Original Research Paper Medical Science

Iatrogenic Bile Duct Injury: Its Complication and Management

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ABSTRACT

BACKGROUND: *Bile duct injury(BDI) is becoming topic of interest because of incidence of it increases over period due to new era of laparoscopic surgery. BDI can occur following open cholecystectomy, laparoscopic cholecystectomy, nontraditional cholecystectomy {including NOTES (natural orifice translumenal endoscopic surgery), SILS (single incision laparoscopic surgery)}, biliary, reconstructive operation, gastric resection, hepatic resection and BDI can even occur in blunt or penetrating injury over abdomen. The ease of management, operative risk, and outcome of bile duct injuries vary considerably, and are highly dependent on the type of injury and its location.*

DATASOURCES: *Medline, PubMed database search was performed to identify relevant articles using the keywords "bile duct injury", "cholecystectomy", and "classification".*

RESULTS: *Bile duct injury during laparoscopic cholecystectomy tends to be more severe than those with open cholecystectomy. Strasberg's classification made Bismuth's classification much more comprehensive by including various other types of extrahepatic bile duct injuries.*

KEYWORDS :

Introduction

Bile duct injury(BDI) is becoming topic of interest because of incidence of it increases over period due to new era of laparoscopic surgery. BDI can occur following open cholecystectomy, laparoscopic cholecystectomy, non-traditional cholecystectomy {including NOTES (natural orifice translumenal endoscopic surgery), SILS (single incision laparoscopic surgery)} biliary reconstructive operation, gastric resection, hepatic resection and BDI can even occur in blunt or penetrating injury over abdomen. The incidence of BDI following open cholecystecomy and laparoscopic cholecystectomy is 0.1-0.2 % and 0.3-0.85% respectively. Bile leak scenario is easily recognized during the first postoperative week. Constant bile effusion is documented through surgical drains, surgical wounds or laparoscopic ports. Patients usually complain of diffuse abdominal pain, nausea, fever and impaired intestinal motility. In addition, bile collections, peritonitis, leukocytosis and mixed hyperbilirubinemia may be part of the clinical setting.

PATHOGENESIS:

Several factors are associated with an increased risk of bile duct injury at cholecystectomy which is divided in following category:

- Patient factor
- Technical factor

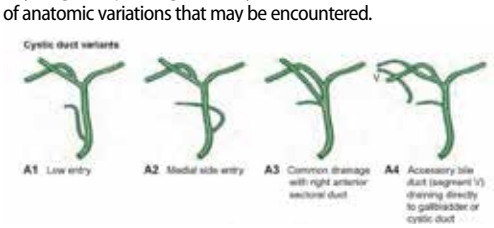
PATIENT RELATED FACTORS:

It will be divided as follows:

- Anatomical variations
- Pathological factors

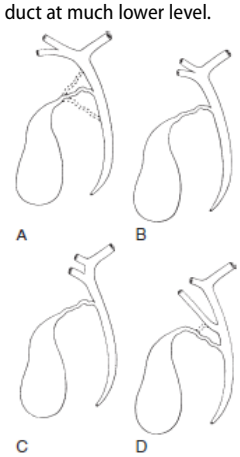
ANATOMICAL VARIATIONS:

Any surgeon operating on biliary tree must be familiar with the wide range of anatomic variations that may be encountered.



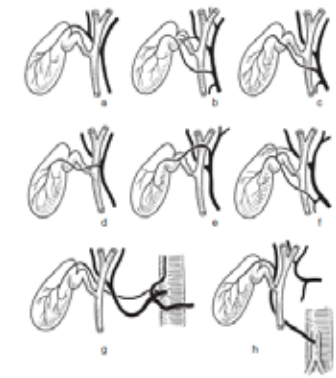
Variations of junctions of cystic duct:

A. The cystic duct join the main bile duct very high at confluence of hepatic ducts or very low at the ampulla of veter.
B. The right anterior and posterior sectoral hepatic ducts join the left hepatic duct at common confluence.
C. The right anterior and posterior sectoral hepatic separately join the left hepatic duct.
D. The right anterior or posterior sectoral hepatic duct join common hepatic duct at much lower level.



Cystic artery variations:

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 anteriorly.
E. Cystic artery originating from the left branch of the hepatic artery.
F. Cystic artery originating from the gastroduodenal artery.
G. Cystic artery arising from the celiac axis.
H. Cystic artery originating from a replaced right hepatic artery.



PATHOLOGICAL FACTORS:

During the early era of laparoscopic cholecystectomy, acute cholecystitis was considered an absolute contraindication. acute cholecystitis, cholangitis and gallstone pancreatitis are associated with dramatically increased incidence of bile duct injuries.

TECHNICAL FACTORS:

- Surgeon factors
- Instrumental factors

SURGEON FACTORS:

- For laparoscopic cholecystectomy, it has long been argued that surgeon inexperience is a major factor, and that with increased familiarity with the procedure, the number of injuries would decrease- so called "learning curve effect". As surgeon experience increases beyond 20 cases, the bile duct injury rate decreases.
- Errors leading to laparoscopic bile duct injuries stem from 'misperception', not errors of skill, knowledge or judgment. The primary cause of errors in 97% cases was a 'visual perceptual illusion' whereas only 3% injuries were due to faults of technical skills. Surgical technique with inadequate exposure and failure to identify structures before ligating or dividing them are the most common cause of significant biliary injury.
- There is bleeding and subsequent attempt to achieve hemostasis as major contributing factor to bile duct injury. If necessary, an additional port should be placed for high powered suctioner/irrigator to precisely define the site of bleeding.

INSTRUMENTAL FACTORS:

Safe cholecystectomy requires clear visualization of relevant anatomy, which demands proper exposure and high resolution video equipment.

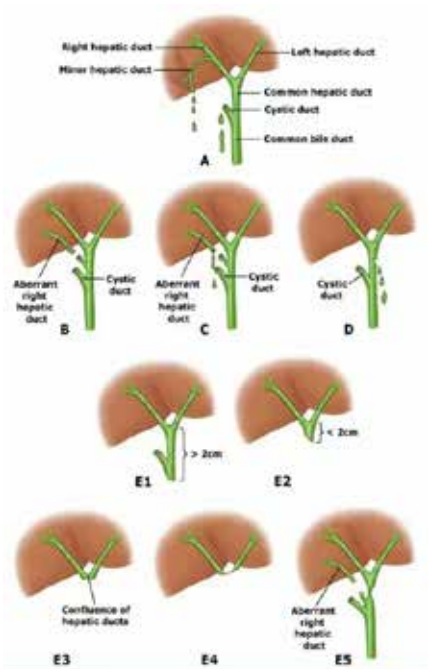
CLASSIFICATION OF BILE DUCT INJURIES:

- STRASBERG CLASSIFICATION
- BISMUTH- CORLETTE CLASSIFICATION
- STEWART-WAY CLASSIFICATION
- MCMAHON CLASSIFICATION
- HANNOVER CLASSIFICATION
- CSENDES CLASSIFICATION
- NEUHAUS CLASSIFICATION
- CUHK CLASSIFICATION
- MATTOX CLASSIFICATION
- AMSTERDAM ACADEMIC MEDICAL CENTER'S CLASSIFICATION

STRASBERG CLASSIFICATION

A	Bile leak from the cystic duct or an accessory duct showing continuity with the common bile duct
B	Section/injury of an accessory duct/sectorial ducts aberrant right hepatic duct with no continuity with the common bile duct with occlusion
C	Leak/open drainage from a sectorial duct/aberrant right hepatic duct with no continuity with the common bile duct
D	Partial section/lateral injury of an extrahepatic duct bile duct with no complete loss of continuity with the rest of the bile duct system
E	Complete section/circumferential injury of the bile duct with subtypes according to the length of the stump at various levels

	E1	Stricture/injury at more than 2 cm distal to bifurcation
	E2	Stricture/injury less than 2 cm distal to bifurcation
	E3	Stricture/injury at bifurcation
	E4	Stricture/injury involving right and left hepatic ducts
	E5	Complete obstruction of entire bile duct



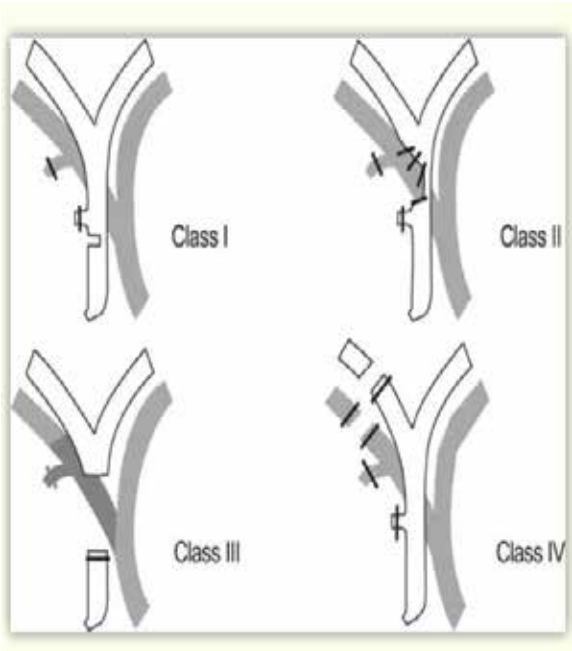
BISMUTH- CORLETTE CLASSIFICATION

TYPE I	low injury with a stump length more than 2 cm
TYPE II	middle level injury with a stump length less than 2 cm
TYPE III	high level injury without common hepatic duct available but preserved confluence
TYPE IV	involves loss of hepatic confluence with no communication between right and left ducts.

STEWART-WAY CLASSIFICATION

It based on the mechanism and anatomy of injury.

I	It refers to the incomplete section of bile duct with no loss of tissue. It has a prevalence rate of 8%	
II	It is a lateral injury of the common hepatic duct that leads to stenosis or bile leak. It is the consequence of thermal damage and clamping the duct with surgical staples. It has a prevalence of 2% with a concomitant hepatic artery injury in 20% of cases. T-tube related injuries are included within this class	
III	It is the most common (60%) represents the complete section of the common hepatic duct. Associated injury of right hepatic artery occurs in 25% of cases	
	IIIa	Remnant common hepatic duct
	IIIb	Section at the confluence
	IIIc	Loss of confluence
	IIId	Injuries higher than confluence with section of secondary bile ducts.
IV	It is right (65%) and accessory right (25%) hepatic duct injuries with associated injury of the right hepatic artery (60%). Occasionally it includes the common hepatic duct injury at the confluence (5%) besides the accessory right hepatic duct lesion (prevalence of 10%)	

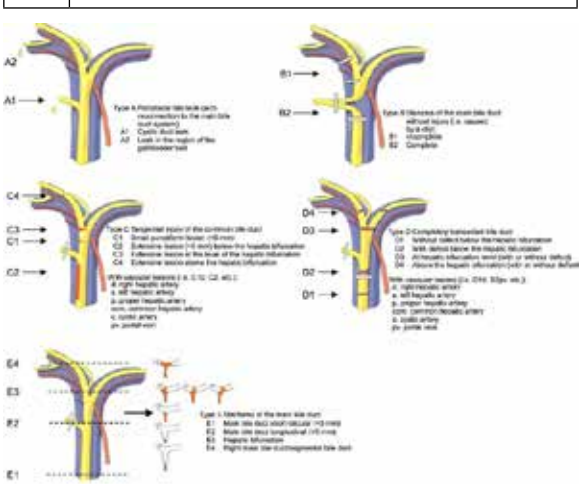


MCMAHON CLASSIFICATION
It is classified by the width of bile duct injury

Minor injury	Lacerations <25% of CBD diameter or cystic-CBD junction
Major injury	Laceration >25% of CBD diameter and post-operative bile duct stricture

HANNOVER CLASSIFICATION
It classifies injuries in relationship to the confluence and also includes vascular injuries.

TYPE A	Cystic and/or gallbladder bed leaks.
TYPE B	Complete or incomplete stenosis caused by a surgical staple.
TYPE C	Lateral tangential injuries.
TYPE D	Complete section of the common bile duct emphasizing their distance to the confluence as well as the concomitant injuries of hepatic artery and portal vein.
TYPE E	late bile duct stenosis at different lengths to the confluence



CSENDES CLASSIFICATION

TYPE I	A small tear of the hepatic duct or right hepatic branch caused by dissection with the hook or scissors during the dissection of Calot's triangle
TYPE II	Lesions of the cysticocholedochal junction due to excessive traction, the use of a Dormia catheter, section of the cystic duct very close or at the junction with the CBD, or to a burning of the cysticocholedochal junction by electrocautery
TYPE III	A partial or complete section of the CBD
TYPE IV	Resection of more than 10 mm of the CBD

NEUHAUS CLASSIFICATION

TYPE A	Peripheral bile leak (in communication with the CBD)	
	A1	Cystic duct leak
	A2	Bile leak from the liver bed
TYPE B	Occlusion of the CBD (or right respectively left hepatic duct, i.e. clip, ligation)	
	B1	Incomplete
	B2	Complete
TYPE C	Lateral injury of the CBD	
	C1	Small lesion (<5 mm)
	C2	Extended lesion (>5 mm)
TYPE D	Transection of the CBD (or right hepatic duct not in communication with the CBD)	
	D1	Without structural defect
	D2	With structural defect
TYPE E	Stenosis of the CBD	
	E1	CBD with short stenosis (<5 mm)
	E2	CBD with long stenosis (>5 mm)
	E3	Confluence
	E4	Right hepatic duct or segmental duct

CUHK CLASSIFICATION

TYPE 1	Leaks from cystic duct stump or small ducts in liver bed
TYPE 2	Partial CBD/CHD wall injuries without (2A) or with (2B) tissue loss
TYPE 3	CBD/CHD transection without (3A) or with (3B) tissue loss
TYPE 4	Rt/Lt hepatic duct or sectorial duct injuries without (4A) or with (4B) tissue loss
TYPE 5	Bile duct injuries associated with vascular injuries

AMSTERDAM ACADEMIC MEDICAL CENTER'S CLASSIFICATION

TYPE A	Cystic duct leaks or leakage from aberrant or peripheral hepatic radicles
TYPE B	Major bile duct leaks with or without concomitant biliary Strictures
TYPE C	Bile duct strictures without bile leakage
TYPE D	Complete transection of the duct with or without excision of some portion of the biliary tree

CLINICAL PRESENTATION:
The patients of BDI can be present in following groups:
- Intraoperative presentation
- Immediate postoperative presentation
- Delayed presentation

Intraoperative presentation:
This group of patients will be present as continuous bile leakage in operative field, one may find lack of continuity in biliary track after removing the gall bladder from the GB fossa during surgery when anatomy becomes more clear. Careful dissection should be done to expose the suspected leakage area. Intraoperative choleangiography will be gold standard investigation to find out bilary leakage.

Immediate postoperative presentation: this group of patients will be present as bilious drain output or bile leakage from incision

site, dehydration, jaundice, sign and symptoms of sepsis with paralytic ileus, and high grade fever.

Delayed presentation:

Patients will be present with sign and symptoms obstructive jaundice with nonspecific symptoms like nausea, vomiting, bloating due to biliary stricture associated with symptoms of portal hypertension in cases of concomitant portal venous injury or severe underlying hepatocellular damage.

COMPLICATIONS:

It can be divided in 2 groups: Early and late complications

Early complications:

- Septicemia, Electrolyte imbalance, coagulopathy, DIC
- Biliary peritionitis
- Biliary fistula
- Subhepatic or subphrenic abscess
- Cholangitis

Late complications:

- Biliary cirrhosis
- Portal hypertension
- Severe malnutrition

INVESTIGATIONS:

- Laboratory investigations
- Radiological investigations

Laboratory investigations:

• **Complete blood count:** shows leukocytosis.
• **Bilirubin:** normal or raised.
• **Liver enzymes:** serum transaminase will be mildly elevated and serum alkaline phosphatase will be significantly raised.
• **Renal function test:** it will be altered due to distributive shock in cases of ongoing biliary leak.
• **Electrolyte:** hypokalemia with hyponatremia.
• **Coagulation profile:** altered due to alteration of vitamin K absorbtion with liver parechymal disease.

Radiological investigations:

• **X-ray abdomen-standing** shows pneumobilia, air fluid levels due to paralytic ileus, elevated right dome of diaphragm due bile collection, basal atelectasis, misplaced clips.
• **Duplex Ultrasonography of abdomen** shows collection in Morrison pouch or subhepatic space, changes of cholangitis with dilatation of IHBR or give information regarding vascular injury.
• **CT scan of abdomen:** shows dilated biliary tree and helps localize the level of ductal obstruction in patients with stricture.
• **Percutanous transhepatic cholangiography (PTC)** provide complete delineation of level and extent of injury , drainage catheter should be left in place following PTC if complex injury is found on choleangiogram, because palpation of catheter helps guide identification of ductal stricture during intraoperative.
• **MRCP:** noninvasive modality provides striking images of biliary tree and yields anatomic information in single study.
• **ERCP**: it is more helpful for incomplete stricture and is appropriate for patients with history of sphincteric damage at previous common duct exploration, or if there is suspicion of papillary stenosis or other periampullary pathology.
• **Isotope scanning:** it may be valuable in assessing bile duct strictures, previous biliary reconstructions and isolated sectoral hepatic duct strictures.
• **Arteriography and delayed-phase portography:** to confirm vascular injury on initial studies, a suspicion of portal hypertension.

MANAGEMENT:

Management strategies' includes treatment at time of initial operation, management of immediate postoperative biliary leak and management of late/delayed complication of biliary injury (surgical repair for biliary stricture and work up and treatment for portal hypertension)

Injury recognized at initial operation: if injury to extrahepatic biliary tree is recognized at time of initial cholecystectomy, the surgeon should consider for repair it immediately. Each failed repair is associated with some loss of bile duct length. Regardless of the location of the lesion, initial repair of the damage recognized at time of cholecystectomy should have 2 basic aim and refer to higher center:

- Maintainance of ductal length below the hilus without sacrifice of tissue.
- Avoidance of uncontrolled postoperative bile leakage

There would be 2 scenarios for bile duct injury

1. Complete bile duct transaction
- End to end repair over a T tube
- Roux-en-Y hepaticojenunostomy

2. Injury to lateral duct wall: primary choledochorrhaphy with CBD exploration.

Management of immediate postoperative biliary leak: in the setting of an external biliary fistula, the essential consideration in management is to avoid early reoperation and carry out appropriate investigations and take time to stabilize and make patient free from the acute complications likes infection and malnourishment, associated with it.

According to drain output of 24 hr, billiary fistula is divided in types: low output if output <300 ml/day and high output if output > 300ml/day, some of low output biliary fistula may result in spontaneous closure if there is no distal obstruction to bile flow, this is partially true for type A and type D injuries. Some of high out biliary fistula get promote closure if relative resistance of transpapillary bile drainage decrease with endoscopic sphincterotomy with distal stent placement

- Medical management
- Endoscopic/percutanous management
- Surgical management

Medical management includes appropriate antibiotics for cholangitis and septicemia, IV fluids for shock, Electrolyte correction, and strict drain output charting with drain culture sensitivity.

Endoscopic/ percutanous management : CT or USG guided percutanous drainage of bilioma or intraperitoneal collection should done and sent for culture; percutanous transhepatic biliary stenting if surgery is not feasible immediately.

Surgical repair is seldom possible initially, with the bile ducts collapsed, deeply bile stained and friable; repair is best delayed, until biliary leak has been controlled completely.

Management of delayed complication of biliary injury: the principle of managing late duct stenoses and strictures includes

- Exposure of healthy proximal bile ducts draining all areas of liver
- Preparation of a suitable segment of distal mucosa for anastomosis
- Creation of a mucosa-to-mucosa sutured anatomosis of the bile ducts to distal conduit, which is almost always a Roux-en-Y loop of jejunum.

In a patient with portal hypertension, initial interventional radiologic management by percutanous placed biliary drainage catheters is probably safer than opearation, due to danger of intraoperative hemorrhage.

Reference

1. Bailey & love's SHORT PRACTICE OF SURGERY 25TH EDITION 2008, Edited by N.S. Williams, C.J.K. bulstrode & P.R.O'CONNLL pg 1111-12,1117-21
2. Maingot's abdominal operatio. 11th edition 2007, Edited by Zinner MJ Ashley SW pg 847-849,858-859
3. Laproscopic versus open cholecystectomy for patient with symptomatic cholecystolithiasis Keus F, de Jong J, Gooszen HG, Laarhoven CJHMB
4. Laparoscopic covereted to open cholecytectomy minimally prolongs hospitalization-Presented at 57th annual meeting of the southwesten Surgical congress, San Antonio, Texas, April 10-12,2005
5. Classification of iatrogenic bile duct injury Wan-Yee Lau and Eric C.H. Lai
6. Management of bile duct injuries: Treatment and Long-Term Results D.J. gouma H. Obertop, Department of surgery, Academic Medical center at the University of Amsterdam, The Netherlands