INTRODUCTION

Laparoscopic cholecystectomy, one of the most commonly performed surgical procedures worldwide, is accepted as the gold standard in the treatment of symptomatic gallstones for its minimal invasiveness, less pain and early recovery. **(1)**

Although laparoscopic cholecystectomy has generally a low incidence of morbidity and mortality and of conversion rate to open surgery, its outcome is particularly affected by the presence and severity of inflammation, advancing patients' age, male sex and greater body mass index. **(2)**

Sometimes Laparscopic Cholecystectomy becomes difficult. It takes longer time even with bile/stone spillage and occasionally it requires conversion to open cholecystectomy. **(3)**

It may be difficult to anticipate preoperatively whether this procedure is going to be easy or difficult in a particular patient. The degree of difficulties is again impossible to predict but it is important to know for better preparedness for the surgeon and explanation to patients for possibility of conversion to open. **(3)**

Preoperative assessment of complexity factors is needed for frequent procedures such as laparoscopic cholecystectomy in order to avoid complications and delays and to guarantee an efficient course of surgery. **(4)**

Previous upper abdominal surgery is associated with a higher rate of adhesions, an increased risk of operative complications, a greater conversion to open surgery rate, a prolonged operating time and longer hospital stay. Also, Laparoscopic cholecystectomy after endoscopic retrograde cholangiopancreatography (ERCP) with endoscopic sphincterotomy (ES) for combined choledochocystolithiasis is more difficult with prolonged procedure than in uncomplicated gallstone disease with a longer post-operative hospital stay. **(5)**

Preoperative complexity estimation in laparscopic cholecystectomy helps surgeons decide whether to proceed with a minimally invasive approach, perform an open procedure or make a referral to a more experienced surgeon. It may also be useful for explaining the various risks of laparoscopic and open procedures.**(6)**

In this study, we will assess the difficulty of Laparscopic cholecystectomy preoperativly and predict its difficulty according to some factors and items.

Aim of Work

The aim of this study is to predict the difficulty of laparscopic cholecystectomy in patients according to the recently published scoring system and to add more items to it.

Study Hypothesis

Preoperative assessment of patients arranged for laparoscopic cholecystectomy minimizes complications and conversion to open cholecystectomy

Surgical Anatomy of the Biliary Tree

The anatomy of the bile duct follows that of the portal system and segmentation of the liver. A bile duct is part of the portal triad, which enters the liver through invagination of Glisson's capsule at the hilum. According to the vascular anatomy, the right and left hemiliver are drained by a right and a left hepatic duct, respectively. Segment 1 is drained by several ducts joining both the right and left ducts close to the biliary confluence at the hilum *(7)*.

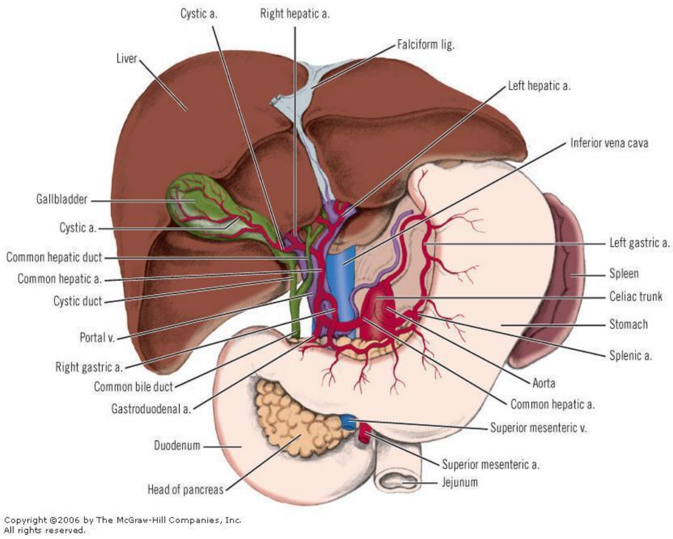

Figure (1): illustrated graph for the gallbladder in relation to the surrounding viscera

Gallbladder

The gallbladder is a flask-shaped, blind-ending diverticulum attached to the common bile duct by the cystic duct. In life, it is grey-blue in color and usually lies attached to the inferior surface of the right lobe of the liver by connective tissue. In the adult the gallbladder is between 7 and 10 cm long with a capacity of up to 50 ml. **(8)**

It usually lies in a shallow fossa in the liver parenchyma covered by peritoneum continued from the liver surface. This attachment can vary widely. At one extreme the gallbladder may be almost completely buried within the liver surface, having no peritoneal covering (intraparenchymal pattern); at the other extreme it may hang from a short mesentery formed by the two layers of peritoneum separated only by connective tissue and a few small vessels (mesenteric pattern). The gallbladder is described as having a fundus, body and neck. **(9)** The neck lies at the medial end close to the porta hepatis, and almost always has a short peritoneal covered attachment to the liver (mesentery); this mesentery usually contains the cystic artery. The mucosa at the medial end of the neck is obliquely ridged, forming a spiral groove continuous with the spiral valve of the cystic duct. At its lateral end the neck widens out to form the body of the gallbladder and this widening is often referred to in clinical practice as

'Hartmann's pouch'. The neck lies anterior to the second part of the duodenum. **(9)**

The gallbladder varies in size and shape. The fundus may be elongated and highly mobile. Rarely the fundus of the gallbladder is folded back upon the body of the gallbladder, the so-called Phrygian cap (Fig. 2). Rarely, the gallbladder may be bifid or completely duplicated, usually with a duplicated cystic duct. **(9)**

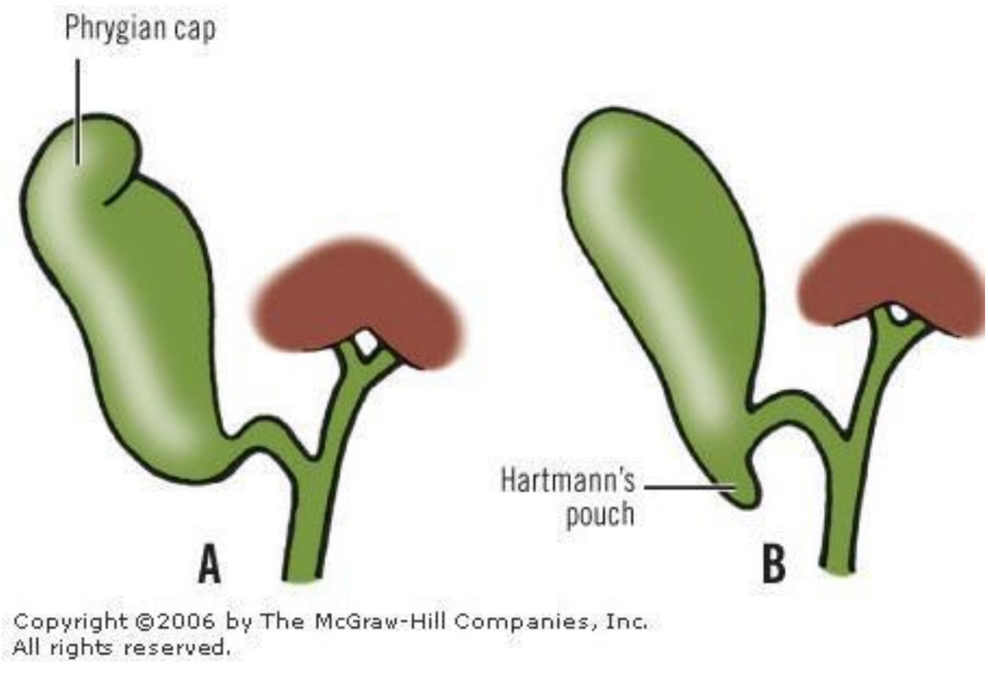

Figure (2): Deformations of gallbladder. A, "Phrygian cap" deformity, showing partial folding of tip of fundus. B, Hartmann's pouch of infundibulum (10)

Extra-hepatic Biliary tree

i. Cystic duct

The cystic duct drains the gallbladder into the common bile duct. It is between 3 and 4 cm long, passes posteriorly to the left from the neck of the gallbladder, and joins the common hepatic duct to form the common bile duct. It almost always runs parallel to, and is adherent to, the common hepatic duct for a short distance before joining it. The junction usually occurs near the porta hepatis but may be lower down in the free edge of the lesser omentum. The cystic duct may have several important variations in its insertion to the common hepatic duct (Fig. 3). The cystic duct occasionally drains into the right hepatic duct in which case it may be elongated, lying anterior or posterior to the common hepatic duct, and joins the right hepatic duct on its left border. Division of the cystic duct must be performed at an adequate distance from the common bile duct to prevent angulation or damage to it. **(8)**

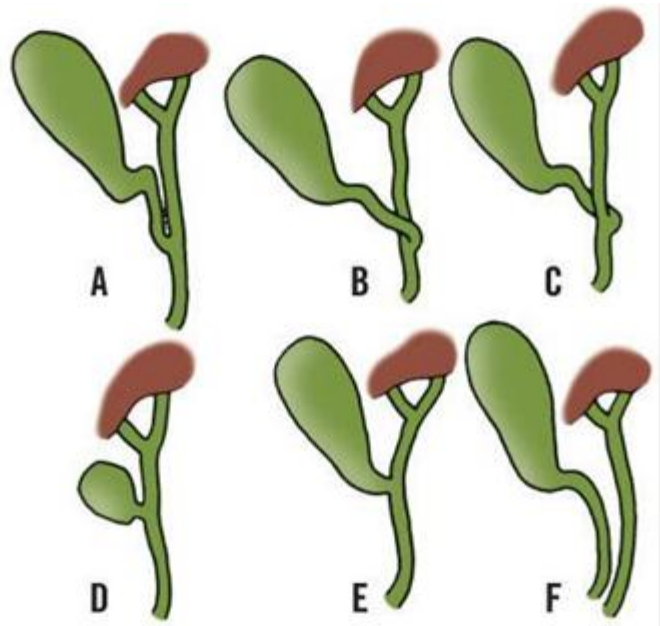

Figure (3): Variations of cystic duct: A, Cystic duct parallels common bile duct before entering it. B-C, Cystic duct crosses common bile duct and enters it on left. D-E, Short cystic duct. F, Long cystic duct enters duodenum. This can also be called absence of common bile duct (separate entrance of common hepatic duct and cystic duct into duodenum) (10)

ii. Hepatic ducts

The main right and left hepatic ducts emerge from the liver and unite near the right end of the porta hepatis as the common hepatic duct. This descends about 3 cm before being joined on its right at an acute angle by the cystic duct to form the common bile duct. The common hepatic duct lies to the right of the hepatic artery and anterior to the portal vein in the free edge of the lesser omentum. **(14)**

iii. Common Bile Duct

The common bile duct is formed near the porta hepatis, by the junction of the cystic and common hepatic ducts. It is usually between 6 and 8 cm long. Its diameter tends to increase somewhat with age but is usually around 6 mm in adults. It descends posteriorly and slightly to the left, anterior to the epiploic foramen, in the right border of the lesser omentum. It lies anterior and to the right of the portal vein and to the right of the hepatic artery. **(11)**

It passes behind the first part of the duodenum with the gastroduodenal artery on its left, and then runs in a groove on the superolateral part of the posterior surface of the head of the pancreas. It lies anterior to the inferior vena cava and is sometimes embedded in the pancreatic tissue. The duct may lie close to the medial wall of the second part of the duodenum or as much as 2 cm from it. Even when it is embedded in the pancreas, a groove in the gland marking its position can be palpated behind the second part of the duodenum. **(11)**

<u>Calot's Triangle:</u>

The near triangular space formed between the cystic duct, the common hepatic duct and the inferior surface of segment V of the liver, is commonly referred to as Calot's triangle. It is enclosed by the double layer of peritoneum which forms the short mesentery of the cystic duct. The base of the triangle thus lies on the inferior surface of the liver. This space usually contains the cystic artery as it approaches the gallbladder, the cystic lymph node and lymphatics from the gallbladder, one or two small cystic veins, the autonomic nerves running to the gallbladder and some loose adipose tissue. It may contain any accessory ducts which drain into the gallbladder from the liver. **(12)**

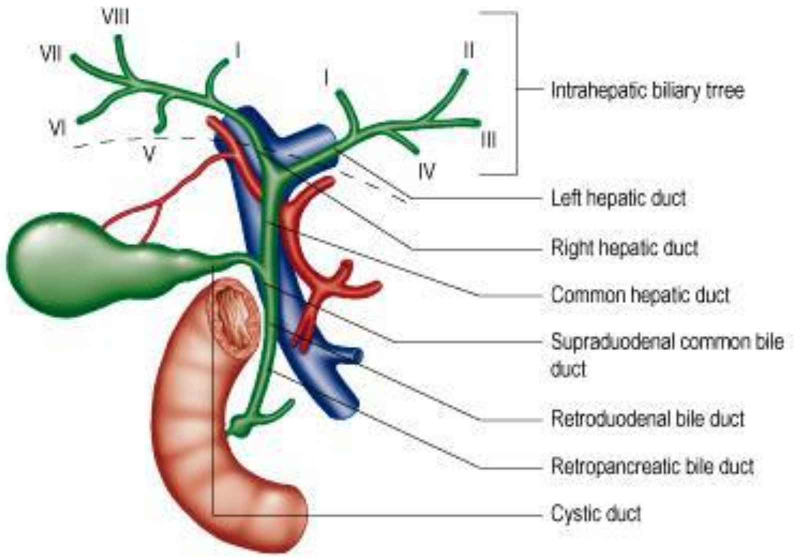

Figure (4): illustrated graph for the gallbladder and the extrahepatic biliary tree (12)

Blood supply, Lymphatics of the Gallbladder:

Cystic artery

The cystic artery usually arises from the right hepatic artery. It usually passes posterior to the common hepatic duct and anterior to the cystic duct to reach the superior aspect of the neck of the gallbladder. It divides into superficial and deep branches.

The cystic artery may have many anatomical variations illustrated in (figure 5). Multiple fine arterial branches may arise from the parenchyma of segments IV or V of the liver and contribute to the supply of the body, particularly when the gallbladder is substantially intrahepatic. **(12)**

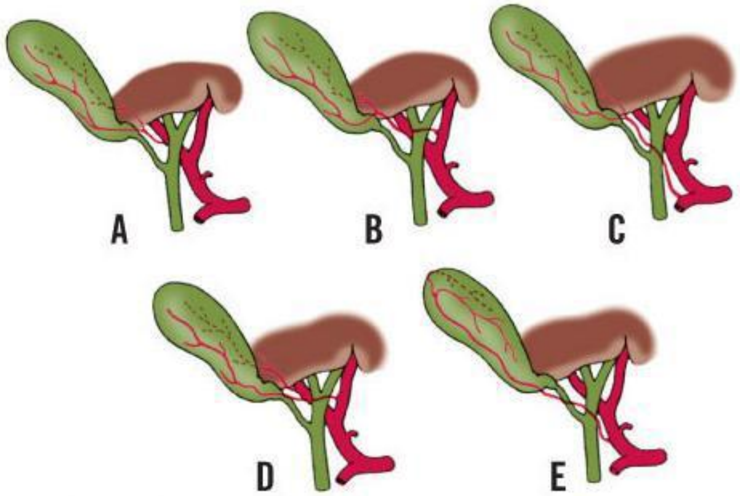

Figure (5): Variations of origin and course of cystic artery: A, Cystic artery arises from right hepatic artery (74.7%). B, Cystic artery arises from left hepatic artery and passes anterior to common hepatic duct (6.5%). C, Cystic artery arises from gastroduodenal artery (2.5%). D-E, Recurrent cystic arteries reach fundus of gallbladder and descend toward neck (rare). In the remainder (approximately 2.3%, not shown), cystic artery arises from a variety of other arteries (12)

Ductal arteries

The common bile duct and hepatic ducts are supplied by a fine network of vessels; anterior to the common bile duct, two to four ascending vessels arise from the retroduodenal branch of the gastroduodenal artery as it crosses the anterior surface of the duct at the upper border of the duodenum. Three or four descending branches of the right hepatic and cystic arteries arise as these vessels pass close to the lower common hepatic duct. These ascending and descending arteries form long narrow anastomotic channels along the length of the duct, which are approximately disposed into medial and lateral 'trunks' although they may lie more anterolateral and posteromedial. **(13)**

Cystic veins

The venous drainage of the gallbladder is rarely by a single cystic vein. There are usually multiple small veins. Those arising from the superior surface of the body and neck lie in areolar tissue between the gallbladder and liver and enter the liver parenchyma to drain into the segmental portal veins. The remainder form one or two small cystic veins, which enter the liver either directly or after joining the veins draining the hepatic ducts and upper bile duct. Only rarely does a single or double cystic vein drain into the right portal branch. **(13)**

Lymphatics

Numerous lymphatic vessels run from the submucosal and subserosal plexuses on all aspects of the gallbladder and cystic duct. Those on the hepatic aspect of the gallbladder connect with the intrahepatic lymph vessels. The remainder drain into the cystic node, which usually lies above the cystic duct in the tissue of Calot's triangle. **(13)**

Laparoscopic anatomy

The advent and popularity of LC has led to a new look and insights into biliary anatomy especially of the Calot's triangle area and the term ‘laparoscopic anatomy’ has actually found a place even in anatomy texts. Although a detailed discussion of all the factors peculiar to laparoscopy that contribute to an increased incidence of injuries is beyond the purview of this review, the different anatomical ‘laparoscopic view’ of the area around the gallbladder especially the Calot's triangle does contribute to misidentification of structures. The method of retraction during the laparoscopic procedure tends to distort the Calot's triangle by actually flattening it rather than opening it out. Also, the reluctance to (or difficulty in) performing a fundus first cholecystectomy during the laparoscopic procedure as opposed to the open procedure also contributes to the same lack of exposure of the Calot's triangle. Finally, the ‘posterior’ or ‘reverse’ dissection of the Calot's triangle, which is popular during an LC, again gives a different view of the area and since the gallbladder is flipped over during this method may lead to further anatomical distortion. The Rouviere's sulcus is a fissure on the liver between the right lobe and caudate process and is clearly seen during a LC during the posterior dissection in a majority of patients. It corresponds to the level of the porta hepatis where the right pedicle enters the liver. It has hence been recommended that all dissection be kept to a level above (or anterior) to this sulcus to avoid injury to the bile duct. Also, this being an ‘extrabiliary’ reference point it does not get affected by distortion due to pathology. Similarly, a clear delineation of the junction of the cystic duct with the gallbladder along with the demonstration of a space between the gallbladder and the liver clear of any other structure other than the cystic artery (safety window or critical view) is also recommended as an essential step to prevent bile duct injury. **(14)**

<u>Anomalies of the hepatic artery:</u>

Anomalies of the hepatic and cystic arteries are present in about 50% of cases. A large accessory left hepatic artery originating from the left gastric artery occurs in about 5% of patients. In 10 to 20% of cases the right hepatic artery originates from the superior mesenteric artery, and in about 5% of cases there are two hepatic arteries, one originating from the common hepatic artery and the other from the superior mesenteric artery. In 3 to 6% of cases the left hepatic artery derives its origin from the left gastric, splenic or superior mesenteric artery or the aorta. **(15)**

A "caterpillar hump" right hepatic artery in front of, or behind the common hepatic duct or common bile duct, and may be mistaken for the cystic artery and therefore ligated. Because the cystic artery that arises from "caterpillar hump" is short, it is easily avulsed from parent trunk. With the right hepatic artery lying anterior to the common bile duct or common hepatic duct, or with the cystic artery coursing anterior to these structures, there is risk of injury to either the common hepatic or common bile duct when the cystic artery is being ligated. An accessory cystic artery may be torn if it is not identified. **(15)**

Anomalies of the gall bladder

The gall bladder anomalies are rare and they may be septated, double, triple, multiseptate or bilobed **(Figure 6).** The exact anomaly depends on sites of disturbance of embryological development. Cystic ducts from double gall bladder may enter the same or different regions of the bile ducts or may form a common cystic duct before entry. The former arrangement is more likely to be encountered. Various associated vascular anomalies may be found**. (16)**

An intrahepatic gallbladder is submerged in the liver and gives the appearance of absence of the gallbladder. Computed Tomography scan or ultrasonography may provide its only evidence. A high percentage of occurrence of lithiasis is associated with this anomaly. At the opposite extreme from intrahepatic gallbladder is the occasional mobile gallbladder, attached to the liver by a mesentery. Such a gallbladder is susceptible to torsion and strangulation. Otherwise, it causes no symptoms. **(16)**