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นิพนธ์ต้นฉบับ **Original Article**

Correlation of Computed Tomographic Findings in Blunt Liver Trauma with Treatments and Outcomes in Nakhonpathom Hospital

ความสัมพันธ์ของภาพถ่ายเอกซเรย์คอมพิวเตอร์ และผลการรักษาของผู้ป่วยที่ได้รับการบาดเจ็บ ของตับที่เกิดจากการกระแทก ในโรงพยาบาลนครปฐม

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ABSTRACT

Purpose: To correlate the grading of CT finding of blunt of liver injury in patients who received computed tomography (CT) imaging to their treatments and outcomes in Nakhonpathom hospital.

Design: Descriptive retrospective study.

Materials and Methods: From January to December 2010, one hundred and twenty-eight patients with blunt abdominal injuries who underwent contrast enhanced abdominal CT scan before their treatments were recruited and reviewed. Classifications according to the American Association for the Surgery of Trauma (AAST) were used. The CT gradings were correlated to the surgical findings and outcomes.

Results : 19 out of 128 patients who suffered a blunt abdominal injury had hepatic injury (14.84%). They were categorized into five grades : 12 patients, grade 1; 3 patients, grade 2; 3 patients, grade 3 and 1 patient, grade 5. There was no patient with grade 4 injury. Other organ injuries were also found such as fractures, splenic, kidney and intestinal injuries. Conservative treatment was given to 14 patients; 11 patients with grade 1, 2 patients with grade 2 and 1 patient with grade 3. Five patients underwent surgery; each with grade 1, 2, 5 and 2 with grade 3. One patient with grade 3 was died from ARDS.

Conclusion : Injury grading with CT may demonstrate the extension in blunt liver injury but it cannot determine the need of surgery.

Keywords: computed tomography, blunt liver trauma.

บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาความสัมพันธ์ระหว่างการบาดเจ็บของตับที่เกิดจากแรงกระแทก ในระดับความรุนแรงต่างๆ ที่ตรวจพบจากภาพถ่ายเอกซเรย์คอมพิวเตอร์ และผลการรักษาของผู้ป่วยในโรงพยาบาลนครปฐม

วิธีการศึกษา: เป็นการศึกษาเชิงพรรณนาโดยเก็บข้อมูลย้อนหลัง (descriptive retrospective study) จากการทบทวนรายงานเวชระเบียนผู้ป่วยจำนวน 128 ราย ที่ประสบอุบัติเหตุกระแทกบริเวณท้องและได้รับการตรวจเอกซเรย์คอมพิวเตอร์ก่อนได้รับการรักษา แบ่งการบาดเจ็บตาม American Association for Surgery of Trauma แล้วจึงเชื่อมโยงความสัมพันธ์กับผลการรักษาที่ได้รับ

ผลการศึกษา : พบผู้ป่วยที่มีภยันตรายของตับ 19 ราย จากผู้ป่วยบาดเจ็บช่องท้องที่ได้รับการเอกซเรย์คอมพิวเตอร์จากทั้งหมด 128 ราย ที่ได้รับการบาดเจ็บที่เกิดจากแรงกระแทกของอวัยวะภายในช่องท้อง ถูกจำแนกตามความรุนแรงเป็น 5 ระดับ โดยมีระดับ 1 มี 12 ราย ระดับ 2 มี 3 ราย ระดับ 3 มี 3 ราย และระดับ 5 จำนวน 1 ราย การบาดเจ็บของอวัยวะอื่นที่พบร่วมด้วย เช่น กระดูกหัก การบาดเจ็บของไต ม้าม และลำไส้ ผู้ป่วย 14 ราย ได้รับการรักษาแบบไม่ผ่าตัด โดยเป็นการบาดเจ็บในระดับ 1 จำนวน 11 ราย ระดับ 2 จำนวน 2 ราย และระดับ 3 จำนวน 1 ราย ผู้ป่วย 5 ราย ได้รับการรักษาโดยการผ่าตัด และผู้ป่วย 1 ราย เสียชีวิตจากภาวะ ARDS

สรุปและข้อเสนอแนะ: การตรวจเอกซเรย์คอมพิวเตอร์ในผู้ป่วยที่ได้รับการกระแทกในส่วนท้องสามารถบอกรายละเอียดการบาดเจ็บของตับ อวัยวะใกล้เคียงและผลการรักษา แต่ความรุนแรงของการบาดเจ็บที่เกิดจากการกระแทกของตับ ที่พบจากการตรวจ เอกซเรย์คอมพิวเตอร์ ไม่ได้เป็นตัวกำหนดว่าต้องผ่าตัดหรือไม่ ทั้งนี้ต้องพิจารณาจากอาการทางคลินิกของผู้ป่วยด้วย

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The liver is the second most commonly injured organ but the most common cause of death in abdominal trauma. The most common cause of liver injury is blunt abdominal trauma, which is secondary to motor vehicle accidents in most instances.

An incidence of liver injury in blunt abdominal trauma varies from 3-8%. Isolated hepatic lesions are rare, so associated injunes of other organs are always involved.[1] The mortality rate of blunt liver injury ranges from 4% to 12%[2], Unlike penetrating injury , the multiple organ injuries have often seen in blunt trauma , making the accurate diagnosis is more difficult and complicated.[1-5]

Computed tomography (CT) scan is the diagnostic modality of choice for the evaluation of blunt liver trauma in hemodynamically stable patients and can accurately help identify hepatic parenchymal injuries, quantify the degree of hemoperitoneum and reveal associated injuries of other abdominal organs, retroperitoneal structures and the gastrointestinal tract. CT is also useful in the assessment of delayed complications in blunt liver trauma, including delayed hemorrhage, hepatic or perihepatic abscess, post-traumatic pseudoaneurysm, hemobilia and other biliary complications such as biloma and bile peritonitis. Follow-up CT is needed in patients with high grade liver injuries to identify potential com-

plication that require early intervention[4,6,7]

The published literatures documented that at least 20-40% of blunt hepatic injury could be successfully treated with conservative management.[4,8] Recent surgical literatures also found that non-operative management of liver injuries following blunt abdominal trauma has become more widely accepted.[4,9,10] Becker et al. belive that injury grading with CT enables the radiologist to distinguish patients who can be safely observed from those who may need surgery.[8] Major hepatic injuries with grade 4 severity and hemodynamically stable can be managed without surgery.[8]

The aim of this study is to determine the value of CT findings in decision-making of the treatment. The author proposes that CT grading system correlates with further treatment and outcome of hepatic injunes.

Mechanism of liver injury

The liver is the largest solid abdominal organ with a relatively fixed position, which makes it prone to injury.[2] The liver is vulnerable to any injury that occurs to the posterior right lobe from a simple compression against the fixed ribs, the spine or the posterior abdominal wall.

Liver injury grading system

The AAST (American Association for the Surgery of Trauma) has developed a scoring system for assessment of the severity of an injury to the liver based on its anatomical structure, including the length and numbers of laceration and the surface area.

Hagiwara, et al. demonstrated that high grade of hepatic injuries (grade 3 to 5) were prone to higher risks of ongoing or delayed bleeding, whereas hepatic embolization in vascular injury is known to improve the success rate of non-operative treatment.

Materials and Methods

From January - December 2010, 128 of patients who were admitted with blunt abdominal trauma and underwent CT scanning during their acute imaging assessment together with stable hemodynamical status were recruited into this study. The mechanisms of injuries were as follows: motor vehicle collision, pedestrian struck by vehicles, falling from height and body assaults. All initial abdominal CT scans were obtained within 48 hours after their admission. The CT scanning was performed from the lung base to the pubic symphysis by using a Brilliance 16 (PHILIPS) with routinely intravenous contrast enhancement by using power injected bolus machine of 100 ml of 300 mg of iodine per milliliter at rate 2-4 ml per second.

The patients' age, mechanism of injuries, treatment, clinical outcomes as well as their CT images of livers and associated organ injuries were recorded and reviewed.

The CT images were reviewed. Other associated organ injuries were also reviewed and recorded. The surgical records of all the patients were reviewed to determine the outcomes of the surgical or nonsurgical management.

The CT images were retrospectively reviewed based on defined criteria. Linear or stellete-shaped hypoattenuating lesions at the hepatic surface or

within the hepatic parenchyma were interpreted as *capsular disruption* or as *intraparenchymal lacerations;* peripheral lenticular lesions were as of hypoattenuation on contrast enhanced CT were interpreted as *subcapsular hematoma* ; round, ellipsoid or irregular lesions within the hepatic parenchyma were interpreted as *intrahepatic hematoma*. Extravasation of contrast material into liver parenchyma was defined as *vascular injury.* CT grades of injury severity for blunt hepatic trauma were classified as in table 1.

Results

Liver injuries were found in 19 from 128 patients (14.84 %) : 3 women and 16 men. Their age ranged from 14 to 63 years (mean = 37.1). The mechanisms of injuries were as follows: motor vehicle collision (n = 94), pedestrian struck by vehicle (n = 22), falling from height (n = 18) and body assault (n = 4)

Table 1 CT-based injury severity of blunt liver injury (AAST)

Grade	Type of injury	Description of injury
I	Hematoma Laceration	Subcapsular nonexpanding < 10% surface area Capsular tear < 1 cm. parenchymal depth
II	Hematoma Laceration	Subcapsular nonexpanding 10-50% surface area. Intraparenchymal nonexpanding < 10 cm. in diameter 1-3 cm. parenchymal depth < 10 cm. in length-
III	Hematoma Laceration	Subcapsular > 50% surface area Intraparenchymal hematoma > 10 cm. in diameter > 3 cm. parenchymal depth
IV	Laceration	Parenchymal disruption involving 25-75% of hepatic lobe
V	Laceration Vascular	Parenchymal disruption involving > 75% of hepatic lobe Juxtahepatic venous injuries
VI	Vascular	Hepatic avulsion

Note: Based on the American Association for the Surgery of Trauma (AAST)

CT findings

CT scans obtained with contrast material enhancement on the basis of the criteria in Table 1, 19 liver injuries were classified as CT grade 1 in 12 patients (fig.1), grade 2 in 3 patients (fig. 2), grade 3 in 3 patients (fig. 3), grade 5 in 1 patient (fig. 4). There was no patient with CT grade 4 injury.

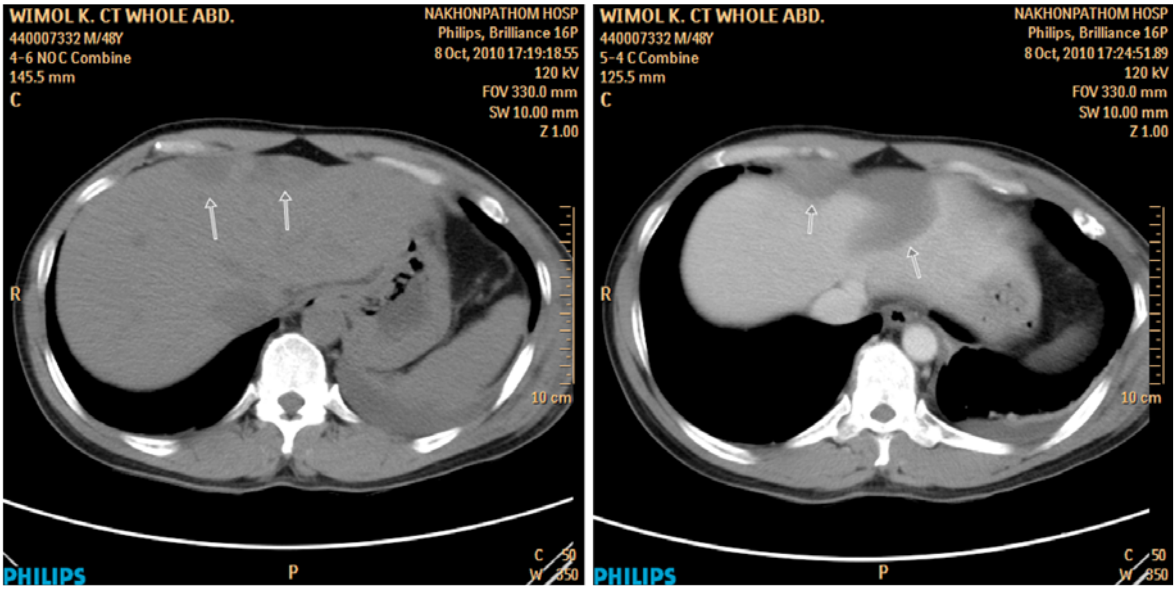

Figure 1 Grade 1 liver injury in 48- year-old male patient admitted following blunt abdominal injury. Axial pre-and post contrast CT scan shows a subcapsular hematoma (arrows)

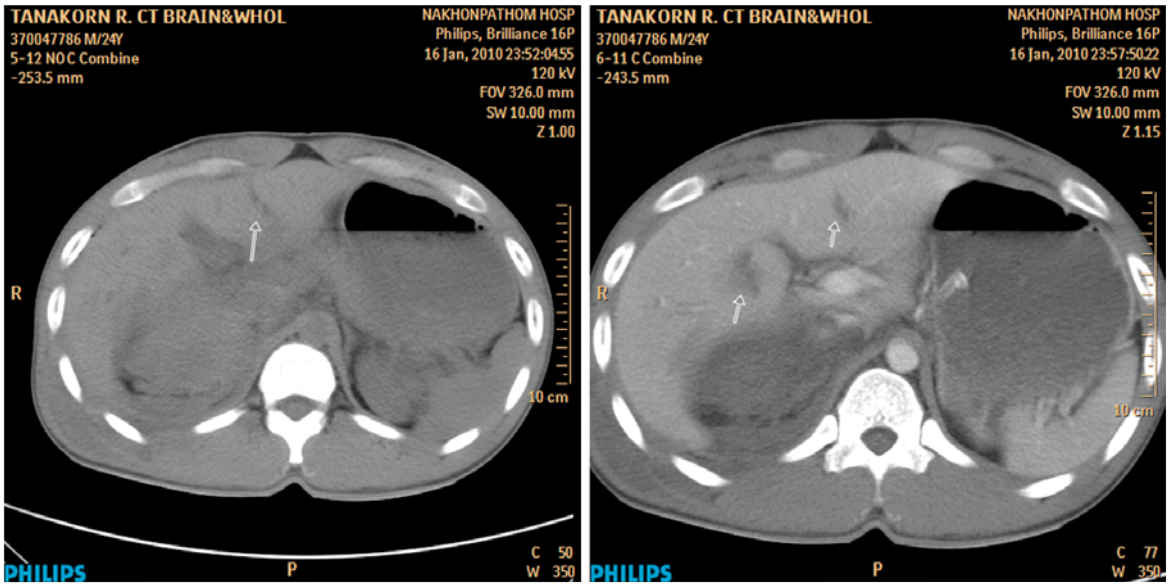

Figure 2 Grade 2 liver injury in 24-year-old male patient admitted following blunt abdominal injury. (a). Axial post-contrast CT scan shows a few of irregular hypodense area at both lobes of liver. These represent lacerations (arrows)

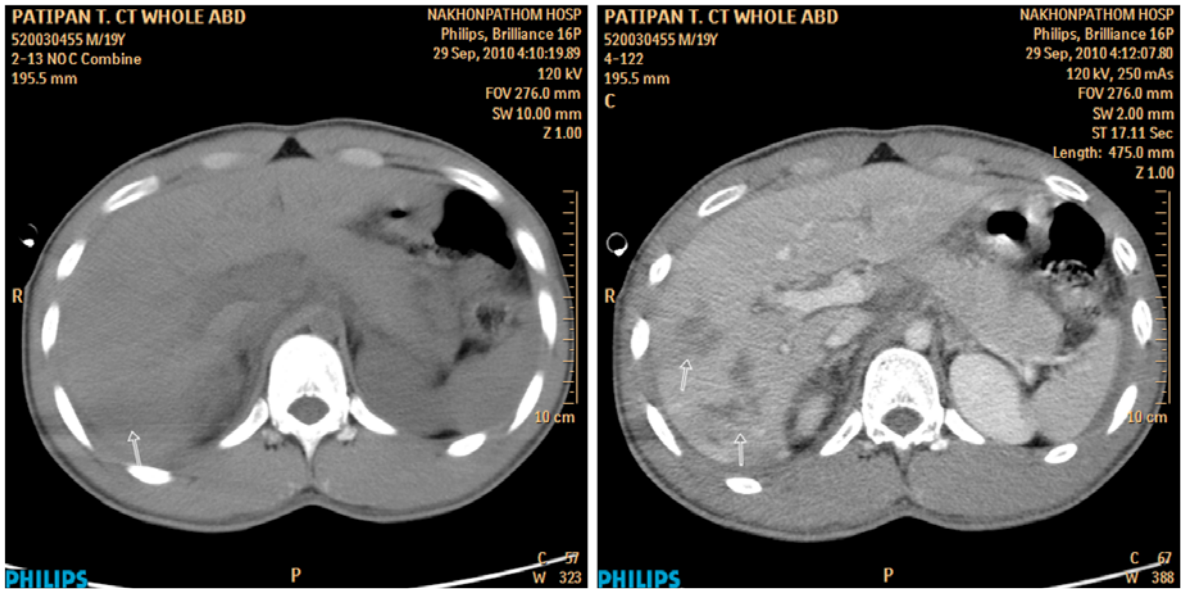

Figure 3 Grade 3 liver injury in 19-year-old male patient admitted following blunt abdominal injury. (a and b) Axial pre- and post contrast CT scans show multiple lacerations at right lobe (arrows)

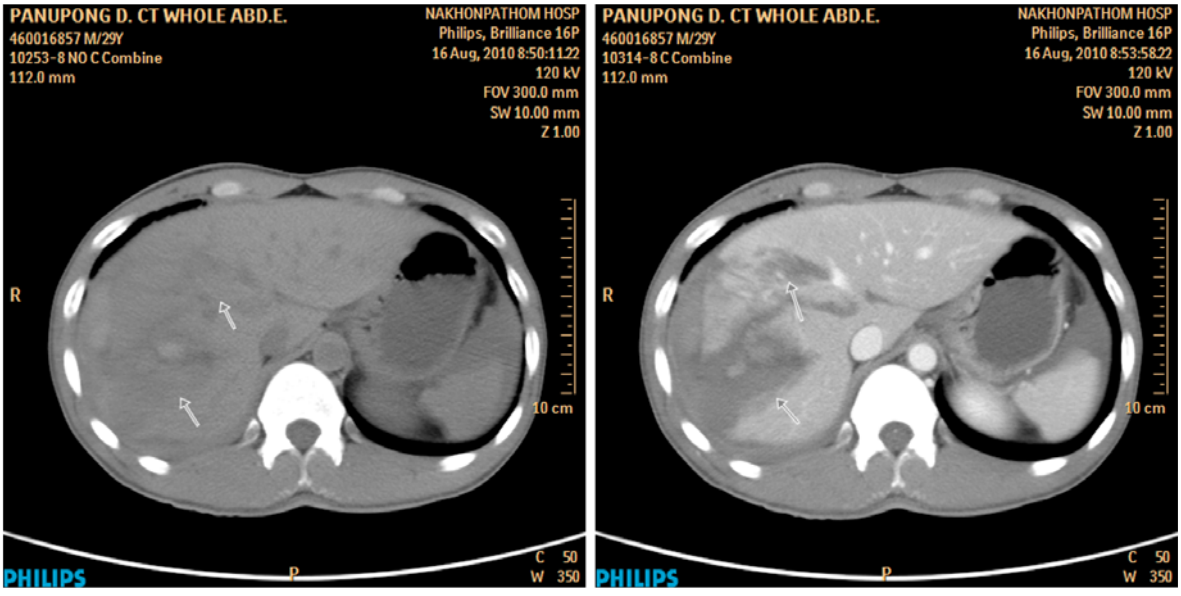

Figure 4 Grade 5 liver injury in 29-year-old male patient with blunt abdominal trauma. (a and b) Axial pre-and post contrast CT scan reveal severe parenchymal disruption. (arrows)

Type of management

The fourteen patients have been successfully treated non-operatively. There was one death in this study which defined as grade 3 liver injury. The cause of death was ARDS. Five cases underwent laparotomy.

I. Patients who were treated conservatively:

Fourteen patients were treated conservatively, including 11 patients with grade 1 hepatic injury, 2 patients with grade 2 hepatic injury and 1 patient with grade 3 hepatic injury as in table 2. Thirteen patients were successful in conservative treatments.

II. Patients who underwent operation:

Five patients who underwent operation were classified into liver injury - related and non liver injury-related as in table 3. There was one patient with grade 1 liver injury who underwent splenectomy due to unstable clinical status.

Operative finding in 1 patient with grade 5 liver injury was parenchymal disruption with perihepatic hematoma. The operative management was liver packing to stop bleeding.

Associated organ injuries

A benefit of using CT scan in the assessment of blunt abdominal injury is the ability to evaluate the injuries of other organs.[8-9] In this study, this benefit was also appreciated, as shown in table 4. The most associated injuries were fractures of ribs whereas the most injured solid organ was the spleen as also described in other literatures.[8-9] Hemoperitoneum was the most common positive finding, found in 11 patients.

Discussion

Recently, conservative treatment has been widely accepted for blunt liver injuries as it decreases surgical complications as well as shortens the length of hospital admissions. CT scan appears to be a desirable tool to assess treatment in blunt liver trauma. However, according to recent literatures, there is no reliable predictor for failed conservative

Table 2 Correlation of CT grading with non-operative treatment (n = 14)

Grade	N of conservative
I	11
II	2
III	1
IV	-
V	-

Table 3 Correlation of CT grading with operative management (n = 5)

Grade	Laparotomy		
	Liver injury - related (n)	**Non liver injury - related (n)**	**Finding**
I	-	1	- Ruptured spleen grade III
II	-	1	- Mesentery injury - Right renal injury grade II - Fracture right rib
III	2	-	- Intraparenchymal hematoma - Subcapsular hematoma
IV	-	-	
V	1	-	- Parenchymal disruption with perihepatic hematoma

Table 4 Associated organs injuries

Injury	Number	Injury	Number
Splenic injury	6	Fracture rib	5
Kidney injury	3	Fracture pelvis	2
Pancreatic injury	1	Fracture femur	1
Hemoperitoneum	10	Muscular contusion	2
Pneumothorax	1	Intramuscular hematoma	1

management demonstrated on CT scan.[1-4,8] The AAST injury grading system appears to predict the need for surgical treatment and patients who require a surgical operation have a poorer prognosis. There has been an increase in the total number of adults with all grades of blunt hepatic injury that can be successfully managed without surgical treatment. The most common cause of the failure in non-operative management of hepatic injury is an ongoing bleeding.

In this study, low grade liver injuries (grade 1 and 2) were exclusively appreciated by non-operative treatment while three in four high grade liver injuries (grade 3-5) underwent operative treatment. One patient with grade 3 liver injury died from ARDS. One patient with grade 5 injury underwent laparotomy with severe liver laceration and hematoma; the surgeons were successful in packing to stop bleeding.

The decision to perform laparotomy was made on basis of both clinical and radiologic findings. Croce et al. considered CT to be unreliable in the assessment of hepatic injury because in 84% of their patients, the CT grades were not correlated to the operative findings. Many lesions were either underestimated or overestimated.[12]

Hemoperitoneum is another CT scan sign that has been receiving much discussion about.[6,7] Hagiwara, et al. successfully treated 54 blunt hepatic trauma patients non-operatively. Twenty-six of them had small to large amount of hemoperitoneum similar to this study that hemoperitoneum was the most common positive finding. Causes of hemoperitoneum were from the liver, spleen, kidney and pancreas which were determined on the basis of sentinel clot.

Due to the small numbers of patient cases that were available for this study, these results are only descriptive of those patients reviewed. Although encouraging, this type of study warrants replication with large numbers of cases to make generalization to the large population.

Conclusion

CT grading criteria may be used to guide further management of blunt hepatic trauma in hemodynamically stable patients. It can help the process of patient selection, i.e. who should or should not undergo operation, embolization or close observation. Although injury grading with CT may reveal the extension of the parenchymal damage, it does not accurately help to predict the outcome of a conservative management. Therefore decision to perform the proper treatment should be based on clinical status and the degree of injury extended to other abdominal organs.

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