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ORIGINAL ARTICLE

Diagnostic Accuracy of Chest X-Ray in Detecting Chest Tube Malpositions

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ABSTRACT

Objective: To determine the diagnostic accuracy of chest x-ray in detecting chest tube malpositions.

Design of the Study: It was a cross-sectional survey.

Place and Duration of Study: This study was carried at the Department of Radiology, Civil Hospital Karachi and Shaheed Mohtarma Benazir Bhutto (SMBB) Trauma Centre Karachi over 6 months from28th January 2021 to 27th July 2021.

Patients and Methods: This study comprised a total of 191 patients with blunt or penetrating chest damage needing a tube thoracotomy. An incision in the skin was made directly above the rib. A suitable-sized chest tube was placed inside, fastened with a silk 1-0 suture, and an aseptic dressing was placed. The patient was subsequently transported for a chest CT scan without contrast and a X-ray of chest (frontal and lateral views). Chest tube malposition, or CTM, was identified on a frontal, lateral, or both radiographs. All information was recorded in the Performa.

Results: The patients were 35.9611.387 years old on average. 26.1% (52/199) of the patients had malposition, which was verified by CT. The frontal chest x-sensitivity, ray's specificity, positive predictive value, negative predictive value, and accuracy in detecting malposition were 36.5%, 100%, 100%, 81.7%, and 83.4%, respectively, and the lateral chest x-were ray's 15.4%, 100%, 100%, 77%, and 77.9%%. The combined frontal and lateral chest x-sensitivity, ray's specificity, PPV, NPV, and accuracy were 38.5%, 100%, 100%, 82.1%, and 77.4%, respectively, in detecting malposition. 83.4% of chest x-rays with combined frontal and lateral views correctly identified malposition.

Practical Implication: A literature search reveals that there is relatively little information available about this topic in our population. As a result, it gives the study a solid justification since its main objective is to compare the diagnostic efficacy of frontal and lateral CXR to that of a CT scan in identifying chest tube malposition.

Conclusion: When a chest x-ray is taken from both the front and the side, its accuracy in detecting malposition is 83.4 percent. In high negative and positive findings for the diagnosis of thorax injuries make chest X-ray an essential aspect of the first therapy of a trauma patient.

Keywords: Diagnostic Accuracy, Thoracostomy, Chest tube malpositions, Chest X-Ray, CT scan, Radiology

INTRODUCTION

The global burden of disease attributable to trauma is substantial.[1] It is a major cause of illness and disability in Pakistan, accounting for a disproportionate share of the country's influx of emergency room visitors.[2,3] The majority of injuries in both rich countries and developing ones like Pakistan are the result of motor vehicle collisions. This is mostly attributable to the rise in urbanisation and population. The lack of large tertiary trauma hospitals, trained medical professionals, medical facilities, ambulatory services, and central locations contribute to a greater rate of death in rural areas versus non-rural areas of Pakistan.[4,5,6]

It is estimated that 25% of all trauma patients die from blunt or penetrating thoracic trauma.[7] Therefore, a crucial part of managing a multi-trauma patient is assessing for and treating chest trauma as soon as possible. According to the American Trauma Life Support (ATLS) recommendations, the first step in treating thoracic trauma is to ensure the patient's airway, oxygenation, breathing, and circulation are all stable.[8,9]

Patients who have sustained thoracic trauma often have tube thoracostomy to treat pneumothorax or hemothorax. This is one of the most popular surgical interventions.[10,11] While it can save lives and has many benefits, it also has risk, the most prevalent of which is chest tube malposition.[12,13] Thirty percent of chest tubes are placed incorrectly, according to research by F. Remerand et al. in 2007.[14] It has been determined that the use of a trocar during the surgery is the single most important risk factor for chest tube malposition, among several others. Poor drainage is just one of the issues that might arise from these malpositions.[11] Ultrasound (U/S) of the chest, chest x-ray (CXR), and computed tomography (CT) scan are all capable of detecting these malpositions. The CT scan is the most reliable method for detecting the aforementioned conditions.[15]

According to research by 26% of chest tubes were malpositioned after emergency tube thoracotomy.[13] Only one of twenty-one chest tube malpositions was picked up by frontal radiographs in the Stark et al. study. However, when a lateral image was included, 8 out of 9 chest tube malpositions were accurately diagnosed.[16]

The incidence of chest tube malposition was reported to be 36.8% across all patients in the study by Kung Lim et al. colleagues. There were 28 cases of chest tube malposition detected by CT, but only 6 by frontal radiography.[17] tudy at Civil Hospital Karachi indicated that the rate of chest tube malposition was 23.3% in local population.[18]

There is very little information on the use of CXR in detecting chest tube malpositions, despite the fact that multiple studies were undertaken to establish the prevalence of chest tube malpositions and the CT scan was thought to be the preferred imaging modality. In contrast to CXR, a CT scan demands that the patient be hemodynamically stable, takes longer, necessitates movement, is more expensive, and its accessibility is a significant issue for our community, particularly in rural Pakistan. Especially our which incorporated lateral radiographs and considerably improved the diagnostic accuracy of CXR in detecting chest tube malposition, was undertaken. Previous studies only considered the diagnostic accuracy of frontal radiographs. This shows that the efficacy of X-rays in diagnosing chest tube malpositions is underrated and that they should be further examined, particularly in our demographic where the accessibility and cost of CT scans are important issues. A literature search reveals that there is relatively little information available about this topic in our population. As a result, it gives the study a solid justification since its main objective is to compare the diagnostic efficacy of frontal and lateral CXR to that of a CT scan in identifying chest tube malposition. in order to support the use of various imaging modalities depending on the hemodynamic

stability, availability, and cost-effectiveness that was in the patients' best interests.

One of the probable limitations with both the studies was small sample size. Moreover, no other local or international such published material was available. Therefore, this study was aimed to determine the diagnostic accuracy of MRI for diagnosis of Wilms tumor taking histopathology as gold standard. This study was conducted over a large sample size in local settings so that results of this study may help in the selection of more appropriate diagnostic approach among such patients in future practice.

PATIENTS AND METHODS

This cross sectional survey was conducted from 28th January 20021 to 27th July 2021 at Civil Hospital Karachi and Shaheed Mohtarma Benazir Bhutto (SMBB) Trauma Centre, Karachi. Using the sensitivity and specificity figures from Masego Candy Mokotedi et al. for x-ray diagnosis of chest tube malposition keeping 95% confidence interval a sample size of 199 cases is estimated using the openepi tools.[18] Patients of both sexes, 15 to 65 years old, who have blunt or piercing chest injuries and need a tube thoracostomy, as well as those who have hemothorax, pneumothorax, or hemopneumothorax Patient who is hemodynamically stable. Within 24 hours following the patient's tube thoracostomy, radiographic imaging was performed using an open method. Patients were excluded needing any type of urgent surgery, including thoraco-abdominal, head and neck, limb, and emergency thoracotomies. Tube thoracostomies that are performed voluntarily as well as those are necessary due to illness or spontaneous pneumothoraxes were also excluded.

After receiving informed consent, the selection criteria called for patients who had had tube thoracostomy as a result of chest trauma. A brief history was obtained, including the sort of trauma and the injury's mechanism. Following written and informed permission, a tube thoracostomy was carried out in accordance with British Thoracic Society (BTS) recommendations.[19] Patients who have experienced chest trauma and appear with pneumothorax, hemothorax, or hemopneumothorax will be our primary focus. An intravenous analgesic and a prophylactic antibiotic were administered to the patient beforehand to ease their discomfort.

According to BTS recommendations, the tube thoracostomy was performed midway down the axillary line, through the triangle of safety formed by the nipple (5th intercostal gap), the lateral border of the pectoralis major muscle, and the anterior border of the lattismus dorsi muscle. A chest tube was inserted with the upward orientation for pneumothorax and the downward orientation for hemothorax and hemopneumothorax. The chest tube was placed above the lower rib to protect the neurovascular bundle. Tube thoracostomy was followed by radiologic imaging within 24 hours to rule out the possibility of chest tube migration or dislodgement.

Because of how easy it is for doctors and radiologists to miss chest tube malposition, it was emphasised that chest X-rays (frontal and lateral views) and CT scans (chest plain) be used to detect it. A diagnosis of CTM required evidence of malposition in the chest tube on either the frontal or lateral radiograph, or both. This information can be found in the Performa that will be referenced shortly.

Once data was collected, it was entered into a database and analysed using SPSS 21.0. Age, the length of time between the initial chest tube insertion and the subsequent CXR and CT scan, and the length of time between the initial chest tube insertion and the subsequent chest tube removal were all used to calculate means and standard deviations for quantitative variables. Quantitative characteristics were analysed by calculating frequencies and percentages for characteristics such as gender, mechanism of injury, trauma type, indication for tube thoracostomy, site of tube thoracostomy, chest tube column movement, and CXR and CT scan findings. The results of the CXR and CT scan were used to determine the true positive, false positive, true negative, and false negative rates.

STUDY RESULTS

There were a total of 191 people who had suffered blunt or piercing chest damage and needed tube thoracostomy. Figure 1 displays the patient age distribution. Patients had an average age of 35.96 11.387 years. Table 1 displays the average number of days it takes to do a chest x-ray and a computed tomography scan after a chest tube has been inserted. The breakdown was as follows: 141 men (70.85%) and 58 women (29.15%) (figure 2). Figure 3 displays that car accidents were the leading cause of injury. 57.29 percent of trauma cases involved multiple injuries, and 42.71 percent involved chest trauma or injury (figure 4). Figure 5 demonstrates that pneumothorax (61.31%), hemopneumothorax (25.13%), and hemothorax (13.57%) were the most common causes of tubal thoracostomy. Figure 6 also shows the reported locations of tubal thoracostomies.

Malposition was seen in 26.1% (52/199) of verified CT births. Table 2 shows that a frontal chest x-ray has a 36.5 percent sensitivity, a 100 percent specificity, an 81.7 percent positive predictive value, and an 83.4 percent negative predictive value for detecting malposition. Figures from table 3 reveal that the lateral chest x-ray has a sensitivity of 15.4%, specificity of 100%, PPV of 100%, NPV of 77%, and accuracy of 77.9% in detecting malposition. Table 4 compares the diagnostic accuracy of CT scan and chest x-ray for detecting chest tube malpositions. When used together, frontal and lateral chest x-rays have a sensitivity of 38.5%, specificity of 100%, PPV of 82.1%, NPV of 77.4%, and accuracy of 100% when it comes to detecting malposition.

Table 1: Descriptive statistics of characteristics of included patients in study

Variables	Mean± SD	95% Confidence Interval for Mean	
		Lower Bound	Upper Bound
Age (Years)	35.96±11.387	34.38	37.55
Time of CXR after chest tube placement (min)	45.30±.14	44.02	46.58
Time of CT scan after chest tube placement (min)	122.94±39.03	117.49	128.39
Chest tube removal time (days)	5.26±1.04	5.11	5.40

Table 2: Details of various variables of patients

Characterstics	Variables	Frequency
Gender	Male	141(70.85%)
	Female	58(29.15%)
Injury Mechanism	RTA	109(54.77%)
	Fall	23(11.56%)
	Firearm	22(11.06%)
	Stab wound	45(22.61%)
Type of Trauma	Poly Trauma	114(57.29%)
	Only Chest Injury	85(42.71%)
Tubal Thoracostomy Indication	Hemothorax	27(13.53%)
	Pneumothorax	122(61.31%)
	Hemopneumothorax	50(25.13%)
Site of Tube Thorcostomy	Right	133(66.33%)
	Left	44(22.11%)
	Both	22(11.06%)

Table 3: Diagnostic accuracy of various modalities of x-ray as compared to ct scan in detecting chest tube malpositions

Variables	Sensitivity	Specificity	PPV	NPV	Accuracy
Malposition Detected On frontal Chest	36.5%	100%	100%	81.7 %	83.4%
Malposition Detected On lateral Chest X-Ray	15.4%	100%	100%	77%	77.9%
Malposition Detected On Chest XRay(Frontal And Lateral)	38.5%	100%	100%	82.1	77.4%

More than 80% accuracy was found in age, gender, mechanism of damage, type of trauma, indication for tube thoracostomy, and site of tube thoracostomy stratification analyses, as illustrated in tables 4.

Table 4: Diagnostic accuracy of chest x-ray (frontal and lateral) as compared to ct scan in detecting chest tube malpositions by age, gender, mechanism of injury, type of trauma, tubal thoracostomy indication, site of tube thoracostomy

Variables	Variables	Sensitivity	Specificity	PPV	NPV	Accuracy
Age	≤ 30	36.4%	100%	100%	78.1%	80.6%
	31-40	23.8%	100%	100%	73.3%	75.4%
	41-50	66.7%	100%	100%	96.7%	96.9%
	>50	83.3%	100%	100%	96%	96.7%
Gender	Male	41.7%	100%	100%	83.3%	85.1%
	Female	31.3%	100%	100%	79.2%	81.0%
Mechanism of injury	RTA	27.6%	100%	100%	76.2%	80.7%
	Fall	100%	100%	100%	100%	100%
	Firearm	42.9%	100%	100%	78.9%	77.3%
	Stab wound	30%	100%	100%	83.3%	84.4%
Type of trauma	Polytrauma	41.2%	100%	100%	80%	82.5%
	Only Chest trauma	33.3%	100%	100%	84.8%	85.9%
Tubal Thoracostomy Indication	Hemothorax	42.9%	100%	100%	83.3%	35.2%
	Pneumothorax	34.3%	100%	100%	81.1%	32.8%
	Hemopneumothorax	46.2%	100%	100%	84.45	36.0%
Site of tube thoracostomy	Right	36.1%	100%	100%	80.8%	82.7%
	Left	43.8%	100%	100%	75.7%	79.5%
	Both	0.0%	100%	0.0%	100%	100%

DISCUSSION

Traditional first-line testing for PTX after trauma or invasive operations has been chest radiographs, which can be used to confirm or rule out the diagnosis. Because chest radiographs are typically taken of the critically ill while they are lying supine or semi-recumbent, their accuracy is compromised. A chest CT or US scan should be performed if there is any uncertainty about the results of a chest x-ray in a stable patient. The thoracic CT scan is the most reliable method for diagnosing PTX and measuring its severity. However, it is costly and therefore not practical for everyday use.[20]

The participants' mean age was 35.9611.387 years old, and there were 2.91 times as many males as females in the study. Patients in the study by Mokotedi et al. had a mean age of 59.515 years old, and 78 percent were males.[21] The majority of patients brought to the emergency room with thoracic trauma were male (66.1%), while the female percentage was lower (33.9%) in the study by Tataroglu et al. the average male age was 35.0, while the average female age was 57.[22]

The most common cause of injury in the current study was car accidents. Most patients (57.29%) had several injuries, the most common of which was chest trauma (42.71% of the time). The majority of tubal thoracostomies were performed due to pneumothorax (61.1%), then hemopneumothorax (25.13%), and finally hemothorax (13.57%). According to research by Chardoli et al., X-rays of the chest miss 5.5% of cases of pneumothorax.[23] Initial chest X-rays for pneumothorax in the emergency room only had a sensitivity of 39.1% in this research. However, the accuracy was spot-on. Evidently, most cases of pneumothorax are missed by standard chest X-rays. Pneumothorax cannot be ruled out by a negative chest X-ray, hence a CT scan is always necessary if the possibility of pneumothorax exists.

Similar findings were reported by Chardoli et al. who concluded that chest X-rays overlook 4 percent of hemothorax patients.[23] The PA chest X-ray was found to be 62.5% sensitive and 100% specific for identifying traumatic pleural effusion in this study. The life-threatening consequence of thoracic injuries is hemothorax. If a hemothorax is suspected, thoracic computed tomography is the preferred diagnostic modality. High levels of sensitivity and specificity, however, allow for its application in management settings.

According to research by 36.8% of chest tubes are placed incorrectly. CT scans detected 28 cases of malpositioned chest tubes, while frontal radiographs detected just 6 patients.[17] In contrast to a previous study on trauma patients, we want to use both frontal and lateral radiographs to improve the diagnostic accuracy of finding chest tube malposition in our next investigation. Malposition was confirmed by CT in 26.1% of the babies in this research. The rate of chest tube malposition was 23.3% in a study done in 2008 at Civil Hospital Karachi.[18]

Frontal chest x-ray had a sensitivity of 36.5%, specificity of 100%, PPV of 81.7%, NPV of 83.4%, and accuracy of 83.4% in this study for detecting malposition. With an AUC of 0.93, 100% sensitivity, and 88% specificity at a cut-off value of 82%, chest drain foreshortening on chest X-ray (CXR) was the greatest signal of a misplaced CD in the study by Mokotedi et al. [19]. With an AUC of 0.83, 75% sensitivity, and 92% specificity at a cut-off of 50 degrees, the angle of CD inclination was larger in individuals with misplaced CD.

Study by Tataroglu et al. found that PA chest X-ray had a sensitivity of 39.1% and a specificity of 100% in identifying pneumothorax. Twenty-four individuals were found to have pleural effusions on CT scans, but only 15 were detected by chest X-rays, with the former having a sensitivity of 62.5% and the latter a specificity of 100%, a positive predictive value of 100%, and a negative predictive value of 98.1%. A chest X-ray had a sensitivity of 62.5%, specificity of 100%, a positive predictive value of 100%, and a negative predictive value of 98.1%. X-rays of the chest revealed a sensitivity of 48.8%, specificity of 100%, a positive predictive value of 100%, and a negative predictive value of 95.6%.[22]

This research is the first of its sort among the local population, and it supplements the scant previous literature on the subject. There is a strong need for such a study in the field of clinical research moving forward.

CONCLUSION

When a chest x-ray is taken from both the front and the side, its accuracy in detecting malposition is 83.4 percent. In high negative and positive findings for the diagnosis of thorax injuries make chest X-ray an essential aspect of the first therapy of a trauma patient.

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