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Analysis of the Degree of Accuracy and Reliability of Emergency Medicine Residents in Interpreting Computed Tomography of the Abdomen

SÜMEYYE TUĞBA SARKI CANDER[1], Sule Akkose Aydin[1], Vahide Aslihan Durak[1], Murat Cetin[2], Deniz Sigirli[3]
[1]Department of Emergency Medicine, Bursa Uludag University Medical Faculty, Bursa, Turkey
[2]Department of First Aid and Emergency Medicine, Izmir Tınaztepe University Medical Faculty, Izmir, Turkey
[3]Department of Biostatistics, Bursa Uludag University Medical Faculty, Bursa, Turkey

Aim
In this study, we aimed to investigate the accuracy and reliability of emergency medicine residents in the interpretation of radiological investigation of patients with trauma, who received abdominal computed tomography in the emergency department.
Materials and Methods
We prospectively evaluated the reports of 200 patients who presented to the Emergency Medicine Department of a University Hospital with trauma, and who received abdominal computed tomography (CT) due to suspected abdominal pathology.
Results
In this study, 33% (66/200) of the patients were female and 67% (134/200) were male. CT scans of these 200 patients were examined by emergency medicine residents and radiology specialists. The results of the study showed that emergency medicine residents performed well in interpreting abdominal CT scans of patients with trauma with an agreement rate of 90.5%. Evaluation of the results obtained in our study suggested that emergency medicine residents generally performed well in interpreting abdominal CT scans of patients with trauma with suspected abdominal pathology in the emergency room.
Conclusion
The high rate of agreement may be associated with the fact that emergency medicine residents are usually the first physicians who meet and treat patients with trauma and thus have gained sufficient experience in this field.

Keywords: abdominal trauma, computed tomography, emergency department, emergency resident
Short Title in English: Emergency Medicine Residents in Computed Tomography

INTRODUCTION

While the extent and workload of emergency services increase every single day, the choice for easily accessible and effective examinations becomes very important in-patient management. It is observed that laboratory tests and imaging performed in the emergency department account for more than 40% of the total cost (1).

More than 11 million people die every year in the world and approximately 8% of the total deaths are due to trauma. The mortality rates of patients with abdominal trauma varied between 12.6% and 21.3%, where the spleen and liver were reportedly the most frequently injured organs (2).

Computed tomography (CT) has emerged as the main imaging method for evaluating patients with multiple trauma subsequent to the introduction of Multi-Slice Computed Tomography (MSCT) (3). MSCT has been incorporated in the current trauma imaging protocol because of its widespread accessibility and adoption (3). In major intraabdominal injuries, the sensitivity and specificity of MSCT are 97%–98% and 97%–99%, respectively (4).

Although interpretation of abdominal CT is a critical issue during emergencies, there are limited number of studies that have analyzed the reliability and accuracy of interpretations of abdominal CT images performed by emergency medicine residents (EMRs). The purpose of our study is to investigate the accuracy and reliability of EMRs with respect to interpretation of CT scans of patients with trauma, who underwent abdominal CT in the emergency room.

MATERIALS AND METHODS

This study was approved by the Clinical Research Ethics Committee of Medical Faculty, dated March 25, 2019 with approval number 2019-6/8. In this study, we included patients with trauma, above 18 years of age, who presented to the Emergency Department between April 4, 2019 and October 4, 2019 and who underwent abdominal CT due to suspected abdominal pathology.The Focused Assessment with Sonography for Trauma (FAST) scans of the patients were performed by the emergency medicine residents first and the patients who were with suspected abdomen pathologies and need further CT evaluation were included in this study. Also, the trauma patients who were under 18 years and pregnant were excluded from the study.

We compared the abdominal CT image interpretations performed by EMRs who had work experience of 2 years with the CT results that were edited and approved by radiologists. We evaluated CT images (coronal, axial, and sagittal sections) of the patients' abdomen using the Picture Archiving and Communication Systems from the monitors in the emergency department.

The presence of pathology in the examination was considered as "pathology exists." The findings of liver laceration, liver hematoma, splenic laceration, splenic hematoma, kidney injury, intraabdominal free fluid, intraabdominal free air, vascular injury, fracture in bone fragments were evaluated separately and recorded as "pathology exists" or "pathology does not exist."

We evaluated the consistency between the two interpretations by comparing the CT interpretation performed by EMRs with the official radiology report after the data recording process. While the results that either EMRs or radiologists evaluated as "pathology exists" and the other as "pathology does not exist" were considered inconsistent, the evaluations made by both the EMRs and radiologists as "pathology exists" or "pathology does not exist" were evaluated as consistent.

Statistical analysis

We used the Shapiro-Wilk test for variables that were suitable for normal distribution. Variables that did not conform to normal distribution were given median (minimum–maximum) values. Categorical variables were given frequency and percentage values (n (%)). McNemar test was used to evaluate the agreement between the

determinations of the radiologist and the EMRs, and sensitivity, specificity, positive predictive value, and negative predictive value criteria were provided. IBM SPSS Statistics 23.0 program was used for statistical analyses. Significance level was considered as $\alpha = 0.05$.

RESULTS

During the six-month period, 33% of the patients who received abdominal CT due to suspected abdominal pathology were female and 67% were male. The median age of the traumatic cases was 40 (minimum–maximum: 19–92) years.

In the study, the most common cause of trauma mechanisms (37%) was the in-vehicle traffic accident. Other common causes of trauma mechanism were falls (32.5%) and motorcycle accident (12.0%). Table 1 shows the distribution of patients according to trauma mechanisms. While 50.5% of the patients with abdominal trauma who presented to the emergency service ended with discharge, there was no case of mortality (Table 1).

We reviewed the consistency between the interpretation of the abdominal CT reports performed by EMRs and radiologists. It was seen that 2 of the 3 patients with splenic hematoma (66.7%) reported by the radiologist as having pathology were evaluated by the EMR physicians as "pathology exists", whereas 193 (98%) of the 197 patients reported by the radiologist as having no pathology were evaluated as "pathology does not exist" by the EMRs. There was a significant agreement between the EMRs and radiologists in terms of splenic hematoma detection ($p = 0.375$). Regarding splenic laceration, while the EMRs detected pathology in 7 of the 8 patients (87.5%) that the radiologist suggested pathology, EMRs considered "pathology does not exist" in 190 (99%) of the 192 patients that the radiologist reported no pathology. Therefore, there was a statistically significant agreement between radiologist and EMRs in detecting splenic laceration ($p = 1.000$). There was a significant agreement between the interpretation performed by EMRs and radiologists with regards to liver hematoma ($p = 0.219$), kidney injury ($p = 0.250$), intraabdominal free fluid ($p = 0.057$), intraabdominal free air ($p = 1.000$), and fracture detection in bone fragments ($p = 1.000$) when there was a meaningful fit. However, there was no significant agreement between the interpretations in terms of liver laceration ($p = 0.022$). Regarding vascular injury, the p-value could not be calculated, as there were no patients with positive pathology detection by EMR or radiologists. Among the 200 patients included in the study, there was no patient with pancreatic injury, and ureter and bladder injury (Table 2).In each subgroup, upon calculation of the sensitivity, specificity, positive predictive value, and negative predictive value criteria of evaluations performed by EMRs against the evaluations of radiologists, it was observed that the highest values were calculated for the determination of intraabdominal free air (Table 3).

In the present study, among all the patients presenting with abdominal trauma, the number of patients with at least one pathology as detected by the radiologists was 62, 54 of them were also detected by EMRs and the sensitivity of EMRs in detecting abdominal pathology was 87%. The number of patients with no pathology detected by radiologists was 138, and 127 of them were found to have no pathology by EMRs as well. The specificity of EMRs for abdominal pathology was 92%. There was a significant agreement between the CT comments made by the EMRs and the radiologists ($p = 0.648$) (Table 4).

DISCUSSION

Intervention and transfer to a hospital are of great significance for the survival of patients with trauma. In a study conducted by Pekdemir et al. in 1997, 90.8% of the patients presented to the emergency department using a vehicle other than an ambulance (5). In the present study, it was noted that 28% (56) of the patients presented to the emergency department trauma unit as outpatients and 72% (144) were brought in by ambulance. In our study, the rate of admission using an ambulance is higher. This may be associated with the fact that trauma patients generally prefer ambulance service for hospital admission and that they are not well enough to present as outpatients following in/off-vehicle traffic accidents. The development of emergency health services has also led to an increase in the number of admissions via ambulance.

In our study, a review of trauma etiologies of the patients showed that the most frequent causes were the in/off-vehicle traffic accidents (44%) and falls (32%), whereas the least frequent cause was tractor accidents (1.5%). In a study conducted by Durdu et al., the frequency of trauma etiologies were found as traffic accidents (58.6%), falling from height (14.9%), assault (11.9%), work accident (9.6%), stab wounds (4.8%), and firearm injuries (0.9%) (6). In a study conducted by Bingöl et al., 61.4% of the patients presented following a traffic accident and 22.4% after a fall from height (7). In a study conducted by Champion et al. on patients with multiple trauma, 49.1% of the admissions were due to traffic accidents, 16.5% due to fall from height, 10% due to gunshot wounds, and 9.5% due to stab wounds (8). In this respect, the results of our study are consistent with other studies in the literature.

In a study conducted by Gönültaş et al. (9), the mean age of patients who presented to the emergency department with abdominal trauma was 36.08 ± 16.1 years, and 90 out of the total 113 patients were men. Further, 80 patients (70.8%) had blunt abdominal trauma, 28 patients (24.7%) had isolated liver, and two patients (1.7%) had splenic injury. In a study conducted by Makay et al. (10) on patients with abdominal trauma, 82.6% of the patients with a mean age of 33.4 ± 12 years were male and 17.4% were female. It was observed that 50.7% of the patients were

exposed to blunt trauma, whereas 49.3% had penetrating trauma. In patients with penetrating trauma, stab wounds were the most common (31.4%), whereas blunt trauma was most common due to traffic accidents (42%). In the present study, the number of patients exposed to blunt trauma was found to be much higher, whereas the number of patients exposed to penetrating trauma was less when compared with other studies. However, the number of male patients was higher among the patients admitted to the emergency department with abdominal trauma, as seen in other studies.

Studies investigating the consistency in radiographic interpretation between EMRs and radiologists are available in the literature. Bagheri-Hariri et al. (11) compared abdominopelvic CT interpretations performed by emergency physicians with radiology reports to evaluate the success of abdominopelvic CT interpretation of emergency physicians and found that emergency physicians were successful in interpreting abdominopelvic CT results ($p < 0.0001$). A similar study conducted by Güven et al. (12), found the sensitivity of emergency physicians in detecting non-traumatic abdominal pathologies between 60%–80%, while the specificity was found to be above 95%. In the present study, there was a statistically significant consistency between the interpretations of radiologists and EMRs with regards to interpretation of splenic hematoma ($p = 0.375$), laceration ($p = 1.000$), liver hematoma ($p = 0.219$), detection of kidney injury ($p = 0.250$), intraabdominal free fluid detection ($p = 0.057$), intraabdominal free air detection ($p = 1.000$), and fracture detection in bone fragments ($p = 1.000$). There was no statistically significant agreement between radiologists' and EMRs' detection of liver laceration ($p = 0.022$). In our study, 90.5% agreement was found between the CT comments made by EMRs and radiologists in patients presenting with abdominal trauma ($p = 0.648$). Accordingly, the sensitivity of EMRs in detecting pathologies in abdominal CT was found to be 87%, whereas the specificity was calculated as 92%.

According to the results of our study, we can conclude that there is no statistically significant agreement ($p = 0.022$) between the interpretation of radiologists and EMRs regarding liver laceration. In the present study, 14 out of the total 200 patients had liver laceration according to the radiologists' final report, whereas 12 of them were considered as "pathology exists" by EMRs. One of the two patients, who was considered as "pathology does not exist" by EMRs was referred to intensive care, while the other patient was hospitalized in the relevant clinic. Since the patient admitted to the intensive care had splenic laceration, he underwent a splenectomy. The patient was transferred to the clinic after 5 days of intensive care hospitalization and was discharged after 2 days of clinical hospitalization. The other patient who was admitted to the relevant clinic did not develop any complications after clinical follow-up and was thus discharged. There was no report of adverse effect of mortality in the two patients whose pathology was not observed by EMRs.

In a study performed by Mucci et al. (13) investigated the consistency of EMR evaluations with expert radiologist reports in cranial CT results of 100 patients with trauma and suggested an 86.6% agreement between EMR evaluations and radiologist reports. Kang et al. (14) in their study investigated the accuracy of interpretations performed by EMRs and radiology residents' of abdominal CT images in patients with nontraumatic abdominal pain and found a consistency of 83.3% between the EMRs' evaluations and official radiology reports. In the present study, the consistency between EMRs, who have completed 2 years in service, and the final report of the radiologists was examined and a better consistency level was found (90.5%) compared to the relevant studies in the literature.

Although abdominal CT interpretation is an important skill, there are limited number of studies in the literature that have analyzed the ability of EMRs to interpret abdominal CT images and the accuracy of such interpretations. Therefore, our study is one among the limited number of studies.

LIMITATIONS

The fact that interpretation performed by EMRs of vascular injuries was 0% in our study could be because vascular injuries are rare and are more difficult to interpret on CT images. Recognition of vascular injuries based on CT images requires more expertise and experience, and EMRs would need to improve themselves in this regard. We suggest planning a detailed emergency medicine education in this regard.

CONCLUSIONS

A general evaluation of the results obtained in our study suggests that EMRs had an overall good performance in interpreting the patients presented to the emergency department with trauma, who had undergone abdominal CT for suspected abdominal pathology. The reason for high rate of agreement can be explained by the fact that EMRs are usually the first physicians who meet and treat patients with trauma.

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TABLES

Table 1. Distribution of patients according to trauma mechanisms

Mechanism	n	%
Fall	65	32.5
In-vehicle traffic accident	74	37.0
Off-vehicle traffic accident	14	7.0
Motorcycle accident	24	12.0

Stab wounds	4	2.0
Blunt trauma	16	8.0
Tractor accident	3	1.5
Total	200	100

Table 2. Comparison of EMRs' and Radiologists' interpretations of abdominal CT images by subgroups

EMR		Radiology		p-value
		Pathology exists	Pathology does not exist	
Splenic hematoma	Pathology exists	2 (66.7)	4 (2.0)	0.375

	Pathology does not exist	1 (33.3)	193 (98.0)	
Splenic laceration	Pathology exists	7 (87.5)	2 (1.0)	1.000
	Pathology does not exist	1 (12.5)	190 (99.0)	
Liver hematoma	Pathology exists	6 (85.7)	5 (2.6)	0.219
	Pathology does not exist	1 (14.3)	188 (97.4)	
Liver laceration	Pathology exists	12 (85.7)	11 (5.9)	0.022
	Pathology does not exist	2 (14.3)	175 (94.1)	
Kidney injury	Pathology exists	2 (40.0)	0 (0.0)	0.250
	Pathology does not exist	3 (60.0)	195 (100.0)	
Intraabdominal free fluid	Pathology exists	2 (15.4)	3 (1.6)	0.057
	Pathology does not exist	11 (84.6)	184 (98.4)	
Intraabdominal free air	Pathology exists	1 (100.0)	0 (0.00)	1.000
	Pathology does not exist	0 (0.00)	199 (100.0)	
Fracture	Pathology exists	33 (97.1)	0 (0.00)	1.000
	Pathology does not exist	1 (2.9)	199 (100.0)	
Vascular injury	Pathology exists	0 (0.00)	-	-
	Pathology does not exist	0 (0.00)	-	

Data are provided as n (%) values. The p-value is from the McNemar test. EMR; Emergency Medicine Resident

Table 3. Sensitivity, descriptiveness, PPD, and NPD criteria of EMRs in detecting abdominal pathologies

Pathologies	Sensitivity	Specificity	PPD	NPD
Splenic hematoma	0.67	0.98	0.33	0.99
Splenic laceration	0.88	0.99	0.77	0.99
Liver hematoma	0.86	0.97	0.54	0.99
Liver laceration	0.86	0.94	0.52	0.98
Intraabdominal free fluid	0.15	0.98	0.40	0.94
Intraabdominal free air	1.00	1.00	1.00	1.00
Kidney injury	0.40	1.00	1.00	0.98
Fracture in bone fragments	0.97	1.00	1.00	0.99

PPD: positive predictive value, NPD: negative predictive value

Table 4. Comparison of EMRs and radiologists by comparison of abdominal CT evaluations

Consistency	Radiologist			p-value
EMR	Exists	Does not exist	Total	
Exists	54 (87.1)	11 (8.0)	65 (32.5)	0.648
Does not exist	8 (12.9)	127 (92.0)	135 (67.5)	
Total	62	138	200 (100.0)	

Data are provided as n (%) EMR; Emergency Medicine Resident