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**Safe Cholecystectomy
A-to-Z**

V K Kapoor

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Safe Cholecystectomy A-to-Z

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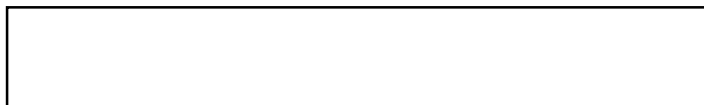
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To

My teacher and trainer

Prof L K Sharma

**Formerly Head of the Department of Surgery
All India Institute of Medical Sciences (AIIMS)**

New Delhi, INDIA

**who taught me
the principles and techniques of
'Safe Surgery'**

and

**my students and trainees,
who are spreading my message of
'Safe Cholecystectomy'
all over the country,
and even abroad.**

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Foreword

What a **clever** book, Safe Cholecystectomy A to Z!

The art of education requires that the teacher engages the attention **and** the imagination of the student. This is not easy to do when writing about cholecystectomy, a subject so familiar, so thoroughly studied by surgeons. The reader is prepared to be “bored to tears” by such a book. What new could possibly be said to engage the reader?



At first blush this assumption is correct. There is nothing strikingly new here. Nonetheless, the alphabetical arrangement of anatomy, pathology, technique and complications keeps the reader bouncing from one subject to another quite rapidly. It is hard to get bored when you move from “Oral dissolution therapy” to “Overconfidence” in three sentences. Some of the entries are pretty rudimentary, but necessary, such as the definition of the cystic duct. Some entries are the succinct summary of knowledge gained from long study and keen observation. Take the entry “Removal”, for example. One might imagine a description of how to remove the gallbladder from the abdomen. Not so. Instead there is a list of when one should remove a subhepatic drain for all the reasons one might place one. What a gem! How many medical students and interns have fallen afoul of their professors by removing a gallbladder drain on the wrong day? It won’t happen after reading this short entry on page 96. (If you are now nervous that this book won’t tell you how to remove the gallbladder, you can find this information under “Extraction” on page 57).

There is another dimension to this book: Sprinkled amongst anatomic and physiological concerns is much wisdom manifest as platitudes, aphorisms, concepts, warnings, and philosophy. What could be listed under “Doubt” or “Panic” or “Retreat”? I won’t spoil the fun. Go look them up. They are listed alphabetically. Some concepts and platitudes are listed several times in several different places. If you read this book cover to cover, you might find this a bit distressing, but like all good education, repetition has its value.

This short book is perfectly suited for the short attention span of modern life. By providing “thought bites”, the reader can chew on as many or as few of the ideas as he or she wishes. The problem is this: The “thought bites” are like potato chips (I think you call them crisps in India). No one can eat just one. In fact, I ate the whole bag. Dig in. You will be licking your fingers when you get to “XGC” the last entry.

My only disappointment was that there were no entries under Y and Z. My imagination was truly engaged, and I was searching for a Z word for Professor Kapoor. Let me suggest one : “**Zero** : The number of important topics in safe cholecystectomy **not** covered by this book” .



John G Hunter, MD FACS

Chair of Surgery

Oregon Health & Science University (OHSU)

Editor, World Journal of Surgery

Portland OR USA

February 16, 2010

Preface

Gall stone disease (GSD) is common all over the world. Laparoscopic cholecystectomy (LC), introduced in the late 1980s, has become the ‘Gold Standard’ of management of symptomatic GSD – albeit without going through the rigorous test of prospective randomized controlled trials. More and more cholecystectomies are being performed after the introduction of LC, as the thresholds for both offering and accepting cholecystectomy have gone down. In the USA (population 300 million), about 750,000 cholecystectomies are performed every year. Presuming the same prevalence rate of GSD, about 2,500,000 cholecystectomies will be indicated in India (population 1,000 million). In northern India, in fact, GSD is very common (more common than in some of the western countries) and starts at a younger age.

Every general surgeon is expected to perform cholecystectomy. Almost all patients with GSD today want and demand LC. Majority of patients undergoing cholecystectomy for GSD are young (more commonly women), otherwise healthy and in the productive years of their lives. It is, therefore, imperative and important that a safe cholecystectomy is performed.

I have penned down the thoughts that come to my mind and sentences that I often (and repeatedly) speak to my trainees when I perform/ assist my young colleagues during cholecystectomy, with the hope that these may help my general surgical colleagues to perform a safe and successful cholecystectomy. My efforts will be rewarded if, after reading this book, even one cholecystectomy is prevented from becoming unsafe for the patient.

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NB Issues related to Bile Duct Injury (BDI) and Gall Bladder Cancer (GBC) have been addressed by me in two separate publications.

Acknowledgements

The idea of 'Safe Cholecystectomy A-to-Z' was conceived by the Author many years ago but he could find time to pen the first draft when he was at the Oregon Health & Science University (OHSU), Portland OR USA on a Fulbright Fellowship in 2008.

The Author is grateful to his faculty colleagues SP Kaushik, Rajan Saxena, SS Sikora, Ashok Kumar, Sujoy Pal, Anu Behari, RK Singh, Anand Prakash and Biju Pottakkat for contributing to the huge departmental experience with laparoscopic cholecystectomy from which the Author has learnt and has described the techniques of safe cholecystectomy.

Acknowledgements are due to Ms Varsha Yadav for typing the manuscript.

Abbreviations

BDI	Bile duct injury
CBD	Common bile duct
CHD	Common hepatic duct
CT	Computed tomography
ERC	Endoscopic retrograde cholangiography
GB	Gall bladder
LC	Laparoscopic cholecystectomy
LFT	Liver function tests
LHD	Left hepatic duct
MRC	Magnetic resonance cholangiography
OC	Open cholecystectomy
RHA	Right hepatic artery
RHD	Right hepatic duct
US	Ultrasonography

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SGPGIMS 1989 - 2010

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Tips for Safe Cholecystectomy

- Adequate formal training in minimal invasive surgery, preferably during post graduation or alternatively as an observer but not merely by attending workshops over weekends
- Proper selection of initial cases - thin built female patient with short history of biliary colics only, no history of acute cholecystitis, thin walled distended gall bladder on ultrasound
- Proper informed consent (including chances of conversion and higher risk of bile duct injury)
- Good quality equipment and instruments
- Proper cleaning and sterilisation of instruments
- A qualified and trained surgeon as the first assistant
- Urinary bladder evacuated just before anaesthesia and surgery
- General anaesthesia
- Open insertion of first canula
- 30° telescope
- All instruments must be introduced, operated and removed under vision
- Fundus retracted upwards towards right shoulder
- Gall bladder neck retracted down and out
- Remember that every patient has his/ her own biliary and vascular anatomy in the Calot's triangle
- Cystic lymph node is an important landmark – keep to its right
- No cautery in Calot's triangle – it should be used in gall bladder bed only
- Suction canula is a good instrument for blunt dissection
- Hug the gall bladder, not the bile duct
- Clipping of the cystic duct flush with the common bile duct is not required
- It is safer to leave a few mm of cystic duct than to encroach even 1 mm on the common bile duct
- Double clips on the retained side of the cystic duct and cystic artery
- Ligature, Haemoclip, Endoloop and stapler are useful devices to tackle a wide cystic duct
- Normal sized common bile duct can easily be mistaken for cystic duct
- Beware of wide cystic duct, long cystic duct, vertical cystic duct – it may be common bile duct
- Very soft (normal) liver, fatty liver and cirrhotic liver can easily be injured during retraction
- Fundus first is a useful technique in difficult cases
- Partial cholecystectomy is an option in case of difficulty
- Panic should be avoided in case of bleeding
- Pressure with a gauze or the mobilised gall bladder will control the bleeding or make it controllable

- Desperate blind attempts to clip or coagulate a bleeding point in a pool of blood must be avoided
- Stumps (cystic duct/ cystic artery) should be examined and re-examined for security of clips and any bile leak/ bleed
- Gall bladder bed should be irrigated and examined for any bleed/ bile leak (from a cholecysto-hepatic duct)
- Presence of bile should make the surgeon stop and look for the source of bile - gall bladder or bile duct
- Extraction of gall bladder under vision to make sure that there is no bile/ stone spill.
- Spilled bile should be sucked out
- Spilled stones should be looked for and removed
- Aponeurosis at 10 mm port sites should be closed
- Surgeon should not have any ego to complete every cholecystectomy laparoscopically
- Conversion is a safety valve and an emergency exit
- Have a low threshold for conversion
- Conversion is not a failure on the part of the surgeon
- Cholecystectomy should not be considered a small/ routine operation and should not be taken lightly/ casually
- Surgeons should avoid the temptation to get their names into books of records
- Experience is no protection against bile duct injury
- All gall bladders, even if they look grossly normal, should be sent for histopathology so as not to miss an incidental gall bladder cancer
- The day after cholecystectomy, the patient should be without pain, sitting up in the bed, having her breakfast and wanting to go home – vitals should be stable/ normal and abdomen soft; if not, observe the patient in the hospital for another day
- In the era of increasing medical litigation, a safe cholecystectomy is safe not only for the patient but for the surgeon also

Safe Cholecystectomy A-to-Z

A

ABC (Argon beam coagulator)

ABC is very effective for controlling capillary ooze from the **GB bed** in liver or a liver **capsule** tear – ABC is, however, expensive and it is not mandatory to have it for performing a safe cholecystectomy.

Aberrant

An aberrant **right hepatic artery** (RHA) may originate from the superior mesenteric artery (SMA) instead of the coeliac axis. It then lies behind and to the right of the common bile duct (CBD) where it may get injured during cholecystectomy. An injury to the RHA may result in **bleeding** during cholecystectomy – desperate attempts to control this bleeding may then cause a bile duct injury.

Absolok (Ethicon Endo-surgery)

Absorbable **PDS** (polydioxanone) **clip** .

Acalculous cholecystitis

Acalculous cholecystitis is more likely to occur in patients with multiple trauma, extensive burns, systemic sepsis, those on total parenteral nutrition (TPN) and those receiving multiple blood transfusions. Acalculous cholecystitis is more likely to progress to **gangrenous cholecystitis** than **acute cholecystitis** caused by gall stones and needs an **emergency** cholecystectomy (cf. **early** cholecystectomy for uncomplicated acute cholecystitis).

Access

Peritoneal access may be difficult because of obesity or due to omentum being adherent to an infra-umbilical scar e.g. of tubal ligation, caesarean section, hysterectomy in women.

Acidosis

Hypercarbia as a result of **CO₂ pneumo-peritoneum** may result in acidosis. End tidal CO₂ (**ET CO₂**) should be monitored to prevent this.

Acute cholangitis

See **Cholangitis**

Acute cholecystitis

Pain in acute cholecystitis resembles **biliary colic** to begin with - it, however, lasts longer (days rather than hours) and is associated with fever. Examination reveals tenderness and guarding in the right upper quadrant; a mass (consisting of inflamed GB with adherent omentum, colon and duodenum) may be palpable. **Leucocytosis**, deranged **LFT** and US findings of peri-cholecystic oedema

and GB wall thickening support the diagnosis.

An attack of acute cholecystitis can be managed in two ways

1. **Early (NOT emergency) cholecystectomy** in the next operating list (NOT in the middle of the night) within 7 days (preferably 3 days) of the onset of the attack – but definitely not after 7 days when inflammation is at its worst. Laparoscopic cholecystectomy (LC) for acute cholecystitis should be performed by an **experienced surgeon** – threshold for **conversion** should be low; conversion rates in acute cholecystitis are higher (10-20%) than those in elective LC.
2. Initial conservative management (nil by mouth, intravenous fluids and **antibiotics**) followed by **elective** (interval) **cholecystectomy** after 4-6 weeks.

Acute pancreatitis

A gall stone (especially a small stone) may slip down a wide **cystic duct** into the common bile duct (CBD) and may cause an attack of acute pancreatitis. A recent attack of acute pancreatitis should raise the suspicion of a CBD stone in a patient with gall stone disease (GSD). Cholangiogram, preferably magnetic resonance cholangiography (**MRC**), may be required before cholecystectomy. In a patient with a remote (say more than 6 months ago) attack of acute pancreatitis, chances of finding a CBD stone are low if LFT and US are normal; cholangiogram is not indicated in such cases.

Adhesions

In patients who have had previous surgery, bowel loops may be adherent to the parietes and may get injured during port insertion (**Fig 1**)

Adhesions between parietes and liver, omentum and liver (**Fig 2**) and between GB and omentum, **duodenum** or **colon**, if present, have to be divided to retract the liver and to expose GB neck.



Fig 1 Bowel loops and omentum **adherent** to parietes; this canula was placed under vision but blind insertion of a canula can easily damage such adherent loops



Fig 2 Omental **adhesions** to liver

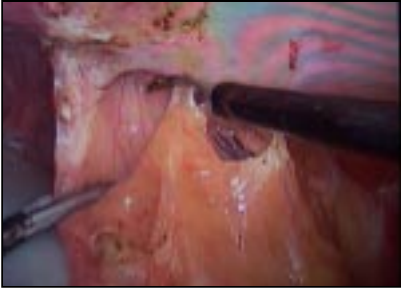


Fig 3 Parietal **adhesions** being separated by sharp dissection with scissors

Adhesions are best divided sharply using scissors with **cautery (Fig 3)**; **Harmonic scalpel** may also be used.

If the omental adhesions to liver are not divided and liver is forcibly retracted upwards, the traction on adherent omentum may cause a liver **capsule** tear and **bleeding (Fig 4)**.



Fig 4 Bleeding as a result of tear of liver capsule caused by traction on an omental **adhesion** to liver

Dense adhesions to GB may contain duodenum and colon and should, therefore, be carefully dissected lest an injury is caused to the bowel. Presence of a **fistula** between the GB and bowel should be suspected in such cases. In case of difficulty, a part of GB wall densely adherent to duodenum/ colon may be left behind.

Advantages

Advantages of **laparoscopic** cholecystectomy (LC) over **open** cholecystectomy (OC) include less pain, less paralytic ileus, less post-operative adhesions, early discharge from hospital, early return to work and better cosmetic result. The price one has to pay, however, is increased risk of **bile duct injury**.

Aerobilia (Pneumobilia)

Presence of air in the GB on US indicates a cholecysto-colonic or cholecysto-duodenal **fistula**. Air may be present in the bile ducts in presence of a cholecho-duodenal fistula or after endoscopic intervention e.g. papillotomy, stenting.

Age

Elderly patients with gall stone disease (GSD) are more likely to have

common bile duct (CBD) stones and an unsuspected/ **incidental** gall bladder cancer (GBC). **Conversion** (from laparoscopic to open cholecystectomy) rates also increase with increasing age.

Agenesis

Agenesis of GB is a rare congenital anomaly. Patient may have symptoms suggestive of gall stone disease (GSD) and US may show '**contracted GB**' – diagnosis is revealed at laparoscopy/ laparotomy.

“In one patient, the ‘GB’ was about to be grasped when the Author felt that it was too thin-walled. Careful inspection revealed that what appeared as GB, in fact, was the common bile duct (CBD) and there was no GB – agenesis of GB”.

Air

Many surgeons use room air for creating **pneumo-peritoneum** – this is cheaper but increases the risk of air embolism as it is not easily absorbed in the blood (cf. CO₂ which is easily and quickly absorbed in the blood and, therefore, has a lower risk of gas embolism).

AMASI (Association of Minimal Access Surgeons of India)

A section of the Association of Surgeons of India (ASI), with more than 2,500 members (www.amasindia.com). AMASI conducts regular and frequent skills courses and awards a Fellowship in Minimal Access Surgery (FMAS).

Ambidextrous

A laparoscopic surgeon should be able to use his/ her both hands with almost equal dexterity (**Fig 5**).

American position

Surgeon stands on the patient's left, camera operator to the surgeon's left and the assistant on the patient's right. Most surgeons, including the Author, prefer this position. (cf. **French position**)

Anaesthesia

Laparoscopic cholecystectomy (LC) must always be performed under general anaesthesia (GA) with endo-tracheal intubation. Any patient who is not fit to undergo GA because of co-morbid conditions, therefore, is not a candidate for LC. Open cholecystectomy may be performed under regional (spinal or epidural) anaesthesia in such cases.



Fig 5 An **ambi-dextrous** laparoscopic surgeon using both hands – right for dissection and left for retraction; camera operator is standing next to the surgeon (both on the left side of the patient – North American technique)

Analgesia

Local anaesthetic e.g. bupivacaine, may be injected into the parietes at the **port** sites for pain control. Post-operative analgesia can be provided by opioid analgesics e.g. fentanyl; more and more anaesthetists, however, are preferring non-steroidal anti-inflammatory drugs (NSAIDs) such as ketorolac, diclofenac, piroxicam, etc. for post-operative pain relief.

Anatomy

Every surgeon who performs cholecystectomy must read (and re-read) the anatomy of the biliary system and remember that there is nothing like a standard normal anatomy. There are so many **variations** of biliary anatomy that each patient has his/ her own individual anatomy. It is very important to dissect, delineate and demonstrate (to the first assistant) the biliary anatomy (cystic duct – common hepatic duct CHD - common bile duct CBD) in each and every patient before any structure is ligated/ clipped or divided.



Fig 6 Tips of instruments meeting at a right angle

Angle

The **epigastric** and **sub-costal trocars** should be so placed in the parietes (far apart from each other) that the ends of the instruments placed through them meet at the GB neck at a right angle (**Fig 6**) and NOT at an acute angle.

Antegrade

Separation of GB fundus and body from the GB bed in liver to begin with and dissection of the GB neck and Calot's triangle as the last step (cf. **retrograde** or classical method where the Calot's triangle dissection is done as the first step).

This (antegrade) method is preferred in case of a **difficult** Calot's triangle and may end up as **partial cholecystectomy** leaving part of the GB neck behind. This method is also preferred by some surgeons who perform open cholecystectomy using a **mini-incision**.

The disadvantage of using antegrade (**fundus-first**) method during laparoscopic cholecystectomy is that the retraction of liver is lost – an **extra port** may, therefore, have to be inserted to introduce a liver retractor.

Antibiotics

Cholecystectomy is classified as a clean – contaminated surgical procedure and only prophylactic antibiotics are indicated. A second generation cephalosporin e.g. cefuroxime or a beta lactam + beta lactamase inhibitor combination e.g. amoxycillin – clavulanic acid is recommended. Only a single dose, given at the time of induction of anaesthesia, is required.

A **therapeutic** course of antibiotics is indicated in patients with acute **cholecystitis** and acute **cholangitis**.

Anti-platelet drugs

Very often, patients with coronary artery disease (CAD) are on anti-platelet drugs e.g. aspirin, clopidogrel, etc. These need to be discontinued for at least 5 days before the patient is taken up for an elective cholecystectomy.

Aponeurosis

After laparoscopic cholecystectomy, the aponeurosis (linea) should be closed with horizontal mattress sutures (**Fig 7**) of long acting absorbable suture (e.g. **PDS**) in the 10 mm port (umbilical and epigastric) incisions to prevent formation of an incisional hernia. A stout port – closure needle is very useful for this.



Fig 7 Horizontal mattress suture to close the umbilical port linea/ aponeurosis

After open cholecystectomy (OC), the midline aponeurosis (linea) is closed with a continuous suture - **PDS** is preferred over **Prolene** as Prolene is likely to be associated with a stitch abscess or sinus, especially in thin-built patients with no sub-cutaneous fat.

Sub-costal incision in OC should be closed in 2 layers – transversus + internal oblique/ posterior rectus sheath (inner) and external oblique/ anterior rectus sheath (outer), both with 1/ 1-0 **PDS**.

Appendectomy

Some surgeons combine cholecystectomy with an incidental appendectomy (*“buy one, get one free”*); this is, however, not required and is not recommended.

Assistance

It is not uncommon for some surgeons to perform cholecystectomy without proper assistance e.g. with a para-medical or even non-medical assistant. It is important to have adequate assistance during cholecystectomy – the first assistant (camera operator), at least, should be a qualified and trained surgeon who knows and understands biliary **anatomy** and principles of surgery.

Asymptomatic

Asymptomatic gall stones (GS) (detected incidentally on US for some unrelated symptoms) are more common than symptomatic GS, as majority of GS are asymptomatic. Only 3-5% of patients with asymptomatic GS may develop symptoms every year; prophylactic cholecystectomy is, therefore, not indicated in patients

with asymptomatic GS; exceptions being immuno-suppressed and those on long-term parenteral nutrition. There may be a case for cholecystectomy in those with multiple small stones (risk of **acute pancreatitis**) or those with a single large stone or GB packed with stones (risk of gall bladder cancer GBC).

Avulsion

If adequate care is not taken, the cystic artery may get avulsed from the right hepatic artery (RHA) resulting in profuse bleeding. This can occur when dissection is being done in the Calot's triangle or when the cystic artery is being clipped. This is more likely to happen when the cystic duct has been clipped and divided and the GB is attached to the hepato-duodenal ligament by the cystic artery only which is being dissected.

Bactobilia

Majority of patients with gall stones have bacteria in their bile – cholecystectomy is, therefore, classified as a clean contaminated operation and prophylactic **antibiotics** are, therefore, indicated.

Bag

A bag is often used for GB specimen retrieval (**Fig 8**). It prevents bile/stone **spill** and contamination of the port of extraction (infection, unsuspected malignancy). Commercial disposable bags are available; they are, however, expensive. The sterile inner bag of a Ryle's tube/ infant feeding tube can be used instead. An envelope shaped bag (one leaf longer than the other) is preferred as it is then easier to hold the longer leaf. A purse string suture placed around the open edge of the bag



Fig 8 GB being extracted in **bag** - some surgeons routinely extract the GB in a bag to prevent contamination of the port site

before it is introduced into the peritoneal cavity helps to close its mouth by pulling on the ends of the suture before its extraction out of the peritoneal cavity.

In case of a large stone, the cannula is removed and the bag is held in a long artery forceps introduced directly through the port incision – this allows dilatation/ stretching of the port site to enable removal of the large stone. Alternatively, the large stone can be crushed and broken into small fragments inside the bag.

Balloon

A balloon tipped catheter can be used for performing **cholangiography** through the cystic duct.

Ball shaped cautery

Ball shaped cautery tip is good for control of diffuse **bleed** from the **GB bed** in liver or from a liver capsule tear. Spray mode of cautery should be used, if available.

Bariatric surgery

Obese patients with gall stones undergoing bariatric surgery should undergo cholecystectomy even if their stones are **asymptomatic**.

BDI (Bile duct injury)

BDI is the most dreaded complication of cholecystectomy – more so of laparoscopic cholecystectomy (LC). The Author has addressed the issue of BDI in a separate publication.

Bed, GB

GB bed in liver usually has a plane which can be safely dissected using **electrocautery (hook or spatula)**. In patients with long-standing inflammation and fibrosis (chronic cholecystitis, especially xantho-granulomatous cholecystitis **XGC**) this plane may get obliterated, making dissection of the GB off its bed in liver difficult. This results in either opening of GB (causing bile or stone **spill**) or entry into the liver parenchyma (causing **bleeding**) – “*Scylla and Charybdis*”. It is, however, preferable to get into the GB rather than into the liver.

GB bed should be inspected for bleeding before the GB is taken off the liver completely – the still attached GB fundus can be used to retract the liver (**Fig 9**); once the GB has been completely taken off the GB bed in liver, liver falls down and GB bed closes, making inspection of the GB bed for bleeding difficult.



Fig 9 Fundus being dissected off from the liver – this should be done after the **GB bed** has been examined for bleeding or bile leak

Belly button

Laparoscopic cholecystectomy is often referred in lay terms as belly button cholecystectomy.

Big vessels

In thin patients, one should be very careful in introducing the **Veress needle** and the **first trocar** as the distance between the anterior abdominal wall and the big vessels (aorta and inferior vena cava IVC) can be very small and a fatal injury can occur to these vessels. A gush of blood out of the Veress needle indicates a major vascular injury – the needle should be left in situ and an immediate laparotomy must be performed to control the **bleeding** and repair the vascular injury. **Help** of a vascular surgeon should be sought, if available.

Biliary colic

Biliary colic is the classical symptom of gall stone disease (GSD). It is a sudden onset continuous severe pain in the right upper abdomen/ epigastrium, generally after a heavy/ fatty meal, which may radiate to the back or right shoulder, often lasts for hours and may be associated with nausea/ vomiting. The term biliary colic is a misnomer as it is not a true colic (cf. intestinal colic, ureteric colic). It may sometimes not be easy to differentiate between the pain of biliary colic and **acute cholecystitis**.

Biliary dyskinesia

Some patients with typical **biliary colic** are found not to have gall stones on US – they may be suffering from biliary dyskinesia which can be diagnosed by

US or isotope hepato-biliary **scintigraphy** before and after a fatty meal.

Bipolar cautery

In bipolar cautery, both positive and negative electrodes are in the hand piece – the current flows between the electrodes and not through the patient's body thus making it safer than **monopolar (unipolar)** cautery. Use of bipolar cautery is essential in a patient with an implanted pacemaker.

Blade No. 11

A stab knife should be used for making the first nick in the common bile duct (CBD) for choledochotomy (after aspiration with a fine bore 23 G needle confirms that the structure in question is the CBD and not an anteriorly placed portal vein) – the incision is then extended with a vascular (Pott's) scissors.

Blade No. 15

A fine blade is used for making a small opening in the **cystic duct** for introduction of canula or catheter into the common bile duct (CBD) for intra-operative cholangiogram (IOC).

Bleeding

Bleeding can occur at several steps during a cholecystectomy. The commonest cause is avulsion of the **cystic artery** from the right hepatic artery (RHA) during dissection in the Calot's triangle (**Fig 10**). In such a situation, a gauze pack should be introduced and pressure applied for at least 5 minutes (*by the clock*). In majority of cases, the bleeding point (cystic artery stump) can be recognized and controlled (**clip, cautery, suture**). In case

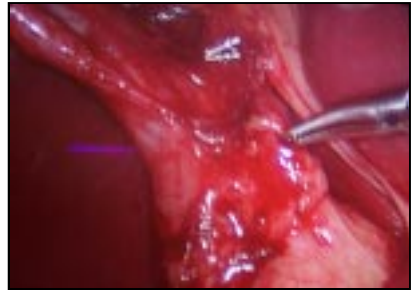


Fig 10 Bleeding in the Calot's triangle

of large and rapid bleed, attempts to suck out blood result in loss of pneumoperitoneum and diminished vision; suction tip should remain dipped in pool of blood to diminish evacuation of gas. Blood may also splash on the tip of the laparoscope and obscure vision; telescope should be withdrawn away from the site of bleed as soon as bleed occurs. In case the cystic artery has been avulsed at its origin from the RHA resulting in a side hole in the RHA, it is better to convert to a laparotomy and repair the hole in the RHA with a fine (5-0/ 6-0) **Prolene** suture. **Help** of a vascular surgeon may be sought, if available. Blind manoeuvres to control bleeding in a pool of blood are dangerous as they may cause a bile duct injury.

Venous bleed usually gets controlled with packing only.

Capillary ooze in the GB bed (**Fig 11**) can be controlled by packing, **electro-cautery** (spray mode with ball electrode), **ABC** (argon beam coagulation), **gelatin foam, oxidized cellulose**.



Fig 11 Bleeding from the GB bed is best controlled with spray cautery or argon beam coagulation (ABC)

Uncontrollable bleeding is one of the common reasons for **conversion** from laparoscopic to open cholecystectomy.

All **port** sites must be inspected from inside (**Fig 12**) for any bleeding after the **canula** is removed.

Common sites of post-operative bleed are cystic artery stump, GB bed and a port site.

Delayed bleeding occurs due to erosion of a vessel (usually the right hepatic artery) by an abscess formed as a result of

infection in the sub-hepatic fossa.

Blind

1. Blind use of haemostats/ clips/ **cautery** in the Calot's triangle in presence of **bleeding** may cause injury to the right hepatic artery (RHA) or the common bile duct (CBD) and must be avoided at all costs. Packing for 5 minutes (*by the clock*) is immensely useful in such situation as it usually helps in identification of the source of bleeding and its proper control.



Fig 12 After removal of each canula, the peritoneal side of the port site (epigastric port * here) should be examined for **bleeding**

2. Blind insertion of the first **canula** with a sharp tipped trocar may result in a major bowel or vascular (aorta/ inferior vena cava IVC) injury. This is more likely to happen in the following situations

- i. A thin built patient where the distance between the anterior abdominal wall and the posterior parietes is very small
- ii. Inadequate pneumo-peritoneum
- iii. Wrong (cranial) direction of insertion
- iv. **Adhesions** between bowel and parietes (due to previous surgery or peritoneal **tuberculosis**).

Blood

In case of bleeding, blood should not be allowed to collect in the sub-hepatic fossa – it gets clotted and is then difficult to remove; also, blood absorbs light and dims the view. Any collected blood should be immediately sucked out.

Blow out

Common bile duct (CBD) obstruction, commonly due to a stone, may cause cystic duct stump to open and result in bile leak. This responds to **endoscopic stenting**.

Blunt

The Author uses the **open technique** (and not Veress needle) for insertion of the first trocar and uses a blunt-tipped **trocar** (**Fig 13**) - the sharp tip of the usual trocar can be blunted locally.



Fig 13 Trocars – upper sharp, lower blunt



Fig 14 Blunt dissection with suction tip in Calot's triangle

Blunt dissection

Suction tip can be used for safe blunt dissection in the Calot's triangle (**Fig 14**), as it is less likely to cause any ductal or vascular injury than a sharp dissector.

Books of records

Some surgeons try to get their names included in various Books of Records by performing cholecystectomy in the shortest possible time or performing the largest number of cholecystectomies in a day – *this is to be condemned. We (surgeons) should not try to get laurels for ourselves at the cost of safety of lives of our patients* – a cholecystectomy done in 15 minutes offers no advantage at all to the patient over one done in 30 or even 60 minutes.

Bouveret syndrome

A large gall stone which has passed from the GB to the duodenum through a cholecysto-duodenal **fistula** and is impacted there to cause gastric outlet obstruction.

Bowel injury

Veress needle or the first trocar may cause bowel injury, especially in patients with previous surgery where a loop of bowel may be adherent to the parietes. The injury may be repaired laparoscopically by an **experienced surgeon**, but indicates **conversion** to laparotomy in majority of cases.

Bubbles

The **cholangiography** catheter should be flushed with saline (before it is inserted) to remove all air, as air bubbles in the common bile duct (CBD) can mimic

stones on cholangiogram. The air bubbles are always round; stones may also be round but are usually faceted.

Bupivacaine

Bupivacaine, a long-acting local anaesthetic, can be injected into the parietes at the **port sites** at the end of laparoscopic cholecystectomy (LC) to reduce post-operative pain.

Buscopan

Intramuscular or intravenous injection of hyoscine butyl bromide – an anti-spasmodic - during and after cholecystectomy relaxes the smooth muscle of the papilla and reduces the intra-biliary pressure thus lessening the risk of a cystic stump **blow out/** leak. The Author uses it in case of a difficult cystic duct/ **partial cholecystectomy**.

Calot's triangle

Bound by the inferior surface of the liver above, the common hepatic duct (CHD) on left and GB neck and **cystic duct** on right – the Calot's triangle contains the **cystic artery** along with the cystic lymph node. Calots' triangle is the most important area of dissection – *the sanctum sanctorum* (**Fig 15**) – in cholecystectomy.



Fig 15 Sanctum sanctorum of Akshardham at NOIDA (indiarouting.com)

Canula (Fig 16)

Canula is the outer blunt-tipped sheath which remains in the **port** for introduction of the telescope and the instruments. Some surgeons erroneously call it **trocár** – trocar actually is the inner pointed introducer which is removed after the canula has been introduced into the peritoneal cavity.



Fig 16 Inner trocar (green) with outer canula (grey)

Capsule, liver

The liver capsule may get torn during retraction of liver (especially if the omentum remains adherent to the liver) resulting in **bleeding**. This bleeding is best controlled by pressure, **spray** mode electro-cautery with **ball** or **spatula** electrode or **ABC** (argon beam coagulation).

Cardio-pulmonary disease

Patients with severe cardio-pulmonary disease may not be fit for general **anaesthesia** and, therefore, for laparoscopic cholecystectomy (LC). Open cholecystectomy (OC) may be performed under regional (spinal/ epidural) anaesthesia in such cases.

C-Arm (Fig 17)

A C-arm is required for fluoroscopic delineation of the biliary **anatomy** and for evaluation of the common bile duct (CBD) for stones during



Fig 17 C arm for intra-operative fluoroscopy and cholangiography

cholecystectomy. It is, however, not mandatory to have it for performing a safe cholecystectomy. Intra-operative cholangiography (IOC) can be performed by placing the X-ray plate behind the patient (centered on the tip of the 9th costal cartilage) and using a portable X-ray machine.

Caterpillar hump (Fig 18)

A hump of the **right hepatic artery (RHA)** on the GB neck – may get injured during dissection in the Calot's triangle resulting in massive **bleeding**.



Fig 18 Caterpillar hump of right hepatic artery

Cautery (Electro-cautery)

Electro-cautery, which uses very high frequency 100 KHz current to generate heat, is a very useful equipment during cholecystectomy but it should be used judiciously and special care should be exercised when using it during dissection in the Calot's triangle (purists, in fact, would not use cautery at all in the Calot's triangle). If at all, only pinpoint cautery (NOT spray mode) should be used in the Calot's triangle and that too at a low power (wattage). If cautery is used in the Calot's triangle, the surgeon should **hug** the GB to avoid **thermal damage** to the right hepatic duct (RHD)/ common hepatic duct (CHD)/ common bile duct (CBD) and the right hepatic artery (RHA). Use of cautery should be avoided after clips have been applied to the **cystic duct** – metal clip may transmit the electric current and cause thermal damage to the CHD/ CBD. **Spray** mode of cautery is useful to control **bleeding** in the GB **bed** after GB has been dissected off the liver. The metal tip of an instrument should be in complete view when cautery is used to avoid inadvertent thermal damage to a structure not in view. Injudicious use of cautery can result in damage to the bowel (duodenum, colon) which may go undetected.

CBD exploration

The common bile duct (CBD) need not be dissected circumferentially; only the anterior surface (infra-cystic supra-duodenal part) needs to be exposed. A fine (23 G) needle aspiration should always be done – bile confirms that it is the CBD (and not portal vein). Two stay sutures with fine (3-0/ 4-0) **Vicryl** should be taken on either side of midline of the CBD – a nick is first made with a stab (No. 11) knife and the incision is then extended with a fine vascular (Pott's) scissors. The length of the incision is guided by the expected size of the CBD stones.

The choledochotomy is closed with interrupted sutures of fine (3-0/ 4-0) **Vicryl** on a round bodied atraumatic needle.

CBD (common bile duct) stones

CBD stones can be present in about 5-10% of patients with gall stones. The stones may be silent or their presence is indicated by jaundice, **cholangitis** or pancreatitis and high serum bilirubin and elevated serum alkaline phosphatase. US shows intra-hepatic biliary radicle dilatation (IHBRD) and dilated CBD; stone in the CBD may or may not be seen on US. Pre-operative cholangiography (**MRC** and **ERC**) confirms the presence of CBD stones.

1. If an open cholecystectomy (OC) is planned for gall stones – OC + open CBD exploration may be better than endoscopic clearance of CBD followed by open cholecystectomy.
2. If laparoscopic cholecystectomy (LC) is planned for gall stones, as is the usual case, there are two options
 - a. If expertise for laparoscopic CBD exploration is available, LC + laparoscopic CBD exploration
 - b. If expertise for laparoscopic CBD exploration is not available, endoscopic clearance of CBD stones followed by LC.

Cellulose, oxidised

Surgicel (Johnson & Johnson) is a useful material to control capillary **bleed** in the GB bed or from the liver parenchyma following liver capsule tear.

Chip

3-Chip camera has better resolution but is not mandatory – a single chip camera is adequate for performing a safe cholecystectomy.

Chlorhexidine

Chlorhexidine gluconate in soap or alcohol is used for skin preparation prior to draping the area of operation.

Cholangiography catheter

Special catheters are available for performing a trans-cystic intra-operative cholangiography (**IOC**). A **ureteric catheter** may also be used.

Cholangiography, pre-operative

Pre-operative cholangiography is indicated to rule out common bile duct (CBD) stones before cholecystectomy for gall stones.

1. Patients with low **risk** of CBD stones (no history of jaundice, cholangitis or acute pancreatitis, normal alkaline phosphatase, normal CBD on US) do not require pre-operative cholangiography.
2. Patients with high (strong) risk of CBD stones (recent attack of **acute pancreatitis**, **jaundice**, dilated CBD on US, CBD stones on US) should go for **ERC** as it offers opportunity for therapeutic intervention in the form of endoscopic removal of CBD stones also.
3. Patients with moderate risk of CBD stones (history of jaundice, remote attack of

acute pancreatitis, elevated alkaline phosphatase) may have **MRC** as it is non invasive – endoscopic intervention will be required if a CBD stone is found on MRC.

Some Japanese surgeons obtain an MRC in all patients undergoing laparoscopic cholecystectomy (LC) – the cholangiogram then serves as a road map of biliary **anatomy** and is expected to reduce the risk of bile duct injury. This approach is, however, not used by most surgeons and is not recommended by the Author.

Cholangio-grasper

A special grooved grasper for holding the **cholangiography** catheter during its insertion into the **cystic duct** for intra-operative cholangiography (**IOC**).

Cholangitis

Fever (with chills and rigors) and jaundice in a patient with gall stones should raise the suspicion of cholangitis due to common bile duct (CBD) stones. Elevated **TLC/ WBC**, bilirubin, alkaline phosphatase and aminotransferases (ALT/ AST) are characteristic. A mild attack of cholangitis can be treated with oral **antibiotics** on an outpatient basis but a patient with severe cholangitis may require hospitalization for parenteral (intravenous) antibiotics. Uncontrolled cholangitis (not responding to parenteral antibiotics) is an indication for endoscopic stenting; percutaneous trans-hepatic biliary drainage (**PTBD**) or surgical biliary drainage in the form of a T-tube choledochostomy should be rarely required.

Cholecysto-cholangiography (Fig 19)

Cholangiography performed by injecting contrast into the GB – this will, however, work only if the **cystic duct** is patent.



Fig 19 Cholecysto-cholangiogram

Cholecysto-choledochal fistula

In **Mirrizi's** syndrome Type II- IV, a fistula is present between the GB neck and the bile duct. It is not advisable to repair this fistula as it will result in a stricture. In type II Mirrizi's (involving less than 1/3 of circumference of CBD), partial cholecystectomy should be performed using fundus first technique leaving a part of the GB neck which is then closed (cholecysto-choledochoplasty). In type III and IV Mirrizi's syndrome (involving more than 1/3 of circumference of CBD), a biliary – enteric anastomosis will be required.

Cholecysto-enteric fistula (Fig 20)

Majority of cholecysto-enteric fistulae are between GB and duodenum (followed by colon and stomach). **Aerobilia/ Penumobilia** on US suggests a cholecysto-enteric fistula. Presence of a cholecysto-enteric fistula is not a contraindication for laparoscopic cholecystectomy (LC) but makes it difficult. A **stapler** may be useful to divide the fistula. A sub-hepatic drain may be placed in such cases.

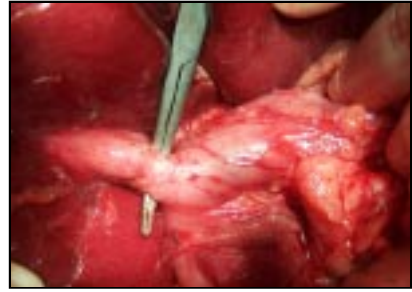


Fig 20 Cholecysto-enteric (duodenal) fistula

Cholecysto-hepatic duct

Small bile ducts running between GB and intra-hepatic bile ducts may be encountered in the GB bed. They are usually not seen and get obliterated during the use of **cautery**. If such a duct is seen while taking the GB off its bed in the liver, it is advisable to clip and divide it. An unobliterated unnoticed cholecysto-hepatic duct in the GB bed is a common cause of bile leak and collection in the post-operative period. This leak will stop spontaneously or after endoscopic intervention (papillotomy with stenting).

Cholecysto-hepatic triangle

See **Calot's triangle**

Cholecystostomy

Cholecystostomy (external drainage of the GB) may sometimes have to be performed for complicated **acute cholecystitis (empyema)**. This can be performed percutaneously (using a transhepatic route) under US guidance or as a surgical procedure. If an empyema is found at surgery – surgical cholecystostomy can be performed after making an opening in the GB fundus and removing all the stones from the GB. A Foley's catheter with bulb inflated in the GB can be used for draining the GB. The catheter may be brought through a flap of omentum which provides a serosal patch cover to the exit site in the GB. **Elective** (interval) **cholecystectomy** can be performed later - preferably after 6-8 weeks

Choledochal cyst (Fig 21)

A choledochal cyst should be suspected in a patient with dilated common bile duct (CBD) if no stones are present in the CBD and if there is disproportionate dilatation of the extra-hepatic bile ducts (CHD/ CBD) as compared

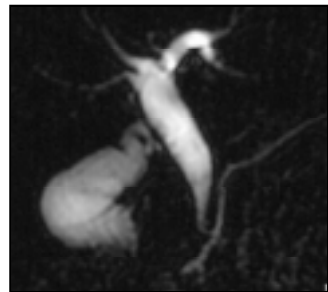


Fig 21 A choledochal cyst may be misinterpreted as a dilated CBD

to the intra-hepatic ducts which are not dilated. CBD dilatation due to CBD stones, on the other hand, produces proportionate dilatation of the intra-hepatic bile ducts also.

Choledocho-duodenostomy (Fig 22)

Choledocho-duodenostomy is indicated in presence of multiple or recurrent common bile duct (CBD) stones. CBD should be at least 12 mm in diameter for an adequate drainage into the duodenum. This is a single layer anastomosis done with interrupted sutures of 3-0/ 4-0 **Vicryl** or **PDS**. Choledocho-duodenostomy is rarely required now because of availability of endoscopic interventions for removal of CBD stones. Choledocho-duodenostomy is, however, a side-to-side anastomosis with problems of the CBD stump (residual or recurrent stones/ sludge and infection).



Fig 22 Air cholangiogram on plain X ray abdomen after **choledocho-duodenostomy**

Choledochoscopy

Choledochoscope is used to ensure that there are no residual stones after a common bile duct (CBD) exploration and **choledocholithotomy**. A 2.8 mm choledochoscope is required for trans-cystic use and 4.8 mm choledochoscope for trans-choledochal use. A uretero-reno scope or nephrosocpe may be used instead.

Choledochotomy

While extending the common bile duct (CBD) incision upwards, care should be taken not to injure the right hepatic artery (RHA) which crosses the CBD from left to right and may sometimes be embedded in the wall of the duct.

Cholesterol

Multiple faceted stones containing cholesterol > 50% of dry weight.

Cholesterol solitaire (Fig 23)

Single, large, translucent stone containing cholesterol > 90% of dry weight.



Fig 23 Small contracted thick walled GB (TWGB) with single large **cholesterol solitaire**

Cirrhotic liver

Cirrhosis is not a contra-indication for laparoscopic cholecystectomy (LC) but LC in a cirrhotic liver is difficult and should be attempted by an **experienced** surgeon. A cirrhotic liver is firm and difficult to retract. Forceful retraction of such a

liver can fracture the firm parenchyma resulting in profuse **bleeding**. Collaterals in the Calot's triangle and the GB bed as a result of associated **portal hypertension** may make dissection difficult and bloody.

Classical (American) position

Patient is placed supine - surgeon and the camera operator stand on the left and the assistant and scrub nurse on the right of the patient. This position is preferred by most surgeons, including the Author.

Cleaning

Laparoscopic surgical instruments should be dismantled and thoroughly cleaned and dried to remove organic matter after every use and before sterilization. This can be done manually with brush and water, using an enzymatic detergent or with an ultrasonic cleaner.

Clean contaminated

Majority of patients with gall stones have **bactobilia** – cholecystectomy is, therefore, classified as a clean contaminated operation and **prophylactic** (not therapeutic) **antibiotics** are indicated.

Click

Two clicks are heard while introducing the **Veress** needle – first when the linea/ **aponeurosis** is punctured and second when the peritoneum is breached.

Clips

Clip applicator is a heavy instrument. The weight of the instrument should remain in the surgeon's hand and should not be allowed to fall on the **cystic duct** and especially the **cystic artery** as it may cause its avulsion.

While applying a clip, both feet of the clip applicator should be seen beyond the cystic duct/ cystic artery to ensure complete clipping of the structure and to avoid any other tissue getting clipped inadvertently (**Fig 24**).

Disposable clip applicator with a pre-load of 20-30 clips, which can be applied successively without the need to remove, reload and reinsert the clip applicator after every clipping saves time.

Clips come in sizes – small 5 mm, medium 7 mm, medium - large 9 mm and large 11 mm.



Fig 24 Both **feet** of the clip applicator should be seen before the clip is applied

Closure

10 mm port sites (linea/ **aponeurosis**) in laparoscopic cholecystectomy (LC) should be closed with a horizontal mattress suture (**Fig 7**) of 1-0 **Vicryl** or **PDS** on a heavy port needle (**Fig 25**). Skin may be closed with suture, stapler, strips or glue.

A midline incision in open cholecystectomy (OC) is preferably closed with heavy (1 or 1-0) long - standing absorbable monofilament suture e.g. **PDS**.

Sub-costal incision in OC should be closed in 2 layers – transversus + internal oblique/ posterior rectus sheath (inner) and external oblique/ anterior rectus sheath (outer), both with 1/ 1-0 **PDS**.



Fig 25 Heavy port needle with PDS for port closure

CO₂ (Carbon di-oxide)

CO₂ is used for creating **pneumo-peritoneum** as it easily dissolves in blood thus decreasing the risk of gas embolism (cf. **air**), is non-combustible (cf. oxygen) and, therefore, prevents sparking during use of **cautery** but may cause **hypercarbia** and **acidosis**.

Coagulation profile

A complete coagulation profile including platelet count, bleeding time (BT), clotting time (CT), prothrombin time (PT) and activated partial thromboplastin time (aPTT) should be obtained in all patients with surgical obstructive jaundice due to CBD stones. **Coagulopathy**, if present, should be corrected before any intervention – surgical or non-surgical.

Coagulopathy

Uncorrectable coagulopathy in a patient with **cirrhosis** is a contraindication for laparoscopic cholecystectomy (LC).

Cognitive

Misidentification of the common bile duct (CBD) as the cystic duct during laparoscopic cholecystectomy (LC).

Cold light source

The light used in laparoscopic cholecystectomy (LC) should be as close to natural light in colour as possible. Heat of the light is decreased by thermal filters and cooling fans. Xenon and halogen sources of cold light are commonly used.

Colon

Right (ascending) colon may be injured while introducing the right lower port if it is placed too posterior. It should be placed under vision, usually in the

anterior axillary line

Confluence

In case of a low confluence of right and left hepatic ducts, the right hepatic duct (RHD) may be mistaken for the **cystic duct** and dissected, ligated/ clipped and divided. This will result in a Bismuth type IV stricture.

Consent

All patients planned for laparoscopic cholecystectomy (LC) should be informed and consented for a possible conversion to an open operation. Author's practice is to inform a 5% chance of conversion (more in men).

Consultation

If the operating surgeon does not have much experience, (s)he should not hesitate to consult a more experienced surgeon if the patient develops post-operative problems.

Contempt

'Familiarity breeds contempt'

Cholecystectomy being a very common operation, some surgeons tend to take it lightly and unconsciously develop a casual (bordering on to callous and careless) attitude towards it; this is to be condemned. **Every** cholecystectomy must be taken seriously.

Contracted GB (Fig 26)

A small contracted GB has no fundus (part of GB protruding beyond the inferior border of liver) which can be held and pushed up to retract the liver. Attempts to push a small contracted GB upwards may result in the grasper causing an injury to the liver parenchyma. With long-standing inflammation (chronic cholecystitis), the GB becomes contracted and thick-walled, making the dissection in the Calot's triangle difficult and increasing the possibility of **conversion** from laparoscopic cholecystectomy (LC) to open cholecystectomy (OC).



Fig 26 Small **contracted GB** with no fundus

Contraindication

Suspicion of gall bladder cancer (GBC) is probably the only absolute contraindication for laparoscopic cholecystectomy (LC). **Cirrhosis, portal hypertension, uncorrectable coagulopathy** and multiple previous upper abdominal operations are relative contraindications for LC – only an **experienced** surgeon

should attempt such cases.

Conversion

Laparoscopic cholecystectomy (LC) should be converted to open cholecystectomy (OC) *by choice* in case of **difficult** pathology rather than *per force* to salvage a complication such as bile duct injury (BDI) or **bleeding**. This is in interest of not only the patient but the surgeon also, as no surgeon would be sued by the patient for converting from LC to OC whereas a bile duct injury is very likely to result in a **medico-legal** suit being filed by the patient against the surgeon.

Conversion of LC to OC should not be considered a complication of LC. It should also not be treated as **failure** on the part of the surgeon but is an indication of a judicious **judgment** on his/ her part.

Males, obese patients, those with long duration of symptoms and with a recent attack or with repeated attacks of **acute cholecystitis**, and those with **contracted** thick-walled gall bladder (**TWGB**) on US are more likely have a conversion from LC to OC.

Cook

Cook **ureteric catheter** may be used for performing intra-operative cholangiography (**IOC**) during cholecystectomy.

Cosmesis

Better cosmetic outcome is a definite advantage of laparoscopic cholecystectomy over open cholecystectomy.

Critical view

Critical view of safety includes demonstration of cystic duct - gall bladder and cystic duct - common bile duct (CBD) junction and a view of the undersurface of liver through the dissected Calot's triangle and GB neck (**Fig 27**).

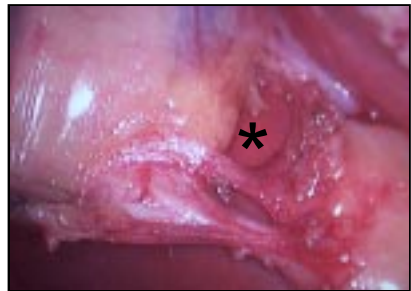


Fig 27 Completed dissection of the Calot's triangle showing cystic duct and cystic artery; note the liver parenchyma (*) seen through the dissected Calot's triangle (**critical view** of safety)

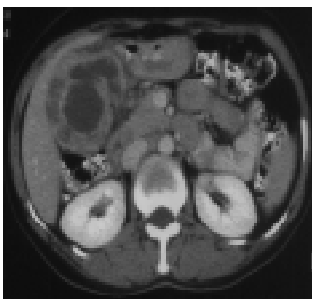


Fig 28 Computed tomography (CT) showing localised GB perforation

CT (Computed tomography)

CT is not required for diagnosis of GB/ CBD stones. **US** is the investigation of choice for GB stones and **MRC/ ERC** for CBD stones.

CT should be done in patients with thick - walled GB (**TWGB**) on US to diagnose/ rule out the suspicion of gall bladder cancer (GBC).

CT is also useful for evaluation of complications of GB stones e.g. **acute cholecystitis, perforation (Fig 28)**, etc.

Cuff

In a difficult Calot's triangle, it is safer to leave a cuff of the GB neck/**Hartman's** pouch adherent to the common bile duct (CBD) (**partial cholecystectomy**) rather than insist on removing the entire GB. The residual cuff may be closed/ oversewn with absorbable suture (e.g. 3-0 **Vicryl**) after destroying the mucosa with **electro-cautery**. **Stapler** may also be used. This is what may be done in Type I **Mirizzi's** syndrome (no cholecysto-choledochal fistula) also.

Culture

GB bile should be sent for culture – the sensitivity pattern of the bacteria may help in planning definitive therapeutic antibiotic therapy, if required later e.g. in case of a bile leak/ collection.

Cystic artery

Many surgeons (including the Author) prefer to dissect, clip and divide the cystic artery first (before the cystic duct), if possible. Division of the **cystic duct** first (before the cystic artery) leaves the GB neck attached to the hepato-duodenal ligament by the tenuous cystic artery alone which is then more prone to getting **avulsed** from the right hepatic artery (RHA).

It is not necessary to bare the cystic artery of all its areolar tissue as attempts to do that may result in an injury to it or its avulsion from the RHA resulting in profuse **bleeding**.

The cystic artery can be taken with

Harmonic scalpel, if available.

Cystic artery usually divides into an anterior and a posterior branch . If the dissection is kept close to the GB (as it should be done), the surgeon is likely to encounter these two branches (**Fig 29**) (rather than the main cystic artery). It is, therefore, important to look for another artery even after one artery has been dissected, clipped and divided.

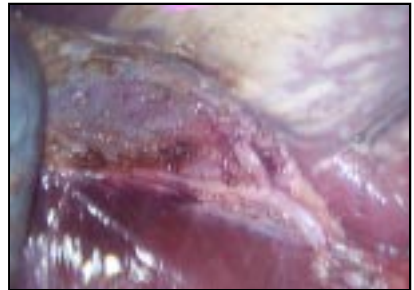


Fig 29 If the dissection is kept close to the GB (as it should be), one may encounter two branches of the **cystic artery**

Cystic duct

1. Some surgeons prefer to dissect and clip/ ligate the cystic duct first (before cystic artery) in order to prevent any small stones in the GB from slipping down through the cystic duct into the common bile duct (CBD).
2. **Electrocautery** should not be used on the cystic duct after it has been clipped – the clipped duct can undergo **thermal injury** and slough off resulting in cystic duct stump **blow out** and bile leak. Also, the metal clip may transmit the

electric current and cause thermal injury to the CBD.

Cystic lymph node (Fig 30)

1. Cystic lymph node (LN) is a very important landmark in the Calot's triangle as the **cystic artery** usually lies close to it (usually posterior or inferior to it). Dissection must always be kept to the right of the cystic LN (close to the GB neck – **hug** the GB) to avoid injury to the right hepatic artery (RHA), right hepatic duct (RHD) and common hepatic duct (CHD).

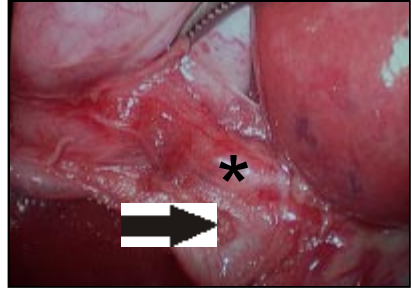


Fig 30 Cystic lymph node (*) is an important landmark in the Calot's triangle – cystic artery (arrow) lies close to it

2. If the cystic LN is removed with the GB, it should be sent separately for histological examination. In case of an **incidental** gall bladder cancer (GBC), a positive cystic LN makes it N+ (stage III), thus necessarily indicating reoperation for completion extended cholecystectomy.

Cystic pedicle

The cystic pedicle containing the **cystic duct** and **cystic artery** along with **cystic lymph node** lies in the Calot's triangle.

Cystic plate (Fig 31)

Cystic plate between the GB and the liver is well formed in the GB neck and body but gets thinned out towards the GB fundus. It is, therefore, more usual to inadvertently enter the liver parenchyma as one moves from the GB body to the GB fundus while dissecting the GB away from its bed in the liver.

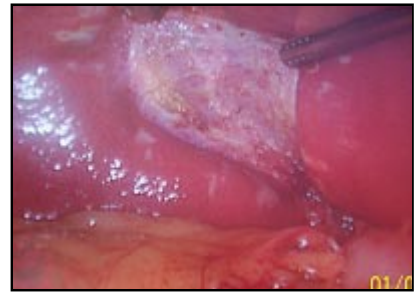


Fig 31 GB bed with intact **cystic plate** and no bleeding



Fig 32 Cystic (cholecysto-hepatic) vein in the GB bed (posterior)

Cystic veins

One or two cystic veins drain into the portal vein; numerous small cystic (cholecysto-hepatic) veins (**Fig 32**) in the GB bed drain directly into the liver. These veins almost never require individual clipping/ ligation – they are easily taken care of by **cautery**.

Dangerous surgery

Dangerous surgery, rather than abnormal **anatomy** or **difficult** pathology, is commonly the cause of a bile duct injury (BDI) during laparoscopic cholecystectomy (LC). Other causes of BDI are

1. Non-observation of the principles of surgery in general and the steps of safe cholecystectomy in particular.
2. Inadequate incision, exposure, and assistance during open cholecystectomy.
3. Unqualified, not properly trained, inexperienced or even overconfident surgeon.

Decompression

A tense distended GB (**mucocoele**) may be difficult to grasp – it should then be decompressed by a needle/ Veress needle/ 5 mm trocar so as to enable a grasper to hold it.

Deever's retractor

A flat bladed retractor used for retracting stomach - duodenum (though left hand of the first assistant is better), colon (though a pack is preferred) and the liver during open cholecystectomy.

Deflation

At the end of laparoscopic cholecystectomy (LC), the abdomen should be deflated as completely as possible; residual **CO₂**/ air in the peritoneal cavity can cause shoulder pain post-operatively.

Deflation should be done through the canula (and not through the port site after removing the canula) – contact of air current with the parietes at the port site is one of the postulated causes of port site metastasis if a LC had been performed for an **incidental gall bladder cancer** (GBC) which was not diagnosed pre-operatively.

Depth perception

A major disadvantage of laparoscopic cholecystectomy (LC) over open cholecystectomy (OC) is lack of depth perception because of a two-dimensional image.

Desjardin's

Desjardin's stone holding forceps is used to grasp and remove stones from the common bile duct (CBD) during open **choleodocho-lithotomy** and from the GB during **cholecystostomy**. Blind insertion of any instrument and use of force should be avoided in the CBD as this may cause damage to the ductal mucosa resulting in fibrosis and stricture.

Diabetes

Evidence does not support **prophylactic** cholecystectomy in diabetics with **asymptomatic** gall stones (GS) though diabetics with symptomatic gall stones are more prone to have severe **acute cholecystitis** e.g. **emphysematous** cholecystitis.

Diameter

A small diameter normal common bile duct (CBD) can be easily mistaken for **cystic duct** and dissected, ligated/ clipped and divided – the classical laparoscopic bile duct injury involving excision of a segment of the CBD.

Diaphragm

If the grasper holding the GB fundus is pushed up hard (especially blindly), it may slip off the GB fundus and cause injury to the right diaphragm.

Diet

1. While waiting for surgery, patients with symptomatic gall stones should be advised to avoid large, heavy fatty meals to prevent an attack of **biliary colic**.
2. For some weeks after cholecystectomy, patients may not tolerate a high-fat diet and should be advised to avoid it.

Difficult

In the Author's opinion, cholecystectomy is one the most 'difficult and dangerous' operations performed by a general surgeon – usually, a complication is not anticipated by the patient who is assured of a quick recovery, early discharge and rapid return to work by the surgeon but a complication in the form of a **bile duct injury** changes the scenario completely. Hernia repair is probably technically easier than cholecystectomy but failure of the operation occurs during long-term follow up. In more major operations, the patient is usually mentally prepared for a complication and, may be, even death.

A cholecystectomy may be difficult for various reasons – **access, view, anatomy** and **pathology**.

Difficult pathology

A cholecystectomy may become difficult because of several reasons – **adhesions** (Fig 3) in the right upper abdomen, fatty/ **cirrhotic** liver, small **contracted** GB (Fig 26), **thick-walled** GB (Fig 23), fibrosed/ obliterated Calot's triangle, **acute cholecystitis**.

Dilate

In presence of large stones in the GB, the port of extraction may have to be dilated with a Kelley's clamp (**Fig 33**) (or enlarged with knife) to facilitate their removal.

Direction

1. The direction of introduction of the first trocar should be caudal (towards the pelvis) and NOT cranial to avoid big vessel (aorta or inferior vena cava IVC) injury.

2. **Cystic duct** is usually horizontal while the common bile duct (CBD) has a vertical course.

3. Inappropriate (upwards) direction of **traction** on the GB neck can make the **cystic duct** vertical and align it with the CBD. Traction on the GB neck should be **down and out**. Too much **lateral traction** on the GB neck, however, can cause **tenting** of the CBD and may make it horizontal, risking its inclusion in the clip/ligature. The traction on the GB neck should, therefore, be released when the first clip is being applied to the cystic duct.



Fig 33 Port of extraction being **dilated** with a large artery forceps (Kelly's clamp) to enable removal of GB

Discharge

About half of the patients undergoing laparoscopic cholecystectomy (LC) are ready to go home (pain free, sitting up, tolerating soft diet, stable vitals, no jaundice, soft abdomen) the day after surgery; the remaining are so on the 2nd day. Some surgeons perform LC on a day care basis – it may be alright to admit the patient to the hospital on the morning of surgery but the Author prefers that *'the patient spends at least one night with the surgeon after surgery'*.

Disposable

Disposable trocars and instruments eliminate the risk of transmission of infections but are expensive. Properly cleaned and sterilized **reusable** instruments are equally good; they are sturdier.

Dormia

A Dormia wire basket is used under **choledochoscopic** vision to engage and remove stones from the common bile duct (CBD) during laparoscopic choledocholithotomy.

Double (Fig 34)

Two clips/ligatures are applied on the side of the **cystic duct/ cystic artery** which is to be retained, for security of clipping/ligature.

Doubt

In case of doubt about the biliary **anatomy**, the operating surgeon should not hesitate to take the opinion of another surgeon who may give an unbiased opinion.

“In one case, the Author was dissecting the cystic duct when another colleague walked in to see what was happening. Her remark ‘Are you sure this is the cystic duct?’ made the Author to stop and realise that it was in fact the common bile duct (CBD) – disaster averted.”



Fig 34 Double clips are applied on the CBD side and single on the GB side

Down and out (Fig 35)

The **traction** on GB neck should be down and out to put the GB neck – **cystic duct** complex at a right angle to the common hepatic duct (CHD) – common bile duct (CBD) complex. An upward traction on the GB neck should be avoided as it puts the cystic duct in line with the CBD – CBD then can be mistaken for cystic duct, dissected, clipped and divided; as dissection proceeds towards the GB body, the CHD is encountered and divided, thus resulting in excision of a segment of the bile duct – the classical laparoscopic bile duct injury (BDI). Too much **lateral traction** on the GB neck, however, can cause **tenting** of the CBD and may make it horizontal, risking its inclusion in the clip/ ligature.



Fig 35 Calot's triangle being opened further; note the **down and out** retraction the GB neck

Drain

Most surgeons (including the Author) do not leave a drain after every cholecystectomy as a routine, but only in selective cases. Drain may be placed in the sub-hepatic fossa in the following situations

1. incomplete/ inadequate/ unsatisfactory haemostasis to monitor bleeding in the post-operative period
2. unsatisfactory **cystic duct** stump e.g. wide cystic duct
3. **partial** cholecystectomy

A closed suction drain (14 F) is preferable to an open drain. A blunt instrument e.g. grasper is introduced through the diagonally opposite epigastric canula and brought out through the right para-umbilical/ right iliac fossa canula – the grasper grasps the tip of the drain and pulls it through the canula into the peritoneal cavity and places it in the subhepatic fossa.

Dubois

Francois Dubois of France was the first to report laparoscopic cholecystectomy in 1989.

Duodenum

First part of the duodenum lies close to the GB and may even be adherent to it (**Fig 36**) and is at risk of injury by the dissector and, more importantly, by the **cautery**. An undetected (missed) duodenal injury may result in post-operative peritonitis and may even be fatal.

‘One of our patients, who died after laparoscopic cholecystectomy, had a cautery caused duodenal injury which was missed during cholecystectomy.’



Fig 36 Duodenum adherent to GB neck

Duration of surgery

The risk of post-operative complications increases with increasing duration of surgery, especially if it runs into hours. The surgeon should, therefore, start thinking of conversion from laparoscopic cholecystectomy to open cholecystectomy if no progress is made for, say, one hour.

Duration of symptoms

Patients with long-standing symptoms of cholelithiasis, especially those with repeated attacks of **acute cholecystitis**, are more likely to have **adhesions**, a thick walled GB (**TWGB**), **contracted** GB, fibrosed and obliterated Calot's triangle – all predictors of **difficult** cholecystectomy and **conversion** from laparoscopic cholecystectomy (LC) to open cholecystectomy (OC).

Duval forceps

A Duval forceps may be used to hold and retract the GB fundus during open cholecystectomy. A sponge holding forceps or a large right angled clamp may also be used.

DVT (Deep venous thrombosis)

Patients with gall stone disease, per se, are not at high risk for developing DVT as they are young, have a benign disease and the duration of surgery is short. Lithotomy position, if used, may cause calf pressure and pneumo-peritoneum causes venous stasis in lower limbs; surgery may be prolonged in a **difficult** GB. All these factors increase the risk of DVT and may indicate venous thrombo-embolism (VTE) prophylaxis.

Dyskinesia

Some patients with typical **biliary colic** may not be found to have gall stones on US. Low GB ejection fraction on cholecystokinin induced isotope hepato-biliary **scintigraphy** is diagnostic. These patients may benefit from cholecystectomy.

Dyspepsia

Gaseous dyspepsia (bloating, fatty food intolerance, indigestion, flatulence) is not always a symptom of gall stone disease. It should be further investigated by upper gastro-intestinal endoscopy (UGIE). This also means that dyspeptic symptoms may persist even after cholecystectomy.

Early cholecystectomy

Cholecystectomy performed on the next day-time operating list (NOT in the middle of the night), preferably within 2-3 (maximum 7) days of onset of an attack of **acute cholecystitis**. Early laparoscopic cholecystectomy (LC) for acute cholecystitis has higher chance of **conversion** and risk of bile duct injury (**BDI**) than elective cholecystectomy for chronic cholecystitis.

cf. Emergency cholecystectomy for gangrenous and emphysematous cholecystitis

'Easy' cholecystectomy

An 'easy' cholecystectomy is a myth. Majority of bile duct injuries (BDI) occur during what was thought of as an easy, straightforward ('laddoo') cholecystectomy.

Ego

Surgeon should not have any ego to complete a cholecystectomy laparoscopically even if it is proving to be difficult. It is better and safer to **convert** by choice than be forced to convert because of a complication such as **bile duct injury** (BDI) or **bleeding**.

Electro-cautery

See Cautery

Electro-surgery

See Cautery

Embolism

Air (gas) may get into an opened vein due to raised intra-abdominal pressure and cause air embolism during laparoscopic cholecystectomy (LC). This is less likely when CO₂ is used.

Emergency cholecystectomy

Immediate cholecystectomy (may be even in the middle of the night) for **gangrenous, emphysematous** cholecystitis.

cf. Early cholecystectomy for acute cholecystitis

Emphysematous cholecystitis

A severe form of **acute cholecystitis** caused by clostridial infection – usually seen in elderly **diabetics**. **Emergency** cholecystectomy is indicated as an emphysematous GB can perforate and cause peritonitis and sepsis.

Emphysema, subcutaneous

Subcutaneous emphysema may occur in some patients after laparoscopic

cholecystectomy – it may look alarming but is innocuous.

Empyema

Acute cholecystitis can evolve into empyema. A **mucocoele** can also get infected and become an empyema. Empyema with clinical features of sepsis may be an indication for a percutaneous (or surgical) **cholecystostomy**.

Endo-loop (Ethicon Endosurgery)

An endo-loop can be used for ligation of the **cystic duct** stump in case of a wide cystic duct as it may not be possible to clip it even with a large clip.

Endoscopic stenting (Fig 37)

Endoscopic stenting (after endoscopic papillotomy EPT) may be required to control bile leak after cholecystectomy.



Fig 37 Endoscopically placed biliary stent in situ

Endo-trainer (Ethicon Endosurgery)

Endo-trainer is a useful device to learn basic and advanced laparoscopic skills.

Epigastric port

The epigastric port may be placed on the right or the left side of the midline (falciform ligament) – placing it on the left avoids cluttering of instruments at the GB neck.

Equipment

Choice of good quality (not necessarily hi-fi and very expensive) equipment goes a long way in performing a safe cholecystectomy.

ERC (Endoscopic retrograde cholangiography)

ERC was the gold standard investigation for diagnosis of common bile duct (**CBD**) stones (**Fig 38**). Availability of non-invasive magnetic resonance cholangiography (**MRC**), however, has changed the algorithm. If suspicion of CBD stone is low/ intermediate and a CBD stone is to be ruled out before cholecystectomy, MRC is the preferred investigation. Majority of low/ intermediate **risk** patients will have a normal CBD on MRC (no stone) – invasive ERC is thus avoided and a cholecystectomy can be performed. Chances of finding a CBD stone in high risk patients are high – these patients should go for ERC when a



Fig 38 ERC showing multiple CBD stones; GB is also visualised with multiple stones

therapeutic intervention (papillotomy and stone extraction) can be performed at the same time.

ESWL

Extra-corporeal shock wave lithotripsy (ESWL) can be used to break a large common bile duct (CBD) stone into small fragments before endoscopic extraction.

ET (End-tidal) CO₂

ETCO₂ should be monitored and maintained at 30 mm Hg to prevent **hypercarbia** as a result of CO₂ insufflation during laparoscopic cholecystectomy (LC).

EUS (Endoscopic ultrasonography)

EUS – a side viewing endoscope with an US probe – is a better investigation than trans-abdominal US to pick up a common bile duct (CBD) stone, especially in the lower CBD. The equipment is, however, expensive and the technique is difficult to master.

Experience

Experience (even large) with laparoscopic cholecystectomy (LC) is no protection against a bile duct injury (BDI) – BDI has occurred even in the hands of experienced surgeons who have performed hundreds (and even thousands) of LC.

Experienced surgeon

A surgeon who has received proper and adequate formal **training** in laparoscopic cholecystectomy (LC) and who has sufficient experience with LC.

Expert witness

Not all bile duct injuries caused during cholecystectomy are as a result of negligence on the part of the surgeon. If the Author is called for opinion as an expert witness in a case of a bile duct injury (BDI) during laparoscopic cholecystectomy (LC), the parameters on which the Author would opine whether the operating surgeon is ‘guilty’ or ‘negligent’ will be **training** of the surgeon in LC, **experience** of the surgeon with LC (no. of cases/ year), nature of **consent** (informed or not), whether the surgeon maintains a log book of all his/ her cases and their outcome, previous injuries caused by the surgeon, how promptly the BDI was suspected/ diagnosed, whether the centre where the operating surgeon works has facilities and expertise for therapeutic endoscopy and interventional radiology (if the patient was managed there) or how promptly the patient was **referred** to such a centre, **information** provided by the operating surgeon to the patient/ relatives about the injury, details of operation notes/ referral note, etc.

Exploratory

An exploratory laparotomy (at open cholecystectomy)/ laparoscopy (at

laparoscopic cholecystectomy) should be performed before cholecystectomy is begun to detect any incidental intra-abdominal pathology.

Extra-corporeal (Roeder) knot

Tied outside and then pushed down the canula into the abdomen with a **knot pusher**.

Extraction

A thin walled GB with small stones may come out through the 10 mm canula (**Fig 39**). Usually, the canula is removed when the GB neck is out of the parietes (**Fig 40**) – the GB is then taken out through the port site incision. It is easier to extract the GB through the umbilical port than through the epigastric port because the sheath

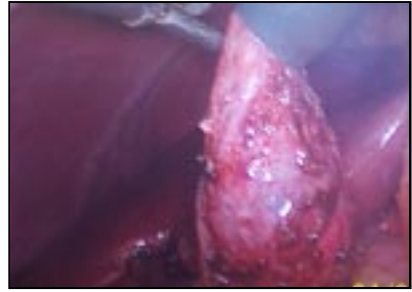


Fig 39 GB being **extracted** out of the epigastric canula (some surgeons prefer to extract it out of the umbilical canula)



Fig 40 GB neck being **extracted** out of the epigastric port site (note that the canula has been removed)

(**aponeurosis**) is more pliable at the umbilicus than in the epigastrium. The GB neck is held in the GB extractor and brought into the port. In presence of multiple stones it may be necessary to remove the stones from the GB while part of it is still in the peritoneal cavity before the GB can be taken out. If there is a large stone in the GB it may

be necessary to either dilate (**Fig 33**) or enlarge the port site or break the stone by crushing it inside the GB. While extracting the GB, the part of the GB inside the abdomen should be under continuous watch (**Fig 41**) for any perforation and bile/stone **spill**; this is possible with a 30° telescope by rotating it.



Fig 41 While the GB is being **extracted** by the surgeon, the camera assistant should keep a watch on the fundus lest the GB fundus gives way resulting in bile and stone spill

Extra port

An extra (5th) port may be required to introduce a liver retractor if segment IV (quadrate lobe) is large and overhanging, thus obscuring view of the Calot's triangle.

Failure

Planned **conversion** (by choice) of laparoscopic cholecystectomy to open cholecystectomy in case of a **difficult** GB is not a failure on part of the surgeon (cf. forced conversion after a complication such as **bleeding** or bile duct injury BDI has occurred).

Falciform ligament

While inserting the epigastric trocar, the falciform ligament should be avoided – trocar should come out either to the right (**Fig 42**) or to the left of the falciform ligament.



Fig 42 Entry of the third (epigastric) port to the right of the **falciform** ligament

Fan shaped

A fan shaped **retractor** for liver may have to be introduced if the GB fundus can not be retracted up (e.g. small GB) or if there is an overhanging segment IV (quadrate lobe) of the liver. It may also be required if a **fundus** first technique is used.

Fatty liver

A fatty liver is firmer than normal (soft) liver and is difficult to retract. Forceful retraction of GB fundus may cause a fracture of a firm liver resulting in **bleeding**. Such bleeding can be controlled by packing/ pressure (with a gauze), spray **cautery** with a **ball/ spatula** electrode, use of **gelatin** foam/ oxidised **cellulose**. Bleeding may be profuse and difficult to control if the fracture is deep into the parenchyma; **conversion** to open operation may then be required.

Fenestrated forceps (Fig 43)

A fenestrated bowel forceps (and not a sharp dissector or grasper) should be used for holding the bowel (transverse colon) to push it away from the right upper quadrant. It may be used to grasp a thick-walled GB (**TWGB**) also.



Fig 43 Good GB fundus projecting beyond liver; held and retracted by **fenestrated** bowel forceps

Fibre optic cable

A fibre optic cable connects the light source to the telescope; it should be handled carefully to prevent fracturing of the optic fibres.

First clip

It is not advisable to apply the first clip on the **cystic duct** flush with the common bile duct (CBD). For the same reason, the traction on GB neck should be released when applying the first clip on the cystic duct, lest a part of the circumference of the CBD is clipped.

“It is safer to leave a few mm of cystic duct than to include even one mm of the CBD in the clip”.

Fistula

If the duodenum or the colon is adherent to the GB and careful gentle dissection does not separate the two organs, a **cholecysto-duodenal (Fig 20)** or **cholecysto-colonic** fistula should be suspected. Presence of a fistula is not necessarily an indication for conversion; it can be tackled by large clips or **stapler**.

Fistula may form between the GB and the common bile duct CBD (cholecysto-choledochal fistula, **Mirrizi’s syndrome**) in patients with long-standing gall stone disease.

Flap valve

A flap valve in the canula remains closed due to a magnetic system but opens spontaneously when an instrument is passed (cf. a **trumpet** valve which has to be pressed to open it).

Flatulant dyspepsia

Flatulant dyspepsia may be present in patients with gall stones (GS) but is not THE symptom of gall stone disease. This means that the cause of dyspepsia should still be investigated (e.g. by UGIE) even if GS are present and that these symptoms may persist even after cholecystectomy.

Flow rate

The initial rate of flow of CO_2 should be set at 1 L/ minute – it can be increased later to 3-5 L/ minute, especially when suction is used. Men with strong muscular abdominal wall achieve high intra-peritoneal pressure with small volume of gas; multi-parous women with weak abdominal muscles, on the other hand, need large volumes of gas to achieve the desired pressure.

Fluoroscopy

Fluoroscopy with **C-arm** is useful while performing intra-operative cholangiogram (**IOC**) to delineate biliary ductal **anatomy** and to detect common bile duct (CBD) stones. It is, however, not mandatory to have it for performing a safe cholecystectomy.

Flush

After stones have been removed from within the common bile duct (CBD) – the CBD as well as the intra-hepatic ducts should be flushed thoroughly and

repeatedly with copious amounts of warm saline using an infant feeding tube, to remove small stones and sludge. **Choledochoscopy** confirms complete clearance of the biliary tree.

Fogarty

A Fogarty balloon catheter can be used to remove multiple small stones and sludge from the common bile duct (CBD). The catheter with deflated balloon is introduced into the CBD through a choledochotomy and is passed beyond the stones – balloon is inflated and the catheter is withdrawn along with the stones and sludge which are retrieved at the choledochotomy site.

Fogging

The telescope tip may get fogged thus blurring vision. It can be touched on the liver surface to defog it. Povidone iodine is also a good solution for preventing fogging. Warm gas/ warm saline for irrigation may also help. Telescope warmers are also available but are expensive.

Follow up

All patients who have undergone cholecystectomy should have at least one follow up visit to check the histopathology report of the GB so that an **incidental** gall bladder cancer (GBC) is not inadvertently missed.

French position

Legs abducted in extended position and the surgeon standing between the legs of the patient. Camera operator stands on the right and first assistant to the left of the patient.

cf. **American position**

French technique

Liver is retracted upwards by a retractor introduced through an epigastric port and the GB neck is retracted down and out by a grasper introduced through a right hypochondrial port. Working port is placed in the left hypochondrium or in the midline between the epigastric and umbilical ports.

Frozen

Long-standing chronic cholecystitis with recurrent attacks of **acute cholecystitis** results in inflammatory fibrosis leading to obliteration of the Calot's triangle – attempts at forceful dissection in the Calot's triangle in such a case may result in injury to the common hepatic duct (CHD) or the right hepatic artery (RHA). **Fundus first** method may be useful in such cases.

Fundus

Fundus of the GB should not be grasped in the first go - a thin walled duodenum/ colon below the liver may sometimes look like the GB fundus (**Fig 44**).

Liver should first be elevated (pushed up) with the closed blunt tip of the grasper to confirm that what appears to be the GB fundus is in fact the GB fundus and not duodenum/ colon. Only then the GB fundus should be grasped with a non-toothed grasper with rachet and retracted upwards towards the right shoulder.

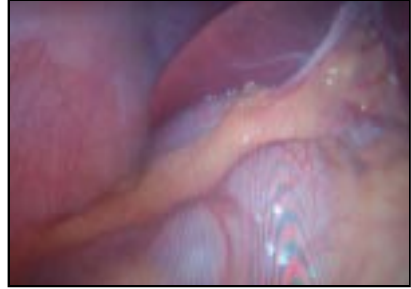


Fig 44 GB fundus or colon or duodenum?

Fundus first (prograde) dissection

This is a very useful technique of open cholecystectomy for a difficult GB (unclear Calot's triangle anatomy). Once GB neck area is reached, GB can be divided leaving a part of GB neck (and cystic duct) behind – **partial cholecystectomy** – to avoid injury to the common hepatic duct (CHD) and the common bile duct (CBD). This is a very useful technique for **Mirrizi's syndrome** also.

During laparoscopic cholecystectomy (LC), once fundus is dissected off the liver it can not be used to retract the liver – an **extra** port is then required to introduce a liver retractor.

Gangrenous cholecystitis

Gangrenous cholecystitis is a complication of **acute cholecystitis** which should be suspected in case of non-response of an attack of acute cholecystitis to conservative management. It merits an **emergency cholecystectomy** (cf. **early cholecystectomy** for uncomplicated acute cholecystitis).

Gasless laparoscopy

Gasless laparoscopy, using abdominal wall lifts, avoids complications of pneumo-peritoneum e.g. gas embolism, shoulder pain and CO_2 toxicity e.g. **hypercarbia, acidosis**.

GB (Gall bladder)

In case of **bleeding** from the GB bed in the liver, the dissected GB can be used as a 'sponge' to assist haemostasis in the GB bed.

Gelatin foam

Gelatin foam (Gelfoam, Cura Medicals) can be used to assist haemostasis in the GB bed.

Gender

'Male' GBs are generally more difficult than 'female' GBs. **Conversion** (from laparoscopic to open cholecystectomy) rates are always more in men than in women.

General anaesthesia

Laparoscopic cholecystectomy (LC) should be performed under general anaesthesia (GA). GA is preferred for open cholecystectomy (OC) also as it provides good muscle relaxation; OC can, however, be performed under regional (spinal/epidural) analgesia also.

Glue

A synthetic glue e.g. cyanoacrylate, can be used in place of sutures to approximate the skin at the port sites; this suture less closure gives a better cosmetic outcome.

Glutaraldehyde

Glutaraldehyde (Cidex, Johnson & Johnson) is commonly used for sterilisation of laparoscopic instruments. This, however, requires immersion for a long period of 10 hours.

Gold standard

Laparoscopic cholecystectomy (LC) has become the gold standard of

management of symptomatic gall stones, though without going through the rigorous test of randomized controlled trials (to compare it with and prove its superiority over open cholecystectomy).

Graspers

GB fundus can be held in a non-toothed grasper with ratchet as this grasper remains in place from the beginning until almost the end of the procedure.

GB neck should be held in a non-toothed grasper without ratchet as it may have to be removed and reapplied at a different point several times during the operation. A bowel holding forceps may also be used.

A toothed grasper may rarely be used in case of a thick walled GB (**TWGB**) which is difficult to hold with a non-toothed grasper.

Grey Turner (Lancet 1944)

“Injuries to the main (bile) duct are nearly always the result of misadventure during operation (cholecystectomy) and are, therefore, a serious reproach to the surgical profession”.

“Injuries to the bile ducts (during cholecystectomy) are unfortunately not rare and often turn out to be tragedies”.

Guttering

The transverse limb of the **T-tube** which is placed in the common bile duct (CBD) after CBD exploration should be guttered – this helps in smooth removal of the T-tube.

Haemolock (Weck)

Haemolock is more secure than ordinary clips. It may be used in case of **wide/** thick-walled cystic duct.

Haemostasis

Haemostasis in the GB bed should be checked once again after the GB has been extracted, by reintroducing the canula and retracting the liver upwards.

At the end of cholecystectomy, each canula should be removed under vision to make sure that there is no trickle of blood from a bleeder in the port site parietes.

HALS (Hand assisted laparoscopic surgery)

In a difficult case or in case of bleeding, a hand introduced through a hand port (e.g. Gelport, Applied Systems) into the peritoneal cavity may be a big help. These ports are, however, very expensive. The Author has, in some cases, introduced his hand directly through an incision (large enough to push the hand but tight enough not to allow gas to leak out).

Harmonic scalpel (Ethicon)

Harmonic scalpel causes less collateral thermal damage than **cautery** as the maximum temperature is 80°C; also, it can provide both coagulation and cutting function.

Harmonic scalpel is not required for laparoscopic cholecystectomy (cf. advanced laparoscopic surgery for which it is almost essential). However, if it is available, it can be used for lysis of **adhesions** and for dissection also. Some surgeons take the **cystic duct** and artery with Harmonic scalpel (no clips), but the Author does not dare to do so and advises against this practice.

“Only thieves get away with what they do.

All thieves get caught – most sooner, some later.”

Hartman's pouch (Fig 45)

Hartman's pouch is an outpouching of the GB neck – usually on its lower/ inferior border. A large stone often gets impacted in the Hartman's pouch. Sometimes, the pouch is on the upper/ superior border of the GB neck – a stone in such a pouch can then compress the common hepatic duct (CHD) (**Mirizzi's** syndrome). It may also get adherent to the CHD resulting in injury to the CHD during



Fig 45 GB fundus retracted upwards to expose the **Hartman's** pouch, GB neck and Calot's triangle

dissection in Calot's triangle. Adhesions between the Hartman's pouch and the duodenum (**Fig 46**) may be the precursor of a cholecysto-duodenal fistula.

Hasson's

Hasson's **open technique** of insertion of the first trocar (without use of Veress needle) is safer than the technique of **blind insertion** after creation of **pneumo-peritoneum** using Veress needle. The Author uses and advocates the open technique of insertion of the first trocar.

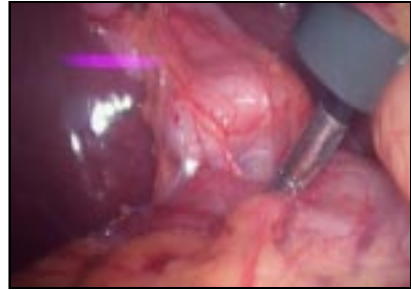


Fig 46 Adhesions between the **Hartman's** pouch and duodenum may be a precursor of a cholecysto-duodenal fistula

Heat

Prolonged use of **cautery** may heat up an instrument tip – the heated tip, if it touches a viscus, may cause **thermal** injury. All instruments must be introduced, manipulated and removed under vision.

Heister

Spiral valves of Heister (they are, in fact, mucosal folds) in the **cystic duct** may make passage of a catheter (for intra-operative cholangiogram **IOC**) or bougie or balloon (for dilatation before a trans-cystic choledocholithotomy) difficult.

Help

In case of a difficulty or problem during cholecystectomy, help of a senior/ more experienced colleague should be obtained, if available and possible. This may hurt the ego of the surgeon but is going to be of immense benefit to the welfare and safety of the patient.

Heparinised saline

Heparinised saline may be placed in the subhepatic fossa to prevent any blood collecting there from getting clotted, thus making it easier to be sucked out. Best approach is, however, to prevent any **bleeding** and, if at all it occurs, to control it then and there rather than allowing the blood to collect.

Hepatic flexure

The hepatic flexure of the right colon should be brought down for better exposure of the hepato-duodenal ligament for common bile duct (**CBD**) **exploration**. **Kocherisation** of duodenum is also essential.

Histopathology

All removed GBs **MUST** be subjected to histo-pathological examination (even if they look grossly normal) so as not to miss an **incidental GBC**.

History

Patients with gall stone disease (GSD) should be asked for duration of symptoms and history of attacks suggestive of **acute cholecystitis**. Those with long duration of symptoms, especially if interspersed with repeated attacks of acute cholecystitis are more likely to have a **difficult GB** viz. **adhesions**, thick walled GB (**TWGB**), fibrosed or obliterated Calot's triangle, etc and higher chances of conversion from laparoscopic cholecystectomy (LC) to open cholecystectomy (OC).

Hole

A hole near the tip of the **canula** allows the intra-peritoneal gas to escape with a hiss that informs the surgeon as soon as the trocar – canula complex enters the peritoneal cavity.

Hook (Fig 47)

Hook should not be used in the Calot's triangle as its sharp tip can cause injury to the common bile duct (CBD)/ right hepatic artery (RHA). It is a useful instrument (along with **cautery**) for dissecting GB off from its bed in the liver. Alternatively, a **spatula** may be used.

Heat generated by **cautery** is inversely proportional to the surface area of the electrode - a hook or needle electrode, therefore, produces more heat than a **spatula** or **ball** electrode.



Fig 47 Posterior peritoneum in GB bed being dissected with **hook** and cautery

Hug

The dissection, especially in the Calot's triangle, must always remain close to the GB - to avoid injury to the bile duct and the hepatic artery.

'The surgeon should hug the GB as he/ she would his/ her girlfriend/ boy friend.'

Hurry

The surgeon should not be in a hurry to complete the cholecystectomy in a 'record' time.

*"A 'quick cholecystectomy'
in a 'simple GB'
by an 'overconfident surgeon'
is a recipe for disaster (bile duct injury)."*

Hypercapnia

Hypercapnia, especially after a prolonged laparoscopic cholecystectomy, may cause **acidosis** and hypertension.

IAGES (Indian Association of Gastro Intestinal Endo-Surgeons)

IAGES, with more than 1,800 members, is one of the largest groups of laparoscopic surgeons in India (www.iages.org.in). It offers a Fellowship programme in endo-surgery.

Ileus, gall stone

A large gall stone may pass through a cholecysto-duodenal **fistula** and cause distal small bowel obstruction (**Fig 48**). Gall stone disease and **aerobilia/pneumobilia** on US and distal small bowel obstruction in an elderly female is suggestive of the diagnosis. Two stage operation - relief of obstruction (by removing the stone through an enterotomy) followed by elective cholecystectomy and repair of the cholecysto-duodenal fistula at a later date, is recommended, especially in a sick patient.



Fig 48 Gall stone ileus

Imaging system

The imaging system for laparoscopic cholecystectomy (LC) includes the telescope, light source, camera and the **monitor**.

Immuno-suppression

Patients with solid organ **transplant** will receive immuno-suppression which may mask signs of inflammation if the patient develops **acute cholecystitis** – prophylactic cholecystectomy is, therefore, indicated in such patients before/ during the transplant, even if the gall stones (GS) are **asymptomatic**.

Incidental cholecystectomy

Cholecystectomy performed for otherwise **asymptomatic** gall stones (GS) during laparotomy for some other indication in order to prevent post-operative **acute cholecystitis**.

Incidental GBC

Incidental gall bladder cancer (GBC), detected for the first time on histopathological examination of a gall bladder removed with a presumed diagnosis of gall stone disease (GSD) should be treated as a semi-emergency – the patient should be referred to a hepato-biliary surgeon/ surgical oncologist as soon as possible for an opinion regarding re-operation for completion extended cholecystectomy which may be required in most cases (except T1a mucosal disease in which case simple cholecystectomy alone is enough).

Incision

Several incisions can be used for performing an open cholecystectomy (OC)

1. Kocher's right subcostal
2. Midline incision is preferred when other associated procedures are also to be performed e.g. splenectomy in a patient with haemolytic anaemia
3. Upper right transverse (trans-rectus) for mini-laparotomy – may be suitable for thin-built patients
4. Right paramedian - rarely used now

When converting from laparoscopic cholecystectomy (LC) to OC, the epigastric and subcostal port sites of LC may become part of the subcostal incision for OC (**Fig 49**).



Fig 49 Epigastric and sub costal ports being joined to form a sub-costal **incision** for conversion of laparoscopic to open cholecystectomy

Incisional hernia

In case of open cholecystectomy (OC), a subcostal incision is less likely to develop an incisional hernia than a midline incision. In laparoscopic cholecystectomy (LC), incisional hernia is most likely to occur at the **umbilical** port site as the linea/ aponeurosis is weakest at this port.

Increase

The number of cholecystectomies being performed has increased after the introduction of laparoscopic cholecystectomy (LC). This may be due to more liberal indications including **flatulent dyspepsia** and **asymptomatic** GS, and lower threshold for offering and accepting cholecystectomy.

Indications

By and large, the indications for cholecystectomy are

1. Symptomatic gall stones (GS) – biliary colic
2. Complications of GS – acute cholecystitis, common bile duct (CBD) stones, acute pancreatitis

Informed consent

All patients undergoing laparoscopic cholecystectomy (LC) should be informed about the procedure – number of incisions (many patients think that LC is an incision-less procedure akin to lithotripsy for renal stones), expected post-operative course and recovery, discharge from the hospital and return to work (so that they can plan alternate arrangements at home, work, etc.) and, most importantly, the chances of conversion to an open operation (Author usually says 5%).

Infundibulum

The neck of the GB where body of the GB narrows into the **cystic duct**.

Injury

As a first step, the area beneath the first trocar should be inspected as soon as the telescope is introduced into the peritoneal cavity to detect any trocar induced omental/ bowel injury/ port site **bleeding** (more so when the first trocar is introduced by the close technique of **blind insertion**).

In situ

In elderly patients with both GB and common bile duct (CBD) stones, who are poor risk for anaesthesia and surgery because of their co-morbid conditions, CBD may be cleared of stones by endoscopic intervention (if all the stones in the CBD can not be removed a stent may be placed to prevent CBD obstruction and **cholangitis**) and the GB (even with stones) may be left in situ.

Inspection

As soon as the telescope is introduced, the omentum/ bowel just underneath the umbilicus should be inspected for any injury caused by insertion of the first trocar – more so if it was a **blind insertion** by closed technique.

Instruments

All instruments must be introduced, moved and removed under vision to avoid an inadvertent injury to a viscus.

Insulation

Insulation of all instruments on which **cautery** is used should be checked thoroughly and carefully before each operation. An area of lack of insulation on an instrument can result in an inadvertent thermal injury to the adjacent organs e.g. duodenum, colon, common bile duct (CBD), etc.

Interval cholecystectomy

Elective cholecystectomy performed 4-6 weeks after an attack of **acute cholecystitis** has been managed conservatively.

Intra-abdominal pressure

During laparoscopic cholecystectomy (LC), intra-abdominal pressure should be maintained at a maximum of 12 mm Hg. In patients with cardio-respiratory disease, a lower (8-10 mm) pressure may be used.

Intra-hepatic

GB may be intra-hepatic thus making it difficult to hold the fundus and retract the liver upwards. In such cases, an **extra** port in right upper abdomen may be required to retract the liver and the right iliac fossa/ para-umbilical port may be

dispensed with.

Recurrent, long-standing inflammation may result in a small fibrosed **contracted** GB thus making it intra-hepatic - in such cases, the plane between the GB and the liver may also get obliterated. Caution has to be exercised while dissecting the GB off its bed in the liver – if the plane of dissection is too close to the GB a hole may be caused in the GB wall resulting in bile and stone **spill**; if the plane of dissection enters the liver parenchyma, **bleeding** may result.

Introduction

No instrument should be introduced into the peritoneal cavity through a **canula** blindly (without its introduction being followed by the telescope and the camera). Blind introduction of an instrument can cause inadvertent damage to omentum, bowel, liver, etc.

IOC (Intra-operative cholangiogram)

In supine position, the common bile duct (CBD) lies over the spine. A slight left elevation of the patient by placing small sand bags behind the left lower chest and left buttock will throw the CBD off the spine on cholangiogram.

There is controversy as to whether an IOC can prevent a bile duct injury (BDI) during cholecystectomy. IOC can prevent injuries which are because of anomalous **anatomy**; those because of **difficult** pathology and **dangerous** surgery will still occur in spite of an IOC. IOC certainly helps in early intra-operative recognition of the injury that may have already occurred. Unlike IOC for detecting **CBD stones** which can be selective (performed in high risk cases only), IOC to prevent a BDI has to be routine (to be performed in all cases).

IOC is usually performed by trans-cystic technique. **Cystic duct** is dissected, a small nick is made in the wall of the cystic duct, a catheter is introduced through the cystic duct into the CBD and contrast is injected. The problem with this technique, however, is that if the so-called cystic duct was, in fact, the common bile duct (CBD), a bile duct injury has already occurred. IOC can be performed by injecting contrast into the GB (**cholecysto-cholangiography**) or by direct CBD puncture (not recommended) also.

IOC is not frequently performed now for diagnosis of CBD stones because of the availability of MRC.

IOC may also be performed after choledocholithotomy for documentation of clearance of the CBD.

Iodine

Povidone iodine (Betadine) is commonly used for preparation of skin before operation.

It is also used for cleaning a fogged telescope tip.

Irrigation

Irrigation with saline (either through a syringe or using a drip set attached

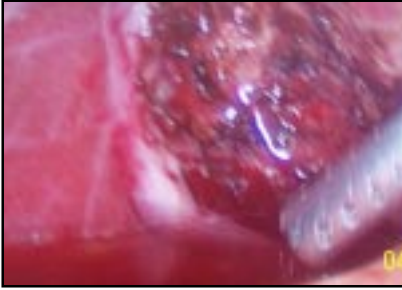


Fig 50 Irrigation of the GB bed to check the site of bleed and to obtain complete haemostasis

Subhepatic fossa should be thoroughly irrigated with copious amounts of saline in case of bile **spill** to dilute the irritant bile.

Port of GB extraction may get contaminated with bile - it should then be irrigated with copious amounts of saline (**Fig 51**) to reduce the risk of infection.

to a plastic saline bottle being compressed by a sphygmo-manometer cuff) is the laparoscopic equivalent of a sponge in an open operation. An irrigation-suction canula helps to suck out the saline at the same time.

GB bed should be irrigated with saline to check for any bleeding points and to obtain complete haemostasis (**Fig 50**).



Fig 51 Port of extraction of GB being irrigated with saline before closure

Jaundice

Patients with common bile duct (CBD) stones may have surgical obstructive jaundice and need preparation before any intervention – surgical or non-surgical (endoscopic or percutaneous). This includes hydration (intravenous fluids), diuresis, correction of **coagulopathy (vitamin K)** and **antibiotics**.

Judgment

Conversion by choice from laparoscopic to open operation in case of a **difficult** cholecystectomy is not a **failure** but an indication of sound and mature judgment on part of the surgeon.

K Vitamin

Patients with common bile duct (CBD) stones and surgical obstructive **jaundice** have **coagulopathy** which needs correction with vitamin K – 10 mg IM once daily for 3-5 days before any intervention (surgical or non-surgical – endoscopic or percutaneous).

Key hole

Laparoscopic cholecystectomy is often referred in lay terms as key hole cholecystectomy.

Knot

Every laparoscopic surgeon should learn the technique of tying a knot - either intra-corporeal (with instruments) or **extra-corporeal** (which is then pushed down with a **knot-pusher**).

Knot pusher

Used to push down an extra-corporeally tied knot.

Kocher's

Kocher's right subcostal incision is preferred (over midline) in heavy built patients with a wide costal margin. It should preferably be closed in two layers – inner transversus + internal oblique/ posterior rectus sheath and outer external oblique/ anterior rectus sheath – both with heavy (1 or 1-0) long acting absorbable suture e.g. **PDS**.

Kocherisation

For open common bile duct (CBD) exploration, duodenum C loop should be kocherised by incising the peritoneum on its right border – this allows the surgeon to palpate the lower CBD.

Duodenal kocherisation should be performed for **choledochoduodenostomy** also.

Landmarks

Duodenum, umbilical fissure, **Rouviere's sulcus** and **cystic lymph node** are some important landmarks during laparoscopic cholecystectomy.

Lane's forceps (Fig 52)

Heavy Lane's forceps are used to hold the skin edges when making an infra-umbilical incision in the linea for **open insertion** of the first trocar – Allis' forceps can be used instead.



Fig 52 Lane's forceps and Langenbeck retractor

Langenbuch

Carl Von Lagnenbuch of Germany performed the first open cholecystectomy in 1882.

Langenbeck retractor (Fig 52)

Small thin-bladed retractors are very useful during **open insertion** of first/ umbilical canula and during closure of **aponeurosis**/ sheath at the port sites.

Laparoscopic cholecystectomy

Laparoscopic cholecystectomy (LC) offers several advantages over open cholecystectomy (OC) viz. less pain, quicker recovery, shorter hospital stay, earlier return to work and better cosmesis. The risk of bile duct injury (**BDI**) in LC is, however, at least 2-3 times that in OC – i.e. about 0.5% - 1 in 200!

Laparoscopic US (Ultrasonography)

Laparoscopic US using high frequency (7-10 MHz) probe is used for common bile duct (CBD) evaluation for stones; it may also evaluate GB wall for any thickening which raises suspicion of gall bladder cancer (GBC) and warrants conversion from laparoscopic cholecystectomy (LC) to open cholecystectomy (OC).

Large

A large gall stone (GS) impacted in the GB neck/ **Hartman's** pouch may make cholecystectomy **difficult** – GB neck becomes difficult to grasp and retract and the Calot's triangle does not open as most of it is occupied by the large stone. An intentional opening in the GB on the stone (towards GB body) and removal of stone out of the GB may help in holding the GB neck and may open the Calot's triangle. The stone taken out of the GB should be immediately placed in a **bag** introduced into the peritoneal cavity, lest it gets lost or is forgotten!

Laser

Laser dissection was promoted for dissection during laparoscopic cholecystectomy (LC) but has gone out of vogue due to increased complications.

Lavage

In case of bile **spill**, the sub-hepatic fossa should be thoroughly lavaged with copious amounts of saline to dilute irritant bile.

Learning curve

Injuries are more likely to occur in the first few laparoscopic cholecystectomies of a surgeon but they have occurred even after the surgeon has performed hundreds (and even thousands) of laparoscopic cholecystectomies.

“Learning curve in laparoscopic cholecystectomy is a myth.”

Left

1. Normally, the **cystic duct** joins the common bile duct (CBD) on its right side; in some cases, however, it may cross the CBD (in front or behind) and join the CBD on its left side
2. Left hand of the first assistant, which retracts the stomach and duodenum down and left, is the most important ‘instrument’ during an open cholecystectomy (OC).

Left alone

The temptation to remove small stones detected in an undilated common bile duct (CBD) on intra-operative cholangiography (IOC) by a choledochotomy should be avoided as it is difficult and may result in an injury to the CBD resulting in fibrosis and stricture. These stones should be left alone during cholecystectomy as they may pass on their own or may be removed by endoscopic intervention (papillotomy and basketing) post-operatively.

Legal

A bile duct injury (**BDI**) is very likely to result in a medico-legal suit against the surgeon; **conversion** (from laparoscopic to open cholecystectomy), on the other hand, will almost never.

LFT (Liver function tests)

A complete LFT must be obtained in all patients with gall stone disease (GSD) planned for cholecystectomy.

Evidence of biliary obstruction (raised serum bilirubin and elevated serum alkaline phosphatase and/ or gamma glutamyl transpeptidase GGTP and dilated CBD on US) classifies the patient as medium/ moderate **risk** for common bile duct (CBD) stones and indicates a pre-operative cholangiogram, preferably MRC. **CBD stones** may, however, be present with a normal LFT also.

Elevated serum alkaline phosphatase in the absence of hyper-bilirubinemia

raises the suspicion of gall bladder cancer (GBC) in a patient with GSD – CT may be obtained for better evaluation of GB wall.

Liberalized

After the introduction of laparoscopic cholecystectomy (LC), indications for cholecystectomy seem to have become liberalized because the number of cholecystectomies being performed has increased.

Lift

Various devices for abdominal wall lift can help to perform gasless laparoscopic cholecystectomy.

Ligaclip (Ethicon Endo-surgery)

Titanium clips used for clipping cystic duct and cystic artery during laparoscopic cholecystectomy.

Ligasure

Ligasure is an energy source which can seal vessels upto 7 mm. While it is very useful for advanced laparoscopic surgery, it is not required for cholecystectomy.

Ligature

In case of a **wide** cystic duct, which can not be clipped even with a large clip (**Fig 53**), a ligature tied around the **cystic**



Fig 53 Wide cystic duct – even large size clips can not cover complete circumference

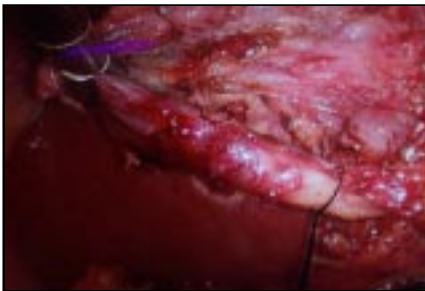


Fig 54 Ligature around a wide cystic duct

duct (Fig 54) crumples it and may then make it clipable.

Before the cystic duct is opened and cannulated for an intra-operative cholangiogram (**IOC**), a ligature is tied around it at its junction with the GB to prevent stone and bile spill.

Light source

Cold light, 250-300 watt, halogen (xenon is better but more expensive).

Linea

See **Aponeurosis**

Lithotripter

A mechanical lithotripter to break **large** stones in the GB before its extraction out of the peritoneal cavity is an expensive option. Stones can be easily broken within the GB with a heavy instrument such as stone holding forceps, ovum forceps or Kelley's clamp.

An endoscopic lithotripter can be used to break a large common bile duct (CBD) stone before its endoscopic removal.

Littlewood's retractor

A narrow bladed fine retractor to retract skin edges up while introducing the first trocar. Lane's forceps can also be used.

Lund

Cystic lymph node (LN) of Lund is an important landmark to locate the **cystic artery** in the Calot's triangle. Dissection kept to the right of the cystic LN will invariably safeguard the common bile duct (CBD).

Luschka, Ducts of

Small bile ducts may drain directly from the liver into the GB in the GB bed – usually they are not seen and **electro-cautery** used for dissecting GB off its bed in the liver seals them; a large duct of Luschka, if not clipped/ ligated, may result in post-operative bile leak.

Male

Cholecystectomy is usually more difficult in males and they are more likely to have a **conversion** from laparoscopic cholecystectomy (LC) to open cholecystectomy (OC) than females.

Maryland dissector

Laparoscopic equivalent of a right angled clamp used in open cholecystectomy (OC) – for dissection in the Calot's triangle.

Micro-lithiasis

Biliary cystals and small stones (microliths) may form biliary **sludge**.

Micro-scissors

Used for making a nick in the anterior wall of the **cystic duct** to cannulate it for intra-operative cholangiography (**IOC**) during laparoscopic cholecystectomy.

Milking

Cystic duct should be milked with a grasper from the common bile duct (CBD) side towards the GB neck to empty it of any stones which may interfere with its clipping and may get pushed down into the CBD during its clipping.

Mini incision

See **Mini laparotomy**

Mini-laparotomy

Some surgeons perform open cholecystectomy (OC) through a mini (about 5 cm) transverse incision. Several types of small transverse trans-rectus incisions have been described to perform OC – the incision should, however, lie on the Calot's triangle rather than on the GB fundus. Lighted retractors, long instruments and use of clips (rather than ligatures) are helpful.

The Author feels that this technique has the disadvantages of both OC and laparoscopic cholecystectomy (LC) added together and does not recommend it, except may be in very thin-built patients.

Mirrizi's syndrome (Fig 55)

Mirrizi's syndrome is defined as common bile duct (CBD) obstruction caused by a large stone in the GB neck (Type I) or a cholecysto-choledochal **fistula** (Type II-IV). It is a manifestation of long-standing gall stone disease (GSD).

Mirrizi's syndrome should be suspected in a patient with GSD and surgical obstructive jaundice

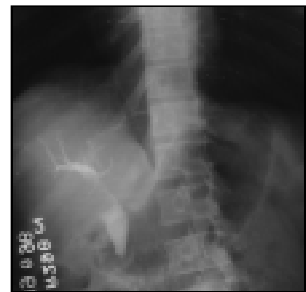


Fig 55 ERC showing large stone (seen as filling defect) in mid CBD – **Mirizzi's** syndrome

(SOJ) with US showing a large stone at the GB neck and mid-CBD block. A pre-operative cholangiogram (**MRC/ ERC**) should be obtained before cholecystectomy. Patients with SOJ may require endoscopic stenting before surgery.

A complete cholecystectomy may not be possible and should not be attempted in a patient with Mirrizi's syndrome as it is likely to result in a bile duct injury (**BDI**). A **partial cholecystectomy** – leaving the part of GB neck adherent to the CBD behind is the treatment of choice. This can be performed laparoscopically by an experienced surgeon. It is, however, safer to convert to open cholecystectomy (OC) and use a **fundus first** technique. GB may be opened at fundus/ body and the large stone removed before the GB neck is divided. A **stapler** may be used.

For type II Mirrizi's syndrome (fistula involving less than 1/3rd of CBD circumference), cholecysto-choledochoplasty (repair of CBD defect with remnant of GB neck) is the treatment of choice.

For Type III-IV Mirrizi's syndrome (fistula involving more than 1/3rd or more than 2/3rd of CBD circumference), a biliary-enteric anastomosis (BEA) in the form of hepatico-jejunostomy (HJ) is indicated.

Missed

Some surgeons do not send a grossly normal looking GB for histological examination – an **incidental** gall bladder cancer (GBC) may, thus, be missed. Such a patient can have local (GB bed) or regional (lymph node LN) recurrence and present after a few months with surgical obstructive jaundice (SOJ), gastric outlet obstruction (GOO) and a mass on imaging (US or CT) – missed GBC. Missed GBC is almost always unresectable.

Rarely, even when the GB is subjected to histopathology, an early GBC can be missed on a routine 3-section (fundus, body, neck) histo-pathological examination.

Missed injuries

Injuries to duodenum, transverse colon and small bowel are often missed during laparoscopic cholecystectomy (LC) and become manifest as peritonitis and sepsis in the post-operative period. The delay in diagnosis and management may prove fatal.

Monitor

Large (at least 20"), non-flickering, medical monitors are preferred.

Monopolar cautery (See Cautery, Electro-cautery, Unipolar cautery also)

Commonest haemostatic equipment - used carefully, it is a safe device.

Mortality

Majority of deaths after open cholecystectomy (OC) are in elderly patients with multiple uncontrolled medical risk factors and co-morbid conditions; very few are a result of the surgical procedure, per se. Deaths after laparoscopic

cholecystectomy (LC), on the other hand, are in young, otherwise healthy patients and are a direct consequence of surgical complications (most commonly bile duct injury BDI).

Mouret

Philip Mouret of Lyon, France performed the first laparoscopic cholecystectomy (LC) in 1987.

MRC (Magnetic resonance cholangiography)

MRC is the investigation of choice for ruling out common bile duct (CBD) stones in patients at intermediate/ moderate **risk** viz. remote history of **jaundice**, **cholangitis** or **acute pancreatitis**, elevated serum alkaline phosphatase or dilated CBD on US. Patients at high risk for **CBD stones**, on the other hand, should go directly for endoscopic retrograde cholangiography (**ERC**) as chances of finding a CBD stone (**Fig 56**) are high and a therapeutic intervention can be performed at the same time. Patients with low risk do not need a cholangiogram.

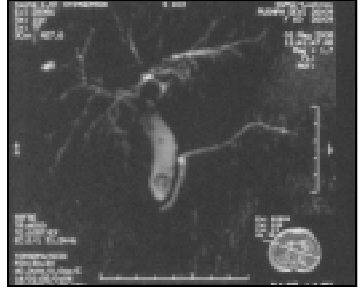


Fig 56 MRC showing large CBD stone

Mucocoele

GB (normal capacity 30-50 ml) has a large capacity to distend – up to 300-500 ml. A hugely distended GB may have to be aspirated before cholecystectomy is started.

Muhe

Erich Muhe of Boblingen, Germany performed the first laparoscopic cholecystectomy (LC) on 12th Sep 1985 – it met with skepticism and he was reprimanded by the German Surgical Society. The same society in 1992, however, honoured him with its highest Anniversary Award.

Murphy's sign

Tenderness on deep inspiration, while the surgeon palpates the right upper quadrant with fingers pushed in beneath the right costal margin, indicates **acute cholecystitis**. It can be elicited by US probe also placed on the GB fundus.

Mycobacteria

Atypical mycobacteria may cause persisting **sinus** after laparoscopic cholecystectomy (LC). Pus from a persisting sinus should, therefore, be sent for acid fast bacilli (AFB) staining and mycobacterial culture-sensitivity, in addition to routine bacterial culture-sensitivity.

Naso-gastric tube

A naso-gastric tube should be passed at induction of anaesthesia to deflate the stomach (distended stomach may obscure the view in the sub-hepatic area) – it can be removed at the time of reversal of anaesthesia.

Neck, GB

The GB body narrows through its neck (infundibulum) into the cystic duct.

Nephroscope

A nephroscope can be used for laparoscopic trans-choledochal choledocholithotomy.

Non-specific symptoms

Nausea, bloating, indigestion and **flatulence (dyspepsia)** are non-specific symptoms and may not necessarily be caused by gall stones – this means that cholecystectomy may not relieve these symptoms.

Normal

A normal intra-operative cholangiogram (**IOC**) has the following features

1. Undilated common bile duct (CBD)
2. Normal tapering at the lower end of the CBD
3. Normal right and left hepatic ducts
4. No filling defects in the CBD or the intra-hepatic bile ducts
5. Free flow of the contrast into the duodenum

North American position

Patient lies supine. Surgeon stands on the left side of the patient. Camera operator stands to the left of the surgeon and the assistant on the right side of the patient. Most surgeons (including the Author) prefer this position for performing laparoscopic cholecystectomy (LC).

North American technique

Liver is retracted by retracting the GB fundus upwards (cranially) towards the right shoulder by a grasper introduced through a right lower (iliac fossa) port and the GB neck is retracted down and out by introducing a grasper through a right hypochondrial (subcostal) port. This technique is used by most surgeons (including the Author).

NOTES (Natural orifice transluminal endoscopic cholecystectomy)

Cholecystectomy has been performed through vagina and stomach, but the Author would prefer to wait and see how this technique evolves and compares

with standard 4 port laparoscopic cholecystectomy (LC).

Number of cholecystectomies

USA (population 300 million) about 750,000 per year

UK (population 60 million) about 40,000 per year

India (population 1,000 million) No data available

Obese

Initially obesity was thought to be a relative contraindication for laparoscopic cholecystectomy (LC) but it is actually advantageous in obese patients as chances of complications such as **wound infection** and **incisional hernia** are less than after open cholecystectomy which would require a long incision in obese patients.

Obese patients may, however, pose special problems for LC.

1. Thick layers of subcutaneous and extra-peritoneal fat make insertion of Veress needle for creation of pneumo-peritoneum difficult.
2. Heavy omentum is difficult to take away from the sub-hepatic area.
3. Fat-laden hepato-duodenal ligament obscures biliary anatomy
4. Fat laden Calot's triangle makes dissection of **cystic duct** and artery difficult.
5. Normal sized canulae and instruments may be too short – longer canulae and instruments may be required. Camera port should be placed in a supra-umbilical (instead of infra-umbilical) position.

Oblique passage

Oblique passage of a canula (especially right para-umbilical) may result in a long tract parallel/ tangential to the parietes resulting in loss of functional (intra-peritoneal) length of the **canula**/ instrument.

Oblique

Oblique (30°, 40°, 50°) view telescopes are useful to 'look around the corners'. Every laparoscopic surgeon should have at least a 30° telescope in addition to a 0° (forward view) telescope.

Observation

Small (< 3 mm) common bile duct (**CBD**) **stones** detected on intra-operative cholangiography (**IOC**) during cholecystectomy may be left alone as they are likely to pass down through the papilla into the duodenum; some surgeons would, however, prefer to get them endoscopically removed post-operatively for fear of them causing **acute pancreatitis**.

OCG (Oral cholecystography) (Fig 57)

OCG was the key investigation for diagnosis of gall stones (GS) before the advent of US but is no longer used. US is the investigation of choice for diagnosis of GS now.



Fig 57 Oral cholecystogram (OCG) was used earlier for diagnosis of gall stones; it is no longer used – ultrasonography (US) is the

OCP (Oral contraceptive pills)

Young women who are on OCPs should be advised to discontinue them for at least 4-6 weeks (and use some other method of contraception) before they are taken up for elective cholecystectomy. This is to reduce the risk of deep venous thrombosis (**DVT**) and pulmonary embolism (**PE**).

Oedema

GB wall oedema (seen as thick GB wall) on US suggests **acute cholecystitis**. Peri-cholecystic oedema (between GB wall and liver parenchyma) is also present.

Olsen clamp

To occlude the **cystic duct** with intra-operative cholangiogram (**IOC**) catheter in situ.

Omental adhesions

In patients who have undergone previous pelvic surgery, omentum may be adherent in pelvis and/ or to the lower midline scar. This makes introduction of the Veress needle/ first canula difficult. An avascular window in omentum is to be found through which telescope can reach to the right upper quadrant.

Omental **adhesions** to the parietes in the right upper quadrant should be divided, preferably using scissors with **cautery** or **Harmonic scalpel**. Good haemostasis should be achieved after separating omental **adhesions** – omental vessels can be a source of a major **bleed**.

Omnitract (Fig 58)

A self retaining retractor system for retracting the costal margin is very useful during open cholecystectomy as it obviates the need of a second assistant. Omnitract (Pilling Weck) is, however, very expensive. A less expensive, yet equally

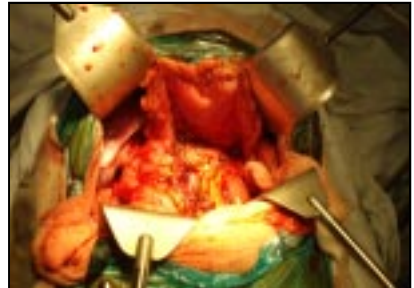


Fig 58 Omnitract (Pilling Weck) in use (Dr TD Yadav PGIMER Chandigarh)



Fig 59 Table mounted self retaining retractor (Dr SP Haribhakti Sterling Hospital Ahmedabad)

effective, option is a table mounted self retaining retractor (**Fig 59**) devised by Dr SP Haribhakti of Sterling Hospital, Ahmedabad (an alumnus of the Department of Surgical Gastroenterology).

Ondansetron

Many anaesthetists give an

injection of ondansetron at the time of induction of anaesthesia to reduce the incidence of post-operative nausea and vomiting (PONV) after laparoscopic cholecystectomy.

Open cholecystectomy

Open cholecystectomy is a time-tested, safe operation. There is nothing against it if return to work and cosmesis are not of much importance to the patient. Risk of bile duct injury (**BDI**) is much less (about 0.2% - 1 in 500) in open cholecystectomy (OC) than in laparoscopic cholecystectomy (LC) (about 0.5% - 1 in 200).

Open technique

Open technique of insertion of the first trocar (cf. Veress needle pneumoperitoneum and **blind insertion** of the first trocar) is preferred by many surgeons (including the Author).

Through a transverse infra-umbilical incision, the junction of the umbilical scar with the fascial **aponeurosis** in midline is exposed. An incision here enters into the peritoneal cavity (**Fig 60**) – the first canula can then be introduced either without a (sharp-tipped) trocar or with a **blunt-tipped** trocar.

The skin and/ or sheath incision in an open technique sometimes becomes larger than the canula resulting in gas leak and loss of pneumo-peritoneum; this can be controlled by plugging the incision with a gauze piece and approximating the two edges of the incision with an Allis' or Lane's forceps.



Fig 60 Open technique of insertion of first canula – peritoneum held in artery clamps

Open the GB

All GBs removed for gall stone disease (GSD) must be opened by the surgeon in the operation room itself (**Fig 61**) before the operation ends – the mucosal surface should be washed with running water (**Fig 62**) and carefully examined for any suspicious area (wall thickening, mass, nodule or ulcer) and subjected to frozen section/ imprint cytology to detect an **unsuspected** gall bladder cancer (GBC), which if found, may warrant open operation for completion of extended cholecystectomy.

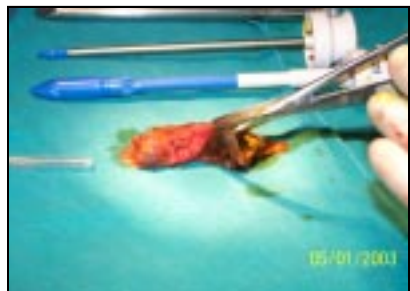


Fig 61 All GBs must be **opened** on the table by the surgeon himself/ herself



Fig 62 Opened GB should be washed in running water and mucosal surface examined for any suspicious area e.g. nodule, ulcer

Packed GB

A GB packed with stones may be difficult to grasp and retract. The GB can then be opened near fundus – body (after introducing a **bag** in the sub-hepatic fossa) and stones removed out of the GB and placed in the bag. This, however, should not be done if the GB has multiple small stones which may be difficult to retrieve from the sub-hepatic fossa.

Pad

The neutral electrosurgical cautery pad (**Fig 63**) should be placed on the buttocks or the thighs to ensure a large area of contact with the patient.



Fig 63 Passive (Neutral) pad (plate) of electro-cautery placed on the thigh to ensure a large area of contact.

Palmer's point

2 cm below the left subcostal margin in the mid-clavicular line – an alternate point for introduction of the Veress needle in case **adhesions** are anticipated/ encountered at the infra-umbilical site e.g. patients with previous lower abdominal or pelvic surgery.

Pancreatico-duodenectomy

Cholecystectomy is a part of the surgical procedure of pancreatico-duodenectomy (PD). GB is distended and cholecystectomy of PD is usually more bloody than that of gall stone disease (GSD).

Panic

Panic should be avoided during **bleeding** – desperate **blind** attempts to clip/ cauterize a bleeding point, which is not seen, are to be condemned as they are likely to result in more injury, especially bile duct injury (BDI). **Pressure** helps to control bleeding. Pressure can be applied with the mobilised GB or a gauze introduced into the peritoneal cavity. Pressure should be applied for at least 5 minutes (by the clock).

Parallel

Normally, the **cystic duct** joins the common bile duct (CBD) at an acute angle; it may, however, run parallel to the CBD and be fused with it. Temptation to dissect it from the adherent CBD with an intent to remove the entire cystic duct may cause injury to the CBD.

Para-umbilical

Some surgeons (including the Author) prefer to put the right para-umbilical

(or right iliac fossa) port (5 mm) as the second port after introducing the telescope through the umbilical (first) port. This para-umbilical port is then used to introduce a grasper which holds the GB fundus and pushes it up to retract the liver. This exposes the GB neck and the Calot's triangle to guide the placement of the epigastric (third) and the sub-costal (fourth) ports which should be directed towards the GB neck (**North American technique**).

Paresthesia

Many patients complain of a troublesome paresthesia in a triangular area after a sub-costal incision for open cholecystectomy (OC). This is because of the division of the lower inter-costal and subcostal nerves. The patient needs to be reassured as this paresthesia improves with time.

Partial (subtotal) cholecystectomy

Partial cholecystectomy is a very useful technique in patients with **difficult** (fibrosed/ obliterated) Calot's triangle – GB is divided at its neck without dissecting the **cystic artery** and **cystic duct** in the Calot's triangle. This can be done using a **stapler** or the residual GB neck can be closed with a continuous interlocking suture of absorbable material (**Vicryl**). Cystic artery is encountered in the GB wall and may need to be controlled.

Partial cholecystectomy is also indicated in patients with **Mirizzi's** syndrome.

In patients with **cirrhosis**, the superior (hepatic) wall of the GB may be left behind to avoid dissection in the GB bed which may be very bloody – the mucosa on the residual GB wall should be cauterized. Same can be done for a **contracted, thick-walled** chronically inflamed GB where planes in the GB bed are obliterated.

A part of the GB wall densely adherent to the duodenum/ colon may be left behind to prevent duodenal/ colonic injury.

Passive

The cautery plate applied to the patient is the passive electrode of the **electro-cautery** system; the large area of contact with the patient ensures that no heat is generated here.

Patch, Transdermal

A transdermal patch of diclofenac (200 mg in 75 sq cm patch) (NuPatch Zydus Cadila) or fentanyl may be used for post-operative analgesia after cholecystectomy.

Pathology

See **Difficult pathology**

PDS (Ethicon)

Polydioxanone – a monofilament, long-acting, absorbable suture, is

preferred over Prolene (propylene – a monofilament, non-absorbable suture) for closure of linea as the latter is more likely to result in a stitch abscess/ sinus.

Peanut

A pledget held in a Robert's forceps is a useful blunt dissector during open cholecystectomy (OC). The blunt tipped **suction** canula is the alternative during laparoscopic cholecystectomy (LC).

Perforation

GB can perforate as a complication of **acute cholecystitis**. Usually the perforation is localized (towards liver in the GB bed or by adherent omentum, duodenum and colon). A free perforation can cause generalized peritonitis. **Emergency** cholecystectomy is usually required but a well localized perforation with no features of peritoneal or systemic sepsis may settle with conservative management and an elective cholecystectomy may be performed later – usually after 6-8 weeks.

Perforation of GB with bile/ stone **spill** is more common during laparoscopic than open cholecystectomy. All spilled stones must be removed and spilled bile should be sucked out.

Peritoneum

Peritoneum on anterior (**Fig 64**) and posterior aspects of the Calot's triangle needs to be incised as the first step – this opens the Calot's triangle for dissection of the cystic duct and the cystic artery.

“One has to open the book to read it”.



Fig 64 Anterior **peritoneum** in Calot's triangle being opened

Pigment GS (Fig 65)

Black or brown stones containing cholesterol < 10% of dry weight. Black spiculated calcium bilirubinate stones are present in haemolytic disorders. Brown soft stones are secondary to bacterial infection caused by stasis.

Pigments stones are common in Southern India (cf. Northern India where **cholesterol** stones are more common).



Fig 65 GB with **pigment** stones; splenectomy has also been done – a case of hereditary spherocytosis

Plasma (Sterrad, Johnson & Johnson)

A low temperature method of sterilization wherein highly reactive plasma is generated by passing radio waves through vaporized hydrogen peroxide (H₂O₂). The sterilization cycle (30 minutes) is much shorter than ethylene oxide (ETO) – about 8 hours.

Pneumobilia

See Aerobilia

Pneumo-peritoneum

Creation of pneumo-peritoneum with Veress needle is essential before insertion of the first trocar in the closed method of **blind insertion**.

Polyp

GB polyps may be benign, pre-malignant or malignant. Commonest benign GB polyps are cholesterol polyps - they are frequently multiple and have no malignant potential. Adenomatous polyp is rare but may have malignant potential.

Indications for cholecystectomy in GB polyps are - symptomatic, large (> 10 mm), sessile, with stones in an elderly patient (> 50 years). If suspicion of malignancy is high (single large > 18 mm sessile polyp), open (not laparoscopic) cholecystectomy should be performed.

If a GB polyp is not operated, follow up should be done with US every 3-6 months – rapid growth in size is an indication for surgery.

PONV

Post-operative nausea and vomiting (PONV) are common after laparoscopic cholecystectomy. **Ondansetron** given at the time of induction of anaesthesia may help to reduce the incidence.

Porcelain GB (Fig 66)

Porcelain GB, even if asymptomatic, is an indication for cholecystectomy due to the higher risk of associated gall bladder cancer (GBC).

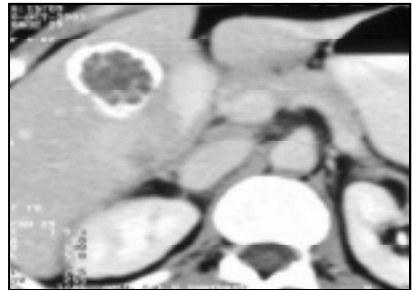


Fig 66 Porcelain GB

Portal hypertension

Portal hypertension is a relative contraindication for laparoscopic cholecystectomy (LC) because of higher risk of **bleeding**. Only an expert and **experienced** surgeon should attempt cholecystectomy in a patient with portal hypertension. Varices may be present in the abdominal wall, hepato-duodenal ligament, Calot's triangle and gall bladder bed in the liver.

Ports

Umbilical 10 mm (camera), epigastric 10 mm (working), right-subcostal 5 mm (GB neck), and right-paraumbilical 5 mm (GB fundus) (**North American technique**).

Port sites may have to be varied depending upon the built of the patient, size of the liver and position of the GB. The Author places the right lower (anterior axillary line) port as the 2nd port (after umbilical as the 1st port) – this grasps the

fundus and retracts the liver to expose the GB neck. The 3rd (epigastric) and 4th (subcostal) ports are then so placed that they are directed towards the GB neck and meet there at a right angle (Fig **).

Position

Elevating the head end of the operating table and tilting it to the left (right side up) lets the omentum and transverse colon with it, to fall down thus exposing the right upper quadrant.

Post - exploratory cholangiography

Clearance of common bile duct (CBD) should be documented by a cholangiogram or by **choledochoscopic** evaluation after CBD exploration.

Post-cholecystectomy syndrome (PCS)

Persistence of symptoms after cholecystectomy. Most PCS occurs in patients who had dyspepsia only (and no **biliary colic**) before cholecystectomy. Other causes of PCS include residual GB in **partial cholecystectomy** or long **cystic duct** remnant (especially with stones).

Posterior cystic artery

A posterior branch of the cystic artery is often present and may be injured during posterior dissection in the Calot's triangle. Even after the cystic artery has been taken, one must keep looking for another artery in the Calot's triangle.

Posterior insertion

A long **cystic duct** may travel behind the common bile duct (CBD) and open into the posterior and sometimes even the left side of the CBD. Attempts to dissect and remove the entire cystic duct in such cases may cause injury to the CBD and should be avoided.

"It is safer to leave a few mm (even a cm) of the cystic duct, as long as it does not contain stones."

Posterior peritoneum (Fig 67)

Peritoneum on the posterior aspect of the Calot's triangle should be incised at an early stage (before dissection in the Calot's triangle) as it opens up the Calot's triangle thus making dissection easier. This is best done by retracting the GB neck upwards and to the left.



Fig 67 Posterior peritoneum in the Calot's triangle being opened

Prediction of conversion

Various factors can predict the chances of conversion from laparoscopic

to open cholecystectomy e.g. old age, **male** gender, **obesity**, long **duration** of symptoms, repeated attacks of acute cholecystitis, **contracted** and thick-walled GB (**TWGB**) on US and presence of **acute cholecystitis**.

Pregnancy

If laparoscopic cholecystectomy (LC) has to be performed during pregnancy, safest period is the 2nd trimester. **Open technique** should be used for insertion of the first canula, intra-peritoneal pressures should be kept low and **ETCO₂** should be monitored.

Preparation

Elderly patients with gall stone disease (GSD) usually have concurrent medical illnesses e.g. diabetes, hypertension, coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), etc. which require careful evaluation, assessment and control before the patient is subjected to general anaesthesia and surgery to prevent/ lessen post-operative morbidity/ mortality.

Pre-peritoneal space

The commonest pitfall in introduction of the **Veress** needle is its tip lying outside the peritoneum in the pre-peritoneal space. Inflow of air dissects the peritoneum further away from the parietes (**aponeurosis**) and makes further introduction of the Veress needle into the peritoneal cavity even more difficult.

Pressure

Intra-abdominal (intra-peritoneal) pressure should be maintained below 12 mm Hg – higher pressures can lead to diaphragmatic elevation, reduced caval return and cause gas embolism.

In case of **bleeding** during open cholecystectomy, the first step should be to apply pressure with a pack (sponge) for at least 5 minutes (*by the clock*). At the end of 5 minutes, either the bleeding would have stopped or its source will be easily identifiable and controllable. During laparoscopic cholecystectomy (LC), pressure can be applied by the mobilized GB or a gauze introduced into the peritoneal cavity.

Prevalence

Gall stone disease (GSD) is common all over the world. About 6 million men and 14 million women in USA have GS. In Kashmir in northern India, as many as 29% of women above the age of 50 years were found to have GS on US. Also, GSD starts in north Indian women at an early age - 15% of women in 30-49 year age group had GS on US.

Preventable

Bile duct injury (BDI), to a large extent, is a preventable complication of cholecystectomy.

Previous cholecystostomy

While performing laparoscopic cholecystectomy after a previous cholecystostomy, the following precautions may be observed

1. the suture fixing the cholecystostomy tube to the skin should be cut - this avoids the tube from coming out of the GB when abdomen distends as pneumo-peritoneum is created
2. for the same reason, insufflation should be slow and gradual, and should be under vision.

Previous laparoscopy

A previous laparoscopy (commonly done in women for tubal ligation) results in a sub-umbilical scar. Trying to introduce a Veress needle or open access through this fibrotic scar may sometimes be difficult. Another site should, therefore, be selected.

Also, the **omentum** may get adhered to the umbilical scar and make peritoneal access difficult.

Previous surgery

Previous abdominal surgery is not a contraindication to laparoscopic cholecystectomy (LC) but may make it difficult especially if it results in formation of **adhesions** which may make creation of **pneumo-peritoneum**, access to the GB and dissection in the Calot's triangle difficult. **Open technique** of first port insertion is preferred. If Veress needle is to be used it should be inserted away from the previous scar (See **Palmer's point**).

Primary CBD stones

Primary common bile duct (CBD) stones without stones in the GB are common in East Asian populations. They are usually brown **pigment** stones.

Primary closure

Common bile duct (CBD) can be closed primarily (without **T-tube**) after **choledochotomy** if a prior endoscopic papillotomy had been done and/ or a stent is in situ.

Pristine

Most GBs that the Author saw in the West (Germany, UK and USA) were thin walled, distended, blue, pristine and virgin GBs, probably because cholecystectomy is advised (by the doctor) and accepted (by the patient) after even one attack of **biliary colic**. A large number of our GBs, however, are **thick-walled**, contracted, inflamed and adherent (to omentum, duodenum and colon) – hence **difficult**. This is because majority of our patients present for cholecystectomy after months (sometimes even years) of symptoms including repeated attacks of biliary colics and several episodes of **acute cholecystitis**.

Progress

Planned (by choice) **conversion** to open cholecystectomy should be seriously considered by the surgeon if no progress is made in the Calot's triangle after about 30 minutes of dissection during laparoscopic cholecystectomy.

Prolene (Ethicon)

A fine (5-0/ 6-0) vascular Prolene suture **MUST** always be available and handy (not opened) in every operation room where a cholecystectomy is being performed. This will be required in case a **bleed** occurs from an injury to the **right hepatic artery** (RHA) or to the portal vein (PV).

Prophylactic

Patients undergoing cholecystectomy need only prophylactic cover of antibiotics (usually single dose) – no need to give a full therapeutic course.

PTC (Percutaneous trans-hepatic cholangiography)

PTC is rarely required in patients with common bile duct (CBD) stones as majority of cases can be managed by endoscopic intervention. Failure to perform endoscopic papillotomy/ stenting in a patient with uncontrolled **cholangitis** may be the rare indication for a percutaneous trans-hepatic biliary drainage (PTBD) in a patient with CBD stones.

Pulsations

After division, **cystic artery** stump must be inspected to look for pulsations which confirm that it was an artery (and not a duct).

Quadrante lobe

Hypertrophied segment IV (quadrante lobe) of the liver can obscure the view of the Calot's triangle. A 5th port may have to be used in the epigastrium to introduce a fan-shaped liver retractor.

Radiolucent

A radiolucent table top helps to perform intra-operative cholangiography (IOC).

Radiolucent (non-calcified) stones in a functioning GB may be treated by **oral dissolution therapy** (with bile acids) if surgery can not be performed because of high risk for anaesthesia due to co-morbid conditions.

Ratchet

A grasper with ratchet is used to hold and retract the GB fundus (and thus the liver) to reduce hand fatigue of the assistant.

Recovery

An uneventful cholecystectomy should result in an uneventful recovery of the patient in the post-operative period – patient sitting up in the bed free of pain, stable vitals (pulse, temperature, blood pressure, respiratory rate) and a soft abdomen with functioning bowels latest by next morning (preferably same evening).

Reddick

EJ Reddick and DO Olsen of Nashville TN performed the first laparoscopic cholecystectomy in USA in 1989.

Redivac

Suction **drain**.

Reducer

A reducer allows a 5 mm instrument to be introduced through a 10 mm canula without gas leak.

Items e.g. needle with suture, gauze piece, **bag**, etc. are best introduced by placing them inside a reducer extra-corporeally and then introducing the reducer into the canula.

Referral

A patient who has sustained a bile duct injury (**BDI**) during cholecystectomy should be referred to a centre where facilities and expertise for therapeutic endoscopy and interventional radiology are available.

“To injure is human, to refer divine”.

Removal

All openable instruments e.g. grasper, dissector, scissors, etc. should be closed (under vision) before removal from the peritoneal cavity.

Canulae must be removed under vision – port sites must be inspected for any bleed (Fig 12) which, if present may be controlled by a coagulating instrument

introduced through a diagonally opposite canula.

Drain placed for incomplete haemostasis may be removed within 24 hours if there is no significant **bleeding**. Drain placed for an anticipated bile leak can be removed in 24-48 hours if there is no bile in drain. Drain placed for an unsatisfactory **cystic duct** stump may have to be retained for 3-5 days.

T-tube, placed after common bile duct (CBD) exploration, should not be removed before 14 days – this time period is required for the tract to mature so that there is no bile leak from the CBD into the peritoneal cavity. The Author prefers to remove the T-tube after 21 days.

Residual/ retained CBD stones

Common bile duct (CBD) stones left in the CBD after a CBD exploration. Best treated with endoscopic/ percutaneous (through T tube track) intervention.

Retractor

A Morris retractor held by the second assistant retracts the right costal margin – a table-mounted self-retaining retractor, such as **Omnitrac** (Pilling Weck), though expensive, can obviate the need of a second assistant.

Retreat

In case of extreme difficulty e.g. dense omental **adhesions**, acutely inflamed GB, unclear Calot's anatomy, the surgeon should not hesitate to retreat and refer the patient to a more experienced surgeon rather than try to complete the cholecystectomy and cause a bile duct injury (**BDI**).

Retrograde

The conventional commonly used method of initial dissection in the Calot's triangle followed by separation of body – fundus from the GB bed in liver (cf. **antegrade** fundus first method).

Reusable

Reusable trocars and instruments are less expensive (per patient) than **disposables** but should be properly **cleaned** and **sterilized** to prevent transmission of infections.

RHA (Right hepatic artery)

Right hepatic artery (RHA) (along with right hepatic duct RHD) may form the left (superior) arm of the Calot's triangle and may get injured (by the dissector or by the **cautery**) during dissection in the Calot's triangle.

Cystic artery can get avulsed from the RHA at its origin – this will result in a hole in the RHA. This requires immediate conversion to laparotomy and repair of the hole with fine (5/0 – 6/0) atraumatic **Prolene**.

Rarely, the RHA may have a long extra-hepatic course and may get injured during dissection of the GB off its bed in the liver.

An injury to the RHA may result in **bleeding** during cholecystectomy – desperate attempts to control this bleeding may cause a bile duct injury (**BDI**).

RHD (Right hepatic duct)

RHD (along with the common hepatic duct CHD) forms the left (superior) arm of the Calot's triangle and may get injured (by the dissector or by the **cautery**) during dissection in the Calot's triangle. Desperate attempts to control **bleeding** in the Calot's triangle by **clips** or **cautery** may also cause injury to the RHD.

Right shoulder

The fundus of the GB should be held in an atraumatic grasper with ratchet and pushed up and out – towards the right shoulder of the patient – to retract the liver.

Risk of CBD stones

Low: no history of jaundice, cholangitis or acute pancreatitis, normal liver function tests (**LFT**), no intra-hepatic biliary radicle dilatation (IHBRD) on US

Intermediate (moderate): remote history of **jaundice**, **cholangitis** or **acute pancreatitis**, abnormal LFT, IHBRD, dilated CBD on US

High: recent history of jaundice, cholangitis or acute pancreatitis, CBD stones on US

Roadmap

A cholangiogram provides a road map of biliary **anatomy** during cholecystectomy to reduce the risk of bile duct injury (BDI). Some Japanese surgeons obtain a pre-operative cholangiogram (**MRC**) in all patients undergoing cholecystectomy; many surgeons advocate a routine intra-operative cholangiogram (**IOC**) in all patients undergoing cholecystectomy. The Author follows a policy of obtaining a pre-operative cholangiogram (**MRC** or **ERC**) selectively, depending upon the **risk** of common bile duct (CBD) stones.

Roeder's knot

Extra-corporeal slip knot – tied outside and then introduced into the peritoneal cavity with a **knot pusher**.

Rotating

A rotating (rather than pushing) motion should be used for introduction of **trocars** – this provides a controlled smooth introduction and reduces the chances of trocar related injury caused by a sudden jerky introduction.

Routine

Few surgeons perform an intra-operative cholangiogram (**IOC**) during

cholecystectomy as a routine with two intents - to demonstrate the biliary ductal **anatomy** to avoid/ lessen bile duct injuries (BDI) and to detect common bile duct (CBD) stones. Performing routine cholangiogram (in all cases, including simple ones) makes it easy for the surgeon to perform it in difficult cases also. The Author, however, follows a policy of selective pre-operative cholangiography and does not perform IOC as a routine.

Rouviere's sulcus (Fig 68)

A sulcus is present to the right of the hepatic hilum, anterior to the caudate process in some patients. It contains the right portal triad. Dissection should be kept anterior to the sulcus.



Fig 68 Rouviere sulcus (arrow) containing the posterior pedicle

Ryle's tube

A distended stomach obscures the view in the right upper quadrant. Ryles tube should be introduced at the time of induction of anaesthesia to evacuate the stomach of liquid and gas. It can be removed at the time of extubation.

Safety shield

Some disposable trocars have a retractable safety shield which covers the sharp trocar tip as soon as it enters the peritoneal cavity.

Safety valve

Conversion from laparoscopic cholecystectomy (LC) to open cholecystectomy (OC) is a safety valve (cf. in a pressure cooker) to defuse the situation of a **difficult** cholecystectomy and avoids complications such as **bile duct injury** (BDI) and **bleeding**.

Saint's triad

Gall stones, hiatus hernia, diverticulosis (not common in Indian patients, though).

Scintigraphy

Isotope hepato-biliary **scintigraphy** with ^{99}Tc labelled hepatic iminodiacetic acid (HIDA) is a useful test in patients suspected to have **acute cholecystitis**. Visualization of the GB indicates a patent **cystic duct** and functioning GB, and virtually excludes a diagnosis of acute cholecystitis.

Scintigraphy is a useful investigation to detect post-cholecystectomy bile leak also.

Secondary stones

Majority of common bile duct (CBD) stones are secondary (cf. **primary** CBD stones) to GB stones – one or more of the GB stones pass through the **cystic duct** into the CBD.

Sectoral duct (Fig 69)

The right (anterior or posterior) sectoral duct may lie low in the Calot's triangle to join the common hepatic duct (CHD). It may, thus, get injured during dissection in the Calot's triangle. It may be mistaken for the **cystic duct** – mobilized, clipped and divided. This injury will result in a Bismuth Type V biliary stricture.

Selective

Most surgeons use intra-operative (per-operative) cholangiography (**IOC**) selectively – in patients with moderate **risk** of common bile duct (CBD) stones (those with high risk should have had



Fig 69 Right sectoral duct joining CBD

a pre-operative **MRC/ ERC**; those with low risk of CBD stones do not need cholangiography).

SELSI

Society of Endoscopic and Laparoscopic Surgeons of India. It conducts training programmes and courses throughout the year.

Semm

Kurt Semm, a German gynaecologist, performed the first laparoscopic appendectomy in 1981, much before laparoscopic cholecystectomy was performed.

Sessile GB

GB may be sessile as a congenital anomaly or may appear sessile because of a very short **cystic duct**. If the cystic duct is adherent to the common hepatic duct (CHD), GB may appear to be sessile (**Fig 70**). In such a case, the common bile duct (CBD) is also very close because the Calot's triangle is very narrow or almost non-existent and the duct may get injured even if the dissection is kept close to the GB.



Fig 70 Sessile GB - no cystic duct (instrument points to the common bile duct)

Severe

Bile duct injuries (**BDIs**) which occur during laparoscopic cholecystectomy (LC) are usually more severe (higher - closer to the hilum, more often complete involving excision of a segment of the bile duct and associated with a vascular injury) than those which occur during open cholecystectomy (OC).

Sharp dissection (Fig 3)

Sharp dissection with scissors (combined with **electro-cautery**) or **Harmonic scalpel** is best for lysing **adhesions**.

Short cystic duct

The size of the Calot's triangle depends on the length of the cystic duct – a short cystic duct is associated with a narrow Calot's triangle and may create difficulty in dissection of the Calot's triangle. Dissection even though kept close to the GB neck may be close to the common hepatic duct (CHD)/ common bile duct (CBD) also and caution needs to be exercised to avoid a bile duct injury (BDI).

Sickle cell disease

Patients with sickle cell disease have crises which may stimulate **biliary colic**. These patients, therefore, are advised to have a **prophylactic cholecystectomy** if they have gall stones (GS) on US even if they are asymptomatic.

SILS

Single incision laparoscopic surgery (SILS) port (Covidien)

Single incision

Trans-umbilical cholecystectomy through a single incision with 3 ports and using flexible instruments has been described recently.

Sinus (Fig 71)

Rarely, a sinus may form and persist after laparoscopic cholecystectomy (LC) – usually around the umbilical or epigastric port (ports of extraction of GB). A common cause is a residual stone in the parietes. The sinus should be explored and laid open to heal by secondary intention. Pus should be sent for smear and culture (including acid fast bacilli AFB) as atypical **mycobacteria** are a common cause of a persisting sinus.



Fig 71 Post laparoscopic cholecystectomy sinuses

Size

Size (diameter) of a duct does not decide whether it is **cystic duct** or common bile duct (CBD). A normal sized (3–4 mm) CBD may easily be mistaken for the cystic duct.

Ski needle

An ordinary $\frac{1}{2}$ circle needle can be converted into a ski needle (for intracorporeal suturing) by straightening its curved base.

Skin incision

The size of the skin incision should be adequate for the diameter of the **canula**. If it is small, the skin offers resistance to the introduction of the canula - this may result in a sudden jerky insertion with risk of injury to the underlying viscera. If it is large, air may leak out.

Skin preparation

Skin should be prepared from nipples to mid thighs and from right flank to left flank with a soap solution followed by an antiseptic solution (**chlorhexidine** in alcohol or povidone **iodine**).

Slipped clip

Slipped **cystic artery** clip may cause **bleeding** – double clipping avoids this. Slipped **cystic duct** clip may cause **bile leak**.

Slipped stones

During manipulation, small stones in the GB may slip through a wide **cystic duct** into the common bile duct (CBD) – these stones may cause post-operative **jaundice**, **cholangitis** and **pancreatitis**. A CBD stone may get impacted at the papilla and raise intra-biliary pressure resulting in cystic duct clip slipping and **bile leak**.

Sludge (See **Microlithiasis** also)

A sludge ball in the GB may sometimes mimic a mass as it may not cast distal acoustic shadowing and may not move with change in position of patient on US because it is stuck to the GB mucosa. CT should be done in such cases to differentiate sludge from GB mass..

Small GB

A small (**contracted**) GB does not have a fundus (Fig 26) for retracting the liver. Holding and pushing the GB body up may cause the instrument to poke into the liver, if adequate care is not taken.

Small GS

Patients with multiple small gall stones (GS) are more likely to have a stone pass down the **cystic duct** into the common bile duct (CBD) to cause **jaundice**, **cholangitis** and **pancreatitis**.

Smoke

Smoke generated during excessive use of cautery can obscure vision; high flow insufflators may help.

Smoking

Patients with gall stone disease who are slated for an elective cholecystectomy should be advised to stop smoking for at least 4-6 weeks before the scheduled date of operation to reduce the risk of post-operative chest complications and deep venous thrombosis (**DVT**) and pulmonary embolism (PE).

Soft liver

A very soft liver may tear as a result of forceful retraction or may get easily damaged by blind insertion of an instrument.

SOOD (Sphincter of Oddi Dysfunction)

Some patients have a typical **biliary colic** but US does not reveal gall stones (GS). These patients may have SOOD which can be diagnosed by biliary manometry – endoscopic papillotomy will be curative.

Spatula

Spatula (along with **cautery**) is a useful instrument to dissect the GB off its bed in the liver; alternatively, a **hook** can be used.

Spatula (along with spray mode cautery) is also useful to control **bleeding** in the GB bed.

Sphincteroplasty

See **TDS (Trans-duodenal sphincteroplasty)**

Spill

Every effort must be made to avoid opening the GB which can result in spill of bile and gall stones (GS) (especially if they are **small** and multiple). GB gets opened most frequently when using **cautery** to dissect a **thin-walled** GB from its bed in the liver. A small opening in the GB can be closed with a clip/ suture to prevent it from getting enlarged with more bile/ stone spill.

Any spilled bile must be immediately sucked out and sub-hepatic fossa should be irrigated with copious amounts of saline to dilute any remaining bile as bile can cause severe irritation/ inflammation and may cause post-operative shoulder pain due to irritation of the diaphragm. Majority of stones will float in saline placed in the sub-hepatic fossa. Spilled stones should be collected and put in a **bag** placed in the sub-hepatic fossa; small stones can be sucked out with a large (10 mm) suction canula.

Sponge holding forceps

Curved sponge holding forceps are often used to grasp the GB fundus and neck for retraction during open cholecystectomy (OC). A large sized right angle clamp may also be used.

Spray

Spray made of **electro-cautery** is useful to control ooze in the GB bed in the liver especially if liver parenchyma has been entered. Spray mode uses very high voltage current and generates high lateral heat. It must not be used in the Calot's triangle as it can cause **thermal injury** to the common bile duct (CBD) or the right hepatic artery (RHA).

Stapler

White - vascular 2.5 mm staple height Endo GIA (US Surgicals) stapler or ETS (Endoscopic Linear Cutter Ethicon Endo-surgery) is usually used to tackle a wide **cystic duct** during laparoscopic cholecystectomy (LC). A blue (3.5 mm) or green (4.5 mm) stapler may be required to perform **partial cholecystectomy** in a thick-walled GB

Staplers are useful for tackling a cholecysto-duodenal **fistula** also.

Stay sutures

For exploration, the common bile duct (CBD) should be opened vertically in the infra-cystic/ supra-duodenal part between stay sutures of fine (3-0/ 4-0) absorbable (**Vicryl**, **PDS**) sutures put on either side of the proposed incision.

Steatotic liver

See **Fatty liver**

Stenting

See **Endoscopic stenting**

Sterilization

After every use, all laparoscopic instruments should be dismantled, cleaned with brush (toothbrush) to remove blood/ tissue, rinsed in running water, dried and sterilized. Pre-cleaning with an enzymatic product (to break down blood/ tissue) may also be done. Various methods of sterilization include steam, glutaraldehyde, ethylene oxide (ETO) and plasma.

Stones in parietes

If the GB gets opened during extraction, stones (especially small) may spill into the parietes – they should be carefully looked for and removed. Residual stones in parietes may result in non-healing of wound and persistent **sinus**.

Strain

After open cholecystectomy (OC), patients should be advised to avoid straining and strenuous activity for about 3-6 months to reduce the chances of developing an **incisional hernia**.

Stumps

Stumps of the **cystic duct** and the **cystic artery** should be inspected for any bile leak and bleed (**Fig 72**) after these structures have been divided and once again at the end of the cholecystectomy.

Subcutaneous

Vessels in the subcutaneous tissue (fat) at the port sites may bleed after the skin incision has been made – they should be controlled by **cautery** before the canulae are placed in the port sites.



Fig 72 At the end of the operation, the cystic duct and cystic artery **stumps** should be inspected to make sure that the clips are intact and there is no bile leak or bleeding

Subcuticular

For better cosmetic results, skin can be sutured with a subcuticular stitch of monofilament absorbable suture (**PDS**).

Subtotal cholecystectomy

See **Partial cholecystectomy**

Sub-umbilical

Veress needle and the first trocar are usually inserted at a sub-umbilical site. In tall-built patients, a supra-umbilical site should be used.

Suction canula

The blunt-tipped suction canula is a good instrument for **blunt** dissection in the Calot's triangle (**Fig 14**) to tease off loose areolar tissue. This, however, should not be attempted if the Calot's triangle has lot of fibrosis due to long-standing chronic inflammation.

Suction-irrigation-hook/spatula

A very useful multi-purpose instrument, especially when bleeding occurs.

Sulcus

See **Rouviere** sulcus

Surgeon

The surgeon (expertise and experience) is the most important risk factor (others being anatomy and pathology) for bile duct injury (BDI) during cholecystectomy.

Surgical biliary drainage

Because of high success rates of non-surgical (endoscopic/ percutaneous) biliary drainage, surgical biliary drainage is rarely required in patients with uncontrolled **cholangitis** due to common bile duct (CBD) stones. If it is required, it is usually in the form of **T-tube** choledochostomy; cholecystostomy is not preferred as the cystic duct may be blocked and it may not drain the obstructed and infected CBD.

Suspicion

Possibility of gall bladder cancer (GBC) should be kept in mind in elderly patients with gall stone disease (GSD). GBC should be suspected if US shows **thick-walled** GB (TWGB). This merits more detailed evaluation of GB wall with contrast enhanced CT - diffuse uniform thickening of GB wall is usually due to chronic cholecystitis or xanthogranulomatous cholecystitis (**XGC**); rarely, it may

be malignant (GBC). Such cases may be attempted laparoscopically, though chances of conversion to open cholecystectomy will be high. Localized, irregular thickening of GB wall raises a suspicion of GBC – such cases should preferably be treated by an open operation.

Suturing skills

Laparoscopic suturing skills are very useful when tackling cholecysto-duodenal **fistula**, **wide cystic duct**, during **partial cholecystectomy** and for control of **bleeding**.

Symptomatic

Biliary colic is THE symptom of gall stones (GS). **Dyspepsia** is usually not because of GS.

Tactile perception

Loss of tactile perception is a disadvantage of laparoscopic cholecystectomy (LC) as compared to open cholecystectomy (OC).

TASKit (Ethicon Endosurgery)

A portable collapsible trainer to practice basic laparoscopic skills. It consists of a web camera which can be connected to a laptop through a USB port.

TDS (Trans-duodenal sphincteroplasty)

Trans-duodenal sphincteroplasty (TDS) may be required to remove a stone impacted at the lower end of the common bile duct (CBD) which can not be removed via a supra-duodenal choledochotomy. It is, however, a major procedure with significant morbidity (bleeding, leak and pancreatitis) and should be performed by an experienced surgeon. If the surgeon is not confident to perform TDS, the safest option will be to drain the CBD with a T-tube and refer the patient to a more experienced surgeon.

TDS is also added after surgical control of post endoscopic papillotomy (EPT) bleed.

Telescope

A 30° telescope (**Fig 73**) is very useful (almost essential) to perform safe cholecystectomy. It allows the surgeon to look at the Calot's triangle both from front (anterior) and behind (posterior).



Fig 73 Telescope 30°

Tenting

Excessive lateral **traction** on the GB neck may cause the common bile duct (CBD) to be tented – the most medial clip on the **cystic duct** may then impinge on the right wall of the CBD. Traction on GB neck should, therefore, be released when the first clip is applied on the cystic duct.

Therapeutic

Patients with acute cholecystitis and acute cholangitis require a therapeutic course of antibiotics – usually intravenous for 5-7 days.

Thermal injury

Thermal injury can be caused to the common bile duct (CBD) as a result of injudicious use of **cautery** during dissection of the Calot's triangle or in a desperate attempt to control **bleeding** in the Calot's triangle. Thermal injury may not be recognized during cholecystectomy and may not manifest in the immediate or early post-operative period which may, thus, be uneventful. The CBD may give way a

few days after cholecystectomy and cause a late **bile leak**. If the CBD wall does not give way, the ischaemia as a result of the thermal injury may result in a late biliary stricture. Biliary obstruction many months after an uneventful cholecystectomy (no bile leak in the post-operative period) is the classical presentation of a thermal injury induced biliary stricture.

Thimble GB

A very small, fibrosed, **contracted**, thimble-like, thick-walled GB (**TWGB**) makes cholecystectomy difficult as there is no fundus to retract the liver and no neck to retract and expose the Calot's triangle (Fig **41). In addition, the Calot's triangle may also be fibrosed/ obliterated because of chronic inflammation.

Thin-walled

Care should be exercised when dealing with a thin-walled GB. Toothed graspers should be avoided, too much force during retraction of the fundus can result in a GB perforation; a hole can be caused in a thin-walled GB during **cautery** dissection in the GB bed.

Threshold

Low threshold for conversion in case of a difficult cholecystectomy can reduce the risk of bile duct injury.

Time

No upper limit of time can be prescribed to complete a cholecystectomy laparoscopically but, as a general rule, if not much **progress** is made in about 30 minutes to 1 hour, the surgeon should seriously think of converting to an open operation.

Timing of cholecystectomy

In patients with biliary **acute pancreatitis**

* Mild attack – cholecystectomy may be performed during the same hospital admission after the attack has resolved.

* Severe attack – there are no clear guidelines but a period of at least 4-6 weeks after the attack of acute pancreatitis has resolved is desirable – US/ CT may be done to ensure that all peri-pancreatic collections have resolved and inflammation (especially in the hepato-duodenal ligament) has settled.

Titanium clips

Titanium clips are inert to radiation. Absorbable clips (**Absolok**) are also available.

TLC (Total leucocyte count)

A raised TLC during an attack of **biliary colic** should raise the suspicion of **acute cholecystitis**.

Topdown

Fundus first technique of cholecystectomy.

Traction

Traction on the GB neck should be '**down and out**' (**Fig 35**) in order to place the **cystic duct** at right angles to the CBD.

Excessive lateral traction on the GB neck may pull and **tent** the common hepatic duct (CHD) - common bile duct (CBD) complex. Before applying the first clip on the cystic duct, traction on the GB neck should be released to avoid clipping the tented CBD.

Training

Proper and adequate formal training (**Fig 74**), preferably during post-graduation in surgery, is very important for performance of a safe laparoscopic cholecystectomy. Attendance at courses and **workshops** offers only familiarity with the procedure and is not synonymous with training.



Fig 74 Formal **training** in minimal invasive surgery is a must - Author (not scrubbed but present in the operation room) supervising and guiding one of his surgical trainees who is doing a laparoscopic cholecystectomy

Trans-cystic tube

A trans-cystic infant feeding tube (instead of **T-tube**) may be introduced into the common bile duct (CBD) and CBD closed primarily after a choledochotomy.

Transplant recipient

A transplant recipient with **asymptomatic** gall stones may undergo cholecystectomy either before or at the time of transplant because risk of **acute cholecystitis** on immuno-suppression, which will be required after transplantation, is high.

Transverse

An upper right transverse incision across the right rectus muscle is used by some surgeons for a **mini-laparotomy** open cholecystectomy (OC) – majority of surgeons (including the Author), however, prefer a proper sub-costal incision for OC.

Trendelenburg

Trendelenburg (head down) position is helpful during insertion of the Veress needle/ first trocar to move the small bowel away from the needle/ trocar tip

which should be directed inferiorly.

Trendelenburg, Reverse

About 15°-20° head up (with right side up) position (after insertion of the first canula) during laparoscopic cholecystectomy (LC) helps the omentum and transverse colon to fall down and to the left.

Trial dissection

In a difficult case, the surgeon may undertake trial dissection for some time while getting mentally prepared to **convert** to an open operation.

Trocar

Trocar is the pointed tipped inner introducer (**Fig 16**) which is removed after insertion of the **canula**; the outer blunt tipped sheath which stays for introduction of telescope and instruments is the canula. Many surgeons, erroneously though, refer to the canula as the trocar.

Trumpet valve (Fig 75)

A trumpet valve remains closed due to a spring mechanism – it has to be opened by pressing the trumpet. It may damage instruments, especially their insulation coating and requires another hand (of the surgeon/ assistant). **Trap valve** is, therefore, better.



Fig 75 Trumpet valve

T-tube

After choledochotomy, the common bile duct (CBD) should be drained by a T-tube (14-16 Fr). The horizontal limb of the T should be trimmed so that its upper part remains in the common hepatic duct (below the confluence) and lower part in the CBD above the papilla. The horizontal limb of the T should be **guttered** for ease of removal.

Tuberculosis

Tuberculosis (TB) continues to be common in India. Tuberculous **adhesions** (especially between the bowel and the parietes) may result in a bowel injury during introduction of the Veress needle and/ or the first trocar. In some of these patients, it is very difficult (and sometimes almost impossible) to enter the peritoneal cavity even at laparotomy.

Reactivation of dormant peritoneal tuberculosis may result in a persistent **sinus** (**Fig 71**) at the port site after laparoscopic cholecystectomy. Atypical **mycobacteria** are often responsible.

TWGB (Thick-walled GB)

GB wall > 3 mm (on US) is described as thick. Diffuse thickening of the GB wall could be present in acute cholecystitis, chronic cholecystitis, xantho-granulomatous cholecystitis (**XGC**) (**Fig 23**) and, rarely, gall bladder cancer (GBC). A diffuse TWGB can be approached laparoscopically though conversion rate will be higher. Irregular or localized thickening of the GB wall should raise a suspicion of GBC and should be further investigated by CT.

Twisting

While inserting the **trocars**, a twisting (rather than pushing) motion should be used to avoid sudden **jerks**.

Udwadia

Tehemton E Udwadia of Mumbai performed the first laparoscopic cholecystectomy in India in 1990. He is the pioneer (*Bheeshma Pitamah*) of minimally invasive surgery in India.

Ultrasonic energy

Vessels up to 5 mm can be sealed by an ultrasonic energy source e.g.

Harmonic scalpel – use of ultrasonic energy causes less **adhesions** than **electro-cautery**.

Umbilical hernia

An umbilical hernia may form through the umbilical scar after laparoscopic cholecystectomy (LC). The sheath/ **aponeurosis** at the umbilical port site should be carefully closed with **PDS** to prevent this.

Unipolar cautery

See **Mono-polar cautery**

Unsuspected GBC

Gall bladder cancer (GBC) detected for the first time during operation for a pre-operative diagnosis of gall stone disease (GSD). Laparoscopic operation should be converted to an open operation in such situations.

Ureteral bougies

Ureteral bougies may be used for dilatation of the **cystic duct** for laparoscopic trans-cystic duct choledocholithotomy.

Ureteric catheter

A ureteric catheter can be used for canulation of the **cystic duct** for intra-operative cholangiography (**IOC**).

Urinary bladder

Urinary bladder should be empty at the time of introduction of the Veress needle and the first trocar. Patient should be instructed to pass urine just before she is shifted to the operation room – it is not necessary to catheterize the urinary bladder.

US (Ultrasonography)

A good US for gall stone disease (GSD) should evaluate the GB wall thickness, intra-hepatic biliary radicles (IHBR) for dilatation, extra-hepatic bile ducts for obstruction and common bile duct (CBD) for stones.

US is a sensitive investigation for GB stones - dense acoustic image with

distal acoustic shadowing (Fig 76) and IHBRD but has a low sensitivity for CBD stones i.e. a normal US does not exclude CBD stone as a small stone in the retro/intra-pancreatic CBD may be missed.

Obesity and gaseous distension make US evaluation difficult.

USA

About 600,000 cholecystectomies are performed in the USA (population 300 million) every year.



Fig 76 Ultrasonography (US) showing single large stone (C) in GB – distal acoustic shadowing (AS) is seen

Valves

Mucosal valves (of **Heister**) in the **cystic duct** may hinder the passage of a catheter through the cystic duct into the common bile duct (CBD) for intra-operative cholangiography (**IOC**).

Canulae have two types of valves

1. **Trumpet** valve – needs to be pressed every time an instrument is introduced; may damage insulation of the instruments.
2. **Flap** (Trap door) valve – opens on its own when an instrument is introduced in the canula.

Variations

Variations in **anatomy** of the bile ducts and the hepatic artery are so frequent that many surgeons (including the Author) believe that there is nothing like normal anatomy – every patient has a unique anatomy which must be delineated and displayed by the surgeon during cholecystectomy.

“Biliary anatomy is like fingerprints (Fig 77) – everyone has his/ her own.”



Fig 77 Biliary anatomy is like fingerprints – everyone has his/ her own.

Vascular injury

Bile duct injury during (BDI) during laparoscopic cholecystectomy (LC) is more often associated with vascular (hepatic artery and portal vein) injury than that during open cholecystectomy (OC).

Major vascular (aorta and inferior vena cava IVC) injury can occur during **blind insertion** of the Veress needle or the first trocar, especially in thin built patients. Expanding central retroperitoneal haematoma is the classical presentation. This is an indication for immediate conversion to open operation – **help** of a vascular surgeon should be sought, if possible.

Vein

Many small cholecysto-hepatic veins (**Fig 32**) drain from the GB directly into the liver. They should be cauterised when the GB is being separated from its bed in the liver.

Venous bleed

Venous bleed from the GB bed may become manifest when intra-abdominal **pressure** reduces after deflation. It is, therefore, a good practice to re-examine the GB bed once more after the GB has been extracted.

Veress needle

Devised by Janos Veress of Hungary in 1938, it has a 2 mm diameter outer sharp needle with an inner blunt stylet which comes out as soon as the needle enters the peritoneal cavity. The spring mechanism of the Veress needle and patency of the needle should be checked before every use. Correct placement of the Veress needle into the peritoneal cavity can be confirmed in several ways.

1. Two gives (clicks) – the first at the aponeurosis and the second at the peritoneum
2. Negative or low (0-6 mm Hg) initial intra-abdominal pressure
3. Saline drop test – a drop of saline placed on the needle gets sucked in
4. Saline instillation test - a few ml of saline introduced through the needle goes in easily and does not return on aspiration
5. The needle can be moved freely in all directions
6. Inflow of gas through the needle produces a tympanic note over the lower costal margin
7. Intra-peritoneal **pressure** increases gradually/ steadily with inflow of gas (the pressure increases suddenly if the needle is in the parietes, usually the pre-peritoneal space).

After introduction of the Veress needle, aspiration should be performed with a syringe to make sure absence of blood, urine or intestinal contents.

Versaport (Autosuture/ Covidien) (Fig 78)

Accommodates both 5 and 10 mm instruments without the need of a **reducer** or adaptor.



Fig 78 Versaport (AutoSuture Covidien)

Vessel sealing system

A bipolar **electro-cautery** system which seals and then cuts a vessel. Not required for laparoscopic cholecystectomy.

Vicryl (Ethicon)

Vicryl (polyglactin) is a long acting absorbable suture used for ligation of **cystic duct**, suture closure of GB neck stump after **partial cholecystectomy** and closure of the common bile duct (CBD) after choledocholithotomy. **Port Vicryl** is 0 (zero) Vicryl suture mounted on a stout needle.

View

The view of the Calot's triangle may be obliterated by adhesions in the right upper quadrant because of previous surgery or previous attacks of acute cholecystitis.

VIP

Even very important patients (VIP) are not immune to a bile duct injury (BDI) during cholecystectomy - British Prime Minister Anthony Eden (Lord Avon) sustained a BDI during (open) cholecystectomy in 1951. A senior judge of a High Court in India sustained a BDI during (open) cholecystectomy performed by a senior and experienced surgeon at a premier medical institution of the country.

Virgin

It is a rare sight to operate on a normal looking, thin-walled 'virgin' GB in India. Even GBs with asymptomatic stones have features of 'sub-clinical' inflammation (**Fig 79**).

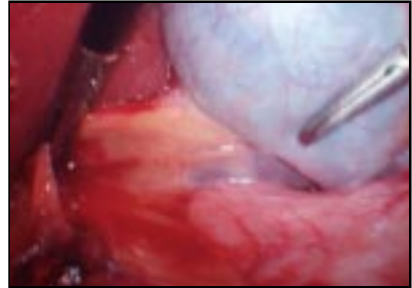


Fig 79 GB with even asymptomatic GS in northern India may not be **virgin**

Visiport (Autosutre/ Covidien)

Visiport is a canula with an optical obturator for introduction under vision. It must be remembered, however, that no device can protect against a faulty technique.

Visual cholangiography

Kathkouda has described (and the Author agrees with and practices) visual cholangiography (**Fig 80**)— demonstration (not dissection) of the common hepatic duct (CHD) above and the common bile duct (CBD) below the point where the **cystic duct** is thought to be joining the CBD. This, however, may not be possible in a fat-laden hepato-duodenal ligament.



Fig 80 Common bile duct in the hepatoduodenal ligament – **visual cholangiography**

Vomiting

Vomiting frequently occurs during/ after an attack of **biliary colic** or an episode of **acute cholecystitis**.

Vomiting is common after laparoscopic cholecystectomy (LC) – many anaesthetists prefer to administer **ondansetron** at the time of induction of anaesthesia to reduce the incidence of post-operative vomiting.

Wash

After extraction of the GB, the port of extraction should be washed thoroughly with saline (Fig 51) to prevent port site infection.

WBC (White blood count)

A raised WBC during an attack of **biliary colic** should raise the suspicion of **acute cholecystitis**.

White balance

White balance of the **imaging system** must be done at the beginning of the procedure before the telescope is introduced into the peritoneal cavity.

Wide

A wide **cystic duct** should be considered to be the common bile duct (CBD) unless proven otherwise viz. by **visual cholangiography**, intra-operative cholangiography (**IOC**) or laparoscopic US (**LUS**).

Once it is proven beyond doubt that it is actually a wide cystic duct and not the CBD, it can be tackled by using large clips, serial clipping, **endoloop** ligature, suture-ligature or stapler. Endoloop, however, can be applied only after the duct has been divided.

Women

Gall stone disease (GSD) is 2-3 times more common in women than in men.

Workshop

Attending workshops is no replacement for adequate formal **training** in laparoscopic cholecystectomy (LC).

Xantho-granulomatous cholecystitis (XGC)

Xantho-granulomatous cholecystitis (XGC), also called chole-granulomatous cholecystitis, is a variant of chronic cholecystitis. XGC is usually associated with diffuse thickening of GB wall; it may also appear as a mass lesion with infiltration of adjacent organs. XGC may mimic GBC on imaging and even at operation.

Suggested Readings

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Suppliers of Laparoscopic Equipment and Instruments

Foreign (available in India)

Aesculup www.aesculup.com

Covidien www.covidien.com

Tyco Healthcare India 10th Floor Building No. 98 DLF Cybercity Phase III
Gurgaon 122002 www.covidien.com

Erbe www.erbe-india.com

Ethicon Endo-surgery (Johnson & Johnson) 30 Forjett Street Mumbai 400036
www.ethiconendo.com

Karl Storz www.karlstorz.com

Medicon www.medicon.de

Olympus - J Mitra A-181 Okhla Industrial Area Phase I New Delhi 110020
www.jmitra.co.in

Stryker India Vatika Towers Block A 1st Floor Golf Course Road Sector 54
Gurgaon www.stryker.com

US Surgical www.ussurg.com

Wolf www.richard-wolf.com

Eagle Medical Systems Vaishno House A-267 Defence Colony New Delhi
110024

Indian

Kalelkar Surgicals

Manju Surgikraft

Om Surgicals 116 KN Road Mulji Devshi Building GF Chinchbunder Mumbai
400009 www.omsurgicals.com

Speaking for Myself

My tryst with destiny: Cholecystectomy and a bile duct injury

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'When God pushes you from a cliff, don't worry because only one of two things can happen—either He'll catch you or teach you how to fly!'

I am a medical student, my father is a surgeon and my mother a gynaecologist in a small town. I still remember that as a medical student, on the first day of our clinics, my professor of surgery had emphasized, 'We are here to prevent complications. Do not go by the statistics of the frequency of a complication. For you as a doctor, it may be only 0.1%, but for the patient and his family it is 100%.'

It all began when I was 19. I was in the third semester of MBB and life was sailing along quietly when in November 2006,

I started having episodes of early morning abdominal pain. I ignored it for some time, as all of us do, but the pain gradually became continuous and persisted throughout the day. Finally,

I decided to get it evaluated. An ultrasonogram (US) showed that I was suffering from acute calculous cholecystitis. It was a surprising diagnosis at my age, but I and my family were not too worried. My third semester examinations were approaching in January 2007 and we decided to get my operation done after my examinations. However, the pain gradually became worse and on 12 December 2006, I had to fly home. On 13 December, I was admitted to a reputed hospital and scheduled for a laparoscopic cholecystectomy the same evening. Little did we know how those 3 hours were going to unsettle our lives. It was a difficult cholecystectomy, with many adhesions, and the procedure

was converted from a laparoscopic one to an open cholecystectomy.

After the surgery, I passed clay-coloured stools and the gall bladder (GB) fossa drain output was 250 ml of bile per day. It did not decrease, but I was discharged with the drain. The night of my birthday that December turned into a nightmare for me. I suddenly experienced a stabbing pain in my entire abdomen. I could neither move, nor lie down. Analgesics did not help and I sat through the whole night. An US done the next morning revealed the presence of about 500 ml fluid in my abdomen. I was immediately shifted to a larger hospital in a major city. By then, the GB fossa drain had stopped draining and hence, it was removed. A computed tomography (CT)-guided pelvic drain was placed and drained fluid for the next 5 days. However, the pain did not subside and I had to sit up throughout the day and night. An isotope scan showed a leak from the biliary system. An endoscopic retrograde cholangiopancreatography (ERCP) done a week later confirmed complete transection of the common bile duct (CBD).

This was the toughest moment of my life. It is in testing times like these that your family's support stands out and keeps you together. My parents were not only my support, but also my only strength. On 31 December 2006, an exploratory laparotomy was performed and the GB fossa drain was replaced. I was discharged 2 days later and asked to wait for 6 weeks for a hepaticojejunostomy (HJ).

The waiting period almost broke me. I had missed my examinations and did

not know what would happen next, and the pain kept coming back. I had lost a lot of weight, and anorexia and constipation were constant companions. To add to this, I had a new appendage—my bile bag. During this time, my younger siblings kept me ticking. In late February 2007, following a magnetic resonance cholangiography (MRC) and percutaneous transhepatic cholangiography (PTC), the HJ was planned. I was then admitted to another reputed hospital in a major city and underwent HJ on 14 March 2007. We believe it is tough to be on the operating side of the operation table, but being on the operation table itself is much tougher. I knew what my parents were going through. I wanted it all to end, for them at least. The HJ was done and my surgeons were satisfied. They had anastomosed the stump of the common hepatic duct (CHD) to the jejunum and they were happy that a single anastomosis was adequate.

However, the worst was yet to come. On the second postoperative day, I suddenly developed tachycardia (140 beats/minute), palpitation and dyspnoea, along with cyanosis. I was connected to a ventilator. A rare nosocomial bacterial killer had attacked me. I later read that only 10% of its victims survive. My lungs were full of transudates and had collapsed. The radiologist at the CT unit told my mother that there was hardly any hope left. My serum bilirubin had risen to 8.5 mg/dl. My parents, who were with me all this time, were shattered. At home, my siblings were anxious. I, meanwhile, slept through the worst 3 days of my life. Chest drains were placed on both sides and finally, I woke up 72 hours later. When I sit back and think now, I can find only one reason for my survival—too many people love me. God had to listen to them! When I woke up, I did not

realize what had happened. I was told of this episode later. Thinking of those moments still brings back the agony. I felt extremely weak; speaking even one complete sentence was a tiring job. Recovery was, however, apparently quick and I was discharged 2 weeks after the operation, but with a T tube *in situ*. However, I was not well for long. I soon developed fever with severe chills and rigors. Intravenous antibiotics did not help, nor did antimalarials. I had to be readmitted for fever and was diagnosed to have a collection of about 100 ml in the GB fossa. The T tube had moved in to the jejunum and was removed. I started to recover and finally rejoined my college on 6 May 2007, after 5 months of absence.

We realized the future implications of all this much later. Over the next year, I had recurrent attacks of fever at intervals of 3–6 weeks. I could not gain much weight. The liver function tests (LFT) showed raised alkaline phosphatase. US and MRC kept showing mild dilatation of the biliary system, but the doctors insisted that all was well. I passed my second professional examinations in January 2008. In May 2008, however, the scourge returned. Just two days before my sixth semester examinations, I developed a fever and my serum bilirubin went up to 8.5 mg/dl. I immediately flew back home, once again missing my examinations. This time, my surgeon decided to go for percutaneous dilatation of the anastomosis. The first session of dilatation on 6 June 2008 failed as the stricture was too tight. The doctors tried again 2 days later, but still could not pass the stricture. I was sent home to wait till the cholangitis subsided. The bile bag was back with me. It was all so sudden; I could not accept that another long dark tunnel lay ahead of me. This time, it was much tougher to accept the gravity of the situation.

Four weeks later, we decided to consult a leading interventional radiologist at another hospital in another major city. I was admitted to that hospital on 6 July 2008. The interventional radiological procedures were painful, each progressively more agonizing than the previous one, yet failing to negotiate the stricture. After several failed attempts, it was decided that surgery would be required. My earlier reports, when analysed here, revealed shocking results. Along with the strictured anastomosis, the right lobe of my liver had apparently atrophied. On 29 July 2008, a fourth operation was performed. The atrophied right hepatic lobe was excised and a stented HJ was done with the left bile duct. Another operation, another stay in the ICU. It was a fight with destiny that we could not afford to lose. I recovered well and was sent back home

2 weeks later with a stent that was draining bile outside. A month passed and in September 2008, the bile was re-routed internally with two biliary drains-cum-stents. The stents were going to be *in situ* for 1 year. Taking care of these two catheters was a hard job. Recurrent low-grade fever and the administration of intravenous antibiotics made it difficult for me to rejoin college. At home, my little brother and sister did their best to keep me in high spirits. I had to miss my third professional MB,BS examinations in December 2008.

Finally, in January 2009, I rejoined college. This time, I had gained weight and felt much healthier. Of course, taking care of the catheter was an everyday chore. Now I was away from home, but my friends were extremely helpful; without their support I could not possibly have stayed in the college.

In May 2009, I appeared for and passed the third professional part I

examination, scoring 64%. Both my stents have now been removed. I have gained 9 kg, my LFTs are normal, I feel much healthier and just hope to be fine now.

I consider this to be my second life, my 'Renaissance', and I owe it to my family, friends and doctors. Without their dedication and unceasing support, I could not have come out of this dark nightmare. I still feel I am blessed to be loved by all of them.

During my ordeal, I missed five-and-a-half months of classes in the first phase of illness. This period included third semester classes and examinations. In the second phase, I missed the sixth semester examinations, seventh semester classes and third professional examinations in December 2008. Fortunately, my performance in the internal examinations helped me appear in the finals each time. I had scored 65% in the first professional examinations (before my illness) and 62% and 64%, respectively, in the second and third professional examinations (during and after my operations). I have not been permitted to appear for the final professional examinations in January 2010 because of my long period of absence. I will probably appear for these examinations in May 2010.

Following the initial hospitalization for a week during the cholecystectomy, I was hospitalized in Delhi several times. The longest period of hospitalization was 15 days, at the time of the HJ, and included a 6-day stay in a surgical ICU. The definitive final surgery entailed an admission of nearly 6 weeks. Thereafter, I had to be admitted for review and change of stents every 3 months till July 2009, for about a week each time.

My parents, especially my mother, have been on leave for practically the entire period of my illness. My mother's accumulated leave has been exhausted.

My father was on leave whenever I was in hospital. The total time is in months.

My two younger siblings, a 13-year-old sister studying in class 8 and a 10-year-old brother studying in class 5, are dependent on my mother for their daily needs. My parents' long absences from home during my hospital stays were trying times for them. They struggled for little things and their scholastic performance was adversely affected. This was the first time they managed without their parents for days and weeks. Despite the problems they went through, they were my closest friends and companions during this time. Also, throughout this trying period, my paternal grandparents were a major source of support. They lived in a big city, but shifted to our town to be with us during the entire episode. They took care of our home and my siblings in the absence of my parents.

It is at times like these that you discover your true friends. Almost every close and distant relative and friend came to see me during this period. Throughout these 2 years, I have had a lot of visitors, including my school teachers, my parents' colleagues and my friends.

Both my parents work for the government. While their insurance through their employer reimbursed a large part of the immense costs involved, it did not cover several costs, such as emergency air travel. It also did not compensate for the loss due to my parents' absence from work.

In the past 3 years, life has changed for me and my family. However, this phase of life has been quite educative. I learnt that one needs to treasure people who stand by one when one is in deep water. By no expressions will I ever be able to thank my family, my friends and my doctors. But I will owe this, my

second life, to all of them.

COMMENT

I sincerely hope that the heart-rending account of this young girl, who sustained a bile duct injury (BDI) during laparoscopic cholecystectomy, will make my surgical colleagues realize and appreciate that (laparoscopic) cholecystectomy is not a simple operation and that a BDI can result in major morbidity, including repeated hospitalizations and interventions (including operations). It puts immense financial, mental, emotional and social stress on the family. A BDI can even cause death and Manali was fortunate to survive. For the surgeon, a BDI could result in a medico-legal suit. I urge every surgeon to take every precaution to make each and every cholecystectomy a safe one.

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