Gallstone and Bile Duct Disease
The GI Perspective

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Cholelithiasis
Cholelithiasis: Gallstones

- Incidence
  - 10% American adults
- Risk Factors
  - Age
  - Female
  - Obesity
  - Estrogen/OCP/Pregnancy
  - Hyperlipidemia
  - DM
  - Ileal disease/Resection

Cholelithiasis

- Stone
  - 75% cholesterol stones
  - 25% pigment stones
    - Black
    - Brown
- Sludge
Cholelithiasis

- Cholesterol Stones
  - Normal Bile Components
    - Cholesterol
    - Phospholipids
    - Bile salts
    - Bilirubin
    - Proteins
  - Bile salts = keeps cholesterol soluble
    - Micelles of above three components
  - Low bile salts = stone formation
  - High cholesterol concentration = stone formation
### Cholesterol Stones

- **Major problem:** supersaturated bile (lithogenic)
  - **Mechanisms**
    - Increased biliary secretion of cholesterol
    - Increased hepatic synthesis of cholesterol
    - Decreased secretion of solubilizing lipids & bile salts

### Cholesterol Stones

- Decreased secretion of solubilizing bile salts
  - Decreased hepatic synthesis of bile acids
  - Bile salt malabsorption
  - Biliary stasis
  - Gallbladder dysfunction
  - Impaired enterohepatic bile salt circulation
Cholithiasis: Role of Enterohepatic circulation

Pigment Stones

- Increased bilirubin load presented to the liver
- Primarily unconjugated bilirubin
- Black Stones:
  - associated with hemolysis
  - Direct increase in unconjugated bilirubin
- Brown Stones
  - associated with stagnant or infected bile
  - Indirect via increase β-Glucuronidase
Clinical Presentation

- 20% develop symptoms
- Biliary colic
  - RUQ/Epigastric pain
  - Last over an hour
  - Occ radiates to right shoulder/back
- Dyspepsia
  - Non-specific

Diagnostic Workup

- Abdominal xray
  - 15% stones visualized
  - Pigmented stones usually radiopaque
- RUQ Ultrasound
  - Examines liver and bile duct
  - Calcified and non-calcified stones
  - Limited by small size
- Endoscopic ultrasound
  - No size limitation
  - Closer examination of bile ducts
  - Limited liver examination
Cholelithiasis

Stone Sludge & Stone

www.med-ed.virginia.edu

Treatment

- Surgery
  - Only if symptomatic, unless
    1. Calcified gallbladder
    2. Sickle cell anemia
- Ursodiol not proven effective
- No medications proven effective
- Not clear if avoiding fatty foods reduces symptoms
Choledocholithiasis

- Usually form in the GB and migrate into the duct
- Exceptions
  - Stasis in the duct (stricture/stenosis)
  - Increased bilirubin within the bile (ie chronic hemolytic anemia)
Choledocholithiasis

- Symptoms
  - Asymptomatic
  - Cholangitis
    - Fever
    - Jaundice
    - Pain
    - Hypotension
    - Confusion
  - Abnormal LFT
    - Hyperbilirubinemia
    - Elevated Alkaline Phosphatase
    - +/- Transaminitis

Charcot’s Triad
Reynold’s Pentad

Choledocholithiasis

- Laboratory Findings: Cholestatic Pattern
  - WBC usually elevated
  - Elevated bilirubin (primarily conjugated)
  - Elevated alkaline phosphatase
  - Elevated glutamyl transpeptidase (GGT)
  - Normal to mildly elevated aspartate aminotransferase (AST) and alanine aminotransferase (ALT)
Choledocholithiasis

- Imaging
  - Primary diagnostic modality
  - Ultrasonography
    - Cutaneous
    - Endoscopic ultrasound
  - MRI/MRCP
  - Endoscopic Retrograde Cholangiopancreatography (ERCP)
  - Percutaneous Cholangiogram (PTC)

Diagnostic & Therapeutic
**ERCP**

- Side-viewing endoscope passed through the mouth into the second portion of duodenum.
- Major papilla identified and catheter inserted with injection of contrast.
- Fluoroscopy utilized to visualize the biliary tree.
- Can evaluate for stenosis, filling defects (stones), bile leak.

**ERCP**

<table>
<thead>
<tr>
<th>Abnormal major papilla</th>
<th>Sphincterotomy</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Abnormal major papilla" /></td>
<td><img src="image2.png" alt="Sphincterotomy" /></td>
</tr>
<tr>
<td>Choledocholithiasis</td>
<td>ERCP</td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
</tr>
<tr>
<td>NORMAL</td>
<td>CHOLEDACHOLITHIASIS</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Choledocholithiasis</th>
<th>ERCP – Basket Retrieval</th>
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<tbody>
<tr>
<td>NORMAL</td>
<td>BASKET RETRIEVAL</td>
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</table>

www.daveproject.org
Choledocholithiasis
Balloons extraction

www.daveproject.org

ERCP

Balloon Assisted Stone Extraction
Post-Stone Extraction
### ERCP

- Highly sensitive and specific for stones
  - 90% sensitivity; 98% specificity
- Offers therapeutics in addition to diagnosis
- Complications
  - Pancreatitis (2-10%)
  - Perforation
  - Bleeding
  - Duct disruption

### MRCP

- Magnetic Resonance Cholangiopancreatography
- MRI visualization of the bile duct and pancreatic duct
- T2 weighted imaging – water content
- High Sensitivity and Specificity for stones
- Visualization of abdominal anatomy: pancreas, liver, etc.
## MRCP

- Romagnuolo et al Ann Int Med 2003
  - Meta-analysis
  - 92% sensitivity for stones
  - 88% sensitivity for mass
- **Drawbacks**
  - Decreased sensitivity for small stones with normal duct size
  - Unable to sample tissue
  - Poor imaging of ampulla of vater
  - Cloustrophobic patients
  - Metal prostheses or implantable devices
  - Contrast

## Endoscopic Ultrasound

- Ultrasound probe at the end of an endoscope
- Maximum depth of penetration: 5-7cm
- Endoscopic ultrasound – minimal barrier between probe and target (i.e. skin, muscle, fat, bowel, peritoneal cavity)
  - advantage over percutaneous U/S
  - Improved resolutions
- Frequency adjustable
  - Low frequency: greater depth of penetration, less resolution
  - High frequency: less depth of penetration, high resolution
- Doppler available on both linear and radial echoendoscopes
  - Vascular assessment
Endoscopic Ultrasound

- Camera
- Light
- Needle Channel
- Ultrasound Probe

Image not available
Normal Pancreas
Body/Tail

EUS
Normal CBD

Stone
Endoscopic Ultrasound
Fine Needle Aspiration

Pancreas Mass
### Endoscopic Ultrasound

- **Garrow et al. 2007**
  - Meta-analysis
  - Sensitivity: 89%; Specificity: 94%
- **Tse et al. 2008**
  - Meta-analysis
  - Sensitivity: 94%; Specificity: 95%
- **Safe procedure**
  - Basic endoscopy risks
  - Minimal risk of FNA
- **High accuracy for mass identification and malignant diagnosis (w/ FNA and cytology)**
- **Identification of microlithiasis**
  - Tandon 2001 Am J Gastro
  - Use of EUS able to diagnose etiology in 21 of 31 idiopathic pancreatitis cases
  - 16% with microlithiasis

### EUS vs MRCP

- **Both high positive and negative predictive value**
- **Both diagnostic w/o therapeutic benefit**
- **Both safe procedure**
- **EUS better for detection/biopsy of small tumors**
- **EUS better for evaluation for microlithiasis**
- **EUS better for ampullary evaluation (endoscopic and sonographic)**
Recommendations
Cholelithiasis Workup

- High suspicion
  - Abnormal LFT
  - Ductal dilation
  - Acute gallstone pancreatitis
  - ERCP
- Intermediate suspicion
  - EUS
- Low suspicion
  - MRCP

Summary

- Careful history and physical examination can be a pivotal component in diagnosis of gallstone disease
- While cholelithiasis is often easily diagnosed via RUQ ultrasound, choledocholithiasis can be more difficult
- The diagnostic workup and management of choledocholithiasis depends highly on the level of clinical suspicion
- EUS and MRCP are safe and accurate alternatives to ERCP for diagnosis of choledocholithiasis.
- EUS offers added feature of identification and biopsy of small malignant lesions of the distal bile duct, pancreas head or ampulla that are often not identified on MRCP or CT.
- ERCP should be used as initial modality only if pretest probability is high.
Gallstone and Bile Duct Disease

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Common Bile Duct Stones
The Problem

770,000 Cholecystectomies/year
10-15% 77,000-115,000 CBDS
## Strategies

Common bile duct stones can be managed/removed…
- Pre-operatively
- Intra-operatively
- Post-operatively
- Procedurally (no operation at all)

### Strategies - Endoscopic

- Selective Preop ERCP
  - *Cost-effective if > 80% probability*
- Selective Post-op ERCP
- Intraoperative ERCP
### Strategies - Operative

- Open common bile duct exploration
- LSCBDE
  - Transcystic Duct (TCCBDE)
  - LS Choledochotomy (LSCD)

### Strategies - Other

Percutaneous transhepatic stenting and removal +/- YAG laser fragmentation or EHL

Laparoscopic assisted transgastric ERCP in post gastric bypass patients
Open Common Bile Duct Exploration

Technical considerations:

Transcholedochal
t-tube
Drainage

Common Bile Duct Stones

T-tube drainage
Common Bile Duct Stones

T-tube drainage: Principles

1. Stenting of sphincter of Oddi
2. Long t-tube tract
3. Elimination of downstream obstruction

Laparoscopic Common Bile Duct Exploration

Technical considerations:

Transcystic
- +/- balloon dilation cystic duct stump
- simple closure of cystic duct

Transcholedochal
- t-tube
- L/S suturing techniques
Laparoscopic Common Bile Duct Exploration

Technical considerations:

Experience in advance L/S techniques

Instrumentation: L/S choledochoscope and supporting instruments

Time

Evaluation of Techniques

• Effectiveness

• Technical Complexity/Experience
  • Cost
CBDS: The Evidence

**RANDOMIZED TRIAL LSCBDE vs SELECTIVE POST OP ERCP**

**CBDS Randomized Trial**
LSCBDE vs Postop ERCP

- **Initial Clearance Rates 75%**
- **Final Duct Clearance 100% vs 93%**
- **Morbidity**
  - LSCBDE 7/40 (18%) {3 bile leaks}
  - Postop ERCP 6/40 (15%) {1 bile leak}
- **Hospital Stay**
  - LSCBDE 1 day (1-26)
  - Postop ERCP 3.5 days (1-11)
**CBDS Randomized Trial**

**Criticism**

- No prospective calculation of sample size
- Failure to evaluate quality of life and economic impact
- ERCP results poor relative to reported literature (95% success)
- Hospital stay could depend on timing of ERCP
- Results of LSCBDE cannot be generalized

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**CBDS Survey**

8,433 cases in Germany

- Morbidity 14%
- Mortality 0.6%
- Incidence of CDE
  - 1991} 7.4%
  - 1998} 3.8%
- Surgeons prefer Postop ERCP (93%)
- LSCBDE does not play a role in Germany

Huttl, TP et al Zentralbl Chir 2002
### CBD Stones Surgeon Experience

Ritchie et al, Ann Surg 1999;230;533-543
- 2434 general surgeons
- # procedures on recertification Application
- Mean # Cholecystectomies/ Yr = 36
- Mean # CBDE/ Yr = 2

Conclusion: Surgeon experience unlikely to support LSCBDE

### LSCBDE vs Postop ERCP
A Decision Analysis

Urbach DR et al Surg Endosc 2001 15:4-13

Structure of the Decision Model
Assumptions
Estimation of Probabilities
LSCBDE vs Postop ERCP
A Decision Analysis

<table>
<thead>
<tr>
<th>Patient with Gallstones</th>
<th>LSCBDE and IOC</th>
<th>SUCCESSFUL IOC</th>
<th>UNSUCCESSFUL IOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBDS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO CBDS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCS CHOLE</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Transcystic CBDE        |                  | COMP           | NO COMP          |
| SUCCESSFUL              |                  |                |                  |
| UNSUCCESSFUL            |                  |                |                  |

| LCS GDE                 |                  | COMP vs NO COMP| OPEN CBD         |
| SUCCESSFUL              |                  |                | POSTOP ERCP      |
| UNSUCCESSFUL            |                  |                |                  |

| COMP vs NO COMP         |                  | POSTOP ERCP    |                  |
| SUCCESSFUL              |                  |                |                  |
| UNSUCCESSFUL            |                  |                |                  |

LSCBDE vs Postop ERCP
Assumed Probabilities  LSCBDE

| IOC Success            | 94% (80-100) |
| Sensitivity            | 89% (80-100) |
| Specificity            | 99% (80-100) |
| Transcystic Success    | 81% (60-100) |
| Bile Leak              | 1.3% (0-5)   |
| LSCBDE Success         | 67% (40-100) |
| Bile Leak              | 2.6% (0-5)   |
| Conversion to Open     | 56% (0-100)  |
# LSCBDE vs Postop ERCP

## Assumed Probabilities ERCP

<table>
<thead>
<tr>
<th>Metric</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOC Success</td>
<td>94% (80-100)</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>89% (80-100)</td>
</tr>
<tr>
<td>Specificity</td>
<td>99% (80-100)</td>
</tr>
<tr>
<td>ERCP Success</td>
<td>98% (80-100)</td>
</tr>
<tr>
<td>Severe Complications</td>
<td>1.1% (0-5)</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>90% (80-100)</td>
</tr>
<tr>
<td>Specificity</td>
<td>100% (80-100)</td>
</tr>
<tr>
<td>Stone Clearance</td>
<td>91% (80-100)</td>
</tr>
</tbody>
</table>

## LSCDBE vs Postop ERCP

## Base Case Cost Assumptions

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Cost Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic ERCP</td>
<td>$1441 (500-2000)</td>
</tr>
<tr>
<td>Therapeutic ERCP</td>
<td>$1971 (1000-3000)</td>
</tr>
<tr>
<td>IOC</td>
<td>$368 (250-1000)</td>
</tr>
<tr>
<td>Transcystic CBDE</td>
<td>$1094 (500-2000)</td>
</tr>
<tr>
<td>LSCBDE (“otom”)</td>
<td>$1769 (1000-3000)</td>
</tr>
<tr>
<td>Open Chole (conversion)</td>
<td>$1794 (1000-3000)</td>
</tr>
<tr>
<td>Complication Bile Leak</td>
<td>$1178 (500-3000)</td>
</tr>
<tr>
<td>Complication ERCP</td>
<td>$5478 (2000-20000)</td>
</tr>
</tbody>
</table>
### LSCBDE vs Postop ERCP

**Incremental Cost vs LS Chole**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSCBDE</td>
<td>$487.50</td>
</tr>
<tr>
<td>Postop ERCP</td>
<td>$550.10</td>
</tr>
</tbody>
</table>

**Savings/Cost**

LSCBDE (Savings) = $62.60

### LSCBDE vs Postop ERCP

**Cost-Effectiveness Ratio**

<table>
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<th>Description</th>
<th>Cost</th>
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<tr>
<td>LSCBDE</td>
<td>$496.81</td>
</tr>
<tr>
<td>Postop ERCP</td>
<td>$563.59</td>
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</tbody>
</table>

{Routine Preop ERCP} = 1518.85
CBD Stones

Example: Minimally Invasive Surgery
<table>
<thead>
<tr>
<th>Laparoscopic Common Bile Duct Exploration vs. ERCP: Cost Analysis</th>
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<tr>
<td><strong>Pre-op ERCP &gt; Intra or post-op management of CBDS whether open or L/S</strong></td>
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<tr>
<th>Laparoscopic Common Bile Duct Exploration vs. ERCP: Cost Analysis</th>
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<tr>
<td><strong>Laparoscopic management of CBDS is the most cost effective</strong></td>
</tr>
</tbody>
</table>
Laparoscopic Common Bile Duct Exploration vs. ERCP: Cost Analysis

Intra-op or Post-op ERCP are the most cost effective when skills or instruments to perform L/S CBDE are not available


Laparoscopic Common Bile Duct Exploration
What is really done out there!

Pre-op ERCP w/ attempts to clear the CBD
Open or L/S CBDE with placement of t-tube if stones remain at cholecystectomy (variable experience)

+/- Post-op ERCP
### Laparoscopic Common Bile Duct Exploration

#### What you should do!

- **ERCP and clearance of duct for “known” CBDS pre-operatively**

- **Attempt to learn advanced laparoscopic techniques in the event an unsuspected CBDS is found at laparoscopic cholecystectomy**

- **Duct clearance (open or L/S techniques) and/or confirmation (IOC) at the time of surgery**

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### Laparoscopic Common Bile Duct Exploration

#### What you should do?

- **Little or no role to leave stones in place and reliance on post-op ERCP for removal unless experience dictates otherwise**
Complications …

- Bile leak
- Common bile duct injury
- Retained stones
- Infection/Abscess
- Bleeding

SILS Cholecystectomy
Complications Related Solely to Cholecystectomy…

- Bile leak
  - Common Bile duct, cystic, hepatic or accessory ducts
- Bile duct injuries
  - Complete transection, partial transection
- Bowel injuries
  - Duodenum, colon, small bowel
- Vascular injuries
  - Hepatic arteries, portal vein

Other Issues to Address Related Solely to Cholecystectomy…

- Conversion to Open is NOT considered a complication
- Intra-operative Cholangiography
  - Undiagnosed pathology
    - Cancer, liver disease
Laparoscopic Cholecystectomy...

- Healthy 42 yo female, elective laparoscopic cholecystectomy for symptomatic cholelithiasis
- Re-admitted 3 days post-op with pain and bilirubin of 4.3

Bile Duct Injury: Transection HIDA Scan
Bile Duct Injury: Transection CT Scan

Bile Duct Injury: Transection ERCP
Bile Duct Injury: Transection ERCP

Bile Duct Injury: Transection PTC
Bile Duct Injury: Transection
Intra-Operative

Bile Duct Injury: Transection Intra-Operative Cholangiogram
Bile Leak and/or Injury

Drain it...
Internal and External drainage

- Internal Drainage…
  - ERCP, PTC
- External Drainage…
  - Control of all bile collections

Fix it…
Primary repair vs. reconstruction

- Primary repair with internal/external drainage…
  - T-tube, PTC
- Reconstruction…
  - Roux-en-Y Hepaticojejunostomy*
  - Choledochoduodenostomy
Strategies - Other

Percutaneous transhepatic stenting and removal +/- YAG laser fragmentation or EHL

Laparoscopic assisted transgastric ERCP in post gastric bypass patients

Percutaneous access and removal of CBDS

Percutaneous transhepatic choledochoscopic holmium-YAG laser or EHL ablation of biliary tract calculi is a viable alternative for stone clearance in patients incapable of having their stones removed endoscopically and unable or unwilling to undergo surgery.
Case:

73 yo female, s/p open cholecystectomy with abdominal pain, increased Ift's and ultrasound consistent with choledocholithiasis

Unwilling to undergo an additional operative procedure

ERCP with ES
PTC

Completion cholangiogram after a single treatment
## Case:

62 yo male, s/p laparoscopic cholecystectomy with abdominal pain, increased lft’s and ultrasound consistent with choledocholithiasis

Physiologically high risk to undergo an additional operative procedure on presentation

## PTC

![Image of PTC](image)
Percutaneous choledochoscopic view

Completion cholangiogram after a single treatment
Laparoscopic assisted transgastric ERCP in post gastric bypass patients