In 71% patients, NCCT identified significant chest injury intricacies that were missed on CXR. These findings were small to moderate hemothorax (n = 49), occult pneumothorax (n= 19), lung contusion (n=12), thoracolumbar vertebral injuries (n= 4), surgical emphysema (n=4), and diaphragmatic injuries (n=2). NCCT Chest was fundamentally more compelling than routine CXR in distinguishing lung injuries. Statistically significant difference was seen in cases of hemothorax (p= 0.004), pneumothorax (p<0.0001), and other injuries like lung contusion, thoracolumbar vertebral fractures, surgical emphysema and diaphragmatic injuries (p=0.016).

Figure 1 Intervention required following blunt trauma chest VATS – Video assisted thoracoscopic surgery



Of all the 100 patients, 29% did not need any form of intervention and were managed with analgesics and incentive spirometry as shown in Figure 1. Intercostal drain placement was sufficient for management of 65% patients. The remaining 6% were initially managed with Intercostal drain placement, however, this subgroup subsequently required Video Assisted Thoracoscopic Surgery (VATS) for retained hemothorax and diaphragmatic injuries. In the study, the observation of additional NCCT Chest findings in 41% patients (occult pneumothorax in 19%; lung contusion in 12%; thoracolumbar vertebral injuries in 4%; surgical emphysema in 4% , and diaphragmatic injuries in 2%) brought about a difference in treatment in these patients in the form of chest tube placement, chest tube adjustment in pneumothoraxes or huge hemothoraces, VATS, ICU care and change in mode of ventilation and respiratory care .

Figure 2 Outcomes following blunt trauma chest



RECOVERY

The overall outcome is depicted in Figure 2. Of the total 100 patients, 74% recovered uneventfully after a follow up period of 3 months, 16% had residual morbidity in the form of pain at the site of fractured ribs and thoracolumbar vertebrae, post-surgery complications like atelectasis requiring bronchoscopy, mechanical ventilation and small diaphragmatic hernias. The overall mortality rate was 10%.

DISCUSSION

After primary survey, CXR is considered as the next step in evaluating traumatic chest injuries. CXR is not useful in many pathologies following blunt trauma chest and it leads to loss of crucial time in "golden-hour". With the advancements in the trauma management protocol, NCCT, a better modality has replaced CXR as the first line diagnostic modality in most of the trauma centers.

Chardoli et al. in their study on chest trauma patients found sensitivity of CXR for hemothorax, vertebral and rib fractures to be 20%, 49% and 49%, respectively. Pneumothorax, foreign body, emphysema, pulmonary contusion, liver hematoma and sternum fracture were not diagnosed with CXR alone in their study. They concluded that applying NCCT scan as the first-line diagnostic modality in hemodynamically stable patients with blunt chest trauma can detect

pathologies which may change management and outcome (11). In another study, El Wakeel et al. found higher sensitivity of NCCT as compared to CXR in detection of intrathoracic injuries (12). In our study we found, CXR to have low sensitivity in diagnosing traumatic intrathoracic injuries compared to chest NCCT scan.

CXR could screen less than 70% of all pathologies except rib fractures in the present study. Missed pneumothorax cases based solely on CXR which are later picked up by CT scan are frequent. Eckstein et al. estimated sensitivity of CXR to be 42% in diagnosis of pneumothorax (9), sensitivity and specificity in diagnosis of pulmonary contusion were 40% and 100%. estimated to be 15.38% and 100%%, respectively.

In our study, NCCT distinguished significant chest injury intricacies in 71% patients which were missed on CXR. These findings were small to moderate hemothorax, occult pneumothorax, lung contusion, thoracolumbar vertebral injuries, surgical emphysema, and diaphragmatic injuries. The extra NCCT Chest discoveries in 41% patients (occult pneumothorax : 19%, lung contusion: 12%, thoracolumbar vertebral injuries : 4%, surgical emphysema: 4% , and diaphragmatic injuries: 2%) brought about a difference in treatment in the form of chest tube placement, chest tube adjustment of pneumothoraxes or huge hemothoraces, VATS, ICU care and change in mode of ventilation and respiratory care and ultimately impacted the outcome. This finding corresponds to a study by Trupka A et al (13).

CONCLUSION

The sensitivity and NPV of CXR was low for hemothorax, pneumothorax, pulmonary contusion, thoracolumbar vertebral injuries, diaphragmatic injuries and subcutaneous emphysema even though the specificity and PPV was high in diagnosing these injuries. CXR performed alone during primary survey is not a reliable tool for evaluation of blunt trauma chest due to its low sensitivity. Additional information obtained with NCCT influences subsequent therapeutic decisions for early management of blunt trauma chest patients and also leads to a significant change in outcome of the patients. NCCT chest should be performed and included as a protocol in all hemodynamically stable cases of blunt trauma chest.

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