

ORIGINAL ARTICLE

Start of Polytrauma Management in University Hospital: First Experience with Liver Trauma

Solvita Stabina*,**, Aleksejs Kaminskis*, Guntars Pupelis*^{**}

*Riga East Clinical University hospital Gailezers, General and Emergency Surgery Department, Latvia

** Riga Stradiņš University, Latvia

SUMMARY

Introduction. Trauma is a leading cause of death, particularly among young patients. Spleen is the most commonly damaged organ in blunt abdominal trauma and liver injury is the main cause of death.

Aim of the study. Review of the literature and recent clinical experience in the management of blunt liver injuries in the Riga East clinical university hospital.

Materials and methods. Three-year experience in the management of liver traumatic rupture was retrospectively and prospectively analysed. The study included 64 patients over 15 years of age with blunt hepatic injuries. Exclusion criteria were patients with life-incompatible haemorrhagic shock. The Statistical analysis of the data was performed by median and mean of the Microsoft Excel 2010 and SPSS 22 version.

Results. A total of 64 patients were treated in our institution during the period from November 2010 till November 2013. Isolated liver injuries were diagnosed in 49 cases, combined liver and spleen injuries in 15 cases. Most commonly mechanism of injury were road traffic accidents, falls and low energy blunt traumas (criminal beaten, sports injuries); 19 patients underwent laparotomy for haemostasis while nonoperative management was used in 45 patients. Haemodynamic stability of the patient and CT confirmed liver injury were the main criteria for nonoperative management. One patient died at the time of laparotomy from injuries not compatible with life – severe head injury with basal skull fracture, aortic arc rupture, flail chest and liver and spleen injury.

Conclusions. Conservative management of liver trauma is justified in haemodynamically(HD) stable patients after thorough risk assessment and computed tomography (CT) based injury grading in centres with sufficient expertise and medical resources.

Key words: liver injury, blunt abdominal trauma, non-operative management

INTRODUCTION

Junior and adult mortality secondary to trauma is constantly high all over the globe. According to statistics from United States mortality secondary to variable type of injuries reached 50.6% among persons in age segment from 1-44 years.(9)

Injury facts:

- More than 180,000 deaths from injury each year - 1 person every 3 minutes
- An estimated 2.8 million people hospitalized with injury each year (13)
- Violence and injuries cost more than \$406 billion in medical care and lost productivity each year (5)

According to prognosis by the year 2020, 8.4 million people may die every year from injury. Traumatic injuries will be from third to second most common cause of disability worldwide.(11) The most common mechanisms of injury are: falling from height, road accidents, blunt force trauma and barotrauma. Road-traffic injuries are major cause of deaths worldwide including Latvia. Traffic is becoming more intense, for example, at the end of 2013, 316 cars per 1000 inhabitants were registered in Latvia, while in 2000 were registered only 237 cars per 1000 inhabitants.(7)

AIM OF THE STUDY

The aims of the study were to analyse our recent 3-year experience after start of polytrauma service in the Riga East clinical university hospital and to summarise the data from literature and existing guidelines about the management of the blunt liver injury.

MATERIAL AND METHODS

Three year experience in the management of liver traumatic rupture was retrospectively and prospectively analysed. Patients were divided in nonoperative management and operative management groups. Main demographic data, ASA score, Glasgow coma score, trauma mechanism, liver injury grade, injury severity score (ISS) and trauma score were recorded, and individual severity of the injury, treatment strategy and final outcomes were analysed comparing two groups. Haemodynamically unstable patients with positive FAST and/or CT confirmed urinary tract diaphragm or hollow viscus injury underwent urgent laparotomy. Nonoperative management (NOM) included continuous monitoring and repeated abdominal ultrasonography during the early ICU treatment period with CT control.

RESULTS

Totally 64 patients with blunt liver trauma were treated during the period between November 2010 and November 2013, from them, 41 male patient with median age 41.9 years ($SD=15.5$) and 23 female patients with median age 33.1 year ($SD=15.1$) years, $p=0.031$. The most common trauma mechanisms were road traffic accidents involving the driver of the vehicle in 33 cases (51.6%). At the next place were falls from height in 16 cases (25%) and low energy blunt trauma in 15 cases (23.4%).

Grade I liver injury were detected in 23 cases (35.9%) with median ISS score 29 (IQR, 28-24) points and two of them (8.7%) underwent surgery because of the bleeding spleen injury, 25 patients (39.1%) were treated with grade II liver injury, median ISS score 33 (IQR, 43-22) points, 9 of them (36.0%) underwent surgery. Grade III injury were found in 12 cases (18.8%), median ISS 35 (IQR, 43-23) points, 5 of them were operated. Severe grade IV liver injuries were in four cases, median ISS 44 (IQR, 62-33) and three of them underwent surgery. In all cases were done perihepatic packing and in two cases were done splenectomy, because of combined spleen injury.

From all 25 (39%) patients had associated intra-abdominal injuries – kidney laceration in 13 cases, pneumoperitoneum in 3 cases, mesenterial rupture in 2 cases. One patient was operated because of grade V kidney, grade IV pancreas, grade II liver and grade II spleen injury and one patient was operated because of diaphragm rupture.

20 years old female died 136 minutes after arrival to the hospital. She was delivered hemodynamically unstable and underwent laparotomy and abdominal packing after positive FAST. Ventricular fibrillation started at the time of surgery and cardio pulmonary resuscitation failed.

DISCUSSION

The surface anatomy of the liver was described as early as 2000 years BC by the ancient Babylonians. Francis Glisson was the first who accurately described the vascular anatomy of the liver in 1654. Rudimentary excisions of eviscerated liver for the patient with penetrating liver injury is defined as beginning of liver surgery. The partial hepatectomy was performed to patient with self - inflicted stab wound. Operation was done by Berta in 1916, and is considered as first partial liver resection.(25) Nonoperative management for blunt liver injury firstly was described in pediatric practice in 1980, and in 1990 in adults. However first issues were addressed by the Eastern Association for the Surgery of Trauma in the Practice Management Guidelines for Nonoperative Management of Blunt Injury to the Liver and Spleen published online in 2003.(15)

One hundred seventy-six articles were identified from National Library of Medicine and the National

Institutes of Health MEDLINE database published after 1996 for blunt liver trauma. Ninety four articles were used to create Eastern Association for the Surgery of Trauma guidelines. The guidelines herald that nonoperative management is the treatment modality of choice for hemodynamically stable patients regardless of the injury degree and the patient's age. Published literature and our study have shown that organ injury grade, ISS score, age and additional injuries such as kidney and spleen is not a contraindication for NOM.

Results of this study are similar to reported data from literature confirming evidence that most patients were adults and the main trauma mechanism was associated with road traffic accidents. Falls from the height were the next most often cause of liver trauma. According to data from this study liver trauma most often lead to Grade I and Grade II injuries in more than one third of cases. Less than one fifth of patients suffered Grade III injury and Grade IV injury was recognized in 6%.(22) Majority of patient with Grade I-III injuries were managed by NOM .(21) Three out of four patients with Grade IV underwent surgery due to associated spleen injury. Main surgical procedure were Damage control perihepatic packing.(16) Main indication for surgery was uncontrolled hemorrhage and associated organ injury.(12) One death in these series was associated with ventricular fibrillation and cardiac arrest during the damage control laparotomy and perihepatic packing.

Injury mechanism

The blunt liver trauma characterized by two mechanisms - the deceleration and crush injury. Deceleration injuries are more typical to road traffic accidents and falls from a height. Liver parenchyma and capsule rupture is the main result of the indirect impact and usually creates lacerations between the segments fifth, sixth, seventh and eighth as well as large hepatic vessels. Crush injuries following direct trauma to the liver usually damage fourth, fifth and eighth segments.(19)

Injury classification (Table N1)

Liver injury ranges from a minor capsular tear, with or without parenchymal injury, to deep tear involving hepatic blood vessels. This scale is useful not only as a descriptive but also as an outcome predictor that facilitates comparisons across groups of patients.

Table N1 Liver injury grading system

Grade	Type	Description
I	Haematoma	Subcapsular < 10% surface
	Laceration	Capsular tear < 1cm parenchymal depth
II	Haematoma	Subcapsular 10 - 50% surface area; intraparenchymal, < 10cm diameter
	Laceration	1-3cm parenchymal depth, < 10cm in length
III	Haematoma	Subcapsular > 50% surface area or expanding, ruptured subcapsular or parenchymal haematoma. Intraparenchymal haematoma .10cm
	Laceration	> 3cm parenchymal depth
IV	Laceration	Parenchymal disruption 25-75% of hepatic lobe
V	Laceration	Parenchymal disruption involving > 75% of hepatic lobe
	Vascular	Juxtavenous hepatic injuries
VI	Vascular	Hepatic avulsion

Diagnostic algorithm. (Figure N1)

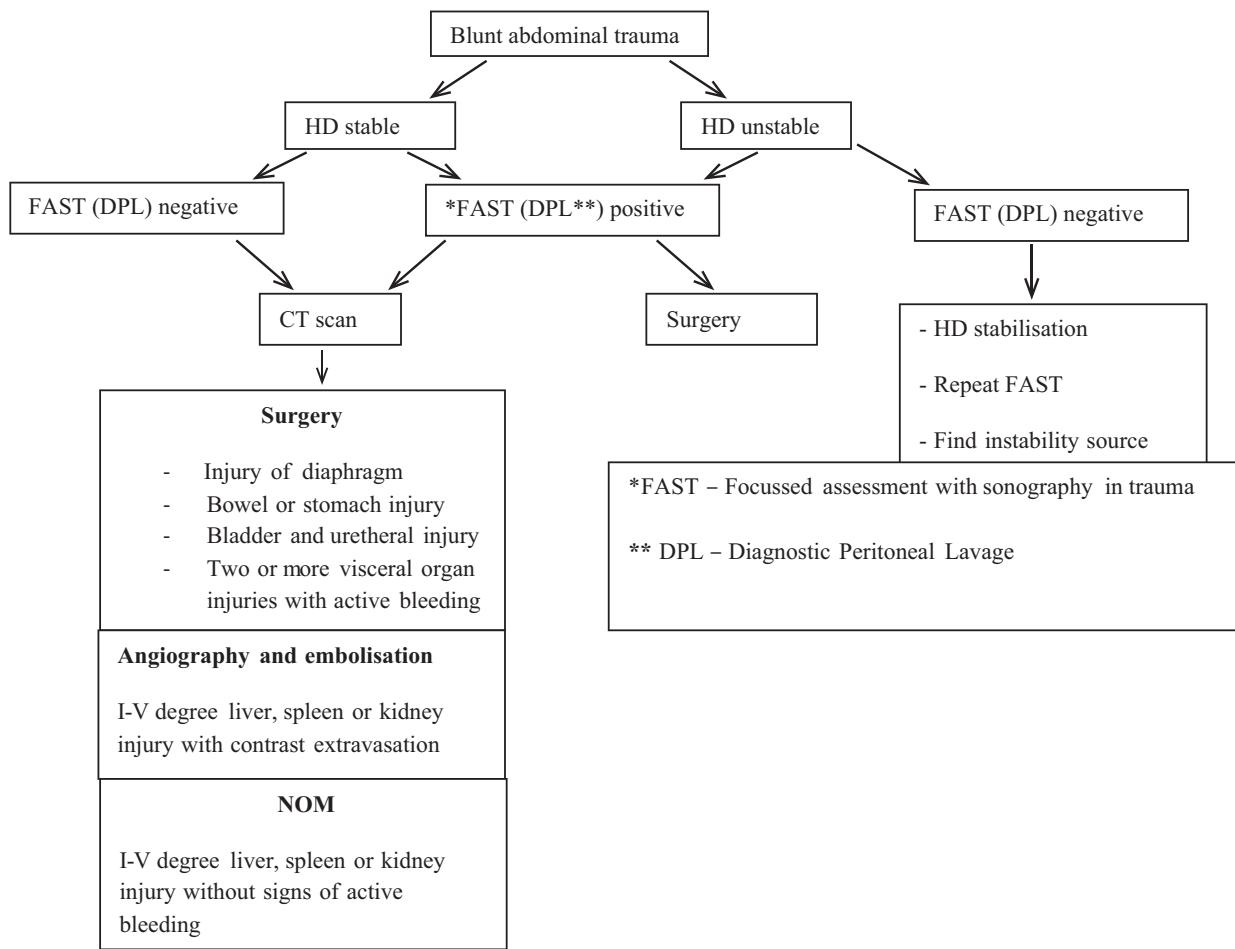


Fig. 1. Algoritm for the management of blunt abdominal trauma

FAST. (Figure N2) Acronym FAST was defined for the first time by international consensus conference committee in 1997. The term describe the application of ultrasound in the initial evaluation of trauma patients.(2) FAST is not detailed abdominal ultrasound examination, but it helps to get around in the limited time situations.FAST scan alone has a sensitivity of 70% and specificity of 100% in combination with physical examination, the sensitivity rises up to 100%.(23) Branney and colleagues in a study on infused volumes of DPL found that only 10% of participants performing FAST could detect fluid volumes of less than 400 mL, the mean detected volume in the peritoneal cavity was 619ml. Von Kuenssberg, Jehle and colleagues found that the mean minimal volume of fluid needed for pelvic ultrasound is 157 mL.

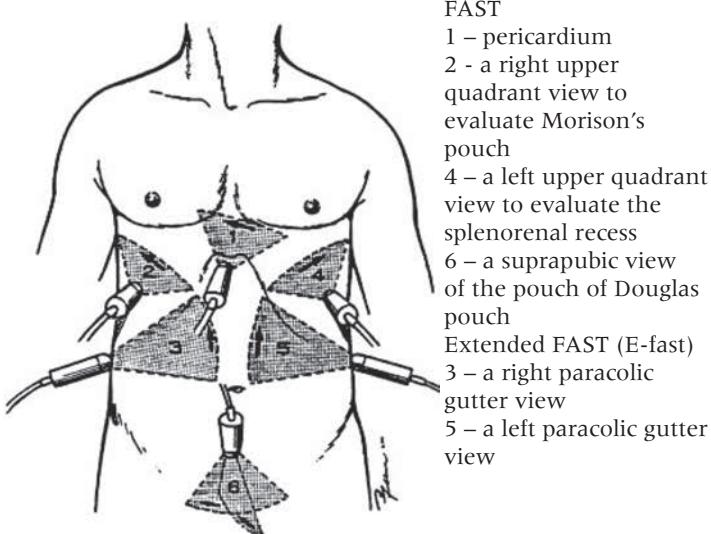


Fig. 2. FAST and E-FAST anatomical references (26)

Other modalities, such as MRI with MR cholangio-pancreatography (MRCP), hepato-biliary scintigraphy, and endoscopic retrograde cholangiopancreatography (ERCP) may require for detecting subacute or delayed complications, such as bile duct leaks, bilomas, and biliary strictures.(27)

Treatment options

Nonoperative management. The Eastern Association for the Surgery of trauma recommends that all hemodynamically unstable patients after blunt abdominal trauma should undergo surgery (Level 1 recommendations), however the same recommendations says that routine laparotomy is not indicated in the hemodynamically stable patient without peritonitis after blunt hepatic injury (Level 2 recommendation). It has been proven that nonoperative management of blunt liver injury can be effective in more than 80% of cases.(4) The careful observation by surgeon and intensive care team with repeated

ultrasound, blood tests and CT (high grade injury) can be the key to successful outcome.

Indications for nonoperative management. (20)

- Hemodynamic stability
- No signs of peritonitis
- Ability to follow serial physical examinations (patient is conscious)
- Absence of other intraperitoneal injuries by CT scan.
- Minimal transfusion requirements 2 units of packed red blood cells (PRBCs)

Complications. Liver related complications - bile leak, hepatic abscess, hepatic necrosis, missed hollow viscus injury and haemobilia, delayed bleeding. Non-liver-related complications - pneumonia, bacteraemia, urinary tract infections, adult respiratory distress syndrome, upper gastrointestinal bleeding, multiple organ failure, compartment syndrome and sepsis.

Hepatic arterial embolisation. Sclafani (1985) demonstrated that angiography and embolization could be used to control haemorrhage from injuries to the liver and spleen. Twelve years later Hagiwara and colleagues stated that this method is an effective alternative to surgery. They concluded that almost all severe hepatic venous bleeding is self-limiting, and angiographic methods are suitable to treat haemorrhage secondary to blunt or penetrating trauma, including iatrogenic arterial injuries resulting from biliary interventions.(18)

Indications for hepatic embolisation:

- Continuous haemorrhage who remain borderline after resuscitation
- Early ongoing bleeding after primary surgical haemostasis
- After damage control laparotomy
- Rebleeding after initially successful embolization
- Other vascular injuries to the liver, such as pseudoaneurysm or arteriovenous fistulae, and increased risk of delayed bleeding

Complications—hepatic pseudoaneurysm, arteriportal or arteriovenous fistulas, delayed haemorrhage, hepatic abscess and necrosis. Capsular retraction, calcifications, or segmental bile duct obstruction may be observed.

Operative management

Simple liver injuries (grades I and II)

Options for the small liver lacerations (up to 3m) - suture hepatorrhaphy using horizontal mattress sutures, electro cautery or argon beam coagulation or application of adhesive sponge. All open bile ducts and blood vessels must be ligate in order to avoid complications.

Complex liver injuries (grade III or greater)

Perihepatic packing (Figure N3,(17)) is the workhorse of surgery for hepatic trauma and is especially useful for high-grade lacerations or parenchymal disruptions. Liver packing often is the only way to save the patient's life in the cases of the severe liver injury. Leading goal of the packing is homeostasis by compressing the bleeding parenchyma between packs placed above and below it. (8)

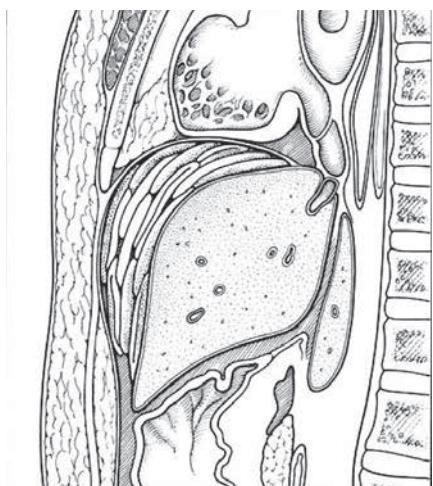


Fig. 3. Perihepatic packing

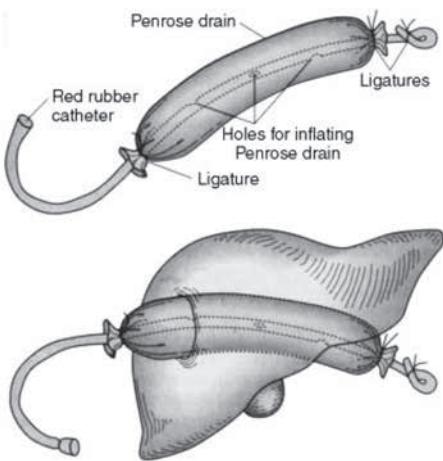


Fig. 4. Internal tamponade using a red rubber catheter and Penrose drain. (26)

Repeated surgery is recommended after hemodynamic stabilization of the patients and recovery of the coagulopathy and acidosis. In general, it is carried out 36 to 48 hours after the injury, but also can be performed within 72 hours. Early removal of the packs can promote repeated bleeding and in such cases must be done re-packing. Leaving the pack for more than 72 hours raise the risk of septic complications. If the packed liver injury is associated with damage control of a bowel injury, intestinal reconstruction should be performed, and the packs should be removed last.(14)

Internal tamponade (Figure N4,(24)). Haemostasis in case of deep lacerations or penetrating liver injury can be done using a tamponade principle. The most convenient way is insertion of a tube (Large chest tube or Foley catheter) with a firmly attached balloon or rubber glove that can be inflated. Sengstaken Blakemore tube or condom can be also used.(10)

Injuries to the retrohepatic IVC or hepatic veins. Techniques for repair of these injuries require methods to decrease blood flow through this area and

include total vascular isolation of the liver (clamping the hepatoduodenal ligament, suprarenal IVC and suprahepatic IVC), use of a transatrial chest tube or endotracheal tube shunts, and venovenous bypass.

Resectional debridement. This method involves removal of damaged tissue till the border of the healthy tissues and provides atypical resection of damaged liver, rather than anatomical resection. All blood vessels and segmental bile ducts must be ligated. Difficult bleeding control is the technical drawback to this method and often ended up with liver packing.(1)(3)

Hepatic resection refers to anatomic removal of a segment (or lobe) and is reserved for patients with total destruction of a segment (or lobe) or when needed to control exsanguinating haemorrhage. Formal resection is rarely used in the trauma setting as it carries a high mortality rate.(6)

Selective hepatic artery ligation can be used to control arterial haemorrhage from the liver parenchyma. This technique is usually allowed because of the high oxygen saturation of the portal blood and can be performed without subsequent hepatic necrosis. It is indicated in the rare instance when selective clamping of an extrahepatic artery causes cessation of arterial bleeding in a hepatotomy or laceration and the bleeding vessel cannot be seen inside the liver.

CONCLUSIONS

Management of blunt abdominal trauma still remains a significant challenge. Recent experience shows that hemodynamically stable patients should undergo CT scan to exclude additional injuries. NOM is recommended for HD stable patients with CT confirmed liver injury without signs of active bleeding and peritonitis.

Conflict of interest: None

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Address:

Solvita Stabina
 Talavas gatve 13 – 8, Riga, Latvia
 E-mail: solvita.stabina@inbox.lv