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AN OVERVIEW ON LIVER TRAUMA DIAGNOSTIC AND MANAGEMENT APPROACH, LITERATURE REVIEW

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ABSTRACT

As the liver occupies significant space of the abdominal cavity, it is prone to penetrative or blunt trauma. This kind of trauma management and diagnosis underwent a lot of changes during the last century. With access to radiological modularity and enhanced medical care, a shift toward non-operative and conservative management emerged. We aimed to review the literature reviewing the etiology of liver trauma, mechanism of injury, clinical presentation, classification, diagnosis, and management options. For the selection of articles, PubMed database was used and then gathered papers underwent a thorough review. In liver trauma, a correct stepladder approach should be done by the treating team to achieve the desired outcome for the patient. Using radiological imaging and assessing the vital signs of the patient is the foundation block in the road of accurate classification. Furthermore, dealing with each case individually in line with the World Society of Emergency Surgery (WSES) updated guidelines would pave the road for the best management option, hence improved the outcomes and reduced mortality.

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Introduction

The liver is one of the most injured organs in blunt trauma, representing 5% of all trauma admissions [1, 2]. As the liver is large, it is more prone to both blunt and penetrative trauma. The liver injury is dealt with either operatively or non-operatively; historically the former was much in use compared to the latter [3]. A study conducted in Saudi Arabia, Riyadh showed that 88.9% of the liver injuries were treated in a non-operative fashion and exhibited a very promising prognosis [4]. The debate between using the two methods almost came to an end with promising imaging techniques such as ultrasonography and CT scan. On the bright side, the mortality of this disease has dropped due to the improvement in the management of haemorrhage and dealing with venous and arterial injuries [5].

Materials and Methods

For the process of selecting relevant articles, PubMed database was used. The following keys used in the mesh ((“Liver injury"[Mesh]) AND (“Diagnosis"[Mesh] OR "Management"[Mesh] OR "Guidelines"[Mesh] "Etiology"[Mesh])). The inclusion criteria for the selected articles were based on one of the following: liver injury, blunt liver trauma, penetrative liver

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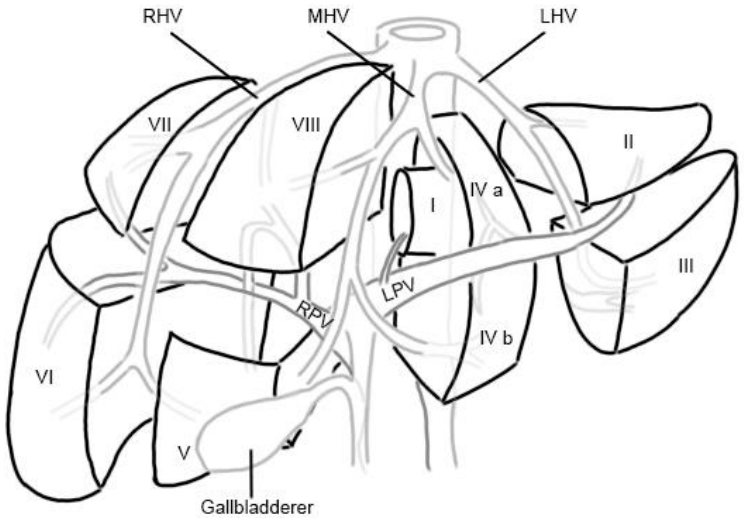
trauma, liver trauma evaluation, management, and diagnosis. The articles that did not have any of the inclusion criteria were not included and were considered to have the exclusion criteria.

Review

Etiology and Mechanism of Injury

The liver is prone to trauma due to multiple variables: its size that occupies a significant amount of the abdominal cavity, its anterior location, and the fragile parenchymal tissue it has. As the function of the liver mandate a tremendous amount of blood flow the wide-bore, thin-walled vasculature results in serious blood loss in liver injuries. The injuries can be either blunt or penetrative, while the former is mostly caused by road traffic accidents among other less common causes like falling and fighting. The exact direction of the injury can help to predict the affected liver segments **(Figure 1)**, the road traffic road accidents associated with deceleration injuries where the liver would lose its fixation sites into the diaphragm and the abdominal wall. This kind of injury would cause detachment between the posterior portion of the liver (segments VI and VII) and the anterior portion (segments V and VIII). This separation would tear the right branch of the hepatic vein, hence leading to a great deal of blood loss. On the other hand, a direct blunt injury toward the abdominal wall would affect the central portion of the liver namely IV, V, and VIII where the hepatic arteries and portal vein are put in danger. Generally speaking, the right lobe of the liver is more affected in blunt trauma rather than the left one [6, 7].

The penetrating injuries are more likely to cause vascular damage, stab injury, and gunshot both can be affecting the portal vein, hepatic arteries, or the vena cava directly. While both stab wounds and gunshots are similar in the affected vessels, gunshots are more likely to cause more severe damage due to the cavitation effect [6].



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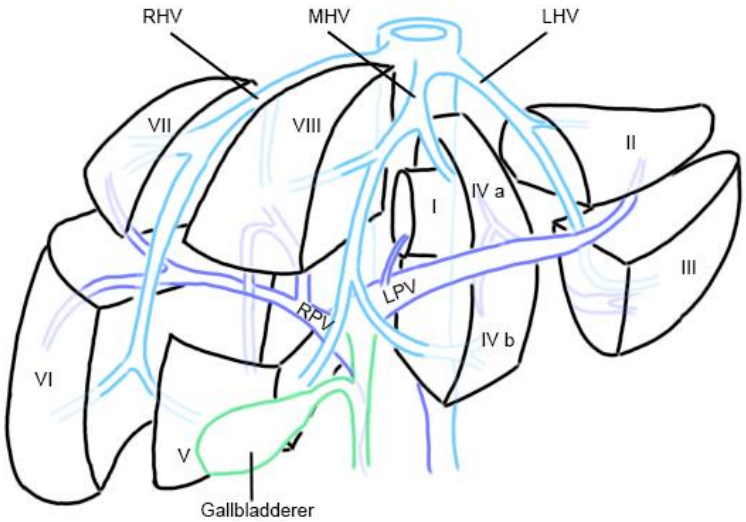

b)

Figure 1. Demonstration of liver segments. LPV: left portal vein, RPV: right portal vein, LHV: left hepatic vein, MHV: middle hepatic vein, RHV: right hepatic vein.

Clinical Presentation

The course of injury is very important to anticipate the symptoms that the patient may exhibit, detailed history concerning the mechanism of injury whether penetrating or blunt along with the proper physical examination and vital signs recording are must. While in blunt injuries the site affected may be concealed and not as apparent in penetrative injuries, both of them must be treated accordingly in the emergency department. The patient may present in a hemodynamically unstable status where immediate intervention is required to restore the baseline of the patient. In a more difficult situation where the injury is blunt and unrecognizable, the doctor must thoroughly examine the abdomen looking for bruises or possible ecchymosis speaking for the internal hemorrhage [3].

Diagnosis

An initial and prompt yet helpful modality to use in case of liver trauma is ultrasonography, specifically focused assessment by ultrasound for trauma (FAST). The method used in FAST is to provide a quick and effective preliminary assessment of the pericardial region, left upper quadrant, right upper quadrant, and pelvis. This modality is usually used in the emergency department to detect the free fluid i.e., hemorrhage if any. The accuracy of ultrasound in detecting both blunt and penetrating abdominal injuries is high, it ranges between 95 to 100 percent in specificity and 63 to 100 in sensitivity, thence it has successfully replaced the diagnostic peritoneal lavage (DPL) in the first steps of diagnosis. The pitfalls of this modality are that it is highly dependable on the operator and can provide misleading information in both directions; false positive and false negative. It also cannot determine the extent of the parenchymal or vascular part injured in sever liver trauma, for this, it never should substitute the computerized tomographic (CT) scan [8-10].

A spiral computerized tomographic (CT) scan is the gold standard in assessing liver injuries in the hemodynamically stable patient. This modality provides an accurate reading for all the liver's parts, subcapsular, intraparenchymal, and vasculature parts. With precision, it can determine the estimation of hemoperitoneum fluid and differentiate between the clotted and active bleeding. The contrast-enhanced CT with different phases allows to capture the source of bleeding and help to determine the best measures to take to manage every particular case. As without the use of the contrast, and sometimes even with the contrast, the source of the peritoneal fluid can be mistaken as in the blunt trauma concurrent injuries to other abdominal organs can happen as well [11-14].

Classification

The World Society of Emergency Surgery (WSES) in their newest guidelines came up with a classification relying on organ injury scale provided by The American Association for the Surgery of Trauma (AAST-OIS), see **Table 1**, and hemodynamic stability. The definition of hemodynamic instability, in adults, is the systolic blood pressure lower than 90 mmHg along with clinical evidence of hemorrhagic shock with skin vasoconstriction, altered consciousness level and/ or shortness of breath, or if the systolic blood pressure is higher than 90 but the patient required bolus infusion/ transfusion, or if the patient received more than four packed red blood cells within the first 8 hours. The WSES classification categorizes the patient into minor (WSES grade I), moderate (WSES grade II), and severe (WSES grade III and IV), see **Table 2**. Based on this classification suggestion of the best method of management is proposed, either non-operative management (NOM) or operative management (OM).

Table 1. The American Association for the Surgery of Trauma classification for liver injury

Grade	Injury type	Injury description
I	Hematoma	Subcapsular <10% surface
	Laceration	Capsular tear <1 cm parenchymal depth
II	Hematoma	Subcapsular 10-50% surface area; intraparenchymal <10 cm diameter
	Laceration 1-3 cm parenchymal depth, <10 cm in length	
III	Hematoma	Subcapsular >50% surface area or expanding, ruptures subcapsular or parenchymal hematoma. Intraparenchymal hematoma >10 cm
	Laceration	>3 cm parenchymal depth
IV	Laceration	Parenchymal disruption 25-75% of hepatic lobe
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe
	Vascular	Juxtavenous hepatic injuries i.e., retrohepatic vena cava/central major hepatic veins
VI	Vascular	Hepatic avulsion

Table 2. World Society of Emergency Surgery liver trauma classification

	WSES grade	AAST	Hemodynamic
Minor	WSES grade I	I-II	Stable
Moderate	WSES grade II	III	Stable

severe	WSES grade III	IV-V	Stable
	WSES grade IV	I-VI	Unstable

Management

According to the World Society of Emergency Surgery, the preferable management for the first three grades is non-operative management (NOM), as in all of them the patients are hemodynamically stable. This management option is considered in the absence of other injuries requiring surgeries. If the patient stability is jeopardized and they show inadequate response to resuscitation, i.e., transient response, operative management should be considered unless of the presence of immediately trained surgeons and operating theatre. CT scan with contrast is the way to go in all of the stable patients, where angiography and angioembolization could be the first line in those who exhibit arterial blush on CT. In NOM, serial physical examination and laboratory testing are required to ensure the success of this type of management and to early detect any undesirable sequelae. The operative management (OM) is mainly considered in WSES grade IV where the patient hemodynamic status is unstable or the patient is non-responsive to resuscitation. The primary goal of operative management is to control hemorrhage and bile. Furthermore, the resection of major hepatic resection should be considered in the subsequent procedure where it goes in debridement manner of the devitalized regions. The major bleeding could be stopped via a different method, for instance argon beam coagulation, compression, simple suture of the hepatic parenchyma, bipolar devices, electrocautery, hemostatic agent, or omental patching [15-17].

Operative Management Options, Non-Definitive

Initial Control of the Bleeding

After incising the abdomen, the main focus is to stop the active bleeding of the vessels. Bleeding control cans start by manual compression of the liver followed by tamponade and packing, in case of failure Pringle's maneuver, clamping the hepatoduodenal ligament with surgical clamp or hand to obstruct the flow of hepatic artery and portal vein. This procedure is considered both therapeutic in case of local vessel damage and diagnostic if otherwise. If the bleeding continues, it is a sign of major vessels involvement, hepatic venous or vena cava, in such cases further packing and tamponade are required to control the bleeding [7, 18].

Damage Control Surgeries

Three phases of damage control surgeries should be maintained, phase one involves hemorrhage control by any previously mentioned means. Phase two consists of resuscitation and stabilization in the intensive care unit for 24-48 hours, followed by phase three; re-exploration and definite management. This type of management was innovated to reduce the metabolic effect of hypothermia, coagulopathy, and acidosis and its possible consequences that may hinder the recovery of the patient. Damage control surgery could also be considered as plan B for ongoing definitive therapeutic surgeries when one of those three parameters severely drops during the operation [19, 20].

Perihepatic Packing

This method has emerged as part of damage control surgeries where it showed great ability to stop the ongoing bleeding, especially in the severely damaged liver. It provides time for intraoperative resuscitation and packing; it also allows the patient to be safely transferred into a more specialized hospital if needed. The technique of perihepatic packing involves approximation of the liver parenchyma followed by placing packs around the liver to provide a tamponade effect by pushing against the thoracic cage. Be alert that excessive packing may lead to the adverse effect of compressing the vena cava and renal vein [18, 20, 21].

Operative Management Options, Definitive

The judgment of the surgeons should shine after the initial non-definitive management, as the following options should be considered if the bleeding persists after the removal of the packing and how this bleeding should be controlled.

Hepatotomy and Selective Vascular Suture or Hepatorrhaphy and Ligation

This procedure was performed under Pringle's maneuver to enhance visualization of the lacerated vessels. Finger fracture of uninjured parenchymal is a blunt separation method to reach the injured vessel which showed good results; however, you should consider the length of the extension that is going to be made to reach the vessel and how much bleeding to be added. In those difficult cases where the liver is mashed, an alternative approach should be considered. Hepatorrhaphy on the other hand, instead of trying to reach the injured vessel it adopts the different approach of suturing the parenchyma to reach the tamponade effect. The downside of this procedure is the risk of parenchymal ischemia, thus it is no longer recommended [7, 22, 23].

Non-Anatomical Resection and Anatomical Resection

In non-anatomical resection, the line is used to resect marked by the injury rather than the anatomical boundaries. It can be used in phase one of the damage management surgeries if needed or in phase three after stabilization. The coagulation profile of the patient should be kept in mind in this procedure to avoid further hemorrhage. Anatomical resection respects the well-

known anatomical borders, this procedure should be strictly used after stabilization of the patient. It provides good management of the bleeding along with sepsis [24-26].

Total Vascular Exclusion and Venovenous Bypass

The total vascular exclusion includes clamping the suprahepatic inferior vena cava and portal triad and infra. This method showed excellent results but with a major drawback if decreased venous return, causing a severe hypotension. In venovenous bypass, the problem of hypotension is overcame by shunting the blood from common femoral and mesenteric veins to the axillary or internal jugular veins [27, 28].

Liver transplant

Liver transplantation sounds like a very effective option in severe liver trauma, theoretically. The logistic of this method usually stand in the face of its success, the long list for donors and how to stabilize the patient until then are the main considerations. Several techniques are introduced to solve the latter obstacle, including construction of a temporary end-to-side portocaval shunt and venovenous bypass, but there is no active solution for the former issue [29, 30].

Conclusion

Liver trauma, either blunt or penetrative, is a crucial injury that must be dealt with in extreme caution and delicacy. Early detection of the problem and proper classification with the help of radiological modularity serves in a better outcome for the patient and lower mortality and morbidity rates. WSES classification draws the outlines for the possible management and when to go to non-operative versus operative options. Historically the absolute way to go used to be the operative one, where the mortality was skyrocketing. Nowadays, with advanced technology and access to CT scans, doctors managed to reach a better outcome with stepwise fashion techniques. The use of a non-operative, operative, or combines approach should be tailored for each patient and the type of the surgeries should be as well.

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