



## Original Article

## Iliac ecchymosis, a valuable sign for hollow viscus injuries in blunt pelvic trauma patients

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## ABSTRACT

**Purpose:** Pelvic fractures are characterized by high energy injuries and often accompanied with abdominal and pelvic organ injury. CT has been applied for several decades to evaluate blunt pelvic trauma patients. However, it has a certain rate of inaccurate diagnosis of abdominal hollow viscus injury (HVI), especially in the early stage after injury. The delayed diagnosis of HVI could result in a high morbidity and mortality. The bowel injury prediction score (BIPS) applied 3 clinical variables to determine whether an early surgical intervention for blunt HVI was necessary. We recently found another clinical variable (iliac ecchymosis, IE) which appeared at the early stage of injury, could be predicted for HVI. The main objective of this study was to explore the novel combination of IE and BIPS to enhance the early diagnosis rate of HVI, and thus reduce complications and mortalities.

**Methods:** We conducted a retrospective analysis from January 2008 to December 2018 and recorded blunt pelvic trauma patients in our hospital. The inclusion criteria were patients who were verified with pelvic fractures using abdomen and pelvis CT scan in the emergency department before any surgical intervention. The exclusion criteria were abdominal CT insufficiency before operation, abdominal surgery before CT scan, and CT mesenteric injury grade being 5. The MBIPS was defined as BIPS plus IE, which was calculated according to 4 variables: white blood cell counts of 17.0 or greater, abdominal tenderness, CT scan grade for mesenteric injury of 4 or higher, and the location of IE. Each clinical variable counted 1 score, totally 4 scores. The location and severity of IE was also noted.

**Results:** In total, 635 cases were hospitalized and 62 patients were enrolled in this study. Of these included patients, 77.4% (40 males and 8 females) were operated by exploratory laparotomy and 22.6% (8 males and 6 females) were treated conservatively. In the 48 patients underwent surgical intervention, 46 were confirmed with HVI (45 with IE and 1 without IE). In 46 patients confirmed without HVI, only 3 patients had IE and the rest had no IE. The sensitivity and specificity of IE in predicting HVI was calculated as 97.8% (45/46) and 81.3% (13/16), respectively. The median MBIPS score for surgery group was 2, while 0 for the conservative treatment group. The incidence of HVI in patients with MBIPS score  $\geq 2$  was significantly higher than that in patients with MBIPS score less than  $\leq 2$  ( $OR = 17.3, p < 0.001$ ).

**Conclusion:** IE can be recognized as an indirect sign of HVI because of the high sensitivity and specificity, which is a valuable sign for HVI in blunt pelvic trauma patients. MBIPS can be used to predict HVI in blunt pelvic trauma patients. When the MBIPS score is  $\geq 2$ , HVI is strongly suggested.

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## Introduction

Pelvic fractures are high energy trauma, which are usually considered a marker for injury severity in traumatic orthopedics and often complicated with multiple and concomitant injuries.<sup>1–3</sup>

Studies have shown that more than one-half of patients with pelvic fractures have various concomitant complications and in some cases could also be combined with abdominal hollow viscus injury (HVI).<sup>4</sup> The correlation between the severity of fractures and the incidence of abdominal HVI is unknown. Missed or delayed diagnosis of abdominal HVI could delay appropriate management and often result in significant morbidity and mortality.<sup>5,6</sup> Hence, an early diagnosis and timely treatment of concomitant injuries are the most important.

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Pelvic fractures can be diagnosed by physical and imaging examinations. However, an early evaluation and diagnosis of the concomitant injuries of HVI especially for comatose patients can be quite difficult.<sup>7,8</sup> CT examination is a well-established and highly accurate imaging modality in assessing the severity of solid organ injuries after blunt abdominal trauma,<sup>9</sup> but several studies reported that the application of CT or physical examination alone in the diagnosis of HVI was unsatisfactory with reported false-negative CT results.<sup>10</sup> The bowel injury prediction score (BIPS)<sup>11</sup> has been used to determine whether to perform early surgical intervention for blunt HVI, but there is also a certain rate of missed diagnosis. Therefore, an early diagnosis of HVI still remains a challenge.<sup>10,12</sup>

In this study, the definition of iliac ecchymosis (IE) is the skin and subcutaneous contusion as deep as the fascia at the iliac and pelvic region after blunt pelvic injury caused by high energy injuries, rather than thrombocytopenia or dysfunction of the coagulation. The positive sign of IE refers to bleeding at the skin and mucous membranes of the iliac and pelvic areas by high-energy blunt trauma, forming red or dark red spots on the skin and mucous membranes with a diameter of about 5 cm or larger, which will not fade under pressure. The assistant diagnostic value of IE for HVI in pelvic fracture patients has not been reported to date. The aim of the study was to research the value of an early diagnosis, further to improve the diagnostic rate of HVI on the basis of MBIPS (BIPS + IE) in blunt pelvic trauma patients at admission, and to reduce complications and mortality through an early surgical intervention.

## Methods

### Patients' information

There are 635 adult blunt pelvic trauma patients included in the study from January 2008 to December 2018 at Qilu Hospital of Shandong University. The inclusion criteria were patients who were verified with pelvic fracture via abdomen and pelvis CT scan obtained in the emergency department before any surgical intervention. The exclusion criteria were preoperative abdominal CT insufficiency, abdominal surgery performed before CT scan and CT mesenteric injury grade 5 injury. All the patients underwent CT examination under the same machine after assessment of hemodynamic stability by surgeons. Pelvic fractures were classified according to Tile classification: 37 cases presented with type A, 397 cases with type B, and 201 cases with type C.<sup>13</sup> This study was approved by the Hospital Ethics Committee of Qilu Hospital of Shandong University and written informed consents were obtained from all patients.

### Diagnostic steps

Vital signs were monitored firstly when patients were admitted to the emergency department. Then physical examinations were quickly performed focusing on fracture sites and IE locations were recorded. Emergency blood test and CT examinations were routinely performed. Intensive CT scans was recommended to be performed within 4 h to observe bowel wall thickening, mesenteric contusion or hematoma, peritoneal effusion and pneumoperitoneum. All patients with pelvic fractures were routinely given digital rectal examination to diagnose low rectal ruptures. It was suggested to immediately conduct exploratory laparotomy if the total score of the MBIPS  $\geq 2$ . The MBIPS was calculated according to McNutt et al.<sup>11</sup>: white blood cell counts of 17.0 or greater, abdominal tenderness, CT scan grade for mesenteric injury of 4 or higher and

the location of IE. Each clinical variables defined 1 score and total 4 score.

### Statistical analysis

Statistical analysis was performed using GraphPad StatMate software (GraphPad Software Inc., San Diego, CA). Statistical tests performed included the Pearson  $\chi^2$  test and the Mann-Whitney *U* test. Two-tailed comparisons were performed using STATA software. It was considered to be statistically significant, if the *p* value was less 0.05.

## Results

In total, 635 cases were hospitalized, 358 males and 277 females, aged from 18 to 65 years old, with a mean age of 41.2 years. Of these, 62 patients met the study criteria. The basic data for the included patients are listed in Table 1. Of the included patients, 77.4% (40 males and 8 females) were operated by exploratory laparotomy and 22.6% (8 males and 6 females) were treated conservatively. In the patients underwent surgical intervention, 46 were confirmed with HVI (45 with IE and 1 without IE). In the patients confirmed without HVI, only 3 patients have IE and the rest patients have no IE. The sensitivity and specificity of IE predicting for HVI can be calculated as 97.8% (45/46) and 81.3% (13/16), respectively. Therefore, IE can be recognized as an indirect sign of HVI because of the high sensitivity and specificity. The median MBIPS score for surgical group was 2, while for the conservative treatment group was 0. The incidence of HVI in patients with MBIPS score  $\geq 2$  was significantly higher than that in patients with MBIPS score  $\leq 2$  (*OR* = 17.3, *p* < 0.001).

The abbreviated injury scale score, grading scale on abdominal tenderness and CT mesenteric injury were significantly increased in the operation group compared to those in non-operation group. Among the 46 surgical intervention patients, 10 cases had jejunum ruptures, 9 ileal ruptures, 22 colon ruptures and 5 rectal ruptures. The 10.9% of patients received repair and the rest (89.1%) received diversion. Among all patients, the severity of pelvic fractures was positively associated with the possibility of the abdominal HVI.

**Table 1**

The basic demographics and clinical characteristics of the patients (*n* = 62).

Variables	<i>n</i> (%)
Age (years)	41.2 (18–65)
Gender (median, range)	
Male	48 (77.4)
Female	14 (22.6)
Mechanism of injury	
Motorcycle collision	8 (12.9)
Motor vehicle crash	38 (61.3)
Fall	10 (16.2)
Other	6 (9.7)
Fracture type (Tile)	
A Type	2 (3.2)
B Type	35 (56.5)
C Type	25 (40.3)
Treatment	
Surgery	48 (77.4)
Non-surgery	14 (22.6)
HVI patients	
With IE	45 (97.8)
Without IE	1 (2.2)
IE patients	
With HVI	45 (93.8)
Without HVI	3 (6.2)

IE: iliac ecchymosis; HVI: hollow viscus injury.

Specifically, the incidence of abdominal HVI was higher in Tile C type pelvic fractures than in Tile A and Tile B pelvic fractures. A typical case is shown in Fig. 1.

## Discussion

In recent years, the incidence of pelvic fractures following/blunt trauma is increasing, especially in complex cases. Incidence of concomitant abdominal HVI accounted for 4%–46.5% in all pelvic fractures.<sup>14</sup> Patients with pelvic fractures and abdominal HVI were in critical condition. An early diagnosis with timely and effective treatment is the key to promoting rehabilitation. From the previous cases, we inferred that the main reasons for missed or delayed diagnoses were as follows: (1) Abdominal symptoms were often covered by fractures and other symptoms in multiple trauma patients.<sup>15</sup> (2) Abdominal symptoms were not obvious in the early stage of injury in some patients. (3) Bowel ruptures were located under the intestinal walls and liver capsules, leading to delayed clinical symptoms, consequently the peritonitis signs appeared until digestive juice or intestinal contents leaks to the abdominal cavity.<sup>16</sup> At present, CT scan has become an indispensable examination method and gold standard in the treatment of patients with blunt pelvic trauma.<sup>1</sup> However, Fakhry et al.<sup>17</sup> found that the false negative rate of CT examination in the diagnosis of small intestinal penetrating injury can be as high as 13%. They also found that surgical treatment was delayed for more than 24 h and the mortality rate increased threefold.<sup>17</sup>

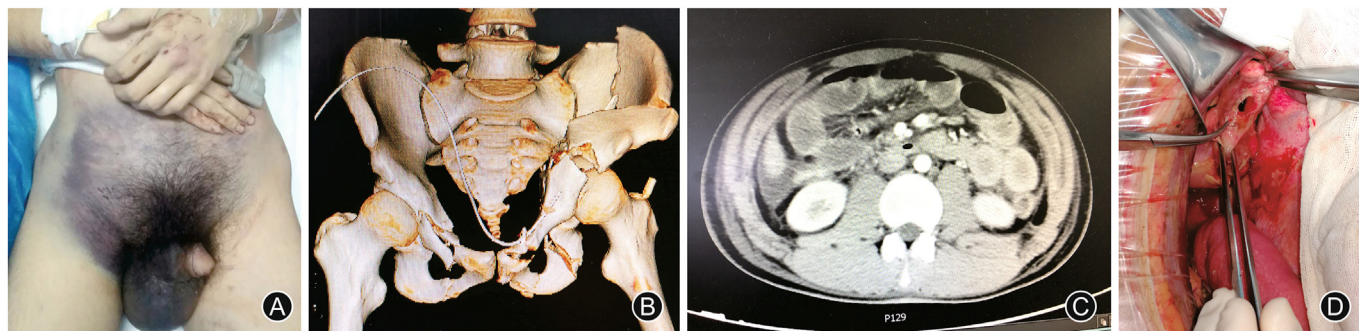
The accuracy of physical examinations in diagnosing HVI was inconsistent with available subject literature. Ecchymosis is referred to hemorrhagic plaque lesions of the skin and mucous membranes. The ecchymosis sign often indicates blood disease, hemorrhagic disease or coagulation abnormalities. Ecchymosis has a certain diagnostic value for specific fracture and organ injuries, for example perineal ecchymosis often indicates urinary system injury, and lumbar ecchymosis indicates pancreatic injury, etc.<sup>18</sup>

IE is defined as the skin and subcutaneous contusion as deep as the fascia at the iliac or pelvic region after blunt pelvic injury caused by high energy injuries, rather than thrombocytopenia and the dysfunction of coagulation. The positive sign of IE refers to bleeding at the skin and mucous membranes of the iliac and pelvic areas by high-energy blunt trauma. It forms red or dark red spots with a diameter of about 5 cm or larger on the skin and mucous membranes and it will not fade under pressure. In this study, 48 patients had IE, and the remaining 14 patients had no IE. Forty-five IE patients were confirmed with HVI. The injury severity score was significantly higher in IE patients. This reminds emergency physician that patients with pelvic fractures and IE are usually more

severely injured, as well as early and prompt diagnosis for these patients can achieve early surgical planning, increase the cure rate and reduce complications and mortality.<sup>19</sup> Some patients also present with ecchymosis due to separation of skin and subcutaneous tissue resulted from shear force, but they had no HVI. Therefore, it was necessary to combine the supplementary examinations, laboratory test and clinical examination for the accurate diagnoses. For patients diagnosed with pelvic fractures by X-ray examinations in emergency room, more attention should be paid to their chest and abdominal symptoms. If the patients had severe pain in their lower chest and abdomen and gradually aggravated, they were more likely to suffer from visceral injuries. Perform diagnostic abdominal puncture and CT examination for these patients in time, of which the correct rescue treatment can be given as soon as possible.<sup>20</sup>

In the process of diagnosing abdominal HVI, abdominal parenchymal organ injury and large blood vessels injury should be excluded. Especially, intra-abdominal active hemorrhaging and retroperitoneal hemorrhaging needed to be identified first.<sup>21</sup> If hemodynamics and shock symptoms were easily stabilized and hemoglobin level was relatively sound, the patients could be treated conservatively under close observation. However, it is difficult to diagnose HVI in patients whose symptoms of shock are difficult to correct and whose hemoglobin decreases progressively. It is reported in the literature that high position diagnostic abdominal punctures could help to identify intra-abdominal hemorrhage and retroperitoneal hemorrhage. At the same time, it is found that the blood of retroperitoneal hematoma penetrates into the abdominal cavity is thinner than that of intra-abdominal hemorrhage, which also helps in identification. We had to exclude the possibility of HVI.<sup>22</sup> Abdominal HVI could usually be diagnosed by peritonitis and free gas under the diaphragm, but the presence of pelvic fractures increased the difficulty of diagnosis. These patients had peritoneal irritation due to retroperitoneal hematoma, and could not be examined by abdominal X-ray in standing position. It was difficult to find free gas under the diaphragm through general X-ray examination.<sup>23</sup>

In this study, we compared the incidence of HVI between IE positive and IE negative patients. We found that in 48 IE positive patients, 45 were diagnosed with HVI, while in 14 IE negative patients, only 1 were diagnosed with HVI in 14 IE negative patients. The incidences of abdominal HVI was significantly higher than that in IE negative patients. We also found that among all the 46 HVI patients, 45 were IE positive. These data indicated that HVI was impossibility concurrent with IE. These results indicated that IE was important in early diagnosis of blunt pelvic trauma patients complicated with abdominal HVI.



**Fig. 1.** A 23 years old man suffered high-energy trauma in a traffic accident, causing pelvic fracture and acetabular both-column fractures complicated with descending colonic rupture. (A) Ecchymosis of lower abdomen, pubic symphysis, scrotum, penis and inguinal area. (B) Three-dimensional CT image of pelvis revealing left acetabular both-column fractures. (C) CT mesenteric injury grading scale 4 (bowel wall thickening and interloop fluid) MBIPIS, 3 score. (D) Exploratory laparotomy findings include mesenteric injury and colostomy was performed at the same time.

In summary, IE is an important new clinical variable and valuable sign for blunt pelvic trauma patients with concomitant abdominal HVI. MBIPS (four predictors: white blood cell count, abdominal tenderness, CT mesenteric injury grading scale and IE) can be used to predict blunt pelvic trauma patients with concomitant abdominal HVI. Due to the limited number of cases included in our research, IE performance needs a further testing.

### Funding

Nil.

### Ethical statement

This study was approved by the Ethics Committee of Qilu Hospital of Shandong University.

### Declaration of competing interest

The authors declare that they have no competing financial interests.

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