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ORIGINAL ARTICLE

Clinical parameters for the early detection of complications in patients with blunt hepatic and/or splenic injury undergoing non-operative management

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Abstract

Background Complications arising during non-operative management (NOM) of blunt hepatic and/or splenic trauma, particularly in cases of severe injury, are associated with significant morbidity and mortality. Abdominal computed tomography (CT) is the gold standard for the initial detection of complications during NOM. Although many institutions advocate routine in-hospital follow-up scans to improve success rates, others recommend a more selective approach. The use of follow-up CT remains a subject of ongoing debate, with no validated guidelines available regarding the timing, effectiveness, or intervals of follow-up imaging.

Objective We aimed to identify the clinical parameters for the early detection of complications in patients with blunt hepatic and/or splenic injury undergoing NOM.

Materials and methods This retrospective cohort study included patients with blunt hepatic and/or splenic trauma treated at Songklanagarind Hospital, a level 1 trauma center, from 2013 to 2022. We assessed all patients indicated for non-operative management and examined their clinical parameters and complications.

Results Of 542 patients with blunt hepatic and/or splenic injuries, 315 (58%) were managed non-operatively. High-grade hepatic injuries were significantly associated with complications, as determined through a multivariate logistic regression analysis after adjusting for factors such as contrast blush findings, age, sex, and injury severity score (ISS) (adjusted OR = 7.69, 95% CI 1.59–37.13; $p = 0.011$). Among the patients with complications ($n = 27$), 17 (63%) successfully underwent non-operative management. Notably, eight patients presented with clinical symptoms prior to the diagnosis of complications, while only two patients had no clinical symptoms before the diagnosis. Tachycardia, abdominal pain, decreased hematocrit levels, and fever were significant indicators of complications ($p < 0.05$).

Conclusion Routine CT to detect complications may not be necessary in patients with asymptomatic low-grade blunt hepatic injuries. By contrast, in those with isolated blunt hepatic injuries that are managed non-operatively, high-grade injuries, the presence of a contrast blush on initial imaging, and the patient's age may warrant consideration for routine follow-up CT scans. Clinical symptoms and laboratory observations during NOM, such as tachycardia, abdominal pain, decreased hematocrit levels, and fever, are significantly associated with complications. These symptoms necessitate further management, regardless of the initial injury severity, in patients with blunt hepatic and/or splenic injuries undergoing NOM.

Keywords Blunt abdominal trauma · Blunt liver injury · Blunt hepatic injury · Blunt splenic injury · Non-operative management · Predictive factors · Delayed complications

Introduction

Trauma is the seventh leading cause of death worldwide, causing an estimated 1.35 million fatalities annually across all age groups. [1] In Thailand, approximately 20,000 people die due to trauma each year, with road traffic accidents alone accounting for roughly 56 daily fatalities. [2] Thankfully, a significant proportion of trauma victims survive; however, nearly 10% of

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all injured patients experience abdominal injuries, and one-third of them sustain severe injuries. [3, 4] Blunt abdominal trauma is more prevalent than penetrating trauma, with the liver and spleen being the most commonly injured organs. [3, 5]

Non-operative management (NOM) for blunt hepatic and/or splenic trauma has become the standard treatment for hemodynamically stable patients. [6] Although success rates have been reported to range from 82 to 100%, [7–10] failure of NOM, particularly in patients with severe hepatic and/or splenic injury, is associated with high overall morbidity and mortality. [6] Furthermore, NOM can lead to delayed hepatic bleeding, hepatic hematoma, biliary leakage/fistula, hemobilia, abscess, delayed splenic rupture, pseudoaneurysm, arteriovenous fistula, and abdominal compartment syndrome (ACS) [8, 11–22].

Currently, abdominal CT scans are the gold standard for initial diagnosis, management, and accurate detection of complications during NOM. [23, 24] Many institutions have advocated routine in-hospital follow-up scans to enhance the success rates, even in asymptomatic patients. However, others have recommended a more selective approach [6, 8, 14, 21].

Various factors have been identified [6, 7, 12, 21, 25–32] as indicators of complications during NOM for blunt hepatic and splenic injuries. These factors included age, sex, vital signs at the emergency room (ER) visit and admission, Glasgow Coma Score (GCS), blood lactate level at ER visit, injury severity, associated injuries, trauma score (comprising the injury severity score (ISS) and revised trauma score (RTS)), presence of a contrast blush on CT images, number of blood transfusions, 20% decrease in hematocrit (Hct) level in the first hour, crystalloid resuscitation, and clinical parameters during admission. A previous systematic review [33] of patients with blunt hepatic and splenic injuries treated with NOM reported clinical signs of complications including tachycardia, hemodynamic instability, hypotension, abdominal pain, peritonitis, decreased hemoglobin levels, decreased Hct levels, elevated liver enzyme levels, and fever.

As the use of NOM continues to increase, the complication diagnosis rate also increases. Although certain complications can be managed through observation or conservative treatment, others require intervention or surgery. Therefore, consideration of specific clinical parameters may be a reasonable approach for the early detection of complications in patients with blunt hepatic and/or splenic injuries undergoing NOM.

Method

Data source and patient selection

This retrospective cohort study focused on blunt hepatic and/or splenic injuries in trauma patients aged 15 years or older. Data were sourced from the Hospital Information System and Trauma Registry Database of Songklanagarind Hospital, a level 1 trauma center in Southern Thailand. The study included all the records of patients admitted between January 2013 and December 2022. Patients who were hemodynamically unstable, died upon arrival at the ER, or were pregnant were excluded from the study. The analysis was centered on hemodynamically stable patients who underwent abdominal CT and were selected for NOM. Hepatic and splenic injuries were graded based on their appearance on CT scans, following the Hepatic and Splenic Injury Scale established by the American Association for the Surgery of Trauma. [34] High-grade injuries were categorized as grades 4 and 5. [35, 36] Follow-up CT scans of patients with high-grade injuries were routinely obtained within 7 days of injury to assess for complications during NOM. Similarly, scans were obtained if patients had clinical indications for complications. This study was approved by the Human Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University (grant number: REC.65–466-10–1).

The n4studies formula was used for estimating the finite population proportions. We hypothesized that the primary factor associated with complications was injury severity, specifically, an injury grade of > III. The population size was set to 500. The estimated incidence of complications in patients with hepatic and/or splenic injuries was 8%, which was derived from the report of this study. We chose a type 1 error rate of 5% and an acceptable proportion error rate of 2%. The estimated sample size required for our study was 294.

Patient variables

The primary outcome of this study was to assess the clinical features associated with complications and their management in patients with blunt hepatic and/or splenic injuries undergoing NOM. The clinical parameters examined included age, sex, injury details (ISS and mechanism of injury), associated organ injuries, vital signs at the initial presentation and admission, initial laboratory investigations, and grade of organ injury. Additionally, we collected data on clinical symptoms and complications during NOM. The methods used for managing complications included surgical intervention, percutaneous drainage (PCD), angioembolization (AE), and conservative treatment.

Statistical analysis

The mean and standard deviation (SD) and median and interquartile range (IQR) were calculated for continuous variables. Percentages were calculated for categorical variables. Univariable analyses of continuous and categorical variables were performed using the Wilcoxon rank-sum

(Mann–Whitney) test and Pearson's chi-square test, as appropriate. A p value of <0.05 was considered significant. A multivariable logistic regression analysis was performed to assess the association between the grade of hepatic and/or splenic injury and complications, adjusted odds ratios (ORs), and 95% confidence intervals (CIs) after adjusting for contrast blush, age, sex, and ISS. All statistical analyses were conducted using the R software.

Results

Between January 2013 and December 31, 2022, 542 patients with blunt hepatic and/or splenic injuries were admitted to our hospital (Fig. 1). After the exclusion of 227 patients who had obvious indications for emergency laparotomy, were pregnant, and died at the ER, 315 (58%) patients with confirmed injured organs on abdominal CT were initially managed non-operatively.

Of the 315 patients with blunt hepatic and/or splenic injuries who underwent NOM, 190 (60%) had isolated blunt hepatic injury, 79 (25%) had isolated blunt splenic injury, and 46 (14%) had both blunt hepatic and splenic injuries. Table 1 shows the patients' demographic characteristics. The median (IQR) age was 36 (25,49) years, the ISS score was 22 (14,29), and 70.8% of the patients were men. The most common mechanism of injury was a motorcycle crash (157 patients, 49.8%). The median (IQR) initial and admission SBP were 130 (116,146) mmHg and 126 (115,141) mmHg, respectively. The mean (SD) and median (IQR) initial and admission pulse rate (PR) were 95.5 (± 19.4) and 88 (76,100). The mean (SD) initial Hct level was 37.7% (± 6.4). The median (IQR) initial lactate level and international normalized ratio were 1.8 (1.1,3) and 1.1 (1,1.2), respectively (Table 2). The results of the initial abdominal CT scan are shown in Table 3. Among patients with isolated blunt hepatic injury, 22 (11.6%) had grade I, 62 (32.6%) had grade II, 49 (25.8%) had grade III, 14 (7.4%) had grade IV, 28 (14.7%) had grade V, and 28 (14.7%) had contrast blush. Among patients with isolated blunt splenic injury, 17 (21.5%) had grade I; 29 (36.7%), grade II; 21 (26.6%), grade III; 10 (12.7%), grade IV; 2 (2.5%), grade V; and 7 (8.9%), contrast blush.

Eighty-one percent (56/69) of the patients with high-grade blunt hepatic or splenic injury underwent routine follow-up abdominal CT scans on day 7 after injury. The complications detected from the abdominal CT scans were pseudoaneurysm ($n=10$), hematoma ($n=9$), abscess ($n=6$), thrombosis ($n=3$), delayed splenic rupture ($n=1$), arteriovenous fistula (AVF), and ACS. Patients may present with more than one complication. None of the patients experienced delayed hepatic bleeding, bile leakage, or hemobilia during NOM.

During the NOM period, 27 patients (8.5%) experienced complications. The factors associated with complications in patients with blunt hepatic and/or splenic injuries undergoing NOM are shown in Table 3. The clinical symptoms including tachycardia, abdominal pain, decreased Hct, and fever were significantly associated with complications ($p<0.05$). Grading of hepatic injury was associated with the complications of isolated blunt hepatic injury ($p=0.001$); however, grading of splenic injury was not associated with the occurrence of complications in patients with isolated blunt splenic injury undergoing NOM.

In the multivariable logistic regression analyses adjusted for contrast blush finding, age, sex, and ISS, the adjusted OR for complications of high-grade isolated blunt hepatic injury was 7.69 (95% CI 1.59–37.13; $p=0.011$) (Fig. 2(2.1)).

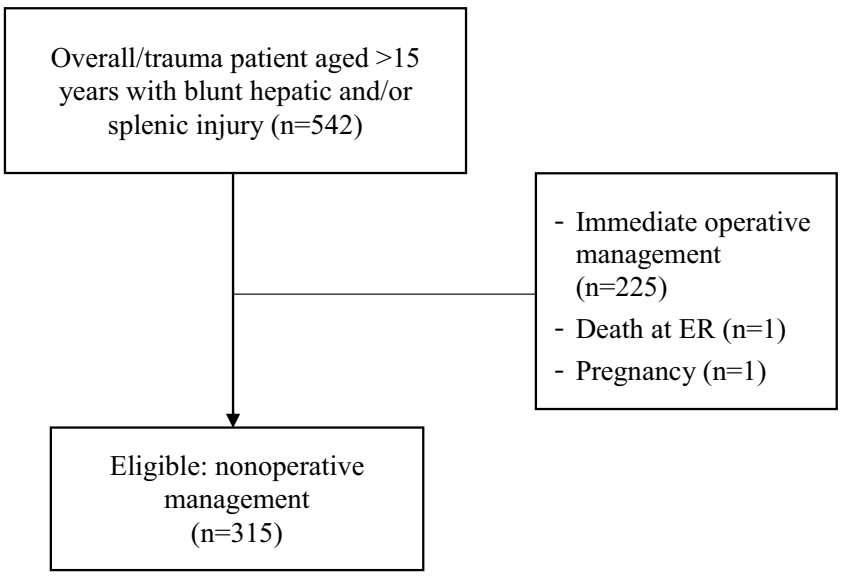

Fig. 1 Flowchart of the patient selection process

Table 1 Demographic characteristics of patients with blunt hepatic and/or splenic injury undergoing non-operative management as initial assessment

	Total ($n=315$)	Injured organ			p value
		Liver ($n=190$)	Spleen ($n=79$)	Both ($n=46$)	
Age, years, median (IQR)	36 (25–49)	39 (25.2–49)	33 (23–49.5)	36.5 (24.5–48)	0.431
Sex, male	223 (70.8)	133 (70)	60 (75.9)	30 (65.2)	0.414
ISS, median (IQR)	22 (14–29)	22 (14–29)	20 (13–27)	23 (17–29)	0.274
Mechanism of injury, *n* (%)					
Mechanism of injury (MVC)	84 (26.7)	52 (27.4)	18 (22.8)	14 (30.4)	
Motorcycle crash (MCC)	157 (49.8)	92 (48.4)	43 (54.4)	22 (47.8)	
Automobile versus pedestrian (AVP)	9 (2.9)	7 (3.7)	2 (2.5)	0 (0.0)	
Bicycle	2 (0.6)	1 (0.5)	1 (1.3)	0 (0.0)	
Falling from the ground level	30 (9.5)	18 (9.5)	5 (6.3)	7 (15.2)	
Fall from height	9 (2.9)	6 (3.2)	2 (2.5)	1 (2.2)	
Assaulted	3 (1)	1 (0.5)	2 (2.5)	0 (0.0)	
Blast	5 (1.6)	3 (1.6)	1 (1.3)	1 (2.2)	
Others	16 (5.1)	10 (5.3)	5 (6.3)	1 (2.2)	
Associated organ injury, *n* (%)					
Head injury	85 (27)	51 (26.8)	22 (27.8)	12 (26.1)	0.975
Chest injury	173 (54.9)	109 (57.4)	45 (57)	19 (41.3)	0.133
Pelvic injury	41 (13)	27 (14.2)	12 (15.2)	2 (4.3)	0.163
Long bone fracture	68 (21.6)	38 (20)	22 (27.8)	8 (17.4)	0.274
Other extra-abdominal organ injury	169 (53.7)	104 (54.7)	43 (54.4)	22 (47.8)	0.692
Other intra-abdominal organ injury	94 (29.8)	57 (30)	23 (29.1)	14 (30.4)	0.985
Vital signs at initial assessment					
SBP, mmHg, median (IQR)	130 (116–146)	133 (119–147)	129 (114–146)	123 (107.8–136.2)	0.039
PR, bpm, mean (SD)	95.5 (19.4)	94.7 (19.2)	95.9 (20.1)	98.4 (19.4)	0.511
GCS, median (IQR)	15 (14–15)	15 (15–15)	15 (15–15)	15 (14–15)	0.338
Vital signs at admission					
SBP, mmHg, median (IQR)	126 (115–141)	127 (117–141)	127.5 (114.8–144)	122 (112–136)	0.186
PR, bpm, median (IQR)	88 (76–100)	88 (76–100)	89 (76–100.5)	87 (72.8–97.2)	0.758
Laboratory tests					
Lactate, median (IQR)	1.8 (1.1–3)	1.8 (1.1–3.1)	1.7 (1.1–2.6)	1.8 (1.1–3.2)	0.764
Hct, mean (SD)	37.7 (6.4)	38.2 (6.1)	36.7 (7)	37.5 (6.2)	0.212
Platelet, median (IQR)	245,500 (194,250–299,750)	248,500 (192,250–298,250)	234,000 (198,250–293,750)	275,500 (217,750–317,000)	0.155
INR, median (IQR)	1.1 (1–1.2)	1.1 (1–1.2)	1.1 (1–1.2)	1.1 (1–1.2)	0.757
Hct at 24 h after injury, mean (SD)	32.2 (6)	32.7 (5.9)	31.9 (6.6)	30.6 (5)	0.114

IQR, interquartile range; *ISS*, injury severity score; *GCS*, Glasgow Coma Score; *Hct*, hematocrit; *INR*, international normalized ratio

Conversely, the adjusted OR for complications of high-grade isolated blunt splenic injuries was not significant (Fig. 2(2.2)). In isolated blunt hepatic injury, contrast blush finding and age were associated with the occurrence of complications with significant differences (adjusted OR = 4.49, 95% CI 1.11–18.12, $p=0.035$ and adjusted OR = 1.04, 95% CI 1–1.08, $p=0.042$) (Fig. 2).

Of the 27 (8.5%) patients with complications during NOM, two (7.4%) underwent surgery due to hepatic abscess/necrosis, three (11.1%) underwent PCD, five (18.5%) underwent AE, and 17 (63%) continued NOM (Table 4). All patients with complications survived. Two patients without complications required surgery for unexplained hypotension, which was attributed to severe head trauma and ileal perforation. The median (IQR) length of stay in the intensive care unit, hospital stay, and hospital costs in patients with complications were greater than those in patients without complications, with nonsignificant differences, except for hospital stay (1.5 vs 1 day, $p=0.055$; 18 vs 12 days, $p=0.024$, 168,686.5 vs 163,668 baht, $p=0.724$). The median duration

Table 2 Complications in patients with blunt hepatic and/or splenic injury undergoing NOM

	Total 315	Liver 190	Spleen 79	Both 46
Pseudoaneurysm	10 (3.2)	5 (2.6)	2 (2.5)	3 (6.5)
Hematoma	9 (2.9)	7 (3.7)	2 (2.5)	0 (0)
Abscess/necrosis	6 (1.9)	5 (2.6)	0 (0)	1 (2.2)
Thrombosis	3 (1)	1 (0.5)	1 (1.3)	1 (2.2)
Delayed splenic rupture	1 (0.3)	0 (0)	1 (1.3)	0 (0)
Arteriovenous fistula (AVF)	1 (0.3)	0 (0)	0 (0)	1 (2.2)
Abdominal compartment syndrome (ACS)	1 (0.3)	1 (0.5)	0 (0)	0 (0)
Bile leakage	0 (0)	0 (0)	0 (0)	0 (0)
Hemobilia	0 (0)	0 (0)	0 (0)	0 (0)
Delayed hepatic bleeding	0 (0)	0 (0)	0 (0)	0 (0)

A patient may present with more than one complication

of repeat abdominal CT scans was the same in both groups (7 days).

Table 5 shows all 10 (37%) patients with complications who underwent surgery and/or intervention, and eight patients who had clinical symptoms before the diagnosis of complications. Only two patients had no clinical symptoms before the diagnosis; one patient showed AVF on abdominal CT scans, but a negative finding was obtained after performing an angiogram. One patient showed splenic pseudoaneurysm and successfully underwent AE.

Discussion

NOM in blunt hepatic and/or splenic injury has become the standard of care in hemodynamic stable patients with a high success rate ranging from 82 to 100%. [7–10, 37] Before a

Table 3 Factors associated with complications during non-operative management in patients with blunt hepatic and/or splenic injury

	Complications ($n=27$)	No complications ($n=288$)	Total ($n=315$)	p value
Age, years, median (IQR)	39 (28.5–55.5)	36 (24–49)	36 (25–49)	0.188
Sex, male	10 (37)	82 (28.5)	92 (29.2)	0.349
ISS, median (IQR)	25 (19–29)	20 (14–29)	22 (14–29)	0.052
Clinical symptoms				
Tachycardia*	9 (33.3)	9 (3.1)	18 (5.7)	< 0.001
Hypotension**	0 (0)	1 (0.3)	1 (0.3)	1
Abdominal pain	3 (11.1)	2 (0.7)	5 (1.6)	0.005
Peritonitis	0 (0)	1 (0.3)	1 (0.3)	1
Decrease in hematocrits***	3 (11.1)	3 (1)	6 (1.9)	0.009
Fever****	8 (29.6)	20 (6.9)	28 (8.9)	< 0.001
Associated injuries, n (%)	20 (74.1)	260 (90.3)	280 (88.9)	0.02
Grade of hepatic injury, n (%)	($n=15$)	($n=175$)	($n=190$)	< 0.001
1	1 (6.7)	21 (12)	22 (11.6)	
2	0 (0)	62 (35.4)	62 (32.6)	
3	3 (20)	46 (26.3)	49 (25.8)	
4	7 (46.7)	36 (20.6)	43 (22.6)	
5	4 (26.7)	10 (5.7)	14 (7.4)	
Contrast blush	8 (53.3)	20 (11.4)	28 (14.7)	
Grade of splenic injury, n (%)	($n=6$)	($n=73$)	($n=79$)	0.438
1	0 (0)	17 (23.3)	17 (21.5)	
2	1 (16.7)	28 (38.4)	29 (36.7)	
3	3 (50)	18 (24.7)	21 (26.6)	
4	1 (16.7)	9 (12.3)	10 (12.7)	
5	1 (16.7)	1 (1.4)	2 (2.5)	
Contrast blush	1 (16.7)	6 (8.2)	7 (8.9)	

IQR, interquartile range; *ISS*, injury severity score

*Tachycardia, HR > 120 beat per minute

**Hypotension, BP < 90/60 mmHg

***Decrease hematocrit levels, Hct decrease ≥ 20% of previous and/or Hct < 24%

****Fever, BT > 38.0 °C

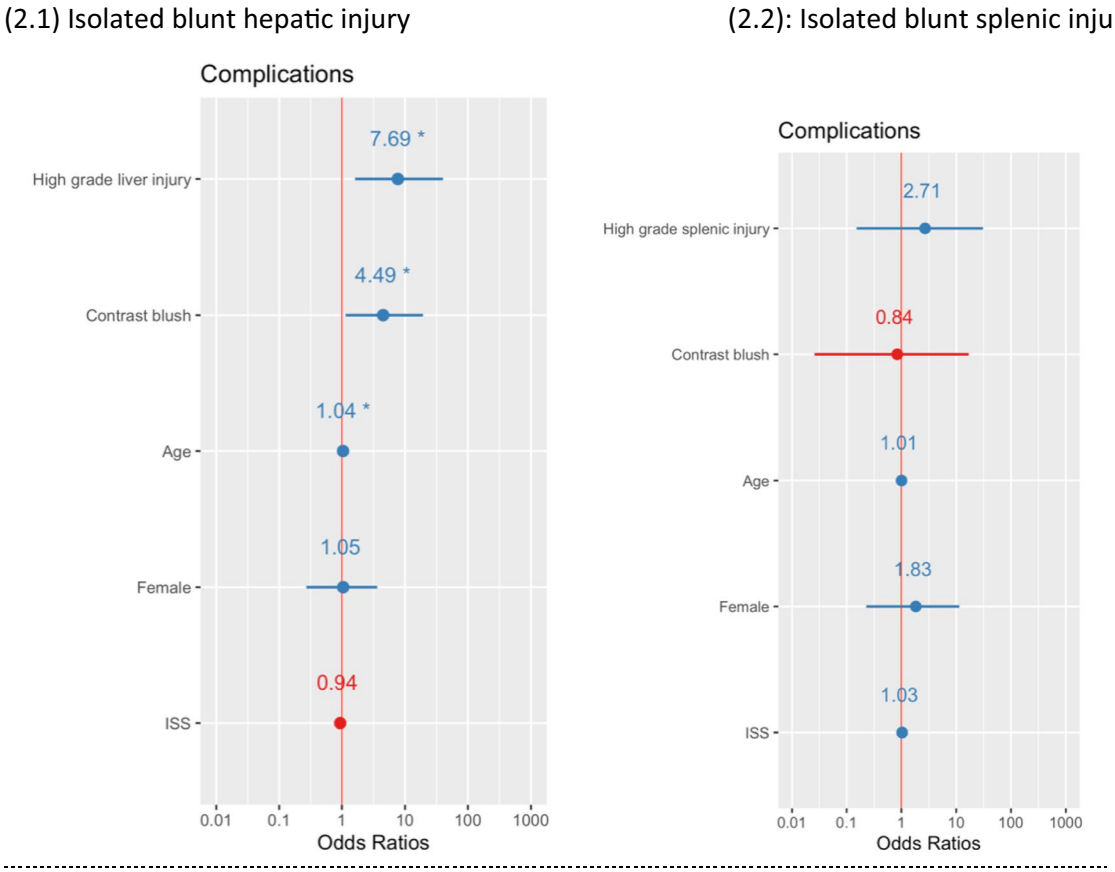

Fig. 2 Multivariable logistic regression of complications in patients with isolated blunt hepatic injury (2.1). Multivariable logistic regression of complications in patients with isolated blunt splenic injury (2.2). *Statistically significant

Table 4 Management and outcome of patients with blunt hepatic and/or splenic injury undergoing non-operative management after complications

	Complications $n=27$	No complications $n=288$	Total $n=315$	p value
Management, n (%)				< 0.001
Surgery	2 (7.4)	2 (0.7)	4 (1.3)	
Percutaneous drainage (PCD)	3 (11.1)	0 (0)	3 (1)	
Angioembolization (AE)	5 (18.5)	0 (0)	5 (1.6)	
Conservative treatment	17 (63)	286 (99.3)	303 (96.2)	
Outcome, n (%)				1
Survive	27 (100)	276 (95.8)	303 (96.2)	
Death from other cause	0 (0)	10 (3.5)	10 (3.2)	
refer	0 (0)	2 (0.7)	2 (0.6)	
Duration of 2nd CT scan, median (IQR)	7 (5–7.2)	7 (6–7)	7 (6–7)	0.823
ICU stay, days, median (IQR)	1.5 (0.8–3)	1 (0–2)	1 (0–2)	0.055
Hospital stay, days, median (IQR)	18 (12.5–23)	12 (8–21)	12.5 (8–21)	0.024
Hospital cost, baht, median (IQR)	168,686.5 (112,902–279,501.5)	163,668 (74,730–300,654)	163,668 (74,907–300,654)	0.724

ICU, intensive care unit stay

Table 5 Patients with complications who underwent intervention and/or surgery

Patient no	Age (years old)	Organ injury and injury grade	Injury severity score	Complications	Clinical symptoms	Duration of follow-up imaging (days)	Management
1	28	- Liver grade III -Spleen grade III	27	Splenic AVF	None	7	Angiogram Finding: no AVF
2	65	Liver grade V with contrast blush	33	-Hepatic abscess -Hepatic hematoma -Small hepatic pseudoaneurysm	Abdominal pain	3	PCD
3	55	-Liver grade IV -Spleen grade II	41	Splenic pseudoaneurysm	None	8	AE
4	37	-Liver grade V with contrast blush	26	Hepatic abscess	-Tachycardia -Fever	3	Surgery
5	59	-Liver injury grade I	17	Hepatic hematoma	-Decreased hematocrit level	1	-AE
6	51	Spleen grade III	27	Delay splenic bleeding	-Decreased hematocrit level -Tachycardia	7	-AE
7	56	Liver grade IV with contrast blush	38	-Hepatic abscess -Hepatic hematoma	-Tachycardia -Fever -Abdominal pain	14	PCD
8	30	Liver injury with contrast blush	30	Hepatic abscess	-Fever -Tachycardia	3	Surgery
9	23	Liver grade IV with contrast blush	25	Hepatic hematoma	-Decreased hematocrit level -Fever	2	PCD
10	43	Splenic grade IV	20	Splenic pseudoaneurysm	-Decrease in hematocrits	5	AE

patient was selected to undergo NOM, an abdominal CT scan was performed as a diagnostic modality with a low incidence of missed intraabdominal organ injury. [8, 38] Abdominal CT scan is the gold standard for diagnostic and grading hepatic and splenic lesions with a sensitivity of 86.6 and a specificity of 100%. [39] Moreover, abdominal CT scans were used to detect complications during NOM with the expectation of increasing the success rate of NOM.

In this study, we routinely requested follow-up CT scans on post-injury day 7 after the initial CT scan of patients with high-grade hepatic and/or splenic injuries. The duration of the follow-up CT scan was determined based on previous studies conducted by Pachter et al. [40] for blunt hepatic injury and Leeper et al. [19] for blunt splenic injury. These studies suggest that a follow-up CT scan between 7 and 10 days after injury can aid in determining the timing of discharge and the early detection of complications in a hospital setting. However, the value of routine imaging remains controversial. Many studies and institutions recommend repeat CT scans selectively in patients with blunt hepatic and splenic injuries [5, 22, 33, 40, 41].

In our study, complications occurred in 7.8% of patients with isolated hepatic injuries and 7.6% of patients with isolated splenic injuries. These results differ from those of previous studies, which reported failure rates of approximately 10% for splenic injuries and 2% for hepatic injuries in patients who underwent non-operative therapy. [14] The variation observed in our study could be attributed to the proportion of patients who underwent a second CT scan, primarily those with high-grade injuries, and a smaller number of patients with isolated blunt splenic injuries. Specifically, the splenic-related complications in our study included pseudoaneurysms (2), hematomas (2), delayed splenic rupture (1), and thrombosis (1). The hepatic-related complications consisted of pseudoaneurysms (5), hematomas (7), hepatic abscess/necrosis (5), thrombosis (1), and ACS (1). Notably, none of the patients developed biliary hepatic complications, such as bile leakage/biloma, hemobilia, or delayed hepatic bleeding.

Among patients who experienced complications, 63% continued conservative treatment. Of the 27 patients with complications, 10 required further management. This included hepatic necrosectomy in two patients with hepatic abscesses/necrosis, percutaneous drainage in three patients (two with hepatic abscesses and one with hepatic hematoma), AE in four patients (two with splenic pseudoaneurysms and two with delayed splenic bleeding and hepatic hematoma), and angiography in one patient (splenic AVF). Notably, AE was

performed more frequently for the treatment of splenic-related complications than hepatic-related complications. This is due to the arterial nature of splenic injuries, which can lead to the development of pseudoaneurysms with delayed rupture. By contrast, liver injuries primarily involve venous bleeding, which can often achieve spontaneous hemostasis. [19, 42] However, early AE may increase the failure rate of NOM, as recommended by the Western Trauma Association and the Eastern Association for the Surgery of Trauma [21, 43].

In blunt hepatic injury, especially in high-grade cases, the severity of the liver injury increases the incidence of complications. [12] Notably, the presence of a contrast blush on CT scans is more likely to lead to NOM failure in patients with blunt hepatic injuries. [16] For splenic injuries, the severity of the injury does not consistently predict the presence of latent pseudoaneurysms. [41] Pseudoaneurysms and delayed splenic bleeding can occur, even in patients with low-grade splenic injuries. In our study, multivariate logistic regression analysis adjusted for contrast blush, age, and ISS revealed that high-grade hepatic injuries, the presence of a contrast blush, and older age were associated with complications. However, the severity of splenic injury was not associated with complications.

The routine use of follow-up CT during NOM for blunt hepatic and/or splenic injuries remains a topic of debate. Some studies suggest that follow-up CT scans should be indicated for patients who develop clinical symptoms, as repeated CT scans in asymptomatic patients often do not alter the management course. [8, 14, 44] Interestingly, clinical parameters during the NOM period may play a crucial role in the early detection of complications, regardless of the initial severity of the injury. The clinical parameters significantly associated with complications in our study included tachycardia, abdominal pain, decreased Hct levels, and fever. Notably, all patients with complications in our study survived.

Limitations

This study has some limitations. This was a single-center retrospective review, which resulted in a lower number of patients compared with previous studies. However, these findings can still benefit our hospital by aiding in the early detection and management of complications during the nonoperative period in patients with blunt hepatic and/or splenic injuries.

Conclusion

Routine CT to detect complications may not be necessary in asymptomatic patients with low-grade blunt hepatic injuries. High-grade hepatic injuries, the presence of a contrast blush on initial imaging, and age may warrant consideration for routine follow-up CT scans, especially in cases of isolated blunt hepatic injuries that are managed non-operatively. The clinical symptoms observed during NOM, such as tachycardia, abdominal pain, decreased Hct levels, and fever, are significantly associated with complications. These symptoms necessitate further management, regardless of the severity of initial injury. The results of this study may be applicable to countries with similar patient populations and characteristics. However, further research is needed to explore the efficacy, safety, and cost-effectiveness of alternative methods for detecting complications, such as laboratory investigations instead of repeat CT scans.

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