
THE DIAGNOSTIC VALUE OF COMPUTED TOMOGRAPHY OF 49 HOLLOW VISCUS INJURY PATIENTS DUE TO BLUNT ABDOMINAL TRAUMA

Mai Duc Hung^{1*},
Nguyen Thi Ly¹,
Ly Lap², Le Van Phuoc³

ABSTRACT

Purpose: We aimed to determine the value of abdominal CT scans in the diagnosis of blunt abdominal trauma with hollow viscus and mesenteric injury.

Methods: Retrospective, cross-sectional description.

Result: Patients averaged 41.14 ± 14.77 years old; male/female sex ratio $\approx 4.5/1$, and the main cause of injuries was traffic accidents (83.7%), with lesions of the small intestine (57.1%), colon (26.5%) and rectum (2.0%). Computed tomography had high specificity in diagnosing the lesion sites, around 1 in cases of the duodenum, small intestine, colon, and rectum. Value of computed tomography with general hollow visceral lesions: the sensitivity was 61.9% and the specificity was 86.0%. Signs of hollow visceral injury with high specificity were free air in the abdomen, free fluid in the abdomen, extravasation of the contrast medium, gas in the gastrointestinal wall, and gastrointestinal wall discontinuity with specificity equal to 100%. The sensitivity of the signs: abdominal free air and gastrointestinal wall thickness were 71.0%.

Keywords: Blunt abdominal trauma, hollow viscus and mesenteric injury.

Corresponding author: Mai Duc Hung, Email: bsmiduchung@gmail.com

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¹ Vietnam Military Medical University

² Ho Chi Minh Institute of cardiology

³ Cho Ray Hospital

1. INTRODUCTIONS

Hollow viscus and mesenteric injury (HVMI) in blunt abdominal trauma (BAT) accounts for about 1-5% and requires early surgery to avoid dangerous complications [1].

Symptoms and clinical signs may not be obvious at first, peritonitis syndrome appears late, but early detection of hollow viscus and mesenteric injury is essential.

In fact, the direct or indirect signs of HVMI on computed tomography (CT) are different. Each organ injury site also has a certain significant diagnostic value per patient. No one denies the suggestive value of CT imaging in the diagnosis of HVMI.

However, there is still much debate about the value of CT imaging on HVMI in BAT due to the high rate of false negatives, accounting for about 15% [1].

Therefore, we undertake this study to determine the value of abdominal CT scans in the diagnosis

of blunt abdominal trauma with hollow viscus and mesenteric injury.

2. SUBJECTS AND METHODS

2.1. Subjects

49 patients with HVMI due to blunt abdominal trauma are treated at Cho Ray Hospital from December 2018 to December 2021 by open laparotomies or laparoscopic surgeries.

- Selection criteria: Patients over 17 years old, with preoperative pelvic abdominal CT scan, confirmed diagnosis of HVMI by surgery.

- Exclusion criteria: Pregnant women; patients had arterial systolic blood pressure < 90 mmHg, heart rate > 110 cycles/min; patients had a penetrating wound to the abdomen; patients disagreed to participate in the study.

2.2. Methods

- Study design: Retrospective, cross-sectional description.

- Sample size: Apply the formula to calculate the sample size by a scale according to the formula:

$$n = Z_{(1-\frac{\alpha}{2})}^2 \times \frac{p(1-p)}{d^2}$$

In there:

n is the minimum sample size required for inclusion in the study;

$Z_{(1-\alpha/2)}$ is the confidence factor (with 95% confidence, $\alpha = 0.05$; we have $Z_{(1-\alpha/2)} = 1.96$);

p is the rate of HVMI in BAT (3%);

d is the absolute error (choosing $d = 0.05$).

Instead of the formula, calculate $n = 45$. In fact, the sample size in this study was 49 patients.

- Research criteria:

+ General characteristics of the study patients: Age, gender, cause of injury, mechanism of injury, location of hollow organ injuries (determined in surgery).

+ Value of CT scanner in the diagnosis of blunt abdominal trauma with HVMI.

- Evaluation of HVMI on abdominal CT according to Panda (2017) [2]:

+ Specific picture of hollow viscus injury: Signs of contrast drainage, discontinuous of intestinal walls.

+ Images suggestive of hollow viscus injury: Mesenteric hematoma, mesenteric infiltrate, abdominal free air, adjacent gases, gut wall hematomas, intestinal wall thickening, abdominal free fluid (no solid organ damage), loculated collection.

+ Read CT scans: 2 radiologists read and agree on the results. Compare imaging findings with clinical diagnoses, successful conservative treatment outcomes, or surgery. Then, identify true positives, false positives, true negatives, and false negatives (table below):

Diagnose	Clinical (+)	Clinical (-)	Sum
CT (+)	a	b	a + b
CT (-)	c	d	c + d
CT	a + c	b + d	

In there, a is the number of true positive cases, b is the number of false positive cases,

c is the number of false negative cases, and d is the number of true negative cases. Thereby, calculating the values of sensitivity, specificity, positive predictive value, negative predictive value. As follows:

$$+ \text{Sensitivity} = \frac{a}{a+c} \times 100\%$$

$$+ \text{Specificity} = \frac{d}{b+d} \times 100\%$$

$$+ \text{Positive predictive value} = \frac{a}{a+b} \times 100\%$$

$$+ \text{Negative predictive value} = \frac{a}{c+d} \times 100\%$$

- Ethical issues: The study was approved by Cho Ray Hospital Ethics Council. All information about patients is confidential and used for research purposes only.

- Data processing: SPSS 22.0 software.

3. RESULTS AND DISCUSSIONS

3.1. Research patients' characteristics

- Gender (n = 49):

+ Female: 9 patients (18.4%).

+ Male: 40 patients (81.6%).

The male/female patient ratio $\approx 4.5/1$.

- Ages (n = 49):

+ From 18 to 20 years old: 2 patients (4.1%).

+ From 21 to 30 years old: 11 patients (22.4%).

+ From 31 to 40 years old: 14 patients (28.6%).

+ From 41 to 50 years old: 9 patients (18.4%).

+ Over 50 years old: 13 patients (26.5%).

+ Average ages: 41.14 ± 14.77 years.

Patients had an average age of 41.14 ± 14.77 years, with most patients aged 21-50 years (69.4%).

- Causes of blunt abdominal injury (n = 49):

+ Work accidents: 5 patients (10.2%).

+ Traffic accidents: 41 patients (83.7%).

+ Life accidents: 2 patients (4.1%).

+ Other accidents: 1 patient (2.0%).

The main cause of injury was traffic accidents (83.7%).

- The mechanism of blunt abdominal injury:

+ Direct: 42 patients (85.7%).

+ Indirect: 7 patients (14.3%).

Most patients with blunt abdominal injuries follow the mechanism of direct injury (85.7%).

- Location of HVMI (n = 49):

+ Small intestine lesions: 28 patients (57.1%).

+ Mesenteric lesions: 21 patients (42.9%).

+ Colon lesions: 13 patients (26.5%).

+ Rectal lesions: 1 patient (2.0%).

Mainly patients had lesions of the small intestine (57.1%) and mesentery (42.9%).

3.2. The value of computed tomography image in the diagnosis of blunt abdominal injury with hollow viscus and mesenteric injury

Table 1. The diagnostic value of some signs of hollow viscus injury on CT scans

CT Signs	Sensitivity	Specificity	Value positive predictions	Value negative predictions
Focal wall discontinuity	26%	100%	100%	18%
Gut wall hematoma	2%	71%	33%	11%
Focal intramural air	7%	100%	100%	15%
Focal hypoenhancement, hyperenhancement adjacent loops	40%	100%	100%	22%
Segmental wall thickening (> 3-4 mm)	71%	29%	86%	14%
Free air in the abdomen	71%	100%	100%	37%
Free fluid in the abdomen	100%	0	86%	
Contrast vascular extravasation	7%	100%	100%	15%

Diagnosing the lesion site on a CT scan is important, helping clinicians to come up with treatment tactics. However, not all cases are easy to detect the location of the lesion. Therefore, detecting direct and indirect signs on CT film, and understanding the value of each sign plays an important role. Some of the diagnostic signs and manifestations on CT scans have also been very different from studies [3], [4].

The main features of traumatic gastrointestinal damage include peritoneal features (such as free fluid, free intra-abdominal gas), mesentery (mesenteric drainage of the mesenteric vessels, mesenteric hematoma) and intestinal features (intermittent thickening of the intestinal wall)... The distribution of these characteristics varies based on the study, the study group, the level of experience of the examiner, and the type of CT scanner used.

Free air in the abdomen is a typical manifestation if there is a perforation or rupture of the intestinal

passage. However, the proportion of patients with this marker ranged from 0-83%.

Persistent loss of the digestive canal is another specific sign of hollow organ injury; This rate is reported to range from 3-100%. Abdominal free fluid is another typical manifestation of hollow organ damage on CT scans; This sign is common and plays an important role in the diagnosis of hollow organ injury caused by trauma.

Our study showed signs of abdominal free air, contrast vascular extravasation, gas in the gut wall or wall discontinuity with 100% specificity (which means that when the above signs are present, there is damage to the hollow organ wall).

However, the sensitivity of the signs is markedly different, such as the sensitivity of the abdominal free air sign, thickening of the gut wall is 71%, the sign of continuous loss of the gut wall is 26%, the hematoma sign of the intestinal wall has a very low sensitivity, only 2%.

Table 2. Comparison of the value of free air signatures on computed tomography scans in blunt abdominal trauma patients with HVMI in several studies

Author	Patients	Sensitivity	Specificity	Value positive predictions	Value negative predictions
Vu Thi Kim Thoa (2008) [5]	92	96,7%	100%	99%	100%
Savitha Bhagvan (2012) [6]	1.250	38%	93%		
Bonomi (2020) [7]	114	35,4%	92,4%	77,2%	66,3%
Our study	49	71%	100%	100%	37%

This comparison table shows that the value of the free air in the abdomen in our study is quite like other studies in terms of specificity (both over 92%). However, the sensitivity of this sign fluctuates depending on the study, such as Vu Thi Kim Thoa's study of 96.7%; of Savitha Bhagvan is 38%; of Bonomi is 35.4%... The sensitivity of intra-abdominal free air markers in our study reached 71%, not as high as some other studies. It is possible that due to high small bowel lesion in this study (57.1%), the small intestine contains less gas, the small intestine loops are close to each other, the connective membrane tends to cover the puncture site quickly, on the other hand, the contraction of the small intestine near the puncture site causes a decrease in the movement of gas from the lumen of the intestine outward, resultant ileus.

Table 3. Comparison of abdominal free fluid marker values on CT scans in patients with HVMI in several studies

Author	Patients	Sensitivity	Specificity
Vu Thi Kim Thoa (2008) [5]	92	100%	
Savitha Bhagvan (2012) [6]	1,250	91%	10%
Bonomi (2020) [7]	114	75%	82%
Our study	49	100%	

We found that 100% patients in the study had abdominal free fluid, with a marker sensitivity of 100%: That like the results of Vu Thi Kim Thoa (100%), but higher than the study of Savitha Bhagvan (91%) and Bonomi (75%).

The extent of abdominal fluid depends on the characteristics of hollow organ damage and associated lesions in cases of solid organ injury, mesenteric damage, the amount of abdominal fluid is usually more. Therefore, this is a highly sensitive but not specific sign for hollow viscus injury in blunt abdominal trauma.

Table 4. Comparison of the diagnostic value of the location of hollow organ lesions on CT scans on blunt abdominal trauma versus surgical findings.

Lesion site	Sensitivity	Specificity	Value positive predictions	Value negative predictions
Duodenum	60%	100%	100%	96%
Small intestine	61%	90%	89%	63%
Colon	38%	100%	100%	82%
Rectum	51%	100%	100%	98%
Mesentery	71%	93%	88%	81%

Diagnosis of lesions of the gastrointestinal wall wall and mesentery on CT scans, comparison of the results of reading the lesion site on CT scans and the results of lesions in surgery, thereby giving sensitivity, specificity, positive predictive values, and negative predictive values for diagnosis on CT scans.

In this study, the specificity of the lesion site is quite high (90% or more) the specificity of diagnosing the site of duodenal, colon, and rectal lesions is 100% (meaning that 100% of patients diagnosed based on CT scans with duodenal lesions, the colon or rectum both have corresponding lesions observed during surgery). In other locations such as the small intestine or mesentery, specificity is also relatively high (reaching 90% and 93%, respectively).

However, the sensitivity of detecting the location of HVMI on CT scans is not high, with the detection of mesenteric lesions having the highest sensitivity (71%), followed by the detection of lesions in the small intestine (61%), duodenum (60%), rectum (51%), and lowest detection of lesions in the colon (38%).

Table 5. Comparison of CLVT scan and surgical results of hollow viscus injury

Lesion on CT scan results	Lesion on surgical results		Sum
	+	-	
+	26	1	27
-	16	6	22
Sum	42	7	49

In this study, we compared the results of hollow organ wall damage on CT diagnosis and surgery at all levels (tear, perforation of the hollow organ wall or no wall damage). The diagnosis of hollow organ wall damage based on CT/surgical imaging reached 26/42 patients (61.9%), specificity was 86%, positive predictive value was 97%, negative predictive value was 26%...

When compared to other authors, the sensitivity and specificity of our study were also within the range allowed in many previous studies. The positive predictive value is high, but the negative predictive value is low, possibly because when taking CT scans, there are many patients who do not identify the location of the damage of the hollow organ, on the other hand, the CT image only has signs of suspected damage (indirect signs), such as fluid and free gas in the peritoneal cavity.

Table 6. Comparison of CLVT scan values of HVMI compared to some studies

Author	Patients	Sensitivity	Specificity	Value positive predictions	Value negative predictions
Mazen Hamidi (2007) [8]	245	97%	95%	82%	100%
Vũ Thị Kim Thoa (2008) [5]	266	89.1%	100%	100%	94.6%
Savitha Bhagvan (2012) [6]	1,250	55.3%	92.06%	61.53%	89.23%
Bonomi (2020) [7]	114	97.9%	98.5%	95.6%	97.6%
Cheng-Chieh Hsia (2021) [9]	12,514	67.8%	96.9%		
Our study	49	62%	86%	97%	26%

Hamidi studied 245 patients with blunt abdominal trauma, found that patients with dense organ damage accounted for a high proportion, such as spleen damage: 38.8%; kidneys: 25.7%; liver: 19.6%; pancreas: 5.3%... Of these, 23 patients had multi-organ lesions (CT values for both solid, hollow, and mesenteric injuries) [8].

Cheng-Chieh Hsia et al. studied a meta-analysis of the accuracy of CT scans to determine the need for open-abdominal surgery for hollow organ injury based on data from 16 different

studies with 12,514 patients [9]; evaluating and summarizing the results of studies on the diagnostic efficacy of CT on gastrointestinal lesions, found that the value of CT scans had a sensitivity ranging from 63-95%, specificity ranged from 96.9-98.9%. A meta-analysis of the studies showed that the value of CT scans had a sensitivity of 67.8% and a specificity of 96.9% [9].

In blunt abdominal trauma, the rate of gastrointestinal injury ranges from 2-6% patients,

caused by strong traumatic force. CT is the first imaging modality for direct force abdominal injury, which provides information about damaged organs that can be used to make treatment decisions. Although CT is highly specific for diagnosing hollow organ damage, sensitivity is insufficient [10], [3].

HVI in blunt abdominal trauma is not high, but the rate of complications and mortality is high. Bonomi et al. conducted a retrospective study of data from 2010-2018, resulting in 114 out of 4,369 patients included in the study, of which 47 were genuinely positive. research indicates high sensitivity and specificity of CT. As such, CT image is a reliable test for the diagnosis of hollow, mesenteric organ damage and is a valuable test of choice for surgical exploration [7].

Table 7. Comparison of CLVT scan results and surgery for mesenteric lesions

Lesion on CT scan results	Lesion on surgical results		Sum
	+	-	
+	15	2	17
-	6	26	32
Sum	21	28	49

Our results found that the value of CT in the diagnosis of mesenteric lesions had a sensitivity of 71%, specificity of 93%, a positive predictive value of 88%, and a negative predictive value of 81%.

4. CONCLUSIONS

The study of 49 patients with hollow viscus and mesenteric injury, open or laparoscopic surgeries, at Cho Ray Hospital, from December 2018 to December 2021, concluded:

- The diagnostic value of CT scan with highly specific duodenal, colon and rectal lesions reaches 100%; with hollow organ wall lesions with a sensitivity of 61.9% and specificity of 86%.

- Signs of hollow organ damage on CT scans: signs of hollow organ damage with high specificity, including signs of free abdominal gas, abdominal free fluid, drainage of contrast vessels, gas in the walls of the digestive tube, continuous loss of the digestive tube wall (all

reach 100%); signs of highly sensitive hollow organ damage, including abdominal free gas, thickening of the walls of the digestive canal (all 71%).

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