Introduction

The vast majority of bile duct strictures are the result of preventable injuires to the extra hepatic biliary tract, usually during the operation of cholecystectomy and, less frequently, gastrectomy, blunt and penetrating abdominal trauma accounts for a small minority ***(Adamsen et al., 1997)***.

The introduction of laparoscopic cholecystectomy in the late 1980s ushered in the era of minimally invasive general surgery. Since then it has become the preferred approach for cholecystectomy. During the initial years of laparoscopic cholecystectomy, when surgeons were in the learning curve of the procedure, there was a significant increase in bile duct injuries compared with open cholecystectomy. However, most surgeons are now past their learning curve, and many considered laparoscopic cholecystectomy to be the basic laparoscopic procedure ***(Calvete et al., 2000)***.

Most major bile duct injuries are as a result of misidentification of ductal structures. Technical complications, such as thermal injury, tenting of the ducts, and dissecting too deeply, are less frequent causes of bile duct injuries. Surgeons inexperience, acute inflammation, cystic duct impaction, excessive bleeding, and aberrant anatomy are all risk factors for bile duct injuries ***(Way et al., 2003)***.

The controversial issue of routine versus selective intraoperative cholangiography was raised because of the ability of intraoperative cholangiography to prevent and identify bile duct injuries. Several studies concluded that routine intraoperative cholangiography reduces both the incidence of injury and time to diagnose ***(Fletcher et al., 1999 and Flum et al., 2001)***.

Approximately 75% of patients with bile duct injuries will have a delayed presentation ranging from days to months, the variety of imaging options for the Postcholecystectomy patient who presents with pain, fever, or jaundice; ultrasound and computed tomography (CT) are both good modalities for assessing fluid collections and bile duct dilatation, and can provide guidance for percutaneous drainage. A hepatobiliary iminodiacetic acid (HIDA) scan can compliment the evaluation by determining whether there is complete ductal obstruction, leakage of bile, or both ***(Misra et al., 2004).***

Once bile duct injury is diagnosed, initial management includes control of sepsis with antibiotics, decompression of the biliary system with a percutaneous transhepatic catheter (PTC) or endoscopic retrograde cholangiography (ERCP), and percutaneous drainage of a biloma/bile leak ***(Misra et al., 2004)***.

Although ERCP is the gold standard for cholangiography, PTC is often required to define the anatomy proximal to the injury. Alternatively, magnetic resonance cholangiopancreatography (MRCP) has evolved into an excellent biliary imaging modality that can rival the detail of direct cholangiography (PTC or ERCP), with negligible morbidity ***(Strasberg et al., 1995)***.

Regardless of the timing of repair, predictors of a good outcome include a tension-free anastomosis to a healthy duct and preservation of the bifurcation. Also, enteric anastomosis to higher, more proximal regions of the extra hepatic duct have a lower stricture rate and when all things are equal, bile duct injuries should be repaired early. Finally, success rates for repair of bile duct injuries can exceed 90% ***(Timothy, 2005)***.

Aim of the work

The aim of this study is to evaluate causes, management and prevention of Postcholecystectomy biliary injuries.

Surgical anatomy of Gall bladder and the extrahepatic biliary system

Understanding the anatomy of the gall bladder and the extrahepatic biliary system is essential to all clinicians caring for patients with hepatobiliary disorders. Biliary anomalies are not uncommon and over 50% of all patients undergoing a biliary tract procedure will have either a ductal or arterial anomaly. The failure to recognize such a congenital problem can result in significant perioperative morbidity ***(Roslyn and Zinner, 1994)***.

Anatomy of The gall bladder and biliary tree

The gall bladder is a pear shaped sac hollow organ that lies in a fossa on the under surface of the liver. Its position is the anatomic boundary between the right and left lobes of the liver ***(Roslyn and Zinner, 1994)***.

The average measures of the gall bladder are 7 to 10cm long, 3cm broad at its widest and 30-50 ml in capacity in normal condition.

It is described as having fundus, body and neck ***(Williams and Dyson, 1992).***

a. The fundus is the rounded blind end of the gall bladder which usually projects a little beyond the sharp lower border of the liver and touches the parietal peritoneum of the anterior abdominal wall at the tip of the right ninth costal cartilage where the transpyloric plane crosses the right costal margin. The fundus lies on the commencement of the transverse colon just to the left of the hepatic flexure ***(Mcminn, 1992)***.

b. The body, is the largest segment of the organ, is directed up and back to the right end of portahepatis, and is continuous with the neck. It is related above to the liver, below to the transverse colon, and further back to the first and upper end of the second part of the duodenum ***(Williams and Dyson, 1992)***.

c. The neck, of the gallbladder is narrow curving up and forwards and then abruptly back and downwards, to be come the cystic duct. The neck is attached to the liver by areolar tissue containing the cystic artery. Also the neck may show a small recess termed as Hartmann's pouch ***(Williams and Dyson, 1992).***

d. Hartmann's pouch, is an asymmetric bulge small bulbous diverticulum, arises from the right side of the neck and typically lying on the inferior surface of the gall bladder. Its anatomic site is clinically significant because of its proximity to the duodenum and because stones may become impacted in the infundibulum and obstruct the cystic duct ***(Roslyn and Zinner, 1994).*** However, the Hartmann's pouch is not a constant feature of the normal gall bladder, and is always associated with a pathological condition ***(Mcminn, 1992).*** Also, the Hartmann's pouch may obscure the common hepatic duct and constitute a real danger point during cholecystectomy ***(Smadja and Blamgart, 1994).***

Blood supply of the Gall Bladder:

The arterial supply of the gall bladder is mainly by the cystic artery and many small vessels from its hepatic bed. The cystic artery pass behind the common hepatic duct and above the cystic duct in the calot's triangle ***(Mcminn, 1992)***.

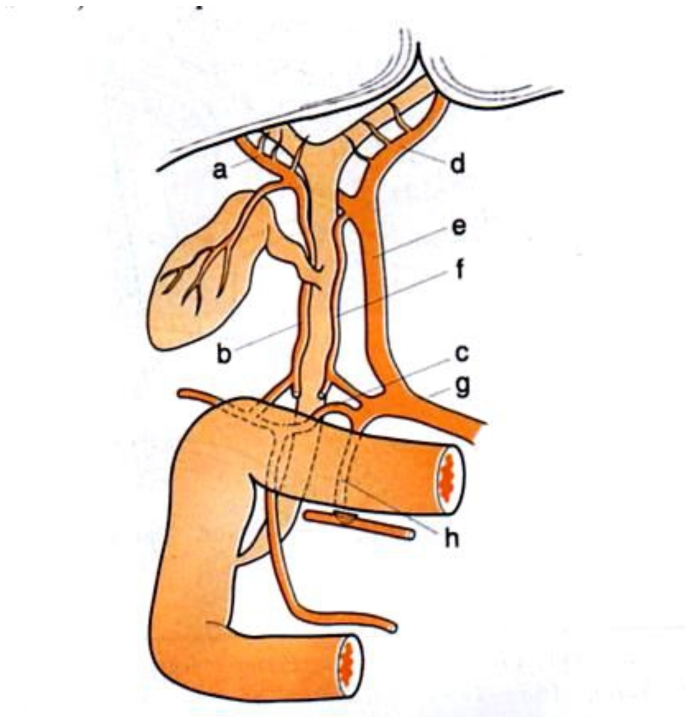

Fig. (1): The anatomy of the gall bladder and bile ducts. Note the arrangement of the arterial tree: (a) right hepatic artery; (b) right choledochal artery; (c) retroduodenal artery; (d) left branch of hepatic artery; (e) hepatic artery; (f) left choledochal artery; (g) common hepatic artery; (h) gastroduodenal artery.

The cystic artery divides into superfacial and deep branches, coursing over the neck and one or two pairs of its branches encircle it and anastomose posteriorly. The cystic artery usually arises from the right hepatic artery crossing anterior or posterior to the common bile or common hepatic duct to reach the gall bladder. It may arise from the hepatic trunk, left hepatic, gastroduodenal, coeliac trunk or superior mesenteric artery ***(Williams and Dyson, 1992).***

Right and left Hepatic Ducts and common Hepatic duct:

The right and left hepatic ducts are formed by the confluence of the segmental ducts within the hepatic lobes then emerge from the portahepatis and join together near its right margin in a Y-shaped manner to form the common hepatic duct ***(Mcminn, 1992).*** The extrahepatic segment of the right hepatic duct is short but the left has a much longer extrahepatic course ***(Smadja and Blumgart, 1994).***

The common hepatic duct is formed by the union of the main right and left hepatic ducts near the portahepatis. This duct is about 4cm long with a diameter of 4mm, it lies in the free edge of the lesser omentum in front of the portal vien and with the hepatic artery on its left side. The common hepatic duct in Joined by the cystic duct usually on the right side about one cm above the duodenum to form the common bile duct ***(Mcminn, 1992).***

The relationship of the right hepatic duct and common hepatic duct to the right hepatic artery is variable.

Usually the right hepatic artery crosses from left to right, dorsal to the right hepatic duct and just superior to the confluence of the right and left hepatic ducts.

However, the artery frequently passes ventral to the right hepatic duct crossing at a level just superior to the transverse course of the cystic artery where it is difficult to distinguish them from each other. Thus the right hepatic artery is susceptible to injury during biliary tract surgery being mistaken as the cystic artery ***(Smadja and Blumgurt, 1994)***.

The most dangerous abnormality is when the right hepatic artery takes a dangerous course in front of a short cystic artery, known as the caterpillar turn or Moynihan's hump with the risk of liver infarction if accidental ligation occurs ***(Russell, 1995).***

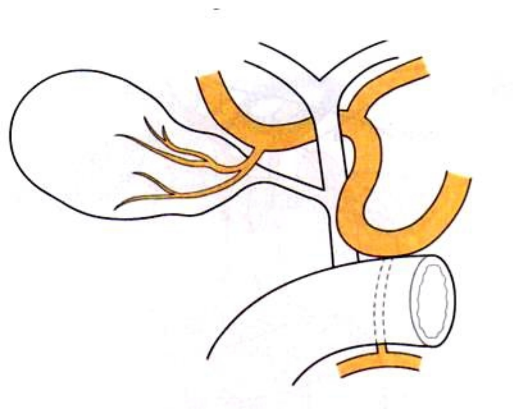

Fig. (2): Tortuous hepatic artery (so-called caterpillar turn or Moynihan's hump) ***(Bailey and Love's, 2000)***.

The Cystic duct:

The cystic duct arises from the neck or infundibulum of the gall bladder and passes backwards, downwards and to the left to join the common hepatic duct, its lumen usually measures 1-3mm and its length is variable (about 0-1cm) depending upon the type of union with the common hepatic duct. The distal end of the cystic duct is usually found in the free border of the hepatoduodenal ligament. This site is known as cholecystoduodenal ligament and is the key to the operative search for the cystic duct ***(Smadja and Blumgurt, 1994)***.

Although most anatomical textbooks indicate that the cystic duct joins the bile duct along its right margin, this arrangement represents only 15-20% of cases. Much more commonly, the cystic duct enters the bile duct either posteriorly or anteriorly (40%).

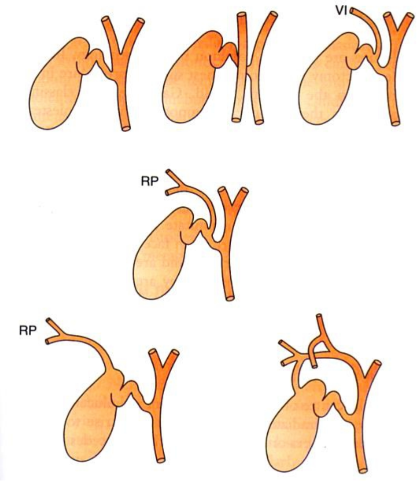

Fig. (3): Patterns of cystic duct anatomy-note segment VI drainage into the cystic duct and the drainage of the right posterior sectorial duct (RP) into the neck of the gall bladder ***(Bailey and Love's, 2000)***.

It also may pursue a spiral or a parallel course with the bile duct. Rarely, the cystic duct joins the right hepatic duct and very infrequently the left hepatic duct ***(Cuschieri and Bouchier, 1990).***

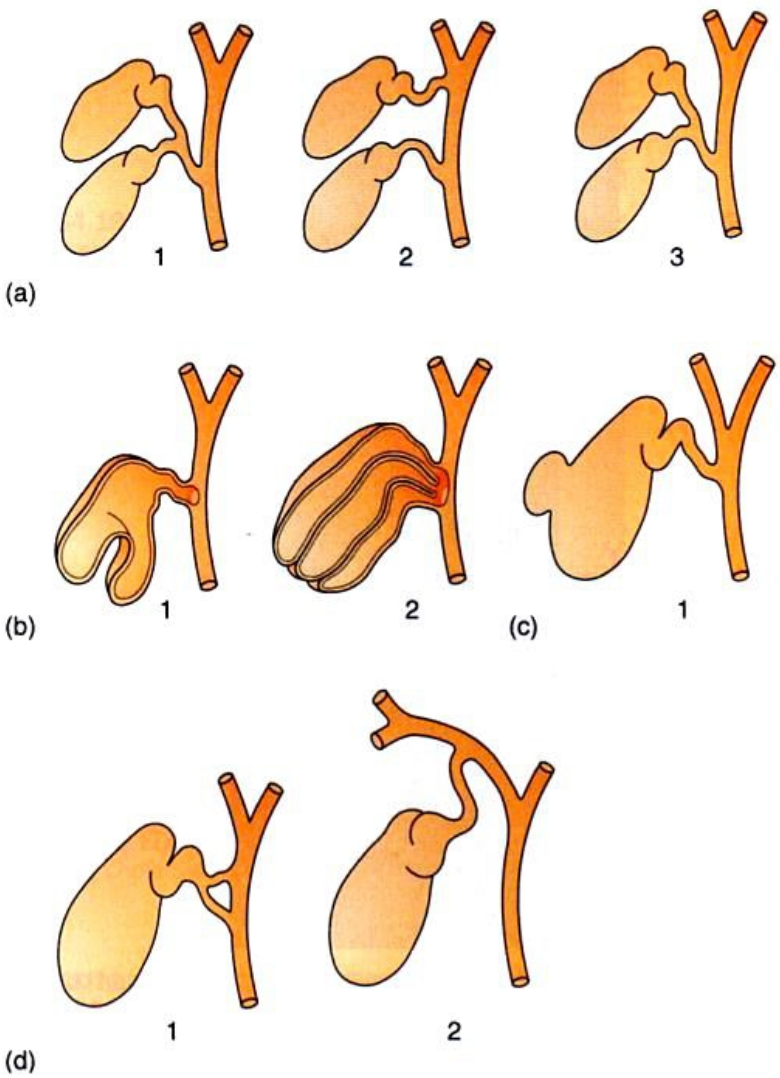

Fig. (4): The main variations in gall bladder and cystic duct anatomy (a) Double gall bladder, (b) Septum of the gall bladder; 1 is the most common, the so-called Phrygian cap. (c) Diverticulum of the gall bladder. (d) Variations in cystic duct insertion ***(Bailey and Love's, 2000)***.

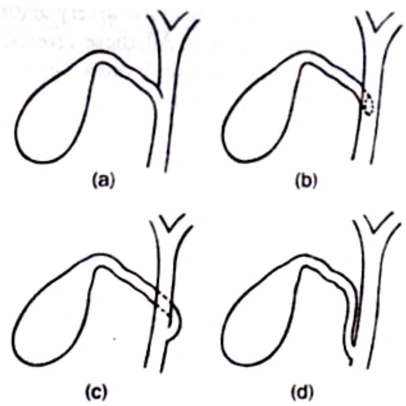

Fig. (5): Schematic representation of the termination of the cystic duct: (a) lateral insertion often depicted as the usual arrangement but which is only encountered in 15-20% of patients; (b) anterior or posterior termination – this is the most common type and accounts for 40% of cases; (c) spiral cystic duct which courses behind the bile duct to open on its medial aspect-this is fairly common and is found in 35% of patients; (d) parallel cystic duct-this is the rarest arrangement and is encountered in 5-7% of patients ***(Cuschieri, 2002)***.

The triangle of Calot:

This is a cholecystohepatic triangle bounded by the hepatic duct medially, the cystic duct and the neck of 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 ***(Britton and savage, 1994).***

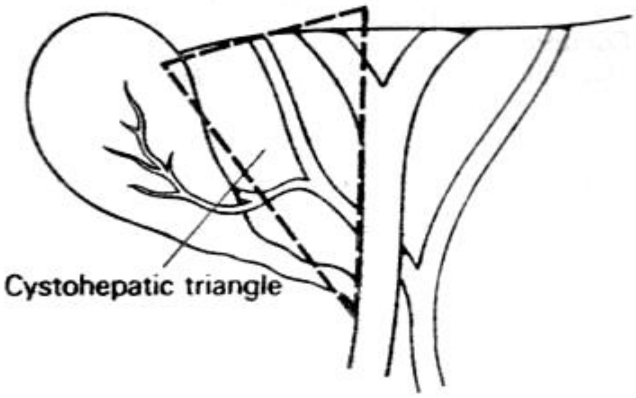

Fig. (6): Cystohepatic triangle of Calot formed by the cystic duct and neck of the gallbladder inferiorly, the liver edge superiorly and the common hepatic duct medially. It contains the cystic artery and lymph node and the right hepatic artery as it emerges from behind the common hepatic duct ***(Cuschieri, 2002)***..

Common Bile Duct:

The common bile duct is formed near the portahepatis by the junction of the cystic and common hepatic ducts, it is usually about 7.5cm long and 6mm in diameter. It extends posteriorly to enter the duodenal wall. The surface anatomy of the bile duct on the anterior abdominal surface is determined by a line starting 5cm above the transpyloric plane and 2 cm right of the median plane and descending vertically for 7.5cm ***(Mcminn, 1992)***. The common bile duct is divided into four segments:

1- Supraduodenal
2- Retroduodenal
3- Infraduodenal
4- Intraduodenal

1- Supraduodenal segment:

It is the longest segment about 2.5cm in length. It lies within the free border of the hepatoduodenal ligament. The hepatic artery lies on the same plane and to the left of the duct. The portal vein lies dorsal to the duct. This part of the duct passes in front of the epiploic foramen (foramen of Winslow) separated from it by the portal vein ***(Smadja and Blumgart, 1994)***.

2- Retro duodenal segment:

This segment of the common bile duct varies from 2.5 to 4.5 cm in length. It lies dorsal to the midsegment of the first portion of the duodenum: It slants obliquely from above downwards and from left to right and lying to the left of this portion is the gastro duodenal branch of the hepatic artery. A short distance further the inferiorly, the common bile duct is crossed anteriorly by the posterior superior pancreatic-duodenal artery ***(Smadja and Blumgart, 1994)***

3- Infraduodenal segment:

This portion of the duct varies from 2 to 3 cm in length. It is related to the head of the pancreas in one of two ways either entirely retropancreatic or within the substance of the dorsal portion of the pancreatic head. The inferior venacava lies just dorsal to this portion of the common bile duct. The gastroduodenal artery lies to the left of upper part of the Bile duct and its superior pancreaticoduodenal branch crosses either ventral or dorsal to this portion of the duct. The large pancreaticoduodenal vein is related to the left border of the pancreatic segment before the vessel joins the portal vein ***(Smadja and Blumgart, 1994).***

4- Intraduodenal segment:

Just before the entrance of the common bile duct into the duodenal wall, it lies dorsal and above the major pancreatic duct. It passes through the duodenal wall tangentially and about 2.cm in length within the duodenal wall both in the muscle layer and submucosal layer at a 7cm distance from the pylorus. Both the common bile duct and the major pancreatic duct empty into the duodenum at the summit of the major duodenal papilla ***(Russell, 1995)***.

The ampulla of Vater:

The ampulla of Vater is formed within the intraduodenal portion of the common bile duct, as the main pancreatic duct joins the posteromedial wall of the transduodenal segment of the bile duct to form one of the following:

A) Common channel in 90% of cases.

B) A localized dilatation of the common channel to form an ampulla of vater which is uncommon (10-20%).

C) The two ducts open separately into the duodenum in 10% of patients.

All previously mentioned forms open in summit of the duodenal papilla ***(Cuschieri and Bouchier, 1990)***.

The sphincter of oddi

This is an extremely loose term as it doesn't clearly denote the exact area of the biliary sphincter that is being