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The Difficult Cholecystectomy



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Abstract

Since the advent of laparoscopic cholecystectomy (LC) in the early 90's, the gold standard for the treatment of symptomatic cholelithiasis is laparoscopic cholecystectomy (LC) via the traditional 4-trocars approach. Other approaches include open access (usually via a right subcostal or paramedian incision), and, usually a consequence of conversion or contraindication to a laparoscopic cholecystectomy, single-trocar and robotic. The NOTES (Natural Orifice Transendoscopic Surgery) approach via culdotomy has been mostly abandoned.

However, there are a number of conditions, situations, and circumstances that can increase the difficulty of the procedure and the risks associated with its performance. Among the latter, bile duct injury (BDI) is a huge concern of laparoscopic cholecystectomy, resulting in significant morbidity and mortality.

Keywords: Laparoscopic cholecystectomy, difficult cholecystectomy, MIrizzi's syndrome, subtotal cholecystectomy.

Introduction

The gold standard for the surgical treatment of symptomatic cholelithiasis is conventional laparoscopic cholecystectomy (LC). Laparoscopic cholecystectomy is one of the most commonly performed operations worldwide. The most common indication for its elective procedure is uncomplicated biliary colic. But there are several conditions that may increase the difficulty and risk of this procedure.[1] The "difficult gallbladder" is a scenario in which a cholecystectomy turns into an increased surgical risk compared with a standard and regular cholecystectomy. The procedure may be difficult due to processes that either obscure normal biliary anatomy (such as acute or chronic inflammation) or operative exposure (obesity or adhesions caused by prior upper abdominal surgery).[2] When operating on a patient with a difficult cholecystectomy, the surgeon has an obligation to turn the operation into a safe cholecystectomy: conversion (to an open procedure), cholecystostomy, or partial/ subtotal cholecystectomy. It is clear and mandatory that damage control is useful to prevent serious complications if encountered during the procedure.

Recognizing a potentially difficult gallbladder is the first step toward mitigating the high risks of operating on such patients. Conversion to an open procedure should not be considered a failure and is mandatory to perform a safe procedure. Quite distinct is the situation

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when conversion is performed to solve intraoperative complications.

Framing the Issue

The difficulty in performing a laparoscopic cholecystectomy may be linked to the following factors:

• The procedure in itself: This point includes the characteristics of the procedure, patient-related factors (such as obesity, coronary artery disease, pulmonary restrictions), instrumentation, technical resources, backup, and the surgeon, who may be more or less experienced and more or less capable when confronting a difficult situation.

• The anatomy: refers to potential aberrant ductal and arterial anatomy, a prominent liver, an intrahepatic or left-sided gallbladder, and all factors very difficult to acknowledge in the preoperative stage.

• The disease affecting the gallbladder: the presence of a fibrosed and contracted gallbladder, an acute or relapsed cholecystitits, a xantogranulatomatous cholecystitis. Even an unexpected gallbladder carcinoma should be considered.

The management of a patient undergoing a laparoscopic cholecystectomy (LC) may be exposed to the occurrence of errors,[3] which may happen in three different stages:

- Preoperative errors: usually linked with errors of knowledge and rules. This fact highlights the importance of a grounded diagnosis based on evidence and following the adequate guidelines for treatment. In that sense, for example, operating on a patient with a 3 mm gallbladder polyp represents an incorrect surgical indication. It frames the case for an unnecessary surgical procedure.

- Intraoperative errors: errors are mostly related with the level of manual skills and dexterity as well as cognitive perception; however, other errors, undetected in the previous stage, may become evident. For example, coagulation disorders or concomitant diseases may not be detected.

- Postoperative errors: linked to the three levels of rules, skills, and knowledge. They may be the consequence of intraoperative errors.

When to Predict a Difficult Laparoscopic Cholecystectomy

A difficult cholecystectomy may be predicted preoperatively based on patient characteristics, as well as by ultrasound and laboratory findings. This step is important, since knowing or assessing the difficult risks may result in a rescheduling of the operation or adopting strategies to achieve a safe cholecystectomy. The following conditions are linked with a higher chance of experiencing a difficult operation[4]:

- Acute cholecystitis, more than 5 days of onset[5]
- Previous cholecystitis episode[6]
- Male sex
- Obesity[7]
- Cirrhosis[8]
- Sclero-atrophic gallbladder
- Thick walls (> 5 mm)
- Previous signs of canalicular dwelling (clinical and laboratory)

Conversion to an open procedure should not be considered as a personal failure. The surgical team needs to fully agree with the concept of "safety first," considering that conversion is performed in order to complete the procedure without additional risks, while preventing complications and not solving intraoperative complications.[9]

A smart surgeon should rely on conversion: when there is lack of progress in the procedure, when the anatomy is unclear, the cystic duct and artery are not distinguished, when there is important bleeding, in cases where a biliary duct injury is detected and the surgeon is not confident to continue the operation in a minimally invasive fashion, or when confronted with lack of infrastructure.

Some of the Difficulties a Surgeon May Encounter and How to Deal With Them

In Table 1, the five steps of a laparoscopic cholecystectomy are described. In each of these steps, the participating surgeon may encounter different situations, which will be tackled in a summarized way.

Table 1. The steps during laparoscopic cholecystectomy

1.	Access to the abdomen
2.	Gallbladder exposure
3.	Dissection of the cystic artery and duct
4.	Gallbladder ectomy
5.	Gallbladder extraction

1. Access to the abdomen

- Obesity: higher BMI (body mass index) patients

represent an additional difficulty with regard to accessing the cavity and performing the operation.

- Previous surgery/ies: a hostile abdomen also conveys additional challenges for entry to the abdomen. A major concern for the surgeon is preventing an intestinal or vascular injury.

- Veress versus Hasson (close versus open)/optic trocar. There is no definitive better entrance method to the abdomen. The surgeon should rely on an approach, which she considers reliable. Another option in patients with high BMI is the use of an optical trocar.[10]

2. Gallbladder (GB) Exposure

A full exposure of the gallbladder with adequate retraction of the fundus and the neck is mandatory for a safe operation. The exposure of the gallbladder may be compromised by its own condition or anatomy, or by external factors.

- Adhesions: should be taken down in order to allow a full retraction of the neighboring organs and a full exposure of the gallbladder.

- Large liver/or fallen down liver: a large liver or a liver that cannot be adequately retracted, may compromise the full exposure of the gallbladder and the Calot triangle. If needed, an additional retractor via a fifth 5 mm trocar may be of valuable help.

- Biliary fistulas: the presence of biliary fistulas to the duodenum or the hepatic colonic flexure request a meticulous dissection, taking-down the trajectory of the communication and repairing the compromised digestive segment.

- Mirizzi syndrome: represents a condition linked to the prolonged evolution of the gallbladder calculous disease.

This condition is named after Pablo Mirizzi, professor of surgery at the University of Córdoba School of Medicine (Argentina), who is credited with the performance of the first intraoperative cholangiography in 1931. The Mirizzi syndrome is defined as the obstruction of the common hepatic duct by an extrinsic compression due to an impacted stone in the gallbladder infundibulum or in the cystic duct. Usually, patients present with jaundice, sometimes fever, and right upper quadrant pain. However, mostly, they present as asymptomatic and the condition is recognized intraoperatively. It should be acknowledged that Mirizzi did not describe the condition known today as Mirizzi syndrome.[11,12] The first published paper describing the condition, known as Mirizzi syndrome, belongs to Puestow.[13] Some years later, Behrend contributed with a similar report.[14]

It was McSherry, who coined the term, 'Mirizzi syndrome', for this condition. Based on ERCP findings, he described two types. Type I is external compression of the bile duct by a large stone or stones, impacted in the cystic duct or in the Hartmann pouch. Type II is cholecystobiliary fistula, caused by a gallstone or gallstones that have eroded into the bile duct.[15] Although Csendes et al. proposed a five type classification[16], the one described by McSherry is still the most applicable and used.

The Mirizzi syndrome is relatively uncommon and frequently related to a long-standing calculous disease. It is found predominantly in the older population with no gender preference. It carries a higher risk of gallbladder cancer, probably, due to persistent and recurrent irritation of the compromised area and chronic biliary stasis.[17] The treatment for this condition is laparoscopic cholecystectomy and, if difficult, conversion with an incidence higher than 70% is recommended. Care to prevent injury to the porta hepatis and bile ducts is strictly recommended. When a fistula traject is present, a common bile duct repair is mandated or even a bilioenteric anastomosis with Roux-in-Y is recommended. Otherwise, repair of the bile duct and placement of a T tube is recommended.[18]

3. Dissection of Cystic Artery and Duct:

- In order to assure the precise identification of both the cystic artery and duct, thus preventing a biliary duct injury, achievement and documentation of the critical view of safety (CVS), is of paramount importance.[19,20]

The CVS includes:

1. Clearance of the cystohepatic triangle (commonly referred to as the triangle of Calot), with the following boundaries: liver edge superiorly, cystic duct inferiorly and laterally, and hepatic duct medially.

2. Cystic plate exposure by removal of the lower one-third of the gallbladder from the gallbladder fossa.

3. Confirmation that two, and only two, structures are entering the gallbladder (the cystic duct and cystic artery)

- A difficult Hartmann pouch, usually due to the impact of a stone, which prevents placing a grasping in the area, may prevent a good exposure of the gallbladder neck and the communication between it and the cystic duct.

- Anatomic variations: every surgeon should be aware of the chance for anatomic changes in the biliary anatomy and the arterial supply to the gallbladder and the liver (cystic and hepatic artery)

- Intraoperative cholangiography: which may be performed either by a transcystic approach or by puncture of the gallbladder.

- The issue of whether or not the performance of an intraoperative cholangiogram (IOC) prevents the occurrence of a bile duct injury is controversial, but there is no doubt that the intraoperative cholangiogram is very useful in the intraoperative recognition of a bile duct injury.[22]

- In our preference, an IOC is performed systematically. However, it should be performed in the following circumstances: unclear biliary anatomy, which is needed to rule out choledocholithiasis and concern for a biliary duct injury. There are three requirements for a normal IOC: the contrast should be seen in both hepatic ducts, lack of filling defects in the common bile duct, and free flow of contrast into the duodenum

- Thermal injuries: the use of energy sources (mostly electrocautery and sometimes ultrasonic devices) request care and delicacy in the management of tissues so as to prevent using the electrocautery close to the titanium clips, because these may expand the current and, thus, injure the bile duct.

4. GB Ectomy

The ectomy of the GB from its liver bed is an important step after placing clips and cutting both the cystic artery and the cystic duct. When facing difficulties, the surgeon may rely on some tricks to complete the operation.

- The puncture and aspiration of the gallbladder fluid

- Aperture: partial aperture of the gallbladder and extraction of stones

- Partial or subtotal cholecystectomy/cholecystostomy (Delajenniere, Pribram) These techniques may aid in the prevention of the biliary duct injuries by staying away from the cystic duct and the bile duct. The Delajenniere technique consists in leaving a remnant of the gallbladder, usually the neck, and placing a tube for draining the bile. Another option is leaving the galllbladder attached to the liver bed and cauterizing it with the electrocautery. The subtotal cholecystectomy has become a widely accepted resource to avoid conversion; in particular, for those surgeons who are not widely trained in open surgery.[22-24]

4. Extraction

The extraction of the gallbladder may be performed either by the umbilical or the subcostal trocar entrance. The use of a pouch is always recommended to avoid spillage and/or loss of stones in the abdominal cavity. When the subcostal trocar opening is enlarged to allow the "delivery" of the specimen, there may be an increased risk of injuring the epigastric artery. This condition may be solved by using the compression of the abdominal wall with an inflated Folley catheter placed through the opening. Some prefer to use the umbilical port, using a 2 cm dilator with the risk of a postoperative umbilical hernia. The rupture or the gallbladder may result in spillage of its content, including stones, and, thus, contribute to postoperative wound infection. The presence of retained stones in the abdominal cavity or in the subcutaneous tissue may generate collections. It is also important to examine the gallbladder specimen to verify that there is only one conduct (the cystic duct) entering into the gallbladder neck and, therefore, confirm the avoidance of a biliary tract injury.

The Tokyo Guidelines 2018 recommend the following steps to achieve a safe cholecystectomy[25]:

• If the gallbladder is distended and interferes with viewing, it should be decompressed by needle aspiration.

• Effective retraction of the gallbladder to develop a plane in the Calot triangle area and identify its boundaries (countertraction).

• Starting dissection from the posterior leaf of the peritoneum covering the neck of the gallbladder and exposing the gallbladder surface above the Rouviere sulcus.

• Maintaining the plane of dissection on the gallbladder surface throughout LC.

• Dissecting the lower part of the gallbladder bed (at least one-third) to obtain the CVS.

• Creating the CVS for persistent hemorrhage, achieving hemostasis primarily by compression and avoiding excessive use of electrocautery or clipping.

Prevention of Biliary Duct Injuries (BDI)

BDI still remains a relatively infrequent event (<1 every 200 to 400 cases), although it represents a leading source of medical malpractice litigation claims against surgeons. Between 34 to 49 percent of all surgeons are expected to encounter such an injury during their professional career. The repair of such injuries is often complex and usually requires several endoscopic and interventional radiology procedures and surgeries.

Major common bile duct (CBD) injury has a substantial and definitive impact on the quality of life, functional status, and survival.

The incidence of BDI in laparoscopic cholecystectomy is reported between 0.4 and 0.6 percent.[26-28] Besides, biliary duct injuries have a definitive impact on and impairment of the quality of life of the affected patients.[29]

Although acute cholecystitis doubles the risk of BDI, the simple and straightforward "simple" and/or "piece of cake" gallbladder should be given due attention. Because of inappropriate and/or excessive traction (both cephalad and lateral), the cystic end into the common bile duct goes usually unrecognized. The misinterpretation leads to the consideration of the CBD for the cystic duct. A clip, or two, are applied and the CBD is cut. As, often, an IOC is not performed, the injury goes unrecognized and the surgeon ends with a total transection of the CBD in between clips. The first symptom is usually postoperative jaundice, leading to additional imaging studies and the postoperative diagnosis of the bile duct injury.[30,31]

There is discussion among authors and researchers regarding the status of bile duct injuries. For many, they represent a surgical complication inherent to the procedure, and most, if not all, surgeons will be confronted with a case in their surgical life. However, there is a growing trend to consider them as an example of a surgical technical error, many times as a consequence of misinterpretation, with the cognitive analysis of intraoperative decisions playing a major role in their production.[32]

From the perspective of human factors and system's safety, the accident analysis of BDI offers the following findings:

- BDI usually follows a definitive sequence.
- The severity of injury depends upon the steps in which the error is identified and the process through which the surgeon stops the procedure.
- In severe injuries, the CBD is cut and divided twice, with the site of injury close to the liver hilum.
- In all situations, the root cause is the misidentification of the distal CBD as the cystic duct. Visual perception during the operation should be considered as a form of heuristics, a rule of thumb, which assists in performing complex tasks and in realizing the mental construction represented by the vision of the surgeon and the whole team.[33]
- Often, however, the procedure is performed as smoothly as in a routine LC, and the surgeon does not notice the BDI.

Therefore, it is recommended to be beware of the following conditions:

- Simple gallbladder, with very easy retraction
- Status of acute inflammation
- Sclero-atrophic gallbladder
- Suspicion of Mirizzi syndrome
- Bleeding of unsuspected origin
- Appearance of unpredicted vessels or ducts
- Deviation of the operating target
- Shifting of dissecting target

There are some warning signs. They may include the surgeon's feelings of hesitation that something unusual has happened, or that a thorough re-evaluation of the situation is mandatory. Encountering the above-mentioned circumstances, typically, means that the surgeon's proficency and ability to deal with the operative conditions have been surpassed.

The Factors Leading to Injury May Be Grouped in the Following[34,35]:

1. Patient and disease
2. Environment
3. Procedure
4. Human factors

In accordance, the prevention of BDI should be founded on the development of strategies for building a safe working system including the described steps[36]:

1. Patient selection

Preoperative identification of patients with high-risk factors may be very helpful in the prevention of BDI. It may also aid in the assignment of more experienced surgeons to assist in the procedure, to schedule the case at an earlier time, or to make arrangements for availability and disposal of intraoperative cholangiography.

These high-risk factors include:

- Current acute cholecystitis or previous episodes of acute cholecystitis
- Simple laparoscopic cholecystectomy
- Severe adhesions due to previous surgery/ ies
- Scarring and inflammation, scleroatrophic gallbladder, suspicion of xantogranulomatous cholecystitis
- Concomitant CBD stones, which may be cleared preoperatively by means of ERCP or simultaneously with transcystic management

2. Control of environment

The operating room environment (personnel, supplies, devices, infrastructure) should provide an appropriate response in such way that problems encountered

during the course of the surgical procedure can be dealt with adequately before they compromise the patient's safety and the surgen's wellness.

3. Design error-proof procedures

The systematic implementation of such procedures, particularly, in academic institutions, where surgical residents and young faculty are involved, is of paramount importance. Some of the important steps to take into account during the performance of a safe laparoscopic cholecystectomy include the following:

a. Identification of the important structures; in particular, the cystic artery, the cystic duct, and the common bile duct. This process of identification is not a dynamic action, but, instead, a state of close inspection. It is important for surgeons to develop an instinct of permanent awareness, where identification and overcoming difficulties are always present.[37]

b. Recognition of ***landmarks,*** such as:

• Confluence of the Hartmann pouch into the cystic duct, as a way of staying away from the common bile duct

• Cystic lymph node, noting that the cystic artery is usually located behind it

• Cystic artery (parallel with cystic duct)

• Common bile duct

• Duodenum

c. Maintenance of proper and adequate traction in both cephalad and caudal direction to expand and allow a correct visualization of the gallbladder fundus and neck

d. Adequate dissection of Hartmann pouch from both anterior, medial, and posterior lateral sides to expose the cystic duct and artery gradually and safely.

e. Proper ***check points***, which represent steps necessary to be overcome safely and which, in turn, add precision to the procedure. These include the following:

1. Gallbladder fundus pushed cephalic, and Hartmann pouch pushed laterally right;

2. Cystic duct before it is clipped and cut;

3. Liver bed after gallbladder-ectomy;

4. Inspection of the removed specimen with the visible orifice of cystic duct;

4. Detailed training program for young surgeons under supervision.

This approach is mandatory in academic institutions and, thus, will provide trainees with a set of adequate abilities, a toolbox, and training to surpass difficulties when no longer under strict supervision. Each institution should develop its own program fitted to the type of patients taken care of in that facility or system. The content should be related to the following topics:

- In-depth knowledge of the basics and fundamentals of anatomy and surgical techniques, as well as surgical alternatives when confronting intraoperative difficulties.
- Technique-related skills, which should be honed in virtual or exvivo simulation models.
- The full development and steps included in a standard error-proof procedure.
- Non–technique-related skills, which include the ability to control the environment, the practical and effectiveness of leadership of a surgical team, proper personal behavior; the calm and appropriate response to difficult situations, and intraoperative inconvenients; the avoidance of dangerous situations, the attention to warning signs; and the willingness to call for help so as not to compromise the patient's safety.

Final Remarks

The primary goal of a laparoscopic cholecystectomy in the treatment of symptomatic cholelithiasis is the safe remotion of the gallbladder and the absence of common bile duct injury.[38,39]

• Some tips to take into account:

- Never perform a laparoscopic cholecystectomy without a skilled surgeon close by.
- Beware of the easy gallbladder.
- Slow down, take your time.
- Knowledge is power, conversion can be the salvation!
- Do not repair a bile duct injury (unless you have performed at least 25 hepaticojejunostomies).
- Do not ignore postoperative complaints (pain, jaundice, major abdominal discomfort, fever).

• Other options when confronted with a difficult laparoscopic cholecystectomy are:

- A percutaneous cholecystostomy, if the risk was identified preoperatively or the patient is a poor surgical candidate.
- An intraoperative cholangiography, which may aid in identifying an injury to the bile duct and solve it, if you are an experienced surgeon.
- A subtotal or partial cholecystectomy
- Ask for help
- Conversion to an open procedure

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The author has no conflict of interest to disclose.

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