Bile Duct Injury

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Bile Duct Injury

Causes and Prevention of Laparoscopic Bile Duct Injuries
Analysis of 252 Cases From a Human Factors and Cognitive Psychology Perspective

Conclusions

- Errors leading to lap BDI stem principally from misperception, not errors of skill, knowledge, or judgment.
- The misperception was so compelling that in most cases the surgeon did not recognize a problem.
- Even when irregularities were identified, corrective feedback did not occur, which is characteristic of human thinking under firmly held assumptions.
- These findings illustrate the complexity of human error in surgery while simultaneously providing insights.
- They demonstrate that automatically attributing technical complications to behavioral factors that rely on the assumption of control is likely to be wrong.

253 major bile duct injuries following laparoscopic cholecystectomy
- 196 women and 57 men
- Mean age 47 years
- (range 19 - 86 years)
Stewart-Way Classification
Laparoscopic Bile Duct Injuries

Class I
CBD mistaken cystic duct - recognized
Cholangiocath incision carried into CBD

Class II
Lateral injury to CHD from clips or cautery
Associated bleeding & poor visibility

Class III
CBD mistaken cystic duct - not recognized
CBD, CHD, R, L hepatic ducts transected and/or resected

Class IV
RHD mistaken for cystic duct; RHA mistaken for cystic; artery, RHD and RHA transected
Lateral injury to RHD from clips or cautery

Laparoscopic Bile Duct Injury Classification Methods

Table 1 Bismuth classification (1982)\(^6\)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Low CHD stricture, with a length of the common hepatic duct stump of &gt;2 cm</td>
</tr>
<tr>
<td>Type 2</td>
<td>Proximal CHD stricture – hepatic duct stump &lt;2 cm</td>
</tr>
<tr>
<td>Type 3</td>
<td>Hilar stricture, no residual CHD, but the hepatic ductal confluence is preserved</td>
</tr>
<tr>
<td>Type 4</td>
<td>Hilar stricture, with involvement of confluence and loss of communication between right and left hepatic duct</td>
</tr>
<tr>
<td>Type 5</td>
<td>Involvement of aberrant right sectoral hepatic duct alone or with concomitant stricture of the CHD</td>
</tr>
</tbody>
</table>

CHD, common hepatic duct.

Laparoscopic Bile Duct Injury Other Classification Methods

Table 2 Proposed definition of major and minor bile duct injuries by McMahon et al. (1995)\(^7\)

<table>
<thead>
<tr>
<th>Major bile duct injury (at least one of the following present)</th>
<th>Minor bile duct injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laceration &gt;25% of bile duct diameter</td>
<td>Laceration of CBD &lt;25% of diameter</td>
</tr>
<tr>
<td>Transection of CHD or CBD</td>
<td>Laceration of cystic-CBD junction (‘buttonhole tear’)</td>
</tr>
<tr>
<td>Development of post-operative bile duct stricture</td>
<td></td>
</tr>
</tbody>
</table>

CHD, common hepatic duct; CBD, common bile duct.

Laparoscopic Bile Duct Injury Other Classification Methods

Table 3 Strasberg classification (1995)\(^10\)

<table>
<thead>
<tr>
<th>Type A</th>
<th>Cystic duct leaks or leaks from small ducts in the liver bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type B</td>
<td>Occlusion of a part of the biliary tree, almost invariably the aberrant right hepatic ducts</td>
</tr>
<tr>
<td>Type C</td>
<td>Transection without ligation of the aberrant right hepatic ducts</td>
</tr>
<tr>
<td>Type D</td>
<td>Lateral injuries to major bile ducts</td>
</tr>
<tr>
<td>Type E</td>
<td>Subdivided as per Bismuth classification into E1 to E5</td>
</tr>
</tbody>
</table>

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Laparoscopic Bile Duct Injury
Other Classification Methods

Table 4  Amsterdam Academic Medical Center's classification by Bergman et al. (1996)\(^\text{11}\)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Cystic duct leaks or leakage from aberrant or peripheral hepatic radicles</td>
</tr>
<tr>
<td>B</td>
<td>Major bile duct leaks with or without concomitant biliary strictures</td>
</tr>
<tr>
<td>C</td>
<td>Bile duct strictures without bile leakage</td>
</tr>
<tr>
<td>D</td>
<td>Complete transection of the duct with or without excision of some portion of the biliary tree</td>
</tr>
</tbody>
</table>

Laparoscopic Bile Duct Injury
Other Classification Methods

Table 5  Neuhaus classification (2000)\(^\text{17}\)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Peripheral bile leak in communication with the CBD</td>
</tr>
<tr>
<td>B1</td>
<td>Cystic duct leak</td>
</tr>
<tr>
<td>B2</td>
<td>Bile leak from the liver bed</td>
</tr>
<tr>
<td>B</td>
<td>Occlusion of the CBD or right respectively left hepatic duct, i.e. clip, ligation</td>
</tr>
<tr>
<td>B1</td>
<td>Incomplete</td>
</tr>
<tr>
<td>B2</td>
<td>Complete</td>
</tr>
<tr>
<td>C</td>
<td>Lateral injury of the CBD</td>
</tr>
<tr>
<td>C1</td>
<td>Small lesion (&lt;5 \text{ mm})</td>
</tr>
<tr>
<td>C2</td>
<td>Extended lesion (\geq 5 \text{ mm})</td>
</tr>
<tr>
<td>D</td>
<td>Transection of the CBD or right hepatic duct not in communication with the CBD</td>
</tr>
<tr>
<td>D1</td>
<td>Without structural defect</td>
</tr>
<tr>
<td>D2</td>
<td>With structural defect</td>
</tr>
<tr>
<td>E</td>
<td>Stenosis of the CBD</td>
</tr>
<tr>
<td>E1</td>
<td>CBD with short stenoses (&lt;5 \text{ mm})</td>
</tr>
<tr>
<td>E2</td>
<td>CBD with long stenoses (\geq 5 \text{ mm})</td>
</tr>
<tr>
<td>E3</td>
<td>Confluence</td>
</tr>
<tr>
<td>E4</td>
<td>Right hepatic duct or segmental duct</td>
</tr>
</tbody>
</table>

CBD, common bile duct.

Laparoscopic Bile Duct Injury
Other Classification Methods

Table 6  Csordas classification (2001)\(^\text{22}\)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>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</td>
</tr>
<tr>
<td>II</td>
<td>Lesions of the cysticcholedochal 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 cysticcholedochal junction by electrocautery</td>
</tr>
<tr>
<td>III</td>
<td>A partial or complete section of the CBD</td>
</tr>
<tr>
<td>IV</td>
<td>Resection of more than (10 \text{ mm}) of the CBD</td>
</tr>
</tbody>
</table>

CBD, common bile duct.

Bile Duct Injury

No classification system is universally accepted as each has its own limitation. The optimal management depends on the timing of recognition of injury, the extent of bile duct injury, the patient's condition and the availability of experienced hepatobiliary surgeons.
Stewart-Way Classification
Laparoscopic Bile Duct Injuries

Class I
- CBD mistaken for cystic duct
- Cholangiocath incision carried into CBD

Class II
- Lateral injury to CBD from clips or cautery
- Associated bleeding & poor visibility

Class III
- CBD mistaken for cystic duct
- Not recognized
- CBD, CHD, R, L hepatic ducts transected and/or resected

Class IV
- RHD mistaken for cystic duct
- RHA mistaken for cystic duct
- RHD and RHA transected
- Lateral injury to RHD from clips or cautery

Diagnoses
- Bifurcation
- Above bifurcation
- Above bifurcation into segmental ducts

Laparoscopic Bile Duct Injury
Mechanisms

1. Tissue overlying the Cystic-CBD junction is not removed
2. The CBD is mistaken for the cystic duct

Levels of Injuries
- Higher the injury, more complex the repair, higher risk of failure

Stewart-Way Classification
Laparoscopic Bile Duct Injuries
Clinical History

40 year old woman -> Lap Chole
Pod 4 abdominal discomfort, difficulty eating, nl LFTs
  HIDA – normal (delayed emptying)
  US – non-dil ducts, small right pleural effusion
Pod 11 seen clinic, Rx’d with Mylicon for gas
Pod 13 went to ER c/o abdominal pain, admitted
  HIDA bile leak, but no obstruction CBD
Pod 14 ERCP:

- Bile Duct Injury Class III
- clip distal CBD, Non-vis Hep Ducts

Clinical History

Pod 14 ERCP - clip distal CBD, Non-vis Hep Ducts

- Exploratory laparotomy (by primary surgeon)
  Class III bile duct injury repaired w/ Roux-en-Y Hep-J

- Repair failed
  Eventually referred to biliary surgeon with successful repair
Clinical History

31 year old woman, Lap Chole for acute cholecystitis
- P-op fever, shoulder pain, abdominal pain, bile JP
- DC Pod 7
- 200cc/day bile JP - observed for 9 days
- Developed acholic stools, nl LFTs
- ERCP

Class II Bile Duct Injury
- presumed retained stone blocking CBD
- stricture CBD at site multiple clips

Clinical History
- ERCP – presumed retained stone blocking CBD
- stricture CBD at site multiple clips
- Class II injury repaired that night, Roux-en-Y Hep-J
- OK for 2 years – recurrent cholangitis
- Referred to a biliary surgeon for 2nd repair
Stewart-Way Classification
Laparoscopic Bile Duct Injuries

Class I
- Abdominal pain, distention, jaundice, fever, leukocytosis
- CT / US: dilated ducts, fluid

Class II
- Abdominal pain, distention, bile leak, jaundice, fever, leukocytosis
- CT / US: dilated ducts, fluid

Class III
- Abdominal pain, distention, bile leak, jaundice, fever, leukocytosis
- CT / US: fluid, non-dilated ducts

Class IV
- Abdominal pain, distention, bile leak, bleeding (can be massive)
- CT / US: fluid, non-dilated ducts

Clinical Presentation

Diagnostic Issues
- Clinical findings can be subtle
  - Abdominal pain, distention, nausea, anorexia
  - Bile leak
  - Despite large amounts of bile in the abdomen
    - Peritonitis is uncommon
  - Labs may be normal or minimally elevated
  - CT Scan / US: non-dilated bile ducts and fluid
  - “Classic findings” of dilated ducts and jaundice less common
- Clinical course initially not recognized as abnormal in 53% of cases

Abnormal Laboratory Data in patients with BDI – not helpful

- Bilirubin
- Alk Phos
- Wbc

% elevated

0 20 40 60 80 100

3/28/2012
Clinical Findings at Initial Presentation

Not reliable

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Diagnostic Delay Increases Morbidity

Diagnostic errors causing delay in diagnosis cause statistically increased incidence in cholangitis, sepsis, peritonitis, abscess

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Diagnostic Delay -> Morbidity

Accuracy of Imaging Studies

HIDA & US significantly less accurate than CT

P < 0.0001
**Diagnostic Issues**

- The significance of an **abdominal fluid collection** or **bilious drainage**
  - Represents a bile duct injury until proven otherwise.
  - Many cases, fluid initially attributed to causes other than a bile duct injury.
  - Bilious drainage observed for an average of 21 days (range 1 - 120 days).

**Impact of Pre-OP Eval / Cholangiogram**

- Incomplete / no biliary imaging leads to significantly higher frequency of failed repair or missed injury.

**Levels of Injuries**

- **No role** for Laparotomy / Laparoscopy without a **complete pre-op evaluation**
  - Failure to identify the injury (38%) leads to a higher repair failure rate.
  - BDI can be compounded by unknowingly oversewing injured bile ducts.

- **Must be ascertained prior to repair by complete biliary imaging for improved success rates with reconstruction.**

- **P < 0.0001**
Management

- Must control intra-abdominal inflammation and infection
  - Drain bile collections or abscess
- Need to obtain complete cholangiography
  - ERCP: Class I and II injuries
  - ERCP / PTC: Class III and IV injuries
- Avoid rush to the OR / repair of a potentially complex injury immediately
  - You want a well patient
- Decide who should repair the injury – highest level of experience available

Who should repair the injury?

Class III Bile Duct Injury

Clip had been removed from CBD before pt transferred
Class III Bile Duct Injury

Debrided CHD

Success of Treatment by Treating Physician

Length of Illness by Treating Physician

During the Original Operation
Clues that the LC dissection is in the wrong plane

- Ductal abnormalities
  - “Cystic duct” not encompassed by clip
  - “Cystic duct” can be traced to the duodenum
  - Accessory duct
  - Bile drainage from a tubular structure
- Cholangiogram
  - Failure to opacify the proximal hepatic ducts
  - Narrowing CBD at the cholangiogram catheter
  - Additional vascular, lymphatic, or ductal structures

Is there a higher success rate for injuries identified at the index operation?

No.

Influence of Operative Recognition Success of Primary Surgeon Repair

<table>
<thead>
<tr>
<th>OP Recogn</th>
<th>Recog Post-OP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>20%</td>
</tr>
<tr>
<td>20%</td>
<td>40%</td>
</tr>
<tr>
<td>40%</td>
<td>60%</td>
</tr>
<tr>
<td>60%</td>
<td>80%</td>
</tr>
<tr>
<td>80%</td>
<td>100%</td>
</tr>
</tbody>
</table>

P = NS
Conclusions

- Should suspect a BDI whenever post-op course is not totally "normal"
  - Bile duct injuries following laparoscopic cholecystectomy can be severe
  - Findings can be subtle
  - Labs can be normal
  - Diagnostic delay increases morbidity

Conclusions

- CT scan most useful to identify BDI findings / bile collection
  - HIDA and US are less reliable
  - Remember: a cystic duct leak, Class I, Class II (with a fistula), Class III, or Class IV injury can have a similar presentation and findings on US / CT scan
  - The only way to differentiate these injuries is with complete cholangiography

Conclusions

- If a bile collection is identified
  - Complete cholangiography - to characterize the injury
  - Intra-abdominal infection and inflammation must be controlled
  - IV abx
  - percutaneous drainage of all bile collections or abscess
  - Decide who should repair the Injury – always opt for surgeon with the most experience

Conclusions

- Repairs done by the Primary Surgeon are less successful
  - IR / endoscopic treatments
    - (often producing multiple & prolonged attempts at dilatation and stenting)
    - are usually unsuccessful and prolong the illness
  - Repairs done by a Biliary Surgeon have the highest success rate and are associated with a shorter length of illness
Evaluation and Treatment

Appreciate the significance of the clinical manifestations

CT scan Imaging

Drain bile collection

Complete cholangiography

Roux-en-Y Hepaticojejunostomy
(by Biliary Specialist)

Bile Duct Injury...

Questions?