

AIM OF THE WORK

The aim. of this study is to discuss the most important causes of acute liver failure in critically ill patients, explaining how to diagnose and monitor them and presenting the methods of management, depending on clear understanding of the basic pathophysiology of acute liver failure in critically ill patients.

INTRODUCTION

Acute liver failure (ALF) is a rare condition in which rapid deterioration of liver function results in altered mentation and coagulopathy in previously normal individuals. U.S. estimates are placed at approximately 2,000 cases per year (*Hoofnagle et al., 1995*).

Acute liver failure is a broad term that encompasses both fulminant hepatic failure and subfulminant hepatic failure (or late-onset hepatic failure). Fulminant hepatic failure is generally used to describe the development of encephalopathy within 8 weeks of the onset of symptoms in a patient with previously healthy liver. Subfulminant hepatic failure is reserved for patients with liver disease for up to 26 weeks before the development of signs of FHF.

The most prominent causes include drug-induced liver injury, viral hepatitis, autoimmune liver disease and shock or hypoperfusion; many cases (~20%) have no discernible cause (*Ostapowicz et al., 2002*).

Acute liver failure often affects young persons and carries a high morbidity and mortality. Prior to transplantation, most series suggested less than 15% survival. Currently, overall

short-term survival with transplantation is greater than 65% (*Ostapowicz et al., 2002*).

Medical management strategy in patients with acute liver failure include two main lines; general measures e.g. patient position and specific measures including endotracheal intubation and ventilation, blood sugar strategy, nutrition management, management of fluids and electrolytes, renal replacement therapy, vasopressor therapy, infection control and treatment, management of cerebral edema and lastly management of coagulopathy (*Kumar et al., 2012*).

Urgent liver transplantation has become the standard of care for most ALF patients in Western countries where ALF survival rates have shown progressive and substantial improvement, with 1-year survival exceeding 80%. However, in developing countries, access to liver transplantation and other extracorporeal liver-assist devices is severely limited and hence, the management is largely supportive. Fortunately, the spontaneous survival of ALF patients has increased over the last 20 years because of earlier disease recognition, better understanding of pathophysiology of various insults and improved intensive care management (*Wigg et al., 2005*).

Indeed, ALF is a potentially reversible condition, where survivors recover completely without any sequelae. Therefore,

if the individual can be supported properly throughout the acute event, recovery will follow the rapid regeneration of hepatocytes. A structured approach to decision making about intensive critical care is important for achieving a good outcome in ALF. The current review highlights the important issues in the management of patients with ALF in intensive care units (*Hughes et al., 2003*).

ANATOMY OF LIVER

The liver is the largest organ in the body and lies in the upper part of the abdominal cavity just beneath the diaphragm and mostly under cover of the ribs. It fills the right muirdnohcropyh and extends across the epigastrium into the left hypochondrium (*Standring et al., 2005*).

The liver is a solid gastrointestinal organ largely occupies the upper quadrant of the abdomen. The costal margin coincides with the lower margin and the superior surface is draped over by the diaphragm. Most of the right liver and most of the left liver is covered by the thoracic cage. The liver extends superiorly to the height of the fifth rib on the right and the sixth rib on the left. The posterior surface straddles the inferior vena cava (IVC). A wedge of liver extends to the left half of the abdomen across the epigastrium to lie above the anterior surface of the stomach and under the central and left diaphragm. The superior surface of the liver is convex and is molded to the diaphragm, whereas the inferior surface is mildly concave and extends to a sharp anterior border (*Townsent et al., 2004*).

- **Hepatic Surfaces:**

The liver has superior, anterior, right, posterior and inferior surfaces, and has a distinct inferior border. However, superior, anterior, right surfaces are continuous with no definable borders. The superior surface is the largest surface and lies immediately below the diaphragm, separated from it by peritoneum except for a small triangular area where the two layers of falciform ligament diverge. The anterior surface is triangular and convex. It is covered by peritoneum except at the attachment of the falciform ligament. It is covered by peritoneum and lies adjacent to the right dome of the diaphragm which separates it from the right lung, pleura and seventh to eleventh ribs. The posterior surface (Fig. 1) is convex, wide on the right, but narrow on the left. The inferior surface is bounded by the inferior edge of the liver. It is marked near the midline by fissure of ligamentum teres (*Standring et al., 2005*).

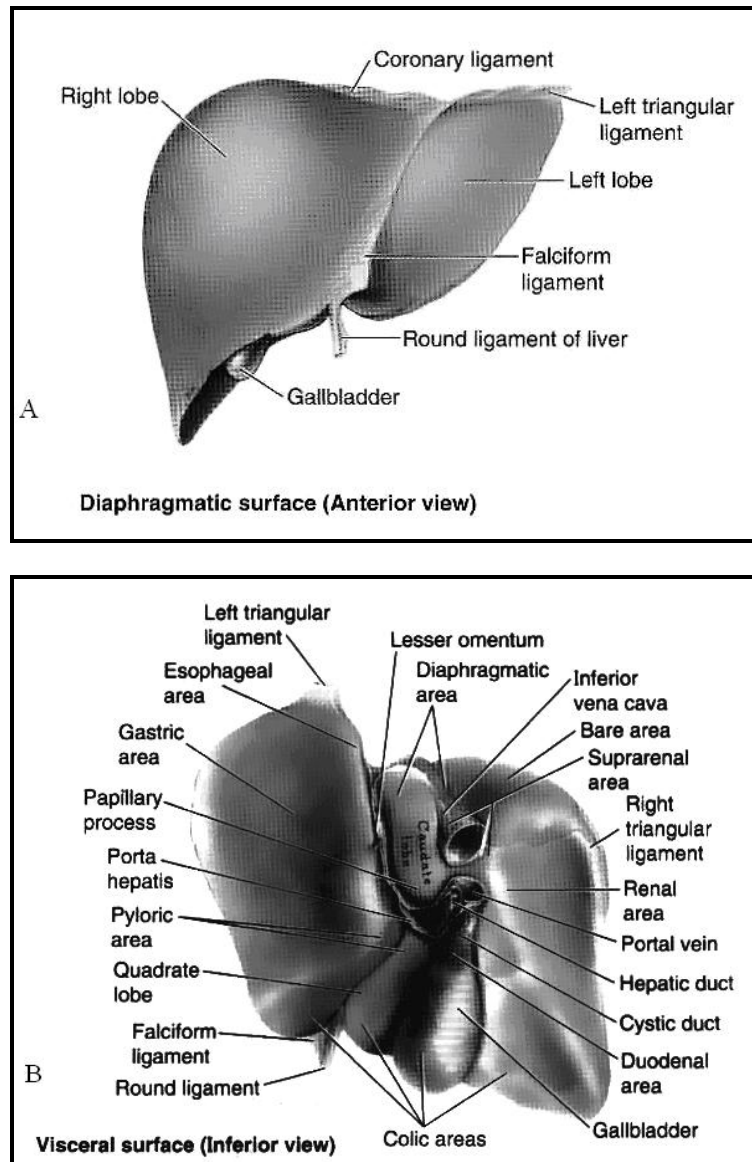


Figure (1): A. Anterior surface of the liver B. visceral surface of the liver (Moore and Dalley, 2006).

- **Important relations:**

Anteriorly: Diaphragm, right and left costal margins, right and left pleura, and lower margins of lungs, xiphoid process and anterior abdominal wall in the subcostal angle.

Posteriorly: Diaphragm, right kidney, hepatic flexure of the colon, duodenum, gallbladder, inferior vena cava, esophagus, and fundus of the stomach (*Snell, 2004*).

- **The Porta Hepatis:**

The portahepatis is the area of the inferior surface through which all the neurovascular and biliary structures, except the hepatic veins, enter and leave the liver (*Standring et al., 2005*).

- **The excretory apparatus of the liver consists of:**

- i. The common hepatic duct
- ii. The gallbladder
- iii. The cystic duct
- iv. The common bile duct

(*Drake et al., 2005*)

- i. The common hepatic duct:**

The hepatocytes secrete bile into the bile canaliculi. The canaliculi drain into the small interlobular biliary ducts and then

into large collecting bile ducts of the intrahepatic portal triad which merges to form right and left hepatic ducts. The right and left hepatic ducts drain the right and the left lobe, respectively. Shortly after leaving the portahepatis, the right and the left ducts unite to form the common hepatic duct, which is joined on the right side by the cystic duct to form the bile duct (**Moore and Dalley, 2006**).

ii. The gallbladder:

The gallbladder is a pear-shaped sac about 10 cm in length and is situated on the inferior surface of segment V of the right liver (Figure 2). It is covered by a layer of peritoneum. It is customarily divided into the fundus, the body and the neck or the infundibulum which leads to the cystic duct (**Cuschiere et al., 2002**).

iii. The cystic duct:

The cystic duct is about 1.5 inches (3.8 cm) long and connects the neck of the gallbladder to the common hepatic duct to form the bile duct. The mucous membrane of the cystic duct is raised to form a spiral fold that is continuous with a similar fold in the neck of the gallbladder. The fold is commonly known as “spiral valve”. The function of the spiral valve is to keep the lumen constantly opened (**Snell, 2004**).

iv. The common bile duct:

The bile duct forms in the free edge of the lesser omentum by the union of the cystic duct and the common hepatic duct. The length of the bile duct varies from 5 to 15 cm. On the left side of the descending part of the duodenum, the bile duct comes into contact with the main pancreatic duct. These ducts run obliquely through the wall of this part of the duodenum, where they unite to form the hepatopancreatic ampulla, the dilation within major duodenal papilla. The circular muscle around the distal end of the bile duct is thickened to form the sphincter of the bile duct (**Moore and Dalley, 2006**).

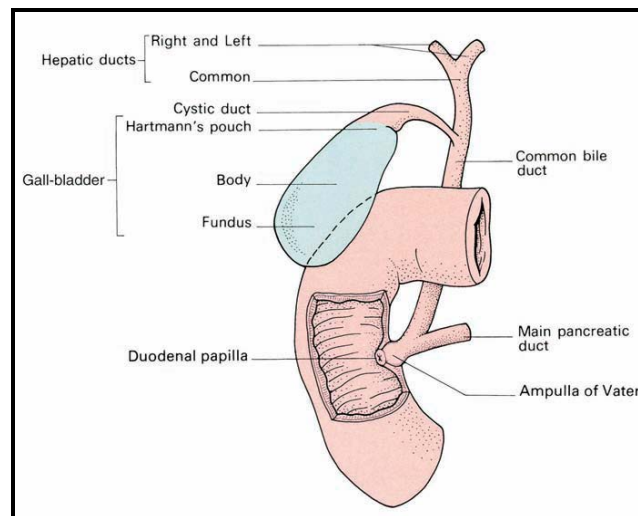


Figure (2): Biliary system (**Harold, 2006**)

- **Functional anatomy of the liver (Hepatic segments):**

The functional anatomy of the liver (fig. 3) is composed of eight segments, each of which is supplied by a single portal triad (also called a pedicle) composed of a portal vein, hepatic artery, and bile duct. These segments are further organized into four sectors that are separated by scissurae containing the three main hepatic veins. The four sectors are even further organized into the right and left liver. This system was originally described in 1957 by Woodsmith and Goldburne as well as Couinaud and defines hepatic anatomy as it is most relevant to surgery of the liver (*Moore and Daley, 2006*)).

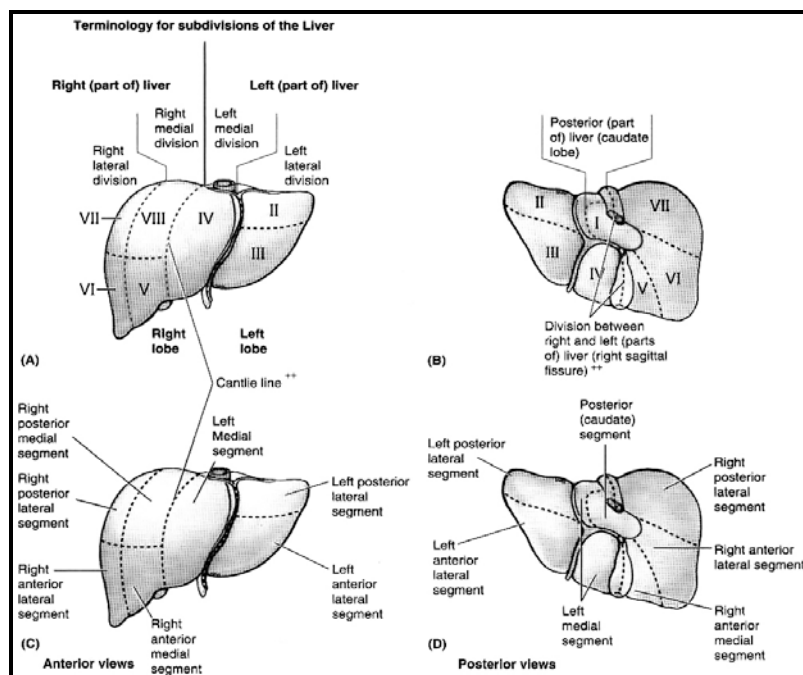


Figure (3): Functional divisions of the liver (*Moore and Dalley, 2006*).

- **Blood Supply of the Liver:**

The liver receives a dual blood supply (Fig. 4) from both the portal vein and the hepatic artery. Although the portal vein carries incompletely oxygenated venous blood from the intestine and the spleen, it supplies up to half the oxygen requirement of the hepatocytes because of its greater flow. This dual blood supply explains the low incidence of hepatic infarction (*Gosling et al., 2002*).

The portal vein:

The portal vein (Fig. 4) provides about 75% of hepatic blood flow, and although it is postcapillary and largely deoxygenated, its large-volume flow rate provides 50% to 70% of the liver's oxygenation. The portal vein forms behind the neck of the pancreas at the confluence of the superior mesenteric vein and the splenic vein at the height of the second lumbar vertebra. The length of the main portal vein ranges from 5.5 to 8cm, and its diameter is usually about 1 cm. The portal vein runs behind the first portion of the duodenum and into the hepatoduodenal ligament, where it runs along the right border of the lesser omentum, usually posterior to the bile duct and

hepatic artery. The portal vein divides into main right and left branches at the hilum of the liver. The left branch of the portal vein runs transversely along the base of segment IV and into the umbilical fissure. The right portal vein has a short extrahepatic course and usually enters the substance of the liver, where it splits into anterior and posterior sectoral branches (*Blumgart, 2000*).

- **The hepatic artery:**

The hepatic artery (Fig.4) representing high flow oxygenated systemic arterial flow, provides approximately 25 % of the hepatic blood flow and 30-50 % of its oxygenation (*Townsent et al., 2004*).

The usual arrangement for the common hepatic artery is to arise from the coeliac axis. After giving off the right gastric and the gastroduodenal arteries behind the antroduodenal region it arches upward along the left side of the bile duct and in front of the portal vein. It then bifurcates into right and left hepatic arteries quite close to the liver (*Cuschiere et al., 2002*).

- **The hepatic vein:**

The three major hepatic veins (Fig. 4) drain from the superior and posterior surface of the liver directly into the IVC. The right hepatic vein runs in the right scissura (between the anterior and posterior sectors of the right liver) and drains most of the right liver after a short (1-cm) extrahepatic course into the right side of the IVC. The left and middle hepatic veins usually join intrahepatically and enter the left side of the IVC as a single vessel, although they may drain separately. The left hepatic vein runs in the left scissura (between segments II and III) and drains segments II and III, and the middle hepatic vein runs in the portal scissura (between segment IV and the anterior sector of the right liver) draining segment IV and some of the anterior sector of the right liver. Multiple small venous branches from the right posterior sector and the caudate lobe drain posteriorly directly into the IVC (*Nakamura and Tsuzuki, 1991*).

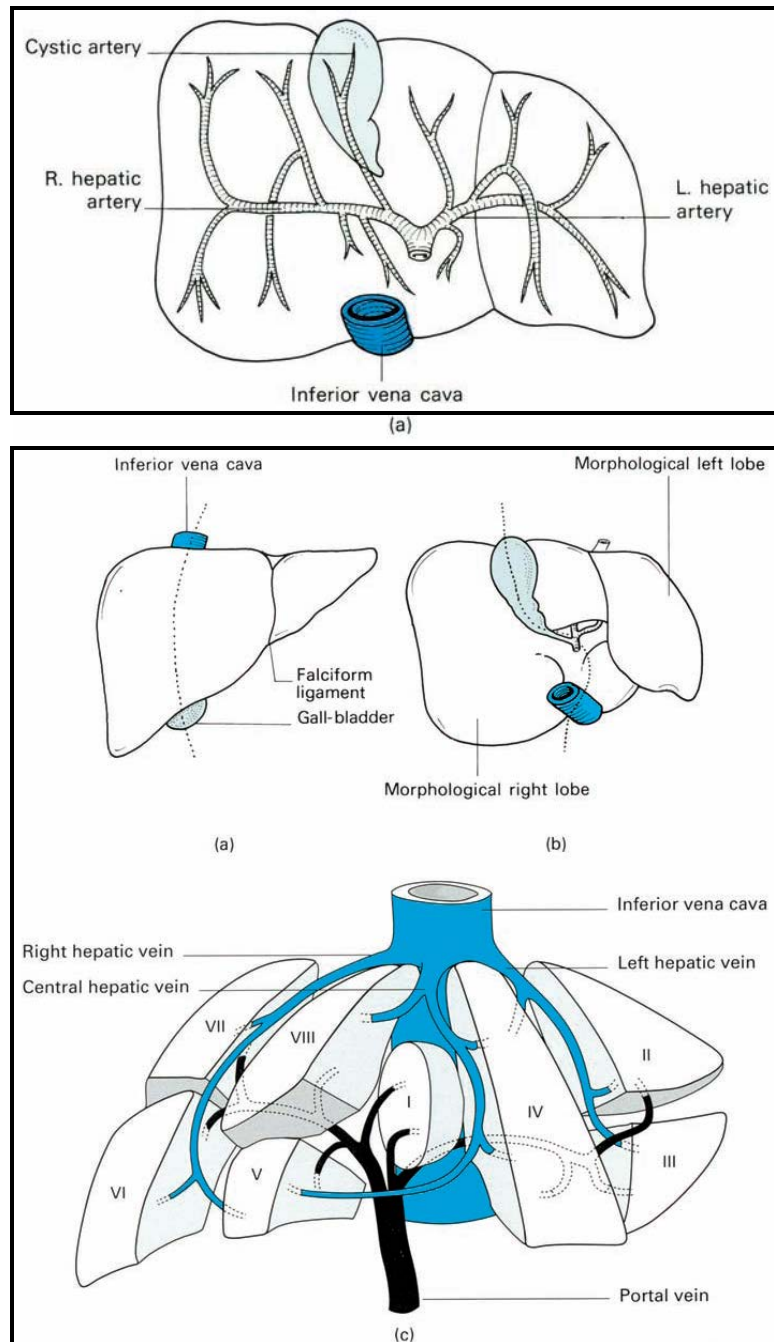


Figure (4): Blood Supply of the liver (*Harold, 2006*).