Bile Duct Injuries

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Introduction

- Bile duct injury (BDI)
  - rare but potentially devastating condition
  - biliary peritonitis & sepsis, cholangitis, portal hypertension & secondary biliary cirrhosis
  - significant morbidity & mortality

- Iatrogenic BDI
  - Increased financial burden (patient or hospital)
  - Malpractice litigation
History

- 56 yrs, male
- Heavy smoker, COPD
- Lap.cholecystectomy elsewhere on 16\textsuperscript{th} May 09 – Acute cholecystitis
- Post-extubation bronchospasm $\rightarrow$ hydrocortisone, nebulisers, antibiotics
- 6\textsuperscript{th} POD $\rightarrow$ Referred to Cardiologist, Dr. A. M for further management of sepsis & respiratory distress $\rightarrow$ CCU
On Examination

- Afebrile, no icterus, extensive wheeze
- P/A – Slight distention, diffuse tenderness & guarding
- Inj. Cefoperazone-Sulbactum & Metronidazole
- Hydrocortisone stopped
- **U/S abdomen (7\textsuperscript{th} POD):** Moderate ascites, aspiration → 700ml thick yellowish fluid. Ofloxacin added
- Post cholecystectomy bile leak
- **Rpt. U/S (9\textsuperscript{th} POD):** More than 1.5 litres ascites
Management

- **CT scan guided drainage (9th POD):** Subphrenic Malecot catheter – 850ml bile drained. 300ml aspirated from pelvis
- **9th POD – 1175ml**
- **10th POD – 700ml** (?
ERCP)
- **11th POD – 900ml, Fluid culture: Klebsiella oxytoca →**
  antibiotics changed to Piptaz & Cifran
- **12th POD – 500ml, MRCP planned**
- **13th POD – 450ml, Malecot catheter fell out. CT guided repositioning done**
- **18th POD – MRCP**
CT scan abdomen
MRCP
# Bile Drainage

<table>
<thead>
<tr>
<th>POD</th>
<th>Amount</th>
<th>POD</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>450ml</td>
<td>23</td>
<td>350ml</td>
</tr>
<tr>
<td>16</td>
<td>400ml</td>
<td>25</td>
<td>200ml</td>
</tr>
<tr>
<td>17</td>
<td>450ml</td>
<td>26</td>
<td>50ml, Bilirubin 0.9mg%</td>
</tr>
<tr>
<td>18</td>
<td>450ml, MRCP</td>
<td>27,28 &amp; 29</td>
<td>Minimal, rpt. Ultrasound</td>
</tr>
<tr>
<td>19</td>
<td>400ml</td>
<td>30</td>
<td>15ml</td>
</tr>
<tr>
<td>20</td>
<td>500ml</td>
<td>31</td>
<td>3ml ➔ Drain removed</td>
</tr>
<tr>
<td>21</td>
<td>350ml</td>
<td>32</td>
<td>no fever or jaundice</td>
</tr>
<tr>
<td>22</td>
<td>400ml</td>
<td>33</td>
<td>Discharged ➔ 28 days</td>
</tr>
</tbody>
</table>
Discussion
Anatomy

- Calot’s triangle – between inferior surface of liver, Cystic duct & CHD
- Contents – Cystic artery, RHA, Cystic lymph node
Bile Duct Injuries (BDI)

- Iatrogenic injury
  - Cholecystectomy
  - Gastrectomy
  - Pancreatectomy
  - ERCP

- Trauma
- Duodenal ulcer
Laparoscopic cholecystectomy (LC)

- Late 1980s
- Gold standard for management of benign gallbladder disease
- Compared with laparotomy
  - Less post-op pain
  - Shorter hospital stay
  - Earlier return to normal activity
  - Better cosmesis
- Iatrogenic bile duct injury rate
  - 0.1% to 0.2% (open) vs 0.4% to 0.6% (lap)
LC & Bile duct injury (BDI)

- LC most common cause of BDI
- More severe than those seen with Open chole
- Learning curve phenomenon?
- BDI after LC stable around 0.6 to 0.7%, 4 times that of open chole – high for a benign condition
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 of BDI

Bismuth classification (1982)

- era of Open Chole
- location of biliary strictures with respect to hepatic bifurcation
- based on most distal level at which healthy biliary mucosa available for anastomosis

- helps surgeon choose appropriate site for repair
- degree of injury correlates with surgical outcomes
Classification of BDI

- McMahon system
  - Bile duct laceration
  - Transection
  - Excision
  - Stricture

- Strasberg classification (1995)
  - Type A to E, with type E subdivided into E1 to E5 like Bismuth classification
## Strasberg classification

<table>
<thead>
<tr>
<th>Type</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Leak from Cystic duct or small ducts in liver bed</td>
</tr>
<tr>
<td>B</td>
<td>Occlusion of an aberrant RHD</td>
</tr>
<tr>
<td>C</td>
<td>Transection without ligation of an aberrant RHD</td>
</tr>
<tr>
<td>D</td>
<td>Lateral injury to a major bile duct</td>
</tr>
<tr>
<td>E1</td>
<td>Transection &gt;2 cm from the hilum</td>
</tr>
<tr>
<td>E2</td>
<td>Transection &lt;2 cm from the hilum</td>
</tr>
<tr>
<td>E3</td>
<td>Transection in the hilum</td>
</tr>
<tr>
<td>E4</td>
<td>Separation of major ducts in the hilum</td>
</tr>
<tr>
<td>E5</td>
<td>Type C injury plus injury in the hilum</td>
</tr>
</tbody>
</table>
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
**Clinical Presentation (post-op)**

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

- **Bile Leak**
  - Bile from intra-op drain or
  - More commonly, localized biloma or free bile ascites / peritonitis, if no drain
  - Diffuse abdominal pain & persistent ileus several days post-op → high index of suspicion → possible unrecognized BDI
“Classical” laparoscopic injury

- CBD mistaken for cystic duct
- CBD clipped & resected
- Proximal dissection & division → injury to RHA
- Loss of length & occlusion of proximal biliary tree with possible concomitant right hepatic ischemia
Classical LC BDI

- Cystic duct
- Common hepatic duct
- Common bile duct
- Accidentally divided hepatic ducts
Intra-op diagnosis

- About 30% BDI recognized at time of initial surgery
- If injury recognized, two options, depending on expertise
  - Drain OR
  - Primary repair at time of LC
    - Primary end-to-end CBD repair or 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
Management

- CT or U/S guided (or surgical) drainage
- Sepsis control → Broad-spectrum antibiotics & percutaneous biliary drainage to control any bile leak → most fistulas will be controlled or even close
- 1.5% mortality rate due to uncontrolled sepsis

- No rush to proceed with definitive management of BDI
- Delay of several weeks allows local inflammation to resolve & almost certainly improves final outcome
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
ERC – clips across CBD

- CBD transection → normal-sized distal CBD upto site of transection
- Percutaneous transhepatic cholangiography (PTC) necessary
- Surgery
Cholangiography (ERCP + PTC)

- Percutaneous transhepatic cholangiography (PTC)
  - defines proximal anatomy
  - allows placement of percutaneous transhepatic biliary catheters to decompress biliary tree → treats or prevents cholangitis & controls bile leak
MRCP / CT cholangiography

- Noninvasive
- May avoid invasive procedures like ERCP or PTC
- CT cholangiography – not adequate for evaluation of bile duct
  - Do not allow intervention
  - Interpretation in presence of bile collection difficult
  - Potentially delays treatment
Definitive management

- Goal
  - reestablishment of bile flow into proximal GIT
  - in a manner that prevents cholangitis, sludge or stone formation, restricturing & 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
- tension-free, mucosa-to-mucosa anastomosis with healthy, nonischemic bile duct
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
Reasons

- **Misidentification**
  - CBD or aberrant RHD mistaken for cystic duct
  - Risk factors → inexperienced, inflammation or aberrant anatomy
  - Infundibular technique – flaring of cystic duct as it becomes infundibulum → misleading in inflammation

- **Technical errors**
  - Cautery induced injury
Prevention

- 30° laparoscope, high quality imaging equipment
- Firm cephalic traction on fundus & lateral traction on infundibulum, so cystic duct perpendicular to CBD
- Dissect infundibulo-cystic junction
- Expose “Critical view of safety” before dividing cystic duct
- Convert to open, if unable to mobilise infundibulum or bleeding or inflammation in Calot’s triangle
- Routine intra-op cholangiogram
- “Fundus-first” dissection
Critical view of safety

- Calot’s triangle dissected free of all tissue except cystic duct & artery
- Base of liver bed exposed
- When this view is achieved, the two structures entering GB can only be cystic duct & artery
- Not necessary to see CBD
<table>
<thead>
<tr>
<th>Cystic duct</th>
<th>CBD</th>
<th>Caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 – 3mm wide</td>
<td>5mm wide</td>
<td>CD &gt; 5mm – Is it CBD?</td>
</tr>
<tr>
<td>Even with low cystic duct insertion, CD rarely goes behind duodenum</td>
<td>CBD goes behind duodenum</td>
<td>Duct behind duodenum must be CBD</td>
</tr>
<tr>
<td>Double cystic duct very rare</td>
<td>--</td>
<td>2 ducts seem to go towards inflamed Gallbladder – one must be CBD</td>
</tr>
<tr>
<td>No vessels on surface</td>
<td>Vessels on surface</td>
<td>--</td>
</tr>
</tbody>
</table>
Routine intra-op cholangiogram (IOC)

- Done via presumed cystic duct
- If this happens to be CBD, injury has already occurred!!

- IOC does not identify all aberrant ducts
- Arterial anatomy not identified

- IOC does not prevent BDI but may reduce its severity (if correctly performed & interpreted, IOC can prevent complete CBD transection)
- IOC → higher rate of intra-op identification of BDI → decreased cost of treatment & shorter hospital stay
Anatomic illusion?

- Misperception (97%) rather than technical error (3%)

- Everyone is susceptible – experience, knowledge & technical skill alone may not be adequate

- Current BDI rate may be near upper limits of human performance (1% mortality accepted for CABG)

- All BDI may not represent “substandard practice”

- Improvements may have to depend on technology
The Future

- No need to dissect cystic duct unlike IOC
- Lap. Ultrasound & Doppler
- Tactile sensor probes
- Intra-op fluorescent cholangiography using IV Indocyanine green
- Injection of a dye into gallbladder to visualise biliary tree
- Intraoperative bile duct visualization using near-infrared hyperspectral video imaging
- Light cholangiography → fibreoptic cable via ampulla of Vater
The reality...

- Technology largely unavailable
- Not validated
- Costly

- For now, no alternative to planned meticulous dissection with precise identification of structures before division
Outcome

- Hospital expenses – Rs. 2,30,000/-
- Plus loss of income for at least 2 months
- Plus loss of income for attenders
- Hopefully, successful conservative management

- ? All is well that ends well OR
- Will he develop a bile duct stricture? ( & then jaundice, cholangitis, portal HT or secondary biliary cirrhosis etc)
Summary

- Multidisciplinary management of BDI → expertise of surgeons, radiologists & gastroenterologists

- From **benign** gallstone disease – bile duct injury → Mismanagement → lifelong disability & chronic liver disease – “**biliary cripple**”

- BDI with lap. Chole → results of operative repair, excellent in Specialist Centres
Acknowledgement

- Dept. of Radiology for significant contributions in the management of this patient

Thank You