List of abbreviations

(LB)…….. liver biopsy

(TE) ……Transient elastography

(ROC)……The area under the receiver operator characteristic curve

(k Pa)……Kilo Pascal's

(E) ……Elasticity

(RF)……Radiofrequency

(MRE)……MR elastography

(ARFI)……Acoustic radiation force impulses

(AOI)……Area of Interest

(FS)……Fibroscan

(FT)……fibrotest

(APRI)…… Aspartate aminotransferase to platelets ratio index

(NASH)……Non alcoholic steatohepatities

Introduction

Fibrosis is defined as an excess deposition of the components of extracellular matrix (i.e. collagens, glycoproteins, proteoglycans) within the liver. This response to liver injury potentially is reversible. In contrast, in most patients, cirrhosis is not a reversible process. Cirrhosis is defined histologically as a diffuse hepatic process characterized by fibrosis and the conversion of normal liver architecture into structurally abnormal nodules. The progression of liver injury to cirrhosis may occur over weeks to years ***(Friedman, 2003).***

Cirrhosis has many possible causes; sometimes more than one cause is present in the same patient. The most common causes are viral hepatitis, chronic alcoholism, Non-alcoholic steatohepatitis (NASH) & Autoimmune hepatitis ***(Mirella et al., 2007)***.

Cirrhosis can cause many serious complications including ascites, variceal hemorrhage, severe bleeding of varices, Spontaneous bacterial peritonitis, Hepatic encephalopathy, Hepatocellular carcinoma. Liver fibrosis is the prognostic hallmark of chronic liver diseases (CLD) ***(Mirella et al., 2007)***. It is evaluated by Aspartate aminotransferase-platlate ratio index, fibrotest ***(Liber et al., 2004),*** Hepascore ***(Adams et al., 2005)*** and is currently best evaluated by histological examination of the liver ***(Mirella et al., 2007).***

Needle liver biopsy is an invasive procedure that is associated with small sample size and inaccurate staging, and provides only a semiquantitative assessment of fibrosis ***(Keyur and Rockey, 2006)***. It has many other disadvantages, including poor patient compliance, sampling errors, and a risk of complications typical of invasive procedures. Together, these constraints of liver biopsy have boosted the search for non-invasive methods to assess progression of fibrosis, which is of strategic importance in the management of patients with CLD ***(Mirella et al., 2007).***

Accordingly elastography techniques have been developed to quantify shear elasticity of human living tissue based on soft -tissue imaging techniques, such as Ultrasound or MRI using either static mechanical compression or acoustic stream waves ***(Rump et al., 2007).***

Transient elastography (FibroScan) is a recently developed, non-invasive device designed to predict liver fibrosis, based upon a mechanical wave generated by vibration. The measurement of the speed of propagation of the wave across the hepatic parenchyma provides an estimate of the liver elasticity, which in turn is a surrogate marker of liver fibrosis ***(Mirella et al., 2007)***.

Aim of the Study

Highlight the accuracy of transient elastography in non invasive quantification of liver fibrosis in patients with chronic liver disease.

Anatomy of the Liver

Gross Morphology and Surface Anatomy of the Liver:

The liver is the largest abdominal organ weighting 1400-1800 gm in adults. It is wedge shaped (with its rounded base to the right) and occupies the right hypochondrium, epigastrium and left hypochondrium as far as left midclavicular line **(Fig.1)** ***(Standrg et al.,2005).*** It is covered by a thin connective tissue capsule (Glisson's capsule) that becomes thicker at the hilum. Where the PV and the hepatic artery enter the organ and where the right and the left ducts and lymphatic exit ***(Michael et al., 2003).***

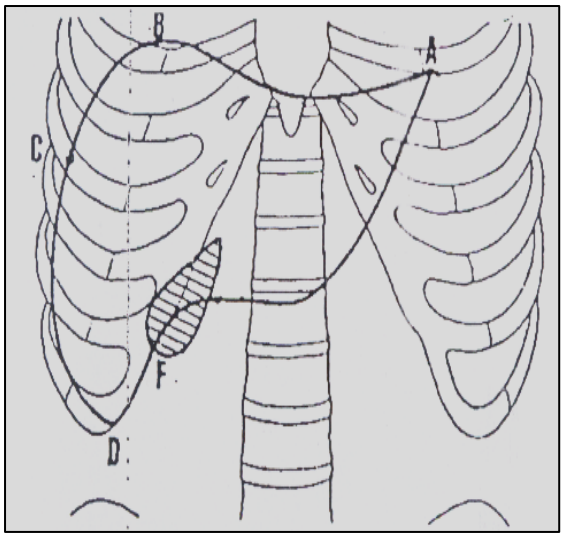

Fig. (1): Surface anatomy of the liver (F= Fundus of the gall bladder) ***(Soyer et al.,1993).***

The upper border (ABC) passing through xiphisternal joint from point (A) at the lower border of the left 5^{th} rib In the

left midclavicular line to point (B) at the upper border of right 4^{th} rib midclavicular to the point (C) at the upper border of right 7^{th} rib In midaxillary line **(Fig.1).**

The right border (C D) extends from point (C) down to point (D) 1/2 cm below the right 10^{th} rib in midaxillary line.

The lower border (D A) extends from point (D) to the tip of right 9^{th} rib, then passes thought transpyloric plane (LI) to the tip of left 8^{th} rib to point (A) ***(Soyer et al.,1993).***

Hepatic surfaces and relations:

It has 2 surfaces; diaphragmatic and visceral surfaces. The diaphragmatic surface mostly related to the diaphragm, which separates theses surfaces from thoracic organs and structures. The remained Inferior (visceral) surface is related to abdominal viscera and is limited below by a sharp inferior border except posteriorly.

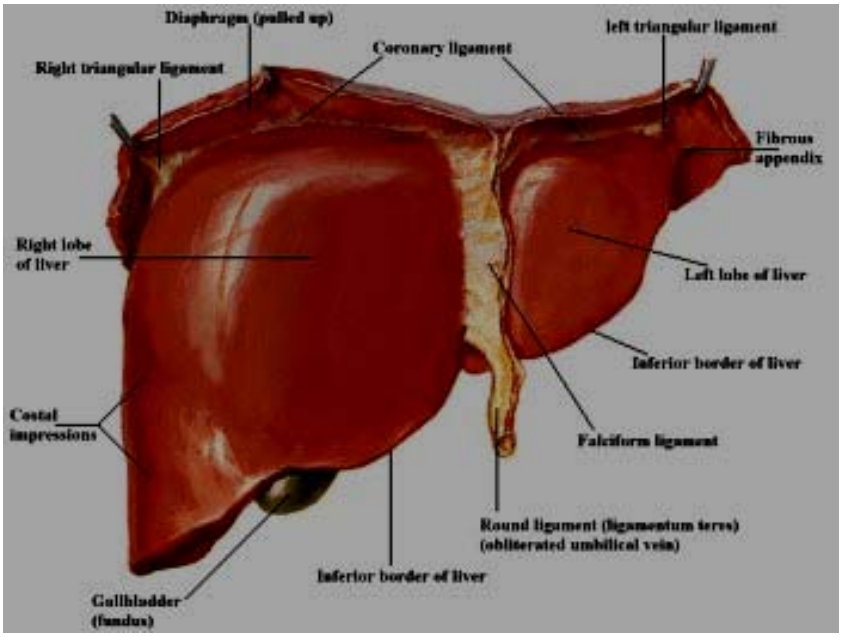

Fig. (2): The diaphragmatic surface of the liver ***(Standrg et al.,2005).***

1. **<u>Diaphragmatic surface</u>:** as a whole, is convex, and fits under the vault of the diaphragm which in front separates it on the right from the sixth to the tenth ribs and their cartilages, and on the left from the seventh and eighth costal cartilages. Its middle part lies behind the xiphoid process, and, in the angle between the diverging rib cartilage of opposite sides, is in contact with the abdominal wall. Behind this the diaphragm separates the liver from the lower part of the lungs and pleuræ, the heart and pericardium and the right costal arches from the seventh to the eleventh inclusive. It is completely covered by peritoneum except along the line of attachment of the falciform ligament **(Fig.2)** ***(Giovannelli et al., 1997).***

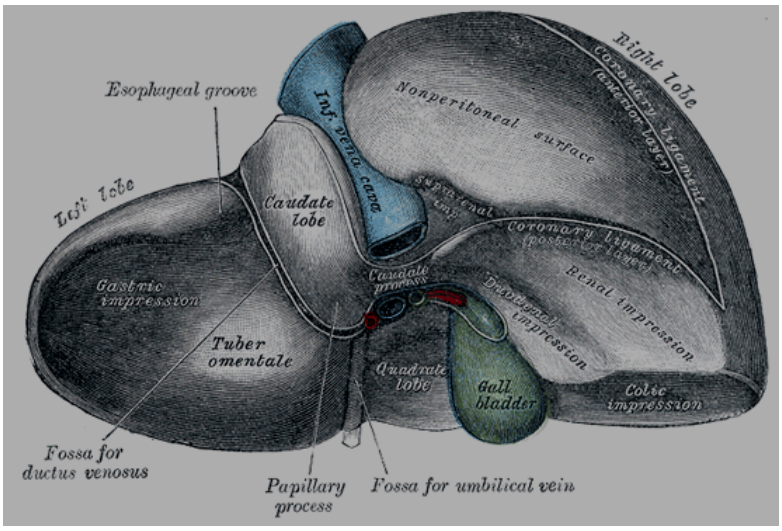

Fig. (3): The Visceral and Posterior surface of the liver ***(Standrg et a1, 2005).***

2. **<u>Inferior or visceral surface</u>**:

This surface is divided into three areas by two vertical features, the GB and the fissure for the round ligament, the upper ends of which are linked by a horizontal cleft, representing the porta hepatis through which pass the branches of the proper HA and PV and hepatic ducts. The round ligament ascends along its fissure to reach the PV. To the left of the fissure the left lobe of the liver overlies the body of the stomach and the lesser omentum.

To the right of the fissure is the small rectangular quadrate lobe, which is related to the anterior aspects of the pyloric region of the stomach and the first part of the duodenum. To the right of quadrate lobe is the GB and renal

impression which accommodates the upper pole of the right kidney. This, Surface of the right lobe is also related to the right colic flexure and the second part of the duodenum **(Fig.3)** ***(Giovannelli et al.,1997).***

Porta hepatis:

The porta hepatis is a short but deep fissure, about 5 cm long, extending transversely across the under surface of the liver, nearer its posterior surface than its anterior border. It separates the quadrate lobe in front from the caudate lobe and process behind. It transmits the hepatic PV, the HA proper, the CHD, nerves and lymphatics. The hepatic duct lies in front and to the right, the HA to the left, and the PV behind and between the duct and artery ***(Kogure et al.,2000).***

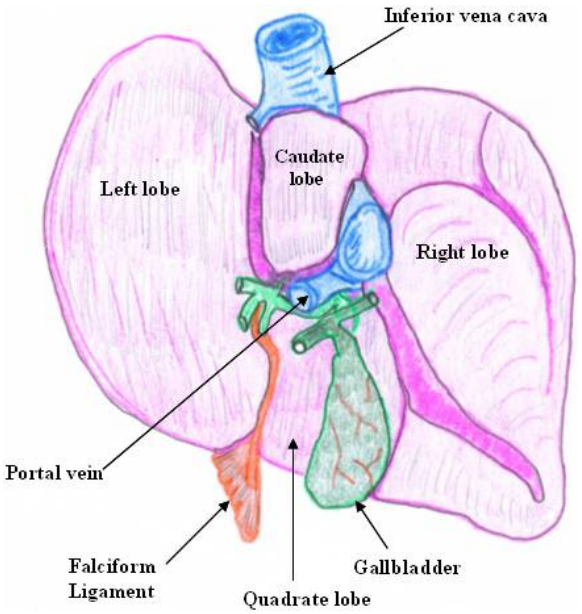

Fig. (4): Anatomical lobes of liver, right, left, caudate & quadrate lobe ***(Chuslip et al.,2002).***

Anatomical lobes of the liver:

By means of the falciform, ligament, fissure for ligmenturn venosum and fissure for ligamentum teres, the liver is divided into right lobe .and smaller left lobe. The right lobe has two small lobes called the caudate and quadrate lobes ***(Chuslip et al., 2002)*** **(Fig.4).**

The right lobe:

It is much larger than the left, the proportion between them as six to one. It occupies the right hypochondrium, and is separated from the left lobe on its upper surface by the falciform ligament; on its under and posterior surfaces by the left sagittal fossa; and in front by the umbilical notch.

It is of a somewhat quadrilateral form, it's under and posterior surfaces being marked by three fossæ: the porta and the fossæ for the gall-bladder and inferior vena cava, which separate its left part into two smaller lobes; the quadrate and caudate lobes.

The left lobe:

Is smaller and more flattened than the right. It is situated in the epigastric and left hypochondriac regions. Its upper surface is slightly convex and is moulded on to the diaphragm; its under surface presents the gastric impression and omental tuberosity.

Caudate lobe:

Boundaries; Right by caval groove, left by fissure for ligamentum venosum, superiorly by left HV and ligamentum venosum in their way to IVC and inferiorly by porta heaptis.

It has two processes, a papillary process projects from its lower left end and a caudate process which projects from its lower right part.

The caudate process has two features:

1. It connects caudate lobe with the rest of the right lobe of the liver.
2. It separates porta hepatic and PV from IVC and from upper boundary of epiploic foramen.

Fissure for ligamenlum venosum provides attachment to the two layers of lesser omentum, and in its depth, runs ligamentum venosum which springs from the left branch of the PV to end in the left hepatic vein or in the IVC.

Oesophageal impression lies on the left lobe of the liver produced by abdominal end of the esophagus ***(Giovannelli et al., 1997).***

The quadrate lobe:

Is an area of the liver situated on the under surface of the right lobe, bounded in front by the anterior margin of the liver; behind by the porta hepatis; on the right, by the fossa for the

gall-bladder; and on the left, by the fossa for the umbilical vein. It is oblong in shape, its antero-posterior diameter being greater than its transverse.

Functional (segmental) anatomy of the liver:

The traditional morphological anatomy is based on the external appearance of the liver but segmental anatomy divide the liver into eight functionally independent segments. Each segment has its own vascular inflow, outflow and biliary drainage. This classification will be presented here with several illustrations ***(Saulius et al.,2006).***

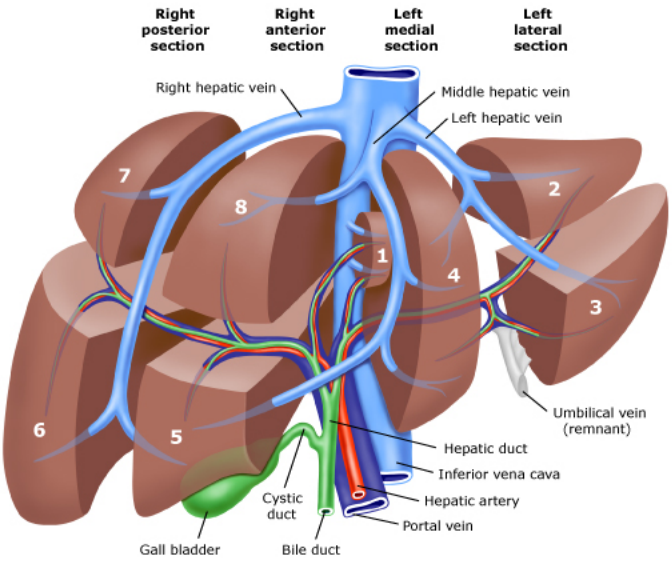

Figure (5): Segmental anatomy of the liver according to Couinaud ***(Bates et al.,2004).***

Segmental anatomy of the liver:

The HVs demarcate the anatomic landmarks for the lobes and segments of the liver. The middle HV delineates the separation between the right and left lobes. The right lobe is comprised of an anterior and posterior segment with the boundary depicted by the right HV. The left lobe is comprised of a medial and lateral segments with the boundary between depicted by the left HV.

Because of new surgical techniques allowing for subsegmentectomy, Bismuth (1982) proposed more detailed classification of liver segmental anatomy lending itself to axial imaging and surgical relevancy. This anatomic classification scheme modified the previously settled one **(Fig.5)** by Couinaud in 1952. It uses the planes of the right and left portal branches, to divide each segment into superior and inferior subsegments ***(Baron et al.,2001).***

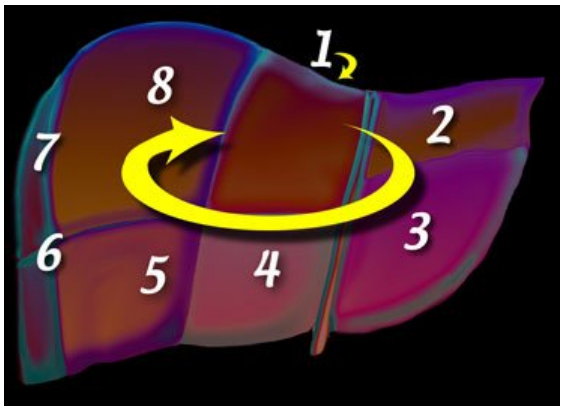

Fig. (6): Clockwise numbering of the segments ***(Bismuth et al.,1982).***

This classification numbered the eight segments **(Fig.6)** based on a clockwise orientation from a frontal projection ***(Bismuth et al., 1982).*** Starting with the caudate lobe as segment I, segment II and III being the superior and the inferior portion of the lateral part of the left lob. Although segment IV is part of the left hemiliver, it is situated more to the right &it is further subdivided into superiorIVa & inferiorIVb .Segments V and VI are the anterior and posterior portion of the inferior parts of the right lobe, while VII and VIII are the posterior and anterior portions of the superior part of the right lobe ***(Lafortune et al.,1991).***

Transverse anatomy:

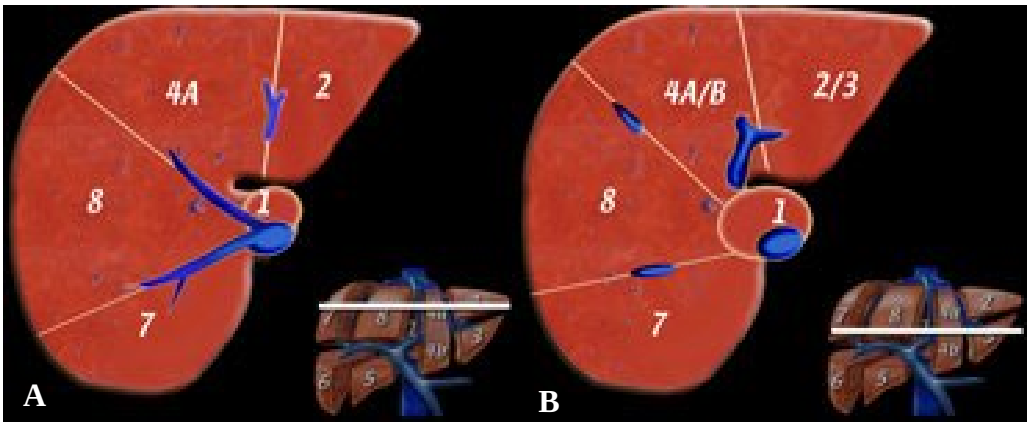

Fig. (7): (A) Above the level of the left portal vein.

Fig. (7): (B) At the level of the left portal vein.

Transverse image through the superior liver segments, which are divided by the hepatic veins **(Fig.7 A)**. The right image shows a transverse image at the level of the left portal vein **(Fig.7 B).** At this level the left portal vein divides the left

lobe of the liver into the superior segments (2 and 4A) and the inferior segments (3 and 4B). The left portal vein is at a higher level than the right portal vein ***(Baron et al.,2001).***

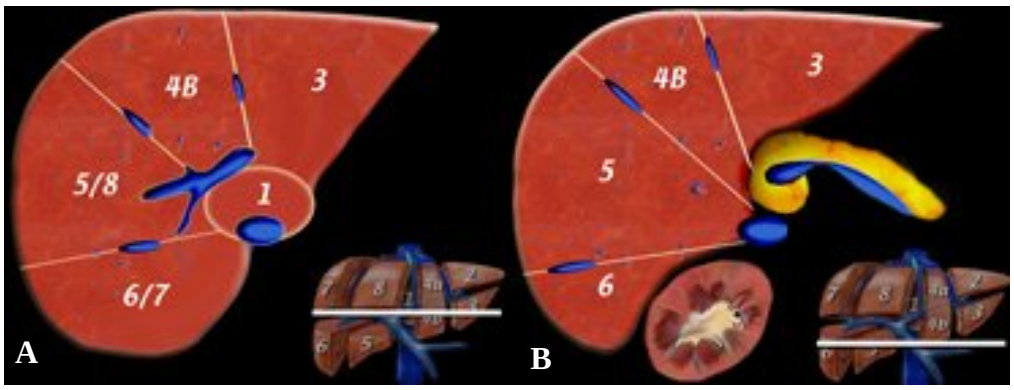

Fig. (8): (A) At the level of the right portal vein

Fig. (8): (B) At the level of the splenic vein.

At the level of the right portal vein. At this level the right portal vein divides the right lobe of the liver into superior segments (7 and 8) and the inferior segments (5 and 6) **(Fig.8 A).** The level of the right portal vein is inferior to the level of the left portal vein. At the level of the splenic vein, which is below the level of the right portal vein, only the inferior segments are seen **(Fig.8 B)** ***(Baron et al., 2001).***