
Laparoscopic Common Bile Duct Exploration

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Dartmouth-Hitchcock

The logo for Dartmouth-Hitchcock, consisting of a stylized graphic of four parallel diagonal lines of increasing length, followed by the text "Dartmouth-Hitchcock".

Disclosures

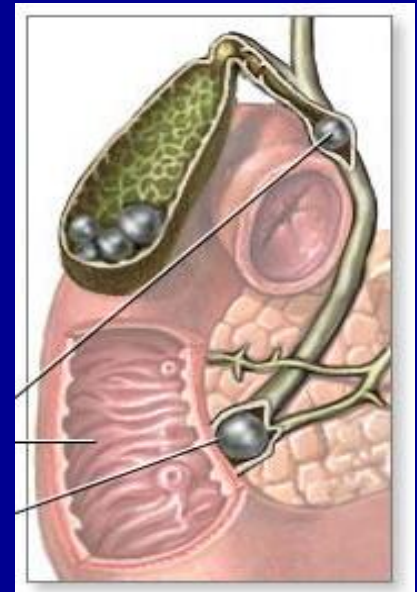
- Consultant: Cook Medical, Boston Scientific
- Royalties: 3-DMed – LCBDE simulator

Outline

- Background and historical perspective
- LCBDE technique and outcomes
- Simulation-based LCBDE training

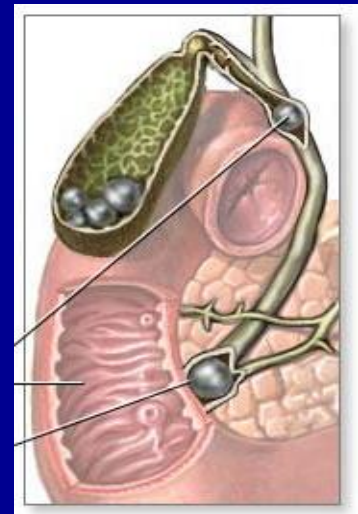
Common bile duct stones: the problem

- Found in 10-14% of cholecystectomy patients
 - Pre-/Intra-/Post-operatively
- Significant morbidity:
 - Obstruction
 - Cholangitis
 - Pancreatitis
 - Bile leaks
 - Re-admission



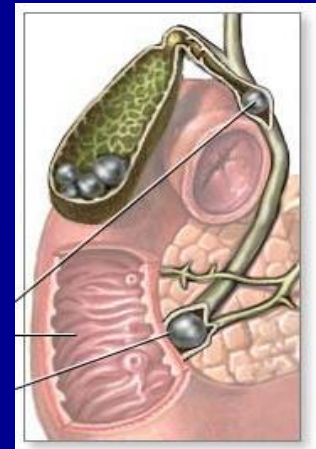
Choledocholithiasis: The Hidden Trap

- 40% are silent preoperatively
- Existing Risk Stratification Guidelines – Unreliable¹
 - ASGE Criteria
 - Sensitivity 55%, Specificity 69%
 - Repeat LFTs or declining LFTs
 - Does not improve accuracy, unreliable at predicting stone passage.



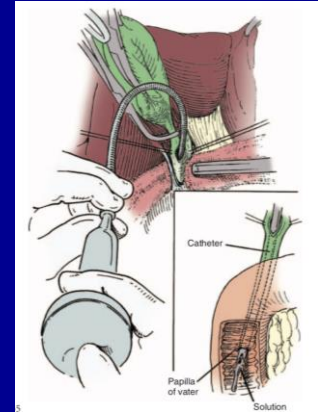
Choledocholithiasis: The Hidden Trap

- Why worry about small stones? Don't they just pass?
- Not as benign as once thought...
- GallRiks cholecystectomy database (n = 38,864)
 - n=3,828 CBD stones, 30 day outcomes
 - 25% led to complications if untreated (e.g. jaundice, cholangitis, pancreatitis, bile leaks)
 - 16% risk, even for small stones (<4mm)
 - Intervention reduced risk by 50% (intra/postop ERCP, bile duct exploration, or flushing/manipulation)

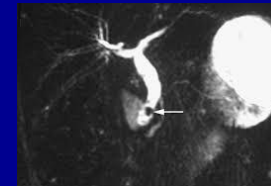


Historical perspective

- Open CBDE (gold-standard) during "open" surgical era
 - ERCP - secondary role

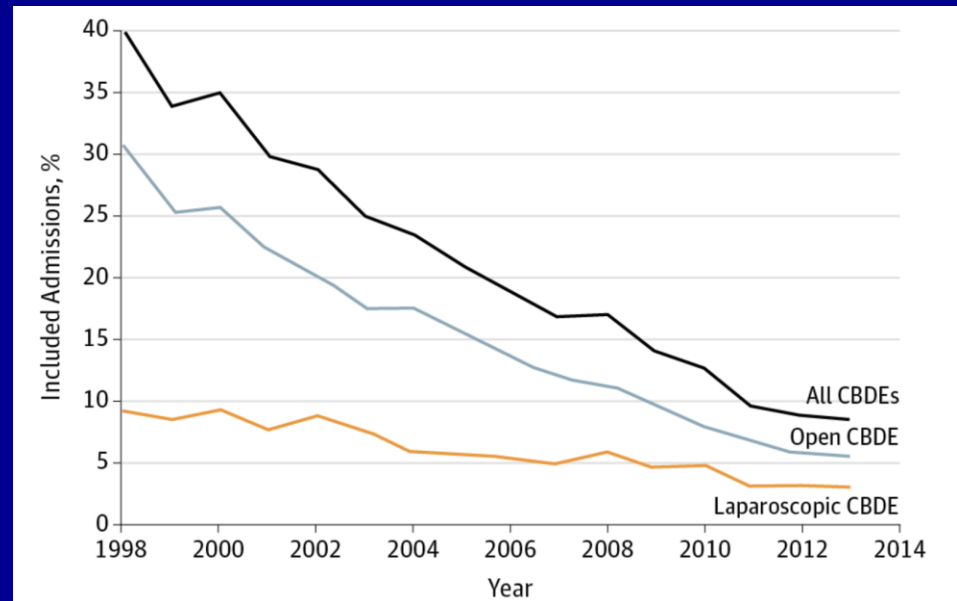


- Lap chole era – CBD stone care becomes fragmented
 - increasing reliance on MRCP, EUS, ERCP, multi-stage care
 - decline in IOC, poor adoption of Lap CBDE by surgeons.



The Great Decline in Biliary Surgery

- Surgical experience in CBDE has declined.
- Mean number of procedures by U.S. graduating chief residents (2005):
 - Lap Chole = 87
 - Open CBDE = 1.7
 - **LCBDE = 0.7**



“A generation of surgeons has emerged from training with little experience in bile duct surgery... we must identify means to train our surgeons, residents, and those in practice in the techniques of bile duct exploration.”

– Jeff Ponsky, Editorial in Surg Endosc (2010).

¹Bell RH Jr, et al. Operative experience of residents in US general surgery programs: a gap between expectation and experience. *Ann Surg* 2009; 249 (5): 719-24.

²Wandling MW et al. “Nationwide Assessment of Trends in Choledocholithiasis Management in the United States From 1998 to 2013.” *JAMA Surg.* 2016.

ERCP plus cholecystectomy: The Good, the Bad, and the Ugly

Good:

- Stone clearance rates: 93-96% (equivalent to CBDE)

Bad:

- Additional procedure, anesthesia
- Morbidity up to 15% (equivalent to CBDE)
 - Post-ERCP pancreatitis
 - Perforation
 - Hemorrhage
 - Cardiopulmonary complications
- Mortality of up to 1% (equivalent to CBDE)
- Length of stay is longer compared to LCBDE (4.3 v. 2.5 days)
- More expensive than LCBDE (\$15,022 v. \$12,987)



¹Christensen M, et al. Complications of ERCP: a prospective study. *Gastrointest Endosc* 2004; 60(5):721-31.

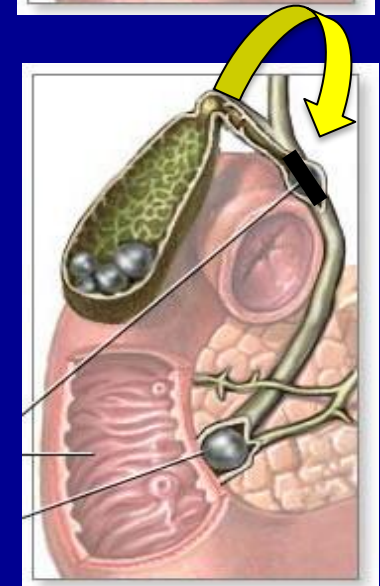
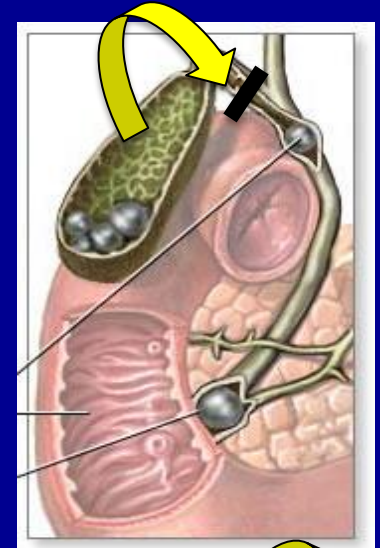
²Schwab B, Teitelbaum EN, Barsuk JH, Soper NJ, Hungness ES. "Single-stage laparoscopic management of choledocholithiasis, : an analysis after implementation of a mastery learning resident curriculum." *Surgery*. 2018.

Laparoscopic Common Bile Duct Exploration: why?

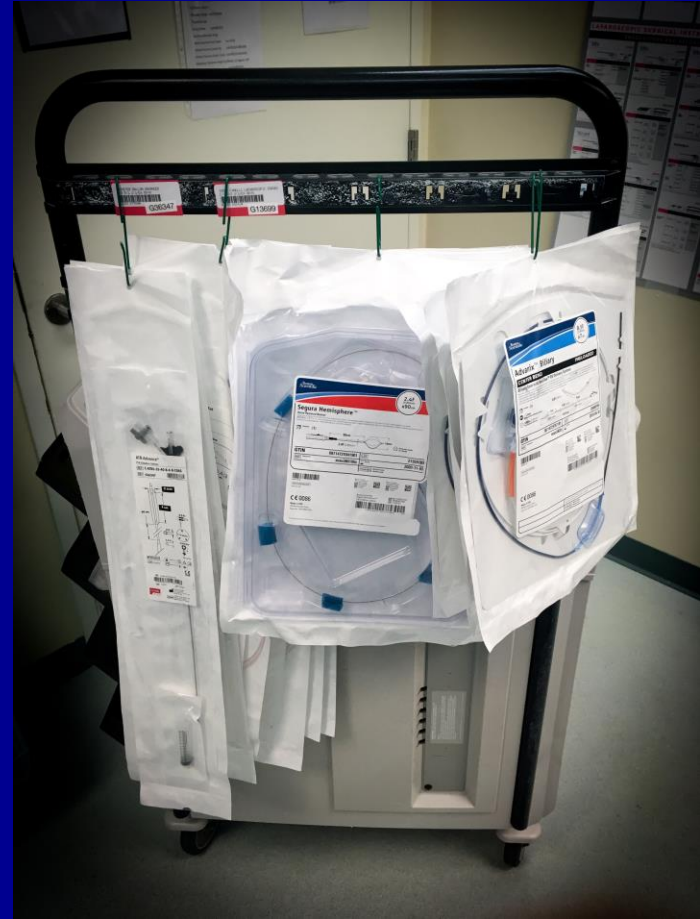
- PROS
 - Reduces reliance on additional expensive/invasive imaging (MRCP, EUS)
 - Reduces need for pre/postop ERCP
 - Equivalent safety and efficacy v. ERCP
 - “One-stop shopping” for patient
 - 2-day shorter length of stay
 - More cost-effective (\$2035 cheaper)
- CONS:
 - Added OR time, equipment
 - Higher technical skill required

Lap CBD Exploration

- **Transcystic**
 - Avoids need for choledochotomy
 - Dependent on cystic duct anatomy (small, distal stones are best)
 - **Technique within reach of most surgeons**
- **Transcholedochal**
 - All stone sizes and locations potentially reachable
 - Only for bile ducts $> 7\text{mm}$ to avoid stricture.
 - Risk of bile leak is higher
 - **Limited to those with advanced suturing skill**



CBD cart

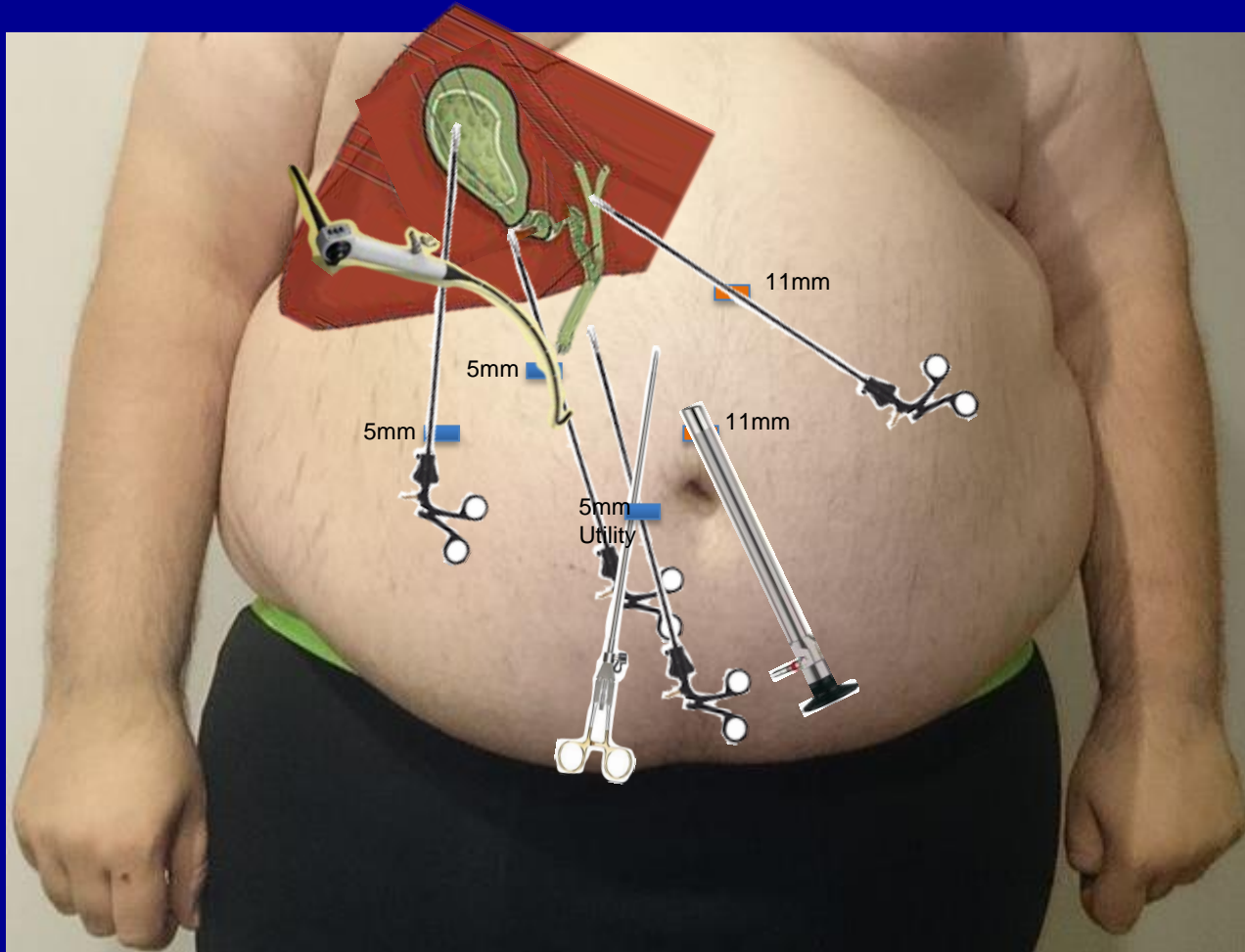


My Algorithm:

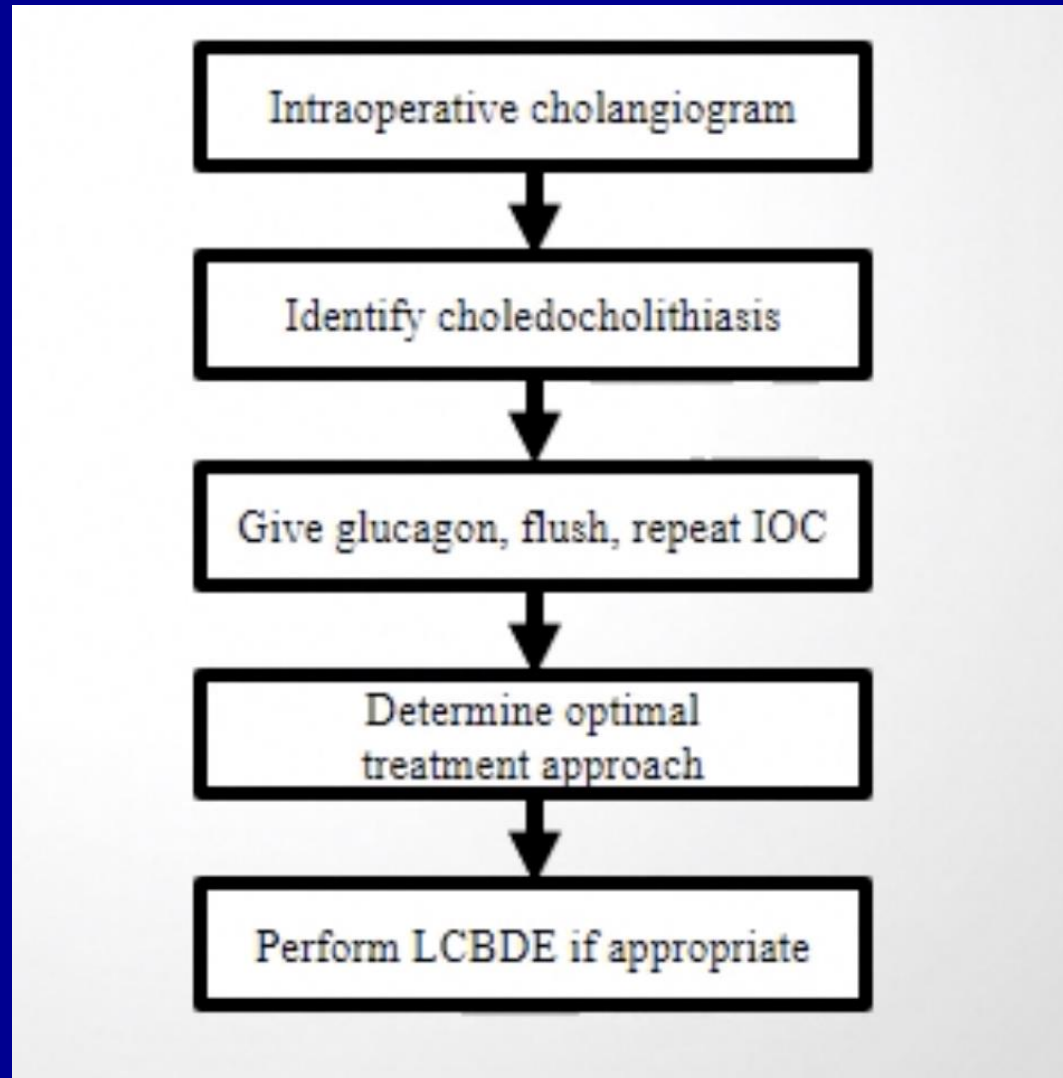
- Does patient have indication for cholecystectomy?
 - Symptomatic gallstones, CBD stones, biliary pancreatitis, cholangitis, cholecystitis, etc.
- **Contraindication to surgery?:**
 - Severe cholangitis or pancreatitis (e.g. unstable pt)
 - Medical (e.g. recent NSTEMI)
 - Suspected malignancy
- **If no contraindication, proceed with LC + IOC**
 - Routine IOC, if (+)
 - transcystic clearance if feasible
 - If unsuccessful and bile duct > 7mm
 - transcholedochal clearance
 - If unsuccessful or small diameter CBD
 - biliary stent plus post-op ERCP



Port placement for LCBDE



Laparoscopic Transcystic Exploration



Routine Cholangiography – How?

- 5F open tip ureteral catheter
 - allows 0.035 guidewire
- Olsen clamp
 - allows catheter fixation without clips
- Saline and 50% contrast syringes
- Avoid iatrogenic bubbles
 - Flush tubing well
 - Do not aspirate with catheter



Routine Cholangiography – How?

- Flatten table
- C-arm
 - Cine mode – “instant replay”
 - Apnea
 - LAO 10-15° if needed to displace spine

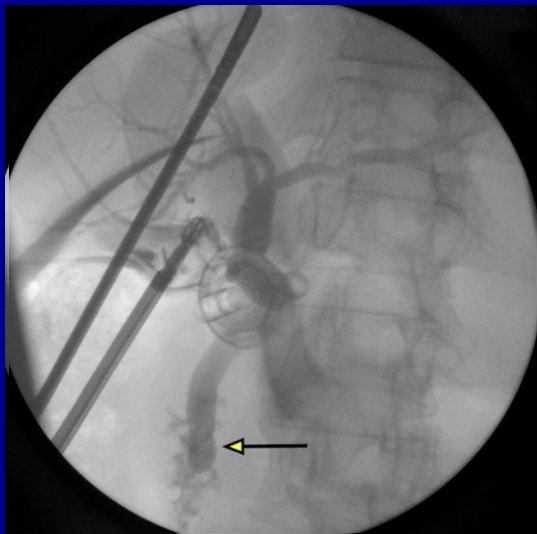
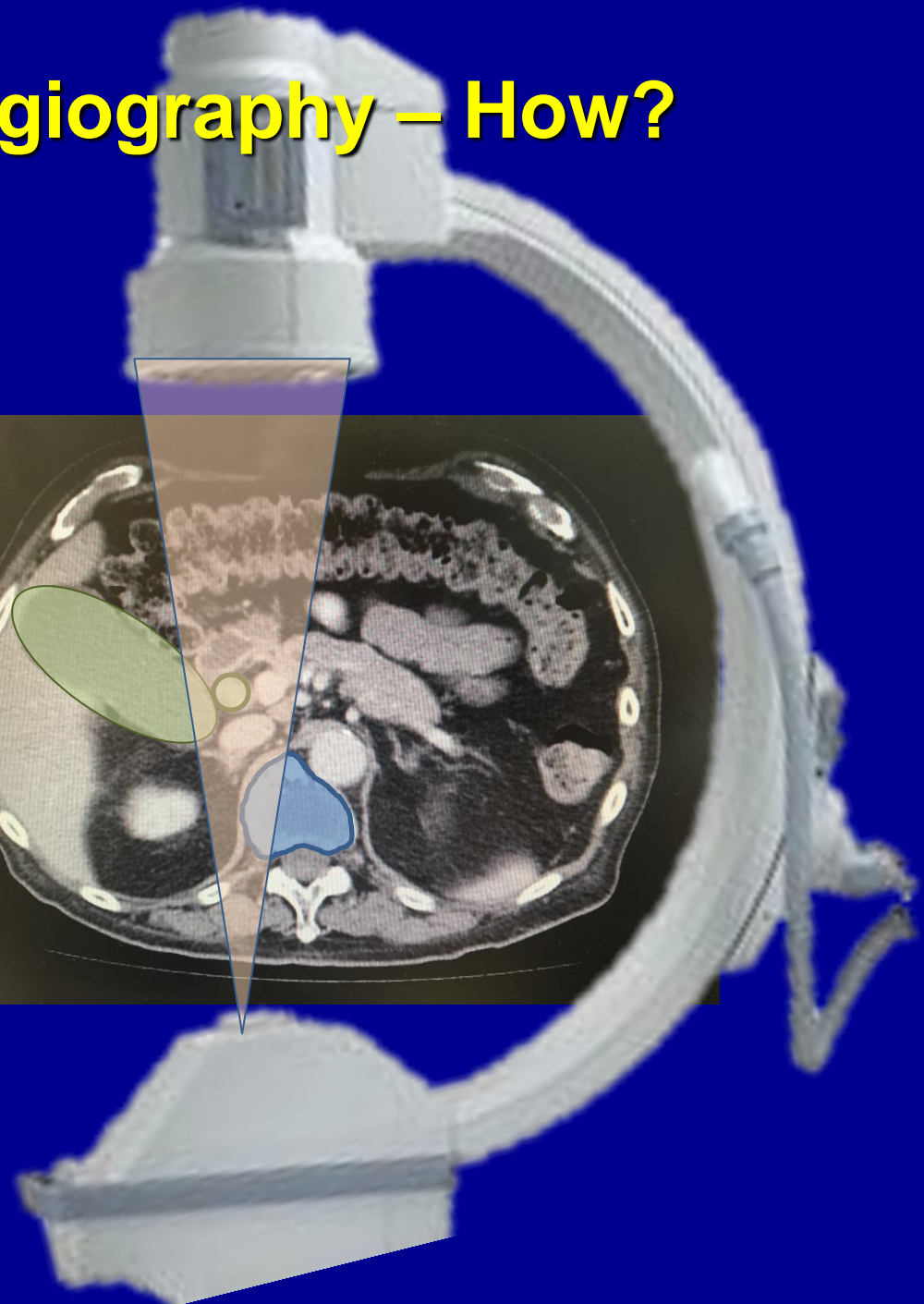
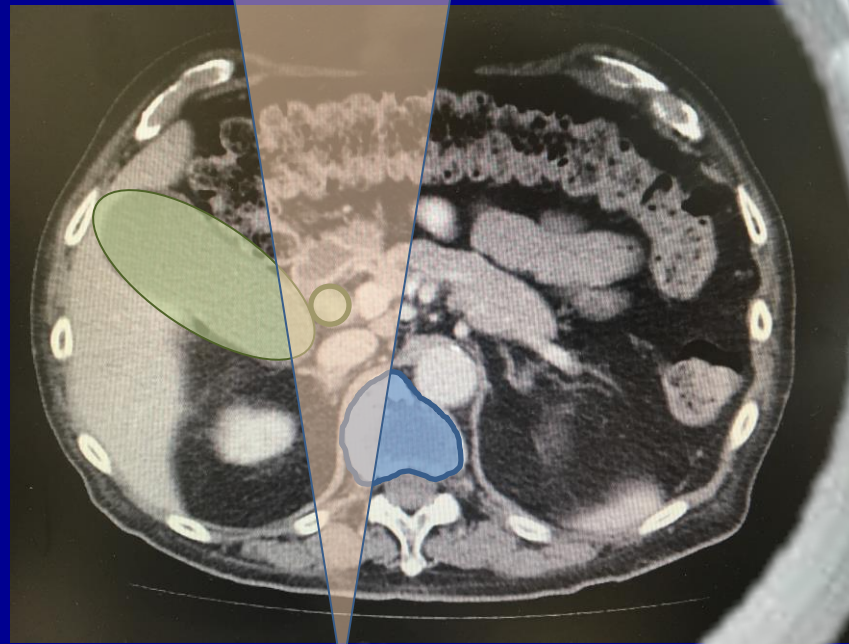
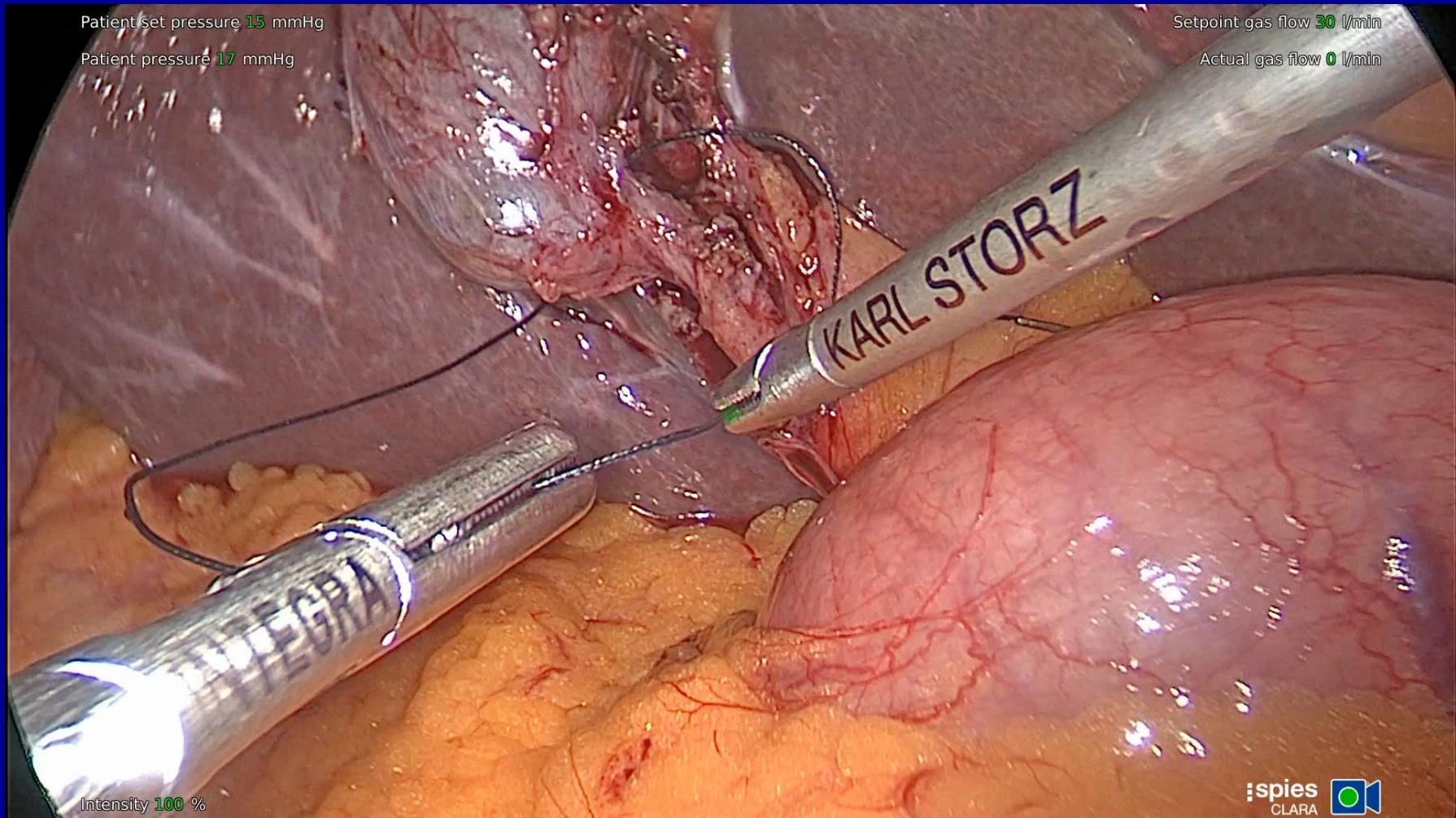








Image courtesy of George Berci

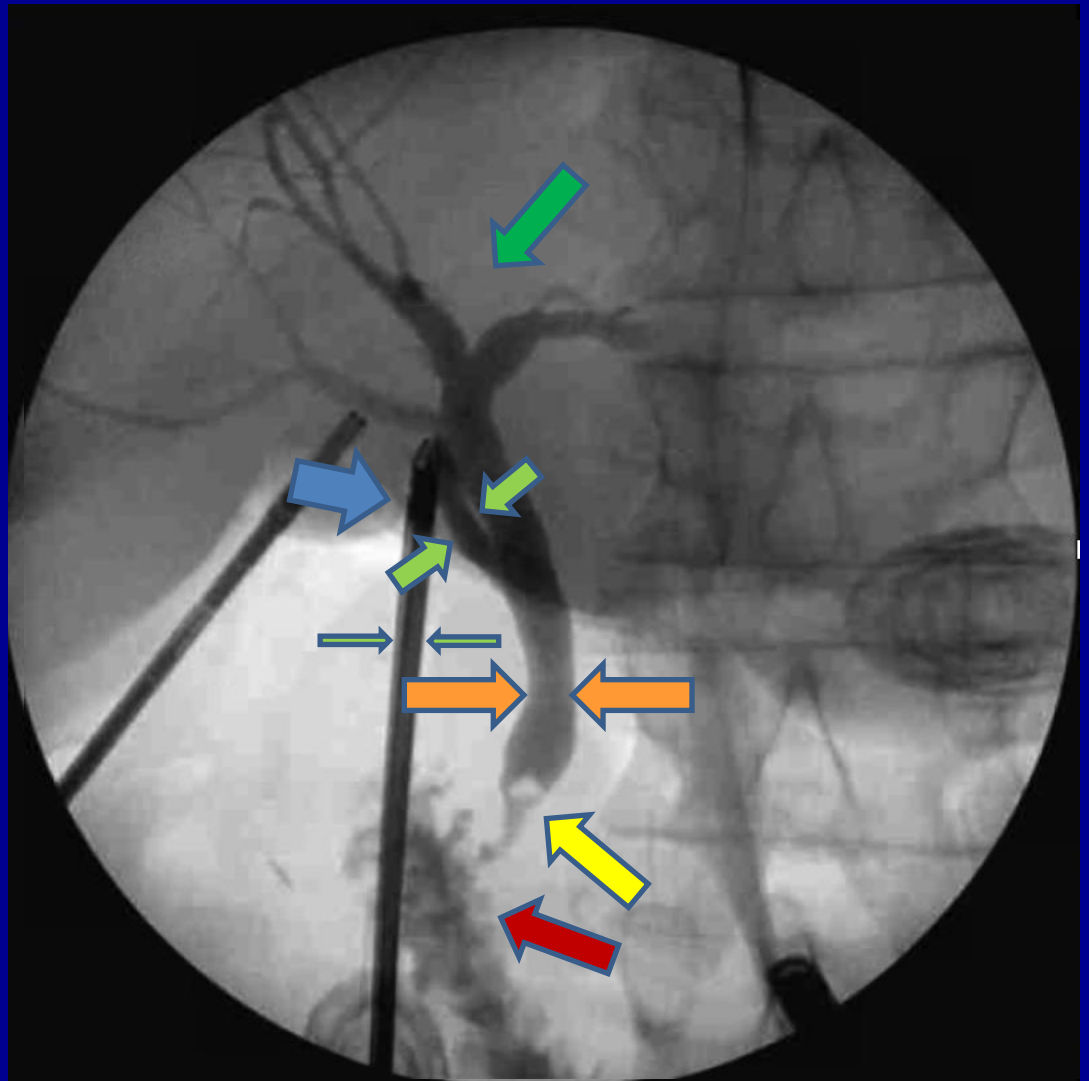


Cholangiography – Tips & Tricks

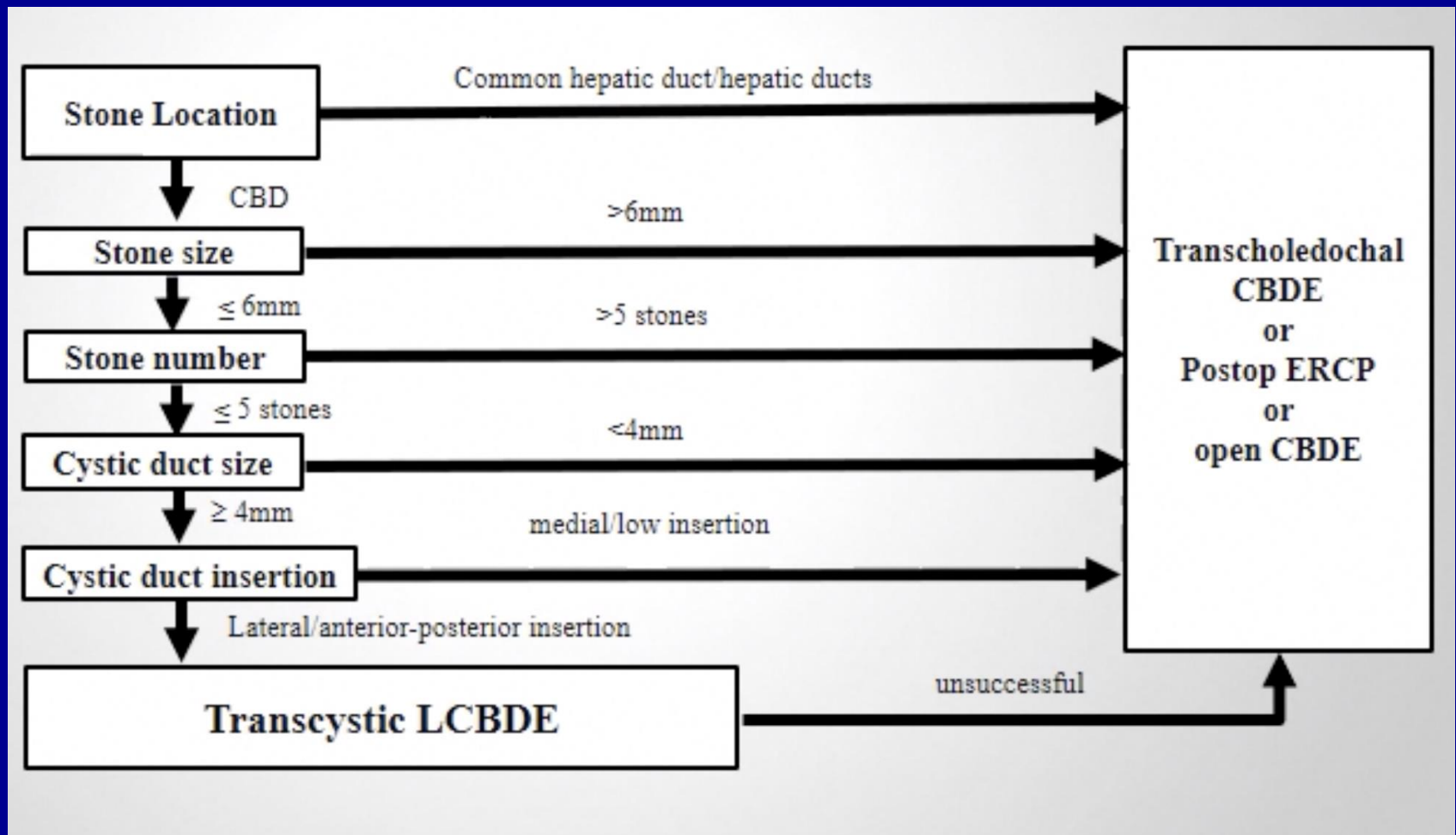


Cholangiography – Case 1

- Position of catheter
 - cystic duct 
- Cystic duct
 - Ant/post
 - 5-6mm 
- Common bile duct
 - 9mm 
 - Distal 5mm stone 
 - Empties 
- Hepatic ducts
 - Normal, all fill 
- Signs of injury
 - none



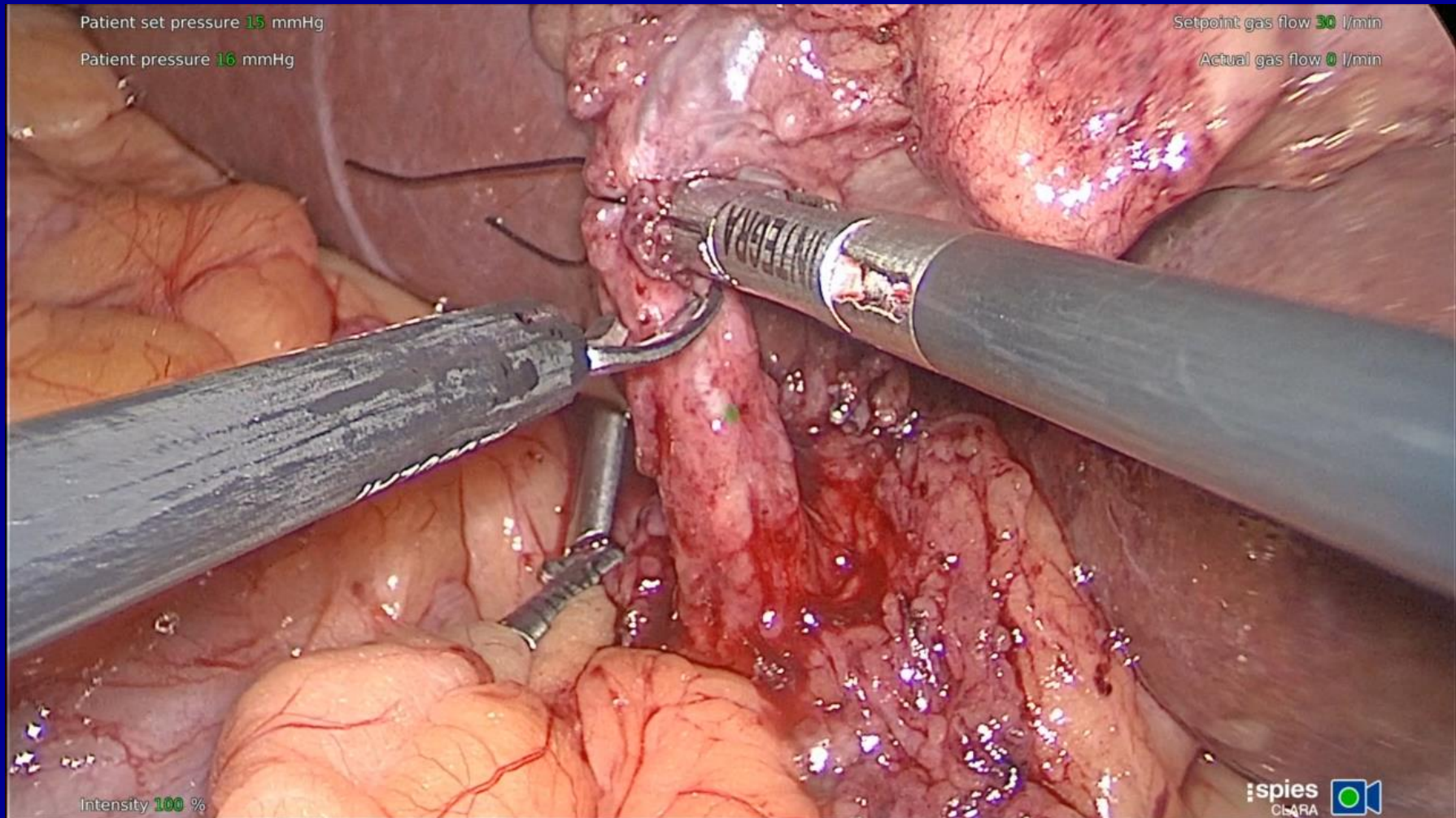
Laparoscopic Transcystic Exploration



Laparoscopic Transcystic Exploration

1. Port placement and dissection to a critical view of safety
2. Cholangiogram
3. Wire access
4. Cystic duct dilation (if necessary)
5. Choledochoscope insertion and maneuvering
6. Stone capture and extraction
7. Completion cholangiogram
8. Cystic duct ligation

Laparoscopic Transcystic Exploration



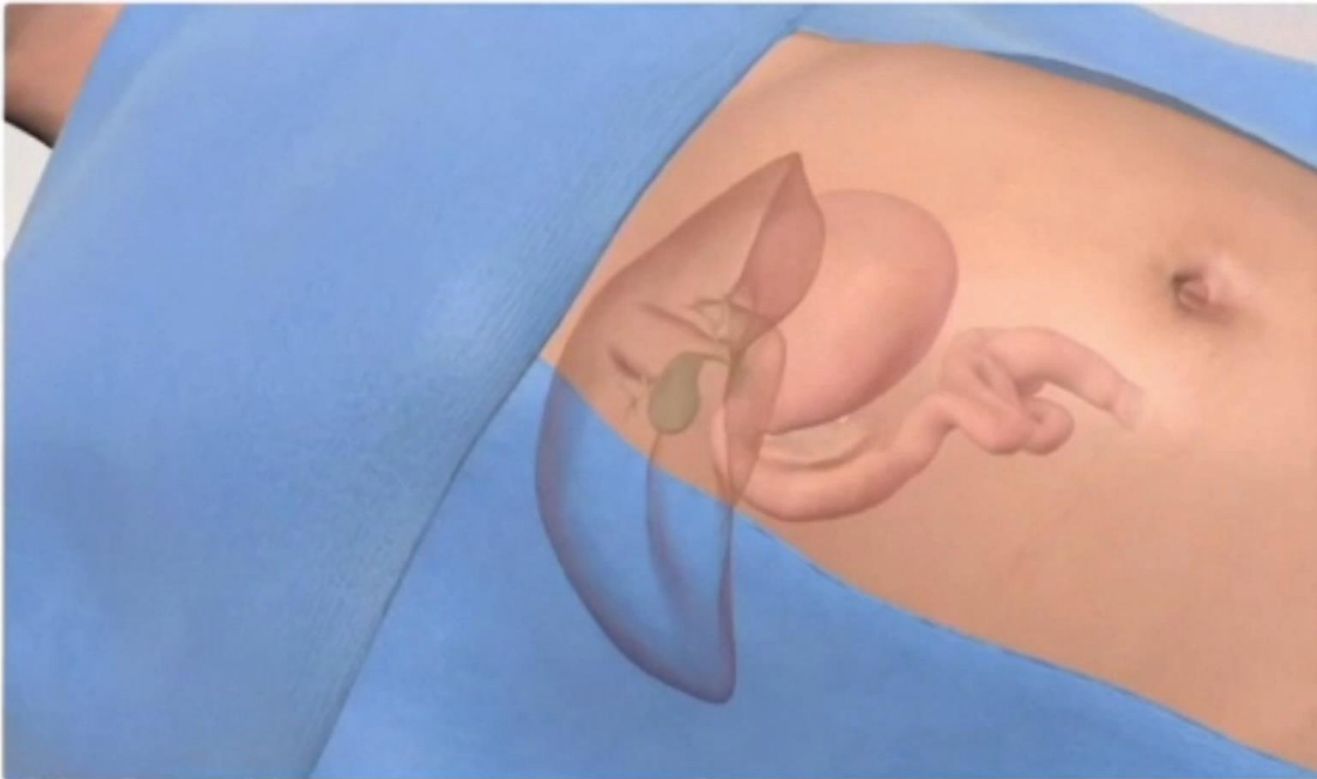
Biliary stents

- 7F plastic stent, wire-guided, transcystic delivery
- Indications:
 - **Temporary drainage**
 - Cholangitis
 - Ampullary edema/spasm
 - Transcholedochal exploration
 - **Bridge to ERCP** (bailout maneuver)
- Remove in 2-4 weeks, outpatient EGD



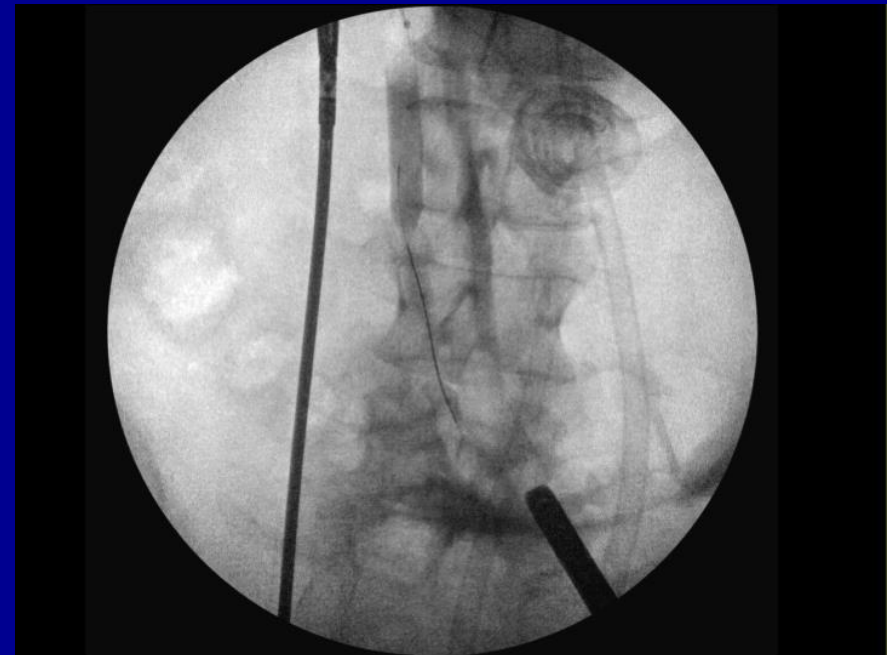
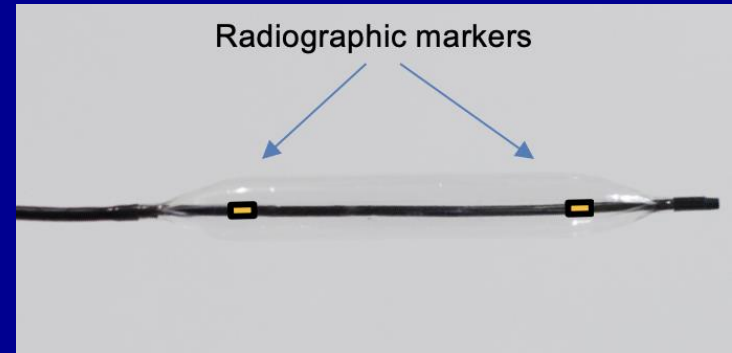
Biliary stents

- Fanelli stent deployment sequence:



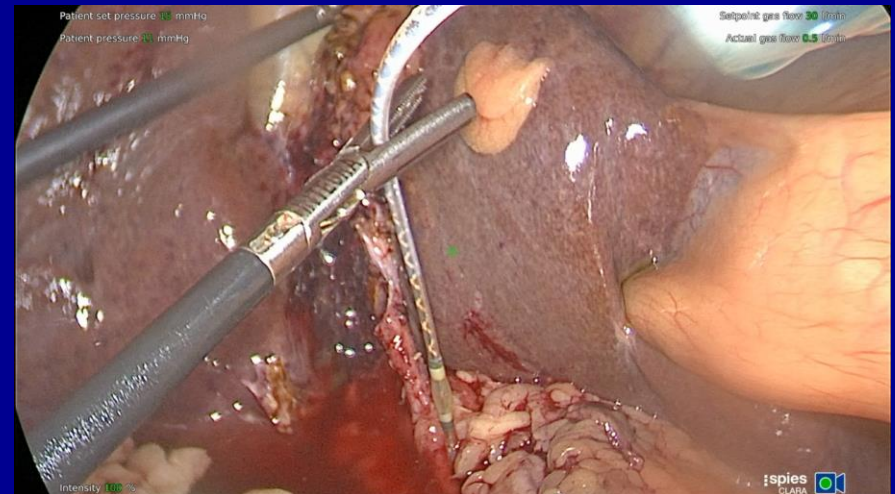
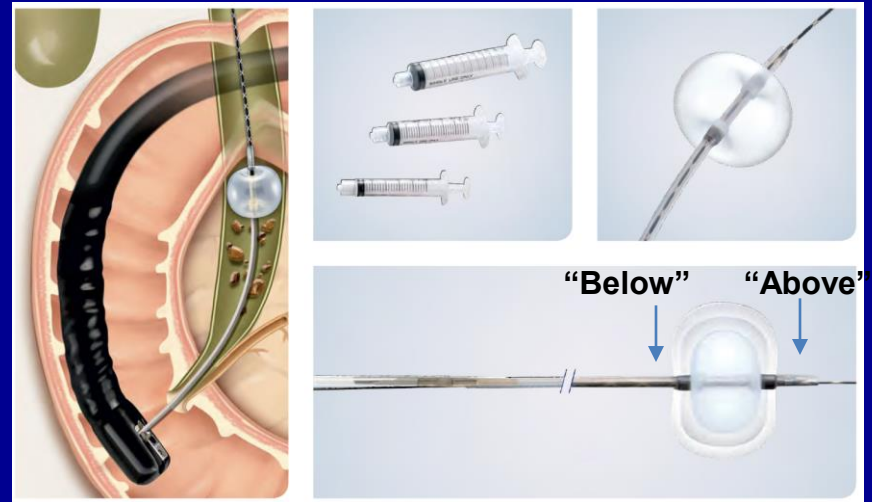
Balloon sphincteroplasty (papillary balloon dilation)

- **Indications:**
 - Stenotic papilla
 - Alternative to transcystic extraction
 - Multiple stones/fragments
 - Choledochoscopy fails
- **NEVER exceed CBD diameter**
- **Caution:** Use selectively, when postop ERCP is the only other option
- **Consider stent** to mitigate potential edema/spasm



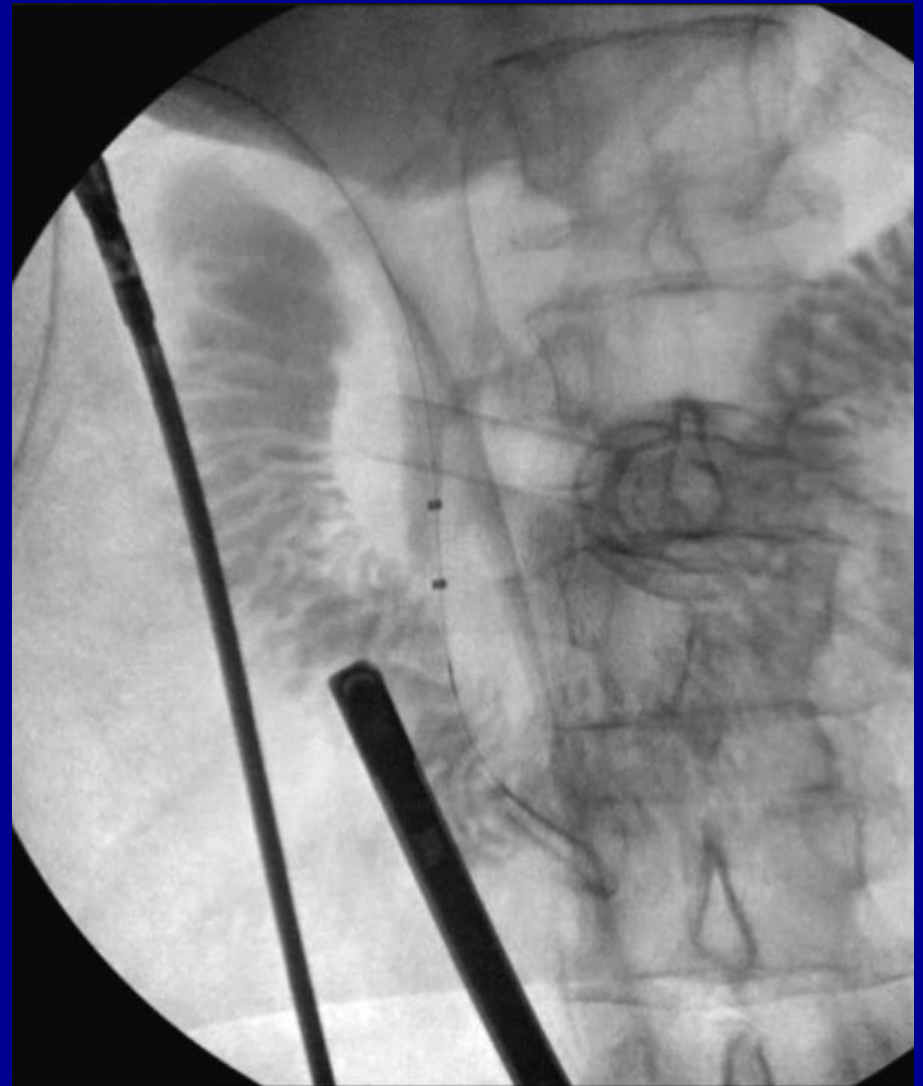
Balloon extraction device

- Common device used for ERCP
- **Features**
 - Soft air balloon, variable diameters
 - Over-the-wire
 - Injection lumen (“Above” or “Below”)
- **Technique:**
 - **Push** stones into duodenum
 - **Pull** tenacious stones from papilla (transcholedochal)
- Use over-wire to prevent false passages
- +/- balloon sphincteroplasty

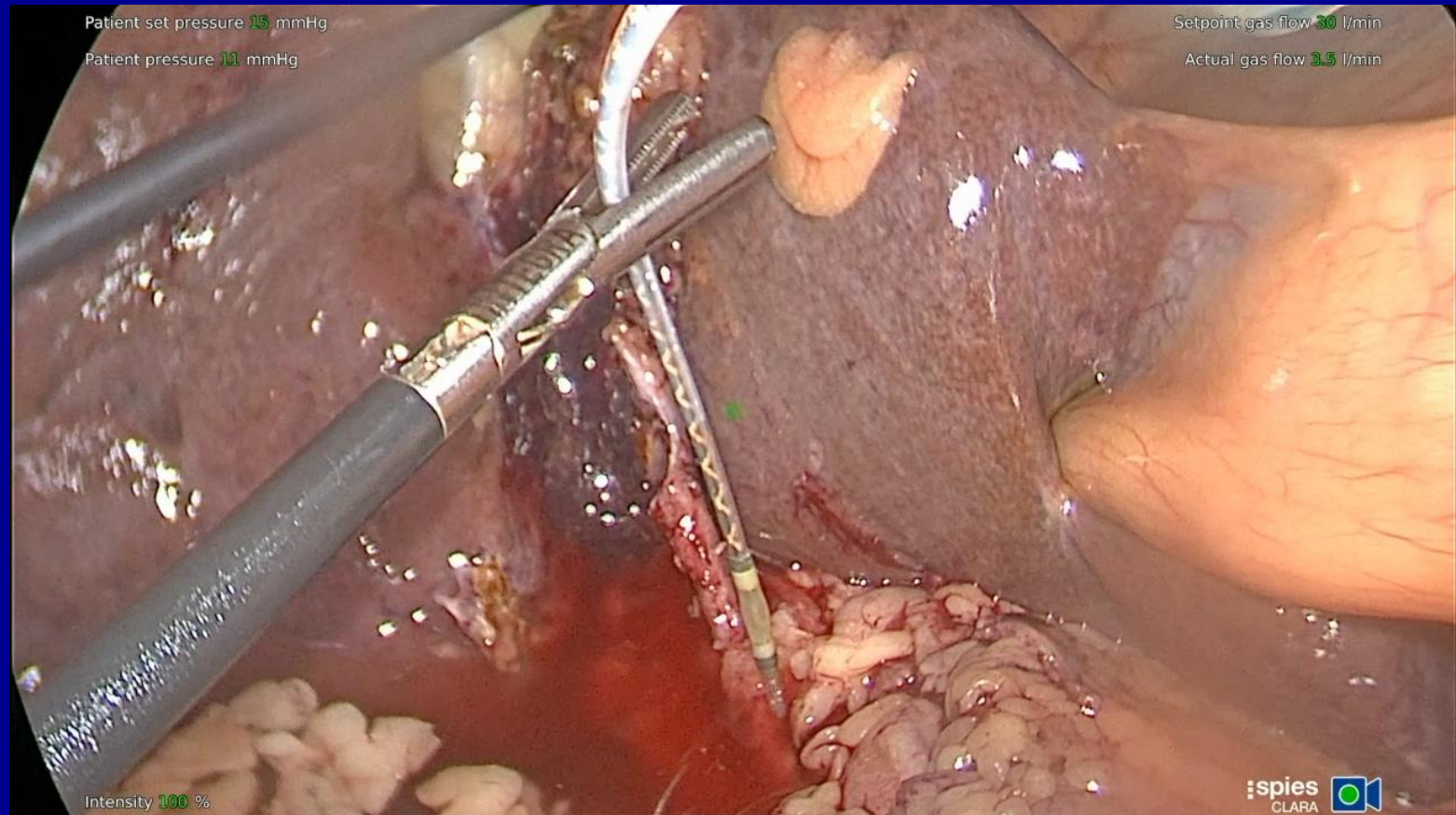


Balloon extraction device: Transcystic use

- Position balloon extractor above stone
- Inflate balloon and push forward

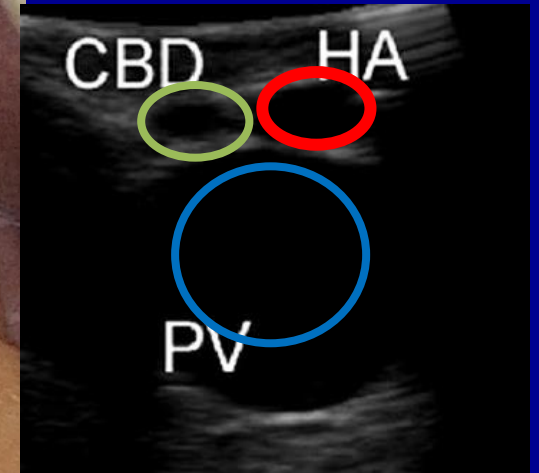
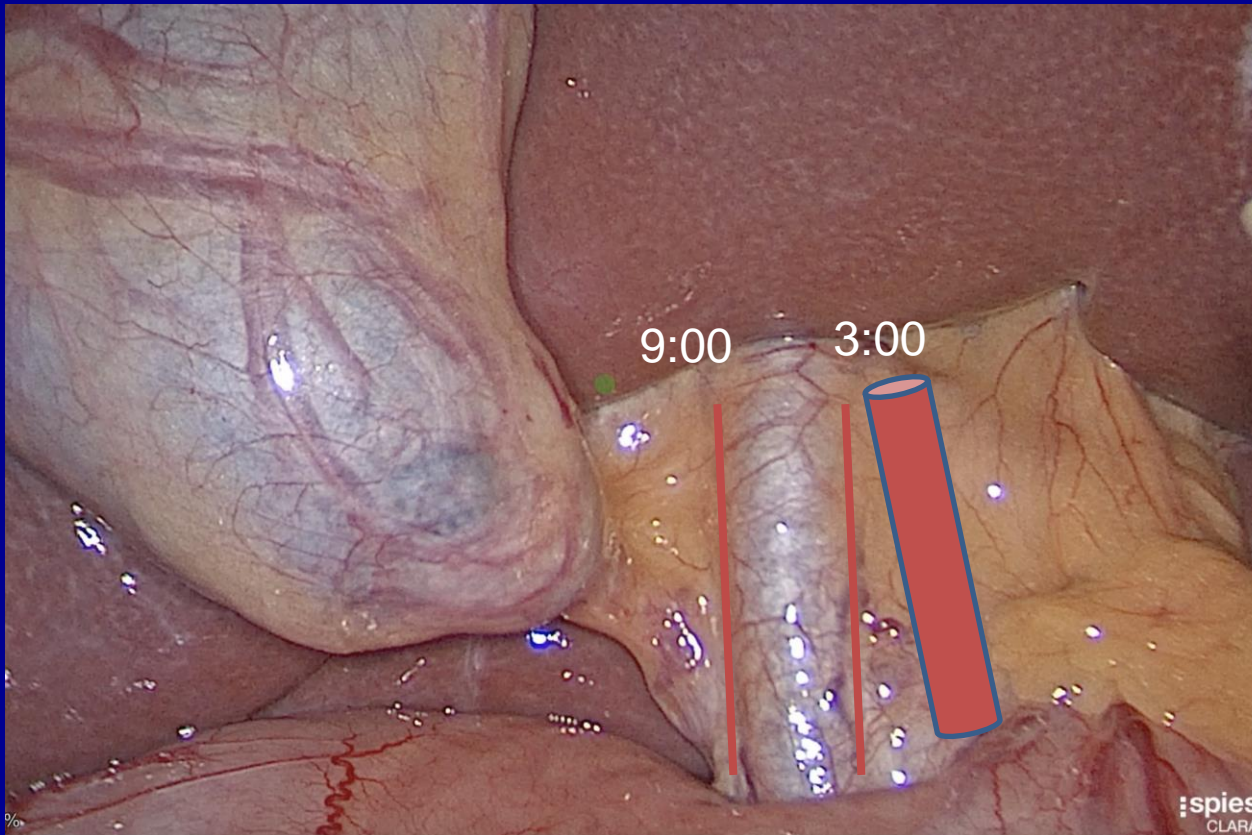


Balloon extraction device: Transcholedochal (“Pull” technique)

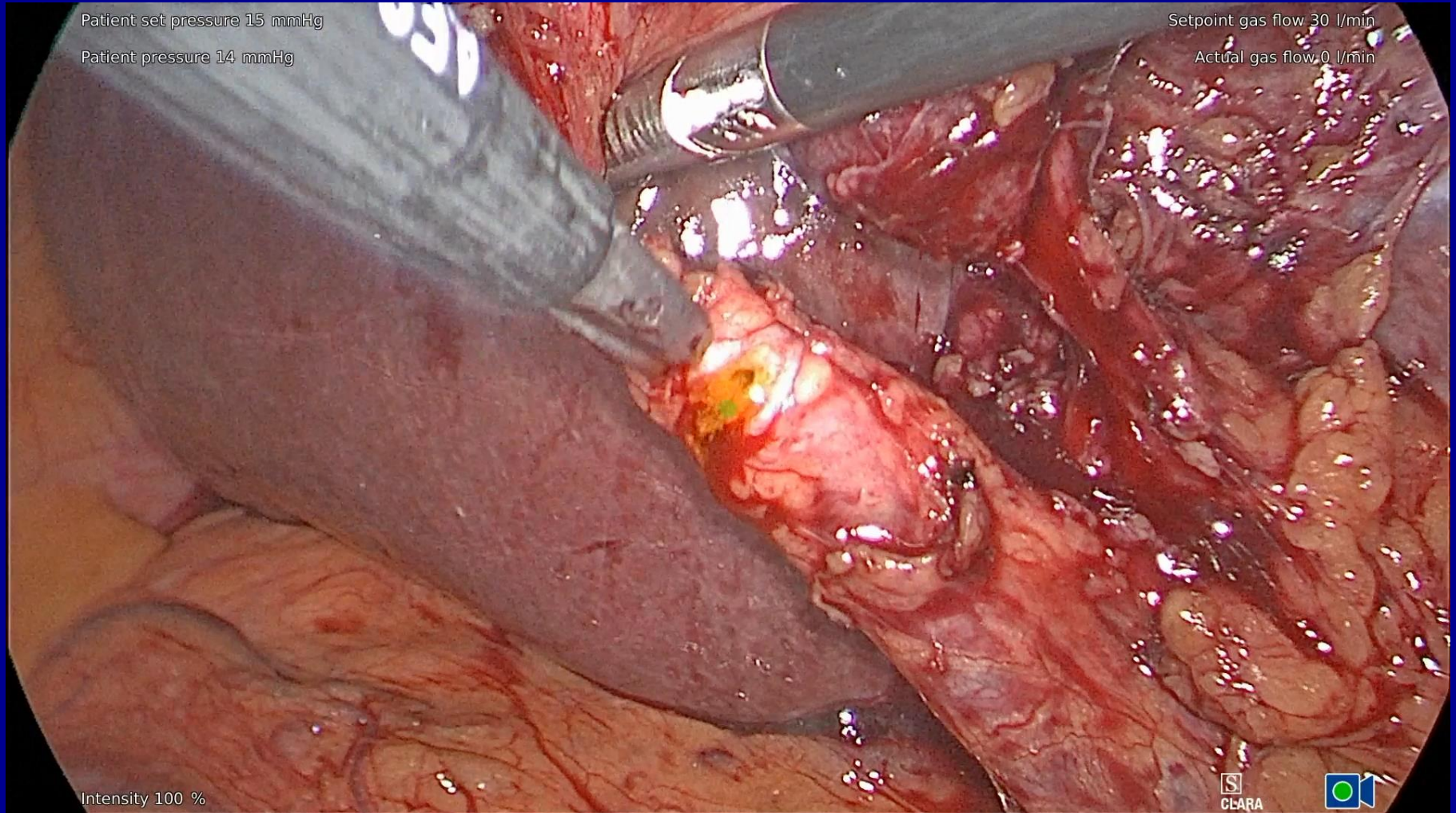


Transcholedochal Exploration

- Anatomy review



Transcholedochal Exploration



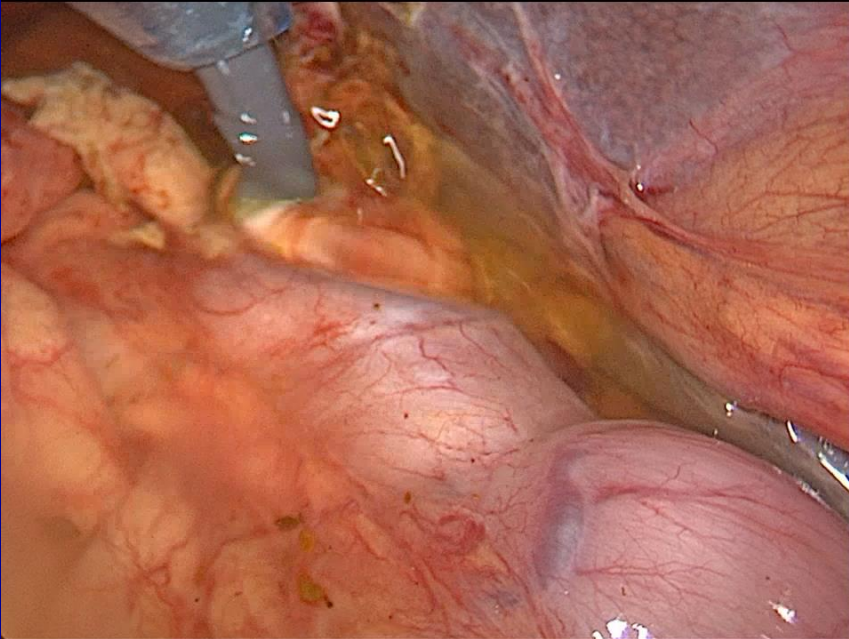
Large or impacted stones

Patient set pressure 15 mmHg

Patient pressure 14 mmHg

Setpoint gas flow 30 l/min

Actual gas flow 0.5 l/min



LCBDE Outcomes

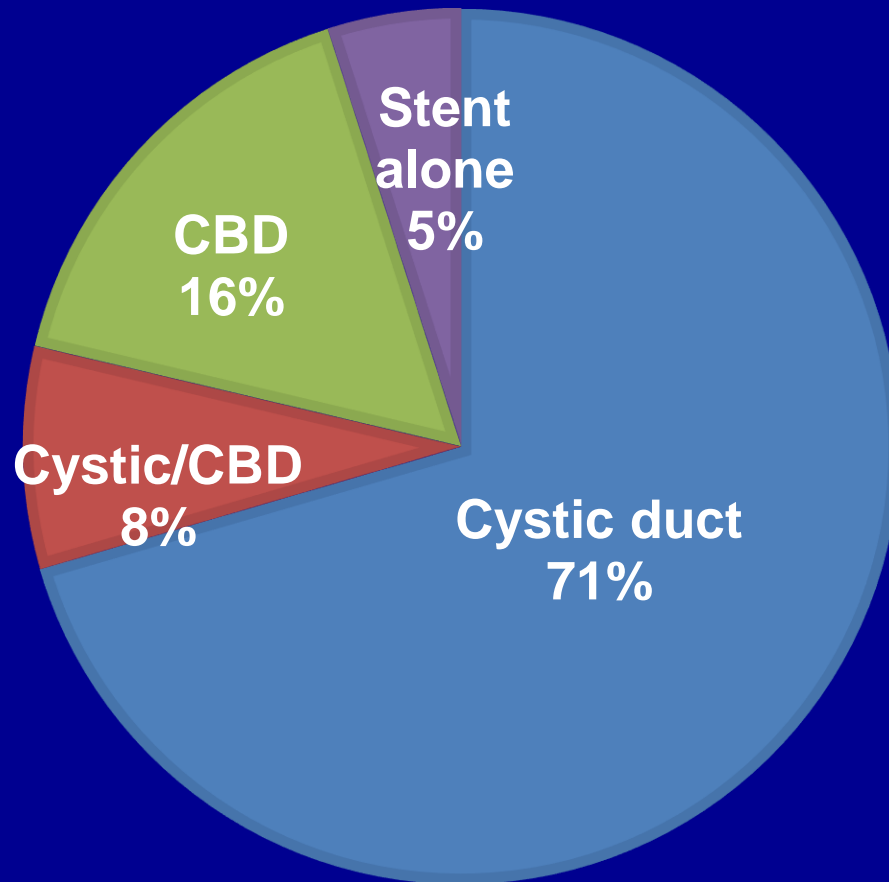
- 61 lap CBDE cases since July 2014
- Case type
 - Diagnostic (8)
 - Stent for ERCP-inaccessible stricture (1)
 - Balloon dilation for papillary stenosis(1)
 - Stones (51)
 - No clearance attempt in 3 cases (stent only)
 - Clearance attempts (n=48)
 - 100% transcholedochal alone
 - 77% transcystic (4 salvaged w TCD, 5 failed)
 - 93% after utilizing both approaches

Success

LCBDE Approach

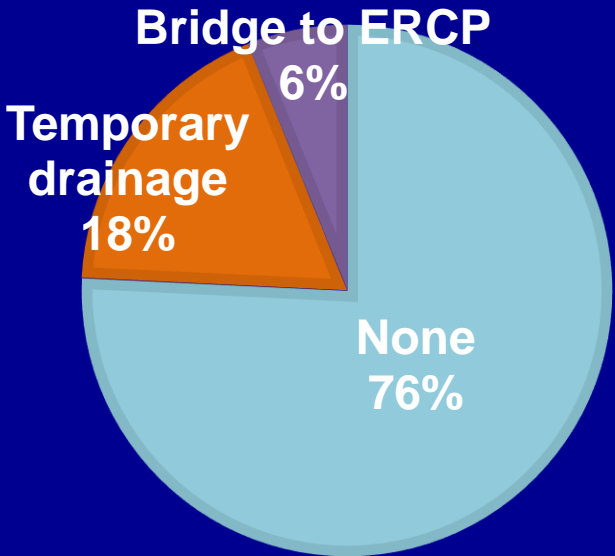
- 61 lap CBDE cases since July 2014

APPROACH

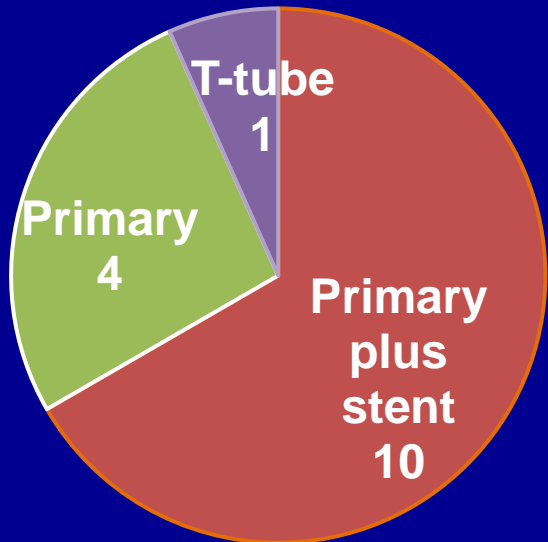


Stent use

- Transcystic cases



- Choledochotomy closures



GO CAMPING, they said



IT'LL BE FUN, they said.

LCBDE-related outcomes, n=61

- Length of hospital stay:
 - Median 2 days
- 2 Re-admissions
 - 1 bleeding → reoperation
 - 1 for pancreatitis → stent removal
- 4 Pancreatitis (mild), spontaneously resolved
- 2 Bile leak
 - cystic duct injury (from balloon), PTC and operative drainage (RYGB anatomy)
 - cystic duct stump (subtotal cholecystectomy), resolved spontaneously
- 1 Retained stones, removed with postop ERCP
- 1 Bacteremia, ascites requiring IR drain
- 1 Mortality within 30 days
 - MI at home on POD 17

Post-op ERCP utilization

- LCBDE stone cases (n=51)
 - Outpatient, elective ERCP (n=6)
 - *3 for stones with intraop stent only*
 - *2 for failed transcystic clearance*
 - 1 for stricture identified intra-op
 - Inpatient, urgent ERCP (n=2)
 - 1 for known stones, unable to stent intraop
 - 1 unplanned for retained stones
- Avoided 43 ERCPs/EUS
- Only 2 inpatient ERCPs required since 2014

The Future of LCBDE?

- Can we train a new generation of surgeons?



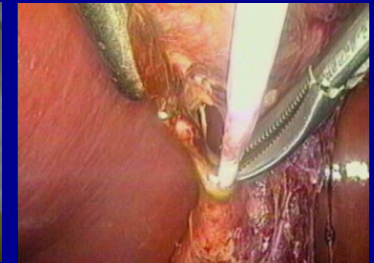
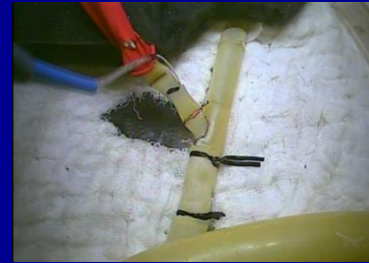
Development and evaluation of a laparoscopic common bile duct exploration simulator and procedural rating scale

Byron F. Santos · Taylor J. Reif · Nathaniel J. Soper ·
Alexander P. Nagle · Deborah M. Rooney ·
Eric S. Hungness

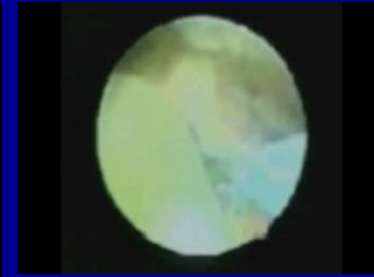
Simulator

Actual

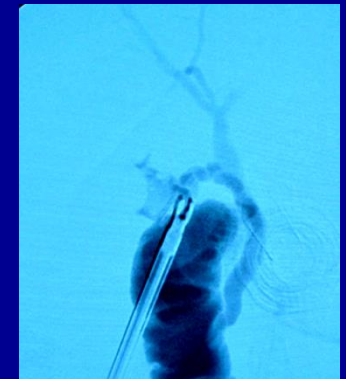
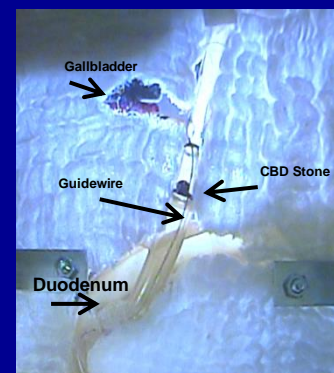
Lap



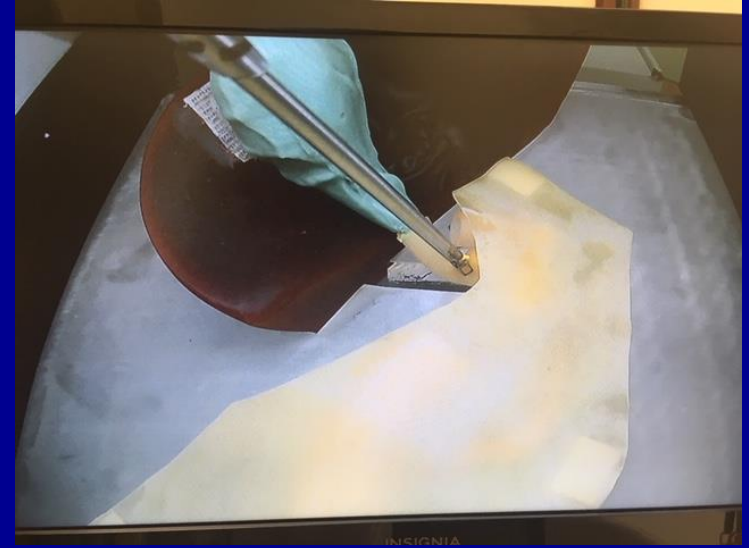
Choledochoscope



Fluoroscopic



Current Simulator (3-Dmed)



Development of LCBDE Rating Scales

Transcystic LCBDE

Item selection:

1. Initial cholangiogram
2. Approach decision
3. Use of adjuncts
4. Wire access
5. Balloon dilation
6. Choledochoscopy
7. Stone capture
8. Stone extraction
9. Closing cholangiogram
10. Cystic duct ligation
11. Fluoro efficiency
12. Scope Irrigation

Technical

0	1	2	3	4
Fail	Poor	Fair	Good	Excellent
Unable to complete (even with guidance)	Requires guidance	No guidance	No guidance	No guidance

Decision-making

0	1	2	3	4
CBD	CBD	CBD	Cystic duct	Cystic duct
Other reason	Misjudges stone location	Misjudges stone size	Delay	No delay

Quantitative

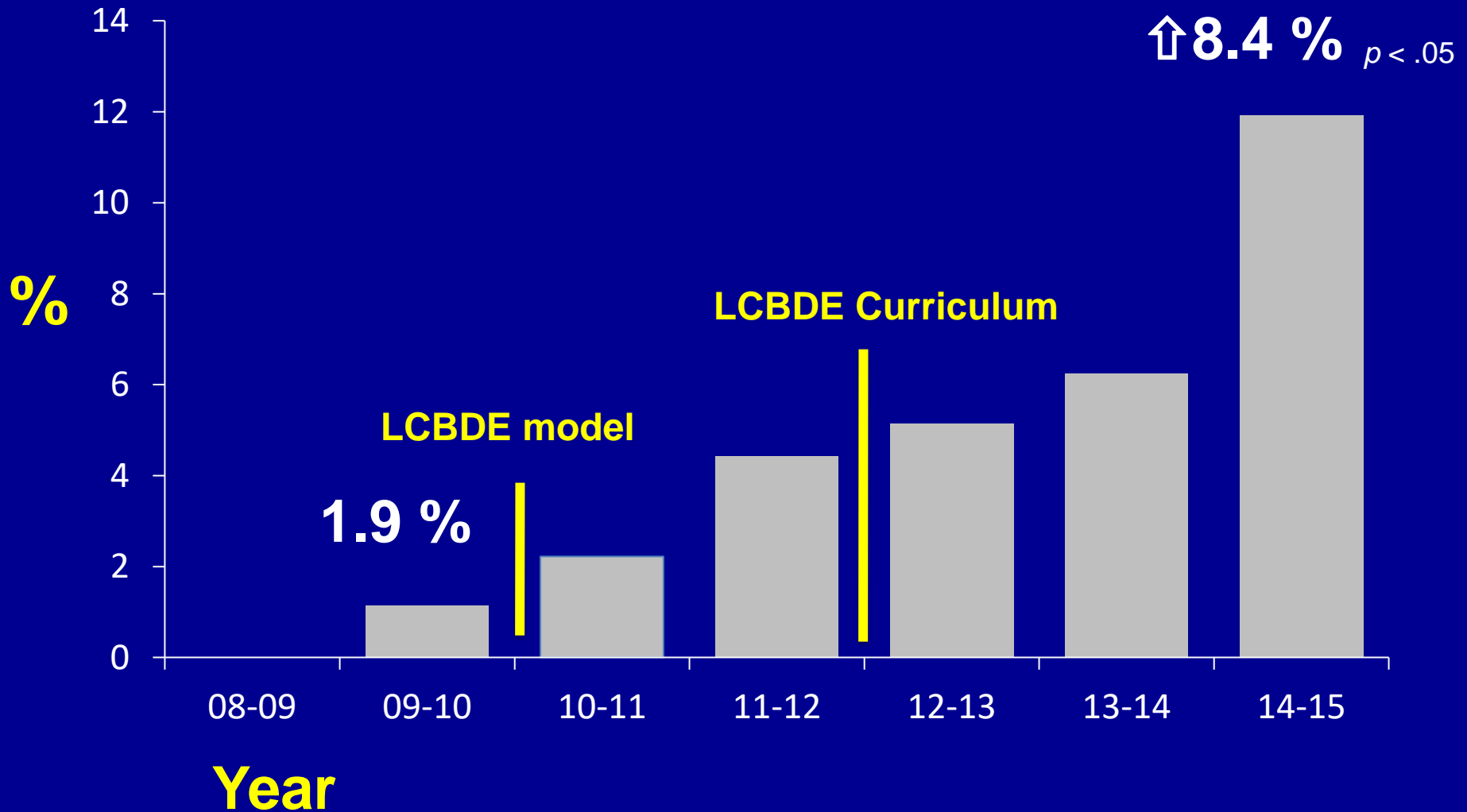
0	1	2	3	4
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A simulator-based resident curriculum for laparoscopic common bile duct exploration

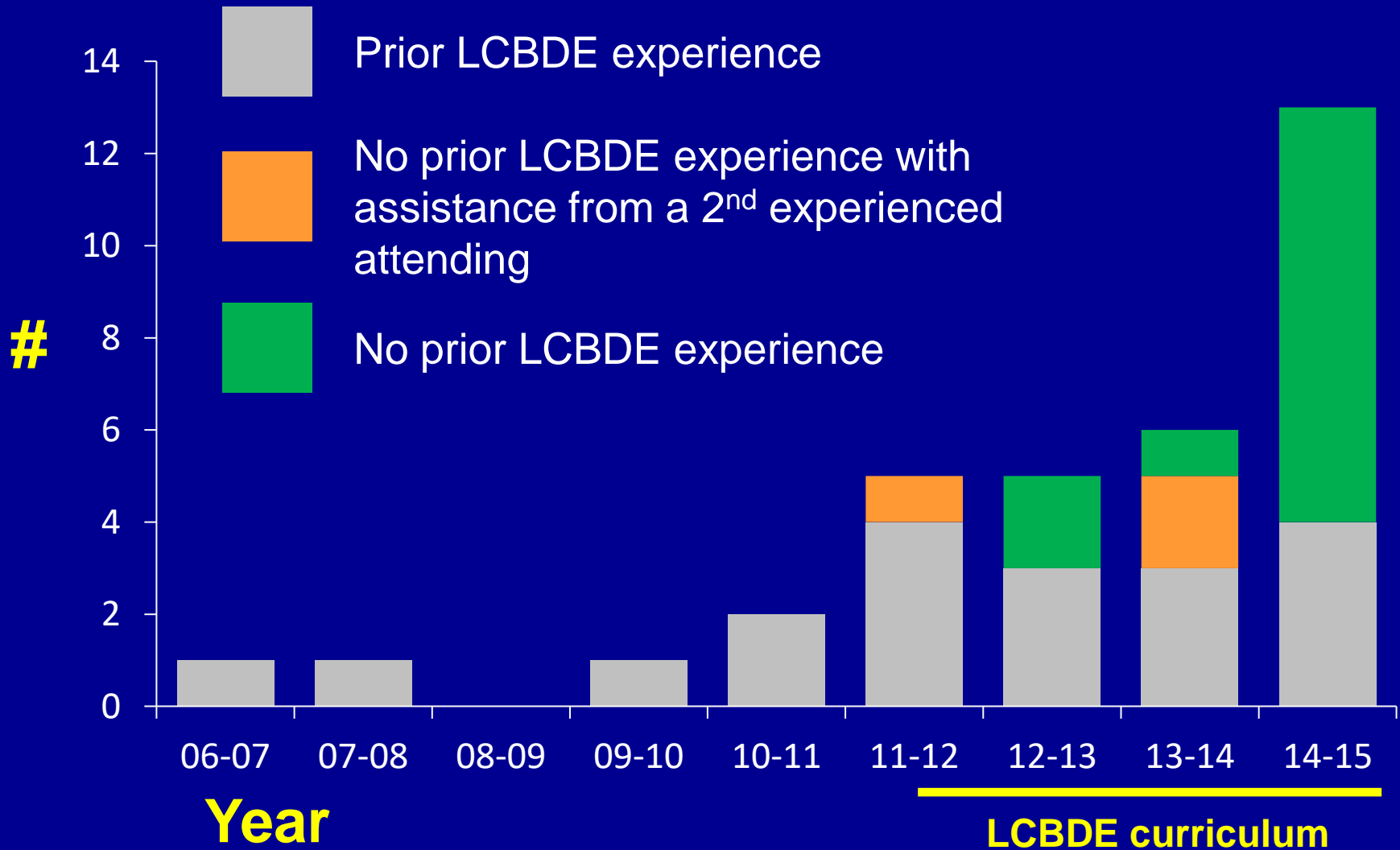
Ezra N. Teitelbaum, MD,^a Nathaniel J. Soper, MD,^a Byron F. Santos, MD,^a Deborah M. Rooney, PhD,^b Pratik Patel, BS,^a Alexander P. Nagle, MD,^a and Eric S. Hungness, MD,^a *Chicago, IL, and Ann Arbor, MI*

- Mastery-learning curriculum for PGY3-5 residents
 - Baseline testing
 - Standardized didactic material
 - Deliberate practice
 - Post-curriculum testing
 - Remediation and re-testing until “mastery” criterion met.

Percentage of CBD stones treated with LCBDE at Northwestern



Type of Attending surgeon performing LCBDE



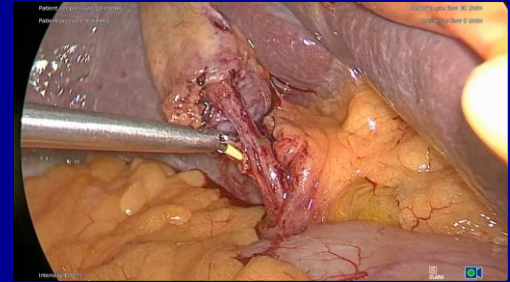
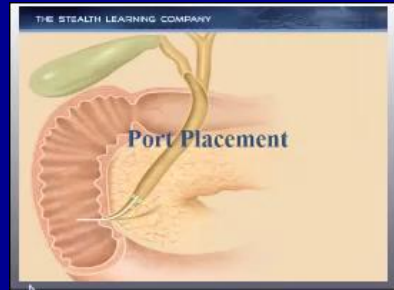
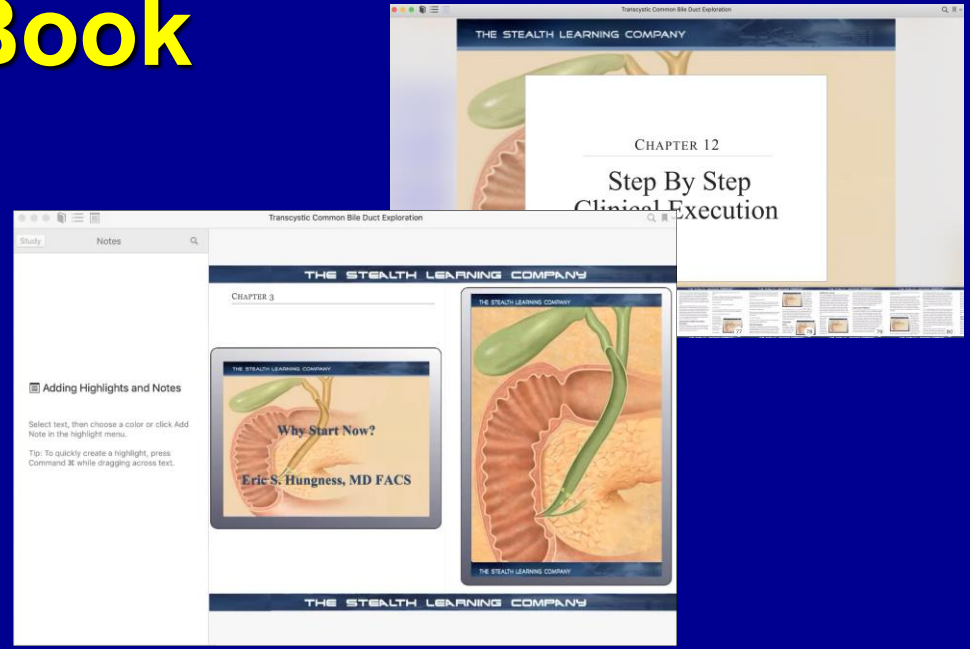
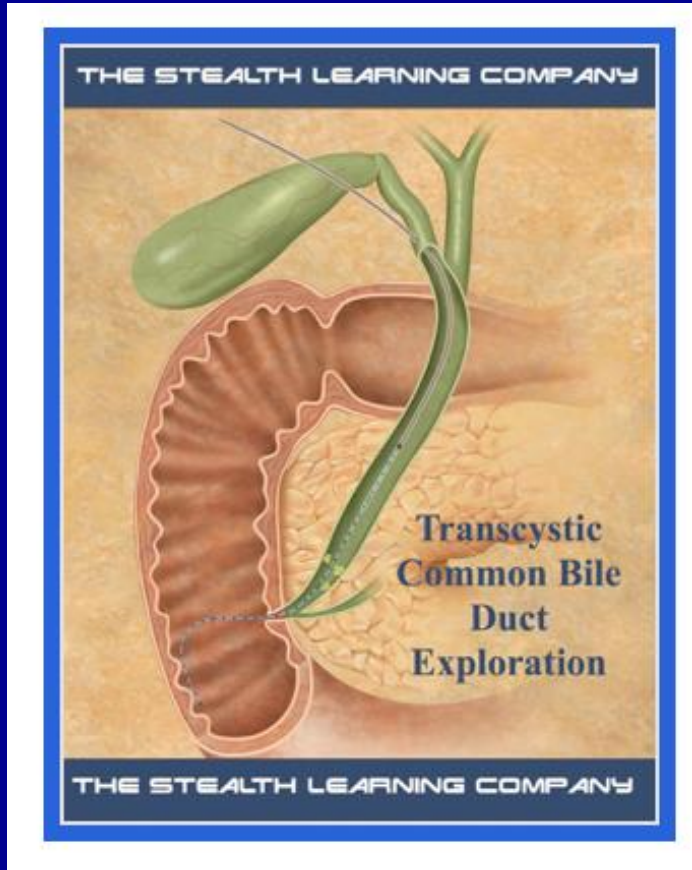
Clinical outcomes

Single-stage laparoscopic management of choledocholithiasis:
An analysis after implementation of a mastery learning resident
curriculum

Ben Schwab, MD ^a, Ezra N. Teitelbaum, MD, MEd ^{a,b}, Jeffrey H. Barsuk, MD, MS ^{b,c},
Nathaniel J. Soper, MD ^a, and Eric S. Hungness, MD ^{a,b,*}

- Simulation-based mastery learning curriculum significantly increased utilization of LCBDE
- Cost-savings compared to ERCP plus cholecystectomy
 - \$2035 cheaper for single-stage management
 - Length of stay – 2.5 days versus 4.6 days.
 - ROI for LCBDE curriculum: 3.8 to 1

iBook



**FREE Download
iTunes**

<https://itunes.apple.com/us/book/transcystic-common-bile-duct-exploration/id1447754319?mt=11>



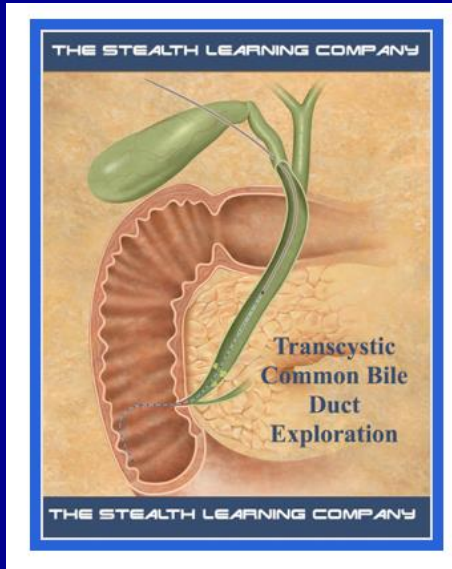
Simulation-based LCBDE Courses

- **American College of Surgeons Annual Meeting**
 - Advanced Skills Training for Rural Surgeons – Laparoscopic Common Bile Duct Exploration
- **Society of American Gastrointestinal and Endoscopic Surgeons (SAGES)**
 - Safe cholecystectomy and CBDE course
- **Veterans Affairs Surgeons Course – in development**
- **Industry courses - Cook Medical**

In Summary

- LCBDE is an effective and safe alternative to ERCP, with shorter LOS and lower costs.
- Embrace CBD stones, and in most cases you can learn to manage yourself.
- LCBDE is easier to learn now than ever:
 - Better technology, instruments
 - Simulation/online resources
 - Surgeons are now better prepared in advanced lap, endo, fluoro, and video games compared to their predecessors

Thank you



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