INTRODUCTION

Laparoscopic liver surgery has evolved rapidly over the past years. The growing experience with these procedures has resulted in a shift in the diagnosis and therapeutic approach to common liver tumors. The fact that resection of benign and malignant hepatic masses can now be accomplished laparoscopically with relatively low morbidity has influenced the decision-making process for physicians involved in the diagnosis and management of these lesions ***(Gugenheim et al., 1996)***.

Hepatocellular carcinoma (HCC) is the third most common cause of cancer-related death worldwide and, owing to changes in the prevalence of the two major risk factors, hepatitis B virus and hepatitis C virus, its overall incidence remains alarmingly high in the developing world and is steadily rising across most of the developed world. Early diagnosis remains the key to effective treatment and there have been recent advances in both the diagnosis and therapy of HCC, which have made important impacts on the disease ***(Poon et al., 1999).***

The mechanism of HCC development differs according to the underlying disease. Infection with HBV can clearly lead to HCC without the intermediate step of cirrhosis, although the majority of patients with HBV-related HCC have cirrhotic disease. Conversely, HCV-related HCC almost always arises in the setting of advanced fibrosis or cirrhosis. A direct hepatocarcinogenic role of HCV has not been clearly proven. Typically, patients who develop HCC in the setting of HBV or HCV have infection that is long-standing (i.e. more than 30 years) ***(Tong et al., 2001)***.

Treatment options for liver cancer vary according to tumor stage. Preoperative portal vein embolization (PVE) and preoperative volumetric determination of the future liver remnant allows safe liver resection ***(Curley and Sielaff, 2006)***.

Ultrasonography is commonly used in programs that screen high risk populations for development of Hepatocellular carcinoma and has been shown to be superior to serum alpha–fetoprotein (AFP) measurement to detect early hepatocellular carcinoma in chronic viral hepatitis. Recently, investigations have been developed for detecting early hepatocellular carcinoma, these include: Doppler U.S and helical C.T which are highly sensitive especially dual and triple phase intravenous contrast. Helical C.T can detect small liver mass less than 2cm ***(Pateron et al., 1994)***.

HCC can be cured by surgery if the tumor is not diffuse and the remaining liver is sufficient to maintain adequate functions. Radiofrequency ablation (RFA) was recently reported to treat (HCC) ranged from 1 to 7cm by laparotomy, laparoscopic and percutaneous techniques ***(Curley and Sielaff, 2006)***.

Over the past twenty years surgeons have developed new surgical procedures and techniques to firstly reduce the unnecessary resection of the liver parenchyma and to decrease intra operative blood loss, one of these techniques is the harmonic scalpel which was designed as a safe alternative to electrocautery for hemostatic dissection of the tissues and was introduced into clinical use nearly a decade ago. This innovative cavitational effects provided by rapidly vibrating blade contacting various tissues. The resulting decrease in temperatures, smoke, and lateral tissue damage placed the harmonic scalpel in contrast to the effects seen with the more traditional electrocautery. In addition the elimination of inadvertent sometimes unrecognized, electrical arcing injuries with their potentially hazardous sequelae supported the role of the harmonic scalpel as a potentially safer instrument for tissue dissection ***(Curley and Sielaff, 2006)*.**

Since the clinical use of radiofrequency ablation (RFA) for human HCC was introduced in 1996 several institutes have reported higher rates of complete necrosis with fewer treatment sessions and lower rates of local recurrence in patients treated with RFA than in those seen in patients treated with percutaneous ethanol injection therapy (PEIT), which was the first and most widely used local ablative therapy. More recently, RFA has become a popular method for treatment of HCC and has been applied as an alternative primary therapeutic modality to hepatectomy in some cases of HCC. The surgical resection is superior to RFA in terms of local recurrence. This may be a result of the safety margin of RFA being narrower than that of surgical resection, as surgeons usually remove the entire segment containing tumors, so the clearance of tumors and any potential sites of microscopic disease will be more complete in these patients. It has been reported that intact nests of viable tumor cells can remain within an otherwise extensively necrotic HCC specimen after RFA ***(Allgaier et al., 2001)***.

Chapter (1)

HISTORICAL BACKGROUND

A discussion of the history of hepatic surgery necessitates a description of the historical consensus on the anatomy of the liver and its significance.

The Egyptians when embalming their kings, considered the liver significant enough to be carefully removed and placed, together with the other internal organs, in a separate container beside the embalmed body. Thus, the liver was considered in antiquity to be the seat of the life force; Plato believed it to be the seat of the 'organic soul' ***(Wolff et al., 2003)***.

In ancient Greece, Zeus punished Prometheus for his sins by chaining him into a rock where every day an eagle comes and fed on his liver where he suffers intolerable pain, thus the liver was under scored as "seat of salvation" ***(Wolff et al., 2003)***.

New anatomical knowledge and illustrations (plates) were first published by the Italian Carpi (1470-1530), the Fleming Vesal (1514-1564), and others. These publications contained accurate descriptions of the liver, and, together with the scientific works of Harvey (1578-1656) and Glisson (1592-1656), in particular, opened up a new view of liver anatomy, which is basically still valid today ***(Wolff et al., 2003).***

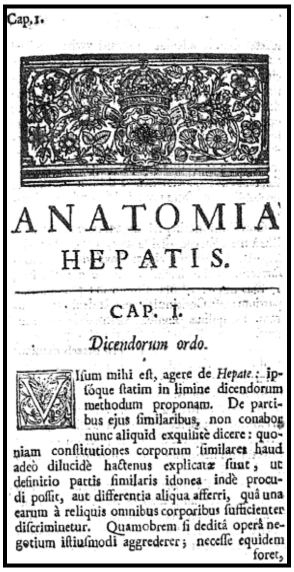
Hepatic surgery in the true sense commenced in the 17th and 18th centuries, as verified by a quotation by MacPerson ***(England, 1688)*** and a report by Berta ***(Italy 1716)*** of the successful removal of prolapsed portions of the liver following abdominal injury ***(Wolff et al., 2003)***.

The first successful intra-abdominal liver resection was undertaken in 1886 by Karl Langenbuch in Germany. Langenbuch, born in Kiel in 1846, studied in Kiel and Berlin, where he became director of the Lazarus Hospital in 1873. He was known to have carried out the first cholecystectomy in 1882, in the case of the partial liver resection, a so-called strangulated lobe was removed ***(Wolff et al., 2003)***.

A detailed case report is also available from Luis of Italy (1886), who removed a pedicled liver tumour the size of a child's head from a 67-year-old man. However, control of the vessel stump did not succeed, and the patient succumbed to haemorrhage 6 hours after the operation. In the USA the first liver resection was carried out by William Williams Keen in 1891 at the Jefferson Medical College in Philadelphia, this was the successful removal of a pedicled cystadenoma of the liver ***(Fronter and Blumgart, 2001)***.

But these successful surgical outcomes should not obscure the fact that great difficulties were encountered in such resections. In particular the danger of exsanguination, and excessive blood loss, were factors limiting the number of liver resections and responsible for the high risk entailed. The search for an effective method of haemostasis began. The suggestion by Pringle in 1908 of reducing bleeding through digital occlusion of the hepatoduodenal ligament in cases of severe liver rupture, thus facilitating management, deserves particular mention ***(Fronter and Blumgart, 2001)***.

Francis Glisson (fig. 1) of Cambridge first described the segmental anatomy of the liver in 1654 but this work remained largely forgotten for nearly 300 yrs. Until a new arrangement of the right and left lobes of the liver and further refined our understanding of lobar anatomy. Probably the most important anatomical contribution to modern liver surgery comes from the work of Claude Couinaud, who in 1957 described his eight segments liver model based on portal venous inflow and hepatic venous outflow. Based on these segments the modern hepatic surgery evolved into various techniques and approaches and permitted more resection potentials for many hepatic tumors that were regarded in the past as unresectable ***(Sielaff and Curley, 2006)***.



Cap. I.

ANATOMIA HEPATIS.

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Fig. (1): Glisson's Anatomia hepatis.

Interest in hepatic surgery began to take hold following the liver transplantations carried out by Starzl in 1963 in Denver, USA ***(Starzl et al., 1992)***.

In the 1960s only single surgical department in Germany carried out intensive work in hepatic surgery and liver transplantation. This was the Surgical Department of the University of Bonn under the direction of Gütgemann who, in 1969, carried out the first liver transplantation in Germany ***(Fronter and Blumgart, 2001)***.

From simple ligatures and transfixing sutures through anatomical resection to vessel ligation, the technique of dividing the parenchyma still depends 'on the skills of the operator', as Anschütz stressed as early as 1903. At that time, preferred methods were thermocauterization and the use of blunt instruments or the fingers, described by Lin in Taiwan in 1958 as 'finger fraction technique', which remain popular to the present day. The technical repertoire has been extended by new techniques such as ultrasound dissection, laser application, and water-jet technology. Management of the resected surface has been expanded by various types of coagulation and fibrin sealant technologies. In the light of all these various advances, it is not entirely surprising that the mortality rate has been reduced from about 15% in the 1960s to 2-3% in the 1990s (***McClusky et al., 1997)***.

As for laparoscopic history, it is difficult to credit one individual with the pioneering of the laparoscopic approach. In

1902, Georg Kelling, of Dresden, Germany, performed the first laparoscopic procedure in dogs and in 1910, Hans Christian Jacobaeus, of Sweden, reported the first laparoscopic operation in humans ***(Westebring et al., 2008).***

In the ensuing several decades, numerous individuals refined and popularized the approach further for laparoscopy. The start of computer chip television camera was a seminal event in the field of laparoscopy. This technological innovation provided the means to project a magnified view of the operative field onto a monitor and, at the same time, freed both the operating surgeon's hands, thereby facilitating performance of complex laparoscopic procedures. Prior to its conception, laparoscopy was a surgical approach with very few applications, mainly for purposes of diagnosis and performance of simple procedures in gynecologic application ***(Westebring et al., 2008).***

The first publication on diagnostic laparoscopy by Raoul Palmer appeared in the early 1950s, followed by the publication of Frangenheim and Semm. Hans Lindermann and Kurt Semm practised CO2 hysteroscopy during the mid-1970s. In 1972, Clarke invented, published, patented, presented, and recorded on film laparoscopic surgery, with instruments marketed by the Ven Instrument Company of Buffalo, New York, USA ***(Clarke, 1972).***

In 1975, Tarasconi, from the Department of Ob-Gyn of the University of Passo Fundo Medical School (Passo Fundo, RS, Brazil), started his experience with organ resection by laparoscopy (Salpingectomy), first reported in the Third AAGL Meeting, Hyatt Regency Atlanta, November 1976 and later published in The Journal of Reproductive Medicine in 1981. This laparoscopic surgical procedure was the first laparoscopic organ resection reported in medical literature ***(Tarasconi et al., 1981).***

In 1981, Semm, from the Universitats Frauenklinik, Kiel, Germany, performed the first laparoscopic appendectomy. Following his lecture on laparoscopic appendectomy, the president of the German Surgical Society wrote to the Board of Directors of the German Gynecological Society suggesting suspension of Semm from medical practice. Subsequently, Semm submitted a paper on laparoscopic appendectomy to the American Journal of Obstetrics and Gynecology, at first rejected as unacceptable for publication on the grounds that the technique reported on was 'unethical,' but finally published in the journal Endoscopy ***(Semm et al., 1983).***

Semm established several standard procedures that were regularly performed, such as ovarian cyst enucleation, myomectomy, treatment of ectopic pregnancy and finally laparoscopic-assisted vaginal hysterectomy (nowadays termed as cervical intra-fascial Semm hysterectomy). He also developed a medical instrument company Wisap in Munich, Germany, which still produces various endoscopic instruments of high quality. In 1985, he constructed the pelvi-trainer (laparo-trainer), a practical surgical model whereby colleagues could practice laparoscopic techniques. Semm published over 1000 papers in various journals ***(Walid et al., 2010).***

He also produced over 30 endoscopic films and more than 20,000 colored slides to teach and inform interested colleagues about his technique. His first atlas, More Details on Pelviscopy and Hysteroscopy was published in 1976, a slide atlas on pelviscopy, hysteroscopy, and fetoscopy in 1979, and his books on gynecological endoscopic surgery in German, English, and many other languages in 1984, 1987, and 2002 ***(Walid et al., 2010).***

Prior to 1990, the only specialty performing laparoscopy on a widespread basis was gynecology, mostly for relatively short, simple procedures such as a diagnostic laparoscopy or tubal ligation. The introduction in 1990 of a laparoscopic clip applier with twenty automatically advancing clips (rather than a single load clip applier that would have to be taken out, reloaded and reintroduced for each clip application) made general surgeons more comfortable with making the lead to laparoscopic cholecystectomies. On the other hand, some surgeons continue to use the single clip appliers as they save as much as $200 per case for the patient, decreasing nothing from the quality of the clip ligation, and add only seconds to case lengths ***(Westebring et al., 2008).***

Laparoscopy has fundamentally changed general and particularly upper gastrointestinal surgery since its inception in the late 1980s ***(Azagra et al., 1996)***.

Gradually this approach has been applied to a wider range of operations and now many complex procedures initially beyond the skill of laparoscopists are being successfully completed ***(Gugenheim et al., 1996)***.

Laparoscopic surgery has enjoyed increasing success since its modest beginning in 1983 and has become the standard of care for cholecystectomy. Evaluation and application of new technologies has allowed for the rapid advancement of laparoscopic surgical techniques ***(Dubois et al., 1991)***.

What remains ill-defined is the application and safety of laparoscopic surgery to complex solid-organ procedures such as liver resection ***(Ferzli et al., 1995)***.

Chapter (2)

ANATOMY OF THE LIVER

The liver is the largest of the abdominal viscera, occupying a substantial portion of the upper abdominal cavity. It performs a wide range of metabolic activities necessary for homeostasis, nutrition and immune defence ***(Elsevier, 2008).***

The liver occupies most of the right hypochondrium and epigastrium, although it frequently extends into the left hypochondrium as far as the left lateral line. In adults the liver weighs 2% of body mass. The liver has an overall wedge shape. The superior and right lateral aspects are shaped by the anterolateral abdominal and chest wall as well as the diaphragm. The inferior aspect is shaped by the adjacent viscera. In life it is reddish brown in colour and although firm and pliant its weight and texture depend in part on the volume of venous blood it contains. The liver capsule plays an important role in maintaining the integrity of its shape. Once the capsule is lacerated, the liver tissue is easily parted and provides only limited support for surgical sutures. These features, in combination with its exceptional vascular supply, make the liver prone to potentially lethal injuries if it is split open ***(Elsevier, 2008).***

The earliest appearance of the liver primordium occurs on day 22 after conception. It appears at the superior intestinal portal, caudal and ventral to the heart. By day 24, the hepatic diverticulum is growing into the transverse septum that, at this stage, contains the vitelline and umbilical veins. Differentiation of the components of the liver (Fig.2) begins before the primordium becomes recognizable ***(Skandalakis et al., 2006).***

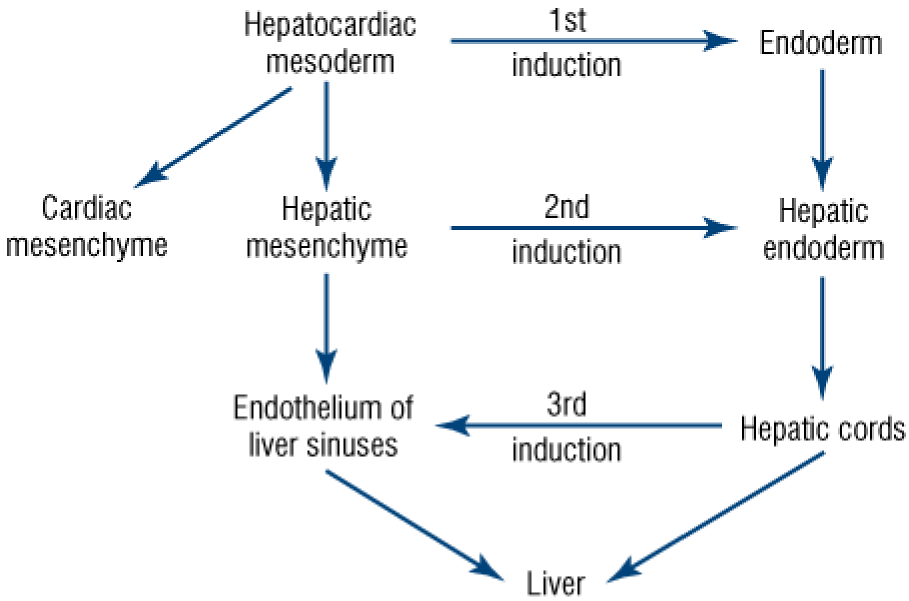

Fig.(2): Differentiation *(vertical arrows)* and induction *(horizontal arrows)* in the development of liver cords and sinuses in the embryo ***(Skandalakis et al., 2006).***

The liver is covered with the capsule of Glisson, which envelops the hepatic artery, portal vein, and bile duct at the hilum of the liver ***(Mirilas et al., 2002).***

Hepatic attachments

The liver is attached to the anterior abdominal wall, diaphragm and other viscera by several ligaments:

Falciform ligament

The liver is attached in front to the anterior abdominal wall by the falciform ligament. The two layers of this ligament descend from the posterior surface of the anterior abdominal wall and diaphragm and turn into the anterior and superior surfaces of the liver. On the dome of the superior surface, the right leaf runs laterally and is continuous with the upper layer of the coronary ligament. The left layer of the falciform ligament turns medially and is continuous with the anterior layer of the left triangular ligament. The ligamentum teres which represents the obliterated left umbilical vein runs in the lower free border of the falciform ligament and continues into the fissure on the inferior surface of the liver ***(Elsevier, 2008).***

Coronary ligament

The coronary ligament is formed by the reflection of the peritoneum from the diaphragm into the posterior surfaces of the right lobe of the liver. Between the two layers of this ligament there is a large triangular area of liver devoid of peritoneal covering called the “bare area” of the liver. The coronary ligament is continuous on the right with the right triangular ligament. On the left, it becomes closely applied, and forms the left triangular ligament. The upper layer of the