International Journal of Collaborative Research on Internal Medicine & Public Health
Vol. 2 No. 4 (April 2010)
pp. 96-107

Liver Trauma: Operative and Non-operative Management

Moosa Zargar, Marjan Laal

Corresponding author: Marjan Laal (laal.marjan@gmail.com)

Correspondence concerning this article should be addressed to Dr. Marjan Laal, Sina Trauma and Research Center, Sina Hospital, Hassan-Abad Square, Hafez Street, Tehran, Iran; Postal Box: 11365-3876; Email: laal.marjan@gmail.com

International Journal of Collaborative Research on Internal Medicine & Public Health
Vol. 2 No. 4 (April 2010)
Pages 96-107

ISSN 1840-4529

http://www.iomcworld.com/ijcrimph/

Paper review summary:
Paper submission: January 06, 2010
Revised paper submission: February 24, 2010
Paper acceptance: March 17, 2010
Paper publication: April 01, 2010

International Journal of Collaborative Research on Internal Medicine & Public Health
Vol. 2 No. 4 (April 2010)
pp. 96-107

Liver Trauma: Operative and Non-operative Management

Moosa Zargar
Sina Trauma and Research Center
Department of surgery, School of Medicine
Tehran University of Medical Sciences (TUMS), Iran

Marjan Laal
Sina Trauma and Research Center, Sina Hospital
Tehran University of Medical Sciences (TUMS), Iran
Email: laal.marjan@gmail.com

Abstract

Background: The liver is the second most commonly injured organ in abdominal trauma, but liver damage is the most common cause of death after abdominal injury. Although urgent surgery continues to be the standard for hemodynamically compromised patients with hepatic trauma, there has been a paradigm shift in the management of patients who have stable hemodynamic. A marked change toward a more conservative approach in the treatment of abdominal trauma has been noted during the last decades. Modern treatment of liver trauma is increasingly non-operative.

Purpose: To find the epidemiology, etiologies and managements of liver trauma in a population based study in Iran.

Material and Method: A study including 16,287 trauma patients referred to the main hospitals of seven cities with different geographic patterns was done in Iran. Eighty-four patients with hepatic trauma during the 1-year period ending March 2000 included in this Cross-Sectional study. We determined the incidence, etiology and management of the patients suffering liver injury. Analysis was done using SPSS 18. Statistical significance was set at $P<0.05$.

Results: Out of 16287 trauma patients 84 (0.5%) had hepatic trauma with male predominance 68(81%). The most type of trauma was blunt and the main cause was motor vehicle crashes. Thirty patients (35.7%) managed non-operatively. There was no significant difference in hospital stay between patients operated and managed non-operatively. There was no mortality in the patients managed non-surgically.

Conclusion: In this study hepatic trauma was in 3.7% of abdominal trauma patients. This study concluded non-operative management of hepatic injuries is associated with a low overall morbidity and does not result in increases in length of stay. Non-operative management is a safe approach for the patients of liver trauma with stable hemodynamic.

Key Words: Liver trauma, Management, Non-operative

Introduction

The liver is the largest solid abdominal organ with a relatively fixed position, which makes it prone to injury (Zangana AM 2007). Damage to the liver is the most common of death after abdominal injury. The most common cause of liver injury is blunt abdominal trauma, which is secondary to motor vehicle crashes (MVC) (Nawaz Khan A *et al.* 2009). The liver is frequently injured following abdominal trauma and associated injuries contribute significantly to mortality and morbidity, and may cause the liver injury to be masked and diagnosis delayed (Beal SL 1990).

Management of hepatic injuries has evolved over the past 30 years. Prior to that time, a diagnostic peritoneal lavage (DPL) positive for blood, was an indication for exploratory celiotomy because of concern about ongoing hemorrhage and/or missed intra-abdominal injuries needing repair (EAST 2003).

The recognition that between 50 and 80 per cent of liver injuries stop bleeding spontaneously, coupled with better imaging of the injured liver by computed tomography (CT), has led progressively to the acceptance of non-operative (NOP) management with a resultant decrease in mortality rates (Pachter HL and Hofstetter SR 1995).

Stimulated by the success of NOP management of spleen and hepatic injuries in children who have stable hemodynamic, there has been a trend towards NOP management in hemodynamic stable adults with similar injuries. A “paradigm shift” is said to occur when the rules governing a process are fundamentally changed, and such is the case with the treatment of liver injuries. Modern treatment of liver trauma is increasingly NOP (Konig T *et al*. 2007).

The treatment of abdominal injuries has evolved and a NOP approach has been adopted in an increasing number of selected patients (Pachter HL and Hofstetter SR 1995). Advantages of NOP management include avoidance of non-therapeutic celiotomies and the associated cost and morbidity, fewer intra-abdominal complications compared to operative repair, and reduced transfusion risks (EAST 2003).

The hemodynamic status of the patient is the most reliable and critical factor for NOP management (Parks RW *et al.* 1999, Coughlin P.A. *et al.* 2004, Sherlock DJ and Bismuth H 1991, Oschner MG *et al.* 1993).

Neither grade of injury nor amount of hemoperitoneum on CT predicts the outcome of NOP management and mandates laparotomy (EAST 2003, Fang JF 1998).

NOP management of hepatic injuries is the treatment modality of choice in hemodynamically stable patients, irrespective of the grade of injury (Lyuboslavsky Y and Pattillo M 2009, Gibson D *et al.* 2006). It is associated with a low overall morbidity and mortality and does not result in increases in length of stay, need for blood transfusions, bleeding complications, or visceral associated hollow viscus injuries as compared with operative management (EAST 2003, Gibson D *et al.* 2006).

Purpose

This study attempted to find the epidemiology, etiologies and managements of liver trauma and to grade injuries according to the Organ Injury Scale, in a population based study in Iran.

Material and Method

A Cross-Sectional study consisting 16287 trauma patients referred to the main hospitals of seven cities (Tehran, Shiraz, Ahwaz, Tabriz, Qom, Mashhad and Kermanshah) from 1999 to 2000 was done. We excluded the entire patients admitted less than 24 hours. Patients with hepatic injury treated at hospitals included in this study.

The following data were collected: demographics, mechanism of injury, pre-hospital care, admission hemodynamic status, grade of hepatic injury, associated injuries, failure of NOP management, hospital stay in intensive care unit (ICU) or in the ward and death.

Statistical analysis was performed with SPSS version 18, using the chi-square test for discrete variables and the unpaired *t* test for continuous variables. Level of significance was set at $P<0.05$.

Assessment of hemodynamic stability was based on routine vital signs. Patients with admission systolic blood pressure greater than 90 mmHg, either at admission or after low-volume crystalloid infusion, were generally regarded as hemodynamic stable. NOP management has been applied to all hemodynamic stable patients with hepatic injury. Patients who were hemodynamic stable and had no other indication for immediate abdominal surgery underwent a computed tomography (CT) scan or sonography, dependant on availability in the centers. Unstable patients underwent DPL to assess free blood in the abdominal cavity.

Injury severity was determined from CT and operative observations, and classified by means of the Liver Injury Scale (LIS) (Table 1) (Moore EE *et al.* 1995).

Table 1: The Liver Injury Scale (LIS) classification

Grade	Description of injury
I	
Haematoma	Subcapsular, non-expanding, less than 10 percent of surface area
Laceration	Capsular tear, non-bleeding, parenchymal depth less than 1 cm
II	
Haematoma	Subcapsular, non-expanding, 10–50 per cent of surface area; or intraparenchymal, non-expanding, less than 2 cm in diameter
Laceration	Capsular tear, active bleeding, parenchymal depth 1–3 cm, less than 10 cm in length
III	
Haematoma	Subcapsular, more than 50 per cent of surface area or expanding; ruptured subcapsular haematoma with active bleeding; intraparenchymal haematoma larger than 2 cm
Laceration	Parenchymal depth more than 3 cm
I	
Haematoma	Ruptured intraparenchymal haematoma with active bleeding
Laceration	Parenchymal disruption of more than 25–50 percent of hepatic lobe
V	
Laceration	Parenchymal disruption of more than 50 per cent of hepatic lobe
Vascular	Juxtahepatic venous injuries
VI	
Vascular	Hepatic avulsion

Hepatic injury was graded according to the Hepatic Injury Scale established by the American Association for the Surgery of Trauma (AAST). Patients who underwent celiotomy for hemodynamic instability or any other indication, either with or without a CT scan, were classified as being treated operatively. Other patients admitted to the ICU or surgical ward for observation were classified as being treated non-operatively. Any patient initially observed in the ICU and subsequently requiring surgery was considered a failure of NOP management. NOP management was discontinued in patients with hemodynamic instability unresponsive to moderate amounts of crystalloid infusion or a significant fall in hematocrit, or if any intra-abdominal hollow viscus injury was suspected. There were no other specifically defined criteria for abandonment of NOP management.

Results

A total number of 16287 trauma patients referred and 2266 (13.91%) patients had abdominal trauma (including both outpatients and inpatients). Out of 84 patients with hepatic injury,

68(81%) patients were male and 16(19%) were female. The average age was 23.8 ± 14.4 years (range 3-67), and the male-to-female ratio was 3.9:1.

Some patients received pre-hospital care which is displayed in Table 2.

Table 2: Pre-hospital care in 84 patients with hepatic trauma

	Frequency	**Percentage**
NO	48	57.1%
YES	46	42.9%
TOTAL	84	100%

Most hepatic trauma patients had blunt injury 63(75%). Blunt liver trauma was 77.8% in males and 22.2% in females. Fifty-three (63.1%) were due to MVCs including car drivers, pedestrians and motorcycles. Non-traffic causes including falls and bicycles were the etiology in 10 patients (11.9%) of blunt hepatic trauma. Penetrating injuries 21(25%) included: knives, guns (gunshot & shotgun injuries) and others. Demographic data showed in Table 3.

Table 3: Demographic data of 84 liver trauma patients

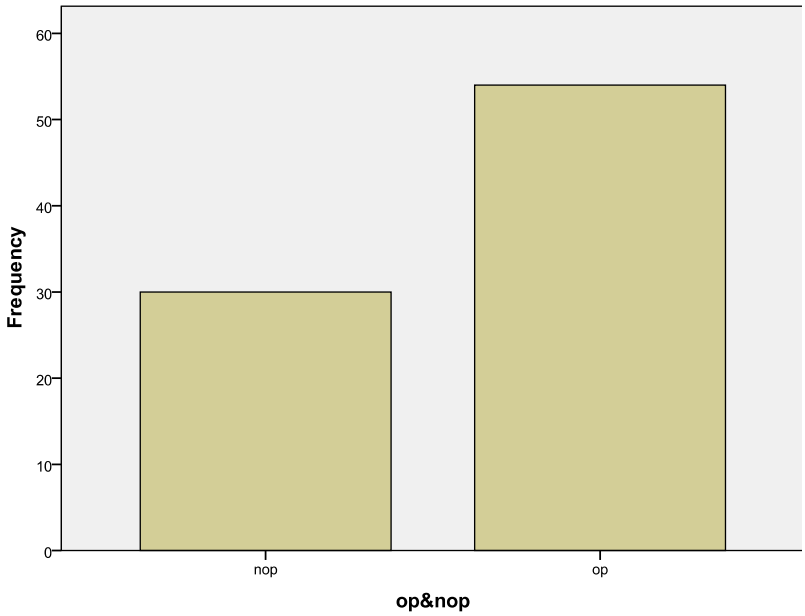
Liver Trauma		**Number**	**Frequency**
Sex	Male Female	68 16	81% 19%
Age	Mean (range)	23.8(3-67)y	
Blunt Trauma	 MVC* Pedestrian Car driver Motorcycles Bicycles Falls	63 53 20 20 13 4 6	75 63.1% 23.8% 23.8% 15.5% 4.8% 7.1%
Penetrating Trauma	 Knives Guns Others	21 16 3 2	25% 19% 3.6% 2.4%

MVC= motor vehicle crash

Associated traumas 66(78.6%) included both intra and extra-abdominal injuries. Spleen trauma was the most common associated injured organ seen in 46 (54.8%) patients. Other associated injuries were thorax 21(25%), pelvic organ 9(10.7%), intracranial injury 8(9.5%) and lower extremity 8(9.5%). Blunt hepatic injury was associated with other organ injuries in 79.4%, spleen trauma in 55.6%, thoracic injuries in 20.6% and head injury in12.7% of cases. Isolated hepatic injuries were in 18 (21.4%) cases. Generally, duration of hospital stay was 0 to 67 days with mean 8.32 and median 5 days and in those with isolated liver injury was 9.1 and 5 days, respectively. Duration of transient disability was 5 to 100 days with mean 28.4 and median 21days. There was no significant difference in hospital stay and transient disability between the patients operated and managed non-operatively.

Patients treated via NOP or operative management. Seven patients (8.3%) with NOP management failed and operated. Figure 1 shows managements of 84 patients in this study.

Figure 1: Managements of 84 patients with liver trauma



NOP= Non-operative
OP= Operative

Patients with failure of NOP management had significantly worse admission hemodynamic parameters, higher ISS and higher grade of liver trauma.

ISS mean and median were 16.4 and 11, respectively. Grading of injury showed significant difference with the management ($p<0.001$). A significantly higher death rate was in the patients with higher ISS ($P<0.0001$). Dead patients had higher grade of injury (Table 4).

Table 4: Grading, management and outcome of 84 studied patients with hepatic trauma

Grade	Frequency (%)	Management		
		NOP	OP	Death
I	23 (27.4%)	14	9	0
II	27 (32.1%)	11	16	1
III	19 (22.6%)	5	14	2
IV	7 (8.3%)	0	7	4
V	4 (4.8%)	0	4	4
VI	4 (4.8%)	0	4	4
Total	**84(100%)**	**30 (35.7%)**	**54 (64.3%)**	**13 (15.5%)**

NOP= Non-operative
OP= Operative

Grading of the hepatic injuries in the study community, according to LIS is presented in Figure 2.

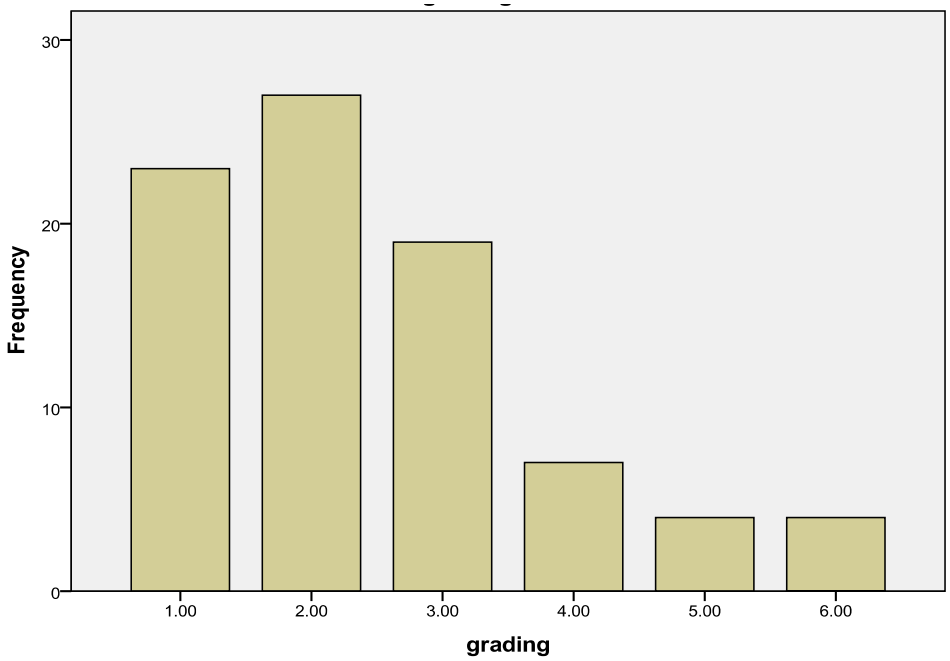


Figure 2: Liver injury scale score in 84 patients with hepatic injury

Patients operated via techniques of; suturing, packing, resection and debridement, and cholecystectomy. Operations of the studied patients are revealed in Table 5.

Table 5: Options in 54 operated patients with liver trauma

Type of operation	Frequency	Percent
Suturing	39	72.2%
Packing	6	11.1%
Resection & Debridement	7	13%
Cholecystectomy	2	3.7%
Total	54	100%

Figure 3 represents type of management and operational option.

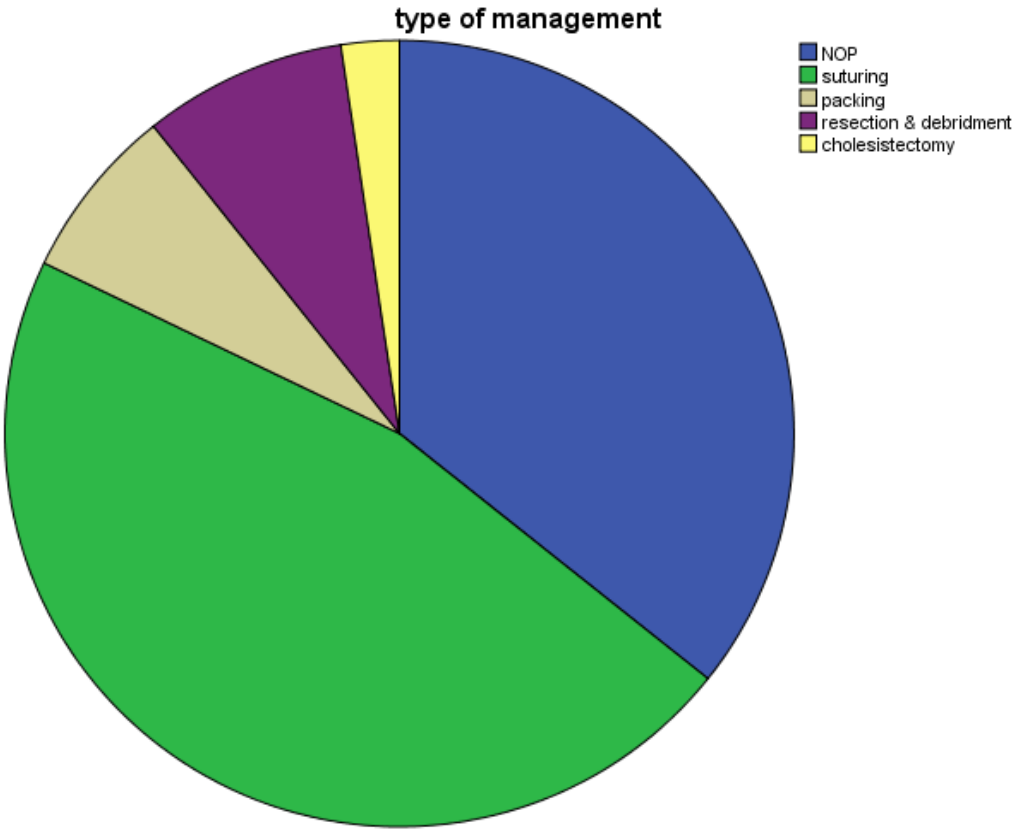


Figure 3: Type of treatment in 84 patients with liver trauma

Thirteen (15.5%) patients died. Two patients with grade IV of injury needed immediate

surgery and died due to severity of injury and hemorrhage. The other dead patients had associated injuries including: head (subarachnoid hemorrhage) and spleen injury in 1, head (subarachnoid hemorrhage) and thoracic injury in 1, pelvic fracture in 1, thoracic injuries resulting in acute respiratory distress syndrome for 5 and spleen injuries in 3. All patients with grade 5 and 6 died, they had high grade of hepatic trauma in addition to the associated injuries.

Limitation of study

Unfortunately we had no documented data regarding transfusion requirements of all patients. In this study all patients with low grade hepatic injury in this study underwent NOP management; we cannot assess safety of this approach for high grade injuries. Patients with liver trauma should have follow-up imaging study and liver function test. In this study, post discharge we had no follow- up assessment.

Discussion

Operative therapy has been the standard of care for liver injuries from the beginning of the century until the beginning of the 1990s. This has been based on the dual rationale of hemostasis and bile drainage. Since the early 1980s, sporadic reports of adult patients with blunt hepatic trauma treated non-operatively have appeared in the literature (Farnell MB *et al.* 1988, Brasel KJ *et al.* 1997). However, surgical literature confirms that as many as 86% of liver injuries have stopped bleeding by the time surgical exploration is performed, and 67% of operations performed for blunt abdominal trauma are non-therapeutic. Imaging techniques, particularly CT scanning, have made a great impact on the treatment of patients with liver trauma, and use of these techniques has resulted in marked reduction in the number of patients requiring surgery and non-therapeutic operations (Nawaz Khan A *et al.* 2009).

Nonsurgical treatment has become the standard of care in hemodynamically stable patients with blunt liver trauma. The use of helical computed tomography (CT) in the diagnosis and management of blunt liver trauma is mainly responsible for the notable shift during the past decade from routine surgical to nonsurgical management of blunt liver injuries. CT is the diagnostic modality of choice for the evaluation of blunt liver trauma in hemodynamically stable patients and can accurately help identify hepatic parenchymal injuries, help quantify the degree of hemoperitoneum, and reveal associated injuries in other abdominal organs, retroperitoneal structures, and the gastrointestinal tract (Yoon W *et al*; 2005).

Almost 80% of adults and 97% of children are treated nonsurgically by using careful follow-up imaging studies. The most common cause of liver injury is blunt abdominal trauma, which is secondary to MVC in most instances (Nawaz Khan A *et al.* 2009). In our study blunt traumas and MVCs were 75% and 63.1%, respectively.

In the literature, blunt liver trauma is associated with spleen injury in 45% of patients. Rib fractures are associated with injury to the right superior aspect of the liver in 33% of patients.

Isolated liver injury occurs in less than 50% of patients. Both blunt and penetrating liver injuries are more common in males. Most liver trauma occurs in adults who drive motor vehicles or engage in fighting (Nawaz Khan A. *et al.* 2009), which are similar to our results mentioned above.

Konig T. et al. reviewed their liver trauma to assess their experience with these injuries, and the success of NOP management protocols and concluded liver trauma managed in a trauma centre has low morbidity and mortality. Mortality is governed mainly by poly trauma and, in the case of the liver, by severity of grade of injury (Konig T *et al.* 2007).

NOP management can safely be applied to hemodynamically stable patients with blunt hepatic injury. Although urgent surgery continues to be the standard for hemodynamically compromised patients with blunt hepatic trauma, there has been a paradigm shift in the management of hemodynamically stable patients. Approximately 85% of all patients with blunt hepatic trauma are stable (Brasel KJ *et al.* 1997).

While small lacerations of the liver substance may be, and no doubt are, recovered from without "operative interference: if the laceration be extensive and vessels of any magnitude are torn, hemorrhage will, owing to the structural arrangement of the liver, go on continuously"(Pringle J.H. 1908).

The patients in whom NOP management failed had significantly worse admission hemodynamic parameters, a higher ISS, more hemoperitoneum, and a higher incidence of vascular blush in the liver on CT. DPL was used only for the unstable, multiply injured patient to diagnose intra-abdominal hemorrhage, or for the diagnosis of hollow viscus injury. In conjunction with the development of CT as the primary diagnostic modality came the additional observation that 60% to 80% of the liver injuries had spontaneously stopped bleeding by the time of laparotomy and also that lack of biliary drainage did not adversely affect outcome (Malhotra AK *et al.* 2000, Fabian TC *et al.* 1991).

Initially, NOP management was applied to only lower-grade hepatic injuries (Durham RM *et al.* 1992, Bynoe RP *et al.* 1992) and to patients with only mild to moderate amounts of hemoperitoneum (Meyer AA *et al.* 1985, Farnell MB *et al.* 1988). As experience accumulated, more patients with blunt hepatic injury were managed non-operatively. In the current study, hemodynamically stable patients with no other injuries requiring operative intervention formed 39% of the total, and 31% of these patients were successfully managed nonsurgically.

In the initial reports of NOP management, there was concern that it would lead to higher transfusion requirements and to prolonged ICU and hospital lengths of stay. Although there have been reports about excessive blood being transfused in the hope that bleeding will stop, in the recent studies, NOP management does not carry with it a greater need for transfusion than operative management. Most reports suggest that transfusion requirements are less with NOP management (Pachter HL *et al.* 1996, Sherman HF *et al.* 1995, Croce MA *et al.* 1995). Our patients non-operatively managed, showed no significant difference in the hospital lengths of stay.

The death rate of all patients with liver injury was 15.5%, very similar to the rate in other

reports (Malhotra AK *et al.* 2000, Croce MA *et al.* 1995). The patients with significant liver injury leading to death usually have early indications for surgery. All the patients managed non-operatively were alive with no death report.

Conclusion

In this study hepatic trauma was in 0.5% of all trauma patients. We concluded hemodynamic stable patients can be managed safely non-operatively, while urgent surgery continues to be the standard for hemodynamic compromised patients with hepatic trauma. NOP management does not lead to longer hospital stay. Low grade injuries can be managed non-operatively with excellent results.

References

Beal SL. Fetal hepatic hemorrhage: an unresolved problem in the management of complex liver injuries. *J of Trauma*. 1990; 30: 163-0.

Brasel KJ, DeLisle CM, Olson CJ and Borgstorm DC. Trends in the management of hepatic injury. *Am J Surg*. 1997; 174: 674–677.

Bynoe RP, Bell RM, Miles WS, Close TP, Ross MA and Fine JG.. Complications of non-operative management of blunt hepatic injuries. *J of Trauma*. 1992; 32:308–315.

Coughlin PA, Stringer MD, Lodge JPA, Pollard SG, Prasad KR and Toogood GJ. Management of blunt liver trauma in a tertiary referral centre. *Br J Surg*. 2004; 91(3): 317-321.

Croce MA, Fabian TC, Menke PG, Waddle-Smith L, Minard G, Kudsk KA, Patton JH, Jr, Schurr MJ and Pritchardet FE. Non-operative management of blunt hepatic trauma is the treatment of choice for hemodynamically stable patients. Results of a prospective trial. *J of Ann Surg*, 1995; 221:744–755.

Durham RM, Buckley J, Keegan M, Fravell S, Shapiro MJ and Mazuski J. Management of blunt hepatic injuries. *Am J Surg*. 1992; 164: 477–481.

EAST Practice Management Guidelines Work Group, Practice management guidelines for the non-operative management of blunt injury to the liver and spleen. 2003; accessed online at: www.east.org/tpg/livspleen.pdf

Fabian TC, Croce MA, Stanford GG, Payne LW, Mangiante EC, Voeller GR and Kudsk KA. Factors affecting morbidity following hepatic trauma. A prospective analysis of 482 patients. *J of Ann Surg*. 1991; 213:540–548.

Fang JF. Pooling of contrast material on computed tomography mandates aggressive management of blunt hepatic injury, *The American Journal of Surgery*. 1998; 176(4):315-319.

Farnell MB, Spencer MP, Thompson E, Williams HJ, Jr, Mucha P, Jr and Ilstrup DM. Non-operative management of blunt hepatic trauma in adults, *J of Surgery*. 1988; 104:748–756.

Galvan DA, Gibson D, Canfield C and Levy P. Selective non-operative management of blunt abdominal trauma. *J of Emergency Medicine*. 2006; 31(2): 215-221.

Konig T, Aylwin C, Walsh M and Hutchins R. Modern management of liver trauma. *J of Injury Extra*. 2007; 38 (4): 117.

Lyuboslavsky Y and Pattillo M**.** Stable Patients With Blunt Liver Injury: Observe, Do Not Operate!! *J of Critical Care Medicine*. 2009; 32(1):14-18.

Malhotra AK, Fabian TC, Croce MA, Gavin TJ, Kudsk KA, Minard G, and Pritchard FE. Blunt Hepatic Injury: A Paradigm Shift from Operative to Non-operative Management in the1990s. *J of Ann Surg*. 2000; 231(6): 804–813.

Meyer AA, Crass RA, Lim RL Jr, Jeffrey RB, Federle MP and Trunkey DD. Selective non-operative management of blunt liver injury using computed tomography. *J of Arch Surg*. 1985; 120:550–554.

Moore EE, Cogbill TH, Jurkovich GJ, Shackford SR, Malangoni MA and Champion HR. Organ injury scaling: spleen and liver. *J of Trauma*. 1995; 38:323-4.

Nawaz Khan A, Vadeyar H, MacDonald S and Chandramohan M. Liver Trauma. 2009; accessed online at: www.emedicine.com/radio/topic397.htm

Oschner MG, Jaffin JH, Golocovsky M and Jones RC. Major hepatic trauma. *J of Surg Clin North Am*. 1993; 73: 337–352.

Pachter HL and Hofstetter SR. The current status of non-operative management of blunt hepatic injuries. *Am J Surg*. 1995; 169; 442-54.

Pachter HL, Knudson MM, Esrig B, Ross S, Hoyt D, Cogbill T, Sherman H, Scalea T, Harrison P, Shackford S, *et al*.. Status of non-operative management of blunt hepatic injuries in 1995: a multicenter experience with 404 patients. *J of Trauma*. 1996; 40:31–38.

Parks RW, Chrysos E and Diamond T. Management of liver trauma. *Br J Surg*. 1999; 86:1121-1135.

Pringle JH. Notes on the arrest of hepatic hemorrhage due to trauma. *J of Ann Surg*. 1908; 48:541–548.

Sherlock DJ and Bismuth H. Secondary surgery for liver trauma. *Br J Surg*. 1991; 78: 1313-1317.

Sherman HF, Savage BA, Jones LM, Barrette RR, Latenser BA, Varcelotti JR, McAuley CE, Jones RT and Myers AH.. Non-operative management of blunt hepatic injuries: safe at any grade? *J of Trauma*. 1994; 37:616–621.

Yoon W, Jeong YY, Kim JK, Seo JJ, Lim HS, Shin SS, Kim JC, Jeong SW, Park JG and Kang HK. CT in Blunt Liver Trauma. *J of RadioGraphics.* 2005; 25:87-104.

Zangana AM. Penetrating liver War injury: A report on 676 cases, After Baghdad invasion and Iraqi Civilian War April 2003. *J of* Advances *in Medical and Dental Sciences*. 2007; 1(1): 10-14.