Laparoscopic CBD Exploration

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INTRODUCTION

Laparoscopic exploration of the common bile duct (CBD) is performed either for the diagnosis or the treatment of CBD stones. CBD stones demonstrated by laparoscopic intraoperative cholangiography (IOC) or laparoscopic ultrasonography (LUS) are extracted either through the cystic duct or through choledochotomy. An alternative for the treatment of CBD stones is to perform an endoscopic sphincterotomy either before, during, or after laparoscopic cholecystectomy.

The main advantages of IOC during cholecystectomy are:

- Detection of CBD stone
- Reduction of the incidence of residual CBD stone
- Delineation of the biliary anatomical variations at risk for bile duct injury

Intraoperative cholangiogram is a highly sensitive tool for detecting choledocholithiasis, with an overall accuracy of 95%. Routine IOC can diagnose unsuspected CBD stone in 1–14% (average 5%) of patients without indications for ductal exploration.

INTRAOPERATIVE CHOLANGIOGRAPHY

Techniques of Cholangiography

Cholangiograms obtained during laparoscopy are usually performed after catheterization of the cystic duct through a cholangioclamp (Storz Endoscopy, USA), or inserting a catheter through a hollow gasketed needle pinned through the abdominal wall along the right subcostal margin. Difficulties in catheterization of the small cystic duct have led to consider cholecystocholangiography by direct puncture of the gallbladder as an alternative to cystic duct cholangiography. Cystic duct cholangiography is clearly better than cholecystocholangiography, and fluoroscopic imaging should be the standard for IOC. Until now, no specific clinically significant complications directly attributable to laparoscopic IOC have been reported.

Expected success rates for laparoscopic IOC are in a 90–100% range. Inability to cannulate a narrow cystic duct is the main cause of failure. When performed after clipping (but not cutting), the anatomical structures identified by careful dissection such as the cystic artery and the cystic duct, a correctly interpreted IOC allows the detection of the most frequently reported cause of CBD injury, i.e., mistaken identification of a narrow main bile duct in place of the cystic duct.

LAPAROSCOPIC ULTRASONOGRAPHY

Several studies on LUS have been published and conclusions of these studies favor LUS as compared to IOC. LUS is performed with a higher success rate, in less time, with better specificity, but with less precision with regard to the delineation of biliary tree anatomy. LUS is of little, if any, helps in the diagnosis or prevention of bile duct injuries. While detection of smaller stones by LUS should increase its sensitivity, most of these stones are reputed to be flushed out through the sphincter and therefore the question arises if such small stones require any treatment at all. Specificity of LUS is higher (less false positives) than of IOC. When IOC and LUS were combined, there is chance of less than 1% of false positives. The question that comes to mind is whether LUS should be a screening test, and IOC performed only in case of doubt or should IOC be the screening test, and LUS used only when IOC is of doubtful value? IOC performs better than LUS to delineate the entire biliary tree, from the intrahepatic tree to the pancreatic portion of the CBD. Injection of saline into the biliary tree enhanced the images obtained by LUS, especially in the distal portion of the bile duct.

Criteria for Routine Intraoperative Cholangiography

Preoperative Factors

- Failed endoscopic retrograde cholangiography ± sphincterotomy
- Ultrasonographic findings
- CBD size (>6 mm)
- Choledocholithiasis
- History of jaundice or pancreatitis
- Elevated bilirubin, alkaline phosphatase, and transaminases

Intraoperative Factors

- Unclear anatomy
- Conversion to open cholecystectomy
- Dilated cystic duct over 4 mm

LAPAROSCOPIC EXTRACTION OF COMMON BILE DUCT STONES

Once detected during laparoscopic IOC, laparoscopic extraction of CBD stones is a logical extension of the procedure. Laparoscopic exploration of the CBD can be performed either through the cystic duct or by laparoscopic choledochotomy. A critical evaluation of the retrospective and prospective series on laparoscopic CBD exploration published since 1989 shows that both procedures are feasible and safe. Any comparisons between the two techniques would be fallacious because of their obviously different indications. Nonetheless, whenever feasible, laparoscopic transcystic CBD exploration best fulfills the expectancy of mini-invasive approach. Laparoscopic management of CBD stones is considered as technically difficult and demanding, requiring advanced laparoscopic skills as well as expensive endoscopic and radiological equipment. Endoscopic sphincterotomy is commonly proposed preoperatively as the alternative to surgery for CBD stones. Endoscopic sphincterotomy is indicated in patients with severe cholangitis for urgent drainage of infected bile, and in patients with retained stones after cholecystectomy. In open conventional surgery, controlled studies have not shown that ES, performed prior to surgery in patients with CBD stones in situ, was superior to single-step surgical management.

In case of preoperative diagnosis of CBD stone, options for management include:

- Preoperative endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic sphincterotomy followed by laparoscopic cholecystectomy
- Conventional open CBD exploration
- Laparoscopic CBD exploration

Today, most of the laparoscopic surgeons prefer the "single-stage" laparoscopic approach to choledocholithiasis. None of the randomized trials published to date concluded superiority of endoscopic treatment alone or associated with surgery as compared to first-line surgical treatment. Immediate postoperative mortality was 2.6% in the endoscopic group as opposed to 1% in the surgical group. In global analysis, the rate of major and minor complications were respectively 8% and 10% after endoscopy followed by surgery, and 8% and 15% after surgery alone.

Study of European Association for Endoscopic Surgery (Table 1)

Choledocholithiasis is found in approximately 10–20% of patients who undergo open cholecystectomies. In the era of laparoscopic cholecystectomies, the prevalence of CBD stones averages 6% (range: 3–10%). The incidence of choledocholithiasis increases over the age of 60 years. To achieve a maximal benefit to risk ratio, radiological investigations of the CBD should be restricted to patients with high suspicion of CBD stones, as determined by preoperative predictive scoring.

TABLE 1: Study of European Association for Endoscopic Surgery (EAES).

	LCBDE	*(ERC ± ES) + LC*	*p*
Patients (N)	133	136	
With CBD	109 (82%)	99 (73%)	
Failed ERCP ± ES		23 (17%)	
Stone clearance		82/98 (84%)	NS
Successful LCBDE	92/109 (84%)	12/17 (71%)	
Conversions	14 (13%)	5 (5%)	NS
Postoperative ES	3		
Complications	21/133	17/136	NS
Deaths	0	2	
Hospital stay (range)	6.4 (4.2–12)	9 (5.5–14)	<0.05

(ES: endoscopic sphincterotomy; LC: laparoscopic cholecystectomy; ERCP: endoscopic retrograde cholangiopancreaticography; LCBDE: laparoscopic common bile duct exploration; NS: nonsignificant)

Diagnostic and therapeutic choices in cholelithiasis must be considered conjointly. Data gathered from randomized trials have demonstrated that endoscopic sphincterotomy, as an additional procedure to surgery, does not improve the clinical results in patients fit for primary single-stage surgical treatment, whether performed laparoscopically or not. Discussions regarding the optimal way to treat patients with demonstrated CBD stones could lead to endless debate. Due to marginal differences between the endoscopic and surgical techniques, the number of patients needed to show any significant difference in terms of morbidity, mortality, or clearance rates would be enormous and therefore unrealistic. Cholangitis, jaundice, and CBD stones, as demonstrated on percutaneous ultrasonography, are the only reliable preoperative indicators available with predictive value of CBD stones better than 50%. Severe cholangitis is an unquestionable indication for urgent endoscopic drainage, regardless of whether the CBD can be cleared of associated stones or not. The notorious insufficiencies of all other preoperative indicators for CBD stones should lead to a requiem for preoperative invasive diagnostic procedures, both in terms of risk, benefits, and costs.

Laparoscopic common bile duct exploration (LCBDE) can be performed via the cystic duct (transcystic approach) or an incision in the CBD (choledochotomy approach). In general, small distal stones are best suited for transcystic removal, while large or proximal stones may require a

choledochotomy approach. All surgeons undertaking laparoscopic cholecystectomy must be able to perform an IOC. When IOC demonstrates CBD stones, appropriate treatment is decided according to available equipment and skills. Transcystic clearance of CBD stones is successful in at least two of three patients. In case of large (>20 mm) stones or other potential difficulties as regards postoperative endoscopic sphincterotomy such as a periampullary diverticulum, conversion to open surgery is indicated in case of failed laparoscopic CBD exploration. In the other cases, the available data do not allow any formal conclusions regarding the alternative between advanced laparoscopic biliary explorations and postoperative endoscopic sphincterotomy. The potential risk of reoperation in case of failed postoperative endoscopic sphincterotomy might be more theoretical than practical. In one decision analysis, assessing different approaches to using ERC in patients undergoing laparoscopic cholecystectomy, postoperative ERC was associated with less costs and morbidity, but laparoscopic CBD exploration was not considered in the study design. Last, before embarking on a more invasive laparoscopic CBD exploration policy for small stones, irretrievable by the transcystic approach, surgeons must remember that asymptomatic migration does exist, even if the definitive fate of small CBD stones remains unknown at the present time. The potential security afforded by temporary biliary drainage still has to be balanced with its unavoidable morbidity.

PROCEDURE

Patient Position

Patient is operated in the supine position with a steep head-up and left tilt. This typical positioning of laparoscopic choledochotomy should be achieved once the pneumoperitoneum has been established **(Fig. 1)**.

Port Position

The standard four-port configuration for laparoscopic cholecystectomy is used. A fifth port should be used later between the right midclavicular and epigastric port just below the subcostal margin for inserting the choledochoscope.

Fig. 1: Patient position for laparoscopic choledochotomy.

The fundus of the gallbladder should be retracted toward the right shoulder and the Hartmann's pouch should be retracted anterolaterally toward right anterior–superior iliac spine. Dissection began onto the neck of the gallbladder and continued proximally until the junction of gallbladder with the cystic duct is clearly defined. Dissection should be continued proximally onto the cystic duct until there was adequate length to perform cholangiogram.

Cystic duct should be milked toward the gallbladder to dislodge any cystic duct stone into the gallbladder. Single titanium clip should be applied on the gallbladder side of cystic duct to prevent any back slippage of gallstone into the CBD and to prevent biliary spillage into the operative field.

A small nick in the cystic duct should be given with the help of hook scissors or microscissors. Intraoperative cholangiogram should be performed using a ureteric catheter (4–5 Fr) or an infant feeding tube (no. 5–6), which is passed through the cystic duct into the CBD. After the insertion of the catheter, a titanium clip should be applied loosely to prevent any back leakage of the contrast medium. Digital C-arm fluoroscopy provided the real-time imaging of the biliary tree. In cases where the cystic duct could not be cannulated, contrast was directly injected into the CBD through a 24-Fr lumbar puncture needle percutaneously.

On cholangiogram, surgeon must look for any filling defect—its size, site, number of bile duct stones, and free passage of contrast into the duodenum and for any anatomical variation of the biliary tree.

Transcystic or transcholedochal approach to remove CBD stones should be decided on the following factors **(Table 2)**.

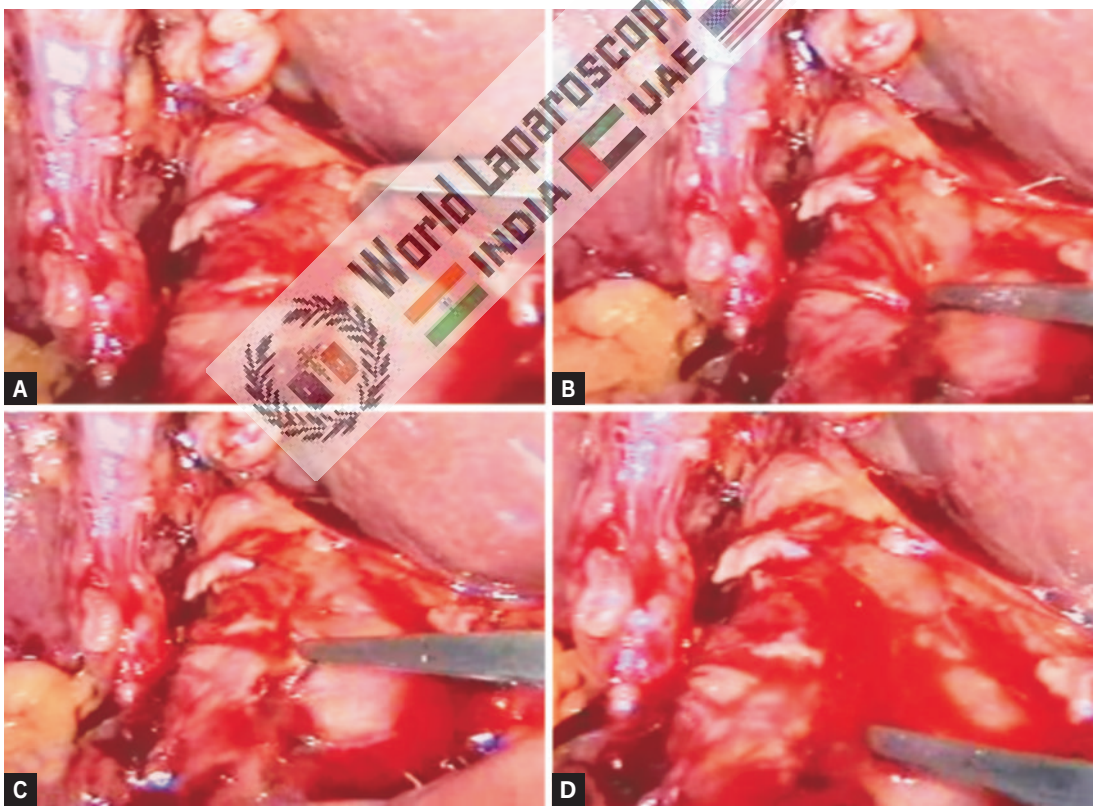
Common bile duct stone should be extracted with the help of Dormia basket/balloon catheter, irrigation/suctioning, or by simply manipulating bile duct using blunt forceps. After retrieving the stones, the cystic duct stump was closed with clips or extracorporeal knots and the gallbladder was removed in the usual manner.

For transcholedochal exploration after opening up of the Calot's triangle, the anterior surface of the CBD should be dissected carefully and choledochotomy should be performed by a longitudinal incision with the help of endoscopic knife just below the insertion of the cystic duct into the bile duct **(Figs. 2A to D)**. Before giving incision with knife, mild coagulation of serosal surface of CBD can help in preventing oozing **(Figs. 3A to D)**. The single large stone can be retrieved by spontaneous evacuation while incising the bile duct, blunt instrumental pressure with atraumatic forceps can facilitate its easy removal **(Figs. 4A to D)**.

In case of multiple stones Dormia basket, Fogarty balloon catheter or irrigation and suction can be used to remove the stone **(Figs. 5 and 6)**.

TABLE 2: Transcystic versus transcholedochal approach for removal of common bile duct (CBD) stone.

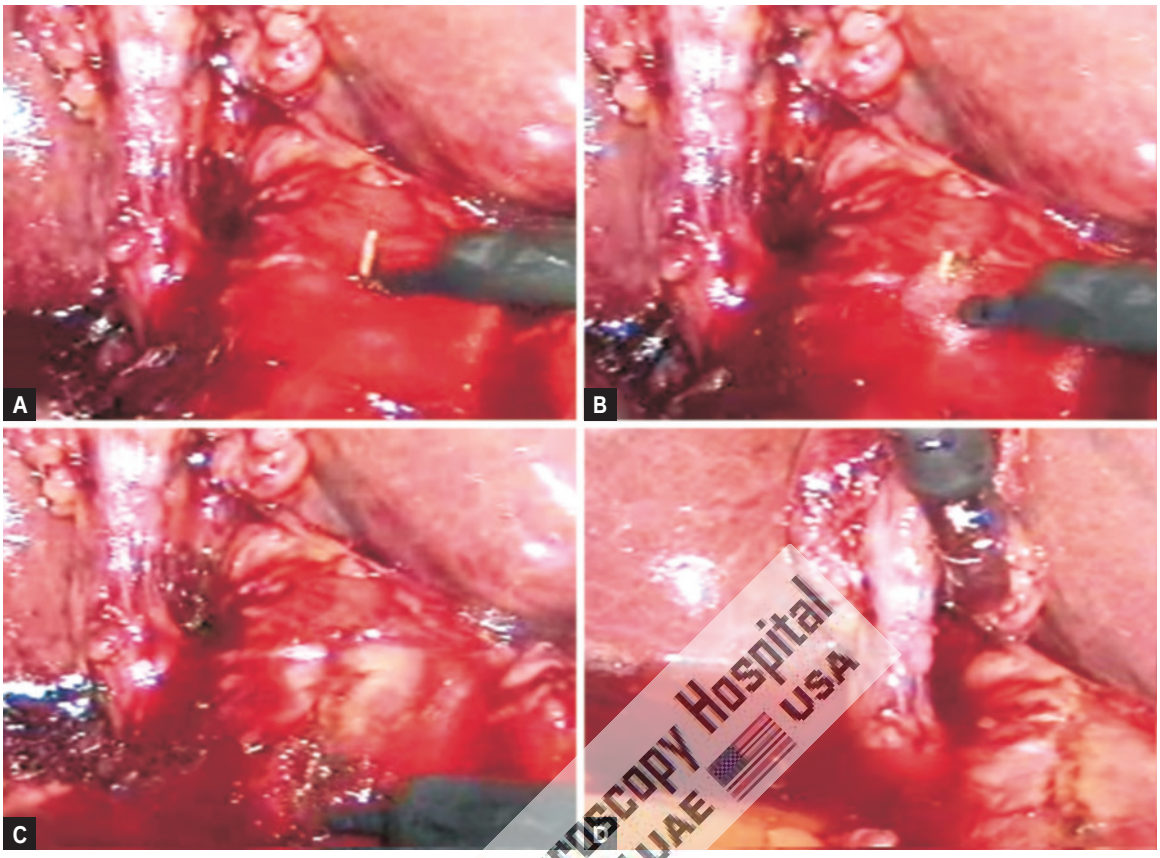
Criteria	*Findings*		*Transcystic approach*	*Transcholedochal approach*	*Any of these approach*
Diameter of cystic duct	<3 mm			Recommended	
Diameter of cystic duct	>3 mm		Recommended	Recommended	Recommended
CBD diameter	<7 mm		Recommended		
CBD diameter	>7 mm		Recommended	Recommended	Recommended
Large stone (>6 mm)				Recommended	
Number of stone	<4		Recommended	Recommended	Recommended
Number of stone	>4			Recommended	
Stone location	Proximal			Recommended	
Stone location	Distal				Recommended
Junction of cystic duct with CBD	Right lateral				Recommended
Junction of cystic duct with CBD	Left lateral or	posterior		Recommended	
Stone impacted in ampulla	Yes				Recommended
Severe inflammation of CBD	Yes		Recommended		
Laparoscopic suturing	Good				Recommended



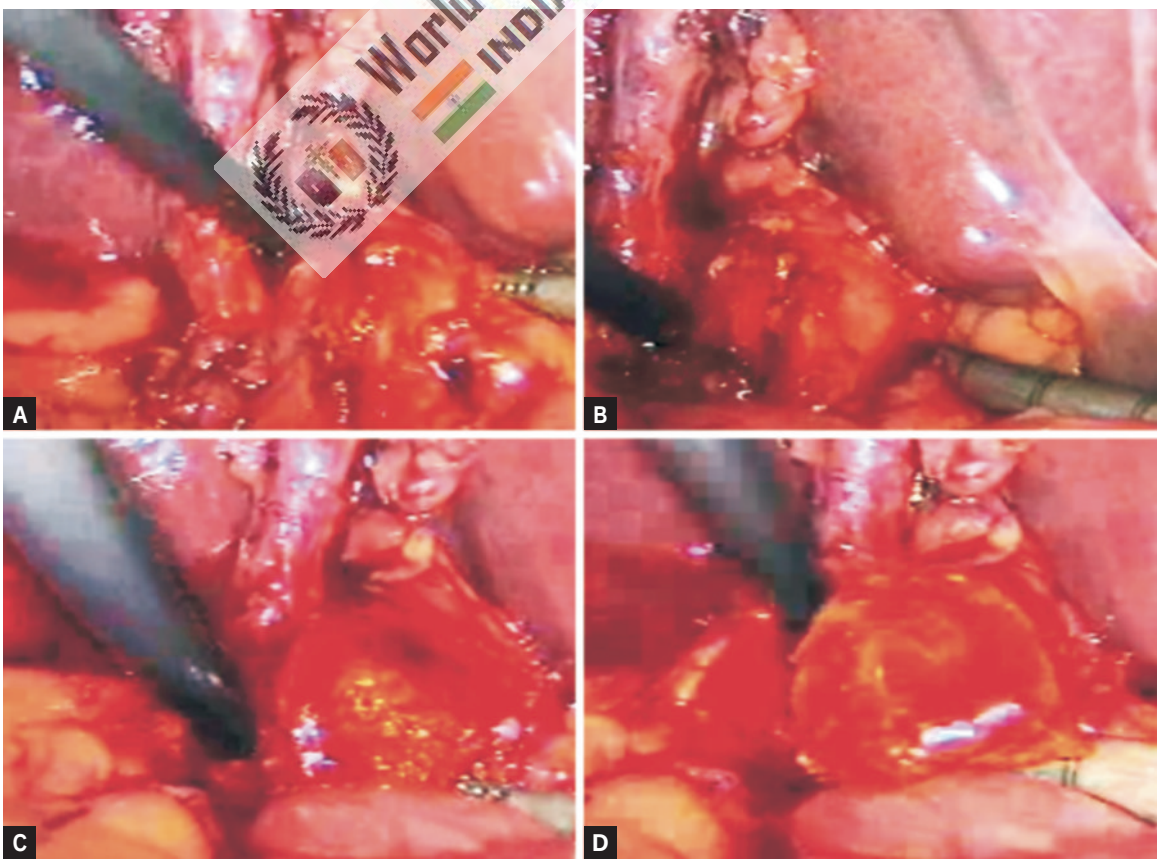
Figs. 2A to D: Endo-knife used to explore common bile duct (CBD).

Completion cholangiography or choledochoscopy must be performed to assess any remaining stone. Some surgeons use 5.5-Fr bronchoscope for this purpose but ideally choledochoscope will give more flexibility.

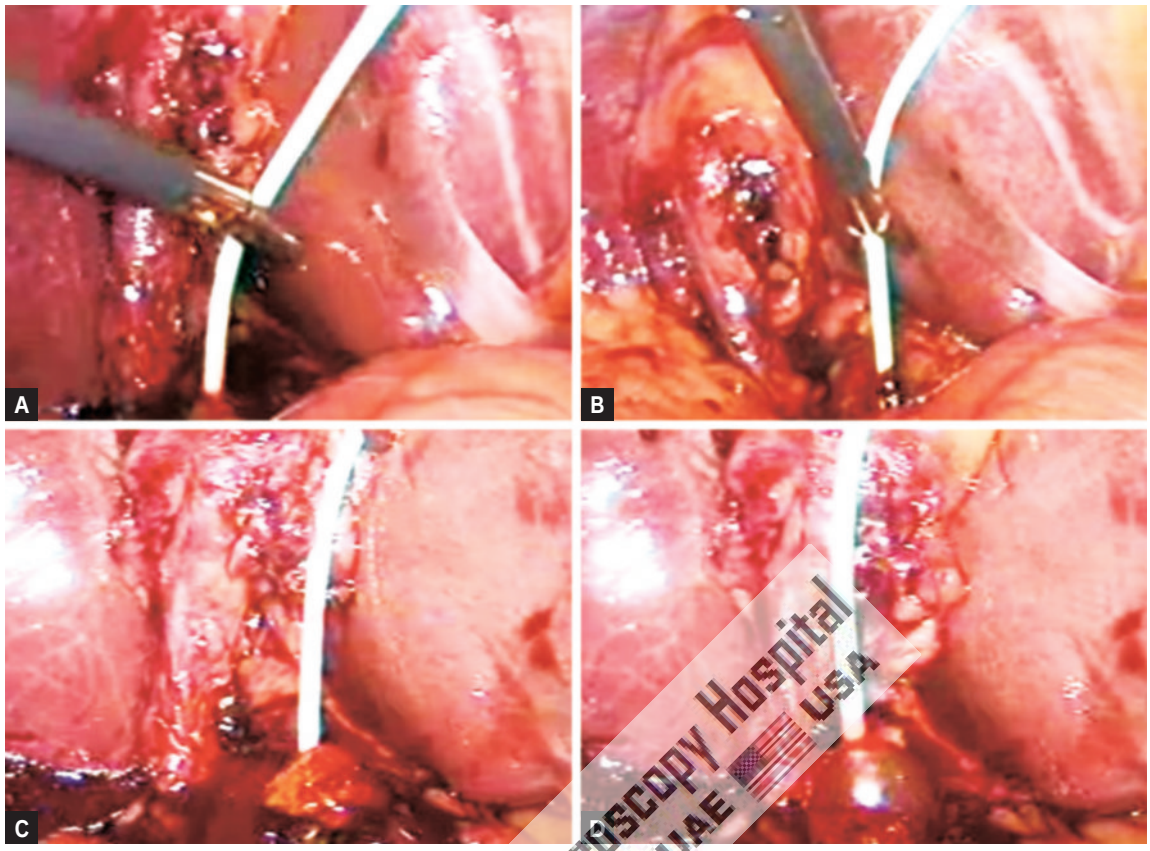
Once all the stone is removed, choledochotomy should be closed over a T-tube with interrupted Vicryl suture **(Figs. 7 to 9)**. In case of single stone, primary closure of CBD after assessing the clearance of the CBD can be tried. After bile duct closure, cholecystectomy should be performed in the usual manner. An intrahepatic nasogastric tube drain should be used routinely in this surgery, which is usually removed on days 3–4 as the output decreased below 30 mL/day.



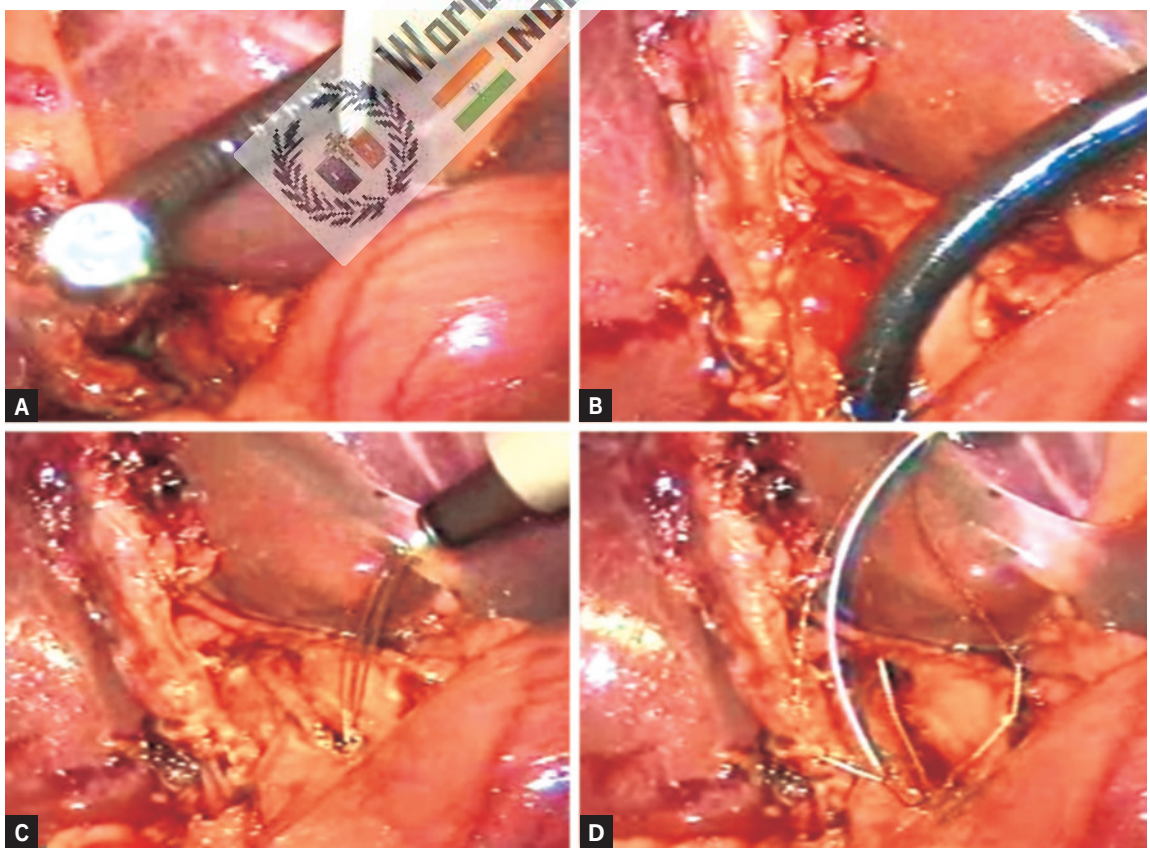
Figs. 3A to D: Mild coagulation current applied over serosal surface of common bile duct.



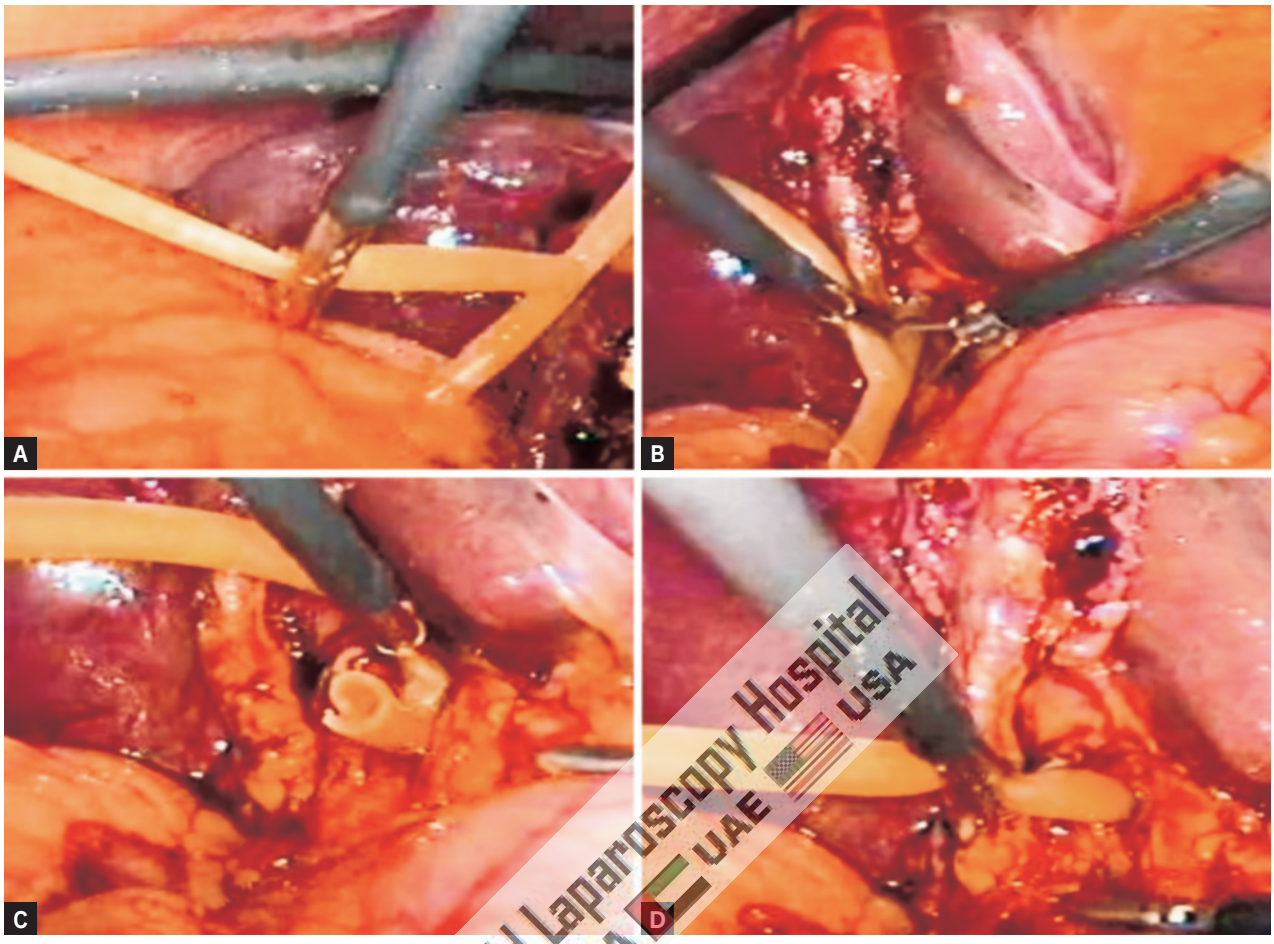
Figs. 4A to D: Bigger single stone can be extracted by milking.



Figs. 5A to D: Fogarty catheter used to extract stone.



Figs. 6A to D: Choledochoscope with Dormia basket is used to extract stone.



Figs. 7A to D: Introduction of T-tube.

T-tube Management

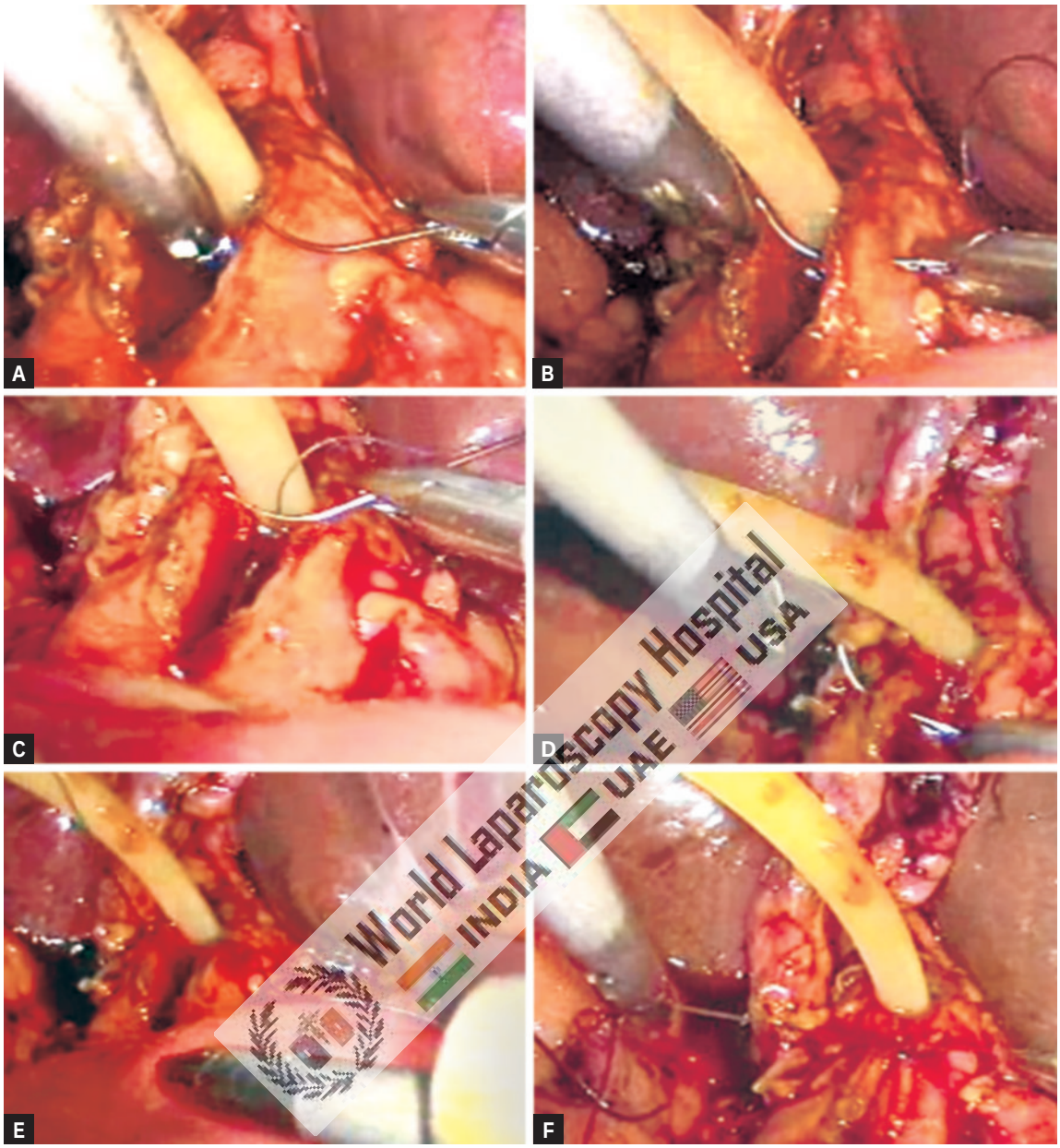
If a T-tube has been placed, a T-tube cholangiogram is performed 24–48 hours postoperatively. If the initial T-tube cholangiogram shows biliary obstruction or retained stones, the T-tube is left open for 1–2 weeks. If a repeat T-tube cholangiogram shows persistent stone or biliary obstruction, ERCP or interventional radiologic procedure via the T-tube is required to clear the duct. A normal T-tube cholangiogram and liver function tests (LFTs) should be ascertained prior to T-tube removal. In patients with a T-tube, the drain should be kept until a T-tube cholangiogram shows no biliary leak or stenosis. In patients without a T-tube, the drain may be removed after LFTs normalize without bilious drain output; alternatively, an HIDA scan can also be obtained to access the biliary anatomy prior to drain removal.

COMPLICATIONS

Common complications after laparoscopic exploration are:

- Bile duct leak
- Persistent stones
- Impacted stones
- Bile duct stricture
- Pancreatitis

Most of the complications are same as found in open CBD exploration. Bile may leak from the cystic duct orifice, cystic duct-CBD junction, or the CBD itself. It occurs in 2–16% of cases. Stones persist in the CBD in 0–5% of patients after surgical CBD exploration. Rarely, severely impacted stones are encountered. Strictures of the bile duct are a long-term complication of CBD exploration that occurs in 0–0.8% of cases. Impacted stones are difficult to remove with Fogarty balloon catheters or wire baskets. Pancreatitis occurs in 0–3% of patients following CBD exploration due to reflux of contrast into the pancreatic duct or ampullary obstruction by stones, edema, or blood clots. In the latter case, ERCP may be required to relieve the obstruction. According to data from the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database, laparoscopic CBD exploration has significantly lower mortality (0.25 vs. 5.5%), surgical site infection rate (1.2 vs. 10%), and overall morbidity rate (3.7 vs. 22%) compared with open CBD exploration. However, the increased morbidity and mortality associated with open exploration may be a reflection of underlying comorbidities or more complicated disease requiring an open approach.



Figs. 8A to F: T-tube is fixed with intracorporeal interrupted surgeons knot.

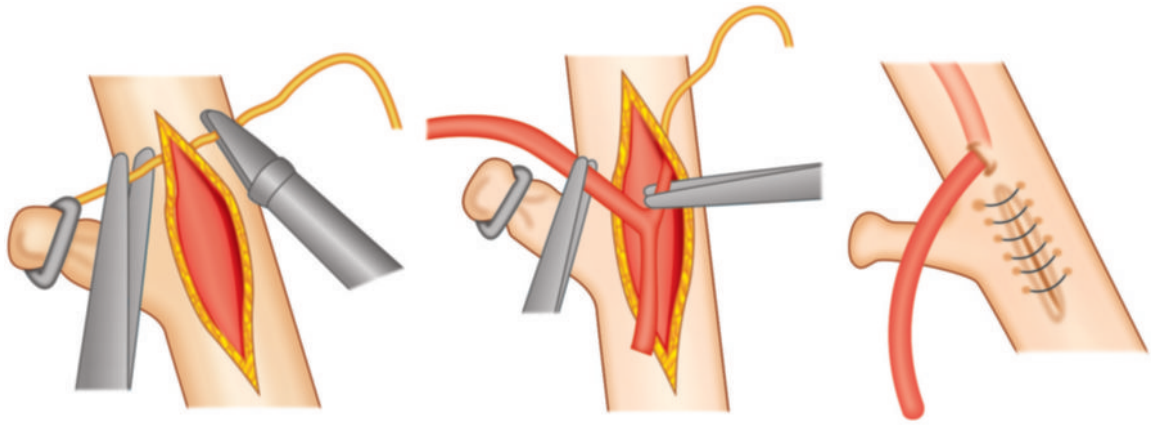


Fig. 9: Diagrammatic representation of T-tube fixation with intracorporeal interrupted surgeons knot.

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