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BLUNT TRAUMA LIVER-CONSERVATIVE OR SURGICAL MANAGEMENT?

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ABSTRACT

Aim: To describe current evidence and guidelines that support non-surgical management of liver injuries in blunt trauma. The liver is the most commonly injured organ in blunt abdominal trauma and the second most commonly injured organ in penetrating abdominal trauma.Hepatic trauma is a common cause for admissions in the Emergency Room. Currently, non-surgical management is the standard treatment in hemodynamically stable patients with a success rate of around 85–98%. In the past, most liver injuries were treated surgically. The liver is a highly vascular organ located in the right upper quadrant of the abdomen and is susceptible to injury from traumatic mechanisms.

Method: Authors reviewed 30 articles and literature search forcurrent evidence and guidelines that support non-surgical management of liver injuries in blunt trauma. The articles publication date was from 1986 to 2015.

Result: Most blunt trauma livers (80% in adults and 97% in children) are treated conservatively [7,8]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.

Conclusion: Most blunt trauma livers (80% in adults and 97% in children) are treated conservatively, hemodynamic stable patients can be managed safely non-operatively, while urgent surgery continues to be the standard for hemodynamic compromised patients with hepatic trauma. Low grade injuries can be managed non-operatively with excellent results. Today non-surgical management is the standard treatment in hemodynamically stable patients with a success rate of around 85–98%. Mortality and morbidity can be significant in high-grade injuries. The overall complications are < 7% but can be as high as 15 to 20% in high-grade injuries. NOP management does not lead to longer hospital stay.

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INTRODUCTION

Blunt Liver- Trauma Conservative or Surgical Management: Liver and spleen together, account for 75% of injuries in blunt abdominal trauma. Though liver is the second most commonly injured organ in abdominal trauma; it is the most common cause of death following abdominal injury. Compared to splenic injuries, management of liver trauma remains a challenge in the best of trauma centers (Feliciano, 1989 and Parks, 1999).

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Today evidence confirms that about 86% of liver injuries have stopped bleeding by the time surgical exploration is performed and 67% of laparotomies done for blunt trauma abdomen are non-therapeutic. Imaging techniques especially (CT) Computerized Tomographic scan has created remarkable impact in managing liver trauma patients by reducing the number of laparotomies. About 80% of adults and 97% of children are presently managed conservatively worldwide at high volume trauma centers Conservative treatment means, repeated clinical monitoring and surgical intervention if conservative treatment fails (Gallardo García, 1991 and David Richardson, 2000). The large size of the liver, the friable parenchyma, its thin capsule and its relatively fixed position make it prone to blunt injury. Deceleration injuries producing shearing forces may tear hepatic lobes and often involve the inferior vena cava and hepatic veins. Liver injury can also occur because of transmission of excessively high venous pressure to remote body sites at the time of impact. Liver's ligamentous attachments to diaphragm and posterior abdominal wallact as sites of shearing forces during deceleration injury. Right lobe is more often involved, owing to its larger size and proximity to the ribs.Pressure on right hemithorax may propagate through the diaphragm producing contusion of dome of right lobe of liver.

History

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 *et al*. 1988, Brasel *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 *et al*. 2009). Failure in non-surgical management is relatively rare but potentially fatal, and needs to be recognized and aggressively treated as early as possible. A comparison of patients receiving operative and nonoperative treatment of liverinjuries has revealed no difference in the length of hospital stay, but requirements for blood transfusion and intra-abdominal complications were significantly lower in those managed conservatively (Llado, 2005 and Gertler, 1986). A steering column injury can damage an entire lobe. Liver trauma may result in subcapsular/intrahepatic hematomas, lacerations, contusions, hepatic vascular injury and bile duct injury.

The hemodynamic status of the patient is the most reliable and critical factor for NOP management (Parks *et al*. 1999, Coughlin *et al*. 2004, Sherlock and Bismuth 1991, Oschner *et al*. 1993). The main cause of failure in non-surgical management is persistent hemorrhage. 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 *et al*. 2009). Konig *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 center 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 *et al*. 2007).

Anatomical classification of liver trauma injuries

The segmentary anatomy of the liver (Fig. 2) bears little importance in trauma, except to describe the site of the injury (Schecter, 2012). In order to provide a common and unified language to facilitate clinical decision-making in cases of trauma, the American Association for Surgery of Trauma published their Organic Injury Scale system in 1994 (AAST-OIS), based on the degree of anatomic disruption of each organ; it describes 6 grades of injury: 1 minimal, 2 mild, 3 moderate, 4 severe, 5 massive and 6 lethal (Moore, 2010). Compression against the fixed ribs, spine or posterior abdominal wall results in predominant damage to segments 6,7 and 8 of the liver (>85%) (Pachter, 1995 and Carrillo, 2000).

Retrohepatic IVC and its branches (*Fig- 1*)*and (Fig- 3)*

In relation to liver trauma we can divide the retro hepatic IVC into four parts: *The supra hepatic group*; which is composed of both *right and left inferior phrenicveins* which drain the right and left diaphragm. The hepatic veins; which are composed of the right, middle and left hepatic vein. There are multiple variations that can exist and its knowledge is important in liver surgery.

The retro hepatic group; which is composed of short veins that drain part of the right hemi liver and the caudate lobe directly into the IVC. These veins are short and very fragile and are prone to injury.

Lastly, the infrahepatic group; which consists mainly of *both the right and left adrenal veins*.

These veins are frequently injured in trauma and if not considered during mobilizing the right liver (Scheuerlein, 2001).

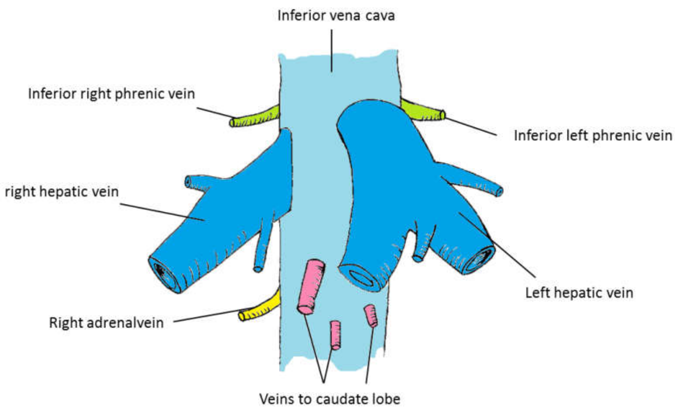

Fig. 1. Retrohepatic IVC and its branches

The 1994 revision of the AAST (American Association for the Surgery of Trauma) liver injury scale is the most widely used liver injury grading system at the time of writing (late 2016).

Classification

Grade I

- Hematoma: subcapsular, <10% surface area
- Laceration: capsular tear, <1 cm parenchymal depth

Grade II

- Hematoma: subcapsular, 10-50% surface area
- Hematoma: intraparenchymal <10 cm diameter
- Laceration: capsular tear 1-3 cm parenchymal depth, <10 cm length (Fig-4).

Grade III

- Hematoma: subcapsular, >50% surface area of ruptured subcapsular or parenchymal hematoma
- Hematoma: intraparenchymal >10 cm or expanding
- Laceration: capsular tear >3 cm parenchymal depth

Grade IV

- **Laceration:** parenchymal disruption involving 25-75% hepatic lobe or involves 1-3 Couinaud segments

Grade V

- **Laceration:** parenchymal disruption involving >75% of hepatic lobe or involves >3 Couinaud segments (within one lobe) (Fig-5)
- **Vascular:** Juxta hepatic venous injuries (retro hepatic vena cava / central major hepatic veins)

Grade VI

- **Vascular:** hepatic avulsion (Schecter, 2012; Moore, 1995; Magaña-Sánchez, 2013) (Fig. 6)
- N.b. advance one grade for multiple injuries up to grade III.

Grade IV and V (AAST-OIS) liver injuries are referred to as complex injuries (Asensio, 2000).

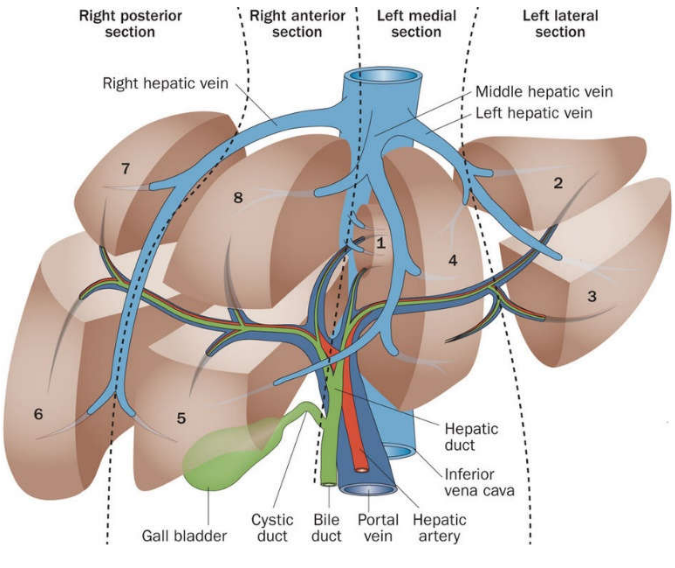

Fig. 2. Figure 2 Segments of the human liver and current surgical nomenclature of liver sections. Picture fromabdominal Anatomy net

Because AAST-OIS grade VI injuries are lethal, many authors suggest that they should not be taken into account for practical purposes in Emergency Room care, as all these patients die at the site of the accident and their diagnosis is confirmed at autopsy (Magaña-Sánchez, 2013). Non-complex AAST-OIS grade I–III hepatic injuries are the most common (Talving, 2003 and Zago, 2013).

Pathophysiology of Trauma on organs

Ultimately, all trauma leads to decreased organ perfusion, cellular ischemia, and a cascade of edema and inflammation. Once begun, inflammation becomes a disease process independent of its origin, and can lead to multiple organ failure and death even after a patient has been completely resuscitated. The CNS response to trauma is predominantly neuroendocrine in nature, and acts to preserve the CNS, heart, and kidneys.

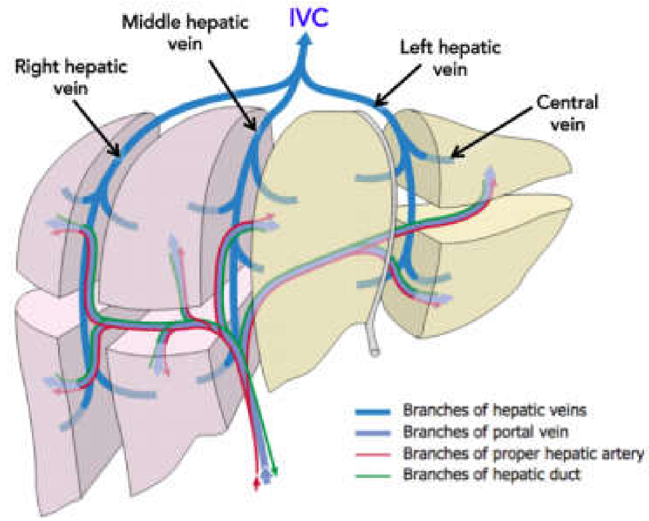

Fig. 3. Liver veins. Picture fromabdominal Anatomy net

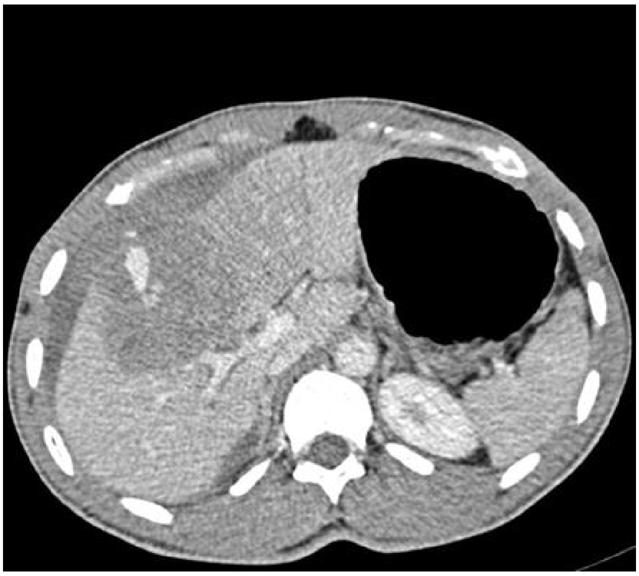

Fig. 4. Liver trauma and laceration with intra-abdominal bleeding

It is enacted primarily by the kidneys and adrenal glands, which collectively produce renin, angiotensin, aldosterone, cortisol, erythropoietin, and catecholamines. The kidney is generally able to maintain GFR via vasoconstriction but loses its ability to concentrate urine (and preserve volume).In most patients, the heart is well-preserved until the late stages of shock, however in elderly patients (with a more fixed stroke volume) or those with cardiac disease, cardiac function may not be responsive to fluid resuscitation and decompensation may occur much earlier (Dark *et al.*). The lungs, which may act as a depository for the mediators of inflammation, are often the sentinel organs for multiple organ system failure (MOSF) in traumatic shock patients (Demling *et al.*). The GI tract vasoconstricts early in the trauma/shock process, exhibits "no-reflow" phenomena (where cellular edema after a hypotensive event prevents microcirculatory flow following restoration of blood pressure) (Reilly and Bulkley) and possibly being the initiating organ in multi-organ failure.

The liver is notable for its susceptibility to reperfusion injury [Chun K *Et al*. Shock 1: 3, 1994] – if recovery of synthetic function does not occur, death is almost always imminent.

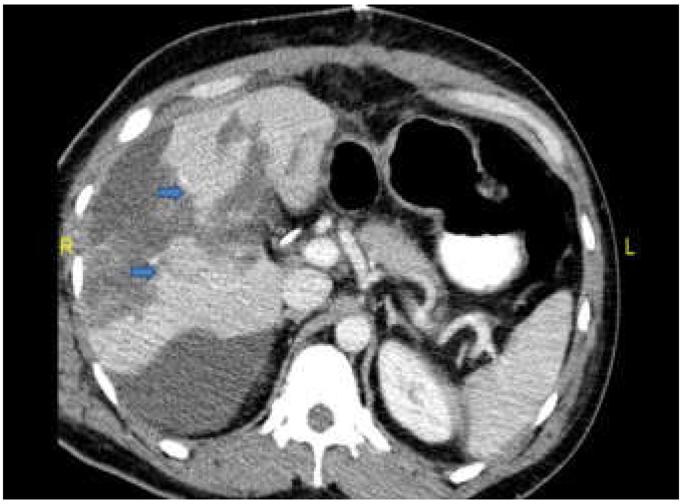

Fig. 5. CT scan showing grade 4 multiple liver lacerations

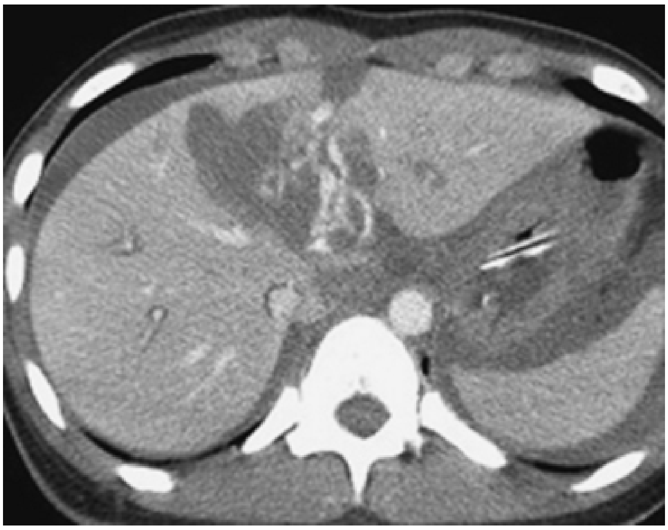

Fig. 6. CT scan showing grade 5 multiple liver lacerations

Symptoms and Signs: The manifestations of severe abdominal hemorrhage, including hemorrhagic shock, and abdominal pain, tenderness, and distention, are usually clinically obvious. Lesser hemorrhage or hematomas cause right upper quadrant abdominal pain and tenderness.

Pathophysiology of liver are: The main immediate consequence is hemorrhage. The amount of hemorrhage may be small or large, depending on the nature and degree of injury. Many small lacerations, particularly in children, finish bleeding spontaneously. Larger injuries hemorrhage extensively, often causing hemorrhagic shock. Mortality is significant in high-grade liver injuries.

Complications: The overall incidence of complications is < 7% but can be as high as 15 to 20% in high-grade injuries. Deep parenchymal lacerations can lead to a biliary fistula or biloma formation. In biliary fistula, bile leaks freely into the abdominal or thoracic cavity. A biloma is a contained collection of bile like an abscess. Bilomas are typically treated with percutaneous drainage. For biliary fistulas, biliary decompression through Endoscopic Retrograde Cholangio Pancreatography (ERCP) is highly successful. Abscesses develop in about 3 to 5% of injuries, often because of devitalized tissue being exposed to biliary contents. Diagnosis is suspected in patients in whom pain, temperature, and WBC count increase in the days after injury; confirmation is by CT. Abscesses are usually treated with percutaneous drainage, but laparotomy may be necessary when percutaneous management fails.

Diagnosis: Imaging (CT or ultrasonography) The diagnosis is confirmed with CT in stable patients and with bedside ultrasonography or exploratory laparotomy in unstable patients.

Signs and symptoms of hepatic injuries are related to the amount of blood loss, peritoneal irritation, right upper quadrant tenderness, and guarding. Rebound abdominal tenderness is common but nonspecific. Occasionally, patients with blunt abdominal trauma do well initially, but they subsequently develop a liver abscess, presumably due to unrecognized liver damage. These patients present with signs and symptoms of deep-seated infection (Arrillo, 2001). Patients may present with severe peritonism due to bile peritonitis resulting from bile leaks. Signs of blood loss, such as shock, hypotension, and a falling hematocrit level, may dominate the picture (Arrillo, 2001). As resuscitation proceeds, a detailed physical examination is carried out. Most conventional texts emphasis the need for a careful history and physical examination of the abdomen. While this is undoubted importance, it is extremely difficult to assess the abdomen in the trauma situation as the history may not be available and all the existing physical signs are misleading. Fresh blood is not a peritoneal irritant (Paterson-Brown, 2005). The mechanism of injury is critically important in assessing the potential for abdominal injury (Paterson-Brown, 2005).

Treatment

- Observation
- Sometimes embolization or surgical repair
- Hemodynamically stable patients who have no other indications for laparotomy (e.g. hollow viscus perforation) can be observed with monitoring of vital signs and serial Hct levels.
- Patients with significant ongoing hemorrhage (e.g. those with hypotension and shock, significant ongoing transfusion requirements, or declining Hct) require intervention.
- Patients whose vital signs are stable but who require ongoing transfusion may be candidates for angiography with selective embolization of bleeding vessels. Unstable patients should undergo laparotomy.
- Success rates for nonoperative management are about 92% for grade 1 and 2 injuries, 80% for grade 3 injuries, 72% for grade 4 injuries, and 62% for grade 5 injuries. Following nonoperative management, there is no consensus in the literature regarding length of ICU stay, hospital stay, resumption of diet, duration of bedrest, or limitation of activity once discharged. (Stassen NA, Bhullar I, Cheng JD.)
- When surgery is done, small lacerations can typically be sutured or treated with hemostatic agents (e.g. oxidized cellulose, fibrin glue, mixtures of thrombin and powdered gelatin). Surgical management of deeper and more complex injuries can be complicated.

Non-operative management of blunt liver trauma:

Two principal aspects rule the current treatment of liver trauma injuries: hemodynamic stability and the mechanism of trauma (Stracieri, 2006). The treatment of patients with blunt liver trauma has changed greatly since 1990. Exploratory laparotomy as routine treatment has been replaced by non-operative management, which is currently standard for liver trauma injuries in most trauma centres (Swift, 2012). Many studies confirm that most patients with liver trauma can be managed non-operatively (Sartorelli, 2000). One study found that 86.3% of patients can be managed without laparotomy (Stassen, 2012). Hemorrhage due to haematoma or liver laceration stops spontaneously in 80% of patients (Stracieri, 2006). Trauma kinematics, the number of injured organs, penetration of the abdominal cavity and hemodynamic stabilities are decisive factors in decision-making on how to manage liver injuries, but they do not constitute absolute contraindications for the non-operative management of liver trauma injuries (Tinkoff, 2008). 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 *et al*. 1996, Sherman *et al*. 1995, Croce *et al*. 1995). One study from Iran demonstrated that, theirnon-operatively managed liver trauma, showed no significant difference in the hospital lengths of stay (Liver Trauma, 2015)

The death rate of all patients with liver injury was 15.5%, very like 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.The advantages of the non-operative management of liver injuries (providing this is possible) are: reduction in hospital care costs, early discharge from hospital, avoiding non-therapeutic laparotomies, a reduction in intra-abdominal complications and fewer blood transfusions (Stassen, 2012).

DISCUSSION

Trauma Evaluation

We should perform the initial resuscitation, diagnostic evaluation and management of the trauma patient with blunt or penetrating trauma based upon protocols from the Advanced Trauma Life Support (ATLS) program, established by the American College of Surgeons Committee on Trauma. The initial resuscitation and evaluation of the patient with blunt or penetrating abdominal or thoracic trauma is discussed in detail elsewhere.

- Confirm the diagnosis by CT in stable patients.
- Treat patients using laparotomy (if unstable).
- Observation (if stable), or selective angiographic embolization (e.g. if stable but requiring ongoing transfusion).
- The main immediate consequence of liver trauma is bleeding, which often stops spontaneously, particularly if injuries are grade 1 or 2, but may require embolization or surgical repair.
- Success rates for nonoperative management are about 92% for grade 1 and 2 injuries, 80% for grade 3 injuries, 72% for grade 4 injuries, and 62% for grade 5 injuries.Grade IV and V (AAST-OIS) liver injuries are referred to as complex injuries.
- About 86% of liver injuries have stopped bleeding by the time surgical exploration is performed.
- 67% of laparotomies done for blunt trauma abdomen are non-therapeutic.
- Today non-surgical management is the standard treatment in hemodynamically stable patients with a success rate of around 85–98%.
- Most blunt trauma livers (80% in adults and 97% in children) are treated conservatively.
- Mortality and morbidity can be significant in high-grade injuries.
- The overall complications are < 7% but can be as high as 15 to 20% in high-grade injuries.
- Complications include formation of biliary fistulas, bilomas, and abscesses.
- Bilomas are treated with percutaneous drainage.
- Abscesses develop in about 3 to 5% of injuries and for biliary fistulas, biliary decompression (ERCP) is highly successful.

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). 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 that lack of biliary drainage did not adversely affect outcome (Malhotra AK *et al*. 2000, Fabian TC *et al*. 1991).

Conclusion

Hemodynamic stable patients can be managed non-operatively, while urgent surgery continues to be the standard for hemodynamic compromised patients with hepatic trauma.
Success rates for nonoperative management are about 92% for grade 1 and 2 injuries, 80% for grade 3 injuries, 72% for grade 4 injuries, and 62% for grade 5 injuries. Low grade injuries can be managed non-operatively with excellent results. Most blunt trauma livers (80% in adults and 97% in children) are treated conservatively. Today non-surgical management is the standard treatment in hemodynamically stable patients with a success rate of around 85–98%. The overall complications are < 7% but can be as high as 15 to 20% in high-grade injuries
Mortality and morbidity can be significant in high-grade injuries. NOP management does not lead to longer hospital stay.

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REFERENCES

Arrillo, E.H., Wohltmann, C. 2001. Evolution in the treatment of complex blunt liver injuries. *Curr Probl Surg.,* Jan; 38(1): 1-60.

Asensio, J.A., Demetriades, D., Chahwan, S., Gomez, H., Hanpeter, D., Velmahos, G. *et al.* 2000. Approach to the management of complex hepatic injuries J Trauma, 48 (2000), pp. 66-69

Brammer, R.D., Bramhall, S.R., Mirza, D.F., Mayer, A.D., McMaster, P., *et al*. 2002. A 10-year experience of complex liver trauma. *Br J Surg*., 89: 1532-1537.

Carrillo, E.H., Richardson, J.D. 2001. The current management of hepatic trauma. *Adv Surg* 35: 39-59.

David Richardson, J., Franklin, G.A., Lukan, J.K., Carrillo, E.H., Spain, D.A., *et al*. 2000. Evolution in the management of hepatic trauma: a 25-year perspective. *Ann Surg* 232: 324-330.

Feliciano, D.V. 1989. Surgery for liver trauma. *Surg Clin North Am*., 69: 273-284.

Gallardo García, M., Navarro Piñero, A., Buendía Pérez, E., Oliva Muñoz, H., De la Fuente Perucho, A., *et al*. 1991. Diagnostic and therapeutic assessment of liver trauma. *Rev Esp Enferm Dig* 79: 105-111.

Gertler, J., Degutis, L.C., Clay, R., Garvey, R., Baker, C.C. 1986. Pitfalls in the diagnosis and management of blunt splenic trauma. *Conn Med*., 50: 645-647.

Jacobs, I.A., Kelly, K., Valenziano, C., Pawar, J., Jones, C. 2001. Nonoperative management of blunt splenic and hepatic trauma in the pediatric population: significant differences between adult and pediatric surgeons? *Am Surg* 67: 149-154.

Liver Trauma: 2015. Operative and Non-Operative Management M. Zargar, Marjan Laal, Sina Trauma and Research Center, Sina Hospital Tehran University of Medical Sciences (TUMS), Iran

Llado, L., Jorba, R., Pares, D., Borobia, F.G., Biondo, S., *et al*. 2005. Influence of the application of a management protocol in the treatment of blunt abdominal trauma. *Cir Esp* 72: 79-83.

Magaña-Sánchez, I.J., García-Núñez, L.M. Loera-Torres, M.A. 2013. Trauma hepático Manual del Curso de Entrenamiento en Cirugía Avanzada en Trauma, Colegio Mexicano de Cirujanos Militares A.C., México D.F. pp. 76-79 [chapter 18]

Magaña-Sánchez, J., García-Núñez, L.M., Loera-Torres M.A. 2013. Trauma hepático Manual del Curso de Entrenamiento en Cirugía Avanzada en Trauma, Colegio Mexicano de Cirujanos Militares A.C., México D.F. pp. 76-79 [chapter 18]

Moore, E.E., Cogbill, T.H., Jurkovich, G.J., Shackford, S.R., Malangoni, H.R. 1995. Champion Organ injury scaling: spleen and liver (1994 revision) *J Trauma*, 38 (1995), pp. 323-324

Moore, E.E., Moore, F.A. 2010. American Association for the Surgery of Trauma Organ Injury Scaling: 50th anniversary review article of the *Journal of Trauma J Trauma*, 69, pp. 1600-1601

Pachter, H.L., Hofstetter, S.R. 1995. The current status of nonoperative management of adult blunt hepatic injuries. *Am J Surg* 169: 442-454.

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

Paterson-Brown, 2005. Core topics in general and emergency surgery; third edition. Elsevier 239-257

Sartorelli, K.H., Frumiento, C., Rogers, F.B., Osler, T.M. 2000. Non-operative management of hepatic, splenic, and renal injuries in adults with multiple injuriesJ Trauma, 49 pp. 56-62

Schecter, W.P., A. Hirshberg, 2012. Injuries of the liver and biliary tract Blumgart's surgery of the liver, biliary tract and pancreas (5th ed.), Elsevier., pp. 1806-1814[chapter 102]

Scheuerlein, H., Kockerling, F. 2001. The anatomy of the liver. In: liver surgery, Operative techniques and Avoidance of Complications. *J.A. Barth, Heidelberg.,* pp 9-38.

Stassen, N.A., Bhullar, I., Cheng, J.D., Crandall, M., Friese, R., Guillamondegui, O. *et al*. 2012. Nonoperative management of blunt hepatic injury: an Eastern Association for the Surgery of Trauma practice management guideline *J Trauma Acute Care Surg,* 73 (Suppl. 4), pp. S288-S293

Stracieri, L.D., Scarpelini, S. 2006. Hepatic injury Acta Cir Bras, 21 (Suppl. 1)., pp. 85-88

Swift, C., J.P. 2012. GarnerNon-operative management of the liver trauma *J R Army Med Corps,* 158., pp. 85-95

Talving, P., Beckman, M., Häggmark, T., Iselius L. 2003. Epidemiology of liver injuries *Scand J Surg*, 92, pp. 192-194

Tinkoff, G., Esposito, T.J., Reed, J. Kilgo, P., Fildes, J., Pasquale, M. *et al*. 2008. American Association for the Surgery of Trauma Organ Injury Scale I: spleen, liver, and kidney, validation based on the National Trauma Data *Bank J Am Coll Surg,* 207., pp. 646-655

Zago, T.M., Pereira, B.M., Nascimento, B., Alves, M.S., Calderan, T.R., Fraga G.P. 2013. Hepatic trauma: a 21-year experience *Rev Col Bras Cir*, 40., pp. 318-322

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