Recent classification of bile duct injury after laparoscopic cholecystectomy

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Introduction

• Laparoscopic cholecystectomy
  – Gold standard treatment of gallstone ds
• Incidence of bile duct injury
  – More common than open technique
• Global incidence of bile duct injury
  – Around 0.5% fairly constantly
<table>
<thead>
<tr>
<th>Author</th>
<th>IBDI incidence following OC</th>
<th>IBDI incidence following LC</th>
</tr>
</thead>
<tbody>
<tr>
<td>McMahon et al\textsuperscript{[14]}, 1995</td>
<td>0.2</td>
<td>0.81</td>
</tr>
<tr>
<td>Strasberg et al\textsuperscript{[15]}, 1995</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Shea et al\textsuperscript{[16]}, 1996</td>
<td>0.19-0.29</td>
<td>0.36-0.47</td>
</tr>
<tr>
<td>Targarona et al\textsuperscript{[17]}, 1998</td>
<td>0.6</td>
<td>0.95</td>
</tr>
<tr>
<td>Lillemoe et al\textsuperscript{[18]}, 2000</td>
<td>0.3</td>
<td>0.4-0.6</td>
</tr>
<tr>
<td>Gazzaniga et al\textsuperscript{[19]}, 2001</td>
<td>0.0-0.5</td>
<td>0.07-0.95</td>
</tr>
<tr>
<td>Savar et al\textsuperscript{[20]}, 2004</td>
<td>0.18</td>
<td>0.21</td>
</tr>
<tr>
<td>Moore et al\textsuperscript{[21]}, 2004</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Misra et al\textsuperscript{[22]}, 2004</td>
<td>0.1-0.3</td>
<td>0.4-0.6</td>
</tr>
<tr>
<td>Gentileschi et al\textsuperscript{[23]}, 2004</td>
<td>0.0-0.7</td>
<td>0.1-1.1</td>
</tr>
<tr>
<td>Kaman et al\textsuperscript{[24]}, 2006</td>
<td>0.3</td>
<td>0.6</td>
</tr>
</tbody>
</table>

IBDI: Iatrogenic bile duct injuries; OC: Open cholecystectomy; LC: Laparoscopic cholecystectomy.
Risk factors

• Patient factors
  – Obesity, advanced age, male sex, adhesion

• Local factors
  – Inflammation and/or infection, hemorrhage, aberrant anatomy
  – Acute cholecystitis, acute biliary pancreatitis, bleeding in calot triangle, scarred or shrunked GB, large impacted stone in hartmann’s pouch

• Extrinsic factors
  – Surgeons’ experience, functioning equipment

“Encountering a potentially dangerous situation”
Direct cause of laparoscopic bile duct injury

• Misidentification errors
• Technical errors
  – Failure to occlude the cystic duct security
  – Too Deep dissection on the liver bed
  – Thermal injury
  – Tenting injury
Avoid technique

• Identification of cystic structure
  – Routine cholangiography
  – Critical view technique: Strasberg
  – Infundibular technique
  – Dissection of main bile duct with visualization of the cystic duct or common duct insertion
Critical view technique

Fig. 2. The critical view of safety is obtained when the lateral and medial aspects of the gallbladder (*horizontal arrow*) have been dissected free, and only 2 structures are seen entering the gallbladder; the cystic artery and the cystic duct (*slanted arrows*).
• Intraoperative cholangiography
  – Controversial
  – Additional information in a difficult cholesystectomy (can not prevent bile duct injury)
  – Cost-effectiveness & efficacy
Fig. 1 Annual incidence of bile duct injury (BDI) and intraoperative cholangiography (IOC) during laparoscopic cholecystectomy (L.C.). The frequencies were calculated based on 31,838 LCs recorded between 1995 and 2005 in the Swiss Association of Laparoscopic and Thoracoscopic Surgery database. Although the frequency of BDIs did not change over this period ($P = 0.560$), the use of IOC decreased significantly ($P < 0.001$) (Cochran–Armitage trend test).
Fluorescent cholangiography illuminating the biliary tree during laparoscopic cholecystectomy

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Background: Although intraoperative cholangiography during laparoscopic cholecystectomy, itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG) itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG) itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG) itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG) itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG) itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG) itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG) itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG) itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG) itself cause injury to the bile duct. Recently, a intravenous injection of indocyanine green (ICG)

Methods: In 52 patients undergoing lapar intravenously 30 min before the patient entered imaging system, which consisted of a xenon light camera that could filter out light wavelengths itself performed during dissection of Calot’s triangle, with that of preoperative cholangiography.

Results: Fluorescent cholangiography delineated common hepatic duct–common hepatic duct junction was visualized. Fluorescent imaging also identified all accessed ducts.

Conclusion: Fluorescent cholangiography enabled dissection of Calot’s triangle. This simple technique minimized injury during laparoscopic cholecystectomy, repositioned.

Paper accepted 16 March 2010

Published online 9 July 2010 in Wiley InterScience

Fig. 1 a Fluorescent cholangiography (left) before dissection of Calot’s triangle clearly shows the cystic duct (arrowhead) running parallel to the common hepatic duct (arrow) as well as the right and left hepatic ducts, which are buried in fat tissues and unidentifiable on colour images (right). b,c Calot’s triangle was dissected to isolate the cystic duct, with voluntary use of fluorescent imaging both from anterior (b) and posterior (c) sides of Calot’s triangle to confirm the absence of aberrant bile ducts. d The cystic duct was closed using surgical clips (see also Video S1, supporting information)
• Intraoperative ultrasound

?
Detection of iatrogenic bile duct lesions

- At time of surgery
  - 10 - 30%
  - Simple injury
  - Complex injury
    - Success rate of first time repair:
      HB surgeon vs primary surgeon (79% vs 27%)

- Most BDIs: not recognized intraop.
  - 2 type of injury: Biliary obstruction and/or bile leak
  - Concomitant vascular injury
Classification of bile duct injury

• Bismuth classification (1982)
• Strasberg modification (1995)
• McMahon et al. (1995)
• Bergman et al. (1996)
• Stewart-Way classification (2003)
• Neuhaus et al. (2004)
• Lau classification (2007)
• Hannover classification (2007)
Bismuth classification


Figure 1 Bismuth classification of IBDI. I: Common bile duct and low common hepatic duct (CHD) > 2 cm from hepatic duct confluence; II: Proximal CHD < 2 cm from the confluence; III: Hilar injury with no residual CHD-confluence intact; IV: Destruction of confluence: right and left hepatic ducts separated; V: Involvement of aberrant right sectoral hepatic duct alone or with concomitant injury of CHD.
An analysis of the problem of biliary injury during laparoscopic cholecystectomy.

Strasberg SM, Hertl M, Soper NJ.

**Figure.** Strasberg-Bismuth classification of laparoscopic injuries to the biliary tract. Reproduced with permission from the *Journal of the American College of Surgeons.*
**Table 2** Proposed definition of major and minor bile duct injuries by McMahon *et al.* (1995)⁷

| Major bile duct injury (at least one of the following present) | Laceration >25% of bile duct diameter  
| Transection of CHD or CBD  
| Development of post-operative bile duct stricture  
| | Minor bile duct injury  
| Laceration of CBD <25% of diameter  
| Laceration of cystic-CBD junction ('buttonhole tear')  

CHD, common hepatic duct; CBD, common bile duct.
**Table 4** Amsterdam Academic Medical Center’s classification by Bergman *et al.* (1996)\(^{11}\)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>Cystic duct leaks or leakage from aberrant or peripheral hepatic radicles</td>
</tr>
<tr>
<td>Type B</td>
<td>Major bile duct leaks with or without concomitant biliary strictures</td>
</tr>
<tr>
<td>Type C</td>
<td>Bile duct strictures without bile leakage</td>
</tr>
<tr>
<td>Type D</td>
<td>Complete transection of the duct with or without excision of some portion of the biliary tree</td>
</tr>
</tbody>
</table>
BILE DUCT INJURIES DURING LAPAROSCOPIC CHOLECYSTECTOMY: A SENSEMAKING ANALYSIS OF OPERATIVE REPORTS

Class I

Class II

Class III

Class IV

Figure 2. Stewart-Way Classification of Laparoscopic Bile Duct Injuries
<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>CBD mistaken for cystic duct, but recognized Cholangiogram incision in cystic duct extended into CBD</td>
</tr>
<tr>
<td>Class II</td>
<td>Lateral damage to the CHD from cautery or clips placed on duct Often associated bleeding, poor visibility</td>
</tr>
<tr>
<td>Class III</td>
<td>CBD mistaken for cystic duct, not recognized CBD, CHD, or right or left hepatic ducts transected and/or resected</td>
</tr>
<tr>
<td><strong>Class IV</strong></td>
<td>Right hepatic duct mistaken for cystic duct; Right hepatic artery mistaken for cystic artery; Right hepatic duct and right hepatic artery transected Lateral damage to the right hepatic duct from cautery or clips placed on duct</td>
</tr>
</tbody>
</table>

CBD, common bile duct; CHD, common hepatic duct.
Management and outcome of patients with combined bile duct and hepatic arterial injuries after laparoscopic cholecystectomy.

Schmidt SC¹, Settmacher U, Langreh JM, Neuhaus P.

Klassifikation der Gallengangsverletzungen

**Typ A** Periphere Galleleckage
(mit Verbindung zum Hauptgallengangssystem)

A1: Cysticusleckage
A2: Leckage im Gallenblasenbett

**Typ B** Occlusion des DHC ohne Verletzung (z.B. Clip)

B1: Inkomplett
B2: Komplett

**Typ C** Tangentielle Verletzung des DHC (Kontinuität erhalten)

C1: Kleine, punktförmige Läsion (< 5 mm)
C2: Ausgedehnte Läsion (> 5 mm)

**Typ D** Komplette Durchtrennung des DHC (oder eines rechten Gallenganges ohne Anschluß an das Hauptgallengangssystem)

D1: Ohne Defekt
D2: Mit Defekt

**Typ E** Stenosen des DHC

E1: DHC kurz, ringförmig (< 5 mm)
E2: DHC langstreckig (> 5 mm)
E3: Hepaticusgabel
E4: Rechter Hauptgallengang / Segmentgallengang
**Classification of iatrogenic bile duct injury**

**Wan-Yee Lau and Eric C.H. Lai**

_Hong Kong, China_

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**Table 8** Lau classification (2007)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Leaks from cystic duct stump or small ducts in liver bed</td>
</tr>
<tr>
<td>2</td>
<td>Partial CBD/CHD wall injuries without (2A) or with (2B) tissue loss</td>
</tr>
<tr>
<td>3</td>
<td>CBD/CHD transection without (3A) or with (3B) tissue loss</td>
</tr>
<tr>
<td>4</td>
<td>Right/Left hepatic duct or sectoral duct injuries without (4A) or with (4B) tissue loss</td>
</tr>
<tr>
<td>5</td>
<td>Bile duct injuries associated with vascular injuries</td>
</tr>
</tbody>
</table>

CBD, common bile duct; CHD, common hepatic duct.
Surgical treatment and outcome of iatrogenic bile duct lesions after cholecystectomy and the impact of different clinical classification systems

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Correspondence to: Dr H. Bektas (e-mail: Bektas.Hu)

<table>
<thead>
<tr>
<th>Type</th>
<th>Injury type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Peripheal bile leakage (in communication with main biliary system).</td>
</tr>
<tr>
<td>A1</td>
<td>Bile leakage from the cystic duct.</td>
</tr>
<tr>
<td>A2</td>
<td>Bile leakage from the gallbalder fossa.</td>
</tr>
<tr>
<td>B</td>
<td>CHD or CBD stricture without damage (eg caused by a clip).</td>
</tr>
<tr>
<td>B1</td>
<td>Incomplete.</td>
</tr>
<tr>
<td>B2</td>
<td>Complete.</td>
</tr>
<tr>
<td>C</td>
<td>Lateral CHD or CBD injury.</td>
</tr>
<tr>
<td>C1</td>
<td>Small spot injury (&lt; 5 mm).</td>
</tr>
<tr>
<td>C2</td>
<td>Large injury (&gt; 5 mm) below the hepatic ducts confluence.</td>
</tr>
<tr>
<td>C3</td>
<td>Large injury at the level of the hepatic ducts confluence.</td>
</tr>
<tr>
<td>C4</td>
<td>Large injury above the hepatic ducts confluence.</td>
</tr>
<tr>
<td>D</td>
<td>Total transsection of CHD Or CBD.</td>
</tr>
<tr>
<td>D1</td>
<td>Without ductal loss below the hepatic ducts confluence.</td>
</tr>
<tr>
<td>D2</td>
<td>With ductal loss below the hepatic ducts confluence.</td>
</tr>
<tr>
<td>D3</td>
<td>At the level of the hepatic ducts confluence.</td>
</tr>
<tr>
<td>D4</td>
<td>Above the hepatic ducts confluence. (with or without ductal loss).</td>
</tr>
<tr>
<td>E</td>
<td>CHD or CBD stricture.</td>
</tr>
<tr>
<td>E1</td>
<td>Short, circular (&lt; 5 mm) CHD or CBD stricture.</td>
</tr>
<tr>
<td>E2</td>
<td>Longitudinal CBD stricture (&gt;5 mm).</td>
</tr>
<tr>
<td>E3</td>
<td>Stricture at the level of the hepatic ducts confluence</td>
</tr>
<tr>
<td>E4</td>
<td>Stricture of the right hepatic duct / sectorral hepatic duct.</td>
</tr>
<tr>
<td>E5</td>
<td>The complete closure of all the bile ducts, including sectoral bile ducts.</td>
</tr>
</tbody>
</table>
Peripheral biliary leakage (Type A injury)

Type A: Peripheral bile leak (with reconnection to the main bile duct system)

A1: Cystic duct leak

A2: Leak in the region of the gallbladder bed
Biliary tract occlusion (Type B injury)

- B1
- B2
- Type B: Stenosis of the main bile duct without injury (i.e. caused by a clip)
- B1: Incomplete
- B2: Complete
Tangential bile duct lesions (Type C injury)

- Type C: Tangential injury of the common bile duct
  - C1: Small punctiform lesion (< 5 mm)
  - C2: Extensive lesion (> 5 mm) below the hepatic bifurcation
  - C3: Extensive lesion at the level of the hepatic bifurcation
  - C4: Extensive lesion above the hepatic bifurcation

With vascular lesions (i.e. C1d, C2, etc.):
- d, right hepatic artery
- s, left hepatic artery
- p, proper hepatic artery
- com, common hepatic artery
- c, cystic artery
- pv, portal vein
Completely transected bile ducts (Type D injury)

Type D  Completely transected bile duct
D1  Without defect below the hepatic bifurcation
D2  With defect below the hepatic bifurcation
D3  At hepatic bifurcation level (with or without defect)
D4  Above the hepatic bifurcation (with or without defect)

With vascular lesions (i.e. D1d, D2pv, etc.):
d, right hepatic artery
s, left hepatic artery
p, proper hepatic artery
com, common hepatic artery
c, cystic artery
pv, portal vein
Late biliary tract stenosis (type E injury)

Type E
- Strictures of the main bile duct
- E1 Main bile duct short circular (< 5 mm)
- E2 Main bile duct longitudinal (> 5 mm)
- E3 Hepatic bifurcation
- E4 Right main bile duct/segmental bile duct
Summery

• A lot of risk factors were involved in bile duct injury during laparoscopic cholecystectomy and more effort for avoid the injury were needed

• There are various classification of bile duct injury. Simple, well designed classification like Strasberg, Hannover classification will be more useful when classify.
Thank you for attention