SAS Journal of Surgery (SASJS) **ISSN 2454-5104**
Abbreviated Key Title: SAS J. Surg.

A Unit of Scholars Academic and Scientific Society, India

Liver Trauma – A Study of Outcome, Complications and Associated Mortality

Dr. Ravindra M Kattimani
Assistant Professor, Department of General Surgery, Dr. D Y Patil medical college and Hospital, Nerul, NaviMumbai, & Ex-Senior resident, Trauma unit, LTMMC, Sion, Mumbai

Original Research Article

***Corresponding author**
Dr. Ravindra M Kattimani

Article History
Received: 18.12.2017
Accepted: 21.12.2017
Published: 30.12.2017

DOI:
10.21276/sasjs.2017.3.12.4

Abstract: This was study under taken to review outcome, complications and associated mortality of liver trauma in surgical unit of teaching Hospital, LTMMC, Mumbai between January 1997 to May 1998. It was retrospective study. All the case records of 60 cases of liver injuries following trauma admitted in trauma care unit were included in the study. All cases of liver injuries were considered as diagnosed by operative findings, ultra-sonography or CT scan findings, post mortem findings. All cases of penetrating injuries underwent emergency exploratory laparotomy. Clinically Stable patients were evaluated further imaging techniques. 25% cases underwent conservative treatment and & 75 % underwent laparotomy. Mortality rate was high in higher grade of liver injury. It is concluded from the study that liver is the most commonly affected organ and the cause is blunt abdominal trauma. Non operative treatment has evolved as treatment of choice in hemodynamically stable patients and patients with lower grade of liver injury, and is less mortality.

Keywords: blunt abdominal trauma, liver injury, laparotomy, conservative treatment, imaging techniques

INTRODUCTION

The liver is the largest glandular organ in the body. It weighs about 1.5 kg in males and 1.3 kg in females. Liver occupies the right hypochondrium. The anterior location with a relatively fixed position and fragile parenchyma and easily destructible capsule make this organ vulnerable to injury. Liver is the organ with highest injury rate in cases of abdominal injury or polytraumatized patients with open or blunt abdominal trauma [1-3]. 80%–90% of hepatic injuries are because of blunt abdominal traumas [4].

The most common cause of blunt abdominal trauma is road traffic accidents. In developed nations trauma of the liver trauma is 20% due to blunt abdominal injury, 30% due to gunshot and 40% due to the stab injury [5]. Right hepatic lobe is more frequently injured as compare to left lobe because of its big size, less mobility.

Diagnosis, management and complications

The diagnose of hepatic trauma includes history of injury, blunt trauma or penetrating trauma, some typical clinical manifestations such as right upper abdominal pain, nausea and vomiting, peritonitis, and signs of hypovolemic shock. Imaging modalities that are widely used include -Abdominal ultrasound and the computed tomography scan (CT scan). CT scan is useful for confirming the injury and helps in defining the grade of injury and intra-abdominal haemorrhage [6, 7].

The American Association for Surgery of Trauma (AAST) has given the standard classification of hepatic trauma. Accordingly hepatic trauma is classified into five grades. Grade I-II hepatic trauma is considered as minor hepatic trauma, accounting for 80%-90% of all hepatic traumas. The hepatic trauma of grade III and above is called serious hepatic trauma, with the mortality rate of 10%, and with associated multiple injuries, the mortality may be as high as 25% [8]. The Serious hepatic trauma combined with parahepatic vena cava injury have mortality rate above 50% [9]. The uncontrolled bleeding is the main cause of liver injury-related death, and is associated with a mortality rate of 54 % [10]. The better understanding of the mechanisms and grade of liver injury helps in the initial assessment and establishment of a management strategy. The modern imaging techniques like ultra sound, CT scanning provides adequate information for definite diagnosis of liver injury or intra-abdominal haemorrhage [6, 7].

The management of traumatic liver injuries has evolved in last 25 years, and the outcome of patients has markedly improved [2, 9, 11]. The Advancement in imaging studies plays an important key role in the conservative management. In early 1970, more than 80% of the liver injuries were managed by operative methods, but after 1990, 80–90% of these injuries were successfully managed by nonoperative means [12]. Thus, non-operative management (NOM) is the

treatment of choice for most patients with blunt liver injuries who are hemodynamically stable and success rates for non-operative management commonly are greater than 95%[2]. Also with improvement in operative techniques as well as perioperative care in the management of blunt liver injury has reduced liver-related mortality [13].

Hepatic-related mortality or deaths are due to ongoing liver bleeding, liver failure, or deaths related to complications of massive fluid resuscitation. Hepatic-related morbidity or complications includes bleeding, biliary fistula, abdominal abscess, cyst formation [4, 14, 15, 16].

In this contest, an attempt has been made to study liver trauma cases in respect to outcome, complications and associated mortality in teaching hospital.

PATIENTS AND METHODS

A retrospective review study was conducted in department of General surgery, LTMMC, Mumbai, over a period of two years from January 1997 to May 1998. During this period, total 60 patients having liver injury following trauma, admitted in trauma care unit were studied. The patient's population included both gender and all ages. Case records of these patients were evaluated for data collection. The study was an observational one and did not involve any fresh intervention and the anonymity of the participants was ensured. This type of study didn't required ethical committee approval.

All cases of liver trauma were considered as diagnosed by intra operative findings, imaging techniques and post mortem findings. All the patients who admitted with the history of trauma were examined carefully and findings were noted. Patients presented with initial shock, were resuscitated immediately with central line and CVP monitoring. Emergency blood investigations were carried out.

All patients with history of penetrating injury were taken for immediate exploratory laparotomy. Stable patients were further evaluated with imaging techniques and diagnostic peritoneal lavage. In all patients who underwent surgery, abdomen opened with mid line incision. Blood and contaminants were evacuated. Liver was mobilised. Hepatic haemorrhage was controlled with proper haemostatic technique. Abdomen was closed in monolayer after surgery. Close drainage was used in most of the cases. Ventilator support was used for post operative patients whenever necessary. All patients were monitored in trauma unit till stabilised or succumbed to death.

RESULTS

Out of 60 patients, 54 (90%) were males and 6(10%) were females (Table 1).According to age distribution , patients ranged between 3-70 years with maximum young patients of 26 cases (43.3%) between age 21-30 years. (Table 2).Out of 60 cases, blunt trauma was seen in 46 (76.7%) cases and penetrating injury was seen in 14(23.3%) cases. (Table 3)According to liver injury grading, there were 17 (28.3%) patients with grade I injury, 26 (43.3%) with grade II injury, 13 (21.7%) with grade III injury, 3(5%) with grade IV injury and 1(1.67%) with grade V injury. (Table 4)

Patients were evaluated with various diagnostic techniques. Abdominal paracentesis was done in 50 cases with total 32 positive finding (64%) and 18 negatives finding (36%). Patients in whom abdominal paracentesis was positive and patients who were hemodynamically unstable were taken for exploration laparotomy urgently, hence no further diagnostic investigations were not done. Ultrasonography of abdomen were done in 38cases with total 33 positive finding (87%) and 5 negatives finding (13%). CT scan was done in 9cases all showing positive finding (100%) (Table 5) 16 patients were managed with non-operative treatment out of which one died due to other cause. 1 patient died before treatment and 43 patients were managed by various surgical procedures out of which 7 died due liver injury & 8 died to other causes (Table 6).

In this study 13(21.7%) of total cases had chest infection, 4(6.7%) had wound infection and 9(15%) had complication associated injury (Table 7). The average hospital stay was 10days. 23 patients stayed for 6-10days &out of which 2 patients died, 10 patients stayed for 15 days, 3 patients stayed for more than 15 days. 9 patients died within 24hours and 9 patients died within 3-5days (Table 8). Mortality increases as grade of liver injury increases. In grade IV and V mortality was 100% and was due to liver trauma itself.

In grade III liver trauma 30.7% mortality was due to liver trauma. In Grade I&II liver mortality was due to other associated injury (Table 9). In the cases managed by conservative treatment, mortality was due to associated injuries (25%). In cases that underwent surgery, 50% mortality was due to liver trauma (Table 10).

Table−1: Gender Distribution

Characteristics	Number	Frequency (%)
Male	54	90%
Female	6	10%

Table-2: Age Distribution

Age range	Number	Frequency (%)
<10	6	10%
11-20	10	16.7%
21-30	26	43.3%
31-40	6	10%
41-50	7	11.7%
>50	5	8.3%

Table-3: Mechanism of Injuries

Mechanism of Injuries	Number	Frequency (%)
Blunt trauma	46	76.7%
Penetrating Injury	14	23.3%

Table-4: Grade of liver injuries

Grade of liver injury	Number	Frequency (%)
I	17	28.3%
II	26	43.3%
III	13	21.7%
IV	3	5%
V	1	1.67%

Table-5: Investigation modalities used in diagnosis

Grade of liver injury		**I**	**II**	**III**	**IV**	**V**	**Total (%)**
Abdominal Paracentesis	Positive	4	15	9	3	1	32 (64%)
	Negative	13	3	2	-	-	18 (36%)
	Total	17	18	11	3	1	50
Ultrasonography USG	Positive	13	8	10	1	1	33 (87%)
	Negative	3	2	-	-	-	5 (13%)
	Total	16	10	10	1	1	38
CT scan	Positive	7	1	1	-	-	9 (100%)
	Negative	-	-	-	-	-	-
	Total	7	1	1	-	-	9

Table-6: Treatment modality and Outcome

Treatment	No. of cases	(%)	Mortality due to	
			Liver injury	other causes
Death before treatment	1	(1.6%)	1	-
Non operative treatment	16	(26.6%)	-	4
Explored and left alone	1	(1.6%)	-	-
Liver suturing done	36	(60%)	3	8
Tractotomy	1	(1.6%)	-	-
Resectional debridement	1	(1.6%)	1	-
Perihepatic packing	4	(6.6%)	3	-

Table-7: Table of Complications

Complications	No. of cases	**%**
Chest infection	13	21.7
Wound infection	4	6.7
Infection related to associated injury	9	15
Due to blood transfusion	1	1.7
Intra-abdominal abscess	2	3.3

Table-8: Table of hospital stay and mortality

Time duration	No. of cases	%	Mortality		
			No. of cases	death due to liver injury	death due to others
Less than 24 hrs	12	20	9	6	3
24-48hrs	2	3.3	-	-	-
3-5days	10	16.7	9	2	7
6-10days	23	38.3	2	0	2
10-15days	10	16.7	-	-	-
More than 15 days	3	5	-	-	-
Total	60	100	20	8	12

Table-9: Relation between mechanism of injury and mortality

Mechanism of injury	No. of cases	Mortality	death due to liver injury	death due to other cause
Penetrating injury	14	4 (28.6%)	-	4 (28.6%)
Blunt trauma	46	16 (34.8%)	8 (17.4%)	8 (17.4%)
Total	60	20	8	12

Table-10: Relation between grade of liver injury and Mortality

Grade of liver injury	No. of cases	Total No. of death	Death due to liver injury	Death due to other cause
I	17	5 (29.4%)	-	5(29.4%)
II	26	5 (19.2%)	-	5 (19.2%)
III	13	6 (46%)	4 (30.7%)	2 (15.3%)
IV	3	3 (100%)	3(100%)	-
V	1	1 (100%)	1(100%)	-

Table-10: Relation between Mode of treatment and Mortality

Mode of treatment	No. of cases	Total No. of death	Death due to liver injury	Death due to other cause
Death before treatment	1	1(100%)	1	0
Conservative treatment	16	4 (25%)	0	4 (25%)
Failed Conservative Treatment followed by surgery	1	1 (100%)	0	1 (100%)
Operative Treatment	42	14(33.3%)	7(50%)	7(50%)

DISCUSSION

Because of relatively fixed position and large size the liver is more prone for injury in blunt trauma of the abdomen. Liver is the second most commonly injured organ in abdominal trauma and the most common cause of death following abdominal injury [17].

This study observed predominant involvement of males (90%) (Table 1) The other published literature also reported higher incidence of trauma and liver injuries in males [18-20]. The peak age of injury was between 21-30 years representing 43 %.(Table2) Sreeramulu's study also showed the mean age of the patients 30 years. The study by Vatanaprasan found most of the patients were male (81.5%) and mainly affected in third decade of life (46.9%) [21]. another study by Kalil reports out 107 cases, 93 were male (86.9%) and 83.2% were in the first four decades of life [22].

In our study 3/4th (76.7%) of total cases had liver injury due to blunt trauma, mainly road traffic accidents.(Table 3) Similarly, many studies had reported that, blunt abdominal trauma is frequent cause of the hepatic injuries [23, 24]. Imaging studies as diagnostic modality for evaluation of presence or absence of liver trauma and grading of liver trauma is used extensively.

In our study, Abdominal Paracentesis done in 50 cases and 32 cases it was positive. Ultrasonography was done in 38 cases and 33 cases it was positive. CT scan was done in 9 cases and all were positive. (Table5) Abdominal Paracentesis is the most commonly used in the diagnostic evaluation of blunt abdominal trauma and is very sensitive for diagnosis of hemo peritoneum [25].

Ultrasonography is a non-invasive procedure. Focused assessment by ultrasound for trauma (FAST) is used in initial trauma evaluation [20]. It provides a quick bedside assessment for hemoperitoneum and

organ injuries. It has a valuable role especially in a haemodynamically compromised patients [26,27]. CT scan gives relatively detailed information of solid organ injuries and retroperitoneal injuries. CT scan is the standard imaging study for hemodynamically stable patients [12, 28, 29].

In our study, 16 patients were managed with non-operative treatment out of which one died due to other cause. 1 patient died before treatment and 43 patients were managed by various surgical procedures out of which 7 died due liver injury & 8 died to other causes. (Table 6) Non-operative management (NOM) is a safe and effective method for management of hemodynamically stable patients with blunt hepatic injuries. The Non-operative management of liver trauma has progressively increased since last 2-3 decades [30,31].

Thus Non-operative management (NOM) has evolved as treatment of choice in patients with blunt liver injuries in hemodynamically stable, with success rate of more than 95% [2,13]. The study Rosemary A. Kozar, et al. also reported Non operative treatment in 453 patients (65%) with hepatic injuries, and rest of 246 patients required immediate operative intervention [16]. In Asfar et al. study about 83 %(98) of blunt hepatic injuries were treated by non-operative therapy, in hemodynamically stable patients. 17 % (19) patients were treated with surgery, with mortality of 21 %(4). [32, 33]

Perihepatic packing and suture hepatorrhaphy are frequently performed procedures to control liver bleeding. Other procedures are direct ligation of bleeding vessels, cauterization, the use of topical haemostatic agents, partial liver resection and hepatic artery ligation [22, 34]. In our study, out of 43 patients 36 patients were treated with suture hepatorrhaphy and 4 patients were treated with Perihepatic packing (Table 6).

In our study 13(21.7%) of total cases had chest infection, 4(6.7%) had wound infection and 9(15%) had complication associated injury. (Table 7)Patients with associated chest injuries were more susceptible to chest infections. The study by Najeeb S. Baboo et al. reports Post operative complications in 34 patients (27.2%), which were; wound infection (15.2%), chest infection (8%) and bile leak and fistulae (4%)[35]. The complications such as bleeding, biliary fistula, abdominal abscess, cyst formation are associated with liver injuries.

The complications dependents upon the severity of liver trauma [4]. The study by Bala et al. reported complications in 5% of patients with liver injuries, in patients with grade III to V injuries. The complications in their study included bile leaks, bilomas, rebleeding episodes, intra hepatic abscess, acute cholecystitis and liver failure [13]. In our study, the known complications like biliary fistula, hemobilia, renal failure were not encountered. The other studies were also described complications related to liver injuries [21, 36]. Thus Liver complications are expected in 30 to 70% cases and the incidence increase with grade of liver injury.

In our study, grade IV and V liver injury cases had 100% mortality. In grade III liver trauma 30.7% mortality was due to liver trauma. In Grade I&II liver injury, mortality was nil (Table 9). In this study, the average hospital stay was 10 days. 23 patients stayed for 6-10days &out of which 2 patients died, 10 patients stayed for 15 days, 3 patients stayed for more than 15 days. 9 patients died within 24hours and 9 patients died within 3-5days (Table 8) The Asfar's study shows average ICU stay of about 5.9 days (range 2-10). The mean hospital stay was about 17.43 ± 7.95 days (range 5-67). [33]

In our study, the mortality rate for patients with hepatic injury was greater for blunt trauma (34 %) than for penetrating one (28 %). (Table 8) Similar results were found with study by Kalil and et al. and. Zago et al. [22, 34] In this study mortality rate was higher in patients who underwent operative procedure than in patients with conservative treatment. (Table 10) Similar result were seen in study Ki Bum Park et al. [32, 37]

CONCLUSION

A case series of 60 cases with liver injury admitted between Jan 1997 to May 1998 in a trauma care unit of general surgery department was presented. The liver injuries were commonly seen in males in 3rd and 4th decades of life.Out of 60, 75% cases were as a result blunt trauma and only 25% cases had isolated liver injury. About 40% cases presented with shock.

All patients with penetrating injury underwent exploratory laporotomy. The blunt trauma cases underwent further evaluation with investigations mainly various imaging techniques. Nearly 25% cases were treated conservatively, in hemodynamically stable patients with mortality rate of almost zero due to liver injury.

43 patients underwent laporotomy. Majority (83%) of them required liver suturing with or with local haemostatic agent. 4 (9%) patients treated with perihepatic packing. The mortality rate in operative cases was 50% due to liver injury. The high rate of mortality was associated with higher grade of liver injuries with 100% mortality in grade IV & V injury and zero mortality in grade I & II injury.

REFERENCES

1. Feliciano DV, Pachter HL. Hepatic trauma revisited. Curr Probl Surg. 1989;26: 453–524.

2. Meredith JW, Young JS, Bowling J, Roboussin D. Nonoperative management of blunt hepatic trauma: the exception or the rule? J Trauma. 1994;36:529–34.
3. Matthes G, Stengel D, Seifert J, Rademacher G, Mutze S, Ekkernkamp A. Blunt liver injuries in polytrauma: results from a cohort study with the regular use of whole-body helical computed tomography. World J Surg. 2003;27:1124–30.
4. Yu W-Y, Li Q-J, Gong J-P. Treatment strategy for hepatic trauma. Chinese Journal of Traumatology. 2016;19(3):168-171.
5. Talving P, Beckman M, Häggmark T, Iselius L. Epidemiology of liver injuries. Scand J Surg. 2003; 92 (3):192-4.
6. Barbuscia M., Querci A., Tonante A. Liver trauma. Diagnosis and treatment. G Chir. 2012;33:66–70.
7. Petrowsky H., Raeder S., Zuercher L. A quarter century experience in liver trauma: a plea for early computed tomography and conservative management for all hemodynamically stable patients. World J Surg. 2012;36:247–254.
8. Doklestić K, Stefanović B, Gregorić P, Ivančević N, Lončar Z, Jovanović B, Bumbaširević V, Jeremić V, Vujadinović ST, Stefanović B, Milić N. Surgical management of AAST grades III-V hepatic trauma by Damage control surgery with perihepatic packing and Definitive hepatic repair–single centre experience. World Journal of Emergency Surgery. 2015 Aug 1;10(1):34.
9. Pachter HL, Spencer FC, Hofstetter SR, Liang HG, Coppa GF. Significant trends in the treatment of hepatic trauma. Experience with 411 injuries. Annals of surgery. 1992 May;215(5):492.
10. Asensio JA, Demetriades D, Chahwan S, Gomez H, Hanpeter D, Velmahos G, Murray J, Shoemaker W, Berne TV. Approach to the management of complex hepatic injuries. Journal of Trauma and Acute Care Surgery. 2000 Jan 1;48(1):66.
11. Malhotra AK, Fabian TC, Croce MA, Gavin TJ, Kudsk KA, Minard G, Pritchard FE. Blunt hepatic injury: a paradigm shift from operative to nonoperative management in the 1990s. Annals of surgery. 2000 Jun;231(6):804.
12. Ahmed N, Vernick JJ. Management of liver trauma in adults. J Emerg Trauma Shock. 2011 Jan¬Mar; 4(1): 114–119.
13. Bala M, Gazalla SA, Faroja M, Bloom AI, Zamir G, Rivkind AI, Almogy G. Complications of high grade liver injuries: management and outcomewith focus on bile leaks. Scandinavian journal of trauma, resuscitation and emergency medicine. 2012 Mar 23;20(1):20.
14. Kozar RA, Moore FA, Cothren CC, Moore EE. Risk Factors for Hepatic Morbidity Following Nonoperative Management. Arch Surg. 2006;141:451-459
15. Kozar RA, Moore JB, Niles SE, Holcomb JB, Moore EE, Cothren CC, Hartwell E, Moore FA. Complications of nonoperative management of high-grade blunt hepatic injuries. Journal of Trauma and Acute Care Surgery. 2005 Nov 1;59(5):1066-71.
16. Ochiai T, Igari K, Yagi M, Ito H, Kumagai Y, Iida M, Matsumoto A, Kumada Y, Shinohara K, Yamazaki S. Treatment strategy for blunt hepatic trauma: analysis of 183 consecutive cases. Hepato-gastroenterology. 2011;58(109):1312-5.
17. Sreeramulu PN, Venkatachalapathy TS, Anantharaj. Blunt Trauma Liver-Conservative or Surgical Management: A Retrospective Study. J Trauma Treat 2012; 1:146.
18. Butt HA, Zahur S, Haq AU. Hepatic trauma: effects of delay in presentation. Ann King Edward Med Uni 2006; 12: 293-5.
19. Khan JS, Iqbal N, Gardezi JR. Pattern of visceral injuries following blunt abdominal trauma in motor vehicular accidents. J Coll Physicians Surg Pak 2006; 16: 645-7.
20. Ali U, Noor A, Shah MM, Alam W. Trauma management in a tertiary care hospital in Peshawar, Pakistan. J Ayub Med Coll Abbottabad 2008; 20: 112-6.
21. Vatanaprasan T. Operative treatment of hepatic trauma in Vachira Phuket Hospital. J Med Assoc Thai. 2005 ;88(3):318-28
22. Kalil M, Amaral IM. Epidemiological evaluation of hepatic trauma victims undergoing surgery. Revista do Colégio Brasileiro de Cirurgiões. 2016 Feb;43(1):22-7.
23. Ahmed M, Manzoor F, Kausar R. Short Term Outcome of Patients with Liver Trauma at Tertiary Care Hospital. Ann. Pak. Inst. Med. Sci. 2017; 13(1):7-10.
24. Brammer RD, Bramhall SR, Mirza DF, Mayer AD, McMaster P, Buckels JA. A 10 years' experience of complex liver trauma. Br J Surg 2002;89:1532–1537.
25. Trunkey DD. Hepatic trauma: Contemporary management. Surg Clin North Am. 2004;84:437–50.
26. Smith ZA, Wood D. Emergency focussed assessment with sonography in trauma (FAST) and haemodynamic stability Emerg Med J 2014; 31; 4; 273-277
27. Scalea TM, Rodriguez A, Chiu WC, Brenneman FD, Fallon WF, Kato K, McKenney MG, Nerlich ML, Ochsner MG, Yoshii H. Focused assessment with sonography for trauma (FAST): results from an international consensus conference. Journal of Trauma and Acute Care Surgery. 1999 Mar 1;46(3):466-72.
28. Poletti PA, Mirvis SE, Shanmuganathan K, Killeen KL, Coldwell D. CT criteria for management of blunt liver trauma: Correlation with angiographic and surgical findings. Radiology. 2000;216:418–27.
29. Becker CD, Mentha G, Terrier F. Blunt abdominal trauma in adults: role of CT in the diagnosis and management of visceral injuries. Eur Radiol. 1998;8:553–62.

30. Park KB, You DD, Hong TH, Heo JM, Won YS. Comparison between operative versus non-operative management of traumatic liver injury. Korean journal of hepato-biliary-pancreatic surgery. 2015 Aug 1;19(3):103-8.
31. Lucas CE, Ledgerwood AM. Changing times and the treatment of liver injury. Am Surg 2000;66: 337-341
32. Suen K, Skandarajah AR, Knowles B, Judson R, Thomson BN. Changes in the management of liver trauma leading to reduced mortality: 15-year experience in a major trauma centre. Anz journal of surgery. 2016 Nov 1;86(11):894-9.
33. Asfar S, Khoursheed M, Al-Saleh M, Alfawaz AA, Farghaly MM, Nur AM. Management of liver trauma in Kuwait. Medical Principles and Practice. 2014;23(2):160-6.
34. Zago TM, Pereira BM, Calderan TR, Hirano ES, Rizoli S, Fraga GP. Blunt hepatic trauma: comparison between surgical and nonoperative treatment. Revista do Colégio Brasileiro de Cirurgiões. 2012 Aug;39(4):307-13.
35. Baboo NS, Mushettet AZ, Kadhum MJ. Liver Injuries Grades and Management. Iraqi Journal of gastroenterology. 2013; 1; 7:19-24
36. Carrillo EH, Spain DA, Wohltmann CD, Schmieg RE, Boaz PW, Miller FB, Richardson JD. Interventional techniques are useful adjuncts in nonoperative management of hepatic injuries. Journal of Trauma and Acute Care Surgery. 1999 Apr 1;46(4):619-24.
37. Chien LC, Lo SS, Yeh SY. Incidence of liver trauma and relative risk factors for mortality: A population-based study. Journal of the Chinese Medical Association. 2013 Oct 31;76(10):576-82.