MANAGEMENT OF BILE DUCT INJURY

Recognition and Operative Treatment

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Nothing to Disclose
Background

• About 750,000 Laparoscopic Cholecystectomies in United States
• Bile Duct injury rate remains 0.2% to 0.4% versus open cholecystectomy rate of 0.1% to 0.2%
• Single Site Cholecystectomy as high as 0.72%
• BDI is most litigated laparoscopic gastrointestinal surgery
Causes of Iatrogenic Bile Duct Injury

- Misidentification of Biliary Anatomy
- Misperception of Biliary Structures
- Aberrant Biliary Anatomy
- Aberrant Arterial Anatomy
- Complicated Cholecystitis with significant inflammation, scarring, perforation or Mirizzi syndrome
Misidentification of Biliary Anatomy

Only about 83% of patients have normal anatomy
Aberrant Biliary Anatomy

- Cystic duct may insert into:
  - the right hepatic duct
  - a right subsegmental branch
  - the left side of the common bile duct.
Aberrant Arterial Anatomy

B: Replaced Right Hepatic Art.

C: Accessory Right Hepatic Art.

N: Right Hepatic Artery Posterior to Hepatic Duct (64%)

O: Right Hepatic Artery Anterior to Hepatic Duct (29%)
Technical Errors

- Failure to control the retained side of the cystic duct
  - Inadequate clip apposition, clip “scissoring,”

- Thermal injury with excessive or blind application of electrocautery, laser dissection, or ultrasonic scalpel

- Tran-section of the cystic duct with cautery can lead to arcing to previously placed clips and result in thermal injury.

- Excessive dissection of the common bile duct may cause local ischemia and stricturing.

- Injudicious application of clips to control bleeding can lead to obstruction of a part of the biliary tree or the entire extrahepatic bile duct.

- Excessive lateral traction of the gallbladder can result in “tenting”

- Too Deep dissection in the gallbladder fossa
Thermal Injuries

- Inappropriate use of electrocautery near biliary ducts
- May lead to stricture and/or bile leaks
- Mechanical trauma can have similar effects
At Risk Patients

- Male
- Advanced Age
- Multiple Comorbidities
- Inflammation of the Gallbladder
Sequelae of BDI

- Biloma formation/ Biliary Fistula
- Cholangitis
- Sepsis
- Bile Duct Stricturing
- Malnutrition (from external loss of bile salts)
- Biliary cirrhosis, or liver atrophy
- Liver Transplantation
- Mortality
## Prevention of BDI

### Safe Surgical Technique in Laparoscopic Cholecystectomy

<table>
<thead>
<tr>
<th>Step</th>
<th>Instructions</th>
</tr>
</thead>
</table>
| **Optimize visualization** | Well-positioned monitor(s)  
Position patient with feet down and slightly rotated to left. 30-degree scope |
| **Orient and inspect**   | Define triangle of Calot and the cystic duct–gallbladder junction.  
Evaluate mobility of gallbladder.  
Is the gallbladder inflamed, intrahepatic?  
Decompress gallbladder if tense and difficult to grasp.  
Is the infundibulum redundant or folded?  
Evaluate liver parenchyma, e.g., cirrhosis, steatosis.  
Will hilar or hepatic-duodenal fat impair visualization of biliary anatomy? |
| **Retract**            | Retract fundus toward diaphragm. Retract infundibulum laterally.              |
| **Dissect**            | Divide medial areolar tissue plane between liver and infundibulum.  
Free inferior portion of gallbladder from gallbladder fossa.  
Define cystic duct and artery.  
Minimize electrocautery dissection.  
Avoid dissection and visualization of common bile duct.  
Excessive clip application (>7) may require conversion to open procedure. |
Complications

• Overall Mortality from BDI is 0% to 4.2%

• Operative Mortality from Repair 1.8%

• Postoperative Complications in over 40%
  - Wound infection (8%)
  - Cholangitis (5.7%)
  - Intraabdominal Abscess/Biloma (2.9%)
  - Stent Related (5.7%)

Predictors of Operative Failure

• History of multiple previous repairs
• High-level injury involving the bifurcation
• Incomplete excision of scarred duct remnant
• Use of nonabsorbable suture
• Use of a two-layer anastomosis
• Failure to eradicate infection before repair
Classification

- Location of injury
- Mechanism & type of injury
- Effect on biliary continuity
- Timing of identification

Each plays significant role in determining appropriate management & operative repair
Classification Systems

Bismuth Classification (1982)
- Open Cholecystectomy Era
- Focuses on extent of healthy bile duct above the injury

Siewert
McMahon
Strasberg
Amsterdam (Bergman)
Neuhaus
Csendes
Stewart-Way
Lau
Hannover
Strasberg Classification

- Type A Cystic duct leaks or leaks from small ducts in the liver bed
- Type B Occlusion of a part of the biliary tree, almost invariably the aberrant right hepatic ducts
- Type C Transection without ligation of the aberrant right hepatic ducts
- Type D Lateral injuries to major bile ducts
- Type E Subdivided as per Bismuth classification into E1 to E5
Strasberg Classification

E: injury to main duct (Bismuth)
- E1: Transection >2cm from confluence
- E2: Transection <2cm from confluence
- E3: Transection in hilum
- E4: Separation of major ducts in hilum
- E5: Type C plus injury in hilum
Stewart-Way Classification

**Table 2**

<table>
<thead>
<tr>
<th>Mechanism of Laparoscopic Bile Duct Injury</th>
<th>Associated RHA Injury (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I CBD mistaken for cystic duct, but recognized</td>
<td>5</td>
</tr>
<tr>
<td>Cholangiogram incision in cystic duct extended into CBD</td>
<td></td>
</tr>
<tr>
<td>Class II Lateral damage to the CHD from cautery or clips placed on duct</td>
<td>20</td>
</tr>
<tr>
<td>Associated bleeding, poor visibility</td>
<td></td>
</tr>
<tr>
<td>Class III CBD mistaken for cystic duct, not recognized</td>
<td>35</td>
</tr>
<tr>
<td>CBD, CHD, RHD, LHD transected and/or resected</td>
<td></td>
</tr>
<tr>
<td>Class IV RHD (or right sectoral duct) mistaken for cystic duct, RHA mistaken 60 for cystic artery; RHD (or right sectoral duct) and RHA transected</td>
<td></td>
</tr>
<tr>
<td>Lateral damage to the RHD (or right sectoral duct) from cautery or clips placed on duct</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: CBD, common bile duct; CHD, common hepatic duct; LHD, left hepatic duct; RHA, right hepatic artery; RHD, right hepatic duct.
Timing of Identification

Intra-op
• Unexpected ductal structures seen bile leak into field from lacerated or transected duct

Post-op
• Depends on continuity of bile duct & presence or absence of bile leak
Intra-op diagnosis

About 30% BDI recognized at time of initial surgery
If injury recognized, two options:

1. Drain
2. Primary repair *(SHOULD BE HEPATOBILIARY SURGEON)*
   - Primary end-to-end CBD repair
   - Roux-en-Y hepaticojejunostomy
   - *Primary repair → high incidence of failure →* percutaneous or endoscopic balloon dilatation later
Post-op diagnosis

Diffuse abdominal pain & persistent ileus several days post-op → high index of suspicion → possible unrecognized BDI

Ultrasound & CT scan
- intraabdominal collections or ascites, if bile leak
- dilatation of biliary tree, if bile duct obstruction

HIDA scan
- If doubt exists, HIDA scan can confirm leak but not the specific leak site
Clinical Presentation (post-op)

Obstruction
- Clip ligation or resection of CBD → obstructive jaundice, cholangitis

Bile Leak
- Bile from intra-op drain
- Localized biloma or free bile ascites /peritonitis,
- Diffuse abdominal pain & persistent ileus several days post-op → high index of suspicion → possible unrecognized BDI
Diagnose

Leak from Cystic Duct

(Strasberg A)
ERCP – clips across CBD

- CBD transection → normal-sized distal CBD up to site of transection
- Percutaneous Transhepatic Cholangiography (PTC) necessary
- Surgery
ERCP

Complete obstruction
PTC

Strasberg E2
MRCP

Strasberg E3
Vascular Injury

Arteriography

Right Hepatic Artery injury
Definitive management

Goal

- reestablishment of bile flow into proximal gastrointestinal tract
- prevent cholangitis, sludge or stone formation, re-stricturing & progressive liver injury

Bile duct intact & simply narrowed → percutaneous or endoscopic dilatation
Biliary enteric anastomosis

Most laparoscopic BDI – complete discontinuity of biliary tree

Surgical reconstruction, Roux-en-Y hepaticojejunostomy

Goal: tension-free, mucosa-to-mucosa anastomosis with healthy, non-ischemic bile duct
ERCP – multiple stents

Lateral duct wall injury or cystic duct leak → transampullary stent controls leak & provides definitive treatment

Distal CBD must be intact to augment internal drainage with endoscopic stent
Cholangiography (ERCP + PTC)

PTC

- defines proximal anatomy
- allows placement of percutaneous transhepatic biliary catheters to decompress biliary tree → treats or prevents cholangitis & controls bile leak
Surgical Repair
Choledocho-choledochostomy
Surgical repair
Choledocho-duodenostomy
Surgical Repair
Hepatico-jejunostomy (Roux-en-Y)
Surgical Repair

Double lumen hepatico-jejunostomy (Roux-en-Y)
Surgical repair
Formation of one anastomosis
Surgical Repair

Left hepatic duct anastomosis

(Segment III / Hepp-Couinaud)
Surgical Repair
Intrahepatic cholanojio-jejunostomy (Longmire)
Surgical Repair
Permanent access hepatico-jejunostomy

Endoscopy through permanent access
Percutaneous balloon dilation
ERCP & PTC
Classic Laparoscopic Injury

--Mistaking the common bile duct for the cystic duct
Case

65 yo male transferred from outside hospital with suspected bile duct injury
PSHx: Gastric bypass surgery
Laparoscopic converted to open with T-tube placement.

Clinical course: Patient arrived stable and non toxic; LFT’s normal; bile drain to gravity and cholangiogram catheter stitched in place.
Treatment Summary

• Strasberg Type A – ERCP ± sphincterotomy ± stent

• Type B & C – traditional surgical hepaticojejunostomy

• Type D – primary repair over an adjacently placed T-tube (if no evidence of significant ischemia or cautery damage at site of injury)

• More extensive type D & E injuries – Roux an-Y hepaticojejunostomy over a 5-F pediatric feeding tube to serve as a biliary stent
Risk Factors for BDI

Acute inflammation at Calot’s triangle
Atypical anatomy
  ▪ aberrant RHD (most common)
  ▪ complex cystic duct insertion

Conditions that impair “Critical view of safety”
  ▪ Obesity & Periportal fat
  ▪ Complex biliary disease: choledocholithiasis, gallstone pancreatitis, cholangitis
  ▪ Intra-op bleeding
Intraoperative Detection

• Only 25-33% of injuries are recognized intraoperatively.
• If experienced, convert to Open Procedure and perform Cholangiography (determine extent of injury).
• If not experienced, perform the cholangiogram laparoscopically with intent of referring patient (placement of drains).
• Consult an experienced hepatobiliary surgeon.

- **CONTROL INFECTION BEFORE REPAIR**

• Acute Management
  – Biliary catheter for decompression of biliary tract and control of bile leaks
  – Percutaneous drainage of intraperitoneal bile collection
Preventative Measures

- Attention to operative details (insufficient close or deep plane)
- Stasberg’s critical view of safety
- Appropriate Handling of Gallbladder
- Careful use of diathermy
- Recognition of Biliary and Vasculature Anomalies
Take Home Message

• Iatrogenic bile duct injury with subsequent biliary fistula or obstruction has significant economic, legal, mental, and physical consequences.

• Preoperative planning, safe operative technique, routine use of IOC or intraoperative ultrasound, and application of “stopping rules” can decrease the risk of biliary injury.

• Early recognition and involvement of a multidisciplinary team specialized in biliary disease can result in successful long-term repair of the biliary injury. After identifying the injury with high-quality imaging (CT or MRCP), ERCP, and/or PTC, the appropriate intervention is determined.
Take Home Message

• Endoscopic stenting is a viable treatment option in selected patients.

• Definitive repair may require biliary-enteric anastomosis

• Postoperative complications are increased with hepatic artery injury, and the most common longterm complication is anastomotic stricture

• Overall, patients will have good surgical outcomes if treated by a multidisciplinary team of hepatobiliary specialists, but may still have significant negative long-term psychological effects.
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