Introduction

Laparoscopic cholecystectomy (LC) is the gold standard for the surgical treatment of symptomatic gallstones. The advantages of this surgical approach have included a positive impact on the postoperative quality of the patient's life as well as optimal short and long term results ***(Maksymliuk, 2014).***

The chief cause for the increased rate of conversion of open surgery has been non visualization of the anatomy at Calot's triangle due to dense adhesions ***(Kato et al., 1996)***.

The most serious complication associated with cholecystectomy is accidental injury to common bile duct (CBD) (0.3-0.4%) ***(Sváb et al., 2005).*** The risk of bile duct injury during open cholecystectomy ranges from 0.1–0.2%. To begin with, laparoscopic cholecystectomy was associated with greater than 2% risk of injury to the biliary tract, but nowadays it has dropped to less than 0.5%, demonstrating that as the experience increases, the risk of injury drops ***(Pleas and Garden, 1998).*** Although a number of factors have been identified as high risk and a number of technical steps have been emphasized to avoid these injuries, the incidence of CBD injury has reached at least double the rate observed with open cholecystectomy.

Preventable technical errors have traditionally been thought to occur in one or more of the three situations:

Firstly, when the operator attempts to clip or ligate a bleeding cystic artery. Secondly, when too much traction has been exerted on gall bladder (GB), so that CBD has tented up into an elbow which was either tied off with ligature or clipped. Thirdly, when anatomic anomalies were not recognized and the wrong structure is divided ***(Barham, 2011).***

The use of the safest surgical technique (not the fastest) available, such as the critical view technique of Strasberg ***(Strasberg et al., 2000)*** with the circumferential dissection of GB at the infundibulum to mimic fundus first cholecystectomy technique of the open era and not clipping or cutting any structure before unequivocal identification of the structure are mandatory components of the safe LC ***(Richard, 2008).***

The cause of the injury is not always clearly identifiable. In more than half of the cases, the injury occurs during maneuvers to isolate the cystic duct or to free GB from CBD. These maneuvers may be more difficult and consequently more dangerous when there is significant inflammation as may be seen in acute cholecystits or in case of obesity, cirrhosis with portal hypertension, previous surgery with peritoneal adhesions or anatomic variations of the hepatic pedicle. This study will be presented to investigate the place of (FFLC) showing the advantages and disadvantages and comparing it with conventional laparoscopic cholecystectomy (CLC) via many different parameters, especially biliary tract injury (***Uyama et al., 1995).***

Aim of the Work

The aim of this study is to assess the feasibility, safety, and outcome of the fundus first laparoscopic cholecystectomy compared with the conventional laparoscopic cholecystectomy for treatment of calcular cholecystitis.

Anatomy of the Biliary Tree and the Gall Bladder

Embryology of the Biliary Tract

The biliary tree and liver develop from a diverticulum of the embryonic foregut at approximately 18 days of gestation. Between the fourth and fifth weeks, the diverticulum consists of a solid cranial portion and a hollow caudal portion. The solid cranial portion differentiates into the liver with the development of hepatocytes and intrahepatic bile ducts, while the hollow caudal portion gives rise to the gallbladder, the extrahepatic bile ducts, and the ventral pancreas ***(Schulick, 2011). (fig1)***

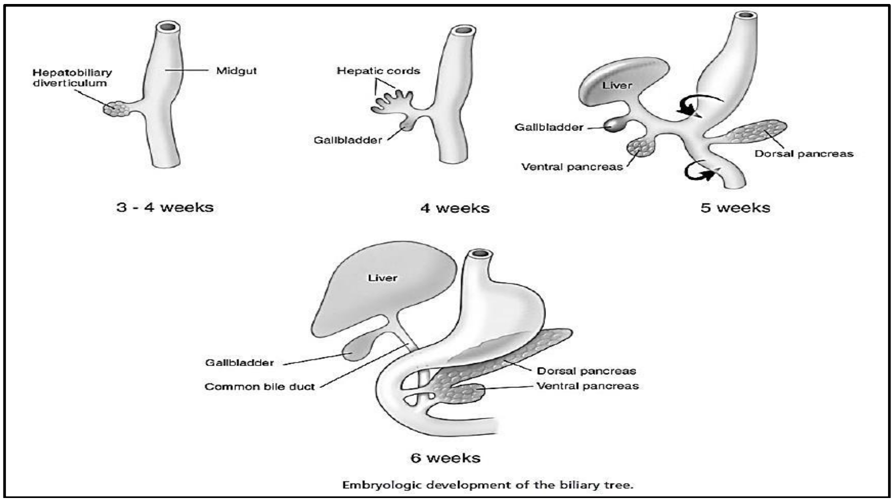

Figure (1): Embryologic development of biliary tree ***(Skandalakis et al., 2004)***

Topographic Anatomy of the Biliary Tree and the Gall Bladder

Gall bladder:

The gallbladder is a reservoir for bile located on the under surface of the liver at the confluence of the right and left halves of the liver. It is separated from the hepatic parenchyma by a cystic plate, which is constituted of connective tissue applied to the Glisson capsule. The gallbladder may be deeply imbedded into the liver or occasionally presents on a mesenteric attachment, but usually lays in a gallbladder fossa. The gallbladder varies in size and consists of a fundus, a body, and an infundibulum. The tip of the fundus usually reaches the free edge of the liver and is closely applied to the cystic plate. The infundibulum of the gallbladder makes an angle with the body and may obscure the common hepatic duct, constituting a danger point during cholecystectomy ***(Schulick, 2011).***

Cystic duct and artery & Calot's triangle:

The cystic duct arises from the infundibulum of the gallbladder and extends to join the common hepatic duct. The lumen measures between 1 and 3 mm in diameter, and its length varies depending on the type of union with the common hepatic duct (Fig. 2). Arterial blood reaches the gallbladder via the cystic artery, which usually originates from the right hepatic artery. Several known variations in the origin and course of the cystic artery are illustrated in (Fig. 3). The venous drainage of the gallbladder is directly into the liver parenchyma or into the common bile duct plexus ***(Schulick, 2011) (figs 2,3).***

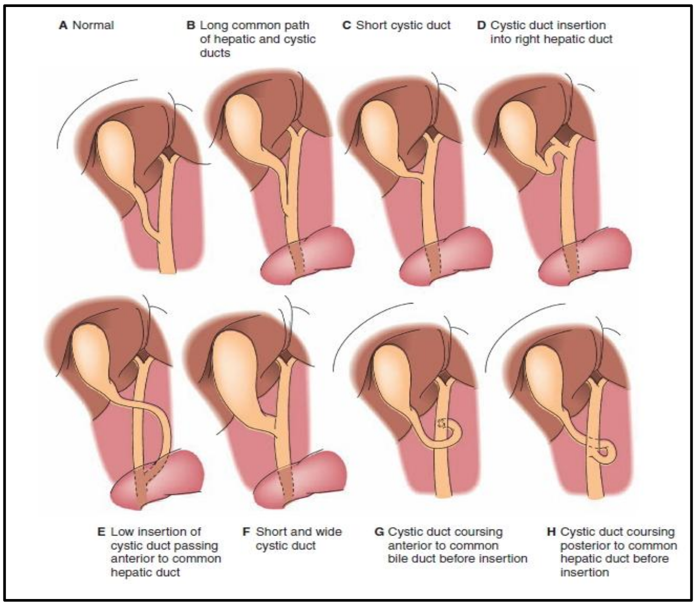

Figure (2): Variations in the junction of the cystic duct and common hepatic duct ***(Schulick, 2011)***

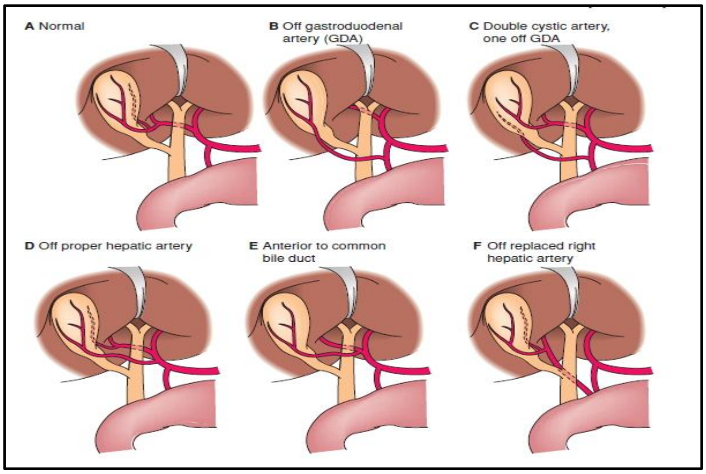

Figure (3): Variations of cystic artery ***(Schulick, 2011).***

Common bile duct:

The cystic and common hepatic ducts join to form the common bile duct. The common bile duct is approximately 8 to 10 cm in length and 0.4 to 0.8 cm in diameter. The common bile duct can be divided into three anatomic segments: supraduodenal, retroduodenal, and intrapancreatic (Fig 4). The supraduodenal segment resides in the hepatoduodenal ligament lateral to the hepatic artery and anterior to the portal vein (Fig. 5). The course of the retroduodenal segment is posterior to the first portion of the duodenum, anteriorto the inferior vena cava, and lateral to the portal vein. The pancreatic portion of the duct lies within a tunnel or groove on the posterior aspect of the pancreas. The common bile duct then enters the medial wall of the duodenum, courses tangentially through the submucosal layer for 1 to 2 cm, and terminates in the major papilla in the second portion of the duodenum (Fig. 4). The distal portion of the duct is encircled by smooth muscle that forms the sphincter of Oddi.

The common bile duct usually joins the pancreatic duct to form a common channel before entering the duodenum at the ampulla of Vater. Some patients will have an accessory pancreatic duct emptying into the duodenum. The blood supply of the common bile duct is segmental in nature and consists of branches from the cystic, hepatic, and gastroduodenal arteries. These meet to form collateral vessels that run in the 3 and 9 o'clock positions. The venous drainage forms a plexus on the anterior surface of the common bile ***(Schulick, 2011) (figs 4,5).***

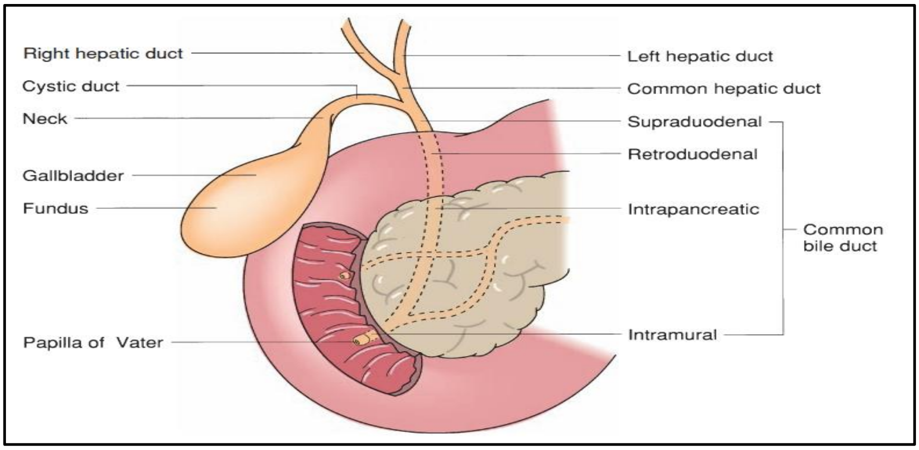

Figure (4): Anatomy of the extrahepatic biliary tree and pancreatic duct ***(Schulick, 2011)***

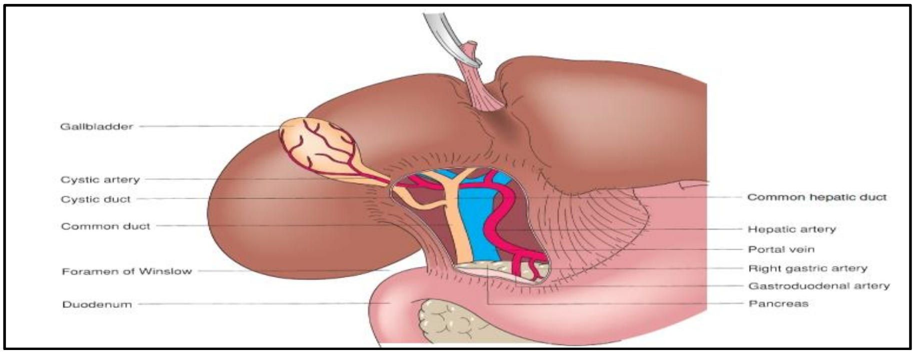

Figure (5): Relationship of structures within the hepatoduodenal ligament ***(Schulick, 2011)***

Sphincter of oddi:

The lower 2.5-3.0 cm of CBD, the distal part of the pancreatic duct, the ampulla of Vater and the duodenal papilla are surrounded by a condensation of circular and longitudinal smooth muscle fibers referred to as sphincter of Oddi, as it was first noted by Oddi in 1888, but it was expanded upon by Boyden s anatomic descriptions in 1936 ***(Cuschieri et al., 2002).*** This sphincteric complex consists of inferior, middle and superior sphincters. The inferior sphincter is the strongest component and is also known as the papillary muscular ball, it surrounds the terminations of the bile and pancreatic ducts and the common channel. The middle sphincter is the longest and thinnest of the components and surrounds the trans-duodenal and a variable portion of the trans-pancreatic segments of the bile duct and the pancreatic duct. The superior sphincters consist of localized thickenings of the middle sphincters around the bile and pancreatic ducts at the proximal end of the sphincter complex ***(Cuschieri et al., 2002).***

Calot's triangle:

It is a cysto-hepatic triangle bounded by the hepatic duct medially, the cystic duct and neck of the gall bladder inferiorly and the inferior surface of the liver superiorly. In this triangle runs the cystic artery, often the right hepatic artery, rarely a bile duct and also contains the cystic lymph node. Hence this triangle has a greatly important area of dissection during cholecystectomy. The apex of the triangle is the most critical area (cysto-hepatic angle) as the cystic artery passes (***Savage and Britton, 2000).***

Nerve supply of the Biliary Tract

Parasympathetic fibres, mainly from the hepatic branch of the anterior vagal trunk, stimulate contraction of the gall bladder and relax the ampullary sphincter. Sympathetic fibres from the coeliac ganglia, which inhibit contraction. Afferent fibres including those subserving pain from the gall bladder may: run with right sided sympathetic fibre and reach spinal cord segments (T7-9) and this explains radiation of the pain to the back in the infrascapular region or run into the right phrenic nerve (C3-5) and this explains the occasional referral of pain to the right shoulder region ***(McMinn, 1994) (fig 6).***

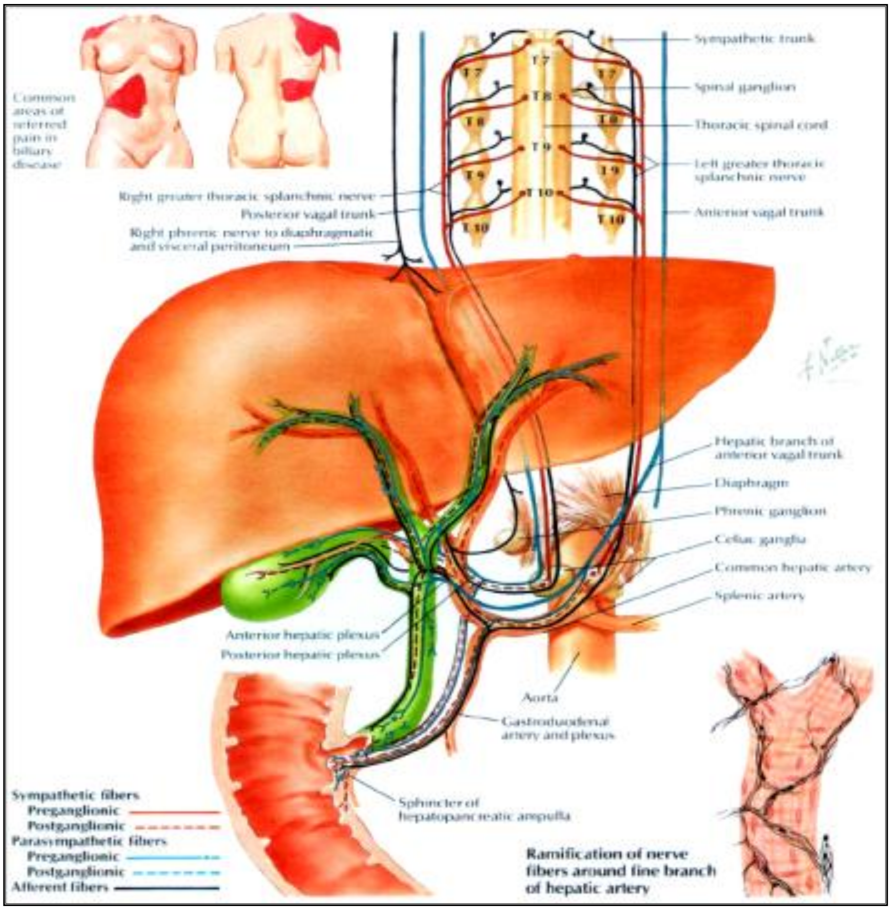

Figure (6): Nerve supply of biliary system ***(McMinn, 1994).***

Arterial Blood Supply of the Biliary System

The extra hepatic bile ducts may receive their arterial blood supply from several different major arteries. ***Northover and Terblanche*** in 1979, conducted resin cast study in human cadavers in which they described two major axial vessels that ran along the lateral borders of the supra duodenal CBD. They named these the 3 o'clock and 9 o'clock arteries. They reported an average of 8 small arteries with a diameter of 0.3 mm supplying the supraduodenal CBD. These arteries arise from below (posterior or anterior superior Pancreatico duodenal artery, gastroduodenal artery, retroportal artery) and above (right hepatic artery, cystic artery, left hepatic artery). In rare cases, there is non axial supply from the common hepatic artery.

The hilar ducts receive numerous arterial branches from the right and left hepatic arteries. These form a rich network around the ducts and are in continuity with the plexus around the CBD. In some cases the 3 o'clock and 9 o'clock arteries may supply the hilar ducts; the retropancreatic portion of the CBD is usually supplied by multiple small branches from the posterior superior pancreatic duodenal artery. The various contributing arteries form an arterial plexus within the wall of the bile duct before giving rise to a capillary plexus. In this study by Northover and Terblanche in 1979, no end-arteries to the CBD were noted ***(Northover and Terblanche, 1979).***

Venous Drainage of the Biliary System

A fine venous plexus that drains into marginal veins surrounds the surfaces of the extra-hepatic and intra-hepatic bile ducts, the marginal veins run in the 3 o'clock and 9 o'clock positions similar to the arterial vessels. Inferiorly, the marginal veins drain into the pancreatico-duodenal venous plexus. Superiorly, the marginal veins have been shown to enter the hepatic substance or join the hilar venous plexus, which eventually drains into branches of the portal vein, the intra-hepatic bile duct venous plexus drains into the adjacent portal vein. The veins of the gallbladder do not follow arterial branches and have direct drainage into the liver ***(Vellar, 2001).***

Anatomical Variations of the Biliary Tract

The anatomy of the biliary tree is highly variable. A thorough knowledge of this variable anatomy is important because failure to recognize the frequent anatomic variations may result in significant ductal injury. Anomalies of the extrahepatic biliary tree may involve the hepatic ducts, CBD, GB or CD as shown in **(Fig. 7).**

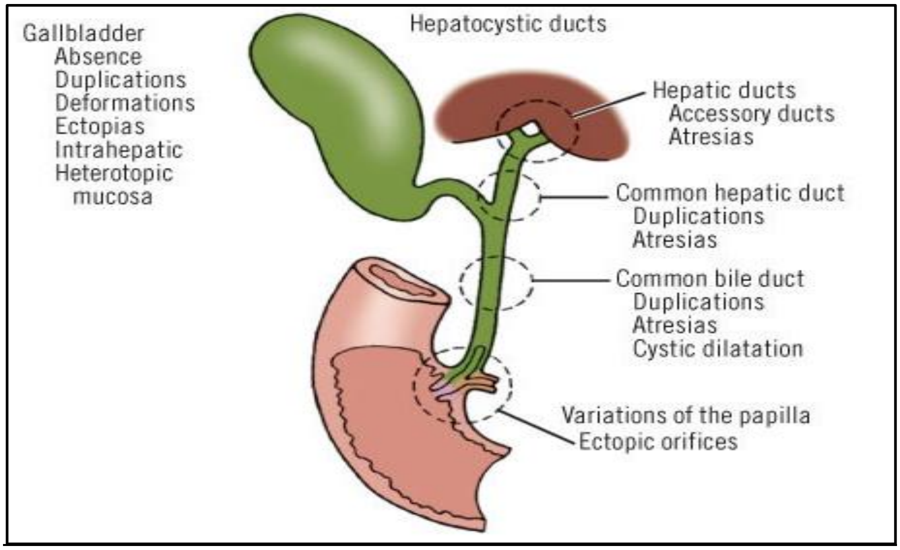

Figure (7): Sites of potential biliary tract malformations ***(Skandalakis et al., 2004)***

Anomalies of the Gall Bladder

Absence of the gall bladder

Occasionally the gallbladder (and usually the cystic duct as well) is absent or vestigial. The absence must be confirmed by ruling out an intrahepatic gallbladder or a left-sided gallbladder ***(Skandalakis et al., 2004).***

Multiple gall bladder

Multiple gallbladders form a continuous spectrum of malformations, from an externally normal organ with an internal longitudinal septum to the most widely separated accessory gallbladders. For practical purposes, the anomalies can be categorized into six basic types. Three types belong to the split primordium group and three belong to the accessory gallbladder group ***(Skandalakies et al., 2004).***

<u>Split primordium group</u>

In a split primordium, multiple gallbladder elements drain to the common bile duct by means of a single cystic duct. The three types follow:

Septate gall bladder. A longitudinal septum divides the gallbladder into two chambers. There may be no external trace of the septum or there may be a fundic cleft extending toward the neck (11.3%) (Figs. 8A, 8B).

Bilobate"V" gall bladder. Two gallbladders, separated at the fundus, are joined at the neck by a single, normal cystic duct (8.5%) (Fig. 8C).

"Y" duplication. Two separate gallbladders are present. Their respective cystic ducts join to form a common cystic duct before entering the common bile duct (25.3%) (Figs. 8D, 8E) ***(Colborn et al., 1987) (fig 8).***

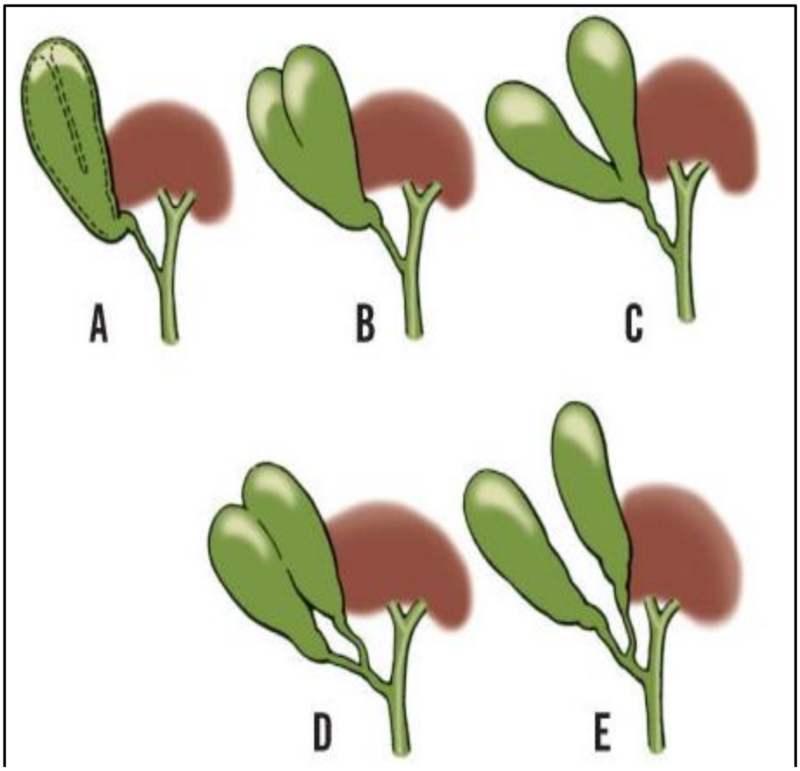

Figure (8): Types of double gallbladder arising from a split primordium ***(Colborn et al., 1987)***