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Hepatic enzymes have a role in the diagnosis of hepatic injury after blunt abdominal trauma

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ABSTRACT

Introduction: Delayed diagnosis of patients with severe liver injuries is associated with an adverse outcome. As computed tomographic (CT) scan is not always available in the management of blunt abdominal trauma worldwide, the present study was undertaken to determine the accuracy of selected haematological markers in predicting the presence of hepatic injury and its severity after blunt abdominal trauma.

Methods: A retrospective review of all patients with blunt abdominal trauma presented to our institution over a 3-year period was performed. Patients were excluded if they suffered penetrating injuries, died in the emergency department or if the required blood tests were not performed within 24 h of the accident. The grading of the hepatic injury was verified using CT scans or surgical findings.

Results: Ninety-nine patients with blunt abdominal trauma had the required blood tests performed and were included in the study. The median injury severity score was 24 (range 4–75). Fifty-five patients had hepatic injuries, of which 47.3% were minor (Grades I and II) while 52.7% had major hepatic injuries (Grades III–V). There were no patients with Grade VI injuries.

A raised ALT was strongly associated with presence of hepatic injuries (OR, 109.8; 95% CI, 25.81–466.9). This relation was also seen in patients with raised AST > 2 times (OR, 21.33; 95% CI, 7.27–62.65). This difference was not seen in both bilirubin and ALP.

ALT > 2 times normal was associated with major hepatic injuries (OR, 7.15; 95% CI, 1.38–37.14; $p = 0.012$) while patients with simultaneous raised AST > 2 times and ALT > 2 times had a stronger association for major hepatic injuries (OR, 8.44; 95% CI, 1.64–43.47).

Conclusion: Abnormal transaminases levels are associated with hepatic injuries after blunt abdominal trauma. Patients with ALT and AST > 2 times normal should be assumed to possess major hepatic trauma and managed accordingly. Patients with normal ALT, AST and LDH are unlikely to have major liver injuries.

Introduction

Computed tomographic (CT) scan of the abdomen is the imaging of choice for further evaluation in patients with blunt abdominal trauma who are haemodynamically stable.[3,11] Accurate diagnosis of the significant injuries could be delayed as not all health institutions worldwide have access to CT scans readily.[9] Focused assessment with sonography for trauma (FAST) in blunt abdominal trauma is important in many aspects, but its numerous limitations have been recognised.[1,14] The overall sensitivity of emergency FAST for detection of blunt hepatic injury was reported to be as low as 72%.[12]

In view of the above issues, several small series had attempted using laboratory tests to detect patients with hepatic injury after blunt abdominal trauma. Should an association between haematological markers and hepatic injuries be present, early identification of patients with hepatic injuries could be performed. This is important as these patients require closer monitoring and/or further investigations in institutions with limited resources or be transferred to Level I trauma centre for subsequent management. However, to our knowledge, data describing this relationship is still limited.

The present study was hence undertaken to determine the accuracy of selected haematological markers in predicting the presence of hepatic injury and its severity after blunt abdominal trauma.

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Methods

Study population

Tan Tock Seng Hospital is a 1300 bed hospital in Singapore that provides medical care to over 1.5 million people. It handles the highest number of trauma patients in Singapore and admits an average of 1000 serious trauma cases yearly, of which 96% were for blunt injuries, with 40% of trauma admissions having an injury severity score (ISS) of more than 16.

A review of a prospectively electronic database of all patients with traumatic blunt abdominal injuries to our institution over a 3-year period (January 2005–December 2007) was performed. Patients were excluded if they suffered penetrating injuries, died in the Emergency department or if the required laboratory tests were not performed within 24 h of the trauma.

The examined haematological markers included aspartate aminotransferase (AST, also known as serum glutamic oxaloacetic transaminase (SGOT)), alanine aminotransferase (ALT, also known as serum glutamic pyruvic transaminase (SGPT)), alkaline phosphatase (ALP), bilirubin and lactate dehydrogenase (LDH). The normal range for the mentioned laboratory tests is shown in Table 1.

Patients were then subdivided into two groups: those with and those without hepatic injuries. Hepatic injuries were graded using the American Association for the Surgery of Trauma (AAST) Organ Injury Scale (1994 version)[7] as shown in Table 2, with information obtained from either surgery, post-mortem examination or CT scans. In this series, minor hepatic injuries were classified as AAST Grades I and II, while major hepatic injuries were classified as AAST Grades III–VI.

Data extracted included age, gender, mechanism of injury, ISS, the AAST grade of hepatic injury, length of stay (LoS) in specialised units (intensive care unit (ICU)/high dependency unit (HDU)), total inpatient LoS and the eventual outcome. All trauma patients with hepatic injuries were managed by the only dedicated surgical trauma team in the institution.

Data analysis was performed by comparing the various characteristics to the chosen outcome using chi square with their odds ratio (OR) and 95% confidence interval (CI) reported. All analyses were performed using the SPSS 13.0 statistical package (SPSS, Chicago, IL) and all p values reported are two-sided, and p values of <0.05 were considered statistically significant.

Results

Study population

During the study period, 99 patients with blunt abdominal trauma had the relevant laboratory tests performed and were included in our series. There were 74 males (74.7%) and their median age of the study group was 35 years old (range 14–79). Most of the patients (83.8%) underwent CT scans, while 38.4% underwent exploratory laparotomy. The median ISS was 24 (range 4–75). Fifty-five (55.6%) patients had hepatic injuries. The median time interval between injury and the blood test was 13 h (range 1–23). Table 3 presents the demographic profile and details of injuries in these 99 patients.

Table 1
Normal range of the various laboratory tests.

Laboratory result	Normal range
AST or SGOT	15–41 U/L
ALT or SGPT	17–63 U/L
ALP	38–126 U/L
Bilirubin	7–31 μmol/L
LDH	250–580 U/L

Table 2
American Association for the Surgery of Trauma (AAST) Organ Injury Scale (1994 version)—hepatic injuries.[7].

Grading of hepatic injuries	Description of injuries
Grade I	Subcapsular haematoma occupying <10% of the liver surface area Laceration <1 cm deep
Grade II	Subcapsular haematoma occupying 10–50% of the liver surface Intraparenchymal haematoma of <10 cm in diameter Laceration 1–3 cm deep and <10 cm in length
Grade III	Subcapsular haematoma >50% of the liver surface (or one that is expanding) Ruptured subcapsular/parenchymal haematoma Intraparenchymal haematoma >10 cm (or expanding) Laceration >3 cm deep
Grade IV	Parenchymal disruption involving 25–75% of the hepatic lobe or 1–3 Couinad's segments within a single lobe
Grade V	Parenchymal disruption involving >75% of a hepatic lobe (or >3 Couinad's segments within a single lobe) Juxtahepatic venous injuries
Grade VI	Hepatic avulsion

Patients with hepatic injuries

In those patients with hepatic injuries, 26 (47.3%) had minor hepatic injuries (Grades I and II) while 29 (52.7%) had major hepatic injuries (Grades III–V). There were no patients with Grade VI hepatic injuries. Their median length of stay in the specialised care units (SICU/HDU) and hospital was 3 (0–61) and 8 (1–111) days respectively. The demographic profile and details of injuries in the patients with hepatic injuries is shown in Table 4.

Haematological markers

In patients with hepatic injuries, AST was raised in all (100%), with a median value of 330 (43–4752) U/L. ALT was raised in 94.5%, with a median value of 282 (22–3473) U/L while LDH was raised in 95.7%, with a median value of 1401 (73–7912) U/L. Both ALP and bilirubin were not raised in the majority of the patients.

Table 3
Characteristics of all 99 patients with blunt abdominal trauma.

	n (%)
Median age (years)	35 (14–79)
Gender	
Male	74 (74.7)
Female	25 (25.3)
Mechanism	
RTA	67 (67.7)
Fall	27 (27.3)
Assault	5 (5.1)
CT scans	
Performed	83 (83.8)
Not performed	16 (16.2)
Surgical intervention	
Performed	38 (38.4)
Not performed	61 (61.6)
Median ISS	24 (4–75)
Outcome	
Alive	84 (84.8)
Death	15 (15.2)

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Table 4
Characteristics of the 55 patients with liver injuries.

	n (%)
Median age (years)	29 (14–75)
Gender	
Male	39 (70.9)
Female	16 (29.1)
Mechanism	
RTA	40 (72.7)
Fall	14 (25.5)
Assault	1 (1.8)
CT scans	
Performed	49 (89.1)
Not performed	6 (10.9)
Surgical intervention	
Performed	10 (27.3)
Not performed	40 (72.7)
Median ISS	27 (4–75)
Grading of liver injury	
Minor liver injuries	26 (47.3)
I	1 (1.8)
II	25 (45.5)
Major liver injuries	29 (52.7)
III	14 (25.5)
IV	11 (20.0)
V	4 (7.3)
VI	0 (0)
Median LOS (HD + SICU)	3 (0–61)
Median hospital LOS	8 (1–111)
Outcome	
Alive	49 (89.1)
Death	6 (10.9)

Relationship between haematological markers and the presence of hepatic injuries

A raised ALT was significantly associated with the presence of hepatic injuries (OR, 109.8; 95% CI, 25.81–466.9). This was also seen in patients with raised AST > 2 times (OR, 21.33; 95% CI, 7.27–62.65) and LDH (OR, 7.33; 95% CI, 1.40–38.38). This difference was not seen in both bilirubin and ALP (Table 5).

Further analysis of selected haematological markers also revealed that ALT is perhaps most ideal to detect hepatic injuries. Its sensitivity (94.5%), specificity (86.4%), positive predictive value (89.7%) and negative predictive value (92.7%) are all favourable for its role as a screening tool compared to the other markers (Table 6).

Relationship between haematological markers and the severity of hepatic injuries

In patients with hepatic injuries, those with a raised serum ALT > 2 times were significantly associated with major hepatic injuries (OR, 7.15; 95% CI, 1.38–37.14) compared to patients with ALT ≤ 2 times. When we analysed patients with simultaneous raised serum AST > 2 times and serum ALT > 2 times against the rest, there appeared to be a stronger association for major hepatic injuries (OR, 8.44; 95% CI, 1.64–43.47). None of the other variables were related to the severity of hepatic injuries (Table 7).

Even though AST and/or ALT are not the ideal screening test to differentiate between major or minor liver injury, each of them has been shown to be associated with a high sensitivity and negative predictive value (Table 8).

Discussion

Hepatic injury is one of the leading causes of death in blunt abdominal trauma. Outcome of liver trauma has been shown to be related to several important factors: increased ISS, worse grading of hepatic injuries, advanced age, operative blood loss and haemodynamic instability on admission.[2,10,15,16] Patients with more severe hepatic injuries would require more intense monitoring and possibly further intervention. This is best achieved in Level I trauma centres. Hence, it is of paramount importance to achieve accurate diagnosis of major hepatic injuries early.

Though CT scan of the abdomen has become the imaging of choice in trauma patients, it can only be carried out if available and in patients who are haemodynamically stable. Furthermore, it is costly, requires radiation exposure, and removes patients from direct clinical care. As a significant number of health institutions worldwide do not have access to CT scans readily,

Table 5
Relationship between the various laboratory tests to liver injuries (part I).

Factor	Liver injury (range)	No liver injury (range)	*p* value	OR (95% CI)
Median AST	330 (43–4752)	53 (20–255)	**<0.001**	**21.33 (7.27–62.65)**
AST ≤ 2 times[a]	6	32		
AST > 2 times	48	12		
Median ALT	282 (22–3473)	33 (11–241)	**<0.001**	**109.8 (25.81–466.9)**
Normal ALT	3	38		
Abnormal ALT	52	6		
Median bilirubin	15 (3–110)	12 (4–46)	0.072	7.24 (0.865–60.58)
Normal bilirubin	42	38		
Abnormal bilirubin	8	1		
Median ALP	51 (16–187)	53 (23–303)	0.58	0.38 (0.033–4.33)
Normal ALP	54	41		
Abnormal ALP	1	2		
Median LDH	1401 (73–7912)	882 (259–2071)	**0.022**	**7.33 (1.40–38.38)**
Normal LDH	2	7		
Abnormal LDH	44	21		

Values in bold: These values are statistically significant.
[a] Odds ratio could not be calculated for raised AST alone as all patients with liver injuries had raised AST.

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Table 6
Relationship between selected laboratory tests to presence of liver injuries (part II).

Factor	Liver injury (*n*)	No liver injury (*n*)	
Abnormal AST	54	15	Positive predictive value = 78.3%
Normal AST	0	29	Negative predictive value = 100%
	Sensitivity = 100%	Specificity = 65.9%	
AST > 2 times	48	12	Positive predictive value = 80.0%
AST ≤ 2 times	6	32	Negative predictive value = 84.2%
	Sensitivity = 88.9%	Specificity = 72.3%	
Abnormal ALT	52	6	Positive predictive value = 89.7%
Normal ALT	3	38	Negative predictive value = 92.7%
	Sensitivity = 94.5%	Specificity = 86.4%	
Abnormal LDH	44	21	Positive predictive value = 67.7%
Normal LDH	2	7	Negative predictive value = 77.7%
	Sensitivity = 95.7%	Specificity = 25.0%	

the initial assessment and the role of FAST become more crucial. But FAST is not always available in all healthcare institutions and one of the major limitations is the technical expertise of the operator.[1,14] Furthermore, patients are usually haemodynamically stable until significant blood loss has occurred. Hence, a delay in achieving the accurate diagnosis and its subsequent appropriate management could compromise the outcome in these patients.

Transaminases are mitochondrial and cytoplasmic enzymes that are commonly found in the hepatic, brain, heart, pancreas and skeletal muscle. The two commonest transaminases included AST and ALT. Raised transaminases are usually present when hepatocytes are damaged, from inflammation, infection, trauma or surgical intervention.[4,8]

Our study concurred with the few series in the literature performed in paediatric and adult patients, relating raised transaminases (ALT and AST) levels to the presence of hepatic injuries after abdominal trauma.[5,6,13,17,18] Both ALP and bilirubin were not useful in the screening of hepatic injuries.

From our study, the authors preferred ALT to AST as a better screening tool for hepatic injuries from its associated high sensitivity, specificity, positive predictive value and negative predictive value. However, it would appear that a normal AST would essentially exclude the presence of any hepatic injuries, but this conclusion necessitates further evaluation.

It would appear that patients with raised ALT > 2 times normal were 7.2 times more likely to possess major hepatic injury. This risk increased to 8.4 times when we included patients with simultaneous raised AST and ALT > 2 times. This led the authors to postulate that the more deranged the transaminases levels, the more severe the hepatic injuries.[6,17,18] Significantly, none of our patients with major hepatic injuries had normal AST, ALT or LDH levels.

Table 7
Analysis of factors predicting minor and major hepatic injuries.

Factor	Minor liver injury (*n*)	Major liver injury (*n*)	*p* value	OR (95% CI)
Median age	28 (14–77)	29 (19–78)		
≤30	15	17	1.00	0.96 (0.33–2.82)
>30	11	12		
Mechanism of injury				
RTA	17	23	0.36	0.49 (0.15–1.65)
Others	9	6		
Median AST	328 (43–754)	366 (59–4752)	0.085	
AST ≤ 2 times	5	1		7.00 (0.76– 64.61)
AST > 2 times	20	28		
Median ALT	243 (22–653)	307 (71–3473)		
ALT ≤ 2 times	9	2	**0.017**	**7.15 (1.38–37.14)**
ALT > 2 times	17	27		
Median bilirubin	17 (4–62)	14 (3–110)		
Normal bilirubin	18	24	1.00	1.25 (0.26–5.93)
Abnormal bilirubin	3	5		
Median ALP	54 (16–102)	47 (25–187)		
Normal ALP	26	28	1.00	1.04 (0.97–1.11)
Abnormal ALP	0	1		
Median LDH	1266 (73–3800)	1420 (696–7912)		
LDH ≤ 2 times	8	9	0.76	1.46 (0.43–4.89)
LDH > 2 times	11	18		
Abnormal AST ≤ 2 times or ALT ≤ 2 times	10	2	**0.008**	**8.44 (1.64–43.47)**
Abnormal AST > 2 times and ALT > 2 times	16	27		
Median ISS	25 (4–75)	29 (9–59)	0.73	
Median LOS (specialised unit)	3 (0–61)	5 (0–27)	0.43	
Median LOS (inpatient)	8 (0–111)	8 (1–92)	0.92	

Values in bold: These values are statistically significant.

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Table 8
Relationship between selected laboratory tests to severity of liver injuries.

Factor	Major liver injury (*n*)	Minor liver injury (*n*)	
AST > 2 times	28	20	Positive predictive value = 58.3%
AST ≤ 2 times	1	5	Negative predictive value = 83.3%
	Sensitivity = 96.6%	Specificity = 20.0%	
ALT > 2 times	27	17	Positive predictive value = 61.4%
ALT ≤ 2 times	2	9	Negative predictive value = 81.8%
	Sensitivity = 93.1%	Specificity = 32.1%	
Abnormal AST > 2 times and ALT > 2 times	27	16	Positive predictive value = 62.8%
Abnormal AST ≤ 2 times or ALT ≤ 2 times	2	10	Negative predictive value = 83.3%
	Sensitivity = 93.1%	Specificity = 38.5%	

In addition, based on its associated high sensitivity, the presence of any significant derangement (>2 times) of AST and/or ALT levels must alert the physicians to the presence of a major hepatic injury. However, the resultant false positives from these tests could be sizeable.

There were several limitations in our study. The data was retrospectively reviewed and the relatively small number of patients in our series could have a considerable impact on the analysis. This was seen when we examined the relationship of abnormal ALT and AST compared to ALT alone (Table 8) to the severity of hepatic injuries. The actual difference between these two groups is because of the movement of only one patient.

Furthermore, the time interval between injury and the procurement of the blood test could not be standardised due to the highly variable timing and location of the accident. However, we have attempted to limit this by only including patients with the necessary blood tests performed within 24 h.

Another significant limitation was that these laboratory tests are not routinely performed as part of the trauma protocol because CT scans or surgical interventions are often performed within an hour from the time of admission to the emergency department. Thus, in centres with available resources, the role of the various haematological markers is limited.

Moreover, as the threshold for undertaking CT scans varies greatly from one institution to another, our findings may not be applicable to the entire population of patients with blunt abdominal trauma. A prospective study that includes all patients who sustained blunt abdominal trauma would be ideal to tackle this issue.

However, this study remains important in examining the accuracy of these tests in predicting hepatic injury and its severity after blunt abdominal trauma. We had successfully identified various markers that could be useful in the initial assessment of these patients.

Therefore in centres with limited resources, we advocate the use of serum ALT and AST as part of the initial assessment of patients after blunt abdominal trauma. An abnormal ALT and AST could imply the presence of hepatic injuries, while the level of the abnormality could determine the severity of the insult to the liver. These could allow clear guidelines to be derived on the urgency for further evaluation and assessment of these patients, such as CT scans or even transferring patients to Level I trauma centres for further management.

Though this could result in a significant number of patients being referred to Level I trauma centre unnecessarily, the aim of initial assessment and management in all patients with blunt abdominal trauma must be to identify the high-risk group. Only then can we institute prompt and appropriate monitoring and resuscitations to improve the outcome.

Our series also suggested that patients with normal ALT, AST and LDH were unlikely to possess significant hepatic injuries and would not require further screening for hepatic injuries. Even if hepatic injuries were present, it is more likely to be minor and can be managed conservatively.

Conclusion

There is an important relationship between ALT and AST and hepatic injuries after blunt abdominal trauma. All patients with raised ALT and AST > 2 times must be excluded from possessing severe hepatic injuries and should be managed accordingly, depending on the available resources. Patients with normal ALT, AST and LDH are unlikely to have major liver injuries.

Conflict of interest statement

There are no financial or other interests with regard to the submitted manuscript that might be construed as a conflict of interest. All the authors of this research paper have directly participated in the planning, execution or analysis of the study, and are aware of and agree to the content of the paper and their being listed as an author on the paper.

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