Role of Laparoscopy in Management of Hepatic Focal Lesions

Thesis

Submitted for partial fulfillment of
M.D. Degree in

General Surgery
By

Ahmed Mohamed Maarouf
M.B.B.Ch, M.Sc

Under supervision of

Prof. Dr. Adel Ahmed Hosny
Professor of General Surgery
Faculty of Medicine, Cairo University

Prof. Dr. Emad Esmat Nour El Din Esmat
Professor of General Surgery
Theodor Bilharz Research Institute

Prof. Dr. Mostafa Abdel-Rahman Elshazli
Professor of General Surgery
Faculty of Medicine, Cairo University

Prof. Mustapha Adham
Dept of HepatoBiliary and Pancreatic Surgery, Liver Transplantation
Edouard Herriot Hospital - HCL, Claude Bernard Lyon I University

Faculty of Medicine
Cairo University
2010

ABSTRACT

Staging laparoscopy has been proposed for liver malignancies to identify missed hepatic or extrahepatic lesions, in order to decrease the incidence of non-therapeutic laparotomy and guide the appropriate treatment. The application of laparoscopic approach has not been fully developed for liver surgery due to the presumed technical difficulties and concern about its feasibility. The aim of this study was to report our experience of laparoscopy ± laparoscopic intraoperative ultrasonography (IOUS) in the management of liver tumours.

From 02/2000 to 11/2006, 18 males and 34 females of a mean age of 50.4±14.3 years (range 20-76) underwent laparoscopic exploration for hepatic focal lesions. Preoperative exploration (US n=52, CT-scan n=46 and MRI n=44, Sonovue US n=6, PET n=4, Octreoscan n=1) detected 107 lesions (diameter from 5 to 140 mm), 39 unilobar and 13 bilobar. A matched group of open resection was studied for comparison as an indirect way to test the necessity for preoperative laparoscopic exploration: 25 males and 12 females of a mean age of 63 ± 13 years (range 27-79) in the period from 05/2005 to 12/2007.

Laparoscopic exploration discovered 10 new lesions in 7 patients (13.4%): 7 by direct exploration and 3 with IOUS. Laparoscopic hepatic resection was performed in 43 cases (82.6%): 2 left hepatectomies, 9 left lateral segmentectomies, 6 segmentectomies and 26 non-anatomical resections. Six had laparoscopic liver biopsies. Three patients had local ablation (2 RFA, 1 cryotherapy). Four had conversion: 2 for haemorrhage, 1 for splenic injury and 1 for technical difficulty. Median surgical time was 1h57. One cardiac patient died from heart falure in early post-operative period, another developed biliary fistula treated by radiological stent, and 3 patients had medical complications. Mean hospital stay was 6±2.8 days (range 2-14). Recurrence occurred in 6 cases: 4 HCC, 1 metastasis and 1 adenoma (3 of them following ablation). Results of the open group as well as the laparoscopic one proved the high accuracy of preoperative imaging. In this study, laparoscopic exploration did not modify the planned treatment but helped optimize the surgical procedure. Besides, laparoscopic hepatic surgery was safe and feasible in well selected patients.

Keywords

Hepatic – resection – laparoscopy – intraoperative ultrasonography - staging – liver – tumour – lesion – feasibility.

ACKNOWLEDGEMENT

First of all thanks are due to God then to my parents who have guided me throughout this work.

With the completion of this work I feel it is my duty to express my deeply sincere gratitude and appreciation for the valuable support and encouragement which I received from my Professor Dr. Adel Ahmed Hosny professor of general, hepatobiliary and laparoscopic surgery, Cairo University, my Professor Dr. Emad Esmat Nour El Din Esmat professor of general, hepatobiliary and laparoscopic surgery, Theodore Bilharz research institute, my Professor Dr. Mostafa Abdel-Rahman Elshazli professor of general, hepatobiliary and laparoscopic surgery, Cairo University, and my Professor Dr. Mustapha Adham professor of hepatobiliopancreatic surgery and liver transplantation, Claude Bernard Lyon I University, France.

Without their help, meticulous supervision continuous support and honest assistance, surely this work would not have appeared in its present form.

LIST OF ABBREVIATIONS

- AFP: Alpha Fetoprotein
- CEA : Carcinoembryonic Antigen
- CEUS: Contrast-enhanced Ultrasonography
- CRLM: Colorectal Liver Metastasis
- CT: Computed Tomography
- FDG: fluorodeoxyglucose
- FNH: Focal Nodular Hyperplasia
- GD-EOB-DTPA: Gadolinium Ethoxybenzyl Diethylenetriaminepentaacetic Acid
- HBV: Hepatitis B Virus
- HCV: Hepatitis C Virus
- HCA: Hepatocellular Adenoma
- HCC: Hepatocellular Carcinoma
- ICG: Indocyanine Green
- IOUS: Intraoperative Ultrasonography
- IV: Intravenous
- IVC: Inferior Vena Cava
- Mn-DPDP: Manganese-Dipyridoxyl Diphosphate
- MRI: Magnetic Resonance Imaging
- PET: Positron Emission Tomography
- RFA: Radiofrequency Ablation
- SL: Staging Laparoscopy
- US: Ultrasonography

CONTENTS PAGE

Introduction	1
Aim of work	2
Rationale of study	3
Surgical Anatomy of the liver	5
Liver imaging	
- Radiological imaging	14
- Nuclear imaging	19
Functional exploration	21
Hepatic Tumours	
- Primary Malignant Tumours	23
- Secondary Malignant Tumours	40
- Benign Liver Tumours	42
Study Protocol	54
Patients and methods	57
Results	69
Discussion	80
Conclusion	96
Summary	98
References	100
Arabic summary	

INTRODUCTION

Laparoscopic exploration with or without intraoperative ultrasonography (IOUS) has been proposed for liver malignancies to identify missed hepatic or extrahepatic lesions, in order to decrease the incidence of non-therapeutic laparotomy.

Certain studies are in favour of the routine use of laparoscopy and IOUS in all patients considered for potentially curative hepatic resection as they identify the majority of patients with occult unresectable disease. (D'Angelica et al., 2002; Thaler et al., 2005; khan and karanjia, 2007)

However, in other studies, this procedure is recommended in selected patients only, and its general use is not indicated. (Weitz et al., 2004; Dede et al., 2007)

Whether to use laparoscopic exploration systematically, in selected cases or trust the findings of preoperative imaging without the need for laparoscopic assessment remains a source of debate.

Another important issue is the use of laparoscopic access to perform the different types of hepatic surgery. Despite the application of laparoscopic approach to a wide range of abdominal surgeries, it has not been fully developed for liver resections. The reasons for this include the presumed technical difficulty and concern about the intraoperative hazards of bleeding and gas embolism. However, technical developments and improved instruments have greatly improved the safety of laparoscopic hepatectomy. The critical determinant for safe laparoscopic hepatectomy is thorough familiarity with the relevant laparoscopic instruments and equipment. (Kaneko, 2005)

Through this retrospective study, the need for laparoscopic exploration in management of liver tumours as regards diagnosis and treatment was assessed and compared to a series of open liver resection.

AIM OF WORK

The aim of this study was to evaluate the role of laparoscopy and intraoperative ultrasound (IOUS) in staging of liver as compared with preoperative imaging. In addition we evaluated the feasibility in management of liver tumours and the effect of newly discovered lesions on the planned procedure. The laparoscopic data were compared to a group of open liver surgery as an indirect way to determine whether laparoscopic staging was mandatory before planned liver resection.

RATIONALE OF STUDY

The detection of a hepatic focal lesion has become a frequent event in medical practice due to the multiplicity of radiological explorations as well as the progress in imaging techniques. The lesion may be incidentally discovered where it may be benign: simple cyst, haemangioma, adenoma, focal nodular hyperplasia (FNH) or focal steatosis. Another mode of diagnosis is by follow up imaging of patients with hepatitis or liver cirrhosis at risk of developing primary tumours, or in patients with extrahepatic malignancy during metastatic work up in search of hepatic metastases.

The actual imaging techniques (ultrasound, ultrasound with I.V. contrast, multiphase Computed Tomography (CT) scan, Magnetic Resonance Imaging (MRI)) provide data, which allows in most cases an aetiological orientation. In practice, radiology has 3 important tasks:

- Provide a preliminary diagnosis,
- Anticipate pathological result
- Guide the surgeon in his plan of management.

Each radiological tool has its own sensitivity and specificity. In a study comparing helical CT and MRI in cases with colorectal metastases as regards sensitivity, specificity and accuracy, it had the following results: 82.5%, 98.8%, & 88.5% respectively for helical CT; and 84.9%, 94.9% & 91.5% respectively for MRI. (Zacherl et al., 2002)

The presence of undetected multiple small sized HCCs and extrahepatic metastases as well as hepatic tumours that nearly disappear on imaging studies following chemotherapy prior to planned resection are difficult situations. These situations pushed surgeons to search for other methods such as staging laparoscopy to reduce the incidence of unnecessary open exploration.

Staging laparoscopy was introduced by some authors to identify missed lesions on preoperative imaging. According to Thaler et al., pre-operative staging laparoscopy with IOUS should be routinely performed to all patients with hepatic colorectal metastases, being able to avoid unnecessary laparotomies in 25% of patients, and influence definitive surgical intervention (Thaler et al., 2005). A non-randomized study by Weitz et al. concluded that the use of diagnostic laparoscopy should be reserved for cases of HCC on top of liver cirrhosis, presence of major vascular invasion or bilobar tumours. (Weitz et al., 2004).

With technical development and progress in surgical skill, laparoscopic liver resection was gradually introduced. The first laparoscopic non-anatomical resection of a FNH was reported by Gagner and colleagues (Gagner et al., 1992), and this was followed by the first report of laparoscopic anatomical liver resection (Azagra et al., 1996). Since this time, improvements in laparoscopic devices have significantly extended the surgeon's ability to perform these procedures safely. However, the laparoscopic access remains controversial as regards the possible hazards including severe haemorrhage that is difficult to control, gas embolism, dissemination of malignant cells at the trocars' sites in case of malignant hepatic lesions. Besides, the indications for laparoscopic hepatectomy rather than open resection of liver tumours are not precise.

SURGICAL ANATOMY OF THE LIVER

Knowledge of normal morphology is basic to an understanding of pathologic processes and the secure practice of hepatobiliary surgery. This chapter is a brief introduction to anatomy of the human liver and its variations.

The normal liver occupies the right upper quadrant and extends from the fifth intercostal space in the midclavicular line to the right costal margin. The lower margin of the liver descends below the costal margin during inspiration. The median liver weight is 1800 g in men and 1400 g in women. (MacSween et al., 2002)

The superior, anterior, and right lateral surfaces of the liver are smooth and convex, fitting against the diaphragm. The posterior surface has indentations from the colon, right kidney, and duodenum on the right lobe and the stomach on the left lobe (Figure 1). (MacSween et al., 2002)

The fibrous capsule on the posterior aspect of the liver reflects onto the diaphragm and posterior abdominal wall and leaves a “bare area” where the liver is in continuity with the retroperitoneum. The liver is supported by the peritoneal reflections that form the coronary ligaments, the right and left triangular ligaments, and the falciform ligament (Figures 1, 4). The lower free edge of the falciform ligament contains the round ligament, which is composed largely of the obliterated umbilical vein. The falciform ligament joins the anterior surface of the liver to the diaphragm. Superiorly, the falciform ligament joins the peritoneal reflections to the left of the vena cava.

The hepatoduodenal ligament connects the liver to the superior part of the duodenum. The free margin of this ligament contains the hepatic artery, portal vein, bile duct, nerves, and lymphatic vessels. These structures connect with the liver in the transverse portal fissure. The caudate lobe of the liver is posterior, and the quadrate lobe anterior, to this fissure. The quadrate lobe is further demarcated on the right by the gallbladder and on the left by the umbilical fissure.

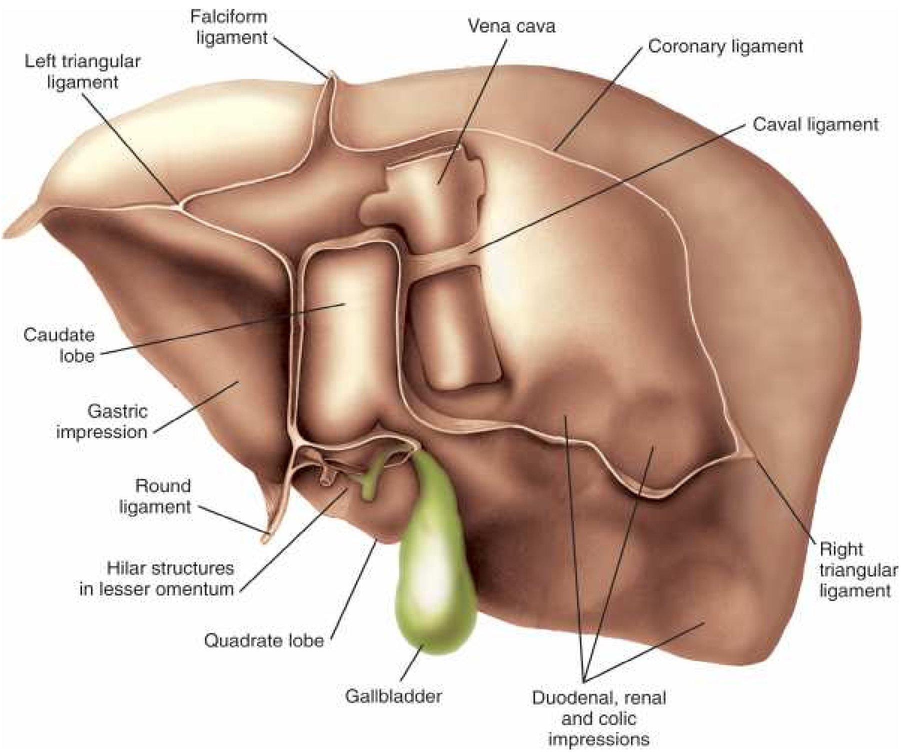

Figure 1: Posterior view of the liver. The shape of the liver is determined by molding against adjacent organs.

Feldman: Sleisenger & Fordtran's gastrointestinal and liver disease, 8th ed.

VARIATIONS IN ANATOMY

An elongation of the right lobe (Riedel's lobe) can be mistaken for hepatomegaly. This anomaly and minor variations in the shape of the liver explain why clinical estimation of liver size correlates poorly with more objective measures.

Deep fissures may demarcate supernumerary lobes. Rarely, the left lobe is attached to the right lobe by a narrow pedicle. Accessory livers may be found in the ligaments or mesentery or on the surface of the gallbladder, spleen, or adrenals.

Atrophy of the left lobe is usually an acquired abnormality resulting from thrombosis of the portal or hepatic veins. Coarse lobulations (hepar lobatum) are a result of obliterative lesions in large and medium-sized vessels, typically after invasion by a neoplasm or in syphilis. (Qizilbash et al., 1987)

LARGE VESSELS OF THE LIVER

A) Portal veins:

The portal vein normally supplies 70% of the blood flow to the hepatic parenchyma. The portal vein receives almost all of the blood flow from the digestive tract between the proximal stomach and upper rectum as well as from the spleen, pancreas, and gallbladder (Fig. 2). The splenic and superior mesenteric veins join behind the pancreas to form the portal vein. The splenic vein sits in a groove of the pancreas and receives the short gastric veins, pancreatic veins, left gastroepiploic vein, and inferior mesenteric vein. The portal vein receives the superior pancreaticoduodenal vein and the left gastric (coronary) vein. The superior mesenteric vein receives the inferior pancreaticoduodenal vein and the right gastroepiploic vein. There is some variation in the veins that drain into the portal system.

The portal trunk bifurcates in the portal fissure. The left branch has a transverse segment that turns caudally to form the umbilical portion, which terminates in the obliterated umbilical vein. The left portal vein supplies the quadrate, caudate, and left lobes of the liver. The right portal vein usually receives the cystic vein.

The periductal venous plexus is a collection of variable veins that arise from the pancreas, duodenum, and stomach. The plexus runs along the common bile duct and drains into the perihilar segments of liver or into large branches of the portal vein. This periductal plexus may explain some examples of focal fatty change and focal fatty sparing because of the variable concentration of insulin delivered to the perihilar parenchyma. (Couinaud 1988, Battaglia et al., 1995)

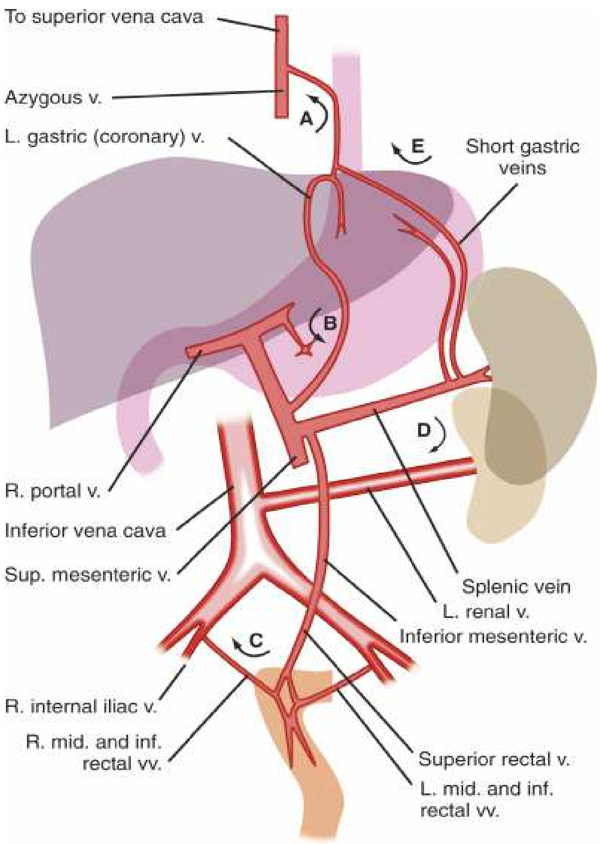

Figure 2: Diagram of the portal circulation. The most important sites for the potential development of portosystemic collaterals are shown. A) Oesophageal submucosal veins, which are supplied by the left gastric vein and drain into the superior vena cava via the azygous vein. B) Paraumbilical veins, which are supplied by the umbilical portion of the left portal vein and drain into abdominal wall veins near the umbilicus. These veins may form caput medusae at the umbilicus. C) Rectal submucosal veins, which are supplied by the inferior mesenteric vein through the superior rectal vein and drain into the internal iliac veins through the middle and inferior rectal veins. D) Splenorenal shunts, which are created spontaneously or surgically. E) Short gastric veins, which are supplied by the esophageal submucosal veins and drain into the splenic vein.

Figure from Lippincott Williams & Wilkins Atlas of Anatomy, 1st Edition. 2008

Anomalies of the Portal Venous System:

Anomalies of the portal venous system are uncommon. A portion of the right liver may be supplied by a branch of the left portal vein. The ductus venosus usually closes shortly after birth. Persistent ductus venosus prevents the normal development of the portal vein, thereby leading to hypoplasia of the intrahepatic branches, nodular hyperplasia of the liver, and hyperammonemia; atrial septal defect has also been associated with this finding. (Wanless et al., 1985)

Atresia or agenesis of the portal vein may be congenital (and often associated with anomalies of the systemic vasculature) or a result of neonatal omphalitis or portal vein thrombosis. Portal vein thrombosis may lead to remodeling of the liver, recognized as nodular hyperplasia or atrophy of the left lobe. Aneurysm of the portal trunk or intrahepatic branches can occur. (Wanless, 2002)

B) Hepatic veins

There are three main hepatic veins. In 80% of persons the middle and left hepatic veins join before entering the vena cava. The major veins divide at acute angles into branches of equal diameter to form an axial tree that receives smaller tributaries at right angles. Anastomoses are commonly found between branches of the hepatic veins.

Several additional veins, including those from the caudate lobe, drain directly into the vena cava. The caudate veins usually remain patent when thrombosis affects the main hepatic veins in Budd-Chiari syndrome, thereby allowing the caudate lobe to undergo compensatory hyperplasia. Webs commonly develop in the hepatic veins and vena cava after thrombosis. Rarely, venous webs are congenital malformations. (Kage et al., 1992)

C) Hepatic arteries:

The common hepatic artery arises from the celiac artery, ascends in front of the portal vein, usually to the left and behind the bile duct, and gives off the left and right hepatic arteries. The gallbladder is supplied by one or two cystic arteries that arise from the right hepatic artery.

Although the left and right hepatic arteries are end-arteries, they often anastomose within the hilar tissues. There are also abundant collateral channels between branches of the celiac axis and branches of the superior mesenteric artery. Anomalies in these large arteries are common. The right hepatic artery may arise from the superior mesenteric artery, and the left hepatic artery may arise from the left gastric artery. (Bengmark and Rosengren, 1970)

Although arterial ligation is usually well tolerated in persons with normal liver function, the cirrhotic liver is highly dependent on arterial flow because of marked loss of portal vein perfusion. Loss of arterial perfusion after liver transplantation is often followed by ischemic stricturing of the bile duct near the hilum, possibly because of ligation of potential collaterals during extirpation of the donor liver. (Hesselink et al., 1987)

SEGMENTAL ANATOMY:

Besides the classical description of liver anatomy, a second description involves the segmental anatomy. This description, initiated by J. Cantlie in 1898, was followed by works of J. Healey and P. Schroy (1953), N. Goldsmith and R. Woodburne (1957), C. Couinaud (1957), and H. Bismuth (1982).

- Classification of Healey and Schroy (1953):

John E. Healey and Paul C. Schroy were the first to divide the liver into functional parts. They suggested a classification based on biliary ducts and hepatic artery branching. They divided the liver into left and right livers and five segments: medial, lateral, posterior, anterior and caudate. They divided the liver by principle plane or Cantlie's line. Cantlie's line goes from the left side of gallbladder fossa to the left side of the inferior vena cava. The left liver is divided into medial and lateral segments by a plane defined by the falciform ligament on the diaphragmatic surface and round ligament on the visceral surface. The right liver consists of anterior and posterior segments, divided by the right fissure. Each segment is further divided into superior and inferior subsegments by a transverse line. Caudate lobe is divided into left and right subsegments by Cantlie's line. The largest part of the caudate lobe is in the medial segment, but the caudate process further continues into the right lobe. Quadrate lobe consists of the inferior part of the medial segment of the left liver.

- Classification of Goldsmith and Woodburne (1957):

N. Goldsmith and R. Woodburne, unlike J. E. Healey and P. C. Schroy (1953), performed studies in vivo and suggested a classification based on portal and hepatic veins. They described right and left lobes and four segments: lateral, medial, anterior and posterior. Each segment consists of two subsegments: superior and inferior. The right and left lobes are divided by a vertical plane, passing from the gallbladder fossa inferiorly to the middle hepatic vein superiorly. This plane is oriented diagonally from the gallbladder fundus anteriorly to inferior vena cava posteriorly. The right lobe consists of anterior and posterior segments and the left lobe – of medial and lateral segments. The caudate lobe derives its arterial blood supply from both the right and left hepatic arteries and its venous blood drains directly into the inferior vena cava. The anterior and posterior segments of right lobe are divided by a vertical plane through the hepatic vein. The medial and lateral segments of left lobe are divided by another vertical plane through a fissure from the round ligament inferiorly and left hepatic vein superiorly. The main hepatic veins run between hepatic segments. The right hepatic vein lies between anterior and posterior segments of the right lobe, the middle hepatic vein lies between the medial and