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Review Article

EMERGENCY MEDICINE SERVICE CAN INTERPRET ABDOMINO-PELVIC CT SCANS WITH CLOSE TO THE SAME ACCURACY AS RADIOLOGY SERVICE

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Abstract

Background: Interpreting abdomino-pelvic Computed Tomography (CT) scanning is substantially important in clinical decision making for emergency medicine (EM) physicians in Emergency department, where radiologist's report is not available all the time. The current research aimed to determine the diagnostic accuracy of EM physicians in the interpretation of abdomino-pelvic CT scan in trauma patients.

Material and Methods: This observational study carried out at a teaching hospital in 2018. The results of abdomino-pelvic CT scans of patients admitted to Emergency Department with abdomino-pelvic trauma, interpreted by EM and radiology physicians were compared. Sensitivity, specificity, positive and negative predictive values and the diagnostic accuracy of EM service interpretation were calculated. kappa coefficient (κ) was obtained to examine the level of concurrence.

Results: A total of Six hundred ninety-nine patients (mean age 34.54; 11% female, %89 male) enrolled. Totally, 183 positive (abnormal) findings were reported by EM physicians, including 170 true positive and 13 false positive. Out of 516 negative reporting, 494 were true negative and 22 were false negative. The sensitivity, specificity, accuracy, positive and negative predictive values of emergency medicine service interpretation were %88.54, %97.44, %95.00, %92.90, and %95.74, respectively. A high agreement level was found between interpretation of EM and radiology services.

Conclusion: The results showed that EM physicians' qualification on of abdomino- pelvis CT scan interpretation is considerable, and they can act on their own judgment and independent from radiologist report, when they are not available. Yet, because of some misinterpretation, more systematic training of abdomino-pelvis CT scan interpretation is needed to optimize the accuracy of the EM physicians.

Keywords: Trauma, Computed Tomography, Emergency Medicine, Radiology.

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INTRODUCTION

Abdominal trauma is a major cause of morbidity and mortality, making it the third trauma result in death. So that, about 13-15% of life-threatening traumas are due to the abdominal trauma (1,2). According to a report by the Institute for Health Assessment and Evaluation (IHME), multiple traumas can cause severe disability to around 50 million people each year worldwide (2). This injury is very common in emergency department patients, and early detection of intra-abdominal injuries in some patients can be challenging, especially in the case of apparently minor trauma or normal clinical examination (3,4). The actual incidence of the abdominal trauma is not clear, but according to the studies, blunt abdominal trauma accounts for about 80% of abdominal injuries in the emergency department (ED) (2,5). Moreover, missed abdominal visceral injuries followed by blunt abdominal trauma are the most prevalent cause of death among these patients, and also one of the leading causes of medico-legal issues (2). The most commonly injured organs are spleen and liver in blunt abdominal trauma, and small and large intestine, and liver in penetrating abdominal trauma, respectively. Intra-abdominal hemorrhage and out of sight injuries are the principal cause of death among abdominal trauma patients, especially in victims who have survived in first hours of resuscitation. (6). In many cases, diagnosing intra-abdominal injuries is difficult, because the simultaneous injuries, making the patient clinical examination unreliable (7,8). Abdominal CT scanning with iv contrast is the gold standard study for diagnosis of abdominal injury, with maximum sensitivity and specificity (97 to 98 percent, respectively) (8,9). It can define the injured organ and the extend of injury. CT scan can also detect retroperitoneal injuries which are not diagnosable in other modalities like FAST (Focused Assessment with Sonography for Trauma) exam and DPL (diagnostic peritoneal lavage), while at the same time evaluating vertebral column and soft tissue (9). Emergency Medicine (EM) specialists are frontline of managing the trauma patients whom prompt and accurate diagnosis of possible injuries is crucial. They play a vital role in surviving these patients, and improving their capabilities in the field of trauma management, can play a significant role in reducing trauma mortality and health care system cost (10-12). Initial management of the trauma patient is directed at identification of life-threatening injuries. While crowded and stressful environment of emergency department making this a challenging responsibility, EM physician's make initial patient management decisions on the basis of their own interpretations of radiographic studies, including abdomino-pelvic CT scans, because radiologists are not usually available for CT scan reporting. Therefore, it is necessary for emergency physicians to optimize their skill at CT scan interpretation. Regarding all this issue, the current study set out to evaluate the diagnostic accuracy of EM physicians in determining intra-abdominal pathologies following abdominal trauma.

MATERIAL AND METHODS

Study Design and Ethical Issues

This observational retrospective study performed in the ED of Firoozgar Hospital, as one of the teaching hospitals affiliated to Iran University of Medical Science in 2018. It was conducted to examine the diagnostic accuracy of EM specialist compared with the radiology specialist regarding traumatic intra-abdominal injuries. The documented interpretations of EM physicians in patients' medical record were compared to subsequent formal reports of radiologist. The study was approved by Ethics Committees of Iran University of Medical Sciences (IUMS).

Inclusion and exclusion criteria

Inclusion criteria were every patient aged above 18, with penetrating or blunt abdomino-pelvic trauma, who is undergoing abdominal-pelvic CT with iv contrast. Exclusion criteria included incomplete medical records, including loss of documented CT interpretation by EM physician or aged younger than 18.

Study Participants and Implementation

Between January 2018 to October 2018, 730 patients referred to ED of firoozgar hospital with abdomino-pelvic trauma and undergone CT scan with IV contrast as a part of their management. Among them, 699 met the inclusion criteria and included in the study. The patients' medical record and the EM physician interpretations of abdomino-pelvic CT scanning were reviewed. All the EM physician's interpretation of CT scan was documented immediately after it was done, because of the need to prompt decision making. According to our hospital insurance system protocol, all CT scans will be reported by radiologist 2-3 days later and will be documented in patients' medical record.

The study attempted to include all abdomino-pelvic CT scans obtained in the ED because of abdominal or poly trauma trauma. According to our exclusion criteria, If the patients' medical record missed the EM physicians' documented interpretation, the case did not include in the study, but if a radiologists' report was missed, the CT scan was sent to the radiology department for formal reporting. The reports of radiology specialist were considered as a standard criterion. Nine important pathology of abdomino-pelvic CT scan in trauma: spleen hematoma and laceration, liver laceration and hematoma (subcapsular, parenchymal), renal injury, hemoperitoneum, retroperitoneal hemorrhage, musculoskeletal injury was reviewed. Data was entered in the predesigned checklist of these nine pathologies (+/-), with two distinct rows for each EM physician and radiologist reports.

Finally, the comparison was made between positive and negative findings of EM specialists, that were provided in the ED, and the subsequent reports of radiology specialist. If the positive and negative findings between the emergency physician and the radiologist matched, the readings were considered concordant. Considering radiologist report as gold standard, false and true negative, false and true positive findings were also calculated.

Data Analysis

Data were analyzed using SPSS v22 software (SPSS Inc., Chicago, IL). The interpretation of radiologist (standard criterion) and EM specialist was compared to obtain the agreement coefficient (kappa) value. Sensitivity, specificity, positive and negative predictive values were computed according to the related formula. Statistical significance was defined as $P < 0.05$.

RESULTS

Six hundred ninety-nine patients, who had both interpretations of EM specialist and reports of radiologist, participated in the study. The mean age of patients was 34.54 ± 9.12, including 79 women (%11) and 620 men (%89). The distribution of patients consisted of 27% above forty years old and 73% under forty years old. The mentioned statistics showed that the abdominal trauma incidence was more among young men ($p<0.001$).

Table 1: Demographic parameters of the study

Group / Age and Gender					**P value**
age average	34.54 ± 9.12		above forty	under forty	
Sexual abundance	men	%89	27%	73%	(p<0.001).
	women	%11			

The most positive finding (pathologies) were musculoskeletal injury (53), liver parenchymal hematoma (29), hemoperitoneum (27) respectively. The positive findings of other parts included liver subscapular hematoma (15), spleen hematoma (13), liver laceration (12), spleen rupture (11), renal injury (5) and retroperitoneal hemorrhage (1). Pancreas injury had 1 positive finding and there was not any report about vascular injury (Table 2).

Table 2: Pathological parameters of the study

	Type of injury	**Abundance (True positive)**
pathologies	musculoskeletal injury	(53)
	liver parenchymal hematoma	(29)
	hemoperitoneum	(27)
	Liver subscapular hematoma	(15)
	spleen hematoma	(13)
	liver laceration	(12)
	spleen rupture	(11)
	renal injury	(5)
	Retroperitoneal hemorrhage	(4)

In terms of trauma type, 7 individuals (1%) were with penetrating trauma, of whom there were 6 positive reported findings and 692 (%99) patients admitted due to blunt abdomino-pelvic trauma (Table 3).

Table 3: Type of trauma and Abundance

	Type of trauma	Abundance
Trauma type	penetrating trauma	7 (1%)
	abdomino-pelvic trauma	692 (%99)

Out of Six hundred ninety-nine patients, 183 positive findings (pathologies) were reported by EM physicians in CT scans, of which, 170 cases were true positives and 13 were false positives, and of the 516 negative reports, 494 cases were true negatives and 22 were the false negatives. According to the above results, the sensitivity, specificity, accuracy, positive and negative predictive values were 88.54%, 97.44%, 95.00%, 92.90%, and 95.74, respectively. The high agreement value (κ= 0.881) were obtained for the interpretation of two radiology and EM physicians.

According to the study findings in terms of injury type, there was 16 spleen hematomas including 13 true positives, 3 false positives, 681 true negatives and 2 false negative reports. Sensitivity, specificity, positive and negative predictive values and accuracy of EM physician reports in terms of spleen hematoma were 86.67%, 99.56%, 81.25%, 99.71% and 99.28% respectively. The kappa coefficient was 0.836%. It was reported that there were 13 positive findings including 11 true positives, 2 false positives, and 686 negative findings were found including 685 true negatives and 1 false negative about spleen rupture. Sensitivity, specificity, positive and negative predictive values and accuracy of EM physicians were calculated as 91.67, 99.71, 84.62, 99.85 and 99.57, respectively. The agreement coefficient was 0.878.

Liver parenchymal hematomas were reported in 31 EM interpretations. From them, 29 were true positive and 2 were false positives. Out of 668 negative findings, 664 were true negatives and 4 false negatives. Sensitivity, specificity, positive and negative predictive values and accuracy of EM physicians were 87.88, 09.70,93.55,99.40,99.14 respectively. Concordance rate (kappa coefficient) was 0.807.

Liver subcapsular hematomas were reported in 18 patients, from them, 15 were true positive and 3 were false positives. Out of 681 negative findings, there were 677 true negatives and 4 false negatives. Sensitivity, specificity, positive and negative predictive values and accuracy of EM physicians were 78.95, 99.56, 83.33, 99.41 and 99.00 respectively. Moreover, the concordance rate (kappa coefficient) was 0.807.

The EM physicians reported 14 cases of liver laceration, containing 12 true positives, 2 false positives, 682 true negatives, and 3 false negatives. Sensitivity, specificity, positive and negative predictive values and accuracy of EM interpretations were 80.00, 99.71, 85.71, 99.56 and 99.28 respectively. The concordance rate (kappa coefficient) was calculated as 0.807.

Renal injury was reported in 5 EM interpretations, which all were true positive. Out of 694 negative findings, 1 was false negatives. Sensitivity, specificity, positive and negative predictive values and accuracy of EM physicians were 88.33,100,100, 99.86 and 99.86 respectively. Concordance rate (kappa coefficient) was 0.908.

Among 27 hemoperitoneum diagnosed by EM physicians, all the cases were true positive. 672 negative cases were recorded which all of them were true negative. Sensitivity, specificity, positive and negative predictive values and accuracy of EM physicians were all 100.00. The concordance rate (kappa coefficient) had the highest value, equal to 1.0.

Five positive findings including 4 true positives and 1 false positive, and 694 negative findings including 691 true negatives and 3 false negatives were reported based on retroperitoneal hemorrhage. Sensitivity, Specificity, positive and negative predictive values, and accuracy of EM physicians were computed as 57.14, 99.86, 80.00, 99.57, and 99.43, respectively. Kappa was 0.665.

The most prevalent injuries were musculoskeletal and 53 musculoskeletal injuries were reported. They included 53 true positives, 0 false positive, 642 true negatives and 4 false negatives. Sensitivity, specificity, positive and negative predictive values, and accuracy of EM physicians were 92.98, 99.38, 100 and 99.43, respectively. The agreement value (kappa coefficient) was computed as 0.961.

The results have been shown in Table 4 and 5. Our study shows significant overall agreement between EM physician and radiologist reporting of abdomino pelvic CT scan finding with high concordance rate. (κ= 0.881). The highest concordance rate was associated with musculoskeletal injuries, liver parenchymal hematomas, and renal injuries (κ> 0.9), and the lowest agreement was observed in retroperitoneal hemorrhage (κ= 0.665).

Table 4. Sensitivity, specificity, positive and negative predictive values, and accuracy of EM physicians

Parameters	Total	spleen hematoma	spleen rupture	Liver parenchymal hematoma	Liver subcapsulr hematoma	L. laceration	Renal injury	hemoperitoneum	Retroperitoneal hemorrhage	Musculoskeletal
Sensitivity	88.54 %,	86.67%,	91.67	78.95	78.95	80.00	8.33	100.00	57.14	92.98
Specificity	97.44 %	99.56%,	99.71	99.56	99.56	99.71	100	100.00	99.86	99.38
Positive predictive value	95.74	81.25%,	84.62	83.33	83.33	85.71	100	100.00	80.00	100
Negative predictive value	92.90 %,	99.71%	99.85	99.41	99.41	99.56	99.86	100.00	99.57	96.23

Accuracy	95.00 %,	99.28%	99.57	99.00	99.00	99.28	99.86	100.00	99.43	99.43
Kappa coefficient	0.881	0.836%.	0.878	0.807.	0.807	0.807.	99.86	1.0	0.665.	0.961

Table 5. Total value of EM physician findings

Parameters	Rate
True positive	170
True negative	494
False positive	13
False negative	22

DISCUSSION

Investigations have shown that delayed diagnosis of intra-abdominal injuries result in increasing the morbidity and mortality of trauma patients, which it can be the preventable by timely diagnosis. Early detection of abdomino-pelvic injuries is important because usually these patients simultaneously have distracting injuries that may confound physical examination of physicians. Likewise, in certain cases, the patient loses his/her level of consciousness or consumes alcohol or other psychoactive drugs which the confound the reliable examination (14-17).

The present study identified that EM physicians has been acquired a considerable skill on the interpretation of abdomen and pelvis CT scanning. According to the results, the sensitivity, specificity, accuracy, positive and negative predictive values were 88.54%, 97.44%, 95.00%, 92.90%, and 95.74, respectively. The high agreement value (κ= 0.881) were obtained for the interpretation of two radiology and EM physicians. In the study by Arentz et al, diagnosis of surgery residents was compared with interpretation of radiologists. It shows that 94 % of abdominal injuries, 96% of head injuries, and 67% of chest injuries were detected appropriately by surgery residents. The result of this study identified that the surgery residents has more accuracy for interpreting the abdominal and head CT scans compare to chest CT scans (20). According to the increasing need to perform brain CT scanning on absence times of the radiologists, Gallager et al. aimed to identify the need for the presence of radiologists in order to interpret brain CT scan. To compare the brain CT scan reports, 62 radiologists, neuro-radiographists, and EM physicians voluntarily participated in the study. Thirty brain CT scans with specific pathologies were interpreted by them, and the results were compared. The statistical data of the study showed that there was no significant difference between the reports of different groups, but the best results belonged to neuro-radiographists, radiologists, and EM physicians, respectively. Researchers recommended that more studies need to be done on these issues (21). Shaker et al. conducted a study for investigating the agreement value of brain CT scan interpretation in trauma patients by EM service along with radiology service. The interpretations of 72 brain CT scans in the first 6 months of 2011 were compared and 49 brain CT scan interpretations of EM group and radiology group (68.1%) were equal. Kappa coefficient obtained as 0.596 which was not a high enough (22). The same study has been done by Mun ja kang with the aim of investigating the diagnostic accuracy of EM residents in interpreting abdominal CT scanning. In 16.7% of 884 cases, the interpretation of EM residents was not the same as radiology attendings. This value was 12.2% among radiology residents which was significantly lower than EM residents, showing that the EM residents need to receive more training about abdominal CT scanning (23).

Managing trauma patients need a complicated series of prompt decision making and good practical skills (18). As one of the frontline who examine trauma patients, the EM specialists should appropriately and purposefully be able to use the diagnostic modalities such as abdomino-pelvic CT scanning, and when radiologist are not available for immediate interpretation, they should interpret CT scans instantly. Thus, it is highly important that the EM specialist have the sufficient skill for CT scan interpretation in trauma patients. (24).

Several studies have shown poor skillfulness of EM physicians regarding CT scans interpretation (16, 25, 26,28), while as one of the first physicians who examine the patients, the EM specialists have to interpret CT scans without any help from other specialists many times. Despite the essential need for skillful emergency physicians in the field of CT scan interpretation, a regular program has not been developed at teaching hospitals. The studies have demonstrated that a short training course for about 1 or 2 hours can increase the ability of EM physicians in interpreting CT scanning (24, 27). In 2016, Kartal et al. evaluated the CT scan interpretation of EM physicians and on-call radiologist. The final reports were made by the radiologist after 1 week. In brain CT scans, the agreement value was 98% for EM physicians, while it was 94% for the on-call radiologist. In terms of chest ST scans, the agreement value was 91% for EM physicians and 93% for the on-call radiologist. There was a good agreement (κ= 0.75) between radiologists and EM physicians regarding the brain and chest CT scans. About the abdominal and pelvic CT scans, the agreement value was 97% for EM physicians and 98% for the on-call radiologist. The intermediate agreement (κ= 0.40-0.75) was detected for EM physicians regarding diagnoses of liver, spleen, kidney and intra-abdominal injuries. This study indicated that EM physicians were detected successfully the fatal injuries after a short training course (29).

CONCLUSION

The results of our study showed that EM physicians' skill on the interpretation of abdomen and pelvis CT scanning is considerable, which can be helpful when radiologist interpretation is not available in the Emergency Department. Yet, due to some potentially concerning misinterpretation rate of CT by emergency physicians, more systematic training of abdomen and pelvis CT scan interpretation is needed to optimize their accuracy. We recommend to integrate some formal radiological courses into training programs of EM residents to optimize their CT scan interpretation skills.

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