MANAGEMENT OF COMMON BILE DUCT INJURY RELATED TO LAPAROSCOPIC CHOLECYSTECTOMY

Essay
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Introduction

Over the last decade, laparoscopic cholecystectomy (LC) has gained worldwide acceptance and considered to be as "gold standard" in the surgical management of symptomatic calcular cholecystitis. However, the incidence of bile duct injury in laparoscopic cholecystectomy is still great compared to classic open surgery. ***(Savader SJ, et al, 2006)***

Technical factors leading to biliary injury are often caused by errors of perception during dissection in Calot’s triangle, including misidentification of anatomy, and failure to recognize injuries when they occur. In addition, acute cholecystitis, a difficult dissection, and bleeding are associated with higher rates of major bile duct injury during LC**.** ***(Stewart L, et al, 2004)***

The care of these patients has evolved over the last 14 years by trial and error, as well as by the individual surgeon or institutional philosophy. Collaboration among surgeons, gastroenterologists, and interventional radiologists is imperative in the care of these complex injuries**.** ***(Lillemoe KD, et al, 2006)***

The control of sepsis and the ongoing bile leak is the primary goal of the initial management of a Bile duct injury (BDI). If this can be accomplished, proceeding with surgical reconstruction is not urgent. In fact, reconstruction in the face of peritonitis portends a statistically worse outcome in patients.

Therefore, institutional practice is to initially control sepsis via radiological intervention and antibiotics and generally operate on patients at a later date, at a median of 5.4 weeks after their index admission when the associated inflammation has subsided***. (Hansen OH, et al, 2002)***

The management of patients following major BDI is a surgical challenge often requiring the skills of experienced hepatobiliary surgeons at tertiary referral centers. ***(Melton GB, et al, 2006)***

Some patients treated via nonsurgical means, such as percutaneous or endoscopic balloon dilatation and stenting of an existing biliary stricture to be repaired after injury during LC***. (Stewart L, et al, 2004)***

Aim of the work:

This essay highlights different types of bile duct injuries, possible causes & recent management whether by conservative, endoscopic or surgical methods.

Anatomy of Biliary System

I - Embryology and Anatomy of the Extra-hepatic Biliary system

Understanding the anatomy of the gallbladder and the extra hepatic 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 an arterial anomaly. The failure to recognize such a congenital problem can result in significant per operative morbidity (Rosylan and Zinner, 1999).

1- Embryology of the biliary tree :

The liver and the biliary tract are derived from the distal part of the forgut. The liver first appears in the 3 week embryo as a hollow endodermal from the forgut. This bud, the future hepatic diverticulum, consists of rapidly proliferating cells that penetrate into the septum transversum in the ventral mesogastrium. These cells eventually develop into the liver, the connection between the hepatic diverticulum and the foregut is preserved to form the bile duct. A ventral outgrowth of the bile duct gives rise to the gallbladder and the cystic duct.

As the intestine rotates, the entrance from the bile duct into the duodenum moves to a position and the common bile duct comes to lie behind the duodenum and the pancreas (Britton and Savage, 1999).

2- Anatomy of Biliary tree:

The extra hepatic biliary tract consists of the three hepatic ducts (right, left and common), the gallbladder and cystic duct and the bile duct.

A- Gallbladder :

This least variable part of biliary tree is usually globular, laying in the undersurface of the right hepatic lobe within the cystic plate, which is constituted of connective tissue closely applied to Glisson's capsule. It is normally bound down to the liver surface by peritoneum except at its neck where the origin of the cystic duct is enveloped in serosa. Sometimes the gallbladder is deeply embedded in the liver but occasionally present on a mesenteric attachment and may then be liable to volvulus ***(Blumgart and Smadja, 1999).***

The gallbladder varies in size and consists of a fundus, a body and a neck. The tip of the fundus usually but not always, reaches the free edge of the liver and is closely applied to the cystic plate. The neck of the gallbladder makes an angle with the fundus. A large gallstone in this part of the neck of the gallbladder creates a Hartman's pouch ***(Wood, 1999).***

Sometimes, freeing of the gallbladder neck during cholecystectomy may threaten the right branch of hepatic artery, common hepatic duct and rarely the right hepatic duct ***(Blumgart and Smadja et al., 1999).***

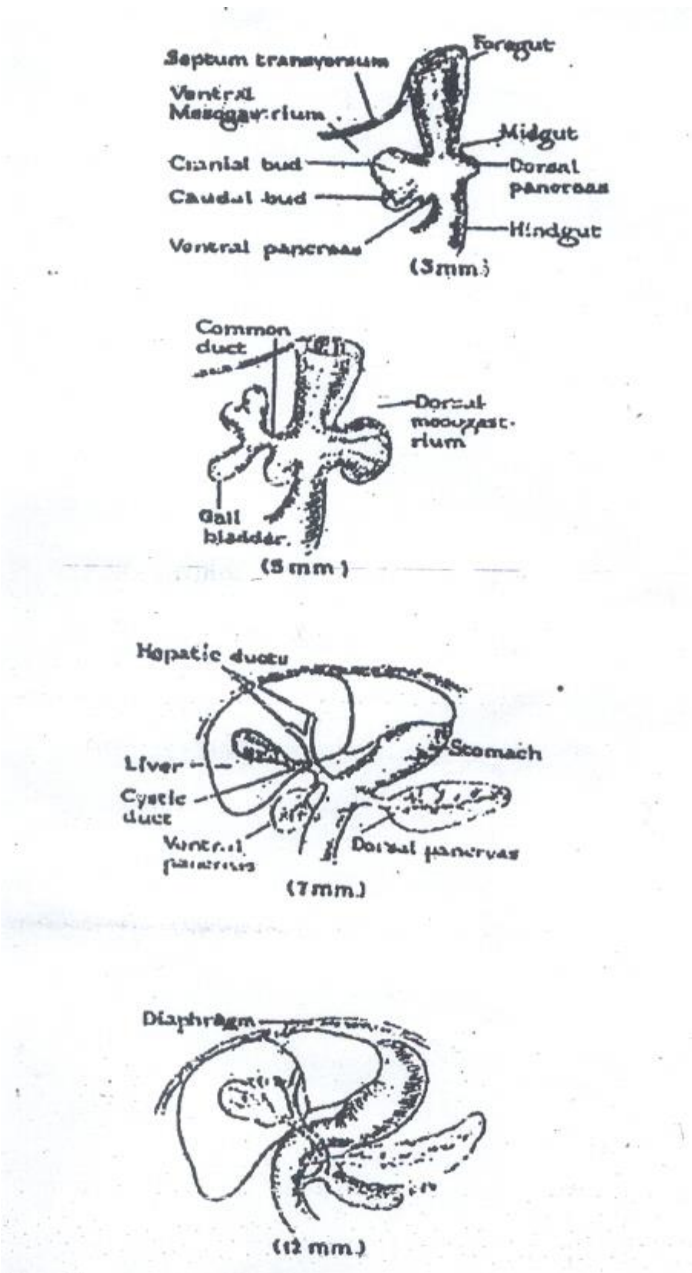


Fig. (1) : Development of extra hepatic biliary tract in the embryo from the 3mm to 12mm stages.

Blood supply of the gallbladder :

The gallbladder receives many small vessels from its hepatic bed, but there is also a cystic artery, usually a branch of the right hepatic artery. It passes behind the cystic duct reaches the neck of the gallbladder and then branches over the surface of the viscous. The artery should be found running towards the gallbladder in Calot's triangle. Venous drainage is the reverse of the arterial pattern, mainly by vessels that pass directly into the gallbladder bed and only rarely supplemented by small veins more commonly double or multiple rather than single that accompany the cystic artery and drain into the right branch of the portal vein.

The lymphatic drainage of the gall bladder:

It may take one of the following routes:

1- The lymph may run directly into the gallbladder bed of the liver via multiple small lymphatic channels between the gallbladder wall and Glisson's capsule of the liver ***(Britton and Savage, 1999).***

2- The lymph may drain towards the cystic duct and into a single node of Lund or a series of nodes overlying the cystic duct, then to nodes close to the hilum of the liver or to nodes above the first part of the duodenum, then to nodes around the celiac axis ***(Harold, 1997).***

The nerve supply of the gallbladder:

The nervous connections with the gallbladder are both sympathetic and parasympathetic. These nerves facilitate, but are not essential, for gallbladder emptying. Conduction of pain from the biliary tree is transmitted via fibers that run with the sympathetic nerves ***(Boyden, 1993).***

Histology of gall bladder :

The gallbladder wall has an outer serous, middle fibro muscular and an inner mucous layer. The serosa covers all the fundus but only coats the inferior surface of the body and neck of the gallbladder, beneath it is sub serous loose connective tissue and adipose peritoneal tissue. The fibro muscular layer is composed of a network of fibrous tissue and several layers of smooth fibers (Williams and Dyson, 1992).

The mucous layer is formed of lax areolar tissue lined with a simple columnar epithelium that sinks into muscle coat to form the crypts of luschka which produce a honeycomb appearance in the body of the gallbladder, but are arranged in spiral manner in the neck (the spiral valve). The mucous-secreting glands are present only in the neck of the gallbladder and are responsible for the mucous secretion in bile, as there is no goblet cell in the gallbladder walls (Hollinshead, 1992).

B- Hepatic duct:

(I) Intra-hepatic Bile Duct Anatomy :

The liver is divided into 2 major portions and a dorsal lobe “caudate lobe”. The right liver and the left liver are respectively drained by the right and left hepatic ducts, whereas the dorsal lobe “caudate lobe” is drained by one or several ducts joining both the right and left hepatic ducts ***(Healy & Scharoy 1993).***

The intrahepatic ducts are tributaries of the corresponding hepatic ducts which form part of the major portal tracts and which penetrate the liver invaginating the Glisson’s capsule at the hilus of the different biliar and vascular elements of major portal triads, the hepatic arterial branches, portal veins and biliary tract. The least liable to variation are portal venous components. In particular, the left branch of the portal vein tends to be constant in location ***(Couinaud, 1997).***

Bile ducts are usually located above the corresponding portal branches, whereas hepatic arterial branches are situated to the veins. Each branch of the intrahepatic portal veins corresponds to one or two bile ducts which form outside the liver, the right and left hepatic ductal systems, converging at the liver hilus to constitute the common hepatic duct. The umbilical fissure divides.

The left liver passing between segment III and segment IV where it may be bridged at its base by a tongue of liver tissue. The ligamentum teres passes through the umbilical fissure to join the left branch of the portal vein within the recesses of Rex. All these biliary and vascular elements are liable to anatomical variation ***(Blumgant & Smadja 1999).***

1- The left hepatic duct :

It drains the three segments "II, III and IV" which constitute the left liver. The duct draining segment III is located slightly behind the left horn of the umbilical recesses, running backwards to join the segment II at the point where the left branch of the portal vein turns forward and caudally at the recessus of Rex ***(Couinaud, 1997).***

The left hepatic duct transverses beneath the left liver at the base of segment IV, just above and behind the left branch of the portal vein crosses the anterior edge of that vein and joins the right hepatic duct to constitute the hepatic ductal confluence. In its transverse portion it receives one to three small branches from segment IV ***(Couinaud, 1997).***

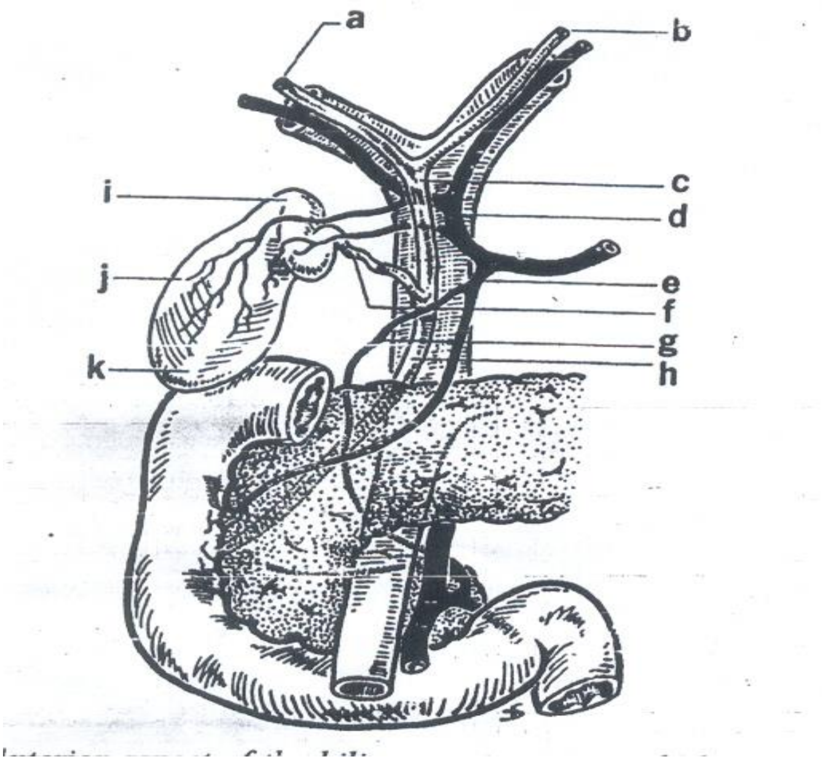


Fig. (2): Anterior aspect of the biliary anatomy : (a) right hepatic duct, (b) left hepatic duct, (c) common hepatic duct, (d) hepatic artery, (e) gastro duodenal artery, (f) cystic duct, (g) retroduednal artery, (h) common bile duct, (I) neck of the gallbladder, (j) body of the gallbladder, (k) fundus of the gallbladder.

2- The right hepatic duct :

It drains segments V, VI, VII and VIII and arises from the junction of two main sectoral ductal tributaries, the posterior or lateral duct and the anterior or medial duct each a satellite of its corresponding vein ***(Last R.J., 1996).***

The right posterior sectoral duct has an almost horizontal course and is constituted by the confluence of the ducts of segments VI and VII. The duct then runs to join the right anterior sectoral duct as it descends in a vertical manner ***(Skandalkis J.E. et al., 1998).***

The right anterior sectoral duct is formed by the confluence of the ducts draining segment V and segment VIII. Its main trunk is located to the left of the right anterior sectoral branch of the portal vein, which presses and ascending cause. The junction of these two main right biliary channels usually takes place above the right branch of the portal vein ***(Blumgart and Smadja et al., 1999).***

The right hepatic duct is readily approached by dividing the peritoneum and fat overlying it in the portahepatis. The right hepatic artery runs inferior to it, while the right branch of the portal vein lies posterior to these two structures ***(Last R.J., 1996).***

(II) Extra-hepatic Biliary Anatomy :

The extra-hepatic bile duct are presented by the extraheptaic segment of the right and left hepatic ducts joining to form the biliary confluence and main biliary channel draining into the duodenum. The accessory biliary apparatus, which constitutes a reservoir, comprises the gallbladder and cystic duct ***(Last R.J.,* 1996).**

The confluence of the right and the left ducts takes place at the right of the hilum of the liver anterior to the portal venous bifurcation and overlying the origin of the right branch of the portal vein. It is separated from the posterior aspect of the quadrate lobe “segment IV” of the liver by the hilar plate. The junction lies between 0.25 and 2.5cm from the surface of the liver ***(Skandalkis J.E. et al., 1998).***

The left duct is longer “average 1.7cm” than the right duct “average 0.9cm” **(*Skandalkis J.E. et al., 1998*)** i.e. the left duct has a much longer extra-hepatic course ***(Blumgart and Smadja et al., 1999).***

The Main Bile Duct and the Sphincter of Oddi

It is divided into two segments the upper segment is called the common hepatic duct joined with the cystic duct to form the second segment, the common bile duct.

(a) Common hepatic duct :

This bile duct segment is of innumerous surgical importance, being involved in two thirds of postoperative strictures ***(Warren et al., 2001).***

It is formed by the final confluence of all ducts issuing from the liver and ends when the lumen of the cystic duct opens into it to form the common bile duct.

Its width doesn't differ significantly from the common bile duct, in most individuals it is 2.3-3.5cm in length but this is variable ***(Northover et al., 1992).***

It has an internal diameter of about 8mm. In about 2% of cases, the common hepatic duct is non-existent, the cystic duct opens into the hepatic duct confluence**.**

In 15-20% the common hepatic duct extends downwards behind the duodenum before the cystic duct opens into it ***(Johnston et al., 1992).***

The major relations of the common hepatic ducts are fairly constant. It lies in the right edge of lesser omentum, with the common hepatic artery to its left and the portal vein situated posteriorly. Its important variable neighbors are the right hepatic artery, cystic artery and cystic duct. As the common hepatic artery normally bifurcates below the hepatic bile duct confluence, the right hepatic has to cross the common hepatic duct to reach the liver. In about 90% of cases, the right hepatic artery passes behind the duct while in the rest it passes in front and hence is more prone to accidental injury ***(Maingot, 2000).***

The cystic artery usually arises in Calot's triangle and hence isn't normally directly related to the common hepatic duct, however, in about 22%, it arises form the right hepatic artery to the left of the common hepatic duct, hence crossing it interiorly in 20% and posterior in the remainder. It is in these individuals that hurried attempts to secure a retracted bleeding cystic artery are especially dangerous ***(Maingot, 2000).***

The cystic duct normally joins the common hepatic duct at an angle, but in about 30% it is estimate bound to the right, anterior or posterior wall for a variable distance before the Lumina join ***(Northover et al., 1992).***

The Cystic Duct

The cystic duct arises from the neck or infundibulum of the gallbladder and extends to join the common hepatic duct. Its lumen usually measures 1-3 mm. Its length is variable, depending upon the type of union with the common hepatic duct. It is commonly 4cm long ***(Skandalakis et al., 1998).***

In most people the duct follows a straight oblique course to join common hepatic duct ***(Northover et al., 1992).***

The junction is easily seen with minimal dissection in about 65%, while in the remainder, often deceptively, the duct runs a longer course, parallel with or spiraling around the common hepatic duct ***(Skandalakis J.E. et al., 1998).***

The distal part of the cystic duct in these circumstances is often incorporated into the wall of the common hepatic duct so that attempts to remove it entirely may lead to duct damage and stricture ***(Maingot, 2000).***

The mucosa of the cystic duct is arranged in spiral folds known as the valves of Heister. Its wall is surrounded by sphincter structure called the sphincter of Lutkens. While the cystic duct joins the common hepatic duct in its supraduodenal segment in 80% of cases.

It may extend downward to retroduodenal or even retro pancreatic area. Occasionally the cystic duct may join the right hepatic duct or a right hepatic sectoral duct ***(Blumgart and Smadja, 1999).***

The cholecysto-hepatic triangle, triangle of Calot and area of Mossman

The triangle is formed by the gallbladder and cystic duct to the right, the common hepatic duct to the left, and the margin of the right lobe of the liver superiorly the triangle originally described by Calot 1891**,** defined the upper boundary as the cystic artery, the triangle has enlarged over years ***(Bismuth, 1992).***

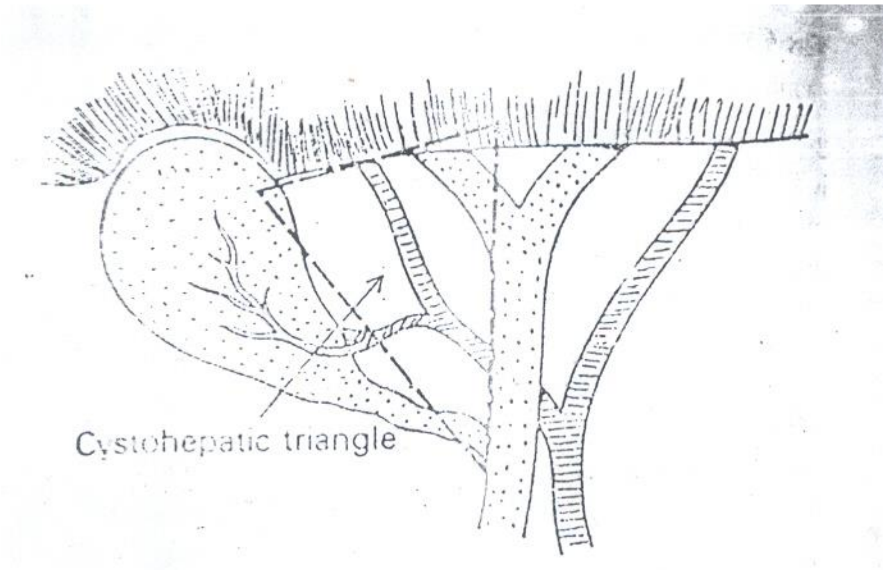


Fig. (3): The cholecysto-hepatic triangle and triangle of Calot formed by the cystic duct and neck of the gallbladder inferiorly, the liver edge superiorly and the common hepatic duct medially.
It contains the cystic artery and lymph node and the right hepatic artery as it emerges from behind the common hepatic duct.

The area of Mossman is defined as a circular area 30mm in diameter fitted into the cysto-hepatic duct angle. Within the boundaries of the modern triangle and of the area of Mossman are a number of structures that must be identified before they are ligated or sectioned. As a general rule, no artery over 3mm in diameter in the triangle will be a cystic artery ***(Skandalakis et al., 1998).***

(b) Common bile duct :

It is formed by the confluence of the common hepatic duct and cystic duct, the common bile duct is normally located in the free edge of the lesser omentum. It passes behind the pancreas to enter the 2nd part of the duodenum ***(Blumgart and Smadja, 1999).***

It is about 7 to 8cm long and 0.8cm wide ***(Wood, 1999),*** with the extremes in 100 dissections 1.5 to 12cm long and 0.4 to 1.3 cm wide ***(Dowdy et al., 1992).***

The portions of the duct have been named according to their relationship to the intestinal viscera: Supraduodenal, retro duodenal, intra-pancreatic and intra-duodenal. The average length of each of these segments is 2, 1.5, 3,1cm, respectively ***(Northover et al., 1992).***

(1) Supraduodenal part :

Its average length is 2cm ***(Skandalakis J.E. , Gray S.W. et al., 1998),*** It lies between the two leaves of the hepatoduodenal ligament, in front of the foramen of Winslow, to the right of the hepatic artery and anterior to the portal vein ***(Blumgart LH, 1999).***

It may be crossed interiorly by one or more of the following: Right gastric, Right hepatic, Supraduodenal or even Gastro duodenal artery. The hepatic artery may lie to the right, left anterior or posterior to the Common Bile Duct ***(Skandalakis J.E. , et al., 1998).***

(2) Retroduodenal Portion :

Its average length is 1.5cm **(*Skandalakis, J.E., et al., 1998);*** it lies between the superior margin of the 1st part of the duodenum and the superior margin of the head of the pancreas. It passes behind the first "superior" part of the duodenum, with the gastro-duodenal artery on its left & then, runs in a groove on the supralateral part of the posterior surface of the head of the pancreas anterior to the Inferior Vena Cava and sometimes embedded in the pancreatic tissue ***(Williams and Dyson et al., 1992).***

It may be free or partially fixed to the posterior duodenal wall. A pancreaticoduodenal artery crosses 1st anterior to the bile duct and then posterior to the duct just before it enters the duodenum, also the middle colic artery is in this neighborhood ***(Northover et al., 1992).***

(3) Pancreatic Portion :

Its average length is 3cm ***(Skandalakis, J.E. et al., 1998)***. There are many variations as regard this part as follows:

- 44% partly covered by a tongue of pancreas.
- 30% completely within the pancreatic substance.
- 16.5% uncovered on the pancreatic surface.
- 9.5% completely covered by two tongues of pancreas.

Even when completely covered, the groove or tunnel occupied by the duct may be palpated by passing the fingers of the left hand behind the 2nd part of the duodenum the groove may be found anterior to the right renal vein ***(Dowdy et al., 1992).***

(4) Intramural Portion :

Its average length is 1.1cm ***(Skandalkis J.E., 1998).***

It passes obliquely through the duodenal wall together with the main pancreatic duct ***(Williams, Warwick Dyson et al., 1992).***

The two ducts usually lie side by side with a common adventitia for several millimeters. The diameter of both ducts decreases within the duodenal wall. The septum between the ducts is reduced to a thin mucosal membrane before the ducts become confluent. The common bile duct and the pancreatic duct end at the papilla of vater, on the postromedial wall of the 2nd part of the duodenum just to the right of the 2nd or the 3rd lumbar vertebra ***(Skandalkis J.E., 1998).***

The junction between the pancreatic duct and common bile duct may be:

(a) Junction is high; the common channel may or may not be dilated to form an "ampulla" 86%.

(b) The common channel is short; no ampulla is present 5%.

(c) The common bile and pancreatic ducts enter the duodenum separately, no ampulla is present (9%) ***(Schwartz S.I., 2001).***

The Sphincter of Oddi

It has been thoroughly studied ***(Boyden, 1993)*** and consists of a unique cluster of smooth muscle fibers distinguishable form the adjacent smooth muscle of the duodenal wall. The papilla of vater at the termination of the common bile duct is a small nipple like structure protruding into the duodenal lumen and marked by a longitudinal fold of duodenal mucosa. The duct wirseing as it runs down parallel with the common bile duct for some 2cm joins it within the Sphincteric segment in some 70-80% of cases ***(Linder and Green, 1994)*** enters the duodenum independently in 10-13% of patients and only 2% is replaced by the duct of santorini ***(Schwartz S.I., 2001).***

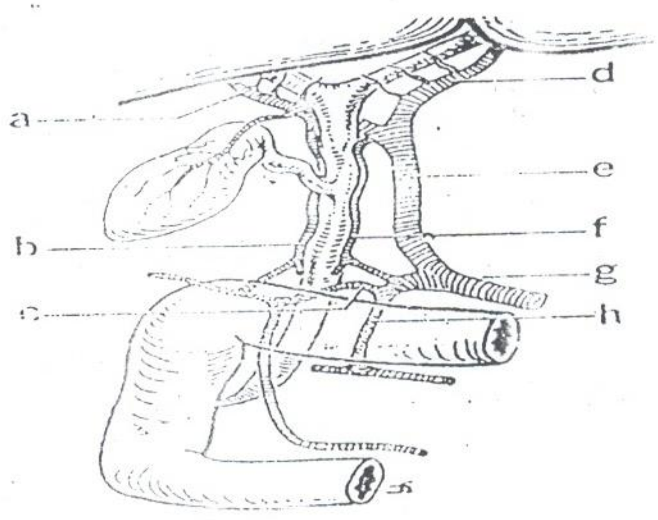


Fig. (4): The bile duct blood supply (Northover and Terblanche 1990). Note the axial arrangement of the vasculature of the supraduodenal portion of the main bile duct and the rich network enclosing the right and left hepatic ducts: (a) right branch of the hepatic artery; (b) 9'clock artery; (c) retro duodenal artery; (d) left branch of the hepatic artery; (e) hepatic artery; (f) 3 o'clock artery; (g) common hepatic artery; (h) gastro duodenal artery.

Blood Supply of Extrahepatic Biliary Ducts :

Until recently, the basis pattern of the bile duct arterial supply was ill-understood. Several authors have reported that the duct was supplied by end-arteries and was thus venerable to devascularization ***(Michels, 1990).***

While others had suggested the presence of dense plexus around the duct, making ischemic injury unlikely after even the most vigorous dissection ***(Park et al., 1993).***

The arteries to the extra hepatic biliary duct anastomisis so freely within the ducts wall that surprisingly large parts of these ducts may be mobilized freely without fear of their developing gangrene ***(Skandalakis et al., 1998).***

Recent studies have confirmed and more precisely described percholeducal arterial plexus, but the consequences of damage to it remain a matter for debate ***(Northover et al., 1992).***

The bloody supply to the left and right hepatic ducts from corresponding arteries and the retro pancreatic bile duct from pancreatic duodenal and retro duodenal arteries ***(Blumgart, 1999).***

The supraduodenal bile duct blood supply is axial i.e. coming from named arteries related to its upper and lower ends. On average, eight vessels, each about 0.3 mm in diameter, arise from the major arteries related to the duct mainly the retro duodenal artery below and the right hepatic and the cystic arteries above and pass axially along the supraduodenal duct to join up with vessels coming from the opposite direction to form freely anatomizing plexus. The most important of these vessels run along the lateral borders of the duct and have been called the 3 o'clock and 9 o'clock arteries and may represent significant supply to the duct with flow coming from below in about 60% of patients from above in 38%. In 2% of cases the common duct is supplied directly from the common hepatic artery in non-axial fashion. Thus the portion of the supraduodenal bile duct proximal to the locus of transaction or damage is vulnerable to ischemia which may contribute to fibrosis and stricture formation during healing**.**

Another important axial vessel, the retro portal artery runs along the posterior surface of the supraduodenal duct. It arises from celiac axis or superior mesenteric artery and passes upward behind the portal vein to reach the duct ***(Northover et al., 1992*****).**

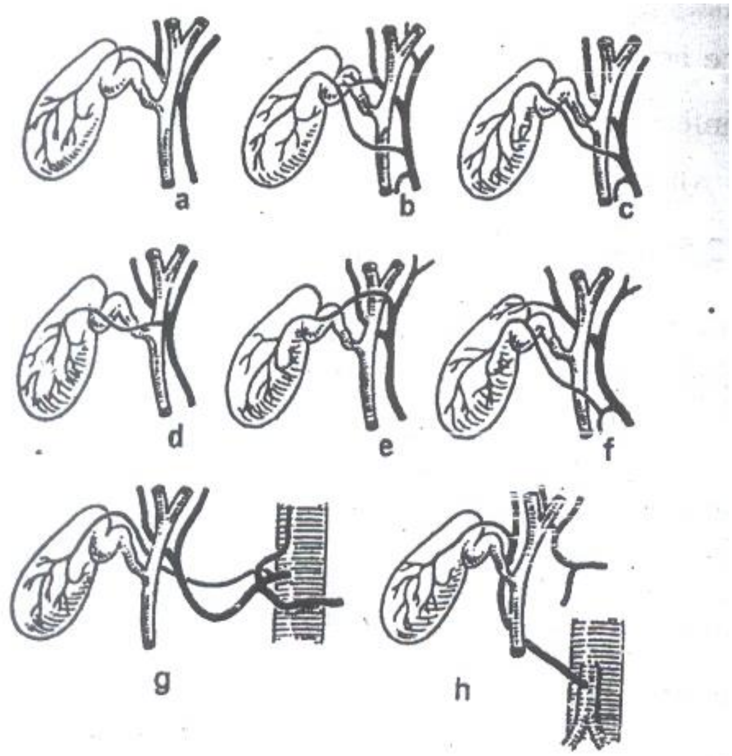


Fig. (5) : Sketch showing the main variations of the cystic artery : ,(a) typical course, (b) double cystic artery, (c) cystic artery crossing anterior to main bile duct; (d) cystic artery originating from the right branch of the hepatic artery and crossing the common hepatic duct interiorly; (e) cystic artery originating from the left branch of the hepatic artery; (f) cystic artery originating form the gastro duodenal artery; (g) the cystic artery may arise from the celiac axis; (h) the cystic artery originates from a replaced right hepatic artery. (Blumgart and Hann, 1999)

The source of blood supply of the retro pancreatic common bile duct is from the retro duodenal artery, which provides multiple small vessels running around the duct to form a mural plexus ***(Blumgart, 1999).***

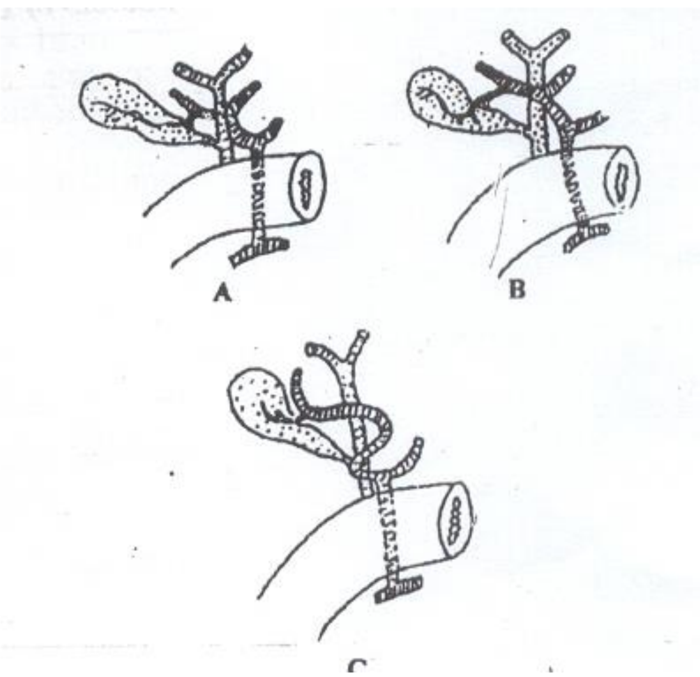


Fig. (6): relationship of right hepatic duct and common bile to the right hepatic artery. (Baily's and Love's, 2002).

Venous Drainage :

The veins draining the bile ducts are satellites to the corresponding described arteries, draining into 3 o'clock and 9 o'clock veins along the borders of the common biliary channel. Veins draining the gallbladder empty into this venous system and not directly into the portal vein. The biliary tree seems to have its own portal Venus pathway to the liver ***(Northover and Terblanche 1992).***

Lymphatic Drainage of the Biliary Tract :

Collecting lymphatic trunk from the left side of the gallbladder drain into the cystic node in the notch of the junction of the cystic and common hepatic ducts. From the left side the collecting ducts enter the node of the hiatus and posterior pancreaticoduodenal nodes. These nodes also receive efferent vessels from the cystic node.

The pericholeducal node receives lymphatic from the extra hepatic bile duct and from the right lobe of the liver. The drainage from these nodes passes to the preaortic nodes around the celiac trunk and the origin of the superior mesenteric artery ***(Skandalkis et al., 1998).***

Nerve supply of the Biliary Tract :

Both sympathetic and parasympathetic vagal fibers derived from the celiac plexus reach the biliary tract; they follow the hepatic artery and its branches. The action of the sympathetic nerves is probably vasomotor, that of the parasympathetic isn't clean.

Complete vagotomy doesn't impair bile output, but it appears to result in permanently enlarged gallbladder ***(Lynn, 1999),*** suggest that there is an intrinsic innervation containing ganglion cells that respond to humoral stimuli, and observes that vagotomy doesn't modify the action of cholecystokinin on the gallbladder.

Pain from the gallbladder may be referred to right sub-scapular region by way of the greater splanchnic nerve and celiac plexus to the somatic nerves or by way of afferent fibers of the coeliac plexus, the phrenic plexus, and the right phrenic nerve.

Histology of the bile ducts :

The large bile ducts have external fibrous (serous) and internal mucous layers. The former is fibro-aereolar tissue with a few longitudinal, oblique and circular nonstriated muscle fibers. The mucosa is a continuous with that of the hepatic ducts, gallbladder and duodenum. Its lining is a columnar epithelium. The bile duct contains many tubulo-alveolar glands which are arranged in clusters and secrete mucin. The circular muscle fibers are well developed at lower parts of main bile duct to form sphincter of Oddi ***(Williams and Dyson, 1992)*.**

II- Embryologic Errors of the Extrahepatic Biliary Tree resulting in Congenital Malformation

Experience suggests that “normal anatomy” is present in less than 50 % of patients and anomalies actually occur with the same frequency ***(Rosylan and Zinner, 1999).***

<u>Variations and Anomalies of Gallbladder :</u>

- Variation in number and size:

a- Agenesis-hypoplasia:

This is rare anomaly of 10,000 cases over 200 of cases of gallbladder agenesis have been reported.

The cystic duct usually absent as well as the gallbladder fossa is poorly developed. Patients with this anomaly have an increased incidence of choleducholithiasis ***(Chaleis and Kloppel, 1999).***

b- Duplication:

In this condition the gall bladder has been subdivided into double gallbladder, having two cystic ducts, septet G.B having multiple lumina but only one cystic duct ***(Chaleis and Kloppel, 1999).***

Duplicated Gallbladder:

According to ***(Weedon, 1997),*** three types are found:

(a) H type: The most common type of duplicated gallbladder is when the cystic duct and accessory cystic duct enter the common bile duct separately.

(b) Y type: The individual cystic ducts may also unite to form a common cystic duct which then drains into common bile duct.

(c) Trabecular type: In the trabecular type or second gallbladder with a duct originating in the liver is found in association with a normally sited gallbladder and duct system.

Multiseptate Gallbladder :

Are divided into a variable number of a communicating chambers by multiple thin longitudinal or transverse septa, it is a rare anomaly**.**

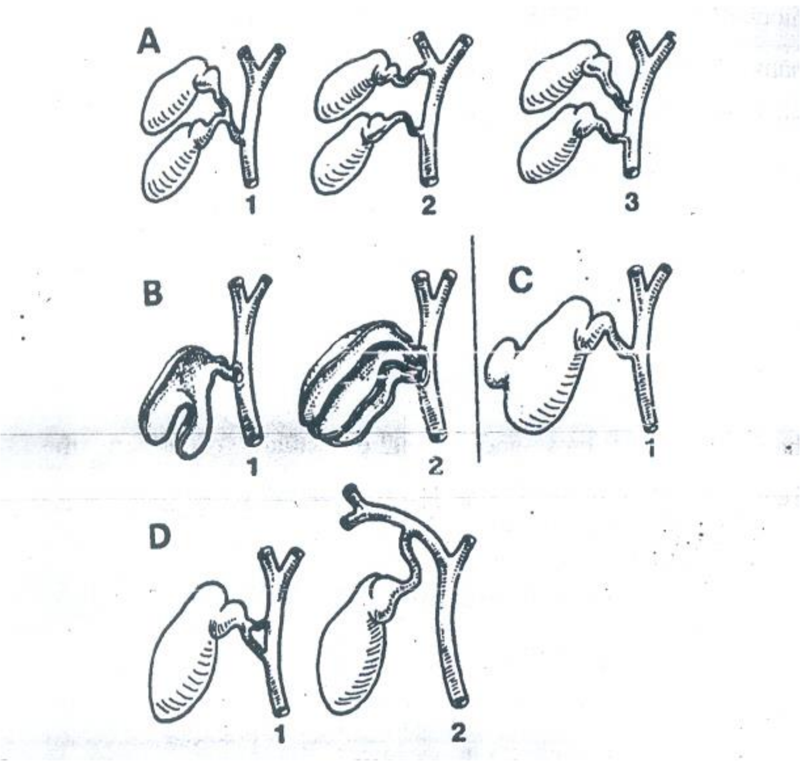


Fig. (7): Main variations in gallbladder and cystic duct anatomy: A) bilobed gallbladder. B) Septum of the gallbladder. C) diverticulum of the gallbladder. D) Variations in cystic ductal anatomy.(Blumgart and Hann, 1999)

Variation and anomalies of Cystic Duct :

1) Anomalies in numbers:

a- Absence of the cystic duct "sessile gallbladder":

The cystic duct is absent in most cases of agenesis of the gallbladder, rarely the duct may be absent in the presence of gallbladder. The gallbladder empties directly into the common hepatic duct. This abnormality closely resembles biliary fistula, in which a large stone perforates the wall of the hepatic duct ***(Weadon, 1997).***

b- Duplication of the cystic duct:

This is extremely rare anomaly, beside a normal cystic duct, a second ascending cystic duct is found, it ends in right or common hepatic duct ***(Weadon, 1997).***

2) Anomalies in course and length:

These are frequently encountered conditions. Most of them are best regarded as variations, rather than anomalies. The mean length of cystic duct is about 3 to 4cm. About 25% of cystic ducts are longer than 5cm.

a) Spinal type: with crossing of cystic duct in front or behind hepatic duct.

b) Parallel type: with deep sometimes double, opening into hepatic duct or separate opening into duodenum.

c) High Opening: of cystic duct into right or left hepatic duct or into bifurcation ***(Charles and Kloppel, 1999).***

Variations and anomalies of Main Hepatic Ducts :

1) Anomalies in configuration:

a- Anomalous bile ducts: variations in configuration are very common. In only 50% of cases can the convergence of right and left hepatic ducts be regarded as completely normal? In all other cases convergence occurs in step like fashion. Sectorial ducts draining small individual segments of the liver unite with the common hepatic ducts at different levels.

It is important that these anatomical variations be known to the surgeon, since the presence of a second large duct may be confused with a cystic duct ***(Charles and Kloppel, 1999).***

b- Accessory bile ducts: Accessory hepatic ducts may open into the cystic duct or the neck of gallbladder, enter the right hepatic duct, enter the right side of common hepatic duct at or very close to the site where cystic and common hepatic duct join, enter the common duct below the insertion of the cystic duct, or enter the gallbladder itself ***(Kihn et al., 2000).***

Accessory hepatic ducts are present in about 10% of human subjects. It is usually the size of a normal cystic duct, but in some cases it may be minute. An undetected injury to one of these ducts may result in no change in the patients' postoperative course or may produce biliary fistula. When accessory duct passes through the cholecystohepatic triangle, it is subjected to inadvertent transaction and bile leakage ***(Schwartz, 2001).***

2) Malposition and Duplication:

Malposition and duplication of the main ducts are rare and usually at postmortem examination. Five different variations have been reported.

a- The common bile duct emptying into the pylorus or the cardiac end of stomach.

b- The common bile duct joining the duodenum independent of pancreatic duct.

c- Bifurcation of common bile duct with separate opening into duodenum.

d- Duplicate of the main ducts.

e- A bifurcating duct with one branch entering the duodenum and other entering the stomach ***(Schwartz, 2001).***

3) Anomalies of Caliber:

a- Congenital biliary atresia**:**

Congenital biliary atresia may result from a failure to develop a normal lumen in the hepatic ducts or in the common bile duct. The incidence is 1/20000 births ***(Schwartz, 2001).***

b- Choleduchus cysts:

Choleduchus cyst is a dilatation of the common bile duct, usually occurring at the lower end. It had got another consequence of in complete canalization of the developing duct, although some authors regard it an acquired process. A congenital weakness of the wall is associated with a distally located, partial obstruction of the bile duct. The resulting cyst gradually enlarges and may contain up to several liters of turbid brown fluid. The condition may produce obstructive jaundice in infancy but usually presents an abdominal mass in late childhood.

The cyst may perforate, causing bile peritonitis. Sometimes there are multiple biliary cysts.

4) Ending Anomalies:

These include anomalies concerning the ending of bile duct in ampulla of Vater and anomalies in the relationship with the pancreatic duct. In 68-86% of individuals the common bile duct and pancreatic emerge to a common channel of 3-8 mm in length before entering the papilla. In 6-22% of individuals the common bile duct and pancreatic duct join without a common duct at the orifice of ampulla of Vater ***(Blumgart, 1999).***

In 8-10% of common bile duct and pancreatic duct have separate opening into duodenum.

These anatomical variants of confluence are known as Y type and U type ***(Schwartz, 2001).***

Arterial Anomalies :

Anomalies of the cystic artery: anomalies of the hepatic cystic arteries are present in about 50% of cases.

Anomalies of arteries of gallbladder are:

a) Cystic artery arises from gastroduodenal artery.

b) Two arteries are arising from right hepatic artery and the other from common hepatic artery.

c) Two cystic arteries, abnormal one arises form left hepatic artery and crosses common hepatic duct interiorly.

d) Cystic artery arises from right hepatic artery but crosses anterior to common hepatic duct.

e) Two cystic arteries arising from right hepatic artery. Right hepatic artery is adherent to cystic duct and neck of gallbladder posterior cystic artery is very short (Common finding) ***(Schwartz, 2001).***

Anomalies of Hepatic Arteries :

a) A “caterpillar hump” right hepatic artery can be in front or behind common hepatic duct or common bile duct and may be mistaken for the cystic artery and ligated because cystic artery arises from caterpillar hump is short, it is easily avulsed from parent trunk ***(Schwartz 2001).***

“Caterpillar hump” right hepatic artery was the most commonly found present in 6.4% of patients operated upon.

b) A large accessory left hepatic artery originates from the left gastric artery occurs in 5% of patients ***(Schwartz, 2001).***

c) In about 5% of cases there are 2 hepatic arteries one originating from the common hepatic artery and the other from superiormesentric artery ***(Schwartz 2001).***

d) In about 3 to 6% of cases the left hepatic artery derives its origin from the left gastric, splenic, superiormesentric artery or from the aorta. In these situations the artery is in danger during performance of subtotal gastrictomy**.**

Mechanism and Classification of Bile Duct Injury

Mechanism and classification of bile duct injury

Bile duct injury (BDI) has long been recognized as serious complication of cholecystectomy and its occurrence has been highlighted with introduction of laparoscopic surgery. Injury to the biliary tree is reported in approximately 0.2% of patients undergoing open cholecystectomy ***(Roslyn et al., 2003).*** The precise rate of BDI in laparoscopic era is however, difficult to determine. A recent study from the west of Scotland does suggest that the bile duct injury rate had fallen from 0.8% to 0.4% in recent years. ***(Richardson et al., 2002).***

Causes of Bile Duct Injuries:

I) Post cholecystectomy injuries:

Injuries to the bile ducts after cholecystectomy vary tremendously in nature as well as consequence. They may range from small post operative fluid collections containing bile that are of little or no clinical consequence to strictures of the intra-hepatic ducts that eventually become intractable to the therapy and require hepatic transplantation ***(Gardenoj, 2001).***

Although rates of bile duct injury reported vary considerably larger series and compiled series reveal range of 0 to 0.8%. In a survey series published by (***Deziel et al., 2003)*** reporting on 77, 604 patients after laparoscopic cholecystectomy, a bile duct injury rate of 0.6% or about twice that associated with open cholecystectomy ***(Deziel DJ et al., 2003).***

Varieties of biliary injuries after cholecystectomy:

a) Cystic duct injuries:

Cystic duct leak appears to be the most common biliary injury associate laparoscopic cholecystectomy. The leak is created by failure to ligate or clip the cystic duct, by inadequate application of endoscopic clips or endoloops, or by proximal leakage of the cystic duct form injury that was unrecognized at the time of operation. Thermal injury may cause dissection of tissue and subsequently cause clips placed on tissue that has been divided with electrocautery to be less secure ***(Mossa, et al., 2002).***

b) Bile duct lacerations, transaction and excisions:

The major difference between bile duct lacerations and excisions is the amount of bile duct tissue that is lost, and thus the possibility for a relatively simple bile duct repairs is less likely. Transactions of the duct require circumferential repair and are associated with greater damage to the microcirculation of the bile duct. As such, they are more likely to cause delay stricture than simple lacerations. Excision may further complicate the issue by removing a linear distance of the common bile duct or common hepatic duct ***(Branum, et al., 2003).***

c) Intrahepatic duct injuries:

Injuries above the bifurcation of the common hepatic duct are being seen more often after lap cholecystectomy ***(Asbun HJ., et al., 2003).***

These injuries occur either during dissection of the gall bladder from its bed in the presence of profound scanning in the triangle of Calot or when misidentification of structures has resulted in dissection being performed on the medial aspect of the common bile duct ***(Asbun HJ. et al., 2003).***

Mechanisms of Injuries and Risk Factors :

Bile duct injuries can be traced to one five errors:

1-The wrong duct is ligated or transected

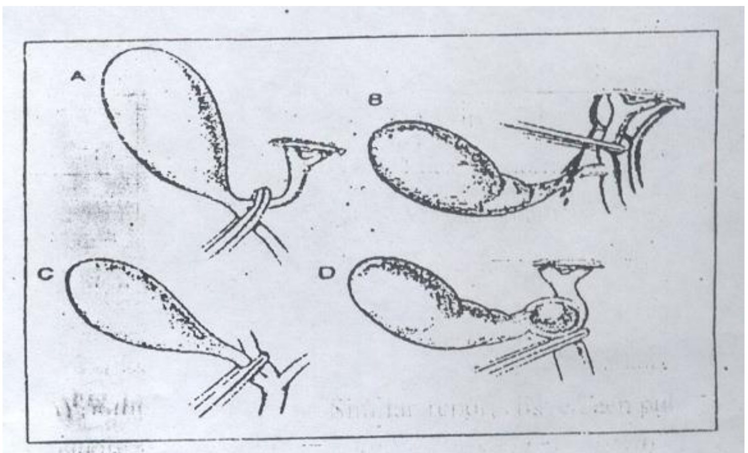
2- The lumen of the bile duct is occluded during (Flush ligation) of the cystic duct

3-The blood supply to the common duct is compromised by excessive dissection,

4-The lumen of the duct is traumatized by forceful "dilatation"

5-Application and control of an energy source are inappropriate.

Almost all injuries to the biliary system can be traced to a failure in one or more of these categories ***(Mossa et al., 2002).***



(Fig. 25) A-D, common errors resulting in bile duct injury during open cholecystectomy

Risk factor:

In an attempt to identify patients who were at increased risk for bile duct injury, a series of 21 patients refereed to the Lahey clinic with iatrogenic common bile duct injuries that followed cholecystectomy were reviewed and it was found that the fibrosis in the triangle of calot acute cholecystitis, obesity, local haemorrhage, variant anatomy and fat in the portahepatis were identified as risk factors ***(Asbun, et al., 2003).*** Undoubtedly, surgical experience is a significant risk factor in the occurrence of bile duct with the incidence appearing to fall as lap. Expertise increases ***(Schol et al., 2001).***

Table (1) : Risk factors for bile duct injury during cholecystectomy (Asbun et al., 2003).

Laparoscopic cholecystectomy	***Open cholecystectomy***
Fibrosis in the triangle of Calot. Acute cholecystitis. Obesity. Local hemorrhage. Variant anatomy. Fat in the porta hepatis.	Fibrosis in the triangle of Calot. Acute cholecystitis. Obesity. Local hemorrhage. Variant anatomy. Fat in the porta hepatis. Inadequate length of incision. Failure to obtain intraoperative cholangiography.

Therefore we can trace the causative factors that predispose to bile duct injury during cholystectomy to:

(1) Anatomical variations:

Bile ducts injury is more likely to occur when the cystic duct, is short, joins the common hepatic duct at a high level, enters a sectoral duct from the right lobe of liver, or runs a long parallel course to the common hepatic duct, or spirals to enter the common duct on its medial surface ***(Martin and Rossi, 2004).*** Despite the fact that there is a high incidence of anatomical abnormality in the disposition and relations of the extra-hepatic biliary tree and arteries, some authors believe the cause of injury isn't so much "Lost anatomy as it is" "a lost surgeon" ***(Munson and Sanders, 2004).***

Table (2): Pathologic conditions predisposing to bile duct injury (Moosa et al., 2002).

Acute cholecystitis. Gangrenous cholecystitis. Perforated cholecystitis. Polycystic disease of the liver. Hepatic cirrhosis.	Scleroatrophic gall bladder. Mirizz's syndrome. Duoednal ulcer. Pancreatic neoplasm and pancreatitis. Hepatic neoplasm and infection.

(2) Pathological factors:

These factors include acute cholecystitis, gangrenous cholecystitis, perforated cholecystitis, and polycystic disease of the liver and hepatic cirrhosis ***(Martin and Rossi, 2004).***

Acute cholecystitis may be accompanied by extensive edema in the region of the portahepatis and Calot's triangle and there may be considerable friability of tissues with distortion of tissue planes rendering dissection hazardous ***(Blumgart and Thompson, 2000).***

(3) Hemorrhage:

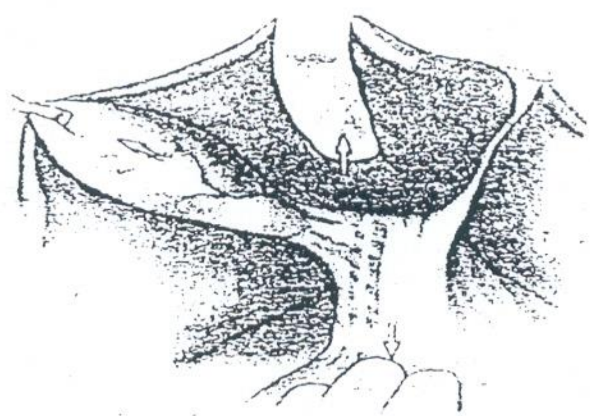
During attempts to control bleeding encountered at the time of cholecystectomy, damage to the bile ducts may occur if clamps are applied blindly ***(Mathews and Blumgart, 2004).***

The bleeding usually arises from the cystic artery or the right hepatic artery, although injury to the common hepatic artery can also occur ***(Mathews and Blumgart, 2004).***

(4) Technical factors the "Dangerous surgery":

a) Inappropriate traction:

The extra-hepatic biliary tree may be injured by excessive traction on the gall bladder, producing a tearing injury of the common bile duct. A similar mechanism may result in avulsion of the cystic duct form its origin. Excessive traction may tent the common bile duct and despite correct identification of the cystic duct, clips may be incorrectly applied to the tented portion of the common bile duct. This type of injury may produce partial or complete biliary obstruction ***(Pleass, and O.J. Garden 2005).***



(Fig. 26) Retraction during open cholecystectomy

b) Dissection injuries:

It is suggested that damage to the vessels supplying the bile duct result in its ischemia with consequent necrosis and stricture. The likelihood of such an event would be in creased by dissection of the bile duct during cholecystectomy, or by undue mobilization of the bile duct prior to cholodoctomy ***(Northrover and Turblenche, 2000).***

c) Thermal and laser injuries:

Excessive or inappropriate use of diathermy within Calot's triangle may produce a burn injury to the adjacent extra-hepatic biliary tree. Typically, this produces a pin hole perforation giving rise to a bile leak in the postoperative period ***(Pleass, and O.J. Garden 2005).***

Complications of bile duct injury:

I- Biliary Stricture:

Strictures of the bile ducts may be benign or malignant.

Postoperative Bile Duct Strictures:

More than 90% of benign biliary strictures occur after injury of the bile ducts during cholecystectomy ***(Czeiniak et al., 2001).*** Regarding the cause and mechanism and risk factors of bile duct injury it was discussed above.

Table (3): Bismuth classification of bile duct strictures (Bisthmus, 1992).

Grade	***Description***
0	Common bile duct
1	Low stricture (>2cm common hepatic duct).
2	Middle stricture (<2 cm common hepatic duct).
3	High stricture (confluence preserved).
4	High stricture (confluence destroyed).
5	Right anomalous duct.

I I) Biliary Fistula:

A biliary fistula is an established, unnatural communication between any portion of the biliary tree and another area or surface ***(Gerald, 2003).***

Biliary fistula may be internal or external.

External biliary fistula:

It is an abnormal, persistent discharge of bile or bile containing fluid usually through the abdominal wall. Biliary fistulae may be intentionally created by the surgeon, e.g. in the creation of a cholycystostomy, but may also occur following hepatobiliary or less commonly pancreatic or gastric surgery ***(Mathews and Blumgart, 2004).***

Aetiology:

We are concerned here with fistulae occurring following a biliary surgical intervention.

* Post-cholycystectomy fistula:

Excessive drainage from operation incisions or drains or abdominal distention with signs of intra-abdominal sepsis noted after cholycystectomy should lead to suspicion of a cystic duct stump leak or a hole in major or accessory duct ***(O'Conner, 2002).***

I I I) Biliary Leakage:

Bile leaking through the surgical incision or from a drain after cholecystectomy immediately raises the suspicion of a major ductal injury ***(William J. Schirmer, et al., 2005).***

The vast majority of bile leak occur in the postoperative period may result form a slipped cystic duct ligature or cut accessory bile duct, trauma to the extra-hepatic biliary tree during cholecystectomy, gastric surgery or pancreatectomy, dislodged T-tube after common bile duct exploration, leakage from bilio-enteric anastomisis or hepatic resections.

Bile leakage raises the suspicion of a major ductal injury. It may also represent damage to smaller subvesical ducts or failure to secure the cystic duct adequately biliary leakage after removal of a T-tube is not uncommon for a few days but if persistent should arouse suspicion of a retained calculus or a missed distal malignant lesion ***(William J. Schimer et al., 2005).***

Carefully performed bilioenteric anastomisis rarely leak for more than a few days and when they do, a technical error, such as suture line disruption or failure to incorporate a significant duct within the anastomisis must be suspected. Alternatively, local factors such as abscess or ischemic necrosis of the duct or bowel wall, must be considered ***(William J., Schimer et al., 2005).***

Biliary leakage following biliary intestinal anastomisis, while relatively uncommon, does occur and is due either to disruption of part of the suture line or to failure of the surgeon to appreciate ductal anatomy, so leaving one or more ducts outside the anastomatic line. This is particularly likely to occur in the hilar region where the made of confluence of the major right and left ducts is extremely variable ***(Kune et al., 2003)***

Suture line disruption may be caused either by technical error, in which cases leakage becomes evident immediately after surgery, or due to some complicating factor such as local abscess formation, postoperative pancreatitis or ischemic necrosis, such leakage only become evident some days after surgery ***(Kune, et al., 2003).***

A persistent biliary leakage after hepatectomy may result from failure to ligate the bile ducts adequately on the transected surface or may be related to a bilioenteric anastomisis ***(William J. Schirmer et al., 2005).***

Classification of the Bile Duct Injuries :

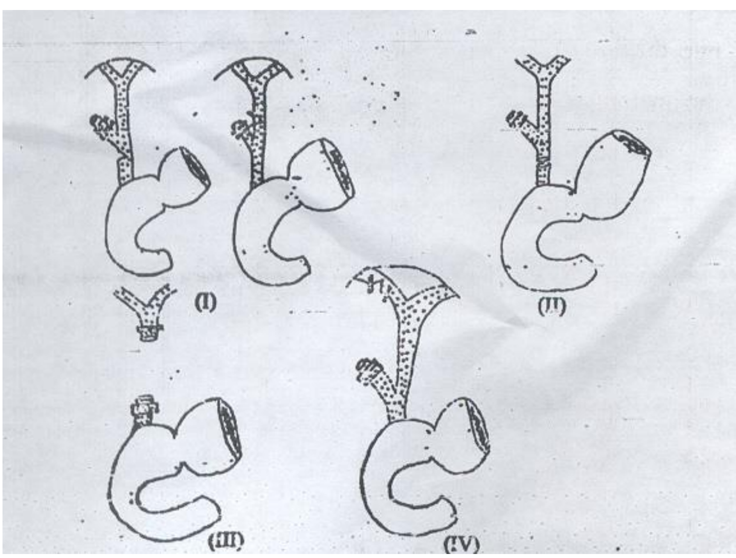
There are actually four types of bile injury:

Type A: Cystic duct leaks or leakage from aberrant or peripheral hepatic radicals.

Type B: Major bile duct leaks with or without concomitant biliary strictures.

Type C: Bile duct stricture without bile leakage and severity of stricture can be graded according to Bismuth “See Latter”.

Type D: Complete transaction of the duct with or without excision of some portion of the biliary tree. The site of the ductal lesion is usually determined by its most proximal border ***(Benjamin, et al., 2004).***



(Fig. 27), Classification of bile duct injuries proposed by War

The most commonly used classification of bile duct injuries is that reported by Corlette and Bismuth in 1981 based on analysis of 643 cases of postoperative biliary stricture. The basis of this classification is the length of the proximal biliary stump, since this is the most important factor in determining the nature of the biliary repair.

Type 1: low common hepatic duct stump > 2.0 cm.

Type 2: middle stricture, length of hepatic duct stump < 2.0 cm.

Type 3: high (hilar) stricture – no serviceable common hepatic duct but the confluence of the right and left hepatic ducts is preserved.

Type 4: high stricture where the confluence is involved and there is no communication between right and left hepatic ducts. The thickness of the fibrosis separating the two branches depends on the extent of the injury, i.e. thin or thick sputum (1-2 cm)

Type 5: combined common hepatic and aberrant right hepatic duct injury separating both from the distal biliary tract.

The Corlette-Bismuth classification has proved useful because it provides essential information on the nature, risks and prognosis after the repair. There is an established correlation between the types of injury and the morbidity, mortality, success and recurrence after repair.

However, the Corlette- Bismuth classification does not stipulate the length of the injury. This information is becoming increasingly important as nowadays, short stricture can be managed by non-operative treatment such as percutaneous endoscopic dilatation or stenting.

A sub classification that indicate the extent of the lesion is desirable, i.e. discontinuity following excision of bile duct, short or long segment stenosis.

The more recent Strasberg classification considers bile injuries from a clinical perspective and includes biliary complications excluded in the Corlette-Bismuth types, e.g. bile leakes and bilomas, and isolated occlusion of the right hepatic duct. In essence it distinguishes two main categories:

- Injuries that separate hepatic parenchyma from the biliary tract.
- Those where the continuity is maintained.

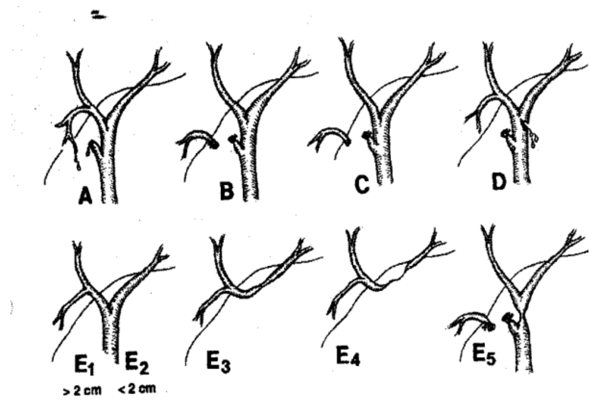
The classification also groups together injuries that have similar presentation and management, as distinct from those that require different management despite having similar presentations.

(Strasberg et al, 2000), introduced a new classification that built upon the traditional Bismuth classification for major injuries, but broadened the detail to separate itemization of injuries seen with increased frequency during laparoscopic cholecystectomy. This classification, based on anatomic location and severity, is widely used currently. From a practical stand point, this classification can offer clues as to what went wrong technically during the ill-fated laparoscopic cholecystectomy (Fig. 28).

Type A injury: bile leak from a minor duct retaining continuity with the common bile duct.
This type of leak results from inadequate closure of the cystic duct or from injury to a small bile duct in the liver bed. It is the least serious because the major ducts are not involved, yet still can be morbid.
Types B and C injuries: creation of a discontinuity for part of the biliary tree.
Types B and C injuries are end lesions that isolate a part of the biliary tree.
The most common variety involves an aberrant right hepatic duct.

About 2% of patients have an aberrant low-lying right duct that drains segments of the right hemiliver, ***(Mercado et al, 2003)***. During dissection, the junction of this aberrant duct with the hepatic duct may be identical to the junction of the cystic duct with the hepatic duct. As such, there can be confusion and true potential for injury. Ductal occlusion injuries are designated type B, and transactions without occlusion are termed type C. The presentation, management, and prognosis of the two types differ considerably.

Type D injury: lateral injury to major bile ducts.
Type D injuries are partial (<50%) and usually lateral transactions of major bile ducts. For example, if the common bile duct (CBD) is misidentified as the cystic duct, inadvertent ductotomy for cholangiography creates a type D injury. If recognized, this may be salvaged by suturing or T-tube placement, something considered acceptable in open cholecystectomy. Type D injuries can evolve to more serious injuries, especially if related to excessive thermal cautery use.



(Fig. 28). the Strasberg Classifications of Biliary Injury from Laparoscopic . Cholecystectomy.

Type E injury: circumferential injury to major bile ducts.
Injury types El to E4 are circumferential injuries based on the level of injury, whereas type E5 injury is a combination of common hepatic duct and aberrant right duct injury. Type E injuries separate the hepatic parenchyma from the lower biliary tract because of stenosis, simple occlusion, or transaction. With the most severe injuries, actual resection of bile duct segments may have occurred.

English Summary

Summary

Cholecystectomy is the most frequently performed operation in abdominal surgery. Laparoscopic cholecystectomy replacing open cholecystectomy is now performed in more than 80% of surgically treated patients for symptomatic gall stones.

Bile duct injuries during laparoscopic cholecystectomy are a serious problem that is better being prevented than treated.

Strasberg et al., 2002: have classified laparoscopic bile duct injury into 5 types:

Type A: Bile leakage from minor ducts.

Type B: Occlusion of aberrant right duct

Type C: Transaction of aberrant right hepatic duct.

Type D: Lateral injury to major e bile ducts.

Type E: Circumferential injury to major bile ducts.

The mechanisms involved in bile duct injuries during laparoscopic cholecystectomy identify the basic error groups:

A) Misinterpretation of the anatomy.
B) Technical errors.

Except for type D and type E injuries, intraoperative identification is uncommon. Even in type E injuries, identification during the operation occurs in only 25% of cases. Injuries have been detected as a result of seeing bile or an open duct. At other times, they have been diagnosed cholangiography or after conversion to an open procedure.

There are several modes of presentation in the postoperative period, but pain with sepsis and jaundice are the two most common. Pain with sepsis tends to occur in injury types associated with biloma types A, C, and D, white understandably jaundice is the most common way that type F injuries present.

Recently, magnetic resonance cholangiopancreatography (MRCP) has emerged as a potentially valuable tool in evaluating proximal bile duct injuries. This non-invasive modality provides sticking images of the biliary tree, and yield anatomical information in a single study that was previously obtainable only with CT and PTC.

Vascular assessment is particularly important if there has been a previous attempt to repair and in the management of more proximal injury, which may be associated with damage to the right hepatic artery.

A multidisciplinary approach (gastroenterologist, radiologist and surgeon) is advocated not only for the diagnostic work-up, but also to decide on the optimal treatment modalities.

There are factors that influence the surgical success rate: preoperative diagnostic evaluation, notably cholangiography, the surgical technique, and the experience of the surgeon.

Bile collections are usually managed by placement of percutaneous intra-abdominal drains under CT or US guidance.

Endoscopic therapy is effective by sphincterotomy, stenting or combination in 66-100% of the patients with bile leaks without further sequelae.

Another method employed in the treatment of bile duct injuries is balloon dilatation and stenting. The balloon dilatation can be performed either via an endoscopic approach or via a percutaneous transhepatic route for higher strictures or recurrent strictures following a hepaticojejunostomy.

The surgical treatment of bile duct injuries should be separated into treatment of injuries detected during the (laparoscopic) procedure, the early postoperative recognized injury (within a few days after surgery); and finally the delayed detected injuries.

Roux -en-Y hepaticojejunostomy has the best success rate for the repair of a transaction or resection injury of the common bile duct or common hepatic duct. Experienced surgeons report a success rate of 8O- and, in series that include less experienced surgeons; the success rate is 60-70%. The advantage of an end-to-end repair includes simplicity and preservation of duct length. This advantage is mitigated by the 5O% stricture rate during follow-up, which usually requires operative revision. The standard operative management for biliary strictures is to perform a tension-free, mucosa-to-mucosa biliary-enteric anastomisis.

Management of Bile Duct Injury

Management of bile duct injuries

Result of early management

The management of bile duct injuries generally is best performed in major medical centers by experienced multidisciplinary teams. This multidisciplinary approach and improved surgical experience have led to a significant improvement in the short-term results from the treatment of these patients. A recent series of 200 consecutive patients managed at the Johns Hopkins Hospital included the deaths of three patients referred after prolonged management at outside hospitals, including attempts at operative management ***(Sicklick JK, et al, 2005)***. All three patients died of multisystem organ failure and sepsis resulting from the uncontrolled biliary leak. These patients did not undergo an attempted surgical repair at Johns Hopkins Hospital. Definitive surgical reconstruction eventually was performed for 175 patients with major bile duct injuries resulting from laparoscopic cholecystectomy. The preoperative mortality rate for the reconstruction was only 1.7%.

In this series, the timing of the repair, the mode of presentation, the previous attempts at repair, and the level of injury did not influence outcome. Postoperative complications did occur for 41% of the patients. Most of these complications, however, were minor and could be managed with either interventional radiology techniques or conservative management.

No patient required reoperation for postoperative complications, and the mean length of hospital stay was only 8 days.

In contrast, failure to define the anatomy by cholangiography, technical considerations, and surgeon experience can lead to less than optimal results. In an analysis of 85 patients presenting with bile duct injuries, ***(Stewart and Way, 2004***), reported that four factors determined the success or failure of treatment, the performance of cholangiography, the choice of surgical repair, the details of surgical repair, and the experience of the surgeon performing the repair. The importance of preoperative delineation anatomy was defined clearly in that 96% of the procedures for which cholangiograms were not obtained before surgery proved to be unsuccessful, and 69% of the repairs were not successful when the cholangiographic data were incomplete. When cholangiographic data were complete, the initial repair was successful for 84% of the patients.

The type of repair also was of primary importance in influencing outcome. A primary end-to-end ductal repair over a T-tube was unsuccessful for all the patients in whom a complete transaction of the bile duct had taken place, whereas 63% of the Roux-en-Y hepaticojejunostomies were successful. Attempts at repair by the primary surgeon were successful in only 17% of the cases, and for no patient was a secondary repair by a primary surgeon successful. If the first repair was performed by a tertiary care biliary surgeon, the success rate was 94%.

The treatment of patients with bile duct injuries depends on the type, level, and extent of the injury, the timing of the diagnosis, the overall status and operative risks of the patient, and the available surgical expertise ***(Rossi and Tsao, 2004).***

A) Pre-operative managment :

Patients with complicated biliary surgery are not good surgical candidates. Dehydration, acidosis, toxemia & hypoproteinemia, all combined with cholangitis, pancreatitis & biliary obstruction, tend to depress liver function. It may require days of a carefully planned preoperative regimen before these patients can safely assume the added burdens of an operation. To ignore this essential preparation is to invite a high morbidity & mortality rate ***(Gerald W, 2003).***

Assessment of these patients includes assessment of general condition of the patient, his blood pressure, ECG & chest x-ray. Also, blood picture & blood urea are assessed because acute renal failure is frequently observed in these patients postoperatively because of the decreased hepatic clearance of endotoxins absorbed from the gut ***(Regison et al., 2001).***

Anemia should be corrected, if necessary, by blood transfusion. Coagulation defects typically manifested by prolongation of the prothrombin time must also be corrected by administration of parentral Vitamin K or fresh frozen plasma ***(Matthews & Blumgart, 2004).***

Patients with prolonged illness may present with malnutrition. Internal feedings through a fine-bore nasal catheter may be successful in some cases but may not be tolerated in sufficient amounts, and parentral nutrition may be necessary.

The use of antibiotics pre-operatively, during the procedure & for several days postoperatively, is strongly recommended when cholangitis is present & to guard against septicemia. The organisms most frequently encountered are E. coli, Staphylococci, Kelbsieilla and Clostridia. A wide variety of organisms can be found but these four types of organisms are responsible for over 80% of positive cultures obtained from the biliary tract ***(Blumgart, 2004).***

B) Non-Operative Management:

1. Management of biliary leak:

Localized bile leaks may often be managed by U.S. or C.T. guided drainage ***(Wolfe et al., 2001)***. Endoscopic sphincterotomy with or without placement of an endoprosthesis may facilitate Closure of the fistula by reducing intraductal pressure ***(Ligoury et al, 2001).*** The combination of distal biliary decompression and external drainage will allow most biliary fistulas to be controlled or even to close. The patient then can be discharged home to allow several months to elapse for resolution of the inflammation in the periportal region and a recovery of overall health status**.**

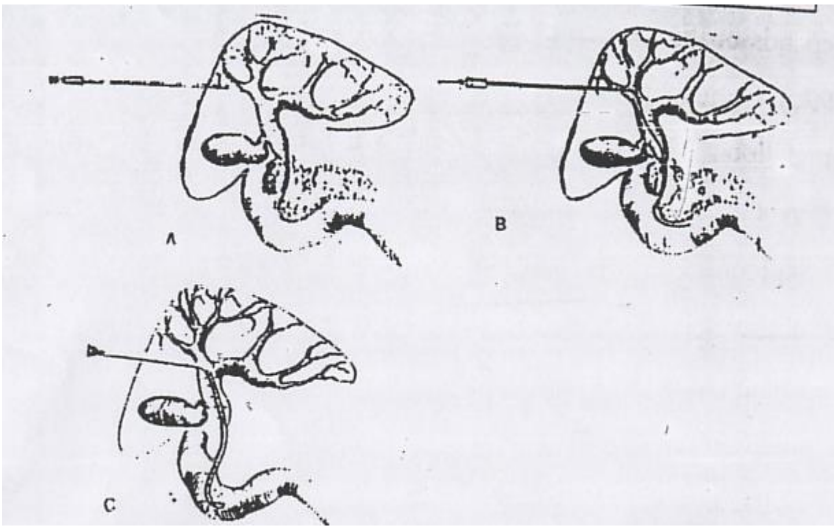
2- Percutaneous management:

Successful visualization of the ducts is achieved in almost all patients with dilated ducts and in over 85% of patients with non- dilated ducts. Dilated biliary systems require drainage to reduce the risk of sepsis and relieve jaundice. A peripheral duct with a direct line of approach to the common hepatic duct is chosen for cannulation. Teflon coated hydrophilic guide wires are particularly useful in traversing even the tightest strictures Subsequent management on the nature of the obstruction demonstrated ***(Rossi et al, 2004).***

Options include:

a) Balloon dilatation: A 7-9 French balloon-tipped catheter is placed in the strictured segment with fluoroscopic guidance and the balloon is inflated until its "waist" within the strictured segment is obliterated. Results suggest that 75% to 80% of strictures will remain patent for at least three years ***(Roslyn et al., 2003).*** In addition dilators of increasing size are then passed through the site of the stircture ***(Rossi and Tsao, 2004).***

b) Percutaneous Transhepatic Drainage (PTD): Before the advent of the thin needle technique, attempts were made to enhance the safety of PTC by leaving a small catheter within the biliary tree and allowing temporary decompression of bile ducts. The patient is placed on broad-spectrum antibiotics immediately before, the procedure. An entry point for the needle is selected in the midaxillary line, usually immediately above the tenth or eleventh rib. Contrast medium is injected through the needle. When the tip of the needle enters the ductal system, contrast agent begins to outline the biliary tree. A 16-gauge sheathed needle is advanced into the duct, and the stent is removed ***(Rossi and Tsao, 2004).***



(Fig. 32). Technique of percutaneous transhepatic biliary drainage (Pleass and Garden, 2005).

c) **The catheter is routinely left** in these patients to minimize the chance of leakage of bile into the subhepatic space, to minimize the chance of sepsis, and to permit future dilation and cholangiography to assess the success of the procedure. How long the stent should remain is controversial ***(Muller et al, 2004),*** Also the long-term results of such techniques and the risk of recurrent stricture remain unclear ***(Pleass and Garden, 2005).***

d) **Endoprotheses:** An endoprothesis may be placed into the bile duct to remove the inconvenience of a catheter protruding from the skin and reduce the risks of infection. Percutaneous placement of plastic endoprothesis requires a transhepatic track of 12 French or greater.

Recently a self-expanding metallic prosthesis has been introduced that needs a smaller percutaneous track and thus, the stent can be inserted immediately without a period of external drainage. Often a percutaneous approach with guide wire manipulation through a stricture is combined with an endoscopic approach. The guide wire is ‘grabbed” in the duodenum and a stent is placed endoscopically. Stent occlusion e.g. by bile encrustations remains a problem, although the expanding metal stents have a longer life span than the plastic endoprothesis. Minor complications such as pain, fever, catheter blockage or leakage occur in 2O% to 40% of patients ***(Roslyn et al, 2003).***

3. Endoscopie management:

Including biliary drainage and or dilatation.

Biliary drainage:

The use of ERCP for the investigation and management of BDI has been well established ***(Pleass and Garden, 2005).*** Transduodenal drainage of the biliary tree is the treatment of choice in patients with leakage from the cystic duct and in selected patients with minor leakage from the common bile duct ***(Rosi and Tsao, 2004).*** Sphincterotomy, stent or naso-biliary drainage has a significant role to play in the immediate management of postoperative bile leaks ***(Pleass and Garden, 2005).*** However, in patients presenting with jaundice without cholangitis, the use of preoperative biliaiy drainage in the patients is controversial. In such patients with benign bile strictures, preoperative biliary decompression has not been demonstrated to improve outcome ***(Pitt et al., 2002).*** Biliary reconstruction of dilated ducts allows for a straight forward anastomisis. In contrast, reconstruction of nondilated duct possible unique challenge on many levels ***(Emond and Marvin, 2001).***

Biliary Dilatation:

More recently, the use of stents and endoscopic ball dilatation has been reported ***(Siegel and Coh, 2004).*** This technique begins with ERCP and endoscope sphincterotomy. The stricture is traversed in a retrograde fashion with an atraumatic guide wire. Sequential dilatation with 4 to 10 mm. balloons is employed. Re-evaluation with cholangiography is performed every 3 to 6 months and re-dilatation is performed necessary ***(Rossi and Tsao, 2004).***

In most cases, an endoprosthesis i.e. stent is left in place following dilatation for at least 6 months ***(Rossi and Tsao, 2004).***It is not worthy to mention that it is difficult to compare results after endoscopic and percutaneous techniques with surgical techniques. Endoscopic and percutaneous dilatation is applicable only in patients with continuity of the biliary tree. In addition, the severity of the stricture, length of follow-up time and post dilatation management are not always comparable. Often stents are left in place for a prolonged period and require multiple exchanges.

No controlled study has clearly compared surgical versus non surgical techniques. Follow-up time is short. In the analysis of results, it important to consider recurrence of symptoms, the need for hospital readmission because of cholanigitis, the need for repeated of stents, and their cost and associated morbidity.

Endoscopic techniques offer a temporary measure in patients with cholangitis and can be used as a more definitive technique in operatively high-risk patients, in patients with difficult proximal strictures, and in patients with portal hypertension and cirrhosis. Endoscopic techniques are associated with long-term results that are similar to those with percutaneous radiologic techniques with the advantage of avoidance of the morbidity related to possible puncture of the liver by PTC ***(Rossi and Tsao, 2004).***

C) Operative management:

The operative management of bile duct injuries depends upon whether the injury is recognized at the time of the original operation in the immediate post operative period or after a delayed interval ***(Lillamoe et al., 2006).***

1) Bile duct injury recognized at the time of the initial operation:

If the injury is recognized at the time of initial operation, then the surgeon should immediately consider his own experience and competence to deal with the injury when available, a more experienced surgeon must be consulted. It is probably preferable to provide external drainage by means of a tube inserted proximally and refer the patient for specialized centre than to complicate the situation by an attempted repair which causes further damage to the ducts ***(Lillemoe et al., 2006).***

The damaged area and the bile duct on either side require careful dissection to define the extent of injury. To accomplish this without making matters worse, laparoscopic procedures should be immediately converted into full laparotomies, and improved exposure must be obtained by extending the incisions and calling for additional assistance to aid in retraction. Operative cholangiography may be needed to delineate the anatomy and type of injury. Unfortunately, the injury in most cases involves transaction or excision of a length of the bile duct ***(Davidoff et al, 2002).***

Regardless of the location of the lesion, initial repair should aim at maintenance of ductal length below the hilus without sacrifice of tissue and avoidance of uncontrolled postoperative bile leakage. There are two major options for the surgeon in cases of complete duct transaction. First, if the ends can be opposed without tension, then end-to-end anastomisis may be feasible.

The duodenum should be mobilized so as to minimize tension, and a single layer of absorbable sutures is used to accomplish the anastomisis. The anastomisis is made over a T-tube brought out of the bile duct away from the line of anastomisis. As 50 to 60% of such anastomisis may subsequently form a stricture and result in loss of length, Roux-en-Y hepaticojejunostomy may be chosen over direct repair for high injuries ***(Bismuth et al, 2000).***

Lateral injuries without loss of length (such as avulsion of cystic duct) are unusual. These injuries are amenable to direct repair of the defect over a T tube. Long lateral injuries which are not circumferential may be impossible to repair without narrowing of the lumen. Vein patch can be used to close the defect and bridge the gap in the bile duct. Others have described the use of cystic duct stump or pedicled flap of the jejunum to close such defects**.** More recently a Roux-en-Y loop of jejunum used a serosal patch is described. A T tube is placed across the defect and its long limb is brought out of the anterior abdominal wall through the jejuenal wall ***(Matthews & Blumgart, 2004).***

* Management of patients at the time of laparoscopic cholecystectomy is dictated by the operative and cholangiographic findings. In cases for which intraoperative cholangiography is performed and the flow to the proximal biliary tree is interrupted, as in the early stages of creating a “classic” bile duct injury ***(Branum G. et al, 2003)***, most surgeons consider the appropriate management simple to be removal of a clip and simple suture repair of the bile duct at the site of the cholangiocatheter entry. Although long-term follow-up results for such cases are seldom reported, in most cases, transient clip application should not be expected to result in a late stricture. Unfortunately, if cholangiography is not performed, the injury usually will not be recognized until the bile duct has been transected. In such cases, the proximal bile duct may be visualized and possibly considered an “accessory duct”. In many cases, this duct is inadequately clipped. More often, with the retraction applied, the surgeon may not even recognize a second duct, and consequently may divide it with cautery or a harmonic scalpel. If the bile leakage is observed or atypical anatomy (e.g., an “accessory” duct) is encountered, no further tissues should be divided, and prompt cholangiography should be performed. If a segmental or accessory duct smaller than 3 mm has been injured and cholangiography demonstrates segmental or subsegmental drainage of the intrahepatic ductal system, simple ligation of the injured duct is adequate. If the injured duct is 4 mm or larger, however, it is likely to drain multiple hepatic segments or the entire right or left lobe, and thus requires operative repair.

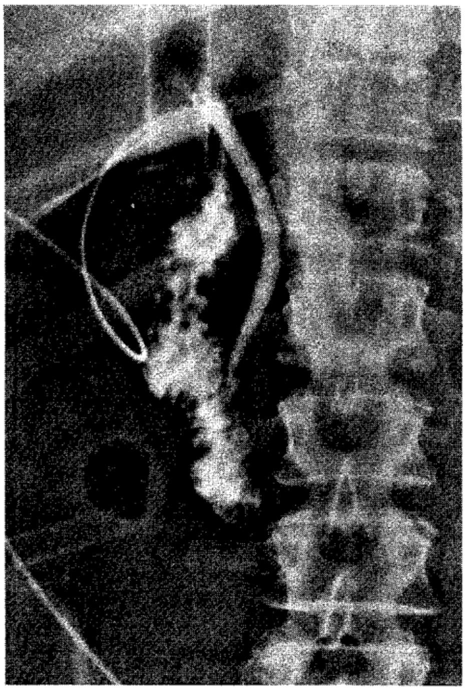
If the injury involves the common hepatic duct or the common bile duct, repairs should be performed at the time of injury. The aim of any repair should be to maintain ductal length rather than sacrifice tissue, and to create a repair that will not result in postoperative bile leakage. If the injured segment of the bile duct is short (<1 cm) and the two ends can be opposed without tension, an end-to-end anastomisis can be performed with placement of a T-tube through a separate choledochotomy either above or below the anastomisis. Generous mobilization of the duodenum out of the retroperitoneum (Kocher maneuver) can be useful in helping to approximate the injured ends of the bile duct.

For proximal injuries near the hepatic duct bifurcation or injured segments of bile duct longer than 1 cm, an end-to-end bile duct anastomisis should be avoided because of the excessive tension that usually exists in these situations. In these circumstances, the distal bile duct should be over sewn, the proximal bile duct debrided of injured tissue, and an anastomisis created to a Roux-en-Y jejunal limb in end-to-side fashion. Most surgeons believe that a transanastomotic stent, usually placed in a retrograde manner through the transected duct and exiting the hepatic parenchyma, is important to allow postoperative external drainage.

Finally, for cases involving a major bile duct injury at or near the hepatic duct bifurcation in a non dilated biliary system, the primary laparoscopic surgeon may feel uncomfortable attempting repair. In such cases, proceeding with an attempt at repair may lead to progression of the injury and diminish the patient's chances for a long-term successful result.

It may therefore be appropriate for the primary surgeon not to attempt repair at this time. In such cases, it is imperative to create a controlled fistula. Placement of a small drainage catheter in retrograde fashion into the transected duct or ducts as well as a closed suction drain in Morison's pouch generally can control the biliary drainage. The patient then can be transferred to a tertiary care center with combined surgical and interventional radiology specialists who can best deal with the problem.

The placement of the intraductal catheter will facilitate percutaneous transhepatic cholangiography and the placement of percutaneous biliary catheters will define the anatomy and further control the fistula.



(Fig. 33). Intraoperative cholangiogram demonstrating normal distal bile duct, but no filling of the proximal biliary tree. This finding is highly suggestive of a bile duct injury

2) Bile duct injury recognized in the immediate postoperative period:

Injury not recognized intraoperatively may present in the first few days following the operation either as excessive bile drainage through the wound or drain site, as bile collection or peritonitis, or as progressive jaundice. In cases presenting with an external biliary fistula, the essential consideration in the management is to avoid early re-operation. Early repair of such injury is far from being simple and sometimes proves impossible, as the bile ducts are not dilated and the inflammation and bile staining of tissues renders exposure of healthy bile duct mucosa extremely difficult. The patient is monitored for fluid and electrolyte balance, infection is treated and provided that there is no distal obstruction to bile flow, spontaneous closure usually occurs. Fistulography may be helpful, if it reveals any continuity between the biliary system and the gastrointestinal tract, then prolonged period o drainage could be waited for closure of the fistula ***(Regison et al, 2001).***

A delayed approach, when indicated, would be easier since bile ducts would have dilated at the time of repair. If the patient presented with progressive jaundice, the injury is managed as outlined for an elective repair ***(Lillemoe et al., 2006, Mathews & Blumgart, 2004).***

Recognition of bile duct injuries in the postoperative period:

Clinical presentation:

Most patients with a bile duct injury after laparoscopic cholecystectomy present during the very early postoperative period in one of two ways. Some patients present with biliary obstruction, manifested as progressive elevation of liver function test levels, particularly total bilirubin and alkaline phosphatase levels. These changes often can be seen as early as postoperative day 2 or 3.

Other patients present with leakage of bile from the injured bile duct. This presentation appears to be more common among patients with bile duct injuries after laparoscopic cholecystectomy than among the patients who underwent open cholecystectomy in an earlier era. Bilious drainage from an operatively placed drain or through the wound after cholecystectomy is abnormal and represents some form of biliary injury. In patients without drains (including patients whose drains have been removed), the bile can leak freely into the peritoneal cavity or loculate as a collection. Free accumulation of bile into the peritoneal cavity results in either bile ascites or bile peritonitis. Although the bile may not actually be infected, the chemical irritation will lead to a clinical presentation suggesting peritonitis. Similarly, a loculated bile collection can result in a sterile biloma or an infected subhepatic or subdiaphragrmatic abscess.

Currently, most patients undergoing laparoscopic cholecystectomy are discharged to home immediately after the operation or within 24 h. Thus, there may be no suggestion of a clinical problem. The development of progressive abdominal pain, nausea, vomiting, abdominal distention, or fever 2 to 5 days after the injury should warrant the surgeon's suspicion of ongoing bile leak. These patients should be seen immediately for evaluation.

Laboratory investigations:

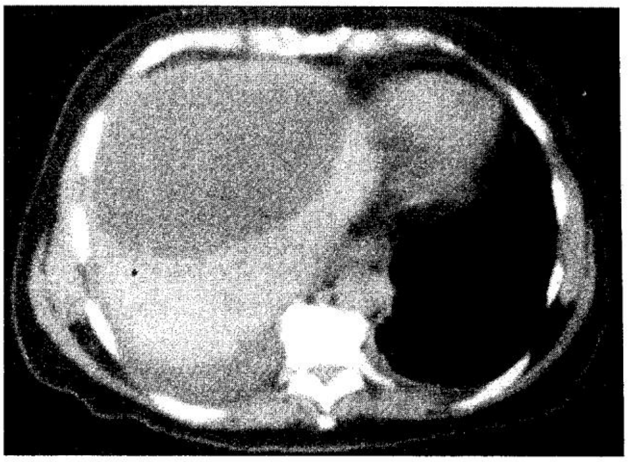
Liver function tests obtained in the early postoperative period, after bile duct injury may show evidence of cholestasis, with elevation of serum bilirubin and alkaline phosphatase levels. For situations involving a bile leak into the peritoneal cavity, these values may be normal. The serum bilirubin may be minimally elevated because of absorption from the peritoneal cavity, usually in the range of 2 to 6 mg/dl.

Radiologic imaging:

The imaging techniques of abdominal ultrasound and computed tomography (CT) play an important initial role in the evaluation of patients with bile duct injuries. For patients who present in the early postoperative period with the clinical suspicion of a bile leak or biliary sepsis, these studies are useful for ruling out intraabdominal collections or free peritoneal fluid. Ultrasound and CT studies also can confirm biliary obstruction by demonstrating a dilated biliary tree. CT is especially useful in identifying the level of obstruction to the extra hepatic bile duct.

If a bile collection is suspected, percutaneous aspiration or drain placement can confirm that the fluid is bile and serve as a step to control the effects of the bile leak. It is imperative that the patient not be taken to the operating room for an attempted repair at this time without further information concerning the site and nature of the injury.

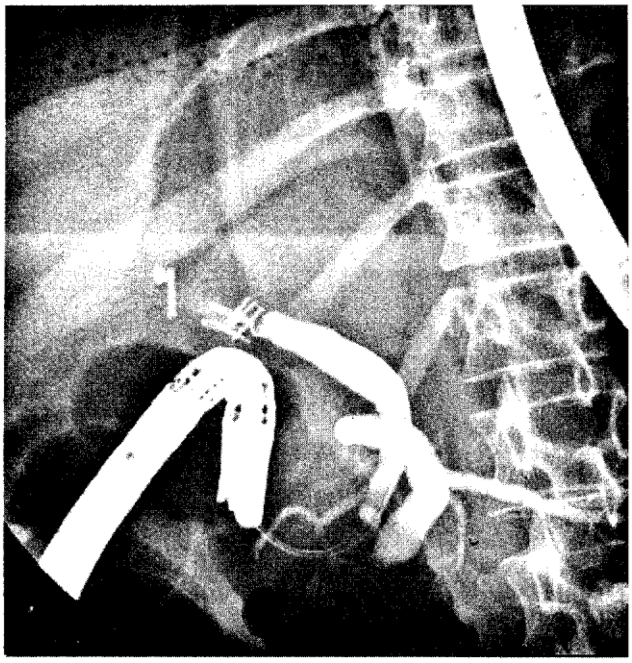
For patients suspected of having an early postoperative bile injury, a radionucleotide biliary scan can confirm bile leakage. This study usually is diagnostic of a bile leak, but is not particularly helpful in identifying the actual site of leakage. Therefore, it may not be able to direct the next steps in evaluation completely. For patients with postoperative external bile fistulas through operatively or postoperatively placed drains, injection of water-soluble contrast media through the drainage tract (sinography) also can define the site of leakage and the anatomy of the biliary tree.



(Fig. 34). Computed tomography (CT) scan showing a large biloma after laparoscopic cholecystectomy bile duct injury.

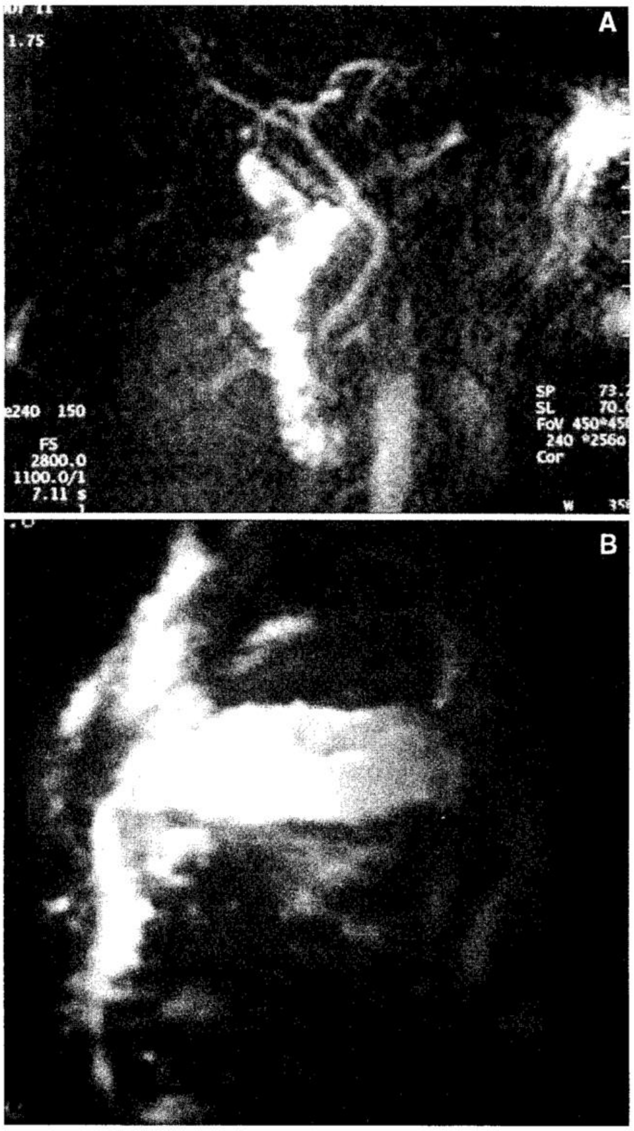
(Fig. 35). Percutaneous transhepatic cholangiogram showing complete transaction of the hepatic duct just below the bifurcation.

The gold standard for the evaluation of patients with bile duct injuries is cholangiography. Percutaneous transhepatic cholangiography (PTC) usually is more valuable than endoscopic retrograde cholangiography (ERC). The PTC procedure is more useful in that it defines the anatomy of the proximal biliary tree to be used in the surgical reconstruction. Furthermore, PTC can be followed by placement of percutaneous transhepatic biliary catheters, which can be useful in decompressing the biliary system either to treat or to prevent cholangitis or to control the ongoing bile leak. This procedure can be technically difficult in patients with a bile leak, and thus a nondilated biliary tree. Nevertheless, most surgeons believe that the role of the interventional radiologist is essential both for defining the proximal anatomy and for placing catheters to control the ongoing bile leak. These catheters also will be of assistance in the surgical reconstruction.



(Fig. 36). Endoscopic retrograde cholangiogram demonstrating complete obstruction of the bile duct associated with a "classic" bile duct injury.

The ERC procedure is less useful than PTC because the discontinuity of the bile duct, most frequently associated with injuries resulting from laparoscopic cholecystectomy, prevents adequate filling of the proximal biliary tree. Often, ERC demonstrates a normal- sized distal bile duct up to the site of the obstruction without visualization of the proximal biliary system (Fig. 37). This is always the case with patients who have the “classic” bile duct injury, in which the distal bile duct is clipped and divided.



(Fig. 37). A) Magnetic resonance cholangiopancreatography (MRCP) demonstrating an intact biliary tree with a cystic duct leak.

B) MRCP demonstrating complete transaction of the bile duct with massive extravasations of contrast into the sub hepatic space.

The development of magnetic resonance cholangiopancreatography (MRCP) provided a noninvasive technique that offers excellent delineation of the biliary anatomy. The quality of these images have led some surgeons the advocate this technique as the initial step in evaluating patients with suspected bile duct injuries. The use of MRCP may eliminate the need to use diagnostic ERC for these patients. If performed as an initial noninvasive technique, MRCP can define a major bile duct transaction, for which ERC will be of no value, as compared with a cystic duct leak, for which ERC can lead to therapeutic stent placement.

Treatment of Biliary Fistula:

The management of bile fistulas developing in the early postoperative period begins with demonstration of the fistula, via fistulography, cholangiography, or HIDA scan ***(Regison et al, 2001).***

The treatment consists of the following:

1- Electrolyte and fluid replacement.

2- Control of infection.

3- Treatment of underlying cause.

1- Electrolyte and fluid replacement :

Electrolyte and fluid replacement and the prevention of fluid and electrolyte depletion follow conventional lines. Estimation of the volume and composition of loss and replacement either orally or, if volume can not be replaced, by venous administration is performed. If there is associated duodenal or pancreatic Juice loss, total parentral nutrition is valuable and often mandatory if further surgery is contemplated ***(Blumgart, 2000).***

Serious acid-base and electrolyte imbalance should be corrected.

Control of infection:

Infection should be controlled with broad spectrum antibiotics: Bile peritonitis results from internal bile fistula and bacterial infection**.** These patients may be critically ill, requiring aggressive fluid resuscitation and broad spectrum antibiotics. Immediate operative exploration is required to drain the peritoneal cavity and control the bile fistula with external drainage. Once infection is under control and nutritional status corrected, carefully planned definitive repair should be undertaken as in simple bile fistulas ***(O'Conner, 2002).***

2- Treatment of the underlying cause :

Post-cholycystectomy biliary fistula:

Small amounts of bile may drain for a few days in the immediate post-operative period following cholcystectomy, with almost always no squeal. However, if large quantities of bile, of the order of 100 ml per day or more, drain in the postoperative period then there is usually a serious cause and indeed operative injury of a major bile duct should be suspected. The essential in management in this situation is not to reoperate rapidly ***(Blumgart, 2000).***

A cautions approach is preferable since even ultimate closure of the fistula with the development of jaundice is usually associated with proximal ductal dilation and easier subsequent repair ***(Blumgart, 2000).*** Should fluid loss from the biliary fistula prove too heavy and prolonged, then the external fistula can, after some weeks, be converted to an internal fistulo-jejnostomy ***(Smith et al., 2002).*** Subsequent definitive repair of the stricture is performed if and when necessary ***(Blumgart 2000).***

Merely be observed. However, recurrent cholangitis secondary to stricture of the common bile or common hepatic ducts may result in cirrhosis and portal hypertension with subsequent liver failure. Liver transplantation has been undertaken in patients with both acute duct and vascular injury, in addition to those with secondary biliary cirrhosis ***(Pleass and Garden, 2005)***

Bile peritonitis:

Patients with bile peritonitis are often desperately ill, especially if the bile is infected, although some patients with sterile bile may accumulate large volumes without overt signs of sepsis. ***(Blumgart et al., 2000)***

Drainage of the bile collection and control of ongoing bile leak is the primary objective, and often requires percutaneous abscess drains in combination with percutaneous biliary catheters. ***(Blumgart et al., 2000).*** Definitive repair is seldom possible initially, with the bile ducts collapsed, deeply bile stained and friable, and is best delayed until the biliary leak has been completely controlled and the patient has been resuscitated fully. ***(Blumgart et al., 2000)***

3) Bile duct injury recognized lately and duct stricture :

Patients who present with symptomatic late biliary strictures will almost certainly require definitive surgical correction. The definitive treatment is best carried out in specialized canters where the over all results in term of f long- term freedom from jaundice, cholangitis and maintenance of good to normal liver function, are excellent “85-90%” and the operative mortality is low “1-5%” ***(Cushierie et al. 2004).***

The exact treatment depends on the pathological anatomy of the stricture:

1) For distal duct stricture:

For strictures of the retropancreatic or the immediate supraduodenal portion of the common bile duct, choledochoduodenostomy is considered an ideal procedure. The anastomisis may be reformed in either side to side or end to side fashion and yields good results if the bile duct is dilated ***(Matthews and Blumgart, 2004).*** Moreover, the anastomisis is amenable to endoscopic dilatation ***(Rossi and Tsao, 2004).***

2) For common hepatic duct strictures with a serviceable extrahepatic duct stump:

Roux en-Y-hepaticojejunostomy is the treatment most commonly used. Some prefer to use an isolated jejunal is operistaltic segment interposed between the stump of the common hepatic duct and the duodenum instead of the Roux-en-Y-loop ***(Rossi and Tsao, 2004).***

3) For high strictures with no residual stump but with an intact hilar confluence:

Dissection of the liver plate to expose the left hepatic duct as it crosses at the bottom of the quadrate lobe "anterior segment IV" enables a good anastomisis to be performed between this duct and a Roux-en-y-jejuenal loop. This technique doesn’t require any splitting or resection of the liver parenchyma ***(Blumgart, 2000).***

4) Destruction of the hilar confluence:

These are the most difficult strictures to deal with and usually require some resection or splitting of the liver substances. An access jejunostomy is increasingly being used in addition to the repair.

This allows percutaneous dilatation if the stricture recurs. All these procedures require stenting either transhepatically or through the jejunal loop. The various options are:

i) Round ligaments approach with anastomisis to the segment III duct.

ii) Excision of the quadrate lobe to identify the right and left hepatic ducts which then anastomosed separately to a Roux-en-Y- Loops.

iii) The smith mucosal graft operation and longmire's procedures. They are seldom used nowadays as their results are inferior to the above procedures ***(Blumgart, 2000).***

Biliary enteric anastomosis with stenting:

The role of transanastomotic stenting remains controversial. ***(Lillimoe et al, 2006)*** suggested that a transanastomotic stent is helpful in all cases. In the early postoperative period, a stent is useful to decompress the biliary tree and provide access for cholangiography. If the injury is of Bismuth Type 1, the use of long-term biliary stenting is not necessary. In these situations, the preoperatively placed percutaneous transhepatic catheter or an operatively placed T-tube is used to decompress the anastomisis for 4 to 6 weeks following reconstruction. However, when adequate proximal bile duct is not vailab1e for a good mucosa-to-mucosa anastomisis such as in cases with prior attempts at repair, long-term stenting of the anastomisis with a Silastic transhepatic stent for about 12 months is favored. Silastic transhepatic biliary stents can be inserted by a number of methods. Preoperatively placed percutaneous transhepatic catheters, Randall-Stone forceps, or a long Bakes dilator can also be used ***(Cameron et al., 2003)***. For strictures of Bismuth Type 2, only one transhepatic stent is usually needed.

However, for higher strictures, Bismuth Type 3 and 4, the right and left main hepatic ducts should have preoperatively placed stents. If preoperative insertion of transhepatic stents was not done, they can be performed intraoperativly. The Silastic stents are 70 cm in length and come in 12 to 22 French sizes. They have multiple side holes along 40% of their length, which reside within the intrahepatic biliaiy tree and Roux-en- y jejunal limb. The ends of the stent exit through the hepatic parenchyma and through a separate stab of the skin. They are fixed to the skin with wire sutures and coveered with bile bags for drainage ***(Liliimoe et al, 2006).***

On the other hand, ***(Rossi and Tsao, 2004)*** suggested that stenting is not required in most patients undergoing hepaticjeujunostomy. On occasions, they used a transhepatic pediatric feeding tube passing through a smal1 segmental duct to facilitate in the performance of the anastomisis. Stents are removed within six weeks to minimize the deposition of debris within the biliary system and the irritative effect of the stent , (***Rossi and Tsao, 2004, Pitt et al, 2002)*** found better results in patients whose stents were in place for one month compared to those removed in less than one month. In general, the likelihood of stenting having benefit in a large mucosa-to-mucosa anastomisis with normal duct tissue (Bismuth Type I) is relatively small. However, a long-term stent may keep questionable anastomisis done through scar tissue open and prevent later fibrosis and stricture ***(Lillimoe et al, 2006).***

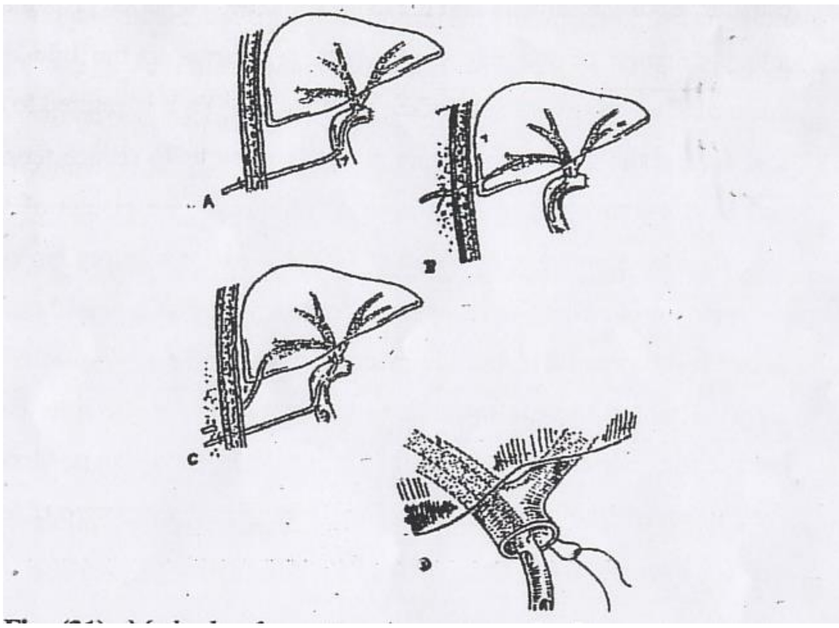


Fig. (38): Methods of stenting. A transjejunaly, B transhepatically, C as a U tube, D fixation of the tube before beginning of anastomisis.

Surgical procedures:

(A) Choledochoduodenostomy :

It is an ideal procedure for stricture of the retropancreatic portion of the common bile duct or of the common bile duct in its immediate supraduodenal portion. The procedure yields better results if the common bile duct is dilated and is performed side-to-side or end-to side. Low injuries suitable for treatments in this manner are unusual after cholecystectomy and occur more often after gastric operations ***(Blumgart and Thompson, 2000).***

Types of Choledochoduodenostomy:

(I) Side-to-side (Lateral) Choledochoduodenostomy:

It is an anastomisis between the anterior surface of the common duct and the posterosuperior aspect of the adjacent duodenum. Sandars, 1999 was the first in the United States to recommend the procedure, and (***Madden et al, 2000)*** in their favorable report, stimulated its use.

Lateral choledochoduodenostomy is technically simpler than choledocholejunostomy. If the common duct is 2cm or larger in diameter, the stoma will probably remain open. It follows that if the stoma is patent, cholangitis will not occur ***(Jones, 2002).***

<u>Technique :</u>

A kocher maneuver to mobilize the duodenum and head of pancreas must be executed so that the duodenum can be brought to the hilus of the liver. A longitudinal choledochotomy is made to the point where the common duct becomes retroduodenal. Careful measurement of the choledotomy must be made to ensure that it is at least 2-5 cm in length. The duodenum is incised toward its lateral edge in a peristaltic direction; this incision should be 2 to 3mm shorter than the length of the choledochotomy, because the duodenal incision will stretch slightly. A single interrupted layer of fine absorbable sutures is used for the anastomisis. A two layered anastomisis will produce too large a ridge and may result in a narrowed opening**.**

Akiyma and Ikezawa, 2000 in a series of 15 patients for up to 5 years after choledochoduodenostomies, in which they used a two-layered interrupted technique with 3/0 silk and 3/0 chronic sutures reported that there was evidence of residual intraluminal silk sutures, with inflammation of the stoma, in 4 of the 15 patients.

Anastomotic stents are not necessary. Drains are optional, but generally drains are not used if the patients have had previous choleystectomy. One of the long-term sequelae reported with the side-to-side procedure has been the *"Sump syndrome"* in which particular matter, stones and food debris accumulate and stagnate in the distal blind end of the common duct, is an occasional cause of recurrent cholongitis which may develop with or without anastomotic stricture ***(Matthews, et al., 2004).*** The treatment of such sequelae often involves endoscopic cannulation of the duodenal-biliary anastomisis to decompress the biliary system, along with antibiotics. Endoscopic sphincterotomy provide distal bile duct drainage of the sump but cannot be used in patients with long strictures. Several patients with this problem require reoperation and conversion to another type of drainage procedure. Lateral choledoduodenostomy is not advisable as treatment of lower biliary tract stricture associated with pancreatitis, since the obstruction of the distal duct in the sump may cause pancreatitis ***(Thompkins, 2000).***

(II) End-to-side (Transection) choledochoduodenostomy :

The end-to-side procedure requires complete division of the bile duct with over sewing of the distal end, and implantation of the proximal cut end into the duodenum. The goal of this procedure, as with all biliary-enteric procedures, is to create an anastomisis that will allow free flow of bile and intestinal content out of the biliary system. A stoma of 2.5cm is the minimum necessary for satisfactory results ***(Tompkins, 2000).***

Results of choledochoduodenostomy :

The postoperative course is remarkably benign and the risks of postoperative T-tube cholangiography are not present. The majority of patients are able to eat by the third postoperative day, and many are ready for discharge after one week ***(Gliedmann and Gold, 2004).***

(***Madden et al., 2000)*** reviewing 1255 choledocho- duodenostomies performed, found an overall mortality rate of 2.7% and the incidence of cholongitis was 0.4 percent, while (***Gliedmann and Gold, 2004)*** reviewing 1882 choledochoduodenostomies reported in the literature , showed a reduced mortality rate to an overall 1.9% and the incidence of cholangitis was 0.9 percent.

So one criticism of choledochoduodenostomy has been that it results in ascending cholangitis from either retained calculi and debris or food particles entering via the newly created anastomisis. Another criticism has been that it results in the creation of a *"blind"* segment or pouch between the anastomisis and the papilla of vater. It is postulated that this blind segment serves as a *"sump syndrome"* and promotes stasis and cholongitis by permitting food particles, infected bile and residual calculi to remain in the distal portion of the common bile duct ***(Gliedmann and Gold, 2004).***

(***Akiyama and Ikezawa, 2000)*** in the series of 15 patients with choledochoduodenostomies noted residual food debris distally in 4 patients who underwent endoscopy annually. The material may be floating and easily washed out or may be adherent. It is important to note that all of these patients had a stoma size of at least 2.5cm.

Again, choledochoduodenostomy may lead to slight bile leak without any constitutional symptoms. This is generally begun and usually subsides within few days. All patients should have air in the biliary tree postoperatively and when evaluation of a choledochoduodenostomy is needed, two options exist. An upper gastrointestinal tract x-ray films should show prompt filling of the biliary tree, and complete emptying should occur by 12 hours and certainly no later than 24 hours. Currently with the HIDA scan, a properly functioning stoma will empty the biliary tree in 45 minutes ***(Gliedmann and Gold, 2004).***

(B) Choldedochojejunostomy :

Because of the problems of recurrent cholangitis, duodenal fistulae, pancreatitis and other associated with duodenal anastomisis, many surgeons have favored the diversion of the biliary system into the jejunum. This may be done by two main procedures ***(Tompkins, 2000).***

1- In-Continuity choledochojejunostomy:

The in-continuity or simple loop of jejunum procedure is less frequently employed because it has the potential risks of an intestinal leak and fistula and often is technically more difficult than the Roux-en-Y procedure because of the shortened mesentery and increased anastomotic tension. Also, the threat of reflux of intestinal contents and cholangitis is still significant ***(Tompkins, 2000).***

2- Roux-en-Y choledochojejunostomy or hepaticojejunostomy*:*

Because biliary tract strictures are essentially iatrogenic in 97 percent of instances and each unsuccessful repair poses increased morbidity and mortality, a kind of reconstruction is desired in which a long lasting primary functional and anatomic situation is restored. The Roux-en-Y diversion is the procedure of choice for many patients with benign bilairy strictures ***(Freund et al, 2002).*** When the stricture is of Bismuth type 1 or 2, then an approach to the common hepatic duct stump is usually not unduly difficult. When, however, the stricture involve the confluence of the right and left hepatic ducts (Type 3) or extends so as to separate these duct (type 4), the problem becomes much more complex and good results more difficult to obtain ***(Blumgart, 2000).***

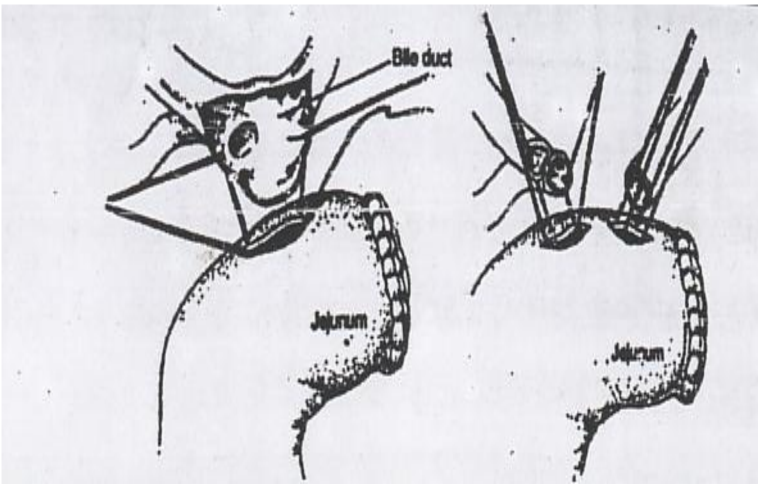


Fig. (39): Technique of Roux-en Y hepaticojejunostomy (Emond and Marvin, 2001).

(A) End-to-side hepaticojejunostomy is constructed with interrupted fine monofilament absorbable sutures. The knots for the back wall are on the inside and are tied after placement of all the sutures.

(B) The same technique may ye used to implant multiple ducts if the scar extends above the confluence. More than one anastomisis is needed if the orifices are more than 1 cm apart.

Repair of high strictures (Bismuth type 2, 3 and 4) is much more demanding and a variety of approaches may be used. The choice of approach depends on the height, extent of the stricture and associated liver disease. The essential and most important point is identification of the bile duct proximal to the stricture ***(Blumgart, 2000).***

Approach to the left hepatic duct:

The divided and tied ligamentum is elevated and used as a retractor. The base of the quadrate lobe is identified between the gall bladder fossa and the umbilical fissure. Splitting of the bridge of liver tissue between the quadrate lobe and the left lateral segment exposes the umbilical fissure. The dissection now proceeds in the plane between the Glisson capsule and the peritoneal reflection encasing surface of the quadrate lobe and exposed for dissection (Lowering of the hilar plate).

Dissection can then proceed toward the right and the area of the confluence of the hepatic ducts and of the right hepatic duct is exposed. In type IV strictures additional exposure and better length of the right hepatic duct may be obtained by incising the liver tissue in the line of the scar of the gall bladder fossa. This liver split allows mobilization of the quadrate lobe. On rare occasions resection of liver tissue may be necessary for exposure of the bile ducts. After adequate exposure has been achieved, the left hepatic duct is incised longitudinally between stay sutures to disclose healthy mucosa for repair ***(Blumgart, 2000).***

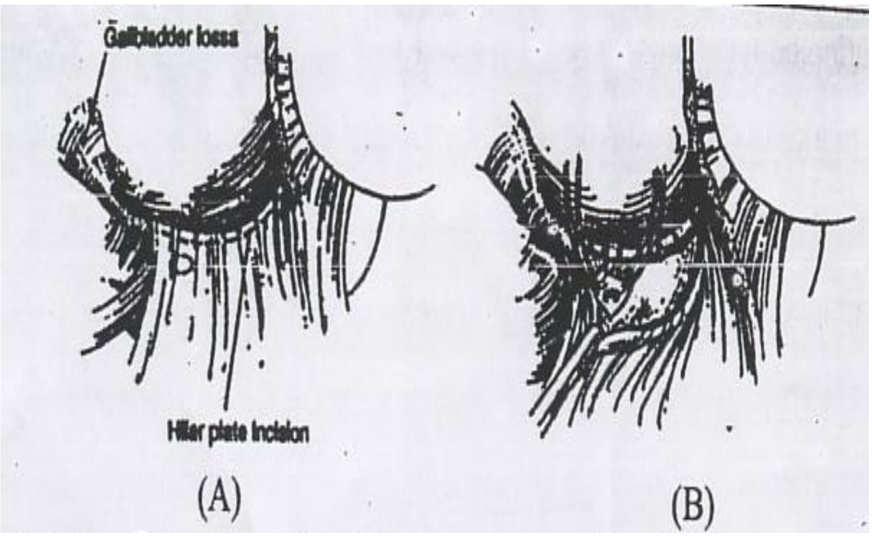


Fig. (40): Dissection of the hilar plate (Emond and Marvin, 2001).

(A) The transverse incision in the thickened tissue of the anterior sheath of the portahepatis is called detachment of the hilar plate and exposes the extrahepatic confluence of the bile ducts. The dotted oval depicts the estimated location of the hepatic duct.

(B) After location of the duct, stay sutures are applied, and the duct is opened longitudinally. The incision is extended onto the right and left ducts as needed to cross any scars and permit anastomisis to healthy mucosa above the Obstruction.

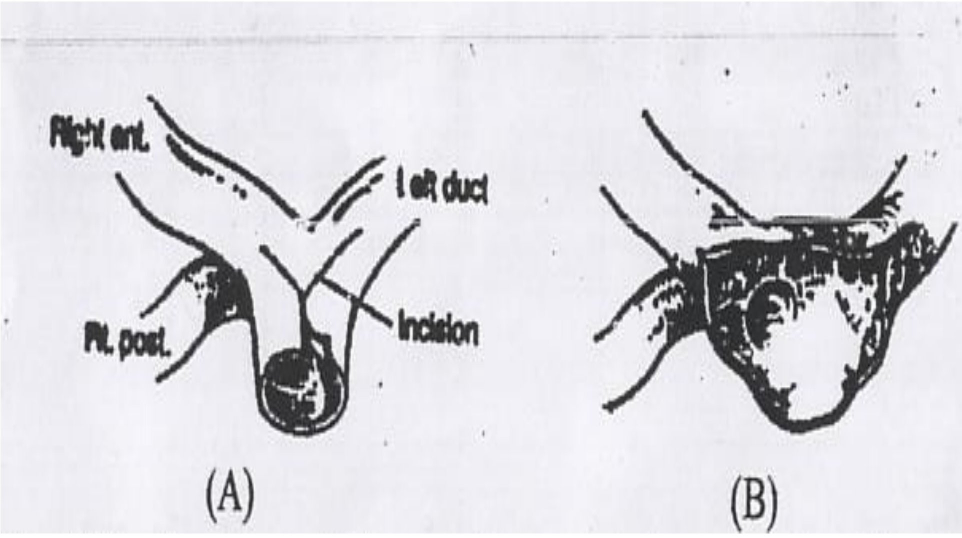


Fig. (41): Opening of the confluence of the main hepatic ducts.(Emond and Marvin, 2001)

(A) The incision is extended onto the anterior walls of the right and left ducts.

(B) The opened confluence creates an orifice of up to 5 cm in width for anastomisis. Note the entry of the posterior duct into the floor of this structure. It may be obstructed by scar and must be found before beginning the anastomisis.

Segment III ductal approach (Ligmentum Teres Approach) :

Occasionally it is very difficult to expose the left duct. This may be due to dense adhesions. Bleeding may be encountered or the quadrate lobe may be large and may overhang the area of the left duct. In these instances repair may be affected dissection of the left hepatic duct within the umbilical fissure (Segment III duct).

This approach should not be used unless there is continuity at the hilus so that the whole biliary tree will be decompressed. If this is not the case, a continuously obstructed right lobe is a source of recurring cholangitis ***(Blumgart, 2000).***

Initially, the ligamentum teres is elevated and the bridge of tissue joining segment IV to the left liver is divided. The ligamentum teres is pulled downward and dissected from the liver. Dissection is begun to the left of the upper surface of the base of the ligamentum teres and the extensions (containing portal branches) are carefully and individually divided between ligatures. The segment III duct itself is exposed above and behind the portal vein. Needle as aspiration may assist in its identification. If exposure is inadequate, then a small split of the liver can be made by dividing liver tissue just to the left of the faliciform ligament. The duct is then opened longitudinally at or usually just beyond the point of its division into the segment II and segment III ducts and it is prepared for anastomisis ***(Blumgart, 2000).***

Mucosal graft technique (The Rodney-Smith Technique):

A “mucosal graft” technique was introduced and popularized in 1969 and was advocated for high biliary strictures, thought too high for a sutured hepaticojejunostomy ***(Pleass and Garden, 2005***). This technique involves a sutureless anastomisis in which a circular portion of the sero-muscular wail of the Roux-en Y jeujenal limb is removed and a transhepatic catheter is placed in the jeujunal limb through a small incision at the mucosa. The mucosa is then anchored to the catheter. Both the catheter and the tented mucosa are pulled proximally, into the lumen of the bile duct where it adheres to the bile duct mucosa the sero-muscular surface of the jejunal limb is sutured to the scar around the duct at the hilum of the liver so as to reduce tension and hold the mucosal graft in position.

Although the results of this technique as reported by (***Smith et al, 2002)*** were satisfactory having a success rate of about 70%, the procedure is not actually based on the principle of precise mucosa-to-mucosa anastomisis ***(Lillimoe et al, 2006).*** This technique also failed to recognize the accessibility to the extrahepatic portion of the left hepatic duct and is no longer recommended routinely because of its high rate of restricture ***(Pleass and Garden, 2005).***

Intrahepatic cholangiojejunostomy:

It is another alternative for patients with multiple operations at the hilum, which makes its dissection impossible. It was described by Longmire and Sanford (1948). This maneuver known as the Longmire procedure involves mobilization of the left lobe of the liver and division of the left lateral segment, exposing the segment III hepatic duct and occasionally segment H bile duct. A Roux-en Y jejunal loop can then be anastomosed to the surface of the exposed liver as an alternative to direct anastomisis to the bile duct (***Lillimoe et al, 2006).***

Drainage of the left lobe through the duct to Segment III and drainage of the right lobe through the duct to segment V are also other alternatives. Segment III duct is identified to the left of the round ligaments as described by ***(Blumgart, 2000)*** these techniques of segmental drainage have, for the most part, replaced the Longmire technique. Techniques of choilangiojejunostomy are complex and require considerable expertise in hepatobiliary surgery ***(Rossi and Tsao, 2004***).

Longmire's procedure :

In 1948 Longmire and Sanford described an approach to the segment II duct of the left lobe of the liver for use when an approach to the hilus was not possible. This approach remains occasionally valuable.

For example, in patients with unilateral left lobe hypertrophy, but should not be employed when the left duct be exposed below the quadrate lobe or within the umbilical fissure. The longmire approach involves removal of liver tissue with greater blood loss and often less effective biliary-enteric anastomisis than that can be obtained by other methods.

Since approached to the left hepatic duct beneath the quadrate lobe or at the ligamentum teres have been employed, the longmire-sanford operation has been reserved for patients with right lobe atrophy accompanied by left lobe hypertrophy, rendering subhepatic dissection of the main left duct or its branches difficult. The essence of the approach is the removal of a portion of the left lobe of the liver so as to expose the dilated intrahepatic ducts of segment II and sometimes segment III. One of the great difficulties of the procedure is that the vessels of the portal triad run in close approximation with the ducts so that some bleeding is inevitable and difficult to control without compromising the duct lumina. This is particularly so if the liver is fibrotic and relatively small. The procedure should thus be used in cases of benign obstruction only with very great caution ***(Blumgart and Thompson, 2000).***

The operation is commenced by mobilizing the left lobe of the liver by division of the left triangular ligament to allow delivery of the left lobe forward into the wound. This maneuver itself may be difficult if the liver is fibrotic, or if there is left lobe hypertrophy. It is preferred in the performance of this operation to apply a liver clamp to the left lobe just to the left of the ligamentum teres. The peripheral portion of the left lobe is then simply resected to reveal the exposed duct and vessels. Slight release of the pressure of the clamp allows identification of the vessels, which are then ligated. A Roux-en-Y loop of the jejunum is then prepared and brought up for anastomisis. Identification of a suitable size may be difficult. In such cases, the Roux-loop may be opened over a considerable length and sutured to Glisson's capsule, although this is not easy. Such sutures may be carried out utilizing mattress sutures passed through the jejunal wall and through the exposed liver substance, ***(Blumgart and Thompson, 2000).***

3) Hepaticoduodenostomy:

Used in selected patients especially when the Roux-en Y limb cannot reach the upper quadrant, hepatic duodenostomy has been performed in an end-to-side manner with good results. This anastomisis would be accessible to endoscopic interventions ***(Rossi and Tsao, 2004).***

Segment II Hepticojejunostomy :

Alternatively, exposure of the segment II duct, which runs close to the posterioinferior surface of the left lobe of the liver, can also be made by incising longitudinally through the liver substance. Homeostasis is secured and a Roux-en-Y loop of the jejunum is brought up for anastomisis ***(Blumgart and Thompason, 2000).***

Patients presented by lobar atrophy:

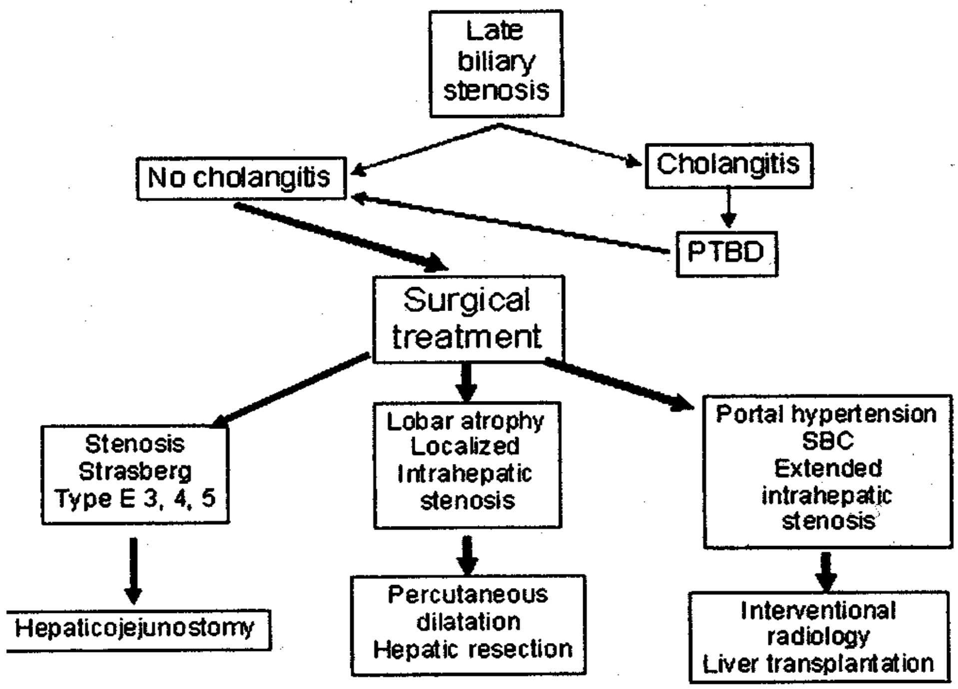
Lobar atrophy is the end-stage evolution of unilateral injury, usually involving the right lobe. ***(Blumgart LH, 2000),*** proposed three etiologies for this problem:

(1) Unilateral vascular injury.

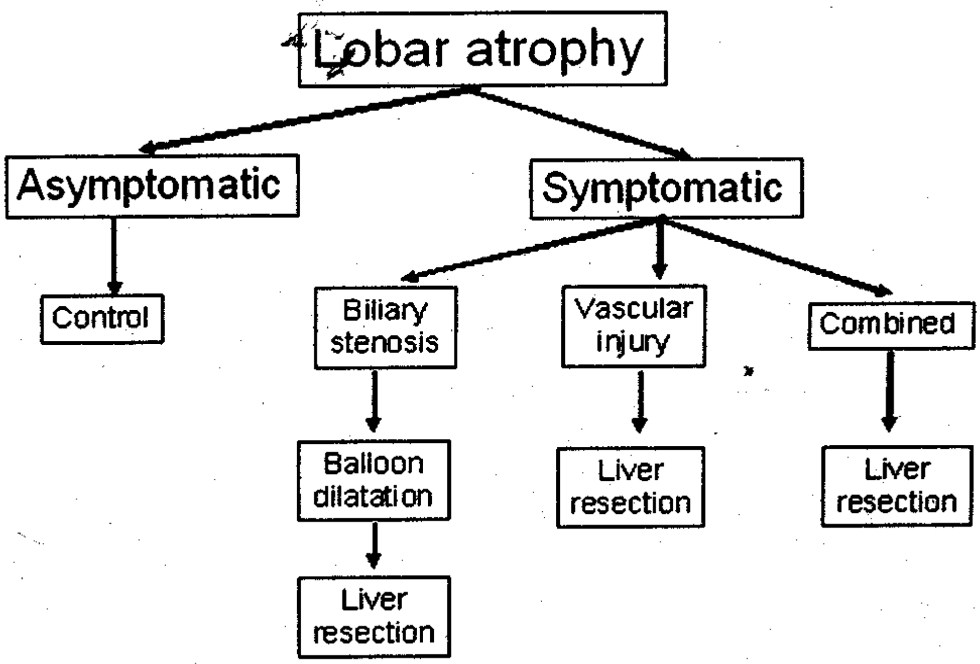
(2) Unilateral biliary stenosis.

(3) 1 and 2 combined.

The association between vascular and biliary injury after a laparoscopic cholecystectomy is described earlier. For the management of patients with a complex BDI, when a lobar atrophy is detected, the algorithm presented in (Fig. 43) is proposed.



(Fig. 42). Algorithm for the management of late biliary stenosis.



(Fig. 43). Algorithm for the management of lobar atrophy.

Patients presented by secondary biliary cirrhosis and portal hypertension:

Successive failures of therapeutic procedures or inappropriate treatment of cholestasis and infection may lead to end-stage liver disease within a few years after the injury ***(Mirza DF, 2005).*** In a historical series of bile duct reconstructions, the incidence of portal hypertension and secondary biliary cirrhosis was 8%.

The existence of portal hypertension is a crucial factor in treatment selection for BDIs. In the BDI series of ***(Chapman et al, 2003)***, 23 patients had portal hypertension and the mortality rate for this group of patient was 26%. The mortality rate for the patients with portal hypertension who underwent any surgical procedure was 23% (n = 5). In contrast, the mortality rate for the patients without portal hypertension who underwent any surgical procedure was only 2% (n = 2). The patients with complex biliary injuries and portal hypertension who had bilioenteric continuity were treated using interventional radiology in our unit. If this continuity does not exist and the patient has some contraindication for liver transplantation, the bile duct is drained with percutaneous transhepatic biliary drainage, and portal hypertension is treated with a transjugular intrahepatic portosystemic shunt or a mesocaval shunt before bile duct repair.

We treated patients with biliary stenosis associated with cavernomatous transformation of the portal vein. These patients had undergone a mesocaval shunt before the hepaticojejunal anastomisis, with a good outcome.

D) Conservative management:

Not all late biliary injuries require intervention. Some patients may remain entirely asymptomatic, the injury being diagnosed by a coincidental abdominal ultrasound or blood test showing elevated liver function. Unneeded intervention in such asymptomatic patients may not be necessary or desirable. If the injury has caused atrophy of part of the liver without resulting in sepsis or cholangitis, the patient may merely be observed. However, recurrent cholangitis secondary to stricture of the common bile or common hepatic ducts may result in cirrhosis and portal hypertension with subsequent liver failure. Liver transplantation has been undertaken in patients with both acute duct and vascular injury, in addition to those with secondary biliary cirrhosis ***(Pleass and Garden, 2005)***

Prevention Of Bile Duct Injury

Prevention of Bile Duct Injury

Prevention of the injury through education and attention to anatomy is the most effective form of prevention. Prevention of biliary injury by continuing to emphasize safe technical aspects of the procedure during residency training, by continuing to evaluate our results in practice, and by promoting ongoing education programs such as this forum to help surgeons achieve this goal. Complications that we see currently are no longer a result of a learning curve experience ***(Martin and Rossi, 2004).***

Continuing education programs for surgeons in practice and good teaching for our residents in training with continued emphasis on proper technique and precautions are key component. The price to pay for the complications of a biliary tract injury is indeed considerable. The morbidity of these complications is reflected in additional procedures and operations, cholangitis, intrabdominal infection, biliary cirrhosis, and, in extreme cases, end- stage liver disease and death ***(Ardiles V. et al, 2006).***

Prevention of iatrogenic injuries to bile ducts during either open or laparoscopic cholecystectomy relies on a thorough understanding of the anatomy of the region, conditions that predispose to the injury, and the mechanisms of injury described**.** It is important to note that the majority of bile duct injuries go unnoticed during 1aparoscopic cholecystectomy, confirming that it is the incorrect interpretation of anatomy which is the underlying cause**.** Epidemiologists classify prevention of health problems into primary and secondary. Primary prevention involves steps aimed at limiting the incidence of disease/complication by controlling causes and risk factors. Secondary prevention aims at early detection of the problem and its prompt and effective management ***(Shallaly and Cuschieri, 2004)***. An overview of different methods of prevention will be discussed.

Primary Prevention:

I) Exposure and Visualization:

It is of utmost importance since the major direct causes of biliary injuries are misidentification of anatomy and technical errors ***(Martin and Rossi, 2004).***

(Mark Caller, 2006), focused on the technical considerations for safely performing laparoscopic cholecystectomy, including proper anatomic dissection and the risks of instrument malfunction. In his paper, he analyzes the technical missteps that may lead to a bile duct injury. He also identifies other risk factors such as operation on the acutely inflamed gallbladder, thermal injury to the bile duct, and tenting injuries.

The immediate recognition of the bile duct injury during cholecystectomy can lead to proper treatment at that time, but points out that in reality, most bile duct injuries are recognized later. For complete evaluation of the patient, accurate delineation of the biliary anatomy, especially the proximal ducts, and that any biliary fistula be controlled before the patient is taken to the operating room, percutaneous transhepatic cholangiography is the best method for imaging the biliary tree because it defines the anatomy of the proximal bile ducts that will be used in the repair. ***(Lillemoe KD, 2006).***

The following precautions should he taken to insure a safe procedure:

1. A 30 degree angle viewing-laparoscope has been widely advocated ever the zero degree forward viewing scope ***(Asbun et al, 2003 and Hunter 2003),*** as it gives better view of the triangle of Calot ***(Shallaly and Cuschieri, 2004).***

2. Firm cephalic retraction of the gallbladder fundus is required to retract the liver and provide exposure of the junction of the cystic duct and common bile duct ***(Crist Gadacz, 2003).***

3. The gallbladder infundibulum should be retracted in a lateral direction to place the cystic duct at a right angle to the common bile duct. This maneuver opens the Calot's triangle and separates the cystic duct from the common hepatic duct ***(Hunter, 2003 and Rossi et al, 2004).***

4. Dissection of the cystic duct should always begin on the neck of the gallbladder; the neck of the gallbladder should be completely mobilized, to visualize the transition between the gallbladder infundibulum and the cystic duct ***(Crist and Gadacz, 2003).***

5. Hemorrhage at portahepatis should be controlled. The blind app1ication of clips or the use of electrocautery in an operative field Obscured by blood should be avoided ***(Crist and Gadacz, 2003).***

Technical considerations in the prevention of biliary injuries:

Laparoscopic cholecystectomy should be performed only by surgeons properly trained, and experience should be correlated with the likely difficulty of the operation according to disease severity. Laparoscopic cholecystectomy for severe acute and chronic inflammation is considerably more difficult, requiring technical experience to minimize the associated higher risks of biliary injury. Inexperienced surgeons must prepare on the basis of clinical predictive factors and make sure they have the help they need during the operation. At times, the safer approach will be laparotomy initially, but never beyond a sensible interval of trial dissection. Laparoscopic cholecystectomy for acute cholecystitis is truly an advanced laparoscopic technique.

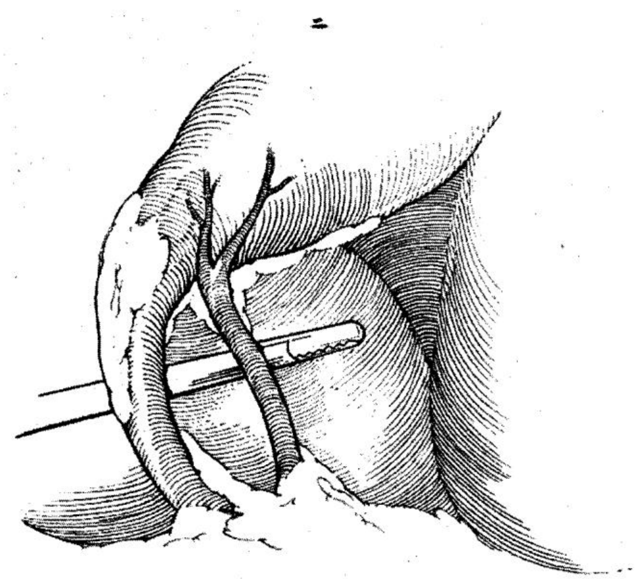
Avoiding misidentification of the cystic structures is the most important factor in preventing biliary injury. Only the cystic duct and artery require division during a cholecystectomy, and all agree that there must be a conclusive technical approach to achieve this division. That said, no technique is foolproof. The critical view technique of Strasberg involves tentative identification of these cystic structures by dissection in the triangle of Calot, followed by dissection of the gallbladder off the liver bed. After complete detachment of the gallbladder, conclusive identification of the cystic structures as the only two strucr1tres entering the gallbladder can be done (Fig. 29). Calot's triangle is cleared of all fat and fibrous tissue, equivalent to the open technique of taking the gallbladder off the liver bed. It is not necessary or recommended that the CBD be visualized.

Some argue that because this critical view technique requires more dissection, the opportunity for injury still exists. However, once the critical view is attained, the cystic structures can be occluded and divided because they have been positively identified. Failure to achieve this critical view is an absolute indication for conversion or possibly cholangiography to define ductal anatomy. In my operative notes, I dictate specifically that I achieved the critical view necessary for cystic structure division.

It is useful to dissect the triangle of Calot from both its dorsal and ventral aspects using a combination of blunt dissection and L-hook electrocautery techniques. The gallbladder infundibulum should be on lateral and inferior traction to create an angle between the cystic duct and the CBD ***(Rattner DW, 2005).*** The plane of dissection should always be maintained on the gallbladder or the cystic duct. To do so, the gallbladder should be followed down to the presumed point of the infundibulum-cystic duct junction and dissection started there.

Routine intraoperative cholangiography is an excellent alternative approach to dissection. This can reduce the incidence of biliary injury, or at least its severity. ***(Flum DR, et al, 2004)***.

Operative cholangiography is best for detecting misidentification of the CBD as the cystic duct. However, operative cholangiograms frequently have been misinterpreted in the presence of injury. The most common misinterpretation is failure to recognize that the bile duct rather than the cystic duct has been incised and cannulated when only the lower part of the biliary tree is seen ***(Collet, 2003) .***



(Fig. 29). The Critical View, according to Strasberg1, provides a definitive anatomical clearance of Calot's triangle that assures the junction of the cystic duct and cystic artery with the infundibulum of the gallbladder.

II) Use of Electrocautery and Laser should be cautious.

III) Conversion from Laparoscopic to Open Procedures:

A conversion rate of 2 - 5% can be expected in the hands of a well trained laparoscopic surgeon**.**

Secondary Prevention:

i) Intraoperative Cholangiography:

The use of intraoperative cholangiography during cholecystectomy has been controversial since its recommendation by Mirizzi in 1937 ***(Shallay and Cuschieri, 2004)***. Some surgeons use it routinely ***(Philips et al, 2003)***.Others selectively or not at all. The debate over routine versus selective intraoperative cholangiography during open cholecystectomy has continued without definite resolution for many years. Most would agree that intraoperative cholangiography is indicated for patients with evidence of common bile duct stones, large cystic ducts, and small calculi and for patients with elevated levels of liver function test ***(Lorimer and Fairfull Smith, 2004).***

(Crist and Gadacz, 2003) in their study comparing rates of success of intraoperative cholangiography demonstrating the biliary anatomy in both open and laparoscopic cholecystectomy Suggest that despite the improvement in the quality of laparoscopic cholangiography, it remains inferior to cholangiography during open cholecystectomy. They supported the selective use of intraoperative cholangiography for indicated cases and not on routine basis. On the other hand***, (Lorimer et al, 2004)*** concluded that the role of intraoperative cholangiography to avoid bile duct injuries is not essential and has been satisfied with the selective use of endoscopic cholangiography and sphincterotomy for the management of common bile duct stones.

However, ***(Pleass and Garden, 2005)***, believe that if Cholangiography is correctly interpreted, major ductal injury will be avoided. Injury will be recognized at an early stage and it will be possible to manage the complication appropriately, thus, minimizing morbidity. Nevertheless intraoperative cholangiography is not a prerequisite for safe performance of laparoscopic cholecystectomy and cannot be relied upon to prevent all biliary injuries. One of the disadvantages of intraoperative cholangiography is that it cannot be repeated after ligation and division of the cystic duct. Thus, injuries inflected after this stage of the operation may not be detected ***(Shallaly and cuschieri, 2004).***

(Traverso LW, 2006), opened the aforementioned forum with a presentation on the routine use of intraoperative cholangiography (IOC) as a valuable tool for lowering the risk of bile duct injury during cholecystectomy He emphasized the diverse pattern of the biliary anatomy and the importance of recognizing biliary anomalies and variations. For him, routine IOC is key to identifying abnormal anatomy and he recommends its regular use during laparoscopic cholecystectomy.

ii) Intraoperative Ultrasound:

There has been one report documenting the benefit of completion intraopertive ultrasonography examination in the early detection of biliary injuries. It has the potential for establishing the integrity of the bile tract at the end of the procedure. It is however, difficult to learn arid interpret accurately ***(Shallaly and Cuschieri, 2004).***

Information about the biliary system is provided by intraoperative cholangiography. This information helps to avoid bile duct injury in at least three ways.

First, the surgeon learns, over time, how to read an IOC, which in turn shows the immense diversity of the biliary tree and the pattern of biliary anomalies.

Second, on a case-by-case basis, IOC discovers whether the patient has a biliary pattern placing him or her at risk for biliary injury (i.e., the injury can be avoided).

Third, if an injury has already occurred, then IOC can provide early detection if the IOC is correctly interpreted. Thus, worsening of the injury can be averted.

Only the information provided by intraoperative cholangiography (IOC) prevents bile duct injury

First, a caveat must be given: An IOC itself cannot prevent a common bile duct (CBD) injury. The information contained in an IOC can only lower the risk of injury of the patient undergoing cholecystectomy.

Another caveat also is necessary: The information provided by IOC can lower the risk of injury only if the IOC is interpreted correctly. This ability is best taught to the surgeon through the routine use of lOCs, which gives the surgeon experience reading lOCs (not depending on the radiologist). The literature supports the conclusion that this level of expertise occurs when a surgeon uses IOC routinely. In fact, as surgeons increase their rate of IOC usage to above 75%, the rate of CBD injury decreases statistically ***(Flum DR, 2004).***

Routine IOC is a great teacher of the diverse patterns exhibited by the human biliary anatomy. The receptive student can discern when an uncommon biliary anomaly is present or when important ducts are absent. The relationship between the increased risks of bile duct injury aid failure to perform an IOC was first well documented in a large population-based study of bile duct injuries by David Fletcher and colleagues ***(Fletcher DR, 2003).***

In addition to the increased risk of bile duct injury without IOC, evidence from analysis suggested that bile duct injury decreased with surgeon experience. It should be noted, however, that even with increasing surgeon experience, the incidence of bile duct injury still was higher among patients who underwent surgery by an experienced surgeon without IOC

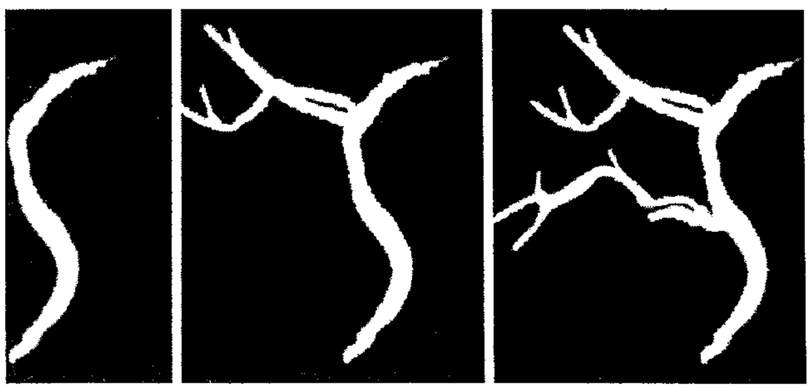
From studies, any surgeon will ask: How does routine IOC result in a lower incidence of bile duct injury? The answer can be summarized in four general areas of information provided by IOC. The first two areas of information are provided over the course of many IOC studies. Over time, the performance of IOC provides the perspective of biliary diversity. After reading many IOCs, the surgeon can recognize both the constancy and the variations in the biliary tree. Also, the surgeon begins to anticipate a pattern of biliary anomalies and then looks for them. On a case-by-case basis, each IOC can provide early detection of an injury if correctly interpreted. If discovered, the injury can be kept minimal. Findings have shown that IOC detects an injury and avoids its conversion to a more serious one ***(Flum DR, 2004).*** Therefore, IOC shows a surgeon how the biliary tree is built for the patient currently undergoing surgery. This imparts an opportunity to look for risky anomalies present in one-fourth of human beings.

How to read an IOC

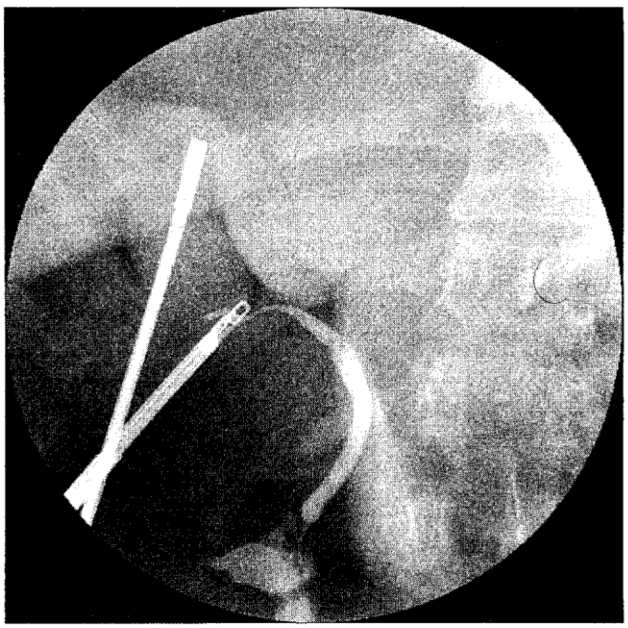
From 420 intraoperative cholangiograms performed routinely during elective cholecystectomy, we found a 4% incidence of a right subsegmental duct inserting near or at the cystic duct. These anomalies are a setup for bile duct injury. We also found that the diminutive biliary tree (CBD smaller than 4 mm) was frequent.

Once the surgeon has read many routine lOCs, it becomes apparent that the only constant in the biliary tree is the sigmoid curve of the CBD. As the left hepatic duct enters the bifurcation and then progresses into the CBD and the ampulla, it forms a sigmoid curve. This is a relatively constant ductal system and represents the way that an IOC can be read. First, the surgeon should search for the constant sigmoid curve. The variables are the different ways the right hepatic ducts and their subsegmental variations enter the sigmoid curve. One example is given in (Fig. 30).

The other variation involves the way the cystic duct enters the CBD. Cystic duct anomalies are found in 12% of cholangiograms, ***(Traverso LW, 2006).*** A cystic duct can pass (usually behind) the CBD and enter its left side, or it can have a dorsal insertion. Not infrequently, a common wall exists between the cystic duct and the CBD. Why is this important? The left-sided and dorsal cystic duct has been shown to cause trouble when clips on the cystic duct are placed too close to the CBD. If the cystic duct is too short, the clip retracts, placing extrinsic pressure on the CBD and possibly resulting in jaundice. This usually is over diagnosed as a CBD stricture when the only necessary treatment is removal of the clips. In a patient who has a long common wall with the cystic duct, the same phenomenon can result if the clips are placed too close to the main bile duct. The condition is akin to Mirizzi syndrome, in which a cystic duct stone causes extrinsic pressure on the CBD, resulting in jaundice.



(Fig. 30). The sigmoid curve, a constant feature of the biliary tree, is represented in the left-hand panel. Then the variables of the biliary tree are added: the right hepatic duct or ducts and the cystic duct. From an actual cholangiogram, the middle panel adds the right hepatic duct from an anterosuperior position. Finally, in the right panel, a right subsegmental branch connects into the side of the cystic duct. The latter anomaly is present in 4% of people.



(Fig. 31). During a laparoscopic cholecystectomy, an intraoperative cholangiograpby (IOC) shows filling with contrast of the cystic duct and the bile duct downstream into the duodenum. The biliary tree upstream from the cystic duct junction is not filled. This pattern may result from underfilling of the ductal system, or it could be that the bile duct was clipped or clamped upstream, indicating an impending transaction. This pattern should never be accepted as normal. It was the most common misinterpretation when an IOC was performed at the time of bile duct injury

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Technique of Laparoscopic Cholecystectomy

Technique of laparoscopic cholecystectomy

Anesthesia:

The patient is premedicated with ternazepam (20-30mg) 2 hours prior to induction, which is carried out with thiopentone and neuromuscular blockade is established using alcuronium. All patients are intubated with a cuffed endotracheal tube and ventilated mechanically. Nitrous oxide (66%), oxygen and enflurane are used to maintain anesthesia ***(Cuschieri and Berci, 2000).***

Monitoring during includes ECG, blood pressure (Dinamap), oxygen saturation (Datascopo Accusat), end-tidal CO2 (Datex Multicap) and urine output. An intravenous injection of a cephalosporin such as cepharoxime (1.0-l.5g) is administrated at the start of the operation ***(Cuschieri ana Berci, 2000)***

At the end of the procedure, neuromuscular blockade is reversed with neostigmine and atropine. Oxygen is administrated for the first 3 hours after operation and morphine is used for postoperative analgesia as required ***(Cuscieri and Berci, 2000).***

Nasogastric intubation and bladder Catheterization:

It is a custom to insert a nasogastric tube to insure complete gastric deflation during the procedure, since a distended stomach and duodenal cap can obscure the operative field. As a safety precaution, the urinary bladder is catheterized prior to the insertion of the Veress needle and the creation of a pneumoperitoneum ***(Cushieri and Berci 2000).***

Laparoscopic Cholecystectomy:
The French Technique

Introduction:

The laparoscopic technique for cholecystectomy, first performed by Phillipe Mouret in Lyon, France, in 1987, was the beginning of a revolution which has spread among general surgeons all over the world. However, it was not until 1989 that several centers in Europe and the United States began clinical work. This simultaneous beginning on both sides of the Atlantic explains why the technique used by the Europeans (French technique) differs in some points from the American one.

Positioning of the Patient and Team:

For positioning of the patient and team, see (Fig. 8 -A). The so called French technique, with the patient in the lithotomy position (or double-access position) and the surgeon standing between the legs of the patient, is that most favored one in Europe. The legs of the patient, which are horizontally oriented, are spread out as much as possible to avoid any kind of vein compression. An anti-Trendelenburg position of 5°-20° and a slight rotation on the left facilitate the exposition of Calot’s triangle especially in obese patients.

The surgeon is seated between the 1eg of the patient allowing him to work in a strictly frontal angle and giving him a better orientation and coordination of his movements (Fig 9). One assistant standing on the left side of the patient holds the camera and retracting the liver with the lateroxiphoidian port; a second should be positioned on the patient’s right side. The surgeon, with the video monitor facing him and above the patient’s head, is able to work with both hands as in open surgery. This position is commonly used for all laparoscopic procedures in the upper abdomen.

Technique:

Four trocars, two 5 mm and two 10 mm in diameter are usually used (Fig. 10). The first 10-mm trocar should be inserted in the upper part of the umbilicus an oblique direction (45° right avoid a secondary dehiscence) after the pneumoperitoneum is established. The laparoscope is then inserted, and after thorough exploration of the abdomen the other trocars are inserted under view. The two 5 mm trocars are placed 1 cm under the right costal margin as far as possible from each other. The lateroxiphoidian trocar is used for retraction, aspiration, and irrigation, and the most lateral one for grasping instruments. The fourth trocar (10 mm) is placed under view in the left hypochondrium, taking as an orientation point the features of the round ligament. This trocar site is used for the introduction of scissors, hook clip appliers, etc. It should be emphasized that the ideal positioning of the trocars is in a lozenge shape, so that an instrument does not disturb the others during its movements. Of course, the positioning of tire trocars should be changed regarding previous surgeries, or in obese patients. In the later all the trocars are placed in the right upper quadrant of the abdomen.

Once the perivesicular adhesions are freed, the neck of the gallbladder is grasped with a forceps and pulled away from the biliary pedicle to unfold and expose the triangle of Calot. This maneuver is essential to separate as much as possible the cystic elements from the hepatic duct and artery. The dissection begins with the posterior aspect of the triangle. The neck of the gallbladder is pulled upward and to the right, and the retractor applied on the biliary pedicle, pushing leftward to expose the posterior aspect of the triangle (Fig. 11).

The peritoneum is opened with scissors or the hook (Fig. 12), and the posterior wall of the gallbladder neck is completely dissected to recognize the junction with the cystic duct, then the neck of the gallbladder is pushed downward and right, and the probe retracts the liver upward to expose the anterior aspect of the triangle (Fig. 13). The cystic duct and artery are dissected after the anterior sheet of the peritoneum. This dissection should be carried out with the smooth instruments very gently from left to right using monopolar electrocautery. Special precautions when using electrocautery in this area are: isolation of the instruments as close as possible to the tip and intermittent use of electrocautery only in tissues elevated by the hook. No monopolar coagu1ation should be used when working close to the common bile duct.

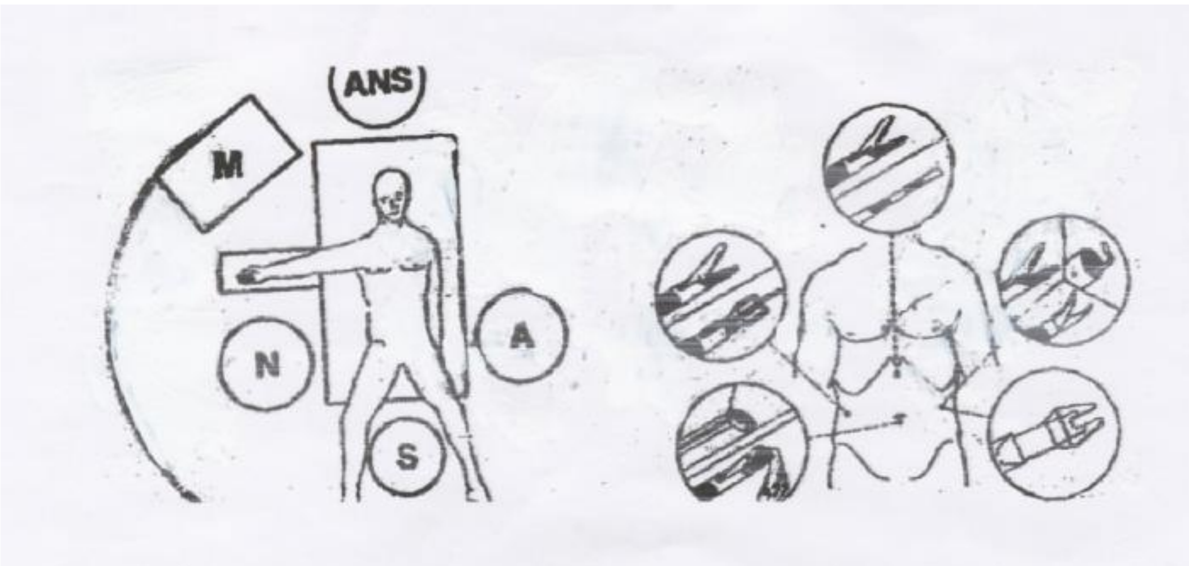

Fig. (8-A): Positioning of the Fig. patient and team.Patient in lithotomy position. ANS, Anesthetist, S, surgeon; A, assistant; N, nurse; M, monitor.

Fig. (8-B): Trocar sites and instrumentation

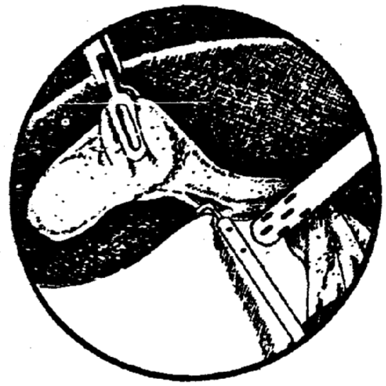

Fig. (9): Incision of hepato-duodenal ligament

Fig. (10): Dissection of the posterior sheath of the hepatoduodenal ligament

Fig. (11): Dissection of the cystic duct

Fig. (12): Closure of cystic duct and artery with clips

Fig. (13): Transection of tubular structures (cystic duct and artery)

Fig. (14): Excision of the gallbladder from the liver bed

The clamping (Fig. 14) and transaction (Fig. 15) of the cystic duct and cystic artery are carried out after the neck of the gallbladder and its junction with the cystic duct are dissected.

The rest of the cholecystecomy is performed as in the American technique (Fig. 16). Cholangiography is performed following selective criteria ***(Carroll, 2005).***

Laparoscopic Cholecystectomy
The American Technique

Introduction

Laparoscopic cholecystectomy has become the standard treatment for symptomatic cholelithiasis since its introduction in March 1987 by Mouret in France. Currently there are no absolute contraindications for laparoscopic cholecystectomy, but there are some relative contraindications, the determination of which depends on the operator’s experience. These include generalized peritonitis, septic shock from cholangitis, and shock from severe acute pancreatitis, Cirrhosis with portal hypertension, severe coagulopathies, cancer of the gallbladder, and third-trimester pregnancy.

All patients must be evaluated for history of prior jaundice, pancreatitis, and suspicion of common bile duct stones. Patients should undergo preoperative ultrasound examination of the upper abdomen and blood tests of liver function. In patients with acute cholangitis or septic shock due to suspected common duct stones preoperative endoscopic retrograde cholangiopancreatography should be considered, especially in those over 65 years of age. Intraoperative cholangiography should be performed on all patients to eliminate the need for preoperative diagnostic RCP and to allow for intraoperative treatment of common duct stones by laparoscopic techniques or by postoperative sphincterotomy. If routine intraoperative cholangiography is not practiced, a very liberal approach to selective cholangiography is indicated, any abnormal liver function test, abnormal amylase, acute cholecystitis, dilated bile duct, or unclear anatomy.

Positioning of the Patient and Team

The patient is positioned in the supine position; with sequential compression devices placed on both legs (see Fig 17).

Technique

In patients who have bad no prior abdominal surgery a Veress needle is placed into the peritoneal cavity in the midline just below the umbilicus. The abdomen is then insufflared with CO_2 to a pressure of approximately l5 mmHg. A 10- to 11-mm trocar is inserted below the umbilicus, and the abdomen is inspected using a 300 angle 10-mm laparoscope (Fig. 18). It is important to inspect immediately below the site of insertion of the Veress needle and the initial trocar since both of these insertions are blind and may cause injury to viscera or blood vessels. All the remaining trocars are placed in the abdomen under direct visua1ization. A second 10- to 11-mm trocar is inserted immediately below the xiphoid process. The trocar should be guided into the abdomen to the right of the falciform ligament and at the lower edge of the liver. A 5-mm trocar is inserted inferior to the 12th rib as far lateral as possible based on the position of the right colon. A large strong grasper is used to grasp the dome of the gallbladder and elevate it over the liver, exposing the hilum (Fig. 19). This grasper is then affixed to the abdominal wall using a towel clamp so that it remains stable throughout the dissection. A second 5-mm grasper is placed just medial to the first trocar as lateral as possible and as close to the costal margin as possible. Positioning of this trocar is crucial for parallel insertion of the cholangiogram catheter into the cystic duct.

Dissection of the hilum should start at the gallbladder - cystic duct junction to avoid dissection near the common duct until there is adequate identification of the anatomy (Fig. 2)). If the junction is net visible the dissection should start high upon the gallbladder. The overlying fat should be grasped and pulled out and downward until the cystic duct is seen.

Meticulous dissection close to the junction of the cystic duct and the gallbladder is safer than early dissection at the junction of the cystic duct and common duct. Once the cystic duct is clearly identified, dissection of tile cystic artery can be performed, again close to the cystic duct-gallbladder junction. One clip is placed on the cystic artery (sentinel clip; Fig. 21) and one clip is placed on the cystic duct close to the gallbladder (Fig. 22). A small incision is made in the cystic duct as proximal to the clip as possible (Fig. 23). A no. 4 end hole urethral catheter is inserted into the cystic duct and is held in place with the cholangioclamp (Fig.24).

Cholangiography is then performed. The clips on the cystic duct and artery should be identified on the cholangiogram (Fig. 25). Additionally, the length of the cystic duct should be evaluated and the cystic duct- common duct junction confirmed. Visualization of dye flowing into the duodenum is mandatory, as is visualization of the right and left hepatic ducts. After the cholangiogram is completed and reviewed, two clips are placed on the “staying” side of the cystic duct, and the cystic duct is divided sharply, not with cautery. Two additional clips are placed on the cystic artery. No specific attempt is made to identify the cystic duct - common duct junction unless a transcystic duct common duct exploration is to be performed.

The gallbladder is grasped at Hartmann’s pouch and elevated as it is being withdrawn inferiorly from the liver. Electrocautery is used to separate the gallbladder from the liver bed, and homeostasis is meticulously maintained with electrocautery or small clips (Fig. 26). Once the gallbladder is freed from the liver, the gallbladder is placed into a plastic pouch, and the liver bed and the clips on the duct and is reinspected. The abdomen is irrigated with saline solution, and all clots and debris are suctioned from under the right lobe of the liver. All trocar sites are then injected with bupivacaine postoperative pain relief. The laparoscope is then repositioned in subxiphoid trocar, and the gallbladder is pulled through through the subumbilical trocar site. The open end of the endopouch is exteriorized and the gallbladder is grasped through the open end of the pouch and pulled through the fascia. The gallbladder and gallstones may need to be morcellated and/or the fascial incision extended. After removal of the gallbladder, all trocar sites are inspected for abdominal wall bleeding, and all the 10-mm fascial incisions are closed with Vicryl sutures.

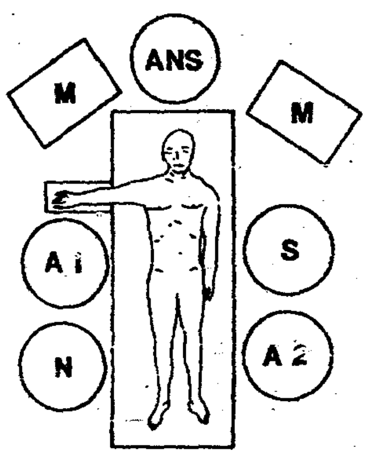

Fig. (15): Positioning of the patient and team. Patient in supine position. ANS, Anesthetist; S, surgeon; A 1, A2, assistants; A", nurse; M, monitor.

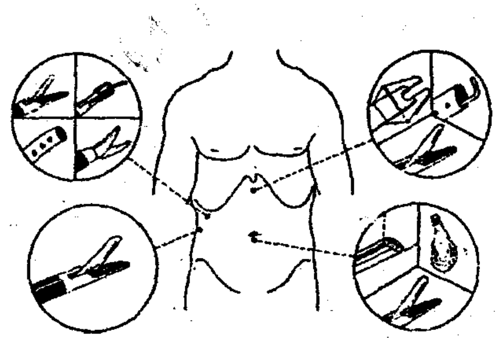

Fig. (16): Trocar sites and instrumentation.

Fig. (17): The gallbladder is grasped at the fundus and the liver retracted cranially.

Fig. (18): Blunt dissection of the hepatoduodenal ligament.

Fig. (19): A sentinel clip is placed on the cystic artery.

Fig. (20): The cystic duct is closed with a clip.

Fig. (21): The cystic duct is incised for the cholangiogram.

Fig. (22): A cholangiography catheter is introduced in the cystic duct.

Fig. (23): This figure represents a cholangiogram. Once the sentinel clip has been identified, an imaginary line should be represented along this clip. When dissecting the gallbladder from the liver bed, surgeons should always stay laterally from this line in order to avoid CBD injuries.

Fig. (24): The tubular structures are transected.

اصابات القنوات المرارية اثناء اجراء عملية استئصال المرارة بالمنظار الجراحي الوقاية والعلاج

رسالة مقدمة توطئة للحصول علي درجة الماجستير في الجراحة العامة
من

الطبيب / رفيق ابراهيم لبيب
بكالريوس الطب والجراحة - جامعة عين شمس

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كلية الطب
جامعة عين شمس
2007

الملخص العربي

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ان استئصال المرارة بالمنظار الجراحي هو من اكثر العمليات الجراحية شيوعا وقد انتشر استخدام المنظار الجراحي في هذه العملية لاستئصال المرارة بدلا من الجراحة التقليدية حتي اصبح هو العلاج التقليدي لكل مريض يعاني من التهاب حصوي مراري.

ان حدوث اصابة للقنوات المرارية اثناء اجراء عملية استئصال المرارة بالمنظار هي مشكلة خطيرة والوقاية منها خير من العلاج.

تقسم اصابة القنوات المرارية في عمليات استئصال المرارة بالمنظار الى ٥ أنواع :
النوع (أ) : تسرب العصارة المرارية من القنوات الصغري.
النوع (ب) : انسداد في القناة الظاهرية اليمني.
النوع (ج) : قص القناة الظاهرية اليمني.
النوع (د) : اصابة جانبية للقناة المرارية الكبري (خارج الكبد).
النوع (هـ) : اصابة كاملة للقناة المرارية الكبري.

ان آلية اصابة القناة المرارية اثناء عمليات استئصال المرارة بالمنظار تتلخص في آليتين : عدم الألمام الدقيق بالتشريح واخطاء التقنية.

من الصعب اكتشاف اصابة القنوات المرارية اثناء اجراء الجراحة عدا اصابات النوعين (د,هـ).حتي في النوع (هـ) فان اكتشاف الآصابة اثناء اجراء الجراحة لا يتعدي ٢٥٪ من الحالات.

ان اكتشاف الآصابة يكون عن طريق ملاحظة تسريب مراري أو ملاحظة فتحة قناة مرارية. وفي بعض الأحيان يكون اكتشاف الاصابة بواسطة تصوير القنوات المرارية أو بعد التحويل الي الجراحة التقليدية.

هناك أكثر من كيفية لظهور الأعراض في فترة ما بعد الجراحة ولكن الآلام المصاحبة للالتهاب والصفرة هما الأكثر شيوعا. والآلام المصاحبة للالتهاب يكثر حدوثها في الأنواع (أ - ج – د). ولكن حدوث صفراء ملحوظة هي أكثر الأعراض شيوعا في الآصابة في النوع (ه).

ظهر حديثا الرنين المغناطيسي علي القنوات المرارية كتقنية كفء في تقييم اصابة القنوات المرارية تحت الكبد. وهذا التطبيق يتميز بالتصوير الدقيق الذي يوفر معلومات تشريحية – من خلال فحص واحد – كان لا يمكن الحصول عليها الا عن طريق التصوير المراري الخارجي عن طريق الجلد والأشعة المقطعية معا.

ويكون تقييم الأوعية الدموية له أهمية خاصة في حالة حدوث محاولة سابقة للاصلاح أو اصابة القنوات المرارية تحت الكبد لاحتمال وجود اصابة مصاحبة للشريان الكبدي الأيمن.

ينصح بالعمل الاستشاري (طبيب جهاز هضمي وطبيب أشعة وجراح) ليس فقط في التشخيص ولكن أيضا في تحديد المنظومة العلاجية المثلي.

هناك ثلاث عوامل تؤثر في نجاح العلاج الجراحي هي : التقييم الشخصي (بالاخص تصوير القنوات المرارية) والتقنية الجراحية وخبرة الجراح.

يعالج تجمع العصارة المرارية عن طريق وضع أنبوب تصريف عبر الجلد لداخل البطن تحت ارشاد الأشعة المقطعية أو الموجات الصوتية.
نسبة نجاح العلاج عن طريق المنظار بواسطة عمل شق أو تركيب دعامة أو كلاهما معا يصل الي ٦٦٪-١٠٠٪ وبدون الاحتياج الي أي تدخل اخر.

طريقة اخري يمكن استخدامها في علاج اصابات القنوات المرارية وهي التوسيع بالبالون وتركيب دعامة. ويمكن استخدام هذة الطريقة عن طريق المنظار أو عن طريق الجلد عبر الكبد في حالة وجود ضيق في القنوات المرارية العليا أو حدوث ضيق مرتجع بعد جراحة توصيل القناة المرارية بالأمعاء.

يقسم العلاج الجراحي لاصابات القناة المرارية الي اصابات تم اكتشافها أثناء الجراحة واصابات تم اكتشافها بعد الجراحة (في خلال أيام) وأخيرا اصابات تم اكتشافها متأخرا بعد الجراحة.

أفضل الطرق نجاحا في علاج اصابة القناة المرارية أو الكبدية هي توصيل القناة المرارية بالأمعاء. فنسبة النجاح المسجلة للجراحين ذوي الخبرة هي ٨٠٪-٩٠٪. أما للجراحين الأقل خبرة فنسبة النجاح هي ٦٠٪-٧٠٪.

أما ميزة توصيل القناة المرارية نهاية الي نهاية فتكمن في بساطة التقنية والحفاظ علي طول القناة المرارية. ولكن هذة الميزة تعاب بنسبة حدوث ضيق في القناة تصل الي ٥٠٪ في الحالات التي تمت متابعتها والتي قد تحتاج الي اعادة التدخل الجراحي. وفي حالات الضيق بالقنوات المرارية فان العلاج التقليدي هو اجراء توصيل القناة المرارية بالأمعاء علي أن تكون بدون شد وتوصيل الأغشية المخاطية بعضها البعض.