Retrospective Evaluation of Magnitude, Severity and Outcome of Traumatic Hepatobiliary Injury at a Level-I Trauma Center in India

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Received: 24 June 2015 / Accepted: 15 September 2015 / Published online: 21 October 2015
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Abstract Liver injury is the major cause of morbidity and mortality in polytrauma patients. This study was conducted to know the burden of hepatobiliary injury and its outcome in our setup. It is a retrospective study of all patients with traumatic hepatobiliary injuries from January 2008 through April 2012 at JPNATC, New Delhi. All patients were resuscitated as per ATLS guidelines. Management of patients was based on hemodynamic status and associated injuries. Liver injury occurred in 7.52 % of all trauma admissions and 20.34 % of total abdominal trauma patients. Most common mechanism of injury was blunt trauma due to road traffic injury among all age groups ($n=234$, 67.83 %). Seventy-five percent of the patients with liver injury were hemodynamically stable at presentation ($n=262$, 75 %). Isolated liver injury was seen in 27 % of the patients. Grade II ($n=138$, 40 %) liver injury was the most common. Of the patients, 68.70 % were managed nonoperatively. Among operatively managed patients ($n=100$, 29 %), 38 % patient underwent immediate laparotomy due to hemodynamic instability. The failure of nonoperative management was in eight (2.32 %) patients with success rate of 96.73 %, i.e., 237 patients out of 245 were successfully managed nonoperatively. Packing was done in 27 % of the patients of high-grade liver injury and was associated with high morbidity and mortality (51 %). The morbidity and mortality of liver trauma were 28.99 % and 12.17 %,

respectively. Liver injury is common in abdominal trauma patients. Most of the patients with liver injury are hemodynamically stable and should be managed nonoperatively with careful monitoring.

Keywords Trauma · Liver · Hepatobiliary injury · Packing · Abdominal trauma

Introduction

The liver is the most commonly injured organ in blunt trauma patients. Although there is well-organized trauma care system in developed countries, the development of trauma care system in India is still in its infancy. Outcome of traumatic hepatobiliary injuries have significantly improved over the years due to improved trauma care system. So, this study was conducted to know the magnitude, severity, and outcome of traumatic hepatobiliary injury in our setup.

Patients and Methods

Study Design

It is a retrospective study of all patients with traumatic hepatobiliary injuries from January 2008 through April 2012 at Jai Prakash Narayan Apex Trauma Center (JPNATC), New Delhi.

Methodology

A data sheet of patients with hepatic injury were reviewed and the following data were collected: demographics, mechanism

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of injury, admission hemodynamics, hepatic injury grade, associated injuries, indication for operative intervention, failure of nonoperative management, complications, transfusion requirement, length of stay in the intensive care unit (ICU) and in ward, and death.

All patients with abdominal trauma were initially resuscitated in emergency department (ED) as per Advanced Trauma Life Support (ATLS) guidelines. Initially, Focused Assessment Sonography for Trauma (FAST) was performed in ED for all patients with abdominal trauma. Assessment of hemodynamic stability was based on vital signs. Patients with systolic blood pressure greater than 90 mmHg, either at admission or after crystalloid infusion (1 to 2 L for adults and 10 ml/kg for pediatric patients), were generally regarded as hemodynamically stable. Patients who were hemodynamically stable and had no other indications for immediate abdominal surgery were further evaluated by contrast-enhanced computed tomography (CECT) scan. Hepatic injury was graded either by CECT scan or intraoperative findings according to the Hepatic Injury Scale established by the American Association for the Surgery of Trauma [1]. All hemodynamically unstable patients of abdominal trauma were directly shifted to operation theatre for exploratory laparotomy.

Patients who underwent exploratory laparotomy for hemodynamic instability or any other indications, either with or without a CECT scan, were classified as being treated operatively. Any patient initially observed in the ICU and subsequently requiring surgery was considered a failure of nonoperative management (FNOM). Nonoperative management was discontinued in patients with hemodynamic instability unresponsive to moderate amounts of crystalloid infusion (i.e., those who show deterioration of perfusion indices as the initial fluid bolus [1 to 2 liter] are slowed to maintenance level) or a significant fall in hematocrit, or if any intra-abdominal hollow viscus injury requiring repair was suspected.

Statistical Method

Median, range, and frequencies were reported as descriptive statistics. The variables were compared using chi-squared test and Student's *t* test for qualitative and quantitative parameters as appropriate. A *p* value of <0.05 was considered significant. SPSS 16 software was used for statistical analysis.

Results

Demographic Profile

There were 345 patients of liver injury during the study period out of which 306 (88.70 %) were male. The age of the patients ranged from 1 to 71 years with median age of 24 years. There

were 94 (27.25 %) patients in the pediatric age group (<18 years). Most of patients, i.e., 209 (60.58 %), were accompanied by relatives followed by 128 (37.11 %) by police and 8 (2.32 %) by bystanders.

Since there is no organized prehospital care system in our setup, most of patients, i.e., 160 (46.37 %), were brought by private vehicles followed by 98 (28.41 %) by Public Call Response (PCR) van, 57 (16.52 %) by ambulance, and 30 (8.70 %) by Centralised Accident and Trauma Services (CATS). Similarly, only 34 (9.86 %) patients were brought within 1 h of injury, i.e., “Golden Hour.” One hundred seven (31.10 %) patients were brought within 6 h of injury, 100 (28.99 %) within 24 h and the remaining 104 (30.15 %) after 24 h of injury.

Liver Injury

Liver injury occurred in 7.52 % of all trauma admissions. It constituted 20.34 % of total abdominal trauma patients (Fig. 1). The most common mechanism of injury was blunt trauma ($n=324$, 93.91 %) due to road traffic injury (RTI) among all age groups (234, 67.83 %). The other modes of injury were fall 58 (16.81 %), assault 29 (8.41 %), railway track injury 7 (2.03 %), and others 17 (4.93 %). Among the pediatric age group (<18 years) ($n=94$), RTI was still the most common mode of injury 56 (59.57 %). The fall from height was present in 22 (23.40 %) patients and assault in 5 (5.32 %) patients.

The grade II liver injury was most common 138 (40 %). There were 59 (17.10 %) grade I, 138 (40 %) grade II, 81 (23.48 %) grade III, 53 (15.36 %) grade IV, and 14 (4.06 %) grade V injuries. There was no grade VI injury in our study.

Out of 345 patients, 262 (75.94 %) patients were hemodynamically stable on presentation and 83 (24.06 %) patients were hemodynamically unstable. Out of 83 hemodynamically unstable patients, 45 (54.21 %) patients became hemodynamically stable after initial resuscitation. There were 20 (24.09 %) transient responders and 18 (21.68 %) did not respond to resuscitative measures that included crystalloid and blood.

The mean injury severity score (ISS) of the patient was 13.44 with $SD\pm 7.81$ (range 3 to 41). Among those who survived, the mean ISS were 12.56 with $SD\pm 7.33$ and among those who died the mean ISS was 19.83 with $SD\pm 8.32$.

Isolated liver injury was present in 96 (27.83 %) patients. Among the associated injuries ($n=249$), the most common injury was other abdominal visceral injuries in 129 (51.80 %). Chest injury was associated in 108 (43.37 %), extremity long bone fracture in 49 (19.67 %), pelvic fracture in 30 (12.04 %), head injury in 28 (11.24 %), spine injury in 15 (6.02 %), and maxillofacial in 14 (5.62 %) (Fig. 2).

Fig. 1 Incidence of liver injury

Among the associated abdominal injury ($n=129$), splenic injury 46 (35.65 %) was most commonly associated with liver injury. It was followed by kidney in 39 (30.23 %), pancreatic and vascular injury including mesenteric injury in 25 (19.37 %), hollow viscus injury 21 (16.27 %), adrenal 16 (12.40 %), stomach 4 (3.10 %), and urinary bladder 2 (1.55 %) patients.

Management

Out of 345 patients, 237 (68.70 %) patients were managed nonoperatively, 100 (28.99 %) patients were managed operatively. The failure of nonoperative management was in eight (2.32 %) patients. Initially, 245 patients were selected for NOM. The success of NOM was 96.73 %, i.e., 237 patients out of 245 were successfully managed nonoperatively.

Operative Management

Among 100 patients who were managed operatively, 55 % was operated due to liver injuries and 45 % were operated because of associated injuries. The most common associated injury was hollow viscus perforation followed by pancreaticoduodenal injuries, other solid organ injuries, and vascular injuries.

As the grade of injury increased, the liver-related operative interventions also increased. Thirteen patients of grade I liver injury were managed operatively all of which were because of associated injuries. Twenty-eight patients of grade II liver injuries were managed operatively out of which only five patients were operated for liver related cause, the remaining 23 patients were operated because of associated injuries. Nineteen patients of grade III liver injuries were operated out of which 13 patients were operated for liver-related cause,

Fig. 2 Associated injuries

Fig. 3 Causes of operative interventions according to grade of liver injury

and six patients were operated for other associated injuries. Twenty-eight patients of grade IV liver injuries were operated out of which 25 patients were operated for liver-related causes and only three patients were operated for associated injuries. In grade V liver injuries, 12 patients were operated and all were because of liver related causes (Fig. 3).

Among the 100 patients of operative management, packing was done in 41 % patients. There were 42.89 % of high-grade liver injury ($n=148$). Packing was done in 27.7 % of high-grade liver injury. The most common operative procedure was packing and DCS followed by homeostasis with local hemostatic agent.

Failure of Nonoperative Management

There were eight cases of failure of NOM. The reason for failure was missed hollow viscus injury in three patients and biliary peritonitis in five patients. There was no mortality in this group of patients (Table 1).

The adjunct procedure like endoscopic retrograde cholangiopancreatography (ERCP) and angioembolization (AE) have role in management of solid organ injuries. The angioembolization was done whenever there was contrast

blush on CECT scan or ongoing bleed while damage control surgery (DCS) was done. AE was done in 25 (7.24 %) patients of liver injury.

Out of 345 patients, 160 (46.37 %) patients required blood transfusion. The median unit of blood transfusion among survivors was 3 while it was double, i.e., 6 units among those who died.

The liver injury was associated with complications in 100 (28.99 %) patients. The bile leak was present in 15 (4.35 %) patients out of which 5 patients required ERCP and stenting because of persistent bile leak. In remaining ten patients, bile leak resolved spontaneously over a period of time.

The most common complication was chest-related pleural effusion and pneumonia. Abdominal collections were most frequent associated intra-abdominal complications and all of which were managed with ultrasound guided pigtail drainage. The incidence of complications was significantly higher in operative group as compared to nonoperative group (45 vs 21 %).

The overall mortality for liver injury was 12.17 % (Table 2). Out of 42 deaths, 25 deaths (59.52 %) were directly related to liver injuries. Death of all the patients that occurred in grade I and II was due to associated injuries, where as only one patient

Table 1 Details of patients of failed nonoperative management

Patient no.	Grade of injury	Reason for failure	Hospital course	Intraoperative findings	Complication
1	II	Duodenal injury	Peritonitis on ^a PAD2	1.5 cm perforation in the third part of duodenum	No
2	III	Bile leak	Peritonitis on PAD2	No bowel injury. Peritoneal lavage done	No
3	II	Small bowel perforation	Peritonitis on PAD2	Small perforation in jejunum	No
4	IV	Bile leak	Peritonitis on PAD3	No bowel injury. Peritoneal lavage done	No
5	IV	Bile leak	Peritonitis on PAD6	No bowel injury. Peritoneal lavage.	Persistent bile leak
6	II	Bowel injury	Peritonitis on PAD3	Small jejunal perforation	No
7	II	Bile leak	Peritonitis PAD2	No bowel injury. Peritoneal lavage	No
8	III	Bile leak	Peritonitis PAD6	Lt hepatic duct injury	Persistent bile leak

^a PAD postadmission day

Table 2 Management and outcome according to grade of liver injury (all the value is in number)

Grade of liver injury	Hemodynamically unstable (<i>n</i> =83)	NOP	OP		FNOM	Death	AE
			Liver related	Liver unrelated			
I	5	46	0	13	0	6	3
II	23	107	5	23	3	10	3
III	25	58	13	6	4	6	6
IV	20	24	25	3	1	13	7
V	10	2	12	0	0	7	2

NOP non operative management, *OP* operative management, *FNOM* failed nonoperative management, *AE* angioembolization

in grade III out of six patients died of associated injuries. The death of all patients in grade IV and V was attributable to liver injuries (Fig. 2). The mortality for NOM group was 23.81 % as compared to 76.81 % for operative group.

Twenty-seven (64.19 %) patients died within 72 h, and 15 (35.71 %) patients died after 72 h of admission to our hospital. The cause of death in early group was coagulopathy and ongoing bleed. The cause of death in patients who died late was septic shock and multiple organ dysfunction syndrome (MODS).

Discussion

In our study, liver injury occurred in 7.52 % of all trauma admissions and it constituted 20.34 % of all abdominal trauma patients. The incidence of liver injury in our study is higher as compared to reported incidence of liver injury in literature. Croce et al. [2] reported 5 % incidence of liver injury while Malhotra et al. [3] had reported 4.6 % incidence of liver injury.

The most common mechanism of liver injury in our study was blunt trauma (94 %) due to road traffic injuries among all age groups, which is much higher than reported in published literature [3, 4]. Petrowsky et al. [4] had reported 84 % incidence of blunt liver injury while Malhotra et al. [3] had shown 82 % incidence of blunt liver trauma due to road traffic injuries.

Although RTI was the most common mode of liver injury, certain mechanisms were peculiar to Indian society such as injury to abdomen by buffalo, physical assault on abdomen by bamboo stick and railway track injuries, unlike reported mechanism in literature. Lessons we have learnt that patients with history of such mechanism of injury should not be dismissed as trivial injury even if there is not much external visible injury; such mechanism also called for a high index of suspicion for major liver injury. Such patients should be thoroughly observed and investigated for liver injury.

Malhotra et al. [3] reported 16 % incidence of isolated liver injury in adult. The reported incidence of isolated liver injury in pediatric age group (43.72 % by Landau et al [5] and 37 %

by Nellenstein et al. [6]) are higher than in adult. It might be due to different mechanism of injury in these different age groups. In our study, the incidence of isolated liver injury was higher (27 %); despite low velocity impact like direct injury to abdomen by buffalo or physical assault with bamboo stick or fall of object over abdomen from less height. As these were low velocity trauma, the impact on the surrounding organs with other associated injuries were less common. The other reason might be that more number of pediatric patients (27.25 %) in our study in whom the reported incidence of isolated injury is higher.

In our study, incidence of high-grade liver injury (grades III, IV, V) was 43 %. However, in literature, the incidence of high-grade liver injury varies widely from 16 to 44 % in different series [7–9]. The reported incidence of high-grade liver injury are 44.2 % by Schnuriger et al. [8], 41 % by Christmas et al. [7] and 16 % by Bala et al. [9]. The low body mass index may also be contributing factor towards sustaining higher grade of liver injury in our patients. Thick subcutaneous fat may act like a cushion for absorbing blunt trauma.

In our study, 60 % patients were accompanied by relatives and brought in private van. In developed country, there is organized prehospital emergency care system and most of the patients were accompanied by trained paramedical personals. This reflects that a proper organized prehospital care and transport system for trauma patients in our setup is the need of the hour.

Recent series of NOM has demonstrated that it is safe and effective in selected patients with both blunt and penetrating abdominal trauma with variable success rate ranging between 83 and 97 % [2–4, 7]. Petrowsky et al. [4] had shown 96 % success rate of NOM with 2.2 % liver-specific failure rate of NOM. In a study by Malhotra et al. [3], the rate of failure of nonoperative management was 7 % (42 patients); 20 were liver related. The causes of non liver-related failures were hollow viscus injury in five, solid organ injury in nine, and urinary bladder rupture in one.

In our study, there were eight cases of FNOM. Liver-related failure was 62 % and was due to biliary peritonitis. Among the remaining three cases, the reason for failure was

missed hollow viscus injuries on initial evaluation by CECT scan of abdomen. So, if the CECT scan could have picked up these injuries, then success of NOM could have been even more. NOM was abandoned in all these patients because of clinical evidence of peritonitis. The five patients had biliary peritonitis and three patients had peritonitis related to missed hollow viscus injuries. All patients developed peritonitis on postinjury days 2 and 3 except in two patients where it was on post-injury day 6. There was no mortality in this group of patients. All the five patients with biliary peritonitis underwent exploratory laparotomy and peritoneal lavage. One patient had left hepatic duct injury. Out of five, two patients required ERCP and stenting in postoperative period for persistent bile leak.

Among operative group, 55 % patients were operated due to liver-related causes. As the grade of injury increased, the liver-related operative intervention also increased. All cases of grade I and II liver injuries were operated due to associated injuries while most of the patients of grade IV injury, and all cases of grade V liver injuries were operated because of liver related causes. In all cases of low-grade injury which was operated for associated injuries, the liver bleeding had either already stopped on its own or hemostasis achieved by local hemostatic agents.

In our study, damage control surgery (DCS) and packing was done in 41 (41 %) of operatively managed patients. It was associated with overall mortality (51 %) and morbidity (48 %). The higher mortality and morbidity in these patients were due to higher grades of injuries. Saverio et al. [10] have recently reported their experience of packing in 39 patients with grade IV and V liver injuries over 14 years. The overall mortality was 51.3 % with liver-related death occurred in 23.1 % patients. The result of packing in our study is comparable to the recent report by Saverio et al. [10].

The value of AE and ERCP in the overall treatment of severe hepatic injuries and complications has been well established [11–14]. In our study, AE was done in 25 (7.24 %) patients. Johnson et al. [13] has shown the successful use of AE in 75 % of patients after DCS, with a large number of subsequent liver-related complications. Similarly, ERCP plays important role in management of posttraumatic bile leak. Bile leak was present in 4 % of our patients. Bile leak in five patients of grade IV and V injuries required ERCP and stenting while in remaining cases, it resolved spontaneously. Sugimoto et al. [15] reported on healing of bile leaks in five of six patients after therapeutic ERCP. Bajaj et al. [16] reported a similar rate of success for therapeutic ERCP for the management of posttraumatic bile leaks [8 of 9 patients (89 %)]. Liver-related complications have been reported to occur in approximately 50 % of patients surviving major hepatic trauma.

The rate of liver-related complications in low-grade injury is low and generally ranges from 0 to 7 % [6, 7]. In our study,

liver injury was associated with complications in 30 % cases. The most common complication was chest related followed by intra-abdominal collections. The incidence of complications was significantly higher in operatively managed patients as compared to NOM (45 vs 21 %). Most of these complications were managed with ERCP, AE, and pigtail drainage.

The overall mortality of liver injury was 12 %. Among all deaths, 60 % of death was caused by liver injury itself. The reported incidence of liver injury mortality in literature is 10–15 % [2, 3, 7]. Schnuriger et al. [8] have reported mortality rate of 16.9 % with overall mortality rate associated solely with liver injury was 4.9 % (nine of 183) and was always related to high-grade injury. Christmas et al. [7] have reported lowest mortality rate of 9.4 %, with 3.7 % related to liver injury itself.

The incidence of mortality was significantly higher in operatively managed patients as compared to NOM group (76 vs 23 %). It was due to higher grade of injury and more number of associated injuries in those patients.

Conclusion

Liver injury is common in abdominal trauma patients. Most of the patients with liver injury are hemodynamically stable and should be managed nonoperatively with careful monitoring.

Conflict of Interest None

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