Original Article

Sensitivity and Specificity of Physical Examination in the Diagnosis of Pneumothorax and Hemothorax

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Abstract:

Introduction: The aim of this study was to evaluate the sensitivity and specificity of history and physical examination in the diagnosis of pneumothorax and hemotorax in blunt chest trauma patients.

Methods: This was a descriptive-analytical study. Physical examination results were compared with findings of chest CT, X-ray, and ultrasound diagnostic methods using ROC curves in SPSS software.

Findings: Three (3.03) patients with pneumothorax and 7 (7.07) patients with hemotrax were found among 99 patients with mean age of 33.4±19.43. The highest sensitivity was due to chest scraping for pneumothorax (66.67%) and hemothorax (100%). The highest specificity was for abnormal lung sounds (Crackle), with 96.88% specificity for pneumothorax and 98.89% specificity for hemothorax. In the study of pneumothorax, the highest PPV and NPV were related to pulmonary sound reduction (12.5% and 98.7%, respectively). In the hemothorax evaluation, the highest PPV was related to chest tenderness (37.5%) and the highest NPV to pulmonary sound reduction (96.3%). The highest accuracy for pneumothorax was for pulmonary sound reduction and abnormal pulmonary sounds for hemothorax. A heart rate above 98.5 was associated with pneumothorax with a sensitivity of 17.6% and a specificity of 66.7%. Diastolic blood pressure below 70.5 with 46.9% sensitivity and 85.7% specificity and respiratory rate below 6.5 with 92.6% sensitivity and 57.1% specificity were associated with hemothorax.

Conclusion: Proper physical examination and history taking can help to diagnose hemothorax and pneumothorax with high sensitivity and specificity complementarity to CT scan or X-ray results.

Keywords: Physical examination, pneumothorax, Hemothorax.

Introduction:

The thorax cavity is a cylindrical space located in the middle of the Mediastinum, with the lungs surrounding it. Inside the mediastinum, there are the organs and structures of the chest such as the heart, large arteries and veins, main bronchi, and the esophagus and etc. (1). Chest injuries are one of the life-threatening forms of trauma to the body and are the second leading cause of trauma death after head trauma. Like other forms of injuries, chest trauma can have a blunt or penetrating mechanism (2). Motor vehicle accidents (MVCs) and falls from highs are examples that blunt trauma to the chest may happen. These injuries disrupt the normal anatomy and physiology of the chest (3). Most thoracic injuries do not require thoracotomy (thoracic surgery) (4). In fact, only 15 to 20 percent of all damage to this area would need thoracotomy. The remaining 85% can be taken care of with simple interventions such as oxygen therapy, assisted breathing, and painkillers. In all cases, thoracic injuries are very important. The organs in this area play an important role in the process of oxygen delivery, breathing and oxygen transfer (5). Damage to chest (especially if not immediately recognized and not properly taken care of) can have significant consequences. Hypoxia, inadequate oxygen content of the blood, hypercarbia (excessive carbon dioxide in the blood), acidosis and shock (6). These complications can lead to longer-term consequences such as multi-organ failure. This failure accounts for 25% of all trauma-related deaths in the thoracic region. Most of the trauma-related deaths to the chest need an emergency surgery. However, less than 15% of thoracic injuries require emergency surgery (7). In other injuries only supportive measures and early treatment are sufficient (8). A survey of 600 trauma-related deaths found that more than half of them were preventable with a prompt diagnosis (9). Accidents are the most common cause of chest trauma (10). Acceptance of accidents as a preventable problem leads to the development of prevention policies and strategies and ultimately a reduction in the number of deaths resulting from them. Simple interventions by physicians and emergency personnel can overcome over 85% of the risk of chest injuries, so accurate and timely recognition of chest injuries is of paramount importance (11). Understanding traumas and investigating and understanding the type of accident will be important in preventing, controlling, and reducing injuries and complications (12). The aim of this study was to evaluate the importance of clinical examination in the diagnosis of complications of thoracic trauma in form of pneumothorax and hemotorax.

Methods:

This is a descriptive-analytical study. All patients with multiple trauma referred to the emergency department of Jahrom Peimaniyeh hospital during 12 months were studied. Exclusion criteria included patients who had been traumatized for more than 6 hours and patients who died. Also traumatic patients intra-abdominal bleeding, Decreased level of consciousness, tension pneumothorax, unstable vital signs (blood pressure lower than 90 and O2saturation <92%), cases of poisoning, and cases with dissatisfaction of participating in study were excluded.

Patients with indications for chest x-ray (blunt trauma patients) were first examined by a physician and completed the mechanism of injury, patient complaints, vital signs, and oxygen saturation based on the checklist full filed by physician. Prior to chest X-ray, all patients underwent linear probe ultrasound by an emergency specialist and the results were recorded. Then chest radiographs were obtained from all patients. Chest computed tomography was performed based on the indications if needed. All radiology images were reported by 2 radiologists and in case of disagreement, the judgment was done by third radiologists.

History and physical examination (PHE) taking were performed for distractor pain, dyspnea, vital signs, chest skin scraping, chest tenderness, pulmonary abnormal sounds, chest deformity, abdominal tenderness, and decreased lung sounds.

Information forms were coded and demographic information were confidential to the researcher. Ethical considerations of research were approved by Ethics Committee of Jahrom University of Medical Sciences (Code: IR.JUMS.REC.1397.055); Consent inform was taken from participants. The information obtained was entered into SPSS 16 software. Given that chest radiographic findings are the gold standard in pneumothorax and hemotorax diagnosis, it was used in comparison of PHE results for calculating sensitivity, specificity, positive predictive value, negative predictive value and accuracy.

The following formulas were used for statistical calculation.

Findings:

The aim of this study was to evaluate the sensitivity and specificity of physical examinations in the diagnosis of pneumothorax and hemotorax in patients with multiple trauma. The aim of this study was to evaluate the sensitivity and specificity of physical examinations in patients with multiple thoracic trauma. 99 patients with mean age of 33.4±19.43 years were studied. 58 (60.4) of them were male. The characteristics of the people surveyed are listed in Table 1.

Results show that 15 (15.15%) patients with dyspnea, 29 (29.29%) with distracting pain, 69 (69.69%) with skin scraping, 15 (15.15) with chest tenderness, 8 (8.08 %) individuals with thoracic tenderness, 1 (1.01 %) with cryptography, 16 (16.16 %) with decreased lung sound, 79 (79.79 %) with chest pain, 3 (3.03 %) with pneumothorax, 7 (7.07 %) patients with hemoterax, 8 (8.08 %) with rib fracture, 18 (18.18 %) with pulmonary abnormal sounds, and 3 (3.03 %) with emphysema in x-ray. No one had emphysema.

According to Table 2, in the sensitivity and specificity of each of the vital signs tests in relation to pneumothorax, the highest sensitivity was due to chest skin scraping (66.67%) and was the most specific to abnormal lung sound (96.88%). The highest Positive and Negative Predictive Value was related to pulmonary sound Reduction (12.5% and 98.7%) and the highest Accuracy was finally to Pulmonary sound Reduction. In the case of hemothorax, the highest sensitivity to chest scraping (100%), the highest specificity to abnormal lung sound (98.89%), the highest Positive Predictive Value to chest tenderness (37.5%) and the highest Negative Predictive Value was pulmonary sound reduction (96.3%) and the highest Accuracy was finally related to abnormal pulmonary sounds (91.75%).

According to Table 3, evaluating the sensitivity and specificity of each of the vital signs tests, only the AUC analysis for pneumothorax was significant (P = 0.032). A heart rate above 98.5 was associated with a sensitivity of 17.6% and a specificity of 66.7% with pneumothorax. In the other cases, there was no statistical significance for sensitivity and specificity. AUC analysis was significant (P = 0.025) for hemotorax in case of diastolic blood pressure. Diastolic blood pressure below 70.5 was associated with a sensitivity of 46.9% and a specificity of 85.7% with hemothorax. AUC analysis was significant for hemotorax with respiratory rate per minute (P = 0.040). Breathing rates below 6.5 minutes were associated with 92.6% sensitivity and 57.1% specificity with hemothorax. In the other cases, there was no statistical significant difference for sensitivity and specificity.

Discussion:

Trauma is a major health problem in most developing societies and causes more deaths in people under 30 than other diseases (13). The patient's history helps determining the severity of the chest trauma. If there is a suspected history of a chest problem, a physical examination of the chest should go beyond the screening to determine the nature of the problem so that it can be diagnosed more correctly. There are findings of physical examination that increase suspicion to some differential diagnoses in the chest (14). Inflammation of the chest wall in the seat belt pattern, point sensitivity on the ribs, reduced respiratory sound in hemothorax, tachypnea, hypoxia, alone or with other symptoms are findings suggesting damage to chest. The mechanism of trauma should also be considered. If the mechanism has a high level of suspicion, an ECG should be performed to evaluate cardiac contraction. Breathing assessment and clinical examination of the chest (respiratory movements and breathing quality) are essential for the diagnosis of major chest injuries such as pneumothorax, open pneumothorax, chest compression, pulmonary congestion, and extensive bleeding. Observing, touching, listening, and especially auscultating to lung sound [90% sensitivity, 98% specificity (15)] provides information on the presence of tension pneumothorax (15). Clinical diagnosis of pneumothorax may require immediate intervention to reduce pressure from the pleural space via needle (16). Repeated examination is necessary to prevent the development of pneumothorax. Pneumothorax is the most common reversible cause of cardiac arrest in trauma patients. Repeated clinical examination along with Initial examination and the history of mechanism of chest trauma, provides information on the possible severity of chest injury (17). When the extent of trauma cannot be determined, contrast-enhanced CT scans are recommended (18). Because chest X-ray sensitivity in emergencies is only 58.3% (19). Chest ultrasound examination shows no sensitivity or specificity for pneumothorax diagnosis when compared to chest X-ray (20). Emergency ultrasound is a reliable method for pleural / pericardial effusion (21, 22).

The limitations of this study were not to evaluate the severity of trauma, the number of days of hospitalization; as well as need for artificial respiratory system and to determine the location, causes of surgical intervention.

Conclusion:

Regarding the results of this study, it can be demonstrated that proper and quick diagnosis and treatment and especially prevention of these injuries are important and due to the high incidence of chest trauma incidents,; by combining appropriate Physical Exam, X-ray and CT scan imaging techniques, It brings us high sensitivity and specificity in diagnosis.

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Tables and Charts:

Table 1: The characteristics of the people surveyed are listed.

Variable	Multiple trauma patients (n=99)
Age, mean (SD)	33.4 (19.43)
Sex (male), n (%)	58 (60.4)

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Trauma mechanism, n (%)	Motorcycle accident	11 (11.11)
	Car accident	43 (43.43)
	Falling down from higher than 3 meters	10 (10.10)
	Falling down without height	6 (6.06)
	pedestrian	12 (12.12)
	other	17 (17.17)

Table 2: Evaluation of sensitivity and specificity of physical examinations in the diagnosis of pneumothorax and hemotorax.

Statistic	**dyspnea**		**distracting pain**		**Scratches on the skin**		**chest tenderness**		**lung abnormal sounds**		**decreased lung sound**		**chest pain**	
pneumothorax	Value	95% CI	Value	95% CI	Value	95% CI	Value	95% CI	Value	95% CI	Value	95% CI	Value	95% CI
Sensitivity	33.33%	0.84% - 90.57%	33.33%	0.84% - 90.57%	66.67%	9.43% - 99.16%	0.00%	0.00% - 70.76%	0.00%	0.00% - 97.50%	66.67%	9.43% - 99.16%	33.33%	0.84% - 90.57%
Specificity	85.11%	76.28% - 91.61%	70.21%	59.90% - 79.21%	28.72%	19.86% - 38.98%	91.49%	83.92% - 96.25%	96.88%	91.14% - 99.35%	85.11%	76.28% - 91.61%	80.85%	71.44% - 88.24%
Positive Predictive Value	6.67%	1.32% - 27.54%	3.45%	0.69% - 15.42%	2.90%	1.31% - 6.29%	0	-	0	-	12.50%	5.31% - 26.68%	5.26%	1.05% - 22.50%
Negative Predictive Value	97.56%	94.71% - 98.89	97.06%	93.62% - 98.67	96.43%	84.08% - 99.28%	96.63%	96.42% - 96.82	98.94%	98.90% - 98.97	98.77%	94.16% - 99.75	97.44%	94.43% - 98.84

		%		%				%		%		%		%
Accuracy	83.51%	74.60% - 90.27%	69.07%	58.88% - 78.07%	29.90%	21.02% - 40.04%	88.66%	80.61% - 94.20%	95.88%	89.78% - 98.87%	84.54%	75.78% - 91.08%	79.38%	69.97% - 86.93%
hemothorax														
Sensitivity	42.86%	9.90% - 81.59%	28.57%	3.67% - 70.96%	100.00%	59.04% - 100.00%	42.86%	9.90% - 81.59%	0.00%	0.00% - 40.96%	57.14%	18.41% - 90.10%	28.57%	3.67% - 70.96%
Specificity	86.67%	77.87% - 92.92%	70.00%	59.43% - 79.21%	31.11%	21.77% - 41.74%	94.44%	87.51% - 98.17%	98.89%	93.96% - 99.97%	86.67%	77.87% - 92.92%	81.11%	71.49% - 88.59%
Positive Predictive Value	20.00%	8.39% - 40.57%	6.90%	2.15% - 19.95%	10.14%	8.95% - 11.48%	37.50%	15.21% - 66.74%	0		25.00%	12.69% - 43.33%	10.53%	3.27% - 29.05%
Negative Predictive Value	95.12%	91.08% - 97.38%	92.65%	88.55% - 95.35%	100.00%		95.51%	91.78% - 97.59%	92.71%	92.56% - 92.85%	96.30%	91.67% - 98.40%	93.59%	90.04% - 95.93%
Accuracy	83.51%	74.60% - 90.27%	67.01%	56.73% - 76.22%	36.08%	26.58% - 46.46%	90.72%	83.12% - 95.67%	91.75%	84.39% - 96.37%	84.54%	75.78% - 91.08%	77.32%	67.70% - 85.21%

Table 3 Sensitivity and Specificity of Vital Symptoms Related to pneumothorax and hemotorax.

	Variable	AUC	P-value	Cut-off	Sensitivity (%)	Specificity (%)
pneumothorax	Heart rate	0.135	0.*032*	98.5	0.176	0.667
	BPS	0.735	0.913	-	-	-
	BPD	0.712	0.701	-	-	-
	Respiratory rate	0.746	0.425	-	-	-
	O_2	0.512	0.581	-	-	-
	GCS	0.214	0.606	-	-	-
Homothorax	Heart rate	*0.681*	*0.117*	-	-	-
	BPS	*0.412*	*0.144*	-	-	-
	BPD	*0.243*	*0.025*	70.5	0.469	0.857
	Respiratory rate	*0.735*	*0.040*	6.5	0.926	0.571
	O_2	*0.302*	*0.096*	-	-	-
	GCS	*0.453*	*0.121*	-	-	-

BPS: Systolic blood pressure, BPD: Diastolic blood pressure, GCS: Glasgow Coma Scale

Formola :

The following formulas were used for statistical calculation.

$$PPV = \frac{sensitivity \times prevalence}{sensitivity \times prevalence + (1 - specificity) \times (1 - prevalence)}$$

$$NPV = \frac{specificity \times (1 - prevalence)}{(1 - sensitivity) \times prevalence + specificity \times (1 - prevalence)}$$

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