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Original Research Article

DIAGNOSTIC ACCURACY OF CHEST X-RAY IN THE DETECTION OF PNEUMOTHORAX IN BLUNT CHEST TRAUMA PATIENTS WITH CT AS THE GOLD STANDARD

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Abstract

Background: To study the diagnostic accuracy of chest X-ray in the detection of pneumothorax in blunt chest trauma patients with CT as the Gold Standard

Methods: The present study was conducted from 31th July 2018 to 30th July 2019. A total of 36 patients were enrolled in the study.

Results: On Chest X-Ray Supine AP view, pneumothorax was detected in 11 of 24 patients. The sensitivity of Chest X-Ray Supine AP view was 45.83%, specificity was 100%, positive predictive value (PPV) was 100%, negative predictive value (NPV) was 48% and accuracy was 63.89% for the diagnosis of pneumothorax.

Conclusion: A Chest radiograph is the most preferred and relevant primary investigation in the diagnosis of pneumothorax even with the various advanced techniques that are available. X-ray being relatively cheaper and is easily available even at the peripheral centers at the primary health care level.

Keywords: X-ray, CT, Pneumothorax

Introduction

Pneumothorax is a common finding in blunt trauma chest patients which is the leakage of air into the pleural space and its immediate intervention and proper treatment can be life-saving. Most of the pneumothorax in patients with chest trauma are small and do not need immediate intervention, however these small pneumothoraces can progress and develop to tension pneumothorax which is life-threatening. Hence diagnosing pneumothorax in patients with chest trauma is important.
Traditionally, when a clinician suspects a pneumothorax, a chest radiograph is obtained before any other investigation.

The radiographic diagnosis of pneumothorax on chest X-ray is made by the presence of a visceral pleural line along the periphery with no lung markings.

Chest radiographs are best at detecting pneumothorax if obtained when patient is in upright position as the radiographic appearance is dependent on gravity.

Obtaining upright X-ray in patients with multiple injuries with chest trauma is practically difficult due to conditions such as the protection of cervical vertebras, hemodynamic instability, immobilization in case of orthopedic injuries, continuing resuscitation and/or altered state of consciousness. In such patients, Supine X-ray has to be obtained.

In a supine Chest X-ray view, the costophrenic angle appears prominent and deepened due to the air that collects at the lung bases known as the deep sulcus sign[1].

Chest X-ray is a good tool in the diagnosis of pneumothorax. X-ray equipment is relatively cheaper and is easily available at the peripheral centers at the primary health care level.

Material and methods

Study design: Cross sectional analytical study.

Setting: Department of Radiodiagnosis, IGMC, Shimla, Himachal Pradesh, India.

Study period: 31st July 2018 to 30th July 2019

Methodology: This study was aimed to compare the diagnostic accuracy of Chest X-ray in comparison and correlation with CT Scan as the Gold Standard on patients being referred to the Department of Radiodiagnosis from various clinical departments in Emergency Section of Indira Gandhi Medical College and Hospital, Shimla for the diagnosis of pneumothorax and other associated chest findings in patients with trauma.

Inclusion Criteria:

1. Patients who presented with history of trauma to the chest.

2. Patients more than 10 years of age.

Exclusion Criteria:

1. Patients treated with open and tube thoracostomy prior to imaging.
2. Patients who were not willing to participate in the study.
3. Pregnant patients.
4. Very sick patients.

Results

Table 1: Demographic data of the patients (n = 36)

AGE(Years)	MEAN	43.56	
	RANGE	12-80	
SEX	MALE	21	58.3%
	FEMALE	15	41.7%
CAUSE OF TRAUMA	FALL FROM HEIGHT	20	55.6%
	ROAD TRAFFIC ACCIDENTS	16	44.4%

The age of patients in our study ranged from 12 years to 80 years. The mean age was 43.56 years. Most of the patients were in the range of 20-40 years (n=13) comprising 30.6% of total. Minimum number of patients were in the age group of <20 years (n=4).Out of the total 36 patients there were 21 male patients (58.3%) and female 15 patients (41.7%).

Table 2: Accuracy of *Chest X-ray findings* in Pneumothorax, Gold Standard – CT Scan (n=36)

Chest X-ray AP View- Pneumothorax	**CT Scan Chest– Pneumothorax**				
	Disease				**Total**
	Present	**n**	**Absent**	**n**	
Positive	True Positive	a= 11	False Positive	c= 0	a+c= 11
Negative	False Negative	b= 13	True Negative	d= 12	b+d= 25
Total	a+b= 24		c+d= 12		36
Statistic	Sensitivity	Specificity	PPV	NPV	Accuracy
	45.83%	100.00%	100.00%	48.00%	63.89%

On Chest X-Ray Supine AP view, pneumothorax was detected in 11 of 24 patients. Statistical analysis showed that, for the detection of pneumothorax, the sensitivity of Chest X-Ray Supine AP view was 45.83%, specificity was 100%, positive predictive value (PPV) was 100%, negative predictive value (NPV) was 48% and accuracy was 63.89%.

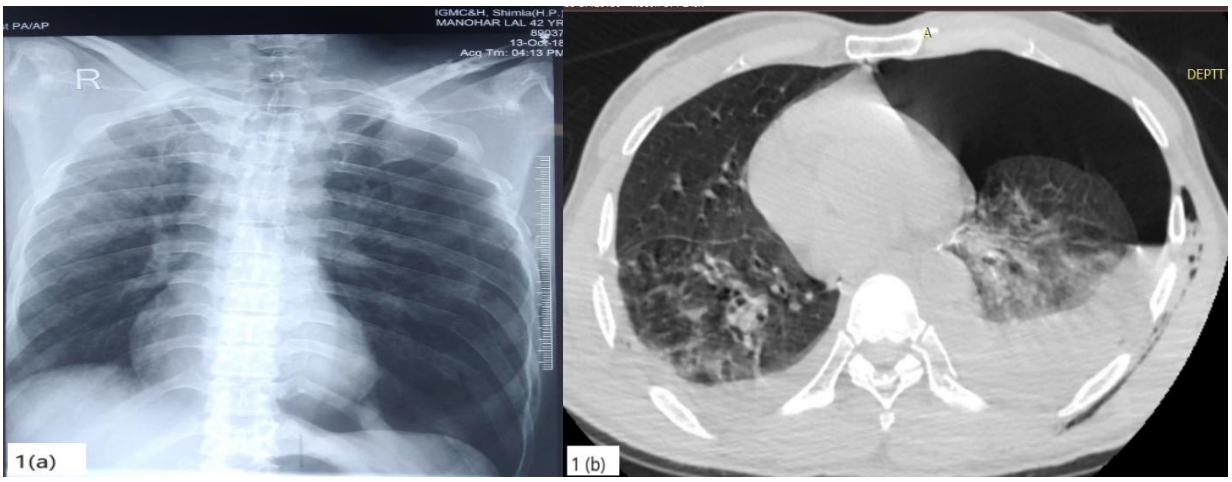

Fig. 1(a): Supine Chest X-ray showing visceral pleural line in left lung field with deep sulcus sign.

Fig. 1(b): CT-Chest showing left pneumothorax, bilateral hemothorax, subcutaneous emphysema along left chest wall.

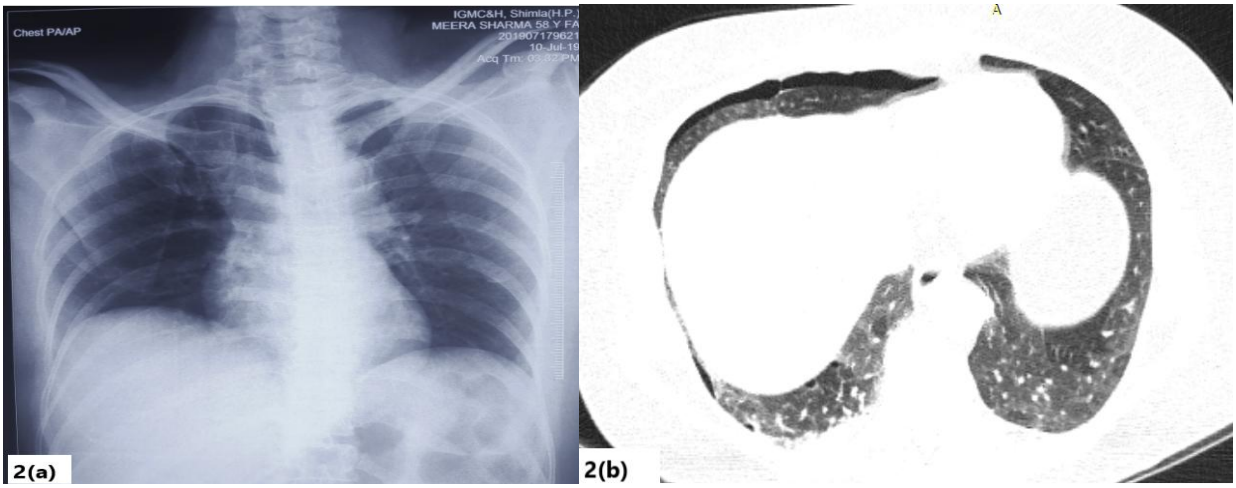

Fig. 2(a): Supine Chest X-ray showing no presence of pneumothorax
Fig. 2(b): CT-Chest showing mild right pneumothorax.

Discussion

The radiographic diagnosis of pneumothorax on chest X-ray is usually straight forward and is made by the presence of a visceral pleural line along the periphery with no lung markings. In a supine Chest X-ray view, the costophrenic angle appears prominent and deepened due to the air that collects at the lung bases known as **the deep sulcus sign[1].**

Khaled Morsy Salama et al[2] in their study found that supine Chest X-Ray showed sensitivity (75%), specificity (88.9%), PPV(76%), NPV(75%) and accuracy (80%); and the specificity and sensitivity of chest ultrasound in diagnosing pneumothorax was 100% and 81% respectively, with overall accuracy 88%. They concluded that the diagnostic accuracy of supine Chest X-Ray were good numbers but still lower than chest ultrasound.

Şeyhmus Kaya et al[3] in their study on 210 patients and they found that the sensitivity of Chest X-Ray AP view was 34.8%, specificity 100%, positive predictive value 100% and negative predictive value 92.6%.

In our study the sensitivity of Chest X-Ray Supine AP view was 45.83%, specificity was 100%, positive predictive value (PPV) was 100%, negative predictive value (NPV) was 48% and accuracy was63.89%. Thus, our study is in agreement with the above mentioned studies.

The British Thoracic Society guidelines divide pneumothoraxes based on the distance from visceral pleural surface (lung edge) to chest wall, with less than 2 cm being small and more than 2 cm large[4].

In patients with chest trauma in the Emergency Department, because of the mandatory supine position, air in the pleural space, if it is free to move, goes toward the anterior thoracic wall. On supine chest X-ray, small pneumothorax may not be detected.

A pneumothorax identified on a CT Scan that cannot be detected on a supine Chest X-ray AP view is termed as 'Occult Pneumothorax'[5].

Oblique Chest X-Ray may be effective at detecting occult pneumothorax with a higher accuracy than Supine AP Chest X-ray[6]. **Matsumoto et al**[6] in their study on 159 patients to study the diagnostic accuracy of oblique chest radiograph for the detection of occult pneumothorax in comparison with ultrasonography of chest found that the sensitivity and specificity of Oblique X-ray Chest for detecting occult pneumothorax was 61.4 % and 99.2 %, as compared with ultrasound which was 62.9 % and 98.8 %, respectively. Lateral or decubitus views may be used in ventilated patients or neonates.

Several well known artefactual appearances can mimic the presence of a pneumothorax and should always be remembered during evaluation of a chest radiograph.

The medial border of the scapula can imitate a lung edge however this shadow will be in continuity with the rest of the bone. Skin folds overlying the chest wall can simulate a visceral pleural line however, skin folds are usually seen to pass outside the chest cavity, and do not run parallel to the chest wall as with a true visceral pleural line. Distal lung markings will also be seen[7]. Clothing or bed sheets may produce a similar artefact.

Conclusion

Early diagnosis of pneumothorax is important as it can be life-threatening and immediate intervention may be needed and life-saving. Chest X-ray is a good tool in the diagnosis of pneumothorax. X-ray equipment is relatively cheaper and is easily available at the peripheral centers at the primary health care level.

Even with the various advanced techniques that are available, Chest radiographs is still the most preferred and

relevant primary investigation in the diagnosis of pneumothorax.

CT scan is considered as the gold standard in detecting pneumothorax, however CT scan is usually available only at higher centers, time consuming, difficult to perform in sick patients and the disadvantage of high radiation exposure.

Chest ultrasound has also been increasingly used to evaluate pneumothorax considering the real-time bedside evaluation especially with critical patients without interruption in the resuscitation process. Various studies[8,9,10,11] have also shown that chest ultrasound has higher sensitivity and specificity in the diagnosis of pneumothorax as compared with chest X-ray. However, chest ultrasound has its limitations in cases of patients with subcutaneous emphysema which in common in traumatic pneumothorax. Chest ultrasound cannot detect preexisting lung diseases and is also operator dependent.

Chest Xray is easily available even at the peripheral centers with less resources. It is also less time consuming with less radiation exposure. It is also simple and can be easily interpreted even by non-trauma physicians.

Matsumoto et al[6] suggested that Oblique Chest X-ray at 45 degree with the horizontal line has higher sensitivity and specificity in the detection of occult pneumothorax as the intrapleural air migrates to the anterior region in the supine position. This is very useful in patients with history of trauma with patient movement being restricted due to potential spine trauma and pelvic fracture. In certain cases, due to various artefacts and optimal, repeating the radiograph, with patient in upright position may increase the accuracy in the detecting pneumothorax.

One of the limitation in our study is that only a smaller number of patients were included and in smaller hospital settings. The patients who were selected were more severely injured than patients who may only receive a chest radiograph without undergoing CT which may have led to some selection bias. The CT scans were often performed more than 30 minutes after initial ultrasound and chest X-Ray, thus giving time for the pneumothorax to enlarge in some cases.

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