IATROGENIC BILIARY TRACT INJURY DURING LAPAROSCOPIC CHOLECYSTECTOMY

An Essay

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LIST OF ABBREVIATIONS

BDI	Bile Duct Injury
CBD	Common bile duct
CD	Cystic duct
CHD	Common hepatic duct
CT	Computed tomography
EBDs	Extra hepatic bile ducts
ERCP	Endoscopic retrograde cholangiopancreatography
GB	Gall bladder
HA	Hepatic artery
HIDA	Hepatobiliary iminodiacetic acid scan
HJ	Hepaticoo-jejunostomy
IBDs	Intra hepatic biliary ducts
IOC	Intraoperative cholangiography
LSC	Laparoscopic cholecystectomy
LHA	Left hepatic artery
LHD	Left hepatic duct
MPD	Main pancreatic duct
MRCP	Magnetic resonance cholangiopancreatography
PTC	Percutaneus trans-hepatic cholangiography
PV	Portal vein
RASD	Right anterior sectoral duct
RHA	Right hepatic artery
RHD	Right hepatic duct
RPSD	Right posterior sectoral duct

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INTRODUCTION

The biliary tract is a complex organ system that performs the simple though vital task of collecting, storing, and delivering bile to the gastrointestinal tract. Diseases of the biliary system can be extremely painful, debilitating, and occasionally life threatening. The complex development of the liver and biliary system in utero can result in multiple anatomic variations. An absolute knowledge of these anatomic variations with careful dissection and identification of structures at the time of surgery is a minimal requirement for the safe performance of any hepatobiliary operation **(McPartland & Pomposelli 2008).**

Because of the unforgiving nature of the biliary system, errors in technique or judgment can be disastrous to the patient, resulting in lifelong disability or death. For this reason, a high premium exists on performing the correct procedure, without technical misadventure, the first time. Equally important is the ability to recognize iatrogenic injury so that prompt repair or referral to a surgeon who has expertise in hepatobiliary surgery can be instituted **(Wu et al. 2007)**

Laparoscopic cholecystectomy "**LSC**" was first introduced in the late 1980s and has become the gold standard for the management of benign gallbladder disease. LSC has been associated with less morbidity, shorter hospital stay, earlier return to normal activity, less postoperative pain, and better cosmesis compared with laparotomy. It is estimated that more than 750,000 laparoscopic cholecystectomy procedures are performed annually in the United States, making it the most frequently performed abdominal procedure **(Lau & Lai 2007).**

LSC has become a common procedure used to treat GB stones in patients who do not have an associated disease in the vicinity of the lesions; however, complications of this procedure remain a problem. The major causes of bile duct injury include technical, pathologic, and anatomic factors. The technical factors include the skill of the surgeon, whereas the pathologic factors include the presence of associated inflammation of the biliary tree. Congenital anomalies and normal variants involving the biliary tract, which include aberrant or accessory biliary ducts, aberrant cystic duct insertion; bile duct cysts, alterations of the biliary tract associated with situs anomalies, and anomalous junction of CBD with the pancreatic duct, are considered the anatomical factors **(Sugita et al. 2008).**

Bile duct injuries range from small postoperative bile leaks, with little clinical significance, to severe injuries and strictures of the intrahepatic ducts with devastating consequences. Injuries resulting from laparoscopic surgery are more complex than open cholecystectomy-associated injuries, frequently involve the proximal bile duct, and result in more extensive stricture formation **(Kaklamanos et al. 2006).**

A major bile duct injury resulting from LSC is a problem with substantial cost to the health care system. Some reported that treatment for LSC-related bile duct injuries can be 4.5 to 26 times the cost of an uncomplicated procedure and carries a significant rate of morbidity and mortality. However intraoperative recognition of such an injury, with immediate conversion to an open procedure for definitive repair, can result in significant cost saving and relates directly to decreased morbidity, mortality, length of hospitalization, and number of operative care days **(Tantia et al. 2008).**

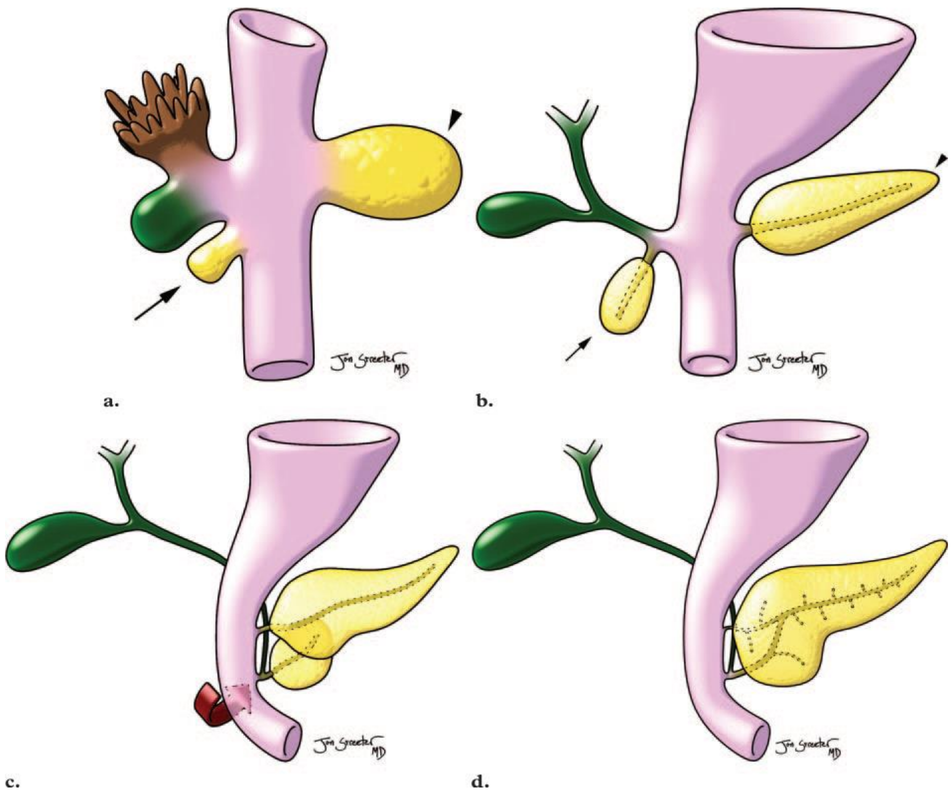
THE AIM OF THE STUDY

The aim of this study is to review the types and mechanisms of iatrogenic bile duct injuries during laparoscopic cholecystectomy and summarize the diagnostic modalities and different options for management.

EMBRYOLOGIC DEVELOPMENT OF THE BILIARY SYSTEM

The hepatobiliary system develops during the second half of the eight week embryonic stage of development, known as the organogenetic period **(Moore & Persaud 2003)**. Many of the anatomic variations of the system are the consequences of occurrences during this period **(Wind 2000)**.

By the 4th week of embryologic growth, ventral (caudal) and dorsal (cranial) outpouchings develop at the junction of the foregut and midgut. The gallbladder, extrahepatic bile ducts (EBDs), central intrahepatic bile ducts (IBDs), and ventral pancreas with its ductal network are derived from the ventral outpouching, the hepatic diverticulum. The dorsal bud arises from the dorsal mesogastrium and is the precursor of the dorsal pancreas and its ductal system. At about this time, the developing ventral pancreas, gallbladder, and bile duct rotate clockwise (when viewed from the top) posterior to the duodenum and join the dorsal pancreas in the retroperitoneum. The ventral pancreatic duct and the CBD are, therefore, linked by their embryologic origins, resulting in the adult configuration of their common entrance into the duodenum at the major duodenal papilla. **(Mortele´ et al. 2006)**



Drawings illustrate the normal embryologic development of the pancreas and biliary tree. The ventral pancreatic bud (arrow in **a** and **b**) and biliary system arise from the hepatic diverticulum, and the dorsal pancreatic bud (arrowhead in **a** and **b**) arises from the dorsal mesogastrium. After clockwise rotation of the ventral bud around the caudal part of the foregut, there is fusion of the dorsal pancreas (located anterior) and ventral pancreas (located posterior). Finally, the ventral and dorsal pancreatic ducts fuse, and the pancreas is predominantly drained through the ventral duct, which joins the common bile duct (CBD) at the level of the major papilla. The dorsal duct empties at the level of the minor papilla. **(Mortele´ et al. 2006)**

At approximately the 7th gestational week, the dorsal and ventral pancreatic ducts fuse in the region of the neck. The territory drained by each system can vary, but in general the dorsal pancreatic ductal system drains the tail, body, and anterior portion of the pancreatic head, whereas the ventral component drains the posterior aspect of the pancreatic head. Both dorsal and ventral ducts variably drain the uncinate process of the pancreatic head. The portion of the ventral duct between the dorsal-ventral fusion point and the major papilla is termed the duct of Wirsung. The portion of the dorsal duct proximal to the dorsal-ventral fusion point is called the main pancreatic duct (MPD); if a segment of the dorsal duct persists distal to the dorsal-ventral fusion point, it is termed the duct of Santorini, or accessory duct. In 30% of individuals, however, the duct of Santorini loses its communication with the minor duodenal papilla and persists only as a branch of the MPD. **(Mortele´ et al. 2006)**

As mentioned earlier, the hepatic diverticulum gives off other structures in addition to the extrahepatic biliary tree and ventral pancreas. The gallbladder arises from the extrahepatic ductal system, with the hepatic parenchyma and intrahepatic ducts being derived from the endoderm at the tip of the diverticulum. The IBDs develop as part of a complex process. At first, there is a web of interconnecting channels within the liver substance. These channels are then obliterated, after which recanalization occurs to form the mature intrahepatic ducts. If interconnecting ducts persist, accessory, anomalous, or aberrant bile ducts may result. **(Taylor & Mortele 2005)**

ANATOMY OF THE BILIARY SYSTEM

The biliary tree consists of the system of vessels and ducts which collect and deliver bile from the liver parenchyma to the second part of the duodenum. Detailed knowledge of biliary tract morphology is essential for diagnostic assessment of patients who have suspected biliary disease, preoperative evaluation of potential living liver donors, hepatic and biliary surgical candidates, and postoperative noninvasive follow-up for patients after transplantation or laparoscopic biliary procedures. **(Kamel et al. 2005)**

NORMAL ANATOMY OF THR BILIARY SYSTEM

The biliary system consists of the intra-hepatic and extra-hepatic biliary tracts. The ducts located in the hepatic parenchyma, those proximal to the right hepatic "**RHD**" and the left hepatic "**LHD**" ducts, represent the intra-hepatic system. **(Reau & Jensen 2008)**

A.INTRA-HEPATIC BILIARY TRACT

There are more than 2 kms of bile ductules and ducts in the adult human liver. The intra-hepatic system is further divided by size into small and large ducts. Intra-hepatic large bile ducts roughly correspond to ducts from the first to the fourth branches of the right and left hepatic ducts. Intra-hepatic small bile ducts are further classified as septal bile ducts, interlobular bile ducts, or bile ductules according to their size and location. **(Cha et al. 2007)**

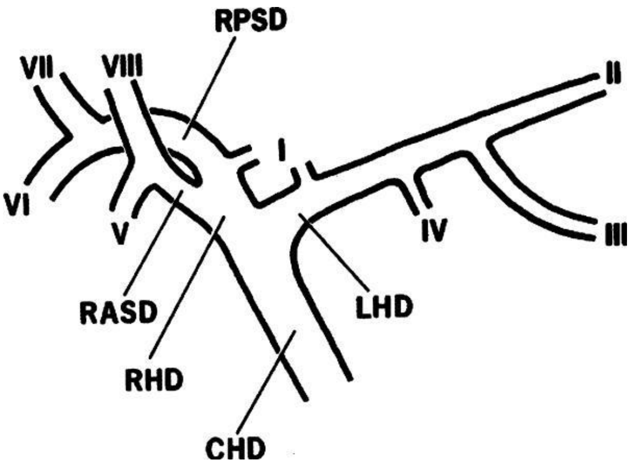


Fig 2**: Typical pattern of intrahepatic biliary branching. (Gibson 2008)**
Segments are numbered according to the system of Couinaud.

CHD: common hepatic duct, RHD: right hepatic duct, LHD: left hepatic duct, RPSD: right posterior sectoral duct, RASD: right anterior sectoral duct**.**

The bile ducts generally follow the internal hepatic segmental anatomy **(Hoe et al. 2006)**. However, marked variation in the branching pattern is common:

A. Major branches:

a. RHD, dividing into the posterior right hepatic duct (dorsocaudal course) and the anterior right hepatic duct (ventrocranial course).
b. LHD (more anterior in position)**.**
c. The bile duct draining the caudate lobe usually joins the origin of the left or right hepatic duct.

B. Segmental branches: