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ORIGINAL ARTICLE

Management of Liver Trauma in Minia University Hospital, Egypt

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Abstract The aim of this study is to present the outcome of operative and non-operative management of patients with liver injury treated in a single institution depending on imaging. This study was conducted at the Causality Unit of Minia University Hospital, and included 60 patients with hepatic trauma from March 2012 to January 2013. In our study, males represent 80 % while females represent 20 % of the traumatized patients. The peak age for trauma found was 11–30 years. Blunt trauma is the most common cause of liver injury as it was the cause in 48 patients (80 %). Firearm injuries are the most common cause of penetrating trauma (60 %) followed by stab injuries (40 %). More than one half of our patients (34 out of 60) were treated with non-operative management (NOM) with a high success rate. The operative procedures done were suture hepatorrhaphy (20 cases), non-anatomical resection in one case, anatomical resection in one case, and damage control therapy using pads in two cases. In another two cases, nothing was done as subcapsular hematoma had resolved. Minia University Hospital is a big tertiary Hospital in Egypt at which blunt liver trauma is more common than penetrating liver trauma. Surgery is no longer the only option available. It has been reserved for extensive lesions with condition of hemodynamic instability or for the treatment of the complications. NOM is an effective treatment modality in most cases.

Keywords Liver trauma · Management · Options · Minia

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Introduction

The liver is the largest intra-abdominal solid organ and is enclosed anteriorly and laterally by the rib cage. The large size of the liver, its friable parenchyma, its thin capsule, and its relatively fixed position in relation to the spine make the liver particularly prone to blunt injury. The right lobe is injured more commonly than the left, as a result of its larger size and proximity to the ribs [1].

Liver trauma is the second most frequent event during an abdominal trauma and is the leading cause of death (20–40 %) in these cases [2].

Most liver injuries (>85 %) involve segments 6, 7, and 8 of the liver, due to simple compression against the fixed ribs, spine, or posterior abdominal wall. Also, pressure through the right hemithorax may propagate through the diaphragm, causing a contusion of the dome of the right lobe of the liver. Furthermore, ligamentous attachment of the liver to the diaphragm and the posterior abdominal wall can act as sites of shear forces during deceleration injury [1].

Associated injury to other organs increases the risk of complications and death. Hepatic trauma requires a high index of suspicion, rapid investigation, accurate classification, and well-defined management protocols to ensure an optimal outcome with minimal long-term consequences. Several classification systems have been proposed in an attempt to incorporate the etiology, anatomy, and extent of injury and correlate it with subsequent clinical management and outcome [3].

Patients and Methods

This study was conducted at the causality Unit of Minia University Hospital, and included 60 patients with hepatic trauma from March 2012 to January 2013. We planned two modalities of treatment, i.e., non-operative (conservative or observation only) management (NOM) and operative (surgical) management.

The criteria for NOM were hamodynamicaly stable patient or with correct response to plasma volume expansion, transfusion requirements related to hepatic injuries of less than 2–3 units of red blood cell concentrates (packed RBCs), absence of signs of diffuse peritonitis on physical examination, and no suspicion of associated abdominal injuries and grades I, II, and III liver injury according to the American Association for the Surgery of Trauma (AAST) Liver Injury Scale.

Criteria for discontinuing NOM were decreased hematocrit in combination with tachycardia with or without hypotension in the first 48 h of observation, >2–4 units packed RBC transfusion in the first 24–48 h of observation, increasing abdominal pain, tenderness, and onset of diffuse peritonitis, expansion of subcapsular or intrahepatic hematoma on a follow up CT, and development of a symptomatic perihepatic fluid collection, hematoma or biloma. Criteria for immediate operation were hemodynamic instability on admission (all patients with systolic arterial blood pressure (SAP) lower than 90 mmHg on admission in the emergency department and were unresponsive to rapid infusion of 2 l of crystalloid solution), peritoneal signs on physical examination, and penetrating injuries in unstable patients.

Midline incision was taken and extended as Mercedes Star, inverted T or J shaped when needed to expose the site of injury. After opening the peritoneum, suction of the blood and perihepatic packing were done followed by vascular control by Pringle maneuver using a vascular clamp, from the left side of the patient. Our policy was to apply this maneuver for 20 min and unclamp the Pringle maneuver for 5 min to allow temporary reperfusion, then mobilization of the liver.

Assessment of the injury was done: If the injury is superficial (II and III), suture hepatorraphy was done. If the injury is deep or there is an avulsed part of the liver (IV and V), resection was done. Hemostasis may be done by omental pack held in place with absorbable sutures crossing the wound edges or by Gelfoam. If there was massive uncontrollable bleeding and the patient is hemodynamicaly unstable, perihepatic packing is done (Damage Control Therapy) and opened again within 48 h after the patient being stable. Tube drains were put in the hepato-renal pouch and in the pelvis. Follow-up after discharge in the outpatient clinic was by imaging (U/S and CT) at 4–6 weeks to detect any complication such as abscess formation, biliary leakage, biloma, and wound problems.

Results

Sixty patients were included in this study and were classified according to the modalities of treatment into two main groups. There were 34 cases in the conservative group, and there were 26 cases in the surgical group. The conservative group includes 27 male and 7 female, while the surgical group includes 21 male and 5 female. We classified our patients according to the age into four groups, and the peak age for trauma was found to be 11–30 years (Table 1).

The mechanism of trauma was blunt in 48 cases and penetrating in 12 cases. In the conservative group, the mechanism was blunt in 32 cases that include motor car accident (MCA) in 20, fall from height (FFH) in 5 and striking hard objects (SHO) in 7, and penetrating in 2 cases. While in the surgical group, the mechanism was blunt in 16 cases that include MCA in 12, FFE in 2 and SHO in 2, and penetrating in 10 cases. There was a significant difference between the two groups as regard mechanism of injury (Table 2).

On admission, 39 patients were hemodynamically stable (28 were treated conservatively, and 11 treated surgically). The other 21 patients were hemodynamically unstable. In the conservative group, 10 cases did not require blood transfusion while the other 24 cases required 1–2 units of blood. While in the surgical group, 3 cases did not require blood transfusion while 15 cases required 1–2 units and 8 cases required more than 2 units.

In 50 cases, the injury was in the Rt lobe of the liver and in 8 cases was in the Lt lobe and in 2 cases the injury was in both lobes. The injury was graded according to AAST after imaging by U/S and CT. In the conservative group, 5 cases were grade I, 17 cases were grade II, 7 cases were grade III, and 5 cases were grade IV. While in the surgical group, 2 cases were grade I, 5 cases were grade II, 6 cases were grade III, 11 cases were grade IV, and 2 cases were grade V.

Concomitant extra-abdominal injuries were found and classified as shown in Table 3. Suture hepatorraphy with chromic catgut was done in 20 cases, resection was done anatomically in one case and non-anatomically in another, damage control therapy using packs was applied for 2 cases due to failure of hemostasis, and nothing was done for subcapsular hematoma in the last 2 cases. For perfect hemostasis, Pringle maneuver was done in 12 cases, gelfoam application was done in 4 cases, omental patch application in 2 cases, and cauterization in 5 cases.

Table 1 Age distribution of patients included in the study

	0–10 years	11–30 years	31–45 years	46–60 years
Conservative	5	23	3	3
Surgical	6	17	2	1

Table 2 Data related to injury of patients included in the study

Data related to patients injury	Treatment		Total $n=60$	x^2 p value
	Conservative $n=34$	Surgical $n=26$		
Mechanism of injury				
MCA	20 (58.8 %)	12 (46.2 %)	32 (53.3 %)	10.7
FFH	5 (14.7 %)	2 (7.7 %)	7 (11.7 %)	0.03*
SHO	7 (20.6 %)	2 (7.7 %)	9 (15 %)	
Stab	1 (2.9 %)	3 (11.5 %)	4 (6.7 %)	
Firearm	1 (2.9 %)	7 (26.9 %)	8 (13.3 %)	
Site of injury				
Right	30 (88.2 %)	20 (76.9 %)	50 (83.3 %)	1.4
Left	3 (8.8 %)	5 (19.2 %)	8 (13.3 %)	0.5
Bilateral	1 (2.9 %)	1 (3.8 %)	2 (3.3 %)	
Grade of liver injury				
Grade I	5 (14.7 %)	2 (7.7 %)	7 (11.7 %)	11.3
Grade II	17 (50 %)	5 (19.2 %)	22 (36.7 %)	0.02*
Grade III	7 (20.6 %)	6 (23.1 %)	13 (21.7 %)	
Grade IV	5 (14.7 %)	11 (42.3 %)	16 (26.7 %)	
Grade V	0 (0 %)	2 (7.7 %)	2 (3.3 %)	

*Statistically significant

In the conservative group, one case had bile leakage and another case had hemobilia. One case had subphrenic collection and three cases with hemorrhage needed exploration after 48 h of conservation. In the surgical group, minimal to moderate biliary leakage was detected in five cases. Massive hemorrhage was observed through the drains in four cases. One of them could be saved with damage control therapy, the hemorrhage in the second patient responded to correction of his coagulation defects, while the last two cases could not be saved and died. Hemorrhage was so severe so death occurred from transfusion reaction in one case and severe hypotension in the other case (Table 4).

Failure of conservative treatment was due to hemodynamic instability and/or peritonitis was detected in three cases during the first 48 h of observation and needed exploration. One case due to grade III liver injury in the Rt lobe, for which hepatorraphy was performed, and two

Table 3 Associated extra-abdominal injuries distribution of patients included in the study

Associated extra-abdominal injuries	Conservative	No.	ttt	Surgical	No.	ttt
Neurological	Brain edema	1	Medical	Brain edema	1	Medical
	Extradural hematoma	2	Surgical	Hemorrhagic contusion	1	Treated conservatively (brain dehydrating measures+stimulants)
				Scalp injury	1	Suture
Cardiothoracic	Hemothorax	2	ICT	Hemothorax	1	ICT
	Pneumothorax	2	ICT	Pneumothorax	2	ICT
	Fracture ribs	3	Binder	Fracture ribs	2	ICT in one and binder in one
	Lung contusion	1	Medical	Lung contusion	1	ICT
Orthopedic	Fracture femur	1	Surgical	Fracture femur	3	Surgical
	Fracture tibia	1	Surgical	Fracture humerus	2	Surgical
				Fracture both bones	1	Surgical
	Fracture pelvis	3	Bed rest+analgesic	Fracture pelvis	1	Bed rest+analgesic

Table 4 Distribution of morbidity during duration of hospital stay and after discharge in patients included in the study

Morbidity	Treatment		Total $n=60$	Fissure exact p value
	Conservative $n=34$	Surgical $n=16$		
Morbidity during duration of hospital stay				
Biliary leakage	1 (2.9 %)	5 (19.2 %)	6 (10 %)	16.5
Hemorrhage	3 (8.8 %)	4 (15.4 %)	7 (11.7 %)	0.02*
Biloma	1 (2.9 %)	3 (11.5)	4 (6.7 %)	
Wound seroma	0 (0 %)	1 (3.8 %)	1 (1.7 %)	
Subhepatic abscess	0 (0 %)	1 (3.8 %)	1 (1.7 %)	
Hepatitis	0 (0 %)	2 (7.7 %)	2 (3.3 %)	
Hemobilia	1 (2.9 %)	0 (0 %)	1 (1.7 %)	
Morbidity after discharge				
Biloma	3 (8.8 %)	3 (11.5)	6 (10 %)	6.5
Abscess	2 (5.9 %)	1 (3.8 %)	3 (5 %)	0.4
Hemobilia	0 (0 %)	1 (3.8 %)	1 (1.7 %)	
Hepatitis	1 (2.9 %)	0 (0 %)	1 (1.7 %)	
Gapped wound	0 (0 %)	2 (7.7 %)	2 (3.3 %)	
Seroma	0 (0 %)	1 (3.8 %)	1 (1.7 %)	

*Statistically significant

cases had devitalized parenchyma (grade IV) and required non-anatomical resection.

Resurgery was required after damage control therapy for 48 h in two patients. One of them was successfully treated with anatomical resection of segments VI and VII together with cholecystectomy, while the other one only required cauterization for bleeding points. Resurgery for damage control therapy because of an observed massive bleeding in the drains was employed in one patient who died after 4 h of resurgery.

In the conservative group, 27 cases stayed in hospital for less than 1 week (3–7 days), while 7 cases stayed for 1–2 weeks (8–12 days). While in the surgical group, 12 cases stayed for less than 1 week (4–7 days), while 11 cases stayed for 1–2 weeks (8–15 days) and 3 cases died on the first day. Three cases died in the surgical group due to massive hemorrhage while no mortality was observed in the conservative group. Twenty cases were followed up by CT. In the conservative group, 28 cases showed satisfactory progress. The other 6 patients developed complications in the form of hepatitis, subphrenic abscess, and biloma. In the surgical group, 18 cases showed satisfactory progress, while 8 cases developed complication. These were wound gape, seroma, hemobilia, subphrenic abscess, and biloma.

Discussion

The liver is the largest solid abdominal organ with a relatively fixed position, which makes it prone to injury. Liver trauma is the second most frequent event during an abdominal trauma and is the leading cause of death (20–40 %) in these cases [2].

In our study, males represent 80 % while females represent 20 % of the traumatized patients. The peak age for trauma found was 11–30 years. The reason is because this age group is closely associated with MCA. The male to female ratio in our study was 4:1. This is similar to a study performed on liver trauma patients which revealed that males (90 %) and females (10 %) were involved in different accident mechanisms [4]. This is expected since males are normally more involved in many hazardous activities.

Major causes of blunt abdominal trauma are motor car accident, fall from height, and striking hard objects. Penetrating injuries are associated mainly with gunshots and stabs [5]. Blunt trauma was reported as a cause of liver injury in 71–75 % of patients in some studies [3, 6]. In accordance to these studies, our study clearly showed that blunt trauma is the most common cause of liver injury.

Firearm injuries are more lethal as compared to stab injuries, because of their blast and cavitational effects [7]. Fortunately, firearm injury was the cause in only 8 out of 60 patients. The requirement for immediate exploration for hepatorraphy or resection in seven out of these eight patients reflects their life threatening nature.

The management of liver injuries has changed with time. During the last decade, there has been a change in the therapeutic protocols related to liver trauma [8]. Surgery is no longer the only option available. Despite the initial skepticism, there has been a progressive acceptation of non-surgical treatment [9]. More than one half of our patients (34 out of 60)

were treated with NOM with a high success rate. This decision is in accordance of others who employed non-surgical treatment in 90–93 % of their patients with liver injury. This success in other studies which reported success rates of 90–93 % could be attributed due to rapid assessment of the injured patient with evaluation of the pulse, blood pressure together with hemoglobin level and hematocrit as well as associated injuries [1, 4, 10].

With the aim of obtaining a reduction in morbidity-mortality, surgery has been reserved for extensive lesions with condition of hemodynamic instability or for the treatment of the complications. Surgical technique has also evolved towards limited resection-debridement, selective vascular ligation, and the use of peri-hepatic packing [11].

Initially, the NOM of blunt liver trauma was restricted to grades I–III liver injury. With increasing experience, more complex liver injuries in patients who remained hemodynamically stable have been included for this mode of treatment [12].

Grades I and II were operated as they have other intra-abdominal injuries needed to be operated on while those with grades III and IV were not as they had isolated liver injuries. In our study, associated extra-abdominal injuries were seen in 32 patients (55 %), while 28 patients (45 %) had isolated liver injury. Thoracic injuries occurred in 14 patients (40 %), head injury occurred in 6 patients (20 %), and bony injuries occurred in 12 patients (40 %). This is similar to a study which reported chest injuries in 55 %, pelvic injuries in 10 %, and long bone injuries in 10 % of patients [4].

In our study, firearm injuries is the most common cause of penetrating trauma (60 %) followed by stab injuries (40 %). This is similar to a study performed on 120 patients with penetrating liver injuries which revealed that firearm injuries tops the list of penetrating trauma patients, constituting 75 % of the total patients [13].

Complications in low-grade hepatic injuries were attributed to associated injuries while in high-grade hepatic injuries the complications were related to the hepatic injury itself [14].

In our study, 7 patients with penetrating trauma and 16 patients with blunt trauma were operated upon but this is in contrast to studies which support the NOM of penetrating liver trauma (stabs and shotgun injuries) especially if the patient was hemodynamically stable. A study performed on 152 patients with penetrating liver trauma revealed that 125 patients (82.2 %) were operated upon due to hemodynamically instability and 27 patients (17.8 %) were treated with NOM due to hemodynamic stability. All these patients were evaluated with serial physical examination and CT scan [15]. These studies support the fact that NOM of the selected cases of penetrating liver trauma is safe especially if the patient was hemodynamically stable.

The operative procedures done were suture hepatorrhaphy (20 cases), non-anatomical resection in one case, anatomical resection in one case and damage control therapy using pads to decrease the bleeding and remove the pads after 24–48 h in 2 cases. In another two cases, nothing was done as subcapsular hematoma had resolved.

In our study, 24 patients (70.5 %) out of 34 patients of liver trauma who were treated by NOM received blood transfusion. This is similar with results of other studies. A study performed on 68 patients revealed that 50 patients of liver trauma who were treated by NOM received blood transfusion [16].

Twenty-three patients out of 26 treated operatively received blood transfusion pre- and postoperatively. These data are matched well with a study performed on 59 patients that revealed that 50 patients received blood transfusion [14].

There is still a debate regarding the timing of follow-up CT scan. Many studies have shown that only little changes are noted on CT scan performed in less than 1 week from injury, and complete resolution occurs by 3 months. The optimal time for follow-up CT scan has been suggested to be between 7 and 10 days from the original injuries. In the present study, 20 patients had follow-up CT scan 1 week after injury. Only six patients show significant changes (biloma). Patients with grades IV or V injury should have at least one follow-up CT scan between 7 and 10 days before discharge to monitor the progress, as they are more likely to develop liver-related complication. These data is matched with other studies. A study performed on 68 patients revealed that follow-up CT abdomen was performed in 23 patients after 1 week. No significant changes were seen in 21 patients; biloma developed in one patient and secondary infection of the hematoma in another. Five patients with grade III and three patients with grade IV liver injury showed some degree of resolution [16].

In our study, 27 patients treated with NOM (79.42 %) were discharged within 1 week, 7 patients (20.58 %) were discharged within 1–2 weeks of admission but no patient stayed for more than 2 weeks. The mean hospital stay in NOM was 7.5 days. A similar finding has been reported by other studies [16].

In our study, 12 patients treated with operative management (46 %) were discharged within 1 week, 11 patients (42 %) were discharged within 1–2 weeks of admission, and no patient stayed for more than 2 weeks. The mean hospital stay in the operated group was longer (10 days). This is in agreement with a study performed on 59 patients with penetrating trauma which revealed that 52 % of the patients were discharged after 1 week, 28 % of the patients were discharged after 2 weeks, and 20 % of the patients were discharged after more than 2 weeks with a mean hospital stay of 15.5 days [14].

Conclusion

Minia University Hospital is a big tertiary Hospital in Egypt at which blunt liver trauma is more common than penetrating liver trauma. Surgery is no longer the only option available. It has been reserved for extensive lesions with condition of hemodynamic instability or for the treatment of the complications. NOM is an effective treatment modality in most cases.

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Compliance with Ethical Standards The title, aim, and plan of the study were discussed and approved regarding ethics of research in the General Surgical Department, Minia Faculty of Medicine. Full written and informed consent was obtained from all relevant participants.

Conflict of Interest The authors declare that they have no competing interests.

Statistical Analysis Data were analyzed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). Quantitative data were expressed as mean±standard deviation, while qualitative data were expressed as number and percentage, and it was compared using chi-square and Fisher's exact test. *P* value of less than 0.05 was considered to indicate significance.

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