(Original Article)

Proper Management and Optimal Duration of CT Scan Post High-grade Traumatic Liver Injury

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Abstract

Background : Currently, there is several controversies on duration and healing rate of high-grade liver injury. The burden of non-healing liver injury affects patient's daily living activities.

Objectives : To investigate outcome and factors associated with the resolution of traumatic liver injury at 4-week period in both low-grade and high-grade liver injury according to American Association for Surgery of Trauma (AAST) liver injury grading scale.

Methods : Medical records review was conducted on all traumatic liver injury patients admitted to Bhumibol Adulyadej Hospital from January 1st, 2014 to December 31st, 2019 and follow up abdominal contrast computerized tomography (CT) scan within 4 weeks after injury. Patient data obtained include age, gender, hematocrit, liver function test, hemodynamic stability, mechanism of injury, operative management, lengths of hospital stay and ICU stay, outcome at follow-up CT scan, and time to follow-up CT scan. Patients were classified into high-grade liver injury (grade IV-V) and low-grade liver injury (Grade I-III). The comparison of outcomes between groups was analyzed and statistical significance was set at p-value <0.05.

Results : A total of 126 traumatic liver injury patients were included. Of which, 54 (43 %) were high-grade liver injury and 72 (57 %) were low-grade liver injury. In overall, 68 (54 %) recovered from liver injury. CT scan at 4-week found resolution of liver injury in 7 % of high-grade injury compared to 89 % in low-grade injury (p-value <0.001). Factors associated with overall healing outcome included blunt mechanism (95 %CI = 1.29-17.48), normal arrival hematocrit (95 %CI = 1.21-10.94) and absence of any liver surgery (95 %CI = 0.99-5.22).

Conclusions : CT scan is a useful modality to evaluate healing of liver injury. Resolution of high-grade injury at 4-week is low. Early transfusion may promote healing of liver injury.

Keywords : high-grade liver injury, nonoperative management, CT scan, trauma

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(นิพนธ์ต้นฉบับ)

การดูแลรักษาและระยะเวลาในการตรวจติดตามด้วยเอกซ์เรย์คอมพิวเตอร์ที่เหมาะสมในผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บที่ตับระดับรุนแรง

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บทคัดย่อ

ความเป็นมาและความสำคัญของปัญหา : ปัจจุบันยังไม่มีข้อมูลที่ชัดเจนเกี่ยวกับระยะเวลาและอัตราการฟื้นตัวของตับที่ได้รับการบาดเจ็บระดับรุนแรงจากอุบัติเหตุ โดยที่ภาวะแทรกซ้อนของการบาดเจ็บของตับที่รักษาไม่หายจะส่งผลต่อการใช้ชีวิตประจำวันของผู้ป่วย

วัตถุประสงค์ : เพื่อศึกษาผลลัพธ์และปัจจัยที่เกี่ยวข้องกับการฟื้นตัวของการบาดเจ็บของตับจากอุบัติเหตุในระยะเวลา 4 สัปดาห์ทั้งในกลุ่มอาการการบาดเจ็บระดับน้อยและระดับรุนแรงตามมาตรฐานของ American Association for Surgery of Trauma (AAST)

วิธีดำเนินการวิจัย : ทำการทบทวนเวชระเบียนในผู้ป่วยอุบัติเหตุที่ได้รับการบาดเจ็บที่ตับทั้งหมดที่เข้ารับการรักษาในโรงพยาบาลภูมิพลอดุลยเดช ตั้งแต่วันที่ 1 มกราคม 2557 ถึง 31 ธันวาคม 2562 และติดตามผลการตรวจเอกซเรย์คอมพิวเตอร์ช่องท้อง (CT) ภายใน 4 สัปดาห์หลังจากได้รับบาดเจ็บ ข้อมูลผู้ป่วยที่เก็บ ได้แก่ อายุ เพศ ค่าความเข้มข้นเลือด (hematocrit) ค่าการทำงานของตับ ค่าความคงที่ของระบบไหลเวียนโลหิต กลไกการบาดเจ็บ การผ่าตัด ระยะเวลาการนอนโรงพยาบาลและในหออภิบาลผู้ป่วยหนัก และระยะเวลาในการตรวจติดตาม CT scan โดยผู้ป่วยได้ถูกจำแนกเป็นการบาดเจ็บของตับระดับรุนแรง (เกรด IV-V) และการบาดเจ็บของตับระดับน้อย (เกรด I-III) โดยได้ทำการวิเคราะห์เปรียบเทียบผลลัพธ์ระหว่างกลุ่ม โดยกำหนดค่านัยสำคัญทางสถิติไว้ที่ $p<0.05$)

ผลการวิจัย : มีผู้ป่วยที่ได้รับบาดเจ็บที่ตับเข้าร่วมงานวิจัยทั้งสิ้น 126 ราย ในจำนวนนี้ 54 ราย (ร้อยละ 43) มีอาการบาดเจ็บที่ตับระดับรุนแรง และ 72 ราย (ร้อยละ 57) มีอาการบาดเจ็บระดับน้อย โดยรวมแล้ว 68 ราย (ร้อยละ 54) หายจากอาการบาดเจ็บที่ตับ การตรวจ CT ที่ 4 สัปดาห์ พบการฟื้นตัวของการบาดเจ็บ ร้อยละ 7 ในกลุ่มที่มีการบาดเจ็บระดับรุนแรง เทียบกับร้อยละ 89 ในการบาดเจ็บระดับน้อย (p-value <0.001) ปัจจัยที่สัมพันธ์กับผลการฟื้นตัวของตับ ได้แก่ กลไกการบาดเจ็บที่เกิดจากการกระทบกระแทก (95 %CI = 1.29-17.48), ค่าความเข้มข้นเลือดแรกรับที่ปกติ (95 %CI = 1.21-10.94) และการที่ไม่ได้รับการผ่าตัดตับ (95 %CI = 0.99-5.22)

สรุป : การตรวจ CT scan เป็นวิธีที่มีประโยชน์ในการประเมินการรักษาอาการบาดเจ็บของตับ โดยอัตราการฟื้นตัวของการบาดเจ็บระดับรุนแรงที่ 4 สัปดาห์อยู่ในเกณฑ์ที่ต่ำ และการให้เลือดในระยะแรกที่ผู้ป่วยมาถึงโรงพยาบาลอาจช่วยส่งเสริมการฟื้นตัวของตับ

คำสำคัญ : การบาดเจ็บที่ตับระดับรุนแรง, การรักษาโดยไม่ผ่าตัด, เอกซ์เรย์คอมพิวเตอร์, อุบัติเหตุ

Introduction

Currently, liver injury patient treatment has been primarily initiated as non-operative therapy (NOM)[1,2]. The assessment of other associated injuries and severity of liver injury based on injury scaling according to the American Association for the Surgery of Trauma (AAST)[3,4]. Most patients with blunt mechanisms tend to success with non-operative therapy without any subsequent complications[2]. CT scan follow-up after high-grade injury may disappear at 4 months[5]. Coccolini F, et al., reported most of liver injuries may resolve in 4 to 6 weeks after trauma thus whenever liver injury has completely resolve, patient may perform daily routine life[6], however, there still controversy in the complete healing time and unknown proper time to follow-up CT scan in high-grade liver injury.

Patient and methods

This is descriptive analysis study primary outcome to determine healing rate of traumatic liver injury at 4-week and secondary outcome to determine clinical factors enhancing resolution of traumatic liver injury.

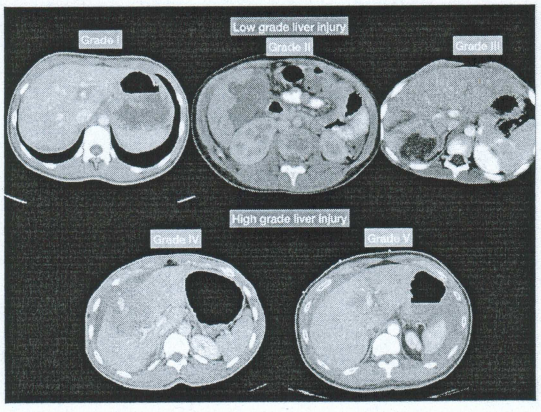
Medical records reviewed and approved by the Institutional Review Board (Registration number 43/62) included all traumatic liver injury patients admitted in Bhumibol Adulyadej Hospital during January 1st, 2014 to December 31st, 2019 and follow up with abdominal contrast computerized tomography (CT) scan within 4 weeks after injury. Patient data obtained included age, gender, hematocrit, liver function test, hemodynamic stability, mechanism of injury, operative management, lengths of hospital stay and ICU stay, outcome at follow-up CT scan and time to follow-up CT scan. All imaging studies were reviewed by single experience radiologists then classified into high-grade liver injury (grade IV-V) and low-grade liver injury (Grade I-III) base on definition of liver injury are classified using AAST grading scale as table 1 and picture 2 and final follow up CT scan are reported as healed liver injury as Picture 3. The different severity grading of liver injury (low-grade vs high-grade). The descriptive statistics data were described by frequencies/ percentages with interquartile range and mean with standard deviation. The descriptive analytic comparison of outcomes between two groups were using statistical significance set at p-value <0.05. Correlation was evaluated using the Chi-square test and logistic regression analysis performed on IBM SPSS Statistics Version 22 (Chicago, IL, USA)

Table 1 American Association for the Surgery of Trauma liver injury severity scale[4]

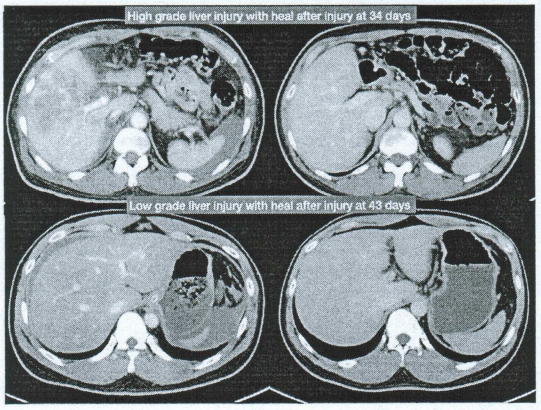
	Grade	Injury Description
I	Hematoma	Subcapsular, < 10% surface area
	Laceration	Capsular tear, < 1 cm parenchymal depth
II	Hematoma	Subcapsular, 10 % to 50 % of liver surface area Intraparenchymal < 10 cm in diameter
	Laceration	Capsular tear 1 - 3 parenchymal depth, < 10 cm in length
III	Hematoma	Subcapsular, > 50 % surface area of ruptured sub capsular or paren chymal hepatoma; intraparenchymal hepatoma > 10 cm or expanding
	Laceration	> 3 cm parenchymal depth
IV	Laceration	Parenchymal disruption involving 25 % to 75 % hepatic lobe or 1 - 3 Couinaud's segments
V	Laceration	Parenchymal disruption involving > 75 % of hepatic lobe or > 3 Couinaud's segments within a single lobe
	Vascular	Juxtahepatic venous injuries (retro-hepatic vena cava/central major hepatic veins)
VI	Vascular	Hepatci avulsion

* Severity of liver injury

Normal liver function test is defined as normal all three liver parameters, Anemia is defined as hematocrits below than 30 % and stable vital signs is defined as no more than shock class 1 as described by ATLS 10th ed[7].



Picture 1 Liver injury scale



Picture 2 Healed of liver injury, Above are high grade liver injury with healed outcome after thirty four days, below are low grade liver injury healed after forty three days

Results

Overall, 152 traumatic liver injury patients were admitted at Bhumibol Adulyadej Hospital during 1st January 2014 to 31st December 2019. Of these 26 patients were excluded because of 22 patients who lost follow-up and 4 patients who died during the follow-up period by other causes not related to trauma. From 126 eligible patients remained in this study, 72 patients were liver injury grade I - III and defined in the low-grade liver injury group, and 54 liver injury patients of grade IV-V defined as the high-grade injury liver group.

The baseline characteristic between groups was shown in Table 2, Mean age of high-grade liver injury was 32.81 ± 13.47-year-old and low-grade liver injury was 32.44 ± 12.82-year-old (p-value 0.875). There were 46 (85.2 %) males and 8 (14.8 %) females in the high-grade group and 60 (83.3 %) males, 12 (16.7 %) females in the low-grade group (p-value = 0.778)

The mean of hematocrit at arrival was 35.41 ± 6.30% and anemia was found in 12 patients (22.2 %) in high-grade group. Meanwhile, in low-grade group, the mean hematocrit was 39.16 ± 5.91 %, and the number of patients with anemia was lower (8 %). In high-grade liver injury, there were blunt mechanisms in 52 (96.3 %) patients and penetrate mechanisms 2 (3.7 %) patients. In low-grade liver injury, there were blunt mechanisms of 57 (79.2 %) patients and penetrate mechanisms 15 (20.8 %) patients (p-value = 0.005).

Vital sign at arrival is stable in 36 (66.7 %) patients in high-grade group and 50 (69.4 %) patient low-grade group (p-value = 0.740). Normal liver function test at arrival were found in 18 (33.3 %) patients' high-grade group and 24 (33.3 %) patients' low-grade group (p-value = 1.00). The baseline characteristic between groups, we have found no significant difference of patients' age, sex, vital sign, and liver function test, but found significant differences in initial hematocrits, and mechanism of injury.

High-grade group found healed outcome after follow up CT scan in 4 (7.4 %) patients, and 64 (88.9 %) patients were found in low-grade group (p-value < 0.001). The mean of time to follow up CT scan was 19.85 ± 13.96 days and 20.50 ± 12.30 days in high-grade group follow by low-grade group (p-value = 0.783). Seventeen (37.5 %) of high-grade liver injury patients underwent liver surgery while 14 (19.4 %) of low-grade liver injury patients underwent liver surgery (p-value = 0.121). The healed outcome is significantly higher in low-grade injury 89 % compared to 7 % in high-grade injury with p-value less than 0.001. But no significant difference in length of hospital stay, ICU stay, and time to follow-up CT scan.

Table 2 Baseline characteristics between group

Characteristics/Grade of injury	High grade (N = 54)	Low grade (N = 72)	p - value
Age, mean (interquartile range), years	32.81 ± 13.47	32.44 ± 12.82	0.875
Sex, n (%)			0.778
Men	46 (85.2 %)	60 (83.3 %)	
Women	8 (14.8 %)	12 (16.7 %)	
Hematocrit at arrival (Hct), (%)	35.41 ± 6.30	39.16 ± 5.91	0.001
Anemia, n (Hct < 30 %)	12 (22.2 %)	6 (8.3 %)	0.027
Mechanism of injury, n (%)			
Blunt	52 (96.3 %)	57 (79.2 %)	0.005
Penetrate	2 (3.7 %)	15 (20.8 %)	
Vital sign at arrival, n (%)			
Stable	36 (66.7 %)	50 (69.4 %)	0.740
Unstable	18 (33.3 %)	22 (30.6 %)	
Liver function test at arrival, n (%)			
Normal	18 (33.3 %)	24 (33.3 %)	1.00
Abnormal	36 (66.7 %)	48 (66.7 %)	
Outcome after follow up CT scan			
No healed	50 (92.6 %)	8 (11.1 %)	< 0.001
Healed	4 (7.4 %)	64 (88.9 %)	
Time to follow up CT scan (day)	19.85 ± 13.96	20.50 ± 12.30	0.783
Liver surgery	17 (37.5 %)	14 (19.4 %)	0.121
Length of Hospital stay (day)	12.97 ± 10	15.33 ± 17.59	0.363
Length of ICU stay (day)	3.13 ± 3.21	3.36 ± 3.17	0.688

Significant factor-enhancing healed outcomes were associated with blunt mechanism, no anemia at arrival, and absence of liver surgery during admission are shown in table 3.

Table 3 Factor-enhancing healed outcomes

Factors	No healed (N = 58)	Healed (N = 68)	p - value	95% CI
Mechanism			0.012	1.29 - 17.48
Blunt	55 (94.8 %)	54 (79.4 %)		
Penetrate	3 (5.2 %)	14 (20.6 %)		
Vital sign at arrival, n (%)			0.822	0.43 - 1.95
Stable	39 (67.2 %)	47 (69.1 %)		
Unstable	19 (32.8 %)	21 (30.9 %)		
Hematocrit at arrival (Hct), (%)			0.016	1.21 - 10.94
Anemia, n (Hct < 30 %)	13 (22.4 %)	5 (7.4 %)		
No anemia	45 (77.6 %)	63 (92.6 %)		
Liver function test at arrival, n (%)			0.800	0.41 - 47.02
Normal	20 (34.5 %)	22 (32.4 %)		
Abnormal	38 (65.5 %)	46 (67.6 %)		
Liver surgery			0.050	0.99 - 5.22
Yes	19 (32.8 %)	12 (17.6 %)		
No	39 (67.2 %)	56 (82.4 %)		

Table 4 High-grade liver injury with the healed outcome

Patient number	Age (yr)	Sex	Mechanism	Vital sign at arrival	Anemia (Hct %)	LFT	LOS (day)	LOS in ICU (day)	Liver surgery
1	26	Male	Penetrate	Stable	Yes (27.9 %)	Abnormal	5	4	No
2	25	Male	Blunt	Stable	No (39.5 %)	Abnormal	19	7	No
3	52	Male	Blunt	Stable	No (47.7 %)	Abnormal	7	1	No
4	19	Male	Blunt	Stable	No	Abnormal	6	1	No

Discussion

This descriptive analysis study reviewed 126 liver injury patients, 54 (43 %) were high-grade liver injury and 72 (57 %) were low-grade liver injury reflex our country has a high incidence of high-grade liver injury and most of the mechanism is blunt trauma. Multidisciplinary team approach needs to apply since the injury patient's arrival in the emergency department. We found 68 patients recovered from liver injury regarding to healed outcome at 4-week included 7.4 % in high-grade injury (n=4) and 88.9 % in low-grade injury (n=64) without open liver surgery. These result are similar to Melloul E., et al[1]. recommended non-operative management (NOM) of Grade III to V blunt hepatic injury is the first treatment option to manage hemodynamically stable patients.

Even in unstable at arrival patients whose need initial resuscitation and close re-evaluation can NOM as our result focusing on high-grade, four healed patients, none have liver surgery and three of them have blunt mechanisms, and no anemia. As shown in Table 4. However, in the overall results, the stable vital sign was not significantly associated with the healed patient (p=0.882) and the stable vital sign was not significantly associated in healed patient (47 (69.1 %) vs 21 (30.9 %), p=0.822, 95 %CI 0.43-1.95). Surgical exploration should reserve for only indicated patients. The non-active bleeding liver injury should not be operated regardless of severity grading from our success in NOM included high-grade liver injury (n 31 vs 95, p=0.050, 95 %CI 0.99-5.22).

According to significant factors including blunt mechanism, normal hematocrit at arrival, and absence of open liver surgery. We hypothesized that early blood transfusion aims to correct initial anemia may associate with an improved healing rate of liver injury.

The mechanism of live injury differs in each country due to the socio-economic environment. Bangkok, Thailand has a major cause of injury from road traffic accidents associated with high incidents of multiple trauma from motor vehicle crashes association. The most mechanism of injury was blunt and show statistically significant enhancing healing factor (54 (79.4 %) vs 14 (20.6 %), p=0.012 (95 %CI 1.29-17.48).

This study shown healing rate more than a half of them (68 patients) resolve of liver injury (Healed) found on CT scans after follow up about 4 weeks (19.85 $\pm$ 13.96, 20.50 $\pm$ 12.30, p = 0.73) and higher healing found in low-grade regarding to healed outcome at 4-week: 7.4 % in high grade injury (n=4) compared to 88.9 % in low grade injury (n=64) (p <0.001). Only 8/72 (11 %) low-grade injury patients found un-healed outcomes at 4 weeks follow up CT scan, however there were no further management or follow up required and on long-term complication and re-admission disappeared in this study. Therefore, we believe that routine follow up CT scan should not be performed in all low-grade liver injuries. This can help with medical cost-saving and reduce unnecessary radiation and contrast exposure.

Limitations

This study is limited base on its retrospective nature. Injury severity score could not be calculated for all patients due to limited available data. The follow-up time to CT scan was performed an average of 20 days, not exactly 4 weeks, due to the limitation of accurate appointments after the injury schedule of CT scan in our institute.

Conclusions

Contrast-enhancing CT scan is a useful modality to evaluate the healing of liver injury and the time to follow-up patients at four weeks is recommended. Associated factors for healed outcome include blunt mechanism, normal hematocrits at arrival, and absence of liver surgery. Lastly, we believe that early transfusion may promote liver injury healing. With some promising data shown in our study, further prospective trials can be helpful.

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