



Original Article

Comparison of the diagnostic accuracy of CT scan with oral and intravenous contrast versus CT scan with intravenous contrast alone in the diagnosis of blunt abdominal trauma

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ABSTRACT

Purpose: Abdominal CT scan using oral and intravenous (IV) contrast is helpful in the diagnosis of intra-abdominal injuries. However, the use of oral and IV contrast delays the process of diagnosis and increases the risk of aspiration. It has also been shown that CT scan with IV contrast alone is as helpful as CT scan with oral and IV contrast and rectal CT scan in detecting abdominal injuries. Therefore, the present study aims to prospectively compare the diagnostic value of CT scan with oral and IV contrast versus CT scan with IV contrast alone in the diagnosis of blunt abdominal trauma (BAT).

Methods: Altogether 123 BAT patients, 60 (48.8%) women and 63 (51.2%) men with the mean age of (40.4 ± 18.7) years who referred to the emergency department of Imam Khomeini Educational and Medical Center in Sari, Iran (a tertiary trauma center in north of Iran) from November 2014 to March 2017 and underwent abdominal CT scans + laparotomy were investigated. Those with penetrating trauma or hemodynamically unstable patients were excluded. The participants were randomly allocated to two groups: abdominal CT scan with oral and IV contrast ($n = 63$) and CT scan with IV contrast alone ($n = 60$). No statistically significant difference was found between two groups regarding the hemodynamic parameters, age, gender, injury mechanisms (all $p > 0.05$). The results of CT scan were compared with that of laparotomy results. The collected data were recorded in SPSS version 22.0 for Windows. Quantitative data were presented as mean and SD.

Results: The sensitivity and specificity of CT scan using oral and IV contrast in the diagnosis of BAT were estimated at 96.48 (95% CI: 90.73 – 99.92) and 92.67 (95% CI: 89.65 – 94.88), respectively; while CT scan with IV contrast alone achieved a comparable sensitivity and specificity of 96.6 (95% CI: 87.45 – 99.42) and 92.84 (95% CI: 89.88 – 95.00), respectively.

Conclusion: CT scan with IV contrast alone can be used to assess visceral injuries in BAT patients with normal hemodynamics to avoid diagnostic delay.

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Introduction

Nearly 1.3 million people die from traffic accidents each year, and 20 – 50 million people are exposed to non-fatal injuries due to trauma. According to statistics, in low-income countries, trauma is one of the most important public health concerns.¹ Abdominal traumas accounts for 15% – 20% of all deaths caused by trauma, which can be either premature (caused by bleeding) or late (caused by infection).² Besides, blunt abdominal trauma (BAT) is

responsible for nearly 80% of all abdominal injuries, resulting in serious morbidity and mortality.³ Although patients with hemodynamic instability or visceral ruptures are transferred to the operating room, stable cases with abdominal trauma routinely undergo CT scan to evaluate the intra-abdominal injuries.^{4,5} In patients with abdominal trauma and stable hemodynamics, oral and intravenous (IV) contrast CT scan and rectal CT scan are accurate tools to identify injuries of the intra-abdominal hollow viscera.^{6,7} However, it has been shown that oral and rectal contrast media are not safe for trauma patients and can lead to delayed diagnosis and treatment.^{6,8} Some studies have suggested that in penetrating trauma, CT scan with IV contrast alone is as effective as that with oral and IV contrast and rectal CT scan in the diagnosis of

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hollow viscus injuries.⁹ The current study aims to compare the diagnostic value of CT scan using oral and IV contrast versus CT scan with IV contrast alone in detecting BAT in patients referred to the emergency department for diagnostic and therapeutic laparotomy.

Methods

Study design and setting

The present prospective study was conducted on BAT patients (age >18 years) with indications for abdominopelvic CT scan, who were referred to the emergency department of Imam Khomeini Educational and Medical Center in Sari, Iran (a tertiary trauma center in north of Iran), from November 2014. Laparotomy was performed for all the included patients in 48 h after hospitalization. Patients with penetrating trauma, not having an abdominopelvic CT scan, or hemodynamically unstable were excluded. Patients were divided into two groups based on a table of random numbers using block randomization. Patients in the first group underwent abdominal CT scan with IV contrast alone at 1 mL/kg (Visipaque, 320 mg/100 mL, GE Healthcare, Ireland), followed by laparotomy based on the results of CT scan; while those in the second group underwent abdominal CT scan with combined oral contrast (Meglumine, 375 mg/mL, Darou Pakhsh Co., Tehran, Iran) at 60 mL and IV contrast (Visipaque, 320 mg/100 mL, GE Healthcare, Ireland) at 1 mL/kg. Approximately 45 min prior to image acquisition patients consecutively received either 1 L non-sparkling water with oral contrast agent, both served at room temperature.¹⁰ Abdominopelvic CT scans were acquired using a 16-slice Siemens system, and a reliable radiologist reported and interpreted the results. All the patients had laparotomy and the diagnostic accuracy of CT scan was assessed based on the laparotomy results in each group.

Based on previous studies,^{9,11} a minimal sample size of 60 people was set for each group. Until March 2017, both groups reached the target of sample size with a total of 123 patients included, 60 in IV contrast alone group and 63 in the combined oral and IV contrast group. There were 60 (48.8%) women and 63 (51.2%) men, with the mean age of (40.4 ± 18.7) years. Overall, 81 (65.8%) patients were motorcyclists, 18 (14.6%) were injured in car accidents, 14 (11.4%) had falls, and 10 (8.1%) were pedestrians (Table 1). Motorcyclists, car accidents and pedestrians belonged to traffic crashes. General data and injury mechanisms revealed no significant differences between two groups (all *p* > 0.05).

Statistical analysis

The collected data were recorded in SPSS version 22.0 for Windows. Quantitative data were presented as mean and SD. As shown in Table 2, the findings of CT scan with oral and IV contrast and CT scan with IV contrast alone for intra-abdominal injuries were compared. The results of laparotomy were the gold standard. Besides, positive and negative predictive values, specificity, and sensitivity were calculated for each group.

Results

Upon admission, for the 123 patients, 19 (15.4%) were intubated, 35 (28.5%) had broken limbs, and 18 (14.6%) had head injuries. Based on the results, 64 (64.2%) patients were transferred to the emergency room by the emergency medical services. Also, 55 (44.7%) patients had a liver damage, 77 (62.6%) had a splenic injury, 17 (13.8%) had a mesenteric injury, 7 (5.7%) had a kidney injury, 41 (33.3%) had an intestinal injury, 4 (3.2%) had a vascular injury, and 5 (4.1%) had other injuries (Fig. 1). The mean systolic blood pressure was (95.9 ± 9.9) mmHg, the mean heart rate was (109.7 ± 14.6)

Table 1
Clinical and epidemiological characteristics of the patients with blunt abdominal trauma.

Variables	Groups		Total	p value
	IV contrast alone (n = 60)	Oral and IV contrast (n = 63)		
Age (years)	41.0 ± 19.5	39.9 ± 18.1	40.4 ± 18.7	0.990
Sex				
Male	32 (53.3)	31 (49.2)	63 (51.2)	0.647
Female	28 (46.7)	32 (50.8)	60 (48.8)	
Injury mechanism				
Motorcyclist	37 (61.7)	44 (69.8)	81 (65.9)	0.550
Car accident	11 (18.3)	7 (11.1)	18 (14.6)	
Fall	8 (13.3)	6 (9.5)	14 (11.4)	
Pedestrian	4 (6.7)	6 (9.5)	10 (8.1)	
Intubation	9 (15.0)	10 (15.9)	19 (15.4)	0.893
Accompanying limb fracture	19 (31.7)	16 (25.4)	35 (28.5)	0.441
Accompanying head trauma	8 (13.3)	10 (15.9)	18 (14.6)	0.690
Visceral injury				
Liver	25 (41.7)	30 (47.6)	55 (44.7)	0.507
Stomach	2 (3.3)	3 (4.8)	5 (4.1)	0.688
Spleen	39 (65.0)	38 (60.3)	77 (62.6)	0.592
Mesentery	11 (18.3)	6 (9.5)	17 (13.8)	0.157
Kidney	3 (5.0)	4 (6.3)	7 (5.7)	0.727
Intestines	20 (33.3)	21 (33.3)	41 (33.3)	> 0.990
Vascular injury	2 (3.3)	2 (3.2)	4 (3.2)	0.960
Others	3 (5.0)	2 (3.2)	5 (4.1)	0.608
Vital signs				
Systolic blood pressure (mmHg)	96.2 ± 8.8	95.6 ± 10.9	95.9 ± 9.9	0.442
Heart rate (beats/min)	110.8 ± 12.9	108.5 ± 16.0	109.7 ± 14.6	0.547
Respiratory rate (breaths/min)	21.0 ± 3.8	20.6 ± 2.7	20.8 ± 3.3	0.994
O ₂ saturation	92.1 ± 2.8	92.1 ± 3.6	92.1 ± 3.3	0.733
GCS score	11.6 ± 1.0	11.7 ± 1.0	11.7 ± 1.0	0.391
Mortality	3 (5.0)	3 (4.8)	6 (4.9)	0.951

Data are expressed as n (%) except for "Age" and "Vital signs", which as mean ± SD. IV: intravenous; GCS: Glasgow coma scale.

Table 2
Diagnostic value of abdominopelvic CT scan with intravenous (IV) contrast alone and CT scan with oral and IV contrast., (95% CI).

Diagnostic method	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Likelihood ratios ⁺	Likelihood ratios ⁻
CT with oral and IV contrast	96.5 (90.73–99.92)	92.8 (89.65–94.88)	67.7 (57.29–76.68)	99.7 (98.36–99.98)	13.4 (9.56–18.88)	0.02 (0.002–0.114)
CT scan with IV contrast alone	96.6 (87.45–99.42)	92.8 (89.88–95.00)	65.2 (54.25–74.75)	99.5 (98.02–99.51)	13.5 (9.58–19.01)	0.1 (0.009–0.14)

beats per min, the mean respiratory rate was (20.8 ± 3.3) breaths per min, the mean O₂ saturation was 92.1 ± 3.3, and the mean Glasgow coma scale (GCS) score was 11.7 ± 1.0; in this study, 6 (4.9%) patients expired (Table 1). Visceral injuries, vital signs upon admission, and mortality showed no significant difference between patients undergoing abdominopelvic CT scan with oral and IV contrast and those with IV contrast alone.

Intra-abdominal injuries are confirmed by the gold diagnosis standard of laparotomy. CT scan of the abdomen and pelvis using oral and IV contrast or IV contrast alone showed similar sensitivity and specificity in detecting visceral injuries (Table 2). All patients who were suspected of vascular injury on CT scan underwent laparotomy. Most laparotomies were related to splenic injuries. Of 41 patients diagnosed with intestinal injury on CT scan, only 15 were confirmed by laparotomy, and there was no significant difference in the diagnosis of intestinal injuries between CT scan with oral and IV contrast and CT scan with IV contrast alone. Some of these patients without laparotomy were excluded.

Discussion

Our results showed that in BAT patients with stable hemodynamics, abdominopelvic CT scan using IV contrast alone had similar diagnostic value as that using oral and IV contrast. In a previous study on BAT patients over 10 years, the use of oral contrast before abdominal CT scan was found not to be necessary in detecting intra-abdominal injuries, which could even delay the process of diagnosis and increase the risk of aspiration and severe pneumonitis.^{11,12} Besides, the dose of CT scan radiation was higher in individuals with oral contrast in the gastrointestinal tract.¹³ Moreover, another study also showed that in patients with distracting injuries, clinical examinations by abdominopelvic CT scan with IV contrast alone were valuable in diagnosing intra-abdominal injuries.¹⁴ However, according to some studies, the sensitivity, specificity, and positive predictive value of abdominopelvic CT scan with oral and IV contrast were much higher than CT scan with IV contrast alone in the diagnosis of small bowel injuries.^{15,16} Besides,

abdominopelvic CT scan with IV contrast alone showed a low sensitivity in the diagnosis of hollow visceral trauma.¹⁷

In the present study, the sensitivity and specificity of abdominopelvic CT scan using oral and IV contrast are 96.5 (95% CI: 90.73 – 99.92), 92.7 (95% CI: 89.65 – 94.88), similar with that using IV contrast alone, which are 96.6 (95% CI: 87.45 – 99.42) and 92.8 (95% CI: 89.88 – 95.00) respectively. Our result is found to be higher than the findings of some previous research 88 (95% CI: 82 – 92), 72 (95% CI: 63 – 80).¹⁸ Nevertheless, in our study, all patients had laparotomy indications, and many patients with injuries on CT scans who were conservatively treated were not included. Besides, the performance indices of CT scan varied in different studies, and in some studies, only peritoneal injury or hollow visceral injury was considered as a positive injury.^{18,19} One of the advantages of abdominopelvic CT scan using oral and IV contrast is in the diagnosis of hollow visceral injuries with the leakage of contrast material, which are rarely detected,²⁰ with no specific CT findings, such as increased intestinal wall thickness, intestinal rupture, or presence of an injury route to the intestine.¹⁹ However, CT scan is accurate in representing peritoneal ruptures and solid visceral injuries.²¹ In the present study, 55 (44.7%) cases of liver injury and 77 (62.6%) cases of splenic injury were diagnosed, while laparotomy indicated liver injury in 90.4% of cases and splenic injury in 72.7% of cases, which shows that some injuries are not seen in abdominal CT scans but confirmed by laparotomy. In this study, out of 41 (33.3%) patients diagnosed with intestinal injuries on abdominopelvic CT images, 15 (12.2%) were confirmed by laparotomy, which shows that the abdominal CT scan has a low accuracy compared with laparotomy in detecting hollow viscera injuries such as intestines. In the current study, most of the injuries were related to the spleen and liver, and the least frequent injuries were related to the hollow viscera, especially the stomach; these findings are consistent with previous research.²²

In this study, the interval between oral contrast administration and CT scan was not calculated, and the consequences of delayed diagnosis were not followed up. In a short time period, the contrast agent may not have yet reached the damaged intestine and thus impossible to migrate to the outside of the intestinal lumen, thereby reducing the diagnostic sensitivity of oral contrast agent.

Based on the present findings, in the evaluation of BAT, it can be helpful to use an oral contrast medium to detect intestinal injuries due to the medium leakage from the rupture site. However, this finding only applies to a small percentage of these trauma, and other CT findings can be used to suggest a diagnosis. On the other hand, delay due to the transfer of oral contrast can also delay the process of diagnosis and treatment. Since in many previous studies, as well as the present study, the positive predictive value and sensitivity of CT imaging without oral contrast was not significantly different from CT imaging with oral contrast in detecting intestinal injuries, imaging with no oral contrast can be used to evaluate BAT in patients with normal hemodynamics and also avoid diagnostic delay.

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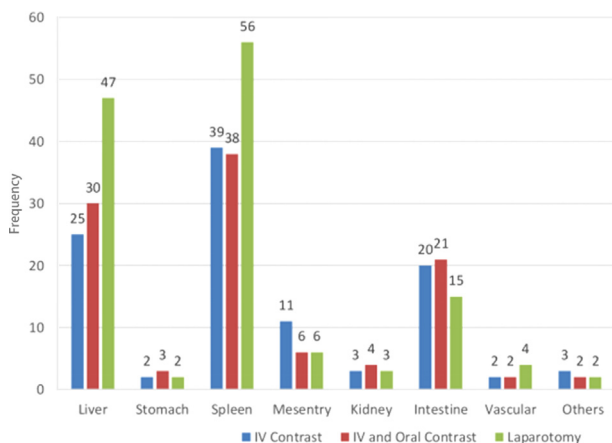


Fig. 1. The frequency of injuries presented in CT scan and laparotomy.

Ethical statement

The study was approved by the vice chancellor for Research of Mazandaran University of Medical Sciences (grant number 1404) and conducted under the Declaration of Helsinki.

Declaration of competing interest

We have no conflicts of interest to disclose.

Author contributions

Hamed Aminiahidashti, Seyed Jalal Mousavi Amiri and Iraj Golikhatir contributed to the project development and study design. Seyed Jalal Mousavi Amiri and Fatemeh Jahanian contributed to data collection and interpretation. Hamed Aminiahidashti, Mohammad Sazgar, FJ contributed to data analysis. Hamed Aminiahidashti, Iraj Golikhatir developed the manuscript. Hamed Aminiahidashti, Seyed Jalal Mousavi Amiri, Iraj Golikhatir critically edited and revised the manuscript. All authors read and approved the final manuscript.

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