

Role of High Intensity Focused Ultrasound in Treatment of Hepatocellular Carcinoma

Essay

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CONTENTS

1- Introduction and aim of the work.....	1
2- Anatomical considerations.....	5
a- Gross anatomy of the liver	
b- Ultrasound anatomy of the liver	
3-Pathological Features of Hepatocellular Carcinoma.....	18
4- Physical Principles of high intensity focused ultrasound (HIFU).....	27
5- Minimally Invasive Treatment of Hepatocellular Carcinoma.....	39
6- High Intensity Focused Ultrasound (HIFU) in treatment of Hepatocellular Carcinoma.....	58
8- Summary and Conclusion.....	86
9- References	91
10- Arabic Summary.....	1

List of Figures

Figure No.	Figure title	Page No.
1	Illustrated photographs show the anatomy of the liver.(A) Superior surface of the liver, (B) Inferior surface	5
2	Diagram shows the intra hepatic vascular and duct systems	6
3	diagram showing the intrahepatic portal circulation	5
4	diagram showing the surgical segments of the liver	12
5	U.S image shows the normal liver echogenicity (Chang et al., 2006).	14
6	US appearance of the left hemi liver by means of subxiphoid and sagittal views	16
7	US approach to the right hemi liver by means of subcostal and intercostals views	17
8	Trabecular hepatocellular carcinoma. Trabecular pattern of well differentiated neoplastic hepatocytes arranged in plates which are between three and four cells in thickness	23
9	Acinar hepatocellular carcinoma. Prevalence of acinar pattern of well-differntiated hepatocytes arranged in acini with dialted lumen	24
10	Fibrolamellar hepatocellular carcinoma. Cords of neoplastic liver cells are separated by lamellar fibrous strands	24
11 (A)	(A) An example of a linear (sine) ultrasound wave; its frequency spectrum contains a single frequency f .	27
11 (B)	A nonlinear ultrasound wave is formed by the energy transfer from the linear wave with the fundamental frequency f into the waves with higher frequencies (also known as harmonics): $2f$, $3f$, etc., and superimposition of these waves. therefore, the frequency spectrum contains the fundamental frequency f as well as higher harmonic	27
12 (A)	A single-element HIFU transducer has a spherically curved surface to focus ultrasound energy into a small focal region in which ablation takes place, leaving the surrounding tissue unaffected.	29
12 (B)	In a phased-array HIFU transducer the position of the focus can be steered electronically by shifting the phases of the ultrasound waves radiated by each element without moving the transducer	29
13 (A)	Absorption of linear ultrasound waves results in predictable cigar-shaped thermal lesion.	37
13 (B)	Irregularly-shaped thermal lesion with evaporated core results from boiling which is induced in tissue by rapid absorption of continuous non linear HIFU waves.	37
13(C)	A lesion containing liquefied tissue may be produced by very short, high-amplitude nonlinear HIFU pulses	37
14 (A)	Four-pronge needle electrode in which an alternating electric	40

Figure No.	Figure title	Page No.
	current at 460 KHz has caused ionic agitation around the electrode tip.	
14. (B)	The ionic agitation , which causes frictional heat immediately around the needle.	40
14.(C)	The heat caused by the agitation expands by conduction into the surrounding tissue to form a roughly spherical thermal injury	40
15 (A)	Tumors less than 2cm can easily be treated with one ablation. The active elements of the ablation needle are centered across the tumor.	42
15 (B)	Tumors larger than 2cm are treated by overlapping ablations.All ablations are centered to touch the center of the tumor	42
16 (A)	HCC before RF ablation.	43
16 (B)	CT scan after the ablation showed that the lesion became avascular, note the peritumoral hyperemia around the ablated tumor (arrow heads)	43
17	Photograph showing ethanol ablation equipment which consists of a syringe, sterile 95% ethanol & a 20 cm long, 21-guage needle	45
18 (A)	Photograph showing a patient positioned in an MRI imaging unit with a radiologist performing the procedure.	46
18 (B)	The flexible laser applicator.	46
18 (C,D)	The treatment needles are inserted within the tumor.	46
18 (E)	MR image shows low signal intensity (arrow) within the lesion caused by laser coagulation of the tumor	46
19	Photograph shows a 3 cm long, oval ice ball developing around the conductive tip of a 5 mm cryo probe	48
20	Drawing shows the blood supply to the liver & hepatic tumor. The tumor drives 95% of its blood supply from the hepatic artery. Normal liver parenchyma receives only 25% of its blood supply from the artery & the remaining 75% from the portal vein	49
21 (A)	Right hepatic arteriogram, obtained after a micro catheter has been advanced into the right hepatic artery through a 5.5-F diagnostic catheter parked in the coeliac artery, demonstrates a hyper vascular tumor in the posterior segment.	51
21 (B)	CT scan obtained before chemoembolization shows a hepatoma in the posterior segment of the right hepatic lobe	51
21 (C)	Post chemoembolization CT scan demonstrates 65% reduction in the tumor volume(arrow) with dense persistent uptake & retention of iodized oil. Oil retention correlates positively with tumor necrosis	51
22	Diagram shows how focused ultrasound beams reach the patient. Generated ultrasound beams are focused onto a target lesion by spherical shaped transducer. Ultrasound beams travel through a water bath (sonic medium) which is in contact with the skin over the target lesion	60

Figure No.	Figure title	Page No.
23	Flowchart shows the algorithm used for selecting the appropriate treatment for HCC	62
24 (A)	Patient positioning during the treatment process. Patient in right lateral position, abdominal area suspended in a water bath, body supported by frames from an overhanging frame.key : 1= HIFU table ; 2 = Overhanging frame; 3 =Water bath; 4 = Ultrasound transducer; 5 and 6 = Cushioned straps ,7 = water proof sheets to prevent spillage from water bath	66
24 (B)	patient can either be in a prone or right lateral position depending on which position will get the lesion closer to the beam	67
25 (A)	Schematic diagram shows the therapeutic plan for HIFU therapy, which was used to ablate the tumors	68
25 (B)	Real-time US images obtained before and after each exposure are immediately compared to determine whether the echogenic changes which indicate the extent of coagulation necrosis had covered the desired treatment area or not	69
26	Successful treatment of a small HCC (hepatocellular carcinoma) lesion. A) <i>Before</i> . Sagittal US (ultrasound) image obtained at the beginning of HIFU treatment shows a small HCC lesion (bold arrow) close to diaphragm. B) <i>After</i> . Sagittal US image obtained immediately at the end of HIFU ablation shows hyperechoic region in the treated area (bold arrow)	72
27	Transverse contrast agent-enhanced CT and MRI of a patient with HCC.	73
28	52-year-old man with hepatocellular carcinoma treated with radiofrequency ablation and then high-intensity focused ultrasound	74
29	Enhanced computed tomography scans obtained in a patient 49 years of age who had one-session high intensity focused ultrasound (HIFU) treatment alone for hepatocellular carcinoma	75
30	Enhanced computed tomography scans obtained in a patient 56 years of age who received one-session high intensity focused ultrasound (HIFU)treatment alone for advanced-stage HCC	76
31	Transverse contrast-enhanced CT images (nonhelical) obtained in a 58-year-old patient who underwent onecourse of TACE and one session of ultrasound ablation for HCC (arrowhead). Compared with tumor size before ablation, anobvious shrinkage was observed in the lesion treated with TACE plus ablation. Images were obtained	77
32	Enhanced MRI changes in a 62-year-old patient with HCC before and 2 weeks after HIFU treatment.	78
33	Long-term Follow-up Results of HCC Patients Treated with HIFU	79
34	Illustration shows HIFU ablation of a hepatic tumor with the tissues out of focus kept undamaged	81
35	Demonstration of the precise non invasive ablative nature of HIFU	82



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INTRODUCTION

Hepatocellular carcinoma (HCC) is one of the most common types of malignancy in humans and is also one of the most difficult types of cancer to treat. Surgical resection can change the natural course of HCC at early stages. Unfortunately, because of tumor multifocality, portal venous tumor invasion, and underlying advanced liver cirrhosis, surgical resection can be performed in only 20% of patients. Therefore, non surgical treatment is the only available option for the majority of patients with HCC (*Feng et al., 2005*).

Several minimally invasive techniques have been used for the local ablation of liver lesions including laser, microwave, radiofrequency, cryo and ethanol ablation. Transcatheter arterial chemoembolization(TACE) is a widely used treatment for patients with large-volume HCC. It is almost impossible to achieve complete necrosis of HCC with embolization of the hepatic artery alone. Viable tumor cells still remaining after TACE may cause local recurrence and distant metastasis. For this reason, TACE has recently been used with other ablative therapies to ablate residual tumor cells (*Feng et al., 2005*).

High-intensity focused ultrasound (HIFU) is a

noninvasive method for the treatment of liver tumors. This procedure is an extracorporeal technology for the thermal ablation of tumors. An ultrasound beam can be focused using an extracorporeal transducer to thermally ablate a large tumor without requiring insertion of instruments into the lesion (**Feng et al., 2004**).

There is a great difference between the acoustic intensities used with HIFU and those of the diagnostic ultrasound. HIFU has significantly higher intensities in the focal region of the ultrasound transducer. While typical diagnostic ultrasound transducers deliver ultrasound with intensities of approximately 0.1–100 W/cm², HIFU transducers deliver ultrasound with intensities in the range of 100–10,000 W/cm² to the focal region (**Dubinsky et al., 2008**).

The major effect of high acoustic intensities in tissue is heat generation due to absorption of the acoustic energy. The heat raises the temperature rapidly to 60°C or higher in the tissue, causing coagulation necrosis within a few seconds. Other mechanical phenomena including cavitation, microstreaming and radiation forces are associated with HIFU (**Dubinsky et al., 2008**).

HIFU can be also used in combination with other

treatment modalities for treatment of advanced HCC. TACE followed by HIFU ablation would be better than TACE alone in the treatment of patients with advanced HCC (*Feng et al., 2005*).

HIFU can be used as an effective modality in patients with advanced HCC, even in those who have failed a prior therapy (*Feng et al., 2004*).

Aim of Work

The aim of this work is to review the role of the high intensity focused ultrasound (HIFU) technology in the treatment of hepatocellular carcinoma being a completely non invasive ablative technique.

Anatomy of The Liver

Gross Anatomy of The Liver:

The anatomy of the liver according to its external appearance identifies a superior or diaphragmatic surface and an inferior or ventral surface. On the superior aspect of the liver the falciform ligament separates the liver into a larger right lobe and a smaller left lobe (**Fig. 1**) (*Majno et al., 2005*).

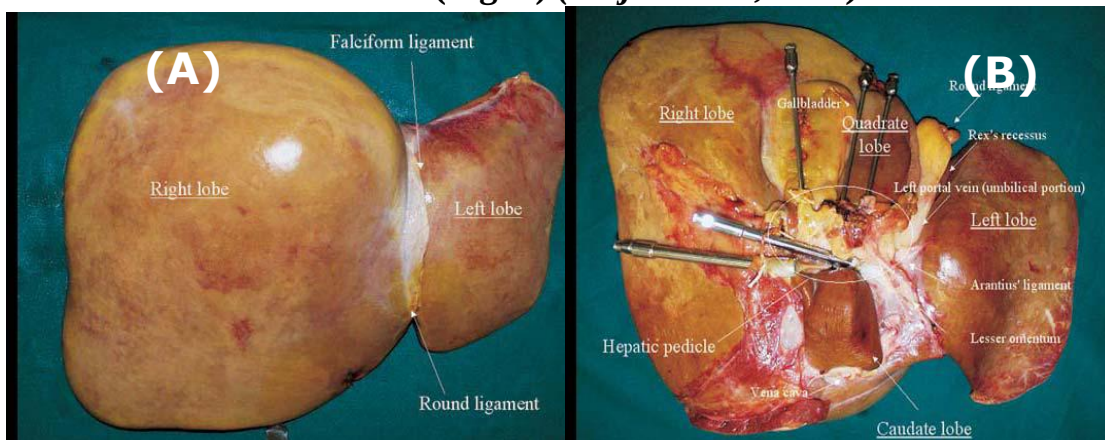


Fig. 1: Illustrated photographs show the anatomy of the liver.(A) Superior surface of the liver, (B) Inferior surface (*Majno et al., 2005*).

Two further lobes are described. The caudate lobe postero-inferiorly between the IVC and fissure for ligamentum venosum and the quadrate lobe antero-inferiorly between the gall bladder and the fissure for ligamentum teres. These lobes are part of the right lobe (*Ryan & McNicholas, 1994*).

The "hepatic pedicle" containing the portal vein, the hepatic artery and the bile duct spreads out, near the liver, in a space called the porta hepatis or hepatic hilum (defined by the

bifurcation of the portal vein) and divides into a shorter right pedicle and a longer left pedicle (*Majno et al., 2005*).

Hepatic Circulation:

The liver receives a dual blood supply from both the portal vein and the hepatic artery (**Fig. 2**). Although the portal vein carries incompletely oxygenated (80 %) venous blood from the intestine and spleen, it supplies up to half the oxygen requirements of the hepatocytes because of its greater flow. This dual blood supply explains the low incidence of hepatic infarction (*Majno et al., 2005*).

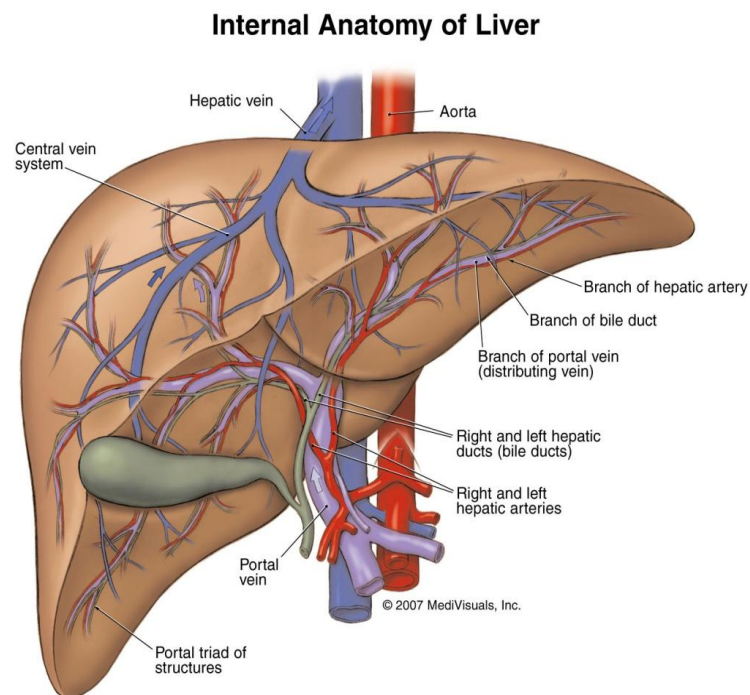


Fig. 2: Diagram shows the intra hepatic vascular and duct systems (*Ryan & McNicholas, 1994*).

Portal Vein:

The portal vein results from confluence of the superior mesenteric and splenic veins posterior to the neck of the pancreas. The portal vein passes in the free edge of the lesser omentum posterior to the bile duct and the hepatic artery to the porta hepatis, where it divides into the right and left branches to the morphological right and left lobes. The portal system is much less prone to anatomical variation than the hepatic artery **(Ryan &McNicholas, 1994).**

The portal venous system comprises all of the veins draining the abdominal part of the digestive tract, including the lower esophagus but excluding the lower anal canal. The portal vein conveys blood from viscera and ramifies like an artery at the liver, ending at the sinusoids. Tributaries of the portal vein, which make up the portal venous system are the splenic, superior mesenteric, left gastric, right gastric, paraumbilical, and cystic veins. The portal triad contains a branch of the portal vein, hepatic artery and bile duct. These are contained within a connective tissue sheath that gives the portal vein an echogenic wall on sonography and allows for its distinction from the hepatic veins, which have an almost imperceptible wall. The main portal vein divides into right and left branches **(Fig. 3)** **(Gallego et al.,2002).**

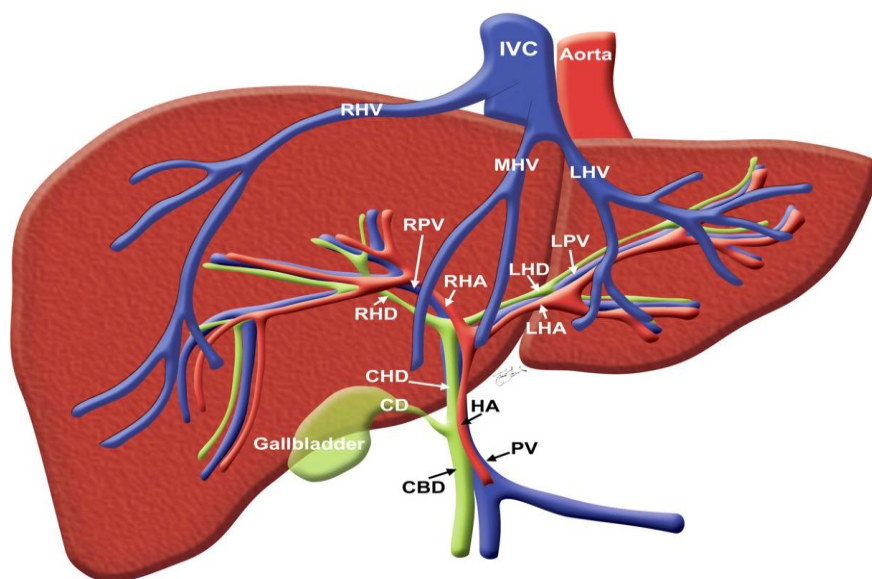


fig 3 :diagram showing the intrahepatic portal circulation (sahani et al ., 2002).

The right portal divides into anterior and posterior branches supplying the right hepatic lobe while the left portal vein divides into ascending and descending branches supplying the left lobe (*Gallego et al., 2002*).

Arterial Supply of The Liver:

The hepatic artery, one of the three branches of the coeliac trunk, supplies the right gastric, gastro duodenal arteries before approaching the liver in the free edge of the lesser omentum, anterior to the portal vein and medial to the bile duct. It divides into right and left hepatic arteries before entering the liver at the porta hepatis. The right hepatic artery usually supplies the cystic artery to the gall bladder. Within the liver, the left hepatic artery supplies the anatomical left lobe, the

quadrate lobe and most of the caudate lobe and the right artery supplies the remainder of the right lobe and a variable small amount of the caudate lobe (*Ryan &McNicholas, 1994*).

Venous Drainage of The Liver:

Blood perfuses the liver parenchyma through the sinusoids and then enters the terminal hepatic venules. These terminal branches unite to form sequentially larger veins. The hepatic veins vary in number and position. In the general population, there are three major veins: the right, middle and left hepatic veins. All drain into the inferior vena cava and like the portal veins without valves. The right hepatic vein is usually single and runs in the right inter-segmental fissure. The middle hepatic vein courses in the main lobar fissure, and forms a common trunk with the left hepatic vein in 65-85 % of cases. The right, middle and left hepatic veins enter the retro hepatic inferior vena cava just before it traverses the diaphragm, approximately 2 cm caudal to the right atrium. Although the liver has a dual blood supply, the hepatic veins provide the sole route for blood exiting the liver (*Ryan &McNicholas, 1994*).

Lymphatic Supply:

There are few or no lymphatic vessels going to the liver, but there is a rich lymphatic drainage from the liver. Minor lymphatic drainage is along the falciform ligament to the para-