When Is It Safe to Continue Laparoscopically?

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Abbreviations

BDI	Bile duct injury
CBD	Common bile duct
CVS	Critical view of safety
IOC	Intraoperative Cholangiography
HPB	Hepato-pancreatic-biliary

11.1 Introduction

Laparoscopic cholecystectomy is one of the most frequently performed surgical procedures in the world, with epidemiological differences and areas with different prevalence. This requires health systems to rationalize expenses, including excellence in quality of results and avoid legal medical litigation to surgeons.

The main purpose of biliary surgery safety is the removal of the gallbladder without bile duct injury (BDI) or the vascular structures of the liver pedicle, with a minimum invasion.

Laparoscopic surgery has solved this with an acceptable conversion rate, up to 15% [1].

The safety of a surgical procedure is determined by the ability to perform surgery without increasing the surgical risks and to resolve complications that may occur during the procedure.

Advances in the prevention of bile duct injuries can be summarized in: the development of the concept of "difficult cholecystectomy" and the derivations of it, the critical view of safety of Strasberg [2], conversion indicators, and technical alternatives to cholecystectomy. All these have been useful to the development of the concept of safe cholecystectomy and the idea of a culture of safety for this procedure.

The term "difficult cholecystectomy" is an extensive, complex, and difficult to define concept in the intraoperative time. It can be said that it is a set of pathological situations that technically prevent cholecystectomy in a regular manner. It refers to cholecystectomy under certain situations that do not allow safe dissection, leading to an extension of surgical time and the risk of complications. In a practical sense, we can say that "risk" is implicitly associated with "safety deficit" during a procedure that both factors have a proportional connection and that the resulting decision has an impact on the outcome of the surgery. There are well-established concepts, vast experience, and literature regarding preoperative risk factors for vascular and/or biliary surgical injury, as well as the intraoperative factors that determine the decision to convert or change tactic to more limited surgeries. Under these circumstances, it is considered that the incidence of complications of the main bile duct as well as vascular structures are 2 to 5 times

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higher in laparoscopic cholecystectomy than in the open one [3].

The objective of this chapter is to analyze intraoperative indicators and the logistical context essential to safely continue with a laparoscopic cholecystectomy, mainly technical, linked to dissection and its difficulties. We will not analyze other factors such as the intolerance of pneumoperitoneum, the inability to achieve a correct working cavity, the failure of surgical instruments, or the expertise of the surgical team.

11.2 Technical Factors that Decrease Security

Cholecystectomy is a procedure that progresses with technical, systematized, and well-defined steps, involving prior theoretical knowledge and surgical skills. It is therefore important that the surgeon realizes when the dissection is becoming unsafe, the risk of injury, as well as the need to establish technical changes that will further lead the procedure to a correct outcome.

The impossibility of carrying on with surgery, anatomical disorientation, and decreased visualization, whatever the cause, are factors that take the procedure away from the safety path, increasing the risks.

There are factors that can affect the safety of a cholecystectomy; we can group them into anatomical, pathological, and technical factors.

The presence of inflammation, an impacted gallstone on the basin, or the impossibility of gallbladder traction affect the correct and safe identification and dissection of the hepatocystic triangle [4]. In order to maintain anatomical orientation as a safety element, several anatomical landmarks have been described, useful in cases where the hepatocystic triangle is not easily identified and that would allow anatomical-spatial reorientation in difficult cases, such as identifying the umbilical fissure or maintaining dissection above Rouviere's sulcus [5].

There are multiple anatomical variants of the bile duct and in relation to the upper biliary confluent, although between 53% and 63% of cases of their formation is modal [6]. Chaib [7] established five types of anatomical variants were characterized in the right liver duct (A1-5) and 6 types in the left liver duct (B1-6). Atypical branching patterns in both right and left liver ducts were found in 14% and 8%, respectively [7].

In our experience, the variation of the highest risk of bile injury is the abouchement of the right lateral duct (segments VI-VII) in the cystic duct (Fig. 11.1).

Regarding the ostium modalities of the cystic duct, they are also very variable; it can flow anywhere on the main bile duct, between CBS and Vater's ampulla [8].

Benson [9] described congenital anatomical variations of extrahepatic bile ducts and classified them in five main types, which are the most seen in surgical practice (Fig. 11.2).

In fact, only 33% of patients have the "classic" anatomical connection between cystic and extrahepatic bile ducts and related arteries, and in 75% of cases, the cystic has an angular input in the hepatic duct, which facilitates its identification and allows surgeons to describe the Calot's triangle [10].

In 20% of the cases, the cystic and hepatic duct come together in a long and parallel path, performing the actual abouchement further down the apparent junction, presenting a path attached in "shotgun pipe" [9, 11], which makes it difficult to identify the cystic duct and produces the bile injury.

In 5–8% of the cases, the cystic is tortuous and it can also be spiral shaped, describing variable entry angles in the common duct. The main bile duct can be surrounded from behind or front to flow to its left edge [11].

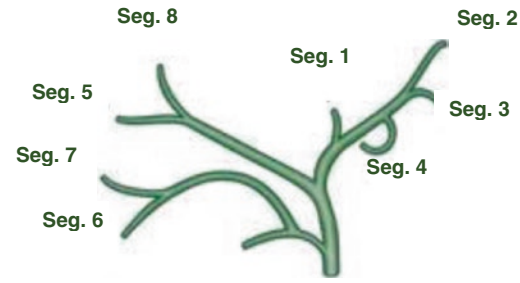

Fig. 11.1 Right lateral sectoral duct ending into the cystic duct. (Courtesy of L. Ruso Martinez)

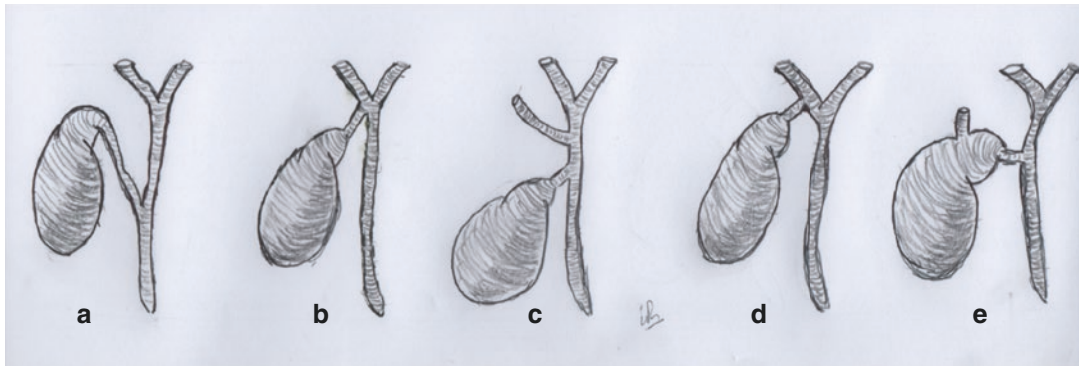

Fig. 11.2 Benson-Page [9] classification for anatomical variations of the cystic duct insertion. (**a**) Long cystic with low insertion in the choledoco; (**b**) cystic ending in the superior biliary confluent; (**c**) right sectorial duct (seg VI-VII) ending close to the cystic end; (**d**) cystic ending in the right hepatic duct; (**e**) "Modal"cystic, ending in common bile duct. (Courtesy of L. Ruso Martinez)

There are pathologies and intraoperative findings that allow us to predict difficulties as they determine by different ways of limitations in the basic principles of a safe cholecystectomy.

Acute cholecystitis generates inflammation of the hepatocystic triangle, which in determining a limitation to CVS is one of the most common causes of tactic change. The presence of acute inflammation causes edema of the adipose cell tissue of the hepatocystic triangle, which can sometimes be a facilitating factor for dissection and anatomical identification, although in others it can easily bleed to contact, limiting it. Gangrenous cholecystitis with gallbladder wall necrosis is a determinant finding in the tactic because it limits the alternative possibilities to total cholecystectomy.

On the other hand, chronic inflammation is a determinant factor of scarring fibrosis at the hepatocystic triangle level. The presence of a complete scleroatrophic gallbladder causes the retraction and difficulty in the grasp; an impacted gallstone on the basin makes it impossible to dissect and display the structures. Mirizzi's syndrome and cholecystoenteric fistula that determine particular and specific anatomical alterations become a technical and tactical challenge, independently of the approach.

All these findings have something in common, the difficulty of getting a CVS (Table 11.1).

Table 11.1 Intraoperative factors of technical difficulties

Thick wall gallbladder
Small gallbladder shrunken in the liver parenchyma
Chronicles/firm adhesions of the colon and duodenum in gallbladder bed
Cirrhotic liver
Misidentification of anatomical structures. Biliary and vascular variations
Permanent bleeding that decreases the vision of the operating field
Failure to progress dissection
Unreasonable dissection time

11.3 Safety Factors

The safety factors that allow to continue with the total cholecystectomy procedure come up from the analysis and knowledge of the technical limitations of it.

11.3.1 Critical View of Safety

Currently the CVS is the paradigm for performing a safe cholecystectomy. Recent recommendations (IRCAD Y SAGES) assume that CVS and training are the most relevant technical factors for decreasing bile duct injury (BDI) and also suggest as technical alternatives, dissec-

tion of the neck, and subtotal cholecystectomy [3, 12, 13].

The CVS is not a technique but is the final vision that is achieved after the dissection of the hepatocystic area, which leaves the duct exposed and the cystic artery, prior to its clipping and section [14, 15].

To achieve the CVS, there are three requirements, well-known: the Calot's triangle must be thoroughly cleaned of fat and fibrous tissue by its anterior and posterior face; the lower part of the gallbladder must be separated from the liver bed (dissection of the cystic plate) so that, finally, only two structures are visible entering the gallbladder. It is not necessary to expose the bile duct. Once the critical security vision is obtained, the cystic structures can be connected [14, 16, 17].

The creation of two holes in the hepatocystic area does not ensure the CVS, until the region is completely dissected, on both sides, with the total circumferential vision of the duct and the cystic artery (double view). This allows a safe identification of a possible third abnormal structure (arterial or biliary) that needs to be preserved.

However, it is difficult sometimes to dissect the structures of the Calot's triangle; to accomplish this can take an excessive time and beyond the conviction of the surgeon who is observing the correct structures, the presence of a Mirizzi's syndrome, gallstones in the Hartmann's pouch that hid the cystic, and the main bile duct; also scarring fibrosis and acute inflammatory edema, the existence of epiploic block, abscess, gallbladder necrosis, or perforation may decrease the safety of the procedure [18].

Likewise, it is a prerequisite to understand the concept of CVS and to be convinced of its usefulness. Nijssen [19] in a recent report shows a review of video and operative notes of laparoscopic cholecystectomy that CVS was achieved in only 10.8% of cases, although it was reported that it was accomplished in 80% of the cases. In a survey of experienced surgeons from 14 Latin American countries, only 21.8% answered correctly to the definition of CVS [20]. In the Ircad [12] study, 76% of general surgeons and 96% of HPB surgeons consistently applied CVS.

Failure to achieve a CVS after a reasonable attempt and the existence of a difficult situation represent a high risk of injury. The CVS prevents injury from misinterpretation of the anatomy, but not by a direct injury as a result of continuing dissection in a hostile environment [14].

In short, safety in cholecystectomy is more complex than theoretical knowledge of CVS principles, since the necessary technical skills and maneuvers may require a level of training which exceeds the safety of the procedure.

11.3.2 Primary Dissection of the Gallbladder–Cystic Junction

In situations of difficulty, such as anatomical identification or when CVS is not achieved, the technical alternative may be the location and primary circumferential dissection of the gallbladder–cystic junction. It starts with the peritoneal section on both sides of the gallbladder basin and continues with blunt dissection from right to left, until an orifice is made at the level of the gallbladder cystic angle. That being stablished and based on the fact that the safe dissection plane is the gallbladder wall, the dissection is maintained through the subsequent plane to avoid vascular or biliary injuries, continuing along the inner edge of the gallbladder, ligating it in an upward direction.

A limitation is that occasionally the cystic artery transgresses the cyst or it is parallel to it, or behind, to end at the gallbladder cystic angle. In these cases, the artery is bound, the presence of the cystic is confirmed, and the dissection is continued upwardly.

This reverse alternative of the infundibular technique avoids the "tunnel effect" well described by Strasberg [21]. It does not require the dissection of the Calot's triangle or the visualization of the main biliary tract, as the dissection is maintained in the area of the hepatocystic ligament at the Hartmann's pouch [22].

11.3.3 Imageology

Getting a bile duct mapping in a difficult surgical environment can be hard, but it is a tool that allows cholecystectomy to continue more safely.

11.3.4 Intraoperative Cholangiography (IOC)

IOC is the most widely used method for the assessment of the bile duct in the intraoperative. While there is no conclusive evidence that the IOC prevents BDI, it is a recommended tool for defining an unclear anatomy during a difficult cholecystectomy [12]. It is a technique that can be performed in 90–95% of cholecystectomies, but in cases of short or thin cystics it can be particularly difficult. Cholecysto cholangiography through infundibular gallbladder opening and puncture or placement of a Foley catheter is a good alternative to achieve biliary opacification.

The limitations of it are that it must be technically well done, visualizing the entire biliary tract, intra and extrahepatic, and the passage of contrast to the duodenum, which involves knowing the biliary anatomy and its variations for a correct interpretation, and being performed without extending the surgical time too long.

Less routine use: Laparoscopic ultrasound. It allows the assessment of biliary and vascular pieces, arterial and venous, with the advantage of being noninvasive and radiation free, although it requires adequate training.

Also, near-infrared fluorescence angiography. Recently implemented, it is effective and safe in several studies, but its use is not yet widespread.

11.3.5 Surgical Time

Surgical time is an indicator itself of difficult cholecystectomy. It depends on multiple factors, such as surgeon skills, surgical team experience, and expertise.

The decision whether to continue with laparoscopy or not does not depend on a time factor but on the balance between difficulties in dissection progress, risks of complications, and extended surgical time.

The time for a change of surgical tactical (cholecystostomy/conversion) varies from 30 to 90 min depending on the experience of the surgical team, bleeding, patient tolerance, and complications.

In a multicenter study, 41% of surgeons consider that the maximum time for laparoscopic cholecystectomy should be 180 min, while 26% do not consider time as a determinant factor for conversion [23]. Recent reports conclude that more than the duration of the cholecystectomy is the experience that determines whether to continue laparoscopically or not [24].

11.3.6 Abstention to Continue

It is an attitude of prudence in the course of an uncertain dissection and/or in the presence of sustained unidentified structures. Therefore, three possibilities come up from this: performing maneuvers to increase vision and facilitate dissection, consult another surgeon or if this is not feasible, and the adoption of alternative techniques.

11.3.7 Maneuvers to Increase Visualization

They are made to improve visualization of the surgical field and to improve dissection. Gallbladder puncture and evacuation, very common in cases of thick-walled gallbladders, of difficult grasp or gallstones impacted on the basin; in that case, if it is feasible, the gallbladder opening and removal of the calculi to continue the procedure safely. Placing a fifth trocar, is a maneuver to keep in mind, as well as the suspension of the round ligament or conversion to

assisted hand, a less frequent procedure that requires experience and suitable equipment for its performance.

11.3.8 Second Opinion

A second opinion consult to a more experienced surgeon or HPB surgery specialist is present in all published recommendations on this topic. In addition, up to 18% prevention of biliary/vascular injuries has been reported when calling a second surgeon because of unexpected findings [25].

11.3.9 Alternatives to Cholecystectomy

While the ideal objective is total cholecystectomy, in cases where the safety of the procedure is at risk, there is the option of alternative procedures that allow the treatment of the pathology without exposing the patient to a high risk of bile or vascular injuries. The clinical judgment of the surgeon is essential to define when a dissection becomes difficult and therefore risky and determines the need for alternative procedures, taking into account their experience and expertise.

11.3.10 Conversion

It is clear that the conversion does not guarantee the security of the procedure and therefore many times is not the solution to the problem. In fact it is a controversial issue among those who find that the conversion is associated to three times more complications, mortality, surgical site infection, hospital stay, and readmission than total laparoscopic surgery, while other authors show that there are eight times more bile duct injuries in unconverted patients [26, 27].

11.3.11 Percutaneous Cholecystostomy

It is a timeserver procedure that causes symptomatic relief until final resolution.

11.3.12 Partial or Subtotal Cholecystectomy

In the face of a frozen pedicle with intense fibrosis, subtotal cholecystectomy is an option, avoiding dissection in a risky area.

Ideally, lithiasis should be removed and then the cauterization of the remaining gallbladder must be performed. These procedures can be performed laparoscopically or after conversion, with the surgeon's experience being a determinant factor. An increase in incidence of bile fistulas in subtotal cholecystectomies has been reported, compared to total cholecystectomy (6.3% vs 0.35%), probably related to the incomplete closure of the residual infundibulum. However, morbidity is relatively low requiring endoscopic resolution between 1.5% and 15% [28]. In a review of 1231 subtotal cholecystectomies, of which 73% were laparoscopic, 0.3% postoperative hemorrhage was found, 2.9% sub hepatic collection, and 0.08% BDI [29]. Therefore, laparoscopic subtotal cholecystectomy is a valid and safe option to avoid BDI during a difficult cholecystectomy. Although with a high biliary leakage rate of 18% [29].

11.3.13 Anterograde Cholecystectomy Technique or Fundus First Cholecystectomy

This technique performed during the conventional procedure is also applicable to laparoscopic approach, but it requires a clear knowledge of the anatomy and cystic plate area and hilum to avoid injury [30]. In our experience, despite the fact that it appears in recommendations of recent publications [12, 13], we consider it a risky technique because the possibility of confusing the dissection planes next to the liver hilum.

11.3.14 When Is It Safe to Continue Laparoscopically?

When difficulties are checked during cholecystectomy, the surgeon should think calmly if the procedure should be carried on laparoscopically.

It is possible to continue laparoscopic surgery in the presence of objective safety indicators when:

- There is the conviction of the surgical team that there is proper exposure of the hepatocystic area and that the visceral tractions are made in a technically correct way.
- An appropriate CVS is established.
- Circumferential dissection of the gallbladder cystic angle is achieved, and the cystic artery is visualized, with double vision of both structures.
- There is no doubt regarding the safety of the ongoing surgical procedure.

This determines that no "no return" maneuvers should be performed that require cholecystectomy of necessity before deciding whether to do the procedure or not. In this situation, intraoperative cholangiography, correctly interpreted, showing the entire bile tree can enable us to continue with the procedure.

Finally, to continue with laparoscopy to the extent that the correct identification of the anatomical structures is achieved, this is the synthesis of dissection plus image in a rational time span.

Failure to progress dissection, whatever its cause, may be the determinant factor in adopting an alternative laparoscopic technique, such as subtotal cholecystectomy or cholecystostomy.

Conversion will be an alternative if the team has experience in open gallbladder surgery. Our consideration will be limited when such experience is exclusively, or almost, laparoscopic. Prior to the decision, the infrastructure conditions must be verified to see if they are in place to continue via laparotomy.

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