Gallstone and Bile Duct Disease
The GI Perspective

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Cholelithiasis

Cholelithiasis: Gallstones

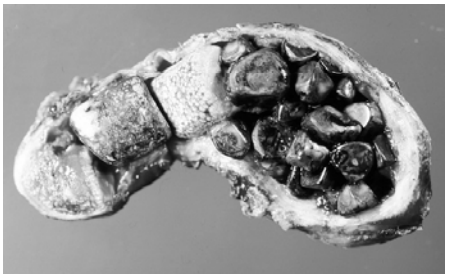
- Incidence
  - 10% American adults
- Risk Factors
  - Age
  - Female
  - Obesity
  - Estrogen/OCP/Pregnancy
  - Hyperlipidemia
  - DM
  - Ileal disease/Resection

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



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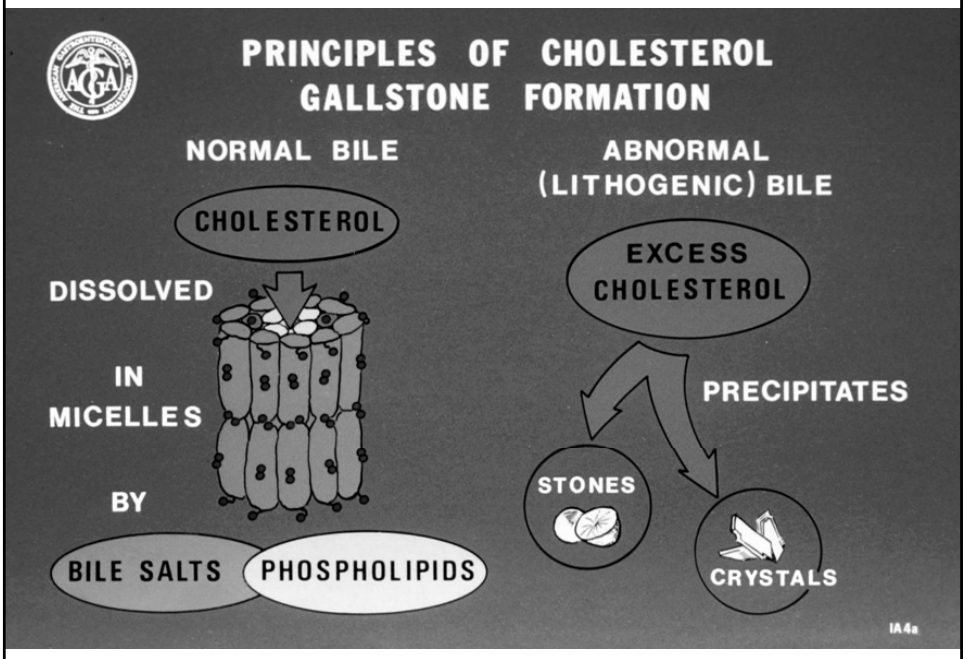


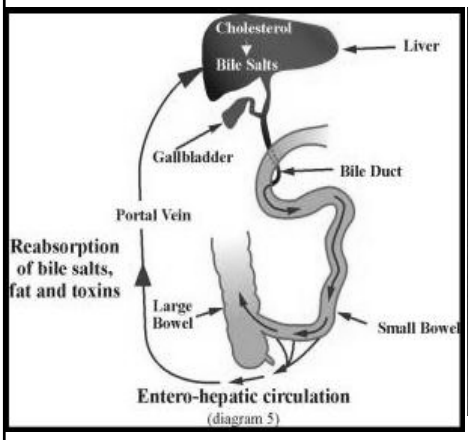
Cholesterol Stones

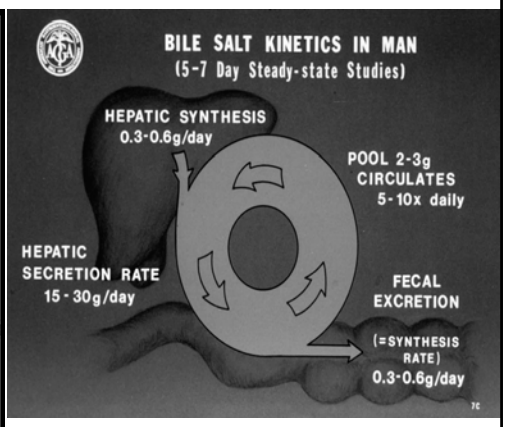
- Major problem: supersatured bile (lithogenic)
  - Mechanisms
    - Increased biliary secretion of cholesterol
    - Increased hepatic synthesis of cholesterol
    - Decreased secretion of solubilizing lipids & bile salts

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





www.hcvets.com

Pigment Stones

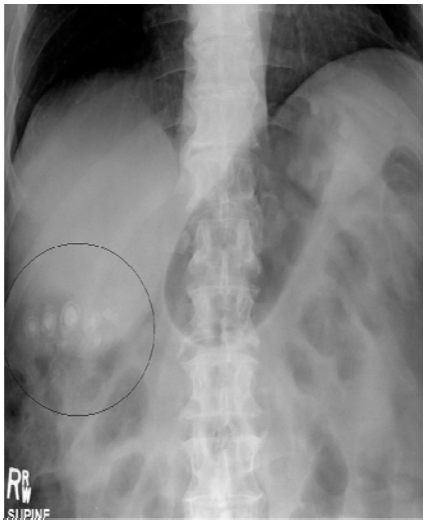
- Increased bilirubin load presented to the liver
- Primarily unconjugated bilirubin
- Black Stones:
  - associated with hemolysis
  - Direct increase in unconjugated bilirubin
- Brown Stones
  - associated with stagnant or infected bile
  - Indirect via increase β-Glucuronidase

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



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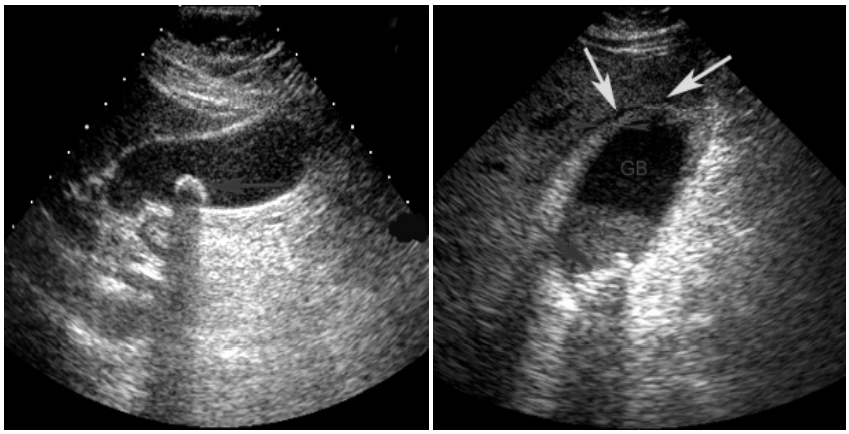
Cholelithiasis



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

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)

Choledocholithias

- Symptoms
  - Asymptomatic
  - Cholangitis
    - Fever
    - Jaundice
    - Pain

    } Charcot's Triad

    - Hypotension
    - Confusion

    } Reynold's Pentad
  - Abnormal LFT
    - Hyperbilirubinemia
    - Elevated Alkaline Phosphatase
    - +/- Transaminitis

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 Cholangiopancreatogrophy (ERCP)
  - Percutaneous Cholangiogram (PTC)

Diagnostic & Therapeutic

Choledocholithiasis

- Imaging
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  - CT
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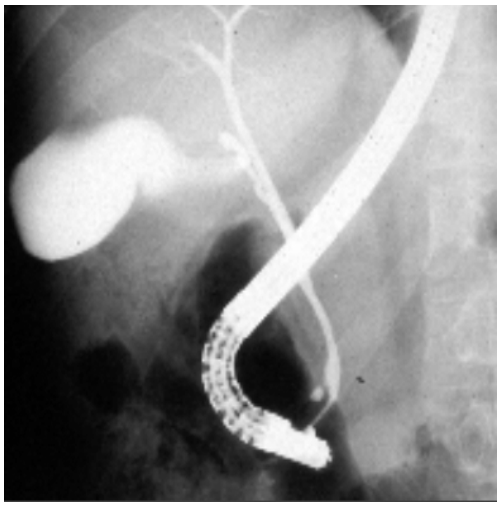
Diagnostic & Therapeutic

ERCP

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

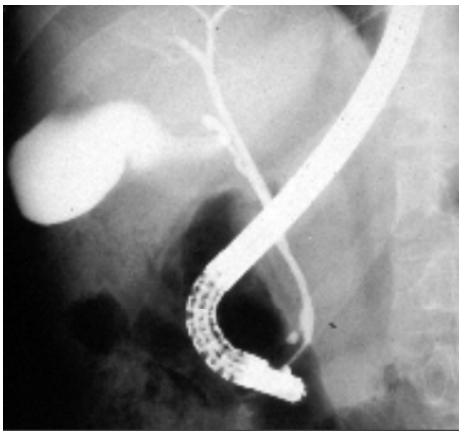


ERCP

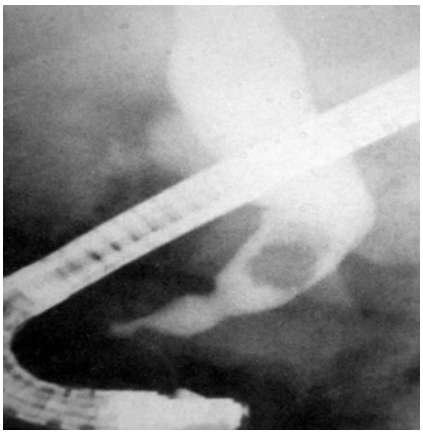
Abnormal major papilla

Sphincterotomy

Choledocholithiasis
ERCP

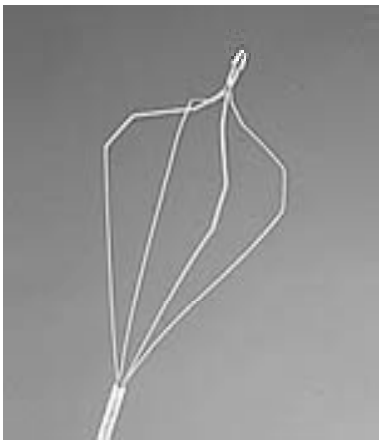


NORMAL



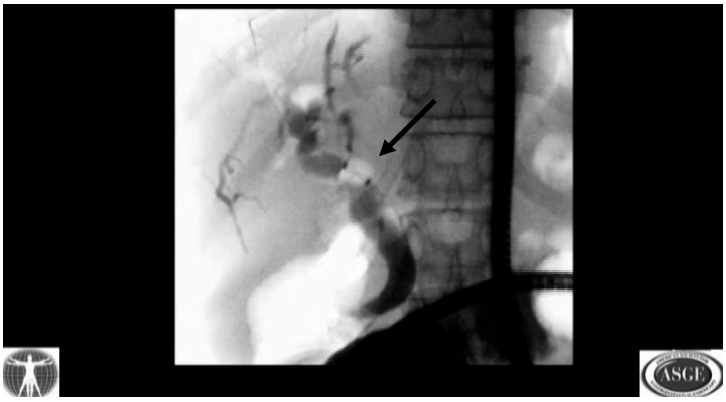
CHOLEDOCHOLITHIASIS

Choledocholithiasis
ERCP – Basket Retrieval



www.daveproject.org

Choledocholithiasis Balloon extraction



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ERCP

Balloon Assisted Stone Extraction

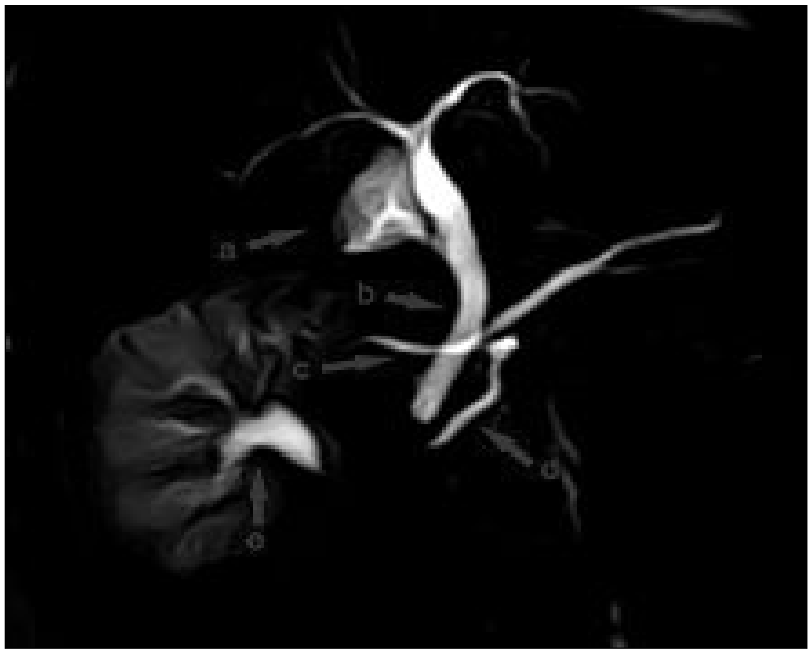
Post-Stone Extraction

ERCP

- Highly sensitivity 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.



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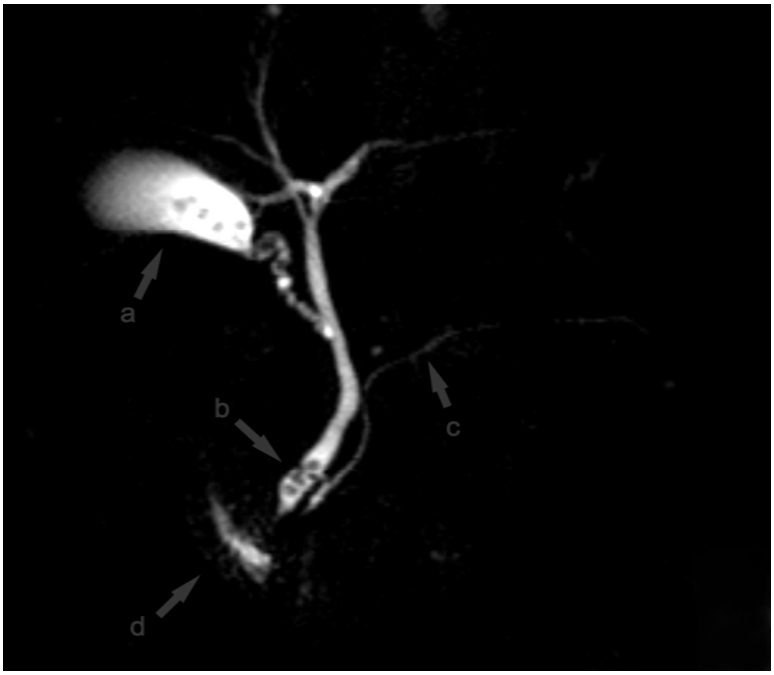


Wikipedia.org

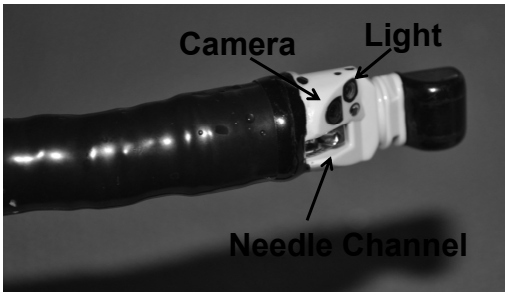
MRCP

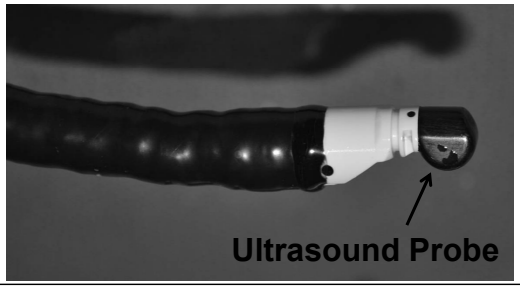
- Romagnuolo et al Ann Int Med 2003
  - Meta-analysis
  - 92% sensitivity for stones
  - 88% sensitivity for mass
- Drawbacks
  - Decreased sensitivity for small stones with normal duct size
  - Unable to sample tissue
  - Poor imaging of ampulla of vater
  - Cloustrophobic patients
  - Metal prostheses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





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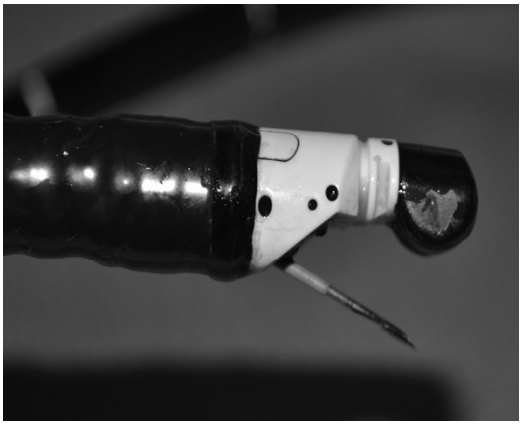
Normal Pancreas Body/Tail

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 diangosis (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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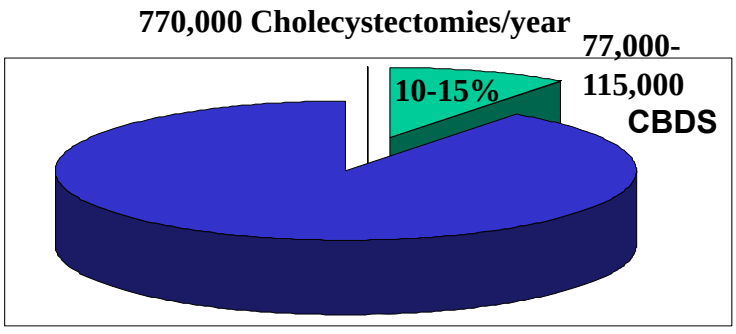
Common Bile Duct Stones The Problem



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

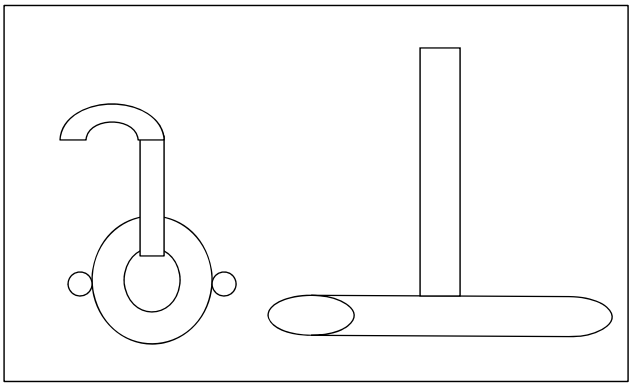
Open Common Bile Duct Exploration

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

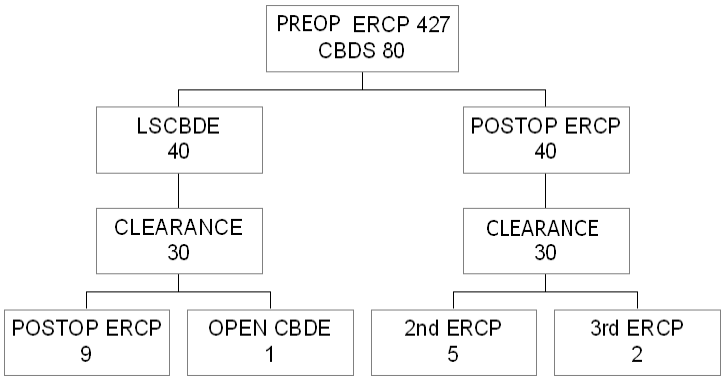
Time

Evaluation of Techniques

- **Effectiveness**
- **Technical Complexity/Experience**
- ***Cost***

CBDS: The Evidence

RANDOMIZED TRIAL LSCBDE vs SELECTIVE POST OP ERCP
Rhodes M, et al Lancet 1998 Jan 17;351(9097):159-61



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

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 Surg1999:230;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

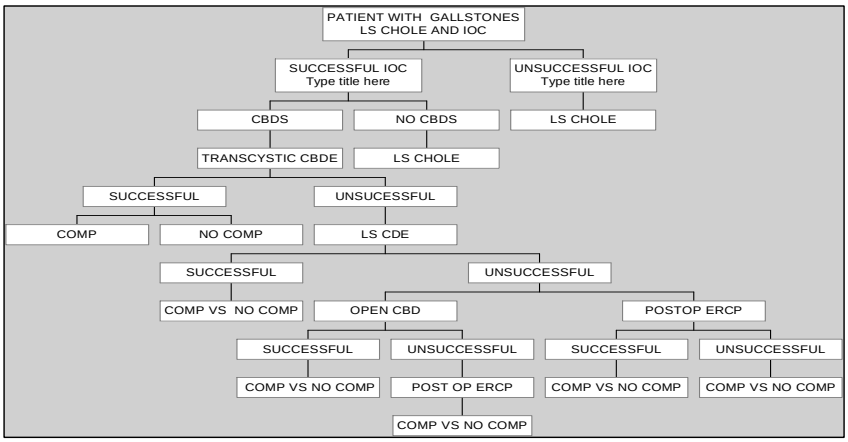
Urbach DR et al Surg Endosc 2001 15:4-13

Structure of the Decision Model

Assumptions

Estimation of Probabilities

LSCBDE vs Postop ERCP
A Decision Analysis



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

IOC Success	94% (80-100)
Sensitivity	89% (80-100)
Specificity	99%(80-100)
ERCP Success	98% (80-100)
Severe Complications	1.1% (0-5)
Sensitivity	90% (80-100)
Specificity	100% (80-100)
Stone Clearance	91% (80-100)

LSCDBE vs Postop ERCP Base Case Cost Assumptions

Diagnostic ERCP	$1441 (500-2000)
Therapeutic ERCP	$ 1971 (1000-3000)
IOC	$ 368 (250-1000)
Transcystic CBDE	$ 1094 (500-2000)
LSCBDE("otomy")	$ 1769 (1000-3000)
Open Chole(conversion)	$ 1794 (1000-3000)
Complication Bile Leak	$1178 (500-3000)
Complication ERCP	$5478 (2000-20000)

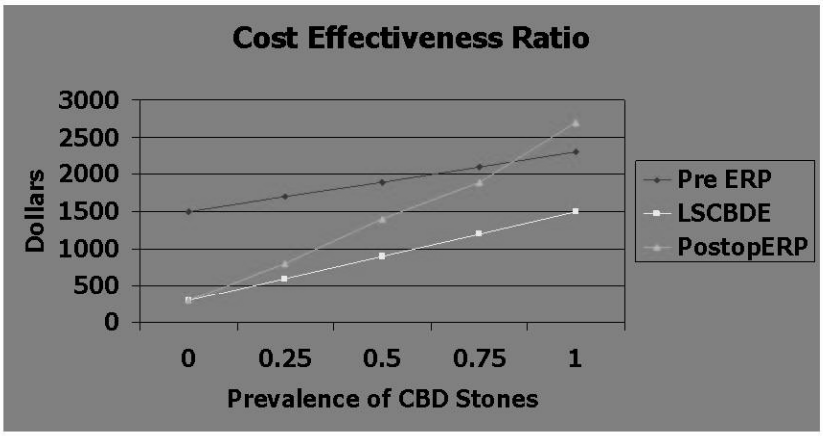
LSCBDE vs Postop ERCP
Incremental Cost vs LS Chole

LSCBDE	$ 487.50
Postop ERCP	$ 550.10
LSCBDE (Savings)/Cost	($ 62.60)

LSCBDE vs Postop ERCP
Cost-Effectiveness Ratio

LSCBDE	$496.81
Postop ERCP	$563.59
{ Routine Preop ERCP	1518.85}

CBD Stones



Example: Minimally Invasive Surgery

Laparoscopic Common Bile Duct Exploration vs. ERCP: Cost Analysis

Pre-op ERCP > Intra or post-op management of CBDS whether open or L/S

Hazey, J.W., Rock, L.M., Marks, J.M., Asseff, D., Ponsky, J. Cost Analysis of Endoscopic Retrograde Cholangiopancreatography in Management of Suspected Choledocholithiasis.

Laparoscopic Common Bile Duct Exploration vs. ERCP: Cost Analysis

Laparoscopic management of CBDS is the most cost effective

Hazey, J.W., Rock, L.M., Marks, J.M., Asseff, D., Ponsky, J. Cost Analysis of Endoscopic Retrograde Cholangiopancreatography in Management of Suspected Choledocholithiasis.

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

Hazey, J.W., Rock, L.M., Marks, J.M., Asseff, D., Ponsky, J. Cost Analysis of Endoscopic Retrograde Cholangiopancreatography in Management of Suspected Choledocholithiasis.

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

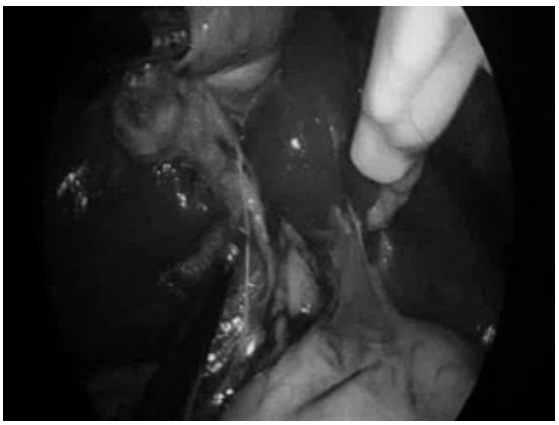
Laparoscopic Common Bile Duct Exploration
What you should do?

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

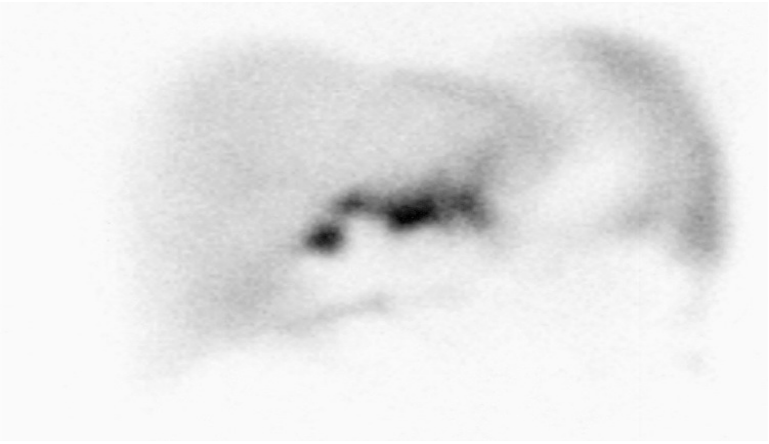
Other Issues to Address Related Solely to Cholecystectomy…

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

Laparoscopic Cholecystectomy…

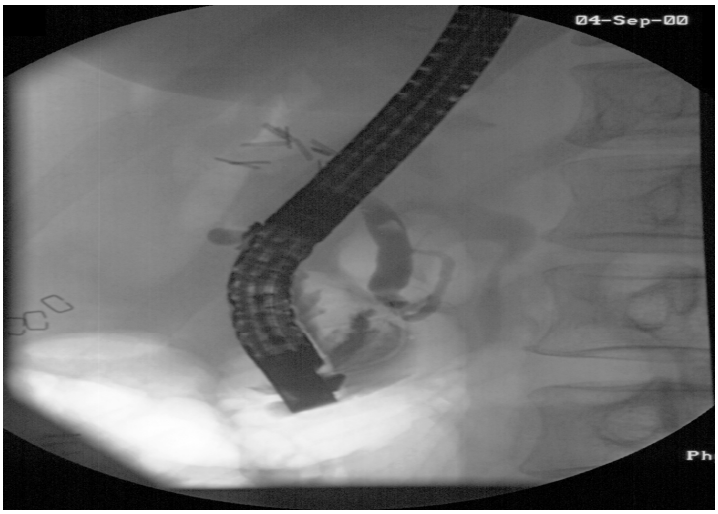
- Healthy 42 yo female, elective laparoscopic cholecystectomy for symptomatic cholelithiasis
- Re-admitted 3 days post-op with pain and bilirubin of 4.3

Bile Duct Injury: Transection HIDA Scan

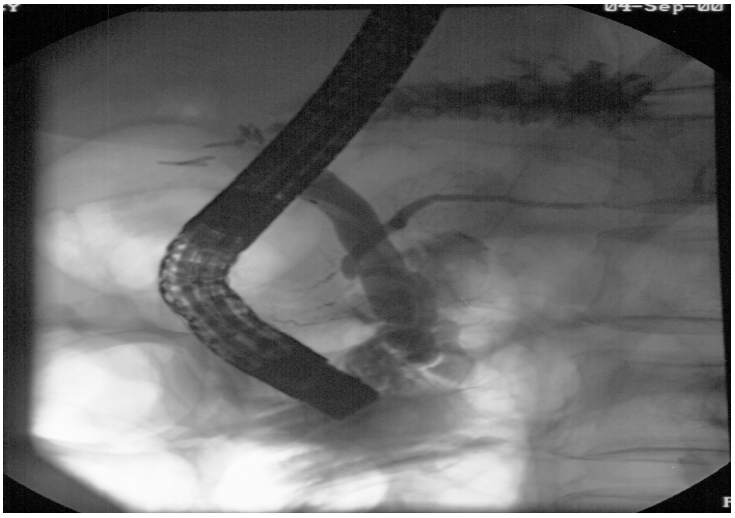


Bile Duct Injury: Transection CT Scan

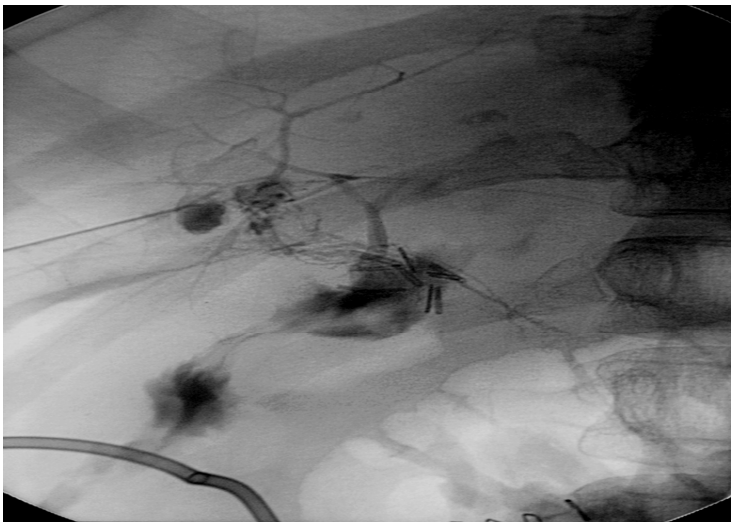
Bile Duct Injury: Transection ERCP



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**

Bile Leak and/or Injury

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

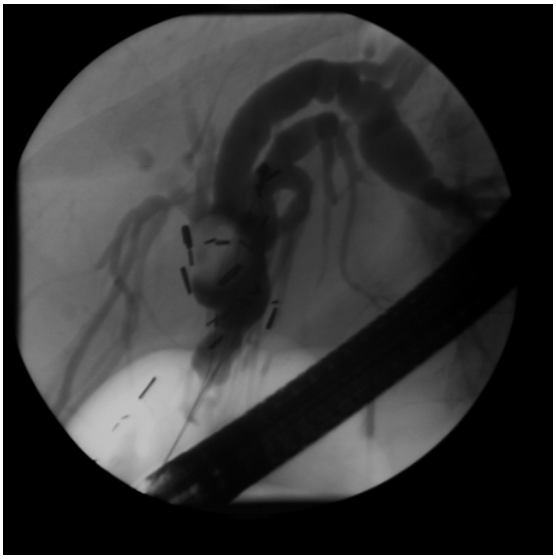
Percutaneous transhepatic choledochoscopic holmium-YAG laser or EHL ablation of biliary tract calculi is a viable alternative for stone clearance in patients incapable of having their stones removed endoscopically and unable or unwilling to undergo surgery.

Case:

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

Unwilling to undergo an additional operative procedure

ERCP with ES



PTC

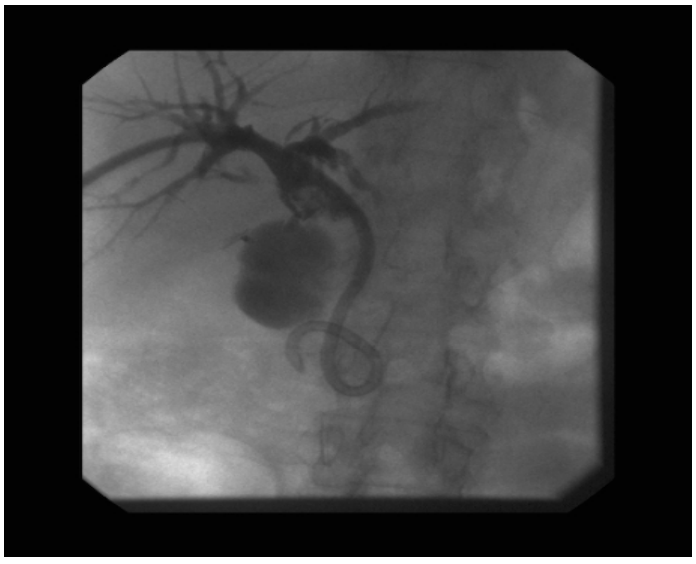
Completion cholangiogram after a single treatment

Case:

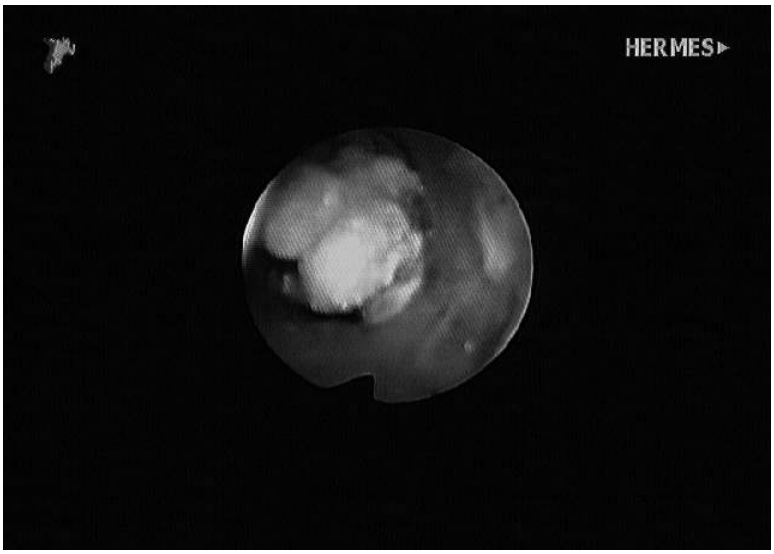
62 yo male, s/p laparoscopic cholecystectomy
with abdominal pain, increased lft's and ultrasound consistent with choledocholithiasis

Physiologically high risk to undergo an additional operative procedure on presentation

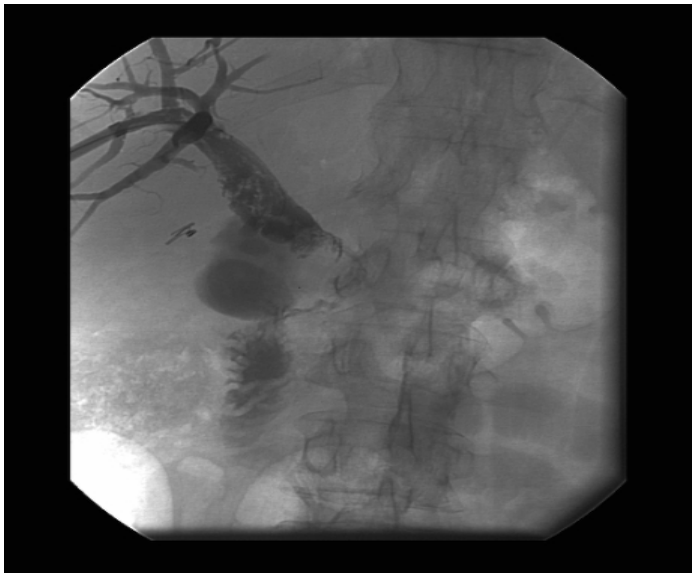
PTC



Percutaneous choledochoscopic view



Completion cholangiogram after a single treatment



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