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Original Article

Effectivity of the Radiological Imaging Methods in the Prediction of the Neurological Loss Risk in Patients with Blunt Chest Trauma

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Keywords: Blunt chest trauma; computed tomography; hemothorax; neurological deficit; pneumothorax; X-ray;.

ABSTRACT

Objective: The study was aimed to investigate the diagnostic differences between X-ray and thorax computed tomography (CT) scan in patients with blunt chest trauma and to determine which radiological method and/or radiological diagnostic criteria are more effective and predictive to diagnose the hemothorax, pneumothorax, and neurological deficit.

Methods: The demographic and radiological imaging results of patients who had blunt chest trauma between April 2011 and December 2018 were analyzed. A total of 869 patients (male=548, female=321) were included in the study. Of the patients, 756 (87%) were assessed by a traffic accident and 113 (13%) by falling from a height. The findings of rib, sternum, and spine fractures, hemothorax, and pneumothorax detected on X-ray and/or thorax CT were evaluated.

Results: Rib fractures ($p<0.001$) and vertebra fractures ($p<0.001$) were detected much more in CT scans than in chest X-rays. ROC curve test revealed that vertebra fracture, hemothorax, and pneumothorax could predict the development risk of the neurological deficit. The logistic regression test results revealed that thorax CT imaging could be the best radiological examination method to be used to diagnose hemothorax ($p<0.001$) and pneumothorax ($p<0.001$) and to predict the development risk of the neurological deficit ($p<0.001$).

Conclusion: In cases with a rib fracture, hemothorax, and/or pneumothorax, advanced vertebral radiological imaging should be performed in order not to overlook vertebral fractures and to predict the development of neurological deficits. Therefore, a thorax CT scan may be the first choice to detect pathological findings in the thoracic vertebrae and other thoracic bone structures.

INTRODUCTION

Chest trauma is the third most common injury after head and extremity injuries in trauma patients. Blunt trauma is often the predominant mechanism of trauma and predominantly damages the nonmediastinal tissues of the chest.[1] The primary mortality rate from blunt chest trauma is between 15% and 25% and can significantly increase the overall mortality rate in the case of multiple injuries.

Thorax radiography plays an important role in the initial emergency examination of the chest trauma patient and facilitates the detection of tension pneumothorax, large volume hemothorax, and flail chest. However, computed tomography (CT) has established itself as the preferred imaging modality for evaluating multiple trauma patients. CT is widely available, rapid, offers the possibility of multiplanar and three-dimensional reconstruction, and identifies spine and lung parenchyma damage better. Thorax CT has been shown to alter patient management in up to 20% of cases with abnormal initial thorax radiographs.[2]

This study aimed to investigate the diagnostic differences between chest X-ray and thorax CT scan in patients with blunt chest trauma and to determine which radiological method and/or radiological diagnostic criteria are more effective and predictive to diagnose the hemothorax, pneumothorax, and neurological loss.

MATERIALS AND METHODS

This retrospective cohort study was approved by the Local Ethical Committee (No: E1-20-363, Date: February 27, 2020). The study was conducted according to the principles of the Helsinki Declaration. Written informed consent forms were obtained from all patients.

Patients

In this study, the demographic and radiological examination results of patients who had blunt chest trauma between April 2011 and December 2018 with an "Injury Severity Score" of 16 and above were analyzed.[3]

The patients included in the study were primarily grouped as follows:

- TRACT group (included patients who had a traffic accident, n=756),
- FFH group (composed of patients who fell from a height, n=113).

In addition, the patients were divided into three groups as follows:

- TRACT-out group (consisted of patients who had a traffic accident outside the vehicle, n=192),
- TRACT-in group (consisted of patients who had a traffic accident inside the vehicle, n=564),
- FFH group (composed of patients who fell from a height, n=113).

Patients with minor chest trauma, penetrating chest injury, blast or gun shoot injury, and patients with incomplete radiological evaluations and incomplete medical records were excluded from the study.

Materials

Any of the pretraumatic radiological reports of the patients were not taken into account in the study. Chest X-ray examination was performed in the first stage of the patients during their admission to the hospital. These images were obtained with the patient in the supine position and the anterior and posterior planes. Then, an assessment with thorax CT was performed as considered necessary by the emergency physicians, radiologists, and/or thoracic surgeons. Since thorax CT imaging is not routinely applied to all trauma cases, all cases included in the study were evaluated according to the thoracic anatomical location of the "Abbreviated Injury Scale (AIS)."[4,5] Sternum fracture, rib fracture, and vertebra fracture were evaluated according to this location system and serious traumas with AIS 3 and above were considered. The presence of the rib fracture, sternum fracture, vertebra fracture, hemothorax, pneumothorax, and neurological deficits was recorded in the study using the chest X-ray and thorax CT results of the patients who were documented before by a team consisting of radiologists, thoracic surgeons, neurosurgeons, and emergency doctors. Then, those radiological images of all patients were reevaluated and interpreted by two radiologists (A.O. and M.E.A.) who were blinded to the study data and patients.

Statistical analysis

Power analysis was applied to the study results using G-Power 3.1 software, and it was concluded that the number of patients included in the study formed a sufficient sample.

The Kruskal–Wallis test and Pearson's Chi-squared test were applied to compare nonparametric data between groups ($p<0.05$). In the statistical comparison of paired groups, the Mann–Whitney U test was applied ($p<0.05$).

Spearman's rho correlation test was used to determine correlations between parameters ($p<0.05$).

The direction and strength of the association between radiological findings and neurological deficit risks were quantified using odds ratio (OR) and their corresponding 95% confidence intervals (95% CI).

To determine the independent variables which could help to determine the treatment method (surgical/conservative treatment) to be applied to the patient and which could predict the mortality likelihood, the ROC curve test was applied ($p<0.05$).

The logistic regression test was applied to determine the best parameters to be able to make these decisions ($p<0.05$).

RESULTS

A total of 869 patients (male=548, female=321) were included in the study. The mean age of the patients was 37 (18–64) years.

TRACT and FFH groups

Of the patients, 756 (87%) were assessed by a traffic accident and 113 (13%) from falling from a height. Statistical analysis results revealed that rib fractures (χ^2=81.305, p<0.001) and vertebra fractures (χ^2=68.756, p<0.001) were detected more in thorax CT images than in chest X-ray images (Table 1). On the other hand, of patients with vertebrae fractures detected on chest X-ray, 45 had accompanying hemothorax, 44 had a pneumothorax, and 24 had neurological deficits. However, of patients with vertebrae fractures detected on thorax CT images, 116 patients had hemothorax, 107 had a pneumothorax, and 55 had a neurological deficit (Table 2). As a result, it was observed that hemothorax (χ^2=9.975, p=0.002) and pneumothorax (χ^2=4.848, p=0.028) developed approximately twice as much in patients who fell from a height, whereas no statistical difference was found between patients in terms of neurological deficit (Table 1).

At the end of the correlation analysis, the neurological deficit finding was positively correlated with the rib fracture detected on chest X-ray (r=0.072, p=0.033), vertebra fracture detected on chest X-ray (r=0.285, p<0.001), vertebra fracture detected on thorax CT (r=0.440, p<0.001), hemothorax (r=0.186, p<0.001), and pneumothorax (r=0.202, p<0.001). In addition, it was observed that there was a positive correlation between hemothorax and vertebra fracture detected on chest radiographs (r=0.263, p<0.001), vertebral fracture detected on thorax CT (r=0.479, p<0.001), and pneumothorax (r=0.311,

Table 1. Demographic and radiological findings of the TRACT group and FFH group

Variable			TRACT	FFH	χ^2	p
			n (%) Median (min–max)	n (%) Median (min–max)		
Age			36.50 (18–64)	40 (20–63)	–2.431*	0.015
Gender		Male	477 (54.9)	71 (8.2)	0.003†	0.957
		Female	279 (32.1)	42 (4.8)		
Rib fracture	Chest X-ray	No	553 (63.6)	81 (9.3)	81.305†	<0.001
		Yes	203 (23.4)	32 (3.7)		
	Chest CT	No	402 (46.3)	50 (5.8)		
		Yes	354 (40.8)	62 (7.1)		
Vertebra fracture	Chest X-ray	No	680 (78.3)	101 (11.6)	68.756†	<0.001
		Yes	76 (8.7)	12 (1.4)		
	Chest CT	No	581 (66.9)	68 (7.8)		
		Yes	175 (20.2)	44 (5.1)		
Hemothorax		No	618 (71.1)	78 (9.0)	9.975†	0.002
		Yes	138 (15.9)	35 (4.0)		
Pneumothorax		No	649 (74.7)	88 (10.1)	4.848†	0.028
		Yes	107 (12.3)	25 (2.9)		
Neurological loss		No	712 (81.9)	101 (11.6)	3.756†	0.053
		Yes	44 (5.1)	12 (1.4)		

*Mann–Whitney U test (p<0.05). †Pearson's Chi-squared test (p<0.05). min: Minimum; max: Maximum; n: Number of patients; χ^2: Chi-squared test; CT: Computed tomography; TRACT: TRACT group (included patients who had a traffic accident); FFH: FFH group (composed of patients who fell from a height).

Table 2. Demographic and radiological findings of patients with vertebra fracture

		Chest X-ray			Thorax CT		
		No	Yes		No	Yes	
		n (%)	n (%)	p	n (%)	n (%)	p
Gender	Male	494 (56.8)	54 (6.2)	0.728	417 (48.0)	131 (15.1)	0.211
	Female	287 (33.0)	34 (3.9)		232 (26.7)	89 (10.2)	
Hemothorax	No	653 (75.1)	43 (4.9)	<0.001	592 (68.1)	104 (12.0)	<0.001
	Yes	128 (14.7)	45 (5.2)		57 (6.6)	116 (13.3)	
Pneumothorax	No	693 (79.7)	44 (5.1)	<0.001	624 (71.8)	113 (13.0)	<0.001
	Yes	88 (10.1)	44 (5.1)		25 (2.9)	107 (12.3)	
Neurological loss	No	749 (86.2)	64 (7.4)	<0.001	648 (74.6)	165 (19.0)	<0.001
	Yes	32 (3.7)	24 (2.8)		1 (0.1)	55 (6.3)	

Pearson's Chi-squared test (p<0.05). n: Number of patients; CT: Computed tomography.

Table 3. Odds ratio test results and their corresponding 95% confidence intervals for the direction and strength of the association between the patients' data and neurological loss risk

Variable		Neurological deficit		95% CI			
		No	Yes	OR	Lower	Upper	p
Rib fracture on chest X-ray	No	600 (69.0%)	34 (3.9%)	1.82	1.04	3.19	0.035
	Yes	213 (24.5%)	22 (2.5%)				
Vertebra fracture on chest X-ray	No	749 (86.2%)	32 (3.7%)	8.78	4.88	15.80	<0.001
	Yes	64 (7.4%)	24 (2.8%)				
Vertebra fracture on chest CT	No	648 (74.6%)	1 (0.1%)	216.00	29.67	1572.39	<0.001
	Yes	165 (19.0%)	55 (6.3%)				
Hemothorax	No	667 (76.8%)	29 (3.3%)	4.25	2.44	7.40	<0.001
	Yes	146 (16.8%)	27 (3.1%)				
Pneumothorax	No	705 (81.1%)	32 (3.7%)	4.90	2.78	8.63	<0.001
	Yes	108 (12.4%)	24 (2.8%)				

Odds ratio test (p<0.05). OR: Odds ratio value; CI: Confidence intervals; CT: Computed tomography.

p<0.001). On the other hand, a positive correlation was found between pneumothorax and vertebra fracture detected on chest X-ray (r=0.326, p<0.001) and vertebra fracture detected on thorax CT (r=0.543, p<0.001).

Odds ratio test results revealed that if rib fracture was detected on X-ray images, it was associated with more than the onefold risk of neurological impairment (OR=1.82, p=0.035). In addition, if vertebra fracture was seen on X-ray images, it was associated with more than the eightfold risk of neurological impairment (OR=8.78, p<0.001). Moreover, if vertebra fracture was seen on CT images, it was associated with more than two hundred and sixty-fold risks of neurological impairment (OR=216.00, p<0.001), and when diagnosed with pneumothorax or hemothorax, it was associated with more than the fourfold risk of neurological impairment (OR=4.25, p<0.001 and OR=4.90, p<0.001, respectively) (Table 3 and Fig. 1).

As a result of the ROC curve analysis, for predicting the presence of hemothorax in patients, it was argued that the chest X-ray could be 26% sensitive and 94% specific (area=0.599, p<0.001), thorax CT imaging could be 67% sensitive and 85% specific (area=0.761, p<0.001), pneumothorax detection could be 38% sensitive and 90% specific (area=0.640, p<0.001), and the neurological deficit

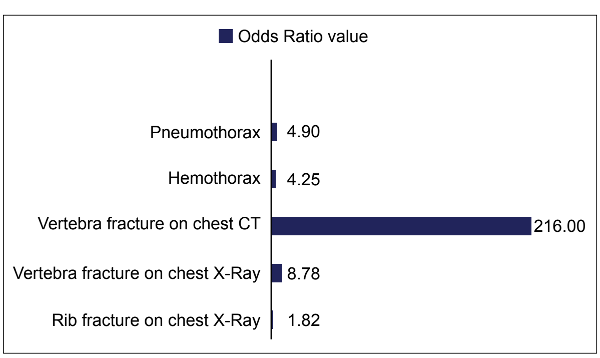

Figure 1. Odds ratio test plot showing the parameters that can be associated with neurological loss in all patients.

could be 16% sensitive and 94% specific (area=0.761, p<0.001), and it was assumed that they could be biomarkers.

In predicting the presence of pneumothorax, it was thought that chest X-ray could be 33% sensitive and 94% specific (area=0.637, p<0.001), thorax CT imaging could be 81% sensitive and 85% specific (area=0.829, p<0.001), detecting hemothorax could be 49% sensitive and 85% specific (area=0.651, p<0.001), and the neurological deficit could be 18% sensitive and 96% specific (area=0.569, p=0.011), and it was assumed that these could be predictive biomarkers.

On the other hand, chest X-ray could be 43% sensitive and 92% specific (area=0.675, p<0.001), thorax CT imaging could be 98% sensitive and 80% specific (area=0.890, p<0.001), detecting hemothorax could be 48% sensitive and 82% specific (area=0.651, p<0.001), and pneumothorax could be 43% sensitive and 87% specific (area=0.761, p<0.001) in predicting the development risk of the neurological deficits, and it was assumed that they could be used as predictive markers (Table 4 and Fig. 2).

The logistic regression test results revealed that thorax CT imaging could be the best radiological examination method to be used to diagnose hemothorax (B=2.450, Wald=160.153, p<0.001) and pneumothorax (B=3.163, Wald=167.276, p<0.001) and to predict the development risk of neurological deficit (B=5.397, Wald=28.333, p<0.001) (Table 4).

TRACT-out, TRACT-in, and FFH groups

When the patients were divided into three groups, it was seen that 192 (22.1%) of the patients were evaluated for out-vehicle traffic accidents, 564 (64.9%) for in-vehicle traffic accidents, and 113 (13%) for falling from a height. There was no statistical difference between the three groups in terms of rib fracture in chest X-rays and thorax CT images. However, there was a statistical difference among the groups in terms of vertebra fracture in thorax CT images

Table 4. ROC curve test results in predicting the neurological loss risk in patients with a traffic accident or a fall from a height

Variable		ROC curve test for neurological loss				
		Area	p	Cutoff value	Sensitivity	Specificity
Hemothorax	Vertebra fracture on chest X-ray	0.599	<0.001	Yes	26%	94%
	Vertebra fracture on chest CT	0.761	<0.001	Yes	67%	85%
	Pneumothorax	0.640	<0.001	Yes	38%	90%
	Neurological deficits	0.557	0.020	Yes	16%	94%
Pneumothorax	Vertebra fracture on chest X-ray	0.637	<0.001	Yes	33%	94%
	Vertebra fracture on chest CT	0.829	<0.001	Yes	81%	85%
	Hemothorax	0.673	<0.001	Yes	49%	85%
	Neurological deficits	0.569	0.011	Yes	18%	96%
Neurological loss	Vertebra fracture on chest X-ray	0.675	<0.001	Yes	43%	92%
	Vertebra fracture on chest CT	0.890	<0.001	Yes	98%	80%
	Hemothorax	0.651	<0.001	Yes	48%	82%
	Pneumothorax	0.648	<0.001	Yes	43%	87%

Variable		Logistic Regression test for neurological loss		
		B	Wald	p
Hemothorax	Chest CT	2.450	160.153	<0.001
Pneumothorax	Chest CT	3.163	167.276	<0.001
Neurological deficits	Chest CT	5.397	28.333	<0.001

ROC curve test and logistic regression test (p<0.05). CT: Computed tomography.

(χ^2=15.942, p<0.001), hemothorax (χ^2=10.015, p=0.007), and pneumothorax (χ^2=6.110, p=0.047) (Table 5).

In the TRACT-out group, there was a positive correlation between the presence of vertebra fracture on chest X-ray and the detection of hemothorax (r=0.276, p<0.001), pneumothorax (r=0.251, p<0.001), and neurological deficits (r=0.243, p=0.001). A positive correlation was found between the presence of spinal fracture in thorax CT and the detection of hemothorax (r=0.501, p<0.001), pneumothorax (r=0.497, p<0.001), and neurological loss (r=0.431, p<0.001). There was also a positive correlation between the detection of pneumothorax and the detection of neurological deficit (r=0.213, p=0.003). In the TRACT-in group, there was a positive correlation between spinal fracture on chest radiographs and the detection of hemothorax (r=0.291, p<0.001), pneumothorax (r=0.397, p<0.001), and neurological loss (r=0.363, p=0.001). A positive correlation was found between the detection of spinal fracture in thorax CT and the detection of hemothorax (r=0.458, p<0.001), pneumothorax (r=0.568, p<0.001), and neurological deficit (r=0.459, p<0.001). There was also a positive correlation between the detection of hemothorax and pneumothorax (r=0.332, p<0.001) and the detection of neurological deficit (r=0.190, p=0.003). There was also a positive correlation between the detection of pneumothorax and the detection of neurological deficit (r=0.226, p<0.001). In the FFH group, a positive correlation was found between gender and hemothorax (r=0.198, p=0.036). A positive correlation was found between the presence of spinal fracture in thorax CT and the detection of hemothorax (r=0.486, p<0.001), pneumothorax (r=0.493, p<0.001), and neurological loss (r=0.373, p<0.001). There was also a positive correlation between the detection of hemothorax and pneumotho-

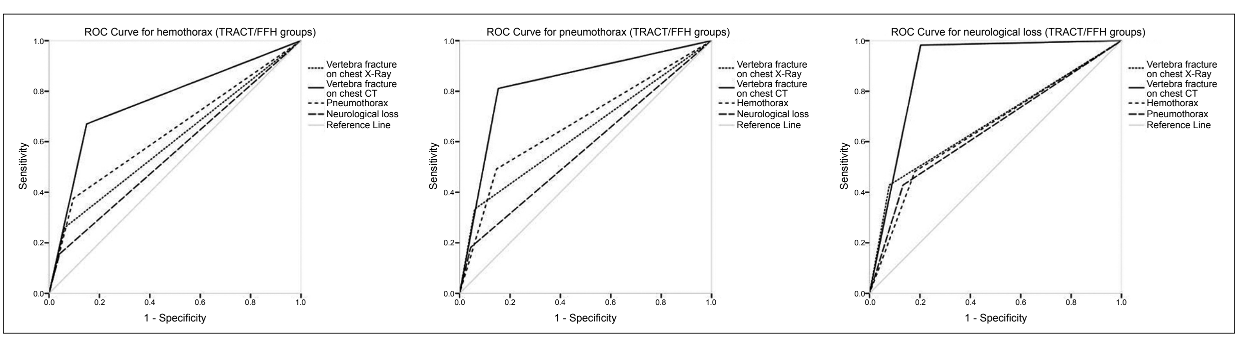

Figure 2. ROC curve analysis revealing the predictive parameter for the hemothorax, pneumothorax, and neurological loss in patients with a traffic accident or a fall from a height.

Table 5. Demographic and radiological findings of the TRACT-out, TRACT-in, and FFH groups

Variable			TRACT-out	TRACT-in	FFH	χ^2	p
			n (%) Median (min–max)	n (%) Median (min–max)	n (%) Median (min–max)		
Age			37 (19–64)	36 (18–64)	40 (20–63)	5.967*	0.051
Gender	Male		122 (14.0)	355 (40.9)	71 (8.2)	0.025†	0.988
	Female		70 (8.1)	209 (24.1)	42 (4.8)		
Rib fracture	Chest X-ray	No	150 (17.3)	403 (46.4)	81 (9.3)	3.338†	0.188
		Yes	42 (4.8)	161 (18.5)	32 (3.7)		
	Chest CT	No	111 (12.8)	290 (33.4)	51 (5.9)	4.810†	0.090
		Yes	81 (9.3)	274 (31.5)	62 (7.1)		
Vertebra fracture	Chest X-ray	No	178 (20.5)	502 (57.8)	101 (11.6)	2.191†	0.334
		Yes	14 (1.6)	62 (7.1)	12 (1.4)		
	Chest CT	No	138 (15.9)	442 (50.9)	69 (7.9)	15.942†	<0.001
		Yes	54 (6.2)	122 (14.0)	44 (5.1)		
Hemothorax		No	156 (18.0)	462 (53.2)	78 (9.0)	10.015†	0.007
		Yes	36 (4.1)	102 (11.7)	35 (4.0)		
Pneumothorax		No	160 (18.4)	489 (56.3)	88 (10.1)	6.110†	0.047
		Yes	32 (3.7)	75 (8.6)	25 (2.9)		
Neurological loss		No	179 (20.6)	533 (61.3)	101 (11.6)	4.142†	0.126
		Yes	13 (1.5)	31 (3.6)	12 (1.4)		

*Kruskal–Wallis test. †Pearson's Chi-squared test ($p<0.05$). min: Minimum; max: Maximum, n: Number of patients, χ^2: Chi-squared test; CT: Computed tomography; TRACT: TRACT-out group (consisted of patients who had a traffic accident outside the vehicle); TRACT-in group (consisted of patients who had a traffic accident inside the vehicle; ; FFH: FFH group (composed of patients who fell from a height).

rax (r=0.242, p=0.010) and the detection of neurological deficit (r=0.204, p=0.030).

DISCUSSION

The results of this study demonstrated that rib fractures and vertebra fractures were detected much more in thorax CT images than in chest X-rays. Vertebra fracture, hemothorax, and pneumothorax detected on X-ray and thorax CT could predict the development risk of the neurological deficit. The regression analysis revealed that a thorax CT scan could be the best radiological method for diagnosing hemothorax and pneumothorax and predicting the development risk of neurological deficit. With these results, it was concluded that in cases with a rib fracture, hemothorax, and/or pneumothorax, a thorax CT scan should be performed in order not to overlook vertebral fractures and the development risk of neurological deficits. Furthermore, it was supposed that CT evaluation may be the first choice to detect abnormalities due to trauma in the thoracic vertebrae and other thoracic bone structures.

Thoracic spine injuries account for 30% of all spinal traumas and are associated with neurological deficits in approximately 60% of cases.[2] The most common modes of injury are burst fractures, particularly wedge fractures and dislocation fractures of the lower thoracic spine.[2] Singh et al.[6] suggested that there may be a very strong relationship between thoracic spine fracture and pulmonary contusion, pneumothorax, and hemothorax and argued that the presence of these findings in a patient with multiple traumas should raise suspicion of the presence of a thoracic spine fracture. The primary goals of chest radiography are to promptly evaluate life-threatening findings such as tension pneumothorax.[1] However, studies have shown that treatment-determining thoracic injuries such as pneumothorax, rib fractures, sternum fractures, and lung contusion found on CT can often be overlooked in primary chest X-rays.[7–11] Therefore, CT has been established as a critical part of the initial evaluation of patients with blunt chest trauma.[1,12] The "Eastern Association for the Surgery of Trauma" and the "American College of Radiology" recommend CT as the modality of choice, whereas "Advanced Trauma Life Support" and the "National Institute for Health and Care Excellence" recommend plain films initially.[13–15]

Considering the results of the present study, it was thought that the incidence of spinal fracture, hemothorax, and pneumothorax was higher in patients who fell from height. When the findings of the chest X-rays were compared with the thorax CT imaging findings, it was seen that more patients were diagnosed with vertebral fractures using thorax CT imaging in all three groups. Thus, CT imaging was concluded to be superior to X-rays in the radiological evaluation of patients with blunt thoracic injuries.

As a result of the correlation analysis, it was thought that the possibility of detecting a neurological deficit might be higher in patients with a rib fracture and/or spinal fracture in chest X-ray images and patients with a spinal fracture in thorax CT images. Also, the possibility of developing hemothorax and/or pneumothorax would be high in patients with spinal fractures detected on chest X-rays and/or thorax CT images. It was observed that the probability of detecting neurological deficit would be high in patients with hemothorax and/or pneumothorax. Odds ratio analysis applied to the data of all patients revealed that the risk of detecting neurological deficits would increase in the condition that rib fractures and vertebral fractures are detected in the X-ray images. Also, it was predicted that the risk of the neurological deficit would increase when vertebral fractures are detected on CT images or when pneumothorax or hemothorax was detected.

At the end of the ROC analysis, it was thought that both chest X-ray and thorax CT imaging could be diagnostic materials in predicting hemothorax, pneumothorax, and neurological deficit. However, at the end of the logistic regression analysis, it was concluded that thorax CT imaging could be superior to X-ray imaging in predicting hemothorax, pneumothorax, and neurological loss. In addition, it was found that the detection of hemothorax and pneumothorax on chest X-rays and thorax CT images could be used as markers to predict neurological deficits. However, at the end of the logistic regression analysis, it was concluded that hemothorax and pneumothorax detected on thorax CT images could be the "best predictors" of the development risk of the neurological deficit. As a result, it was concluded that a thorax CT scan may be the best radiological method for both diagnosing hemothorax and/or pneumothorax and predicting the development risk of neurological deficit.

On the other hand, it was thought that the possibility of detecting neurological deficit would be high in patients who were brought in with an out-vehicle traffic accident when spinal fractures were detected on chest radiographs. Also, it was observed that the probability of the presence of a spinal fracture would be high in patients with hemothorax and/or pneumothorax detected by chest radiographs. Furthermore, it was seen that the probability of detecting spinal fracture and neurological deficit in these patients would be high when hemothorax and pneumothorax were detected on chest CT images.

The development risk of the neurological deficit in patients with pneumothorax would be high and also the possibility of detecting neurological deficit could be high in patients who were brought in with an in-vehicle traffic accident when rib fractures and/or spinal fractures were detected on chest radiographs. Furthermore, it was found that the possibility of hemothorax and/or pneumothorax would be high in patients with spinal fractures on chest radiographs. Also, it was observed that the probability of detecting hemothorax, pneumothorax, and neurological deficits in these patients would be high when spinal fractures were detected in thorax CT images.

According to the results of the present study, the probability of pneumothorax and/or neurological deficit is much higher in patients with hemothorax. No statistical correlation was found between the detection of rib and/or spinal fractures on chest X-rays and the detection of hemothorax, pneumothorax, and neurological deficits in patients brought in with a fall from a height. However, under the condition that hemothorax and pneumothorax were detected on thorax CT images, it was seen that the probability of detecting spinal fracture and neurological deficit in these patients would be high. Also, it was thought that the possibility of pneumothorax and/or neurological deficit would be high in patients with hemothorax.

This study had some limitations. First, the severity levels and anatomical locations of the pneumothorax and hemothorax in the patients and the levels of neurological losses were not included in this study because it was outside the scope of this study. In addition, postdiagnosis treatment processes and outcome and mortality rates were not analyzed in this study. Second, comorbidities that may affect the diagnosis and treatment modalities of patients were not included in this study. Finally, because of the retrospective property of this study, angiographic findings of vascular structures in the thoracic cavity could not be evaluated in this study.

CONCLUSION

The results of this study demonstrated that a thorax CT scan could be the best radiological method for diagnosing rib fracture, vertebra fracture, hemothorax, and pneumothorax and predicting the development risk of neurological deficit rather than chest X-rays. Therefore, it was considered that CT evaluation may be the first choice to detect abnormalities due to trauma in the thoracic organs, thoracic vertebrae, and other thoracic bone structures.

Conflict of Interest and Financial Disclosure Statements

The authors declare that they have no conflict of interest. They also declare that they have not engaged in any financial relationship with any company whose product might be affected by the research described or with any company that makes or markets a competing product.

Informed Consent

Informed consent was obtained from all individual participants or their parents who were included in this study.

Ethics Committee Approval

This study approved by the Ankara City Hospital Clinical Research Ethics Committee (Date: 27.02.2020, Decision No: E1/20/363).

Informed Consent

Retrospective study.

Peer-review

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Authorship Contributions

Concept: U.Y., I.A.; Design: U.Y., I.A., B.B.; Supervision: B.B.; Materials: O.O.Y., U.Y.; Data: I.A., E.C.; Analysis: O.O.Y., A.Ö., M.E.A., B.B.; Literature search: I.A., E.C.; Writing: U.Y., B.B.; Critical revision: U.Y., I.A., O.O.Y., B.B.

Conflict of Interest

None declared.

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Künt Göğüs Travması Olan Hastalarda Nörolojik Kayıp Riskinin Öngörülmesinde Radyolojik Görüntüleme Yöntemlerinin Etkinliği

Amaç: Çalışmamızda hemotoraks, pnömotoraks ve nörolojik kayıp teşhisinde künt göğüs yaralanmalı hastalarda akciğer grafisi ile toraks bilgisayarlı tomografisi (BT) arasındaki tanısal farklılıkların araştırılması, hangi radyolojik yöntem ve/veya radyolojik tanı kriterlerinin daha etkili ve öngörücü olduğunun belirlenmesi amaçlanmıştır.

Gereç ve Yöntem: Bu çalışmada Nisan 2011 ile Aralık 2018 tarihleri arasında künt göğüs travması geçiren hastaların demografik ve radyolojik görüntüleme sonuçları analiz edildi ve 756 trafik kazası hastasının (%87) ve 113 (%13) yüksekten düşme hastasının sonuçları çalışmaya dahil edildi. Hastaların akciğer grafisi ve toraks BT sonuçları incelenerek kaburga, sternum, omurga kırıkları ve nörolojik kayıpları, hemotoraks ve pnömotoraks bulguları değerlendirildi.

Bulgular: Bilgisayarlı tomografide kaburga kırığı ($p<0.001$) ve vertebra kırığı ($p<0.001$) direk grafiye göre daha fazla saptandı. ROC-Curve testi, röntgen ve toraks BT'de saptanan vertebra kırığı, hemotoraks ve pnömotoraksın nörolojik kayıp olasılığını öngörebileceğini ortaya koydu. Lojistik Regresyon testi sonuçları, toraks BT görüntülemenin hemotoraks ($p<0.001$) ve pnömotoraks ($p<0.001$) tanısında ve nörolojik kayıp ($p<0.001$) gelişme olasılığını öngörebilmede kullanılabilecek en iyi radyolojik inceleme yöntemi olabileceğini gösterdi.

Sonuç: Çalışma sonuçları kaburga kırığı, hemotoraks ve pnömotoraks olan olgularda vertebral hasarı gözden kaçırmamak ve nörolojik kayıp olasılığını öngörebilmek için ileri omurga radyolojik görüntüleme yöntemlerinin kullanılmasının gerekli olabileceğini gösterdi. Bu çalışmanın sonunda torakal vertebra ve diğer torakal kemik yapılarındaki travma sonrası patolojik bulguları saptamaya yönelik BT ile değerlendirmenin ilk seçenek olabileceği savunuldu.

Anahtar Sözcükler: Künt toraks travma; hemotoraks; nörolojik kayıp; pnömotoraks; toraks bilgisayarlı tomografisi; X-ray.